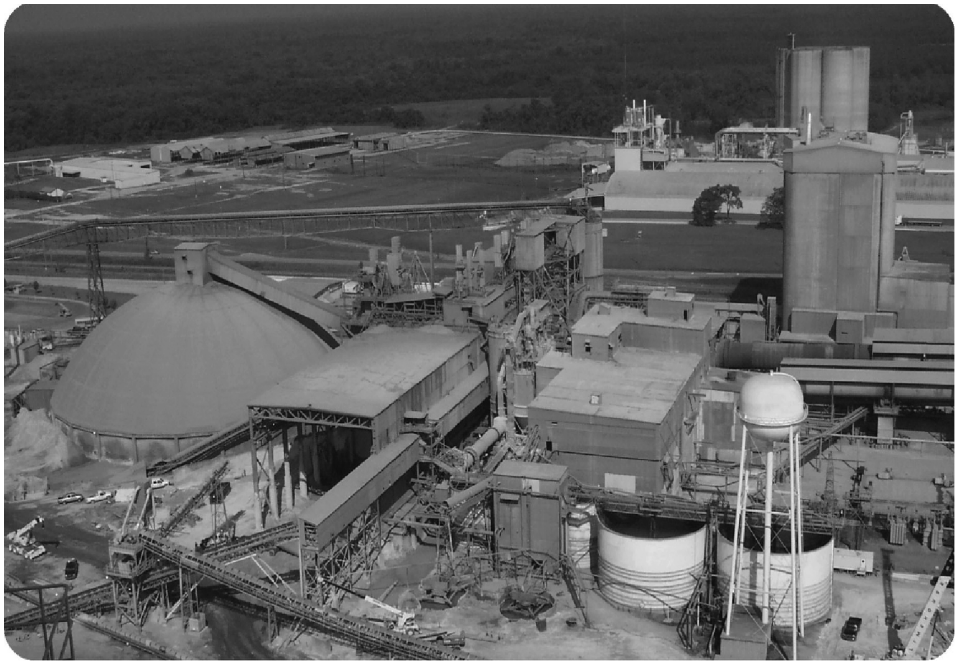
User Manual

Original Instructions

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

(Using PanelView 550)

Bulletin Number 7000A



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Rockwell Automation

Important User Information

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

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

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

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

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

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

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

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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

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

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

Overview

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Who Should Use This Manual

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

What Is Not in this Manual

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

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

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

Three User Manuals address this product line:

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

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

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

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

Reference Manuals (for "A", "B" and "C" Frame drives) are also available. These manuals provide additional technical information

about the drive components. Contact your local Rockwell Automation Sales office to order copies of these publications.

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

Manual Conventions

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

WARNING

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

ATTENTION

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

Both of the above could indicate:

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

SHOCK HAZARD

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

General Precautions

ATTENTION

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

ATTENTION

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

ATTENTION

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

Who to Call for Commissioning

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

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

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

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

Notes:

Overview of Drive

Introduction

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

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

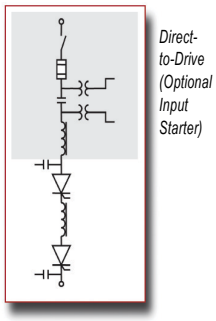
The PowerFlex 7000 is a global product that adheres to the most common standards from NEC, IEC, NEMA, UL, and CSA. It is available with the world's most common supply voltages at medium voltage, from 2400-6600 volts.

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

Drive Configurations – PowerFlex 7000 “A” Frame

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

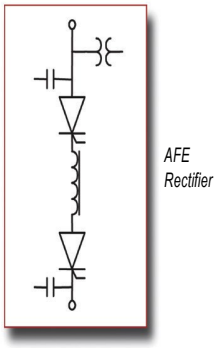
- Elimination of isolation transformer results in reduced losses and saved space
- An integrated system solution for fewer connections and reduced installation costs
- New or existing motors
- Small system footprint
- 3 cables in/3 cables out on entire system for easy installation
- Low line harmonics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



Direct-to-Drive (Optional Input Starter)

Configuration #2
AFE Rectifier
(Separate isolation transformer)

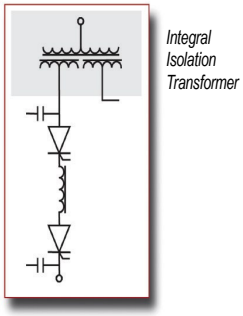
- Optimum installation flexibility with connection to indoor or outdoor isolation transformers
- Compact packaging for smallest footprint requirements
- New or existing motors
- 3 cables in/3 cables out for easy installation
- Low line harmonics and high power factor (typical current THD < 5%, PF > 0.98)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



AFE Rectifier

Configuration #3
AFE Rectifier
(Integral isolation transformer)

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



Integral Isolation Transformer

Topology

The PowerFlex 7000 utilizes a Pulse Width Modulated (PWM) – Current Source Inverter (CSI) for the machine side converter as shown in Figure 1.1. This topology offers a simple, reliable, cost-effective power structure that is easy to apply to a wide voltage and power range. The power semiconductor switches used are easy-to-series for any medium voltage level. Semi-conductor fuses are not required for the power structure due to the current limiting DC link inductor.

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

The PowerFlex 7000 has the additional benefit of inherent regenerative braking for applications where the load is overhauling the motor, or where high inertia loads need to be slowed down quickly. Symmetrical Gate Commutated Thyristors (SGCTs) are used for machine converter switches and line converter switches.

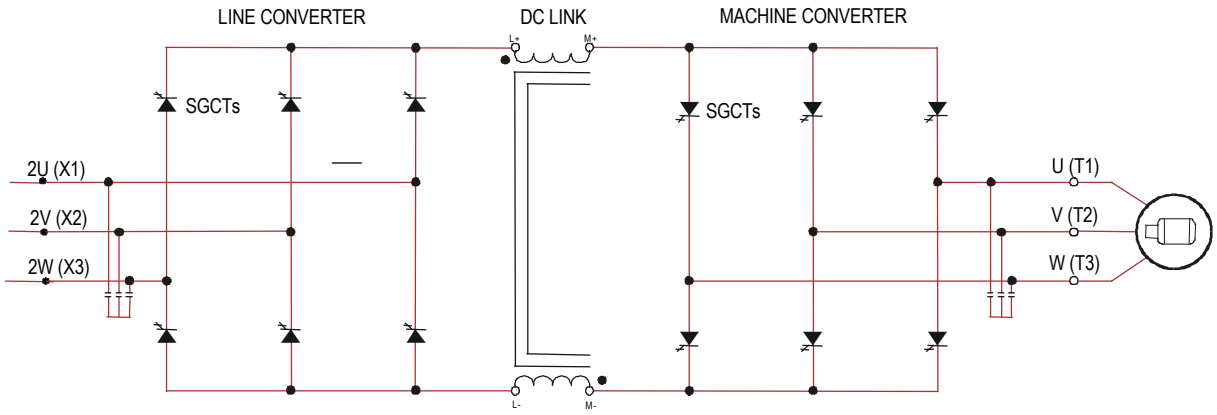


Figure 1.1 – PWM-CSI AC Drive

Rectifier Designs

Active Front-End (AFE) Rectifier

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

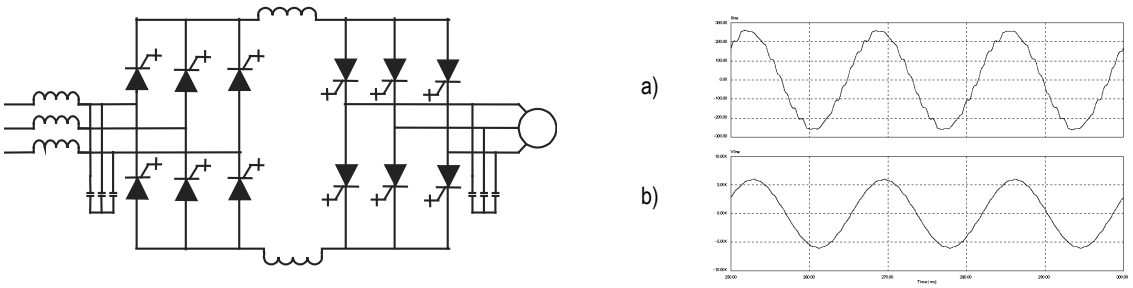
Many competing technologies in today's MV market require a multi-winding transformer to mitigate the unwanted harmonics through cancellation by phase shifting the transformer secondary windings. Depending on the topology, the transformer can have up to 15 sets of secondary windings.

Elimination of the isolation transformer reduces capital and installation costs, saves on valuable floor space, reduces operating costs and increases overall system efficiency.

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

The filter resonant frequency is placed below 300 Hz (for a 60 Hz system) where no residual harmonics exist. This prevents the excitation of system harmonic frequencies. Other factors that are considered when designing the filter are the input power factor and the requirement on Total Harmonic Distortion (THD) of input current and voltage waveforms.

The small integral AC line reactor (see Fig. 1.2) provides additional filtering and current limiting features to a line side short circuit fault. The line current and voltage waveforms are also shown in Figure 1.2. The line current THD is approximately 4.5%, while line-to-line voltage THD is approximately 1.5%. (THD of line voltage is a function of system impedance.) Input power factor with the AFE rectifier is near unity throughout a typical operating speed range for variable torque loads.



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

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

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

Isolation transformers are available:

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

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

"Direct-to-Drive" Technology

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

Motor Compatibility

The PowerFlex 7000 achieves near sinusoidal current and voltage waveforms to the motor, resulting in no significant additional heating or insulation stress. Temperature rise in the motor connected to the VFD is typically 3 °C (5.4 °F) higher compared to across-the-line operation. Voltage waveform has dv/dt of less than 10 volts per microsecond. Reflected wave and dv/dt issues often associated with VSI (voltage source inverter) drives do not exist with the PowerFlex 7000. Typical motor waveforms are shown in Figure 1.3. These motor friendly waveforms are achieved by utilizing a selective harmonic elimination (SHE) pattern in the inverter to eliminate major order harmonics, in conjunction with a small output capacitor (integral to the drive) to eliminate harmonics at higher speeds.

Standard motors are compatible without de-rating, even on retrofit applications.

Motor cable distance is virtually unlimited. This technology is capable of controlling motors up to 15 km (9.3 miles) away from the drive.

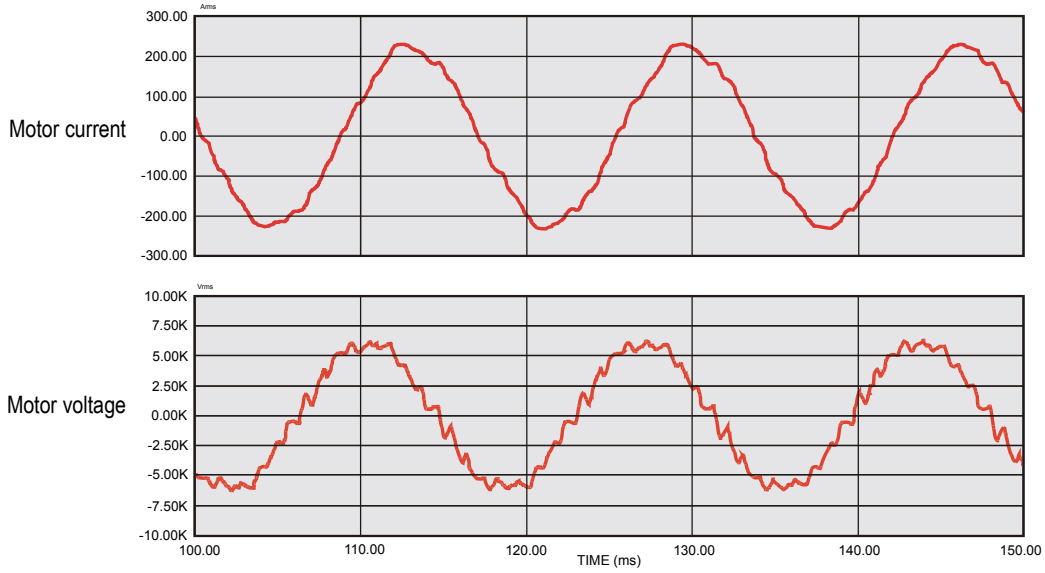
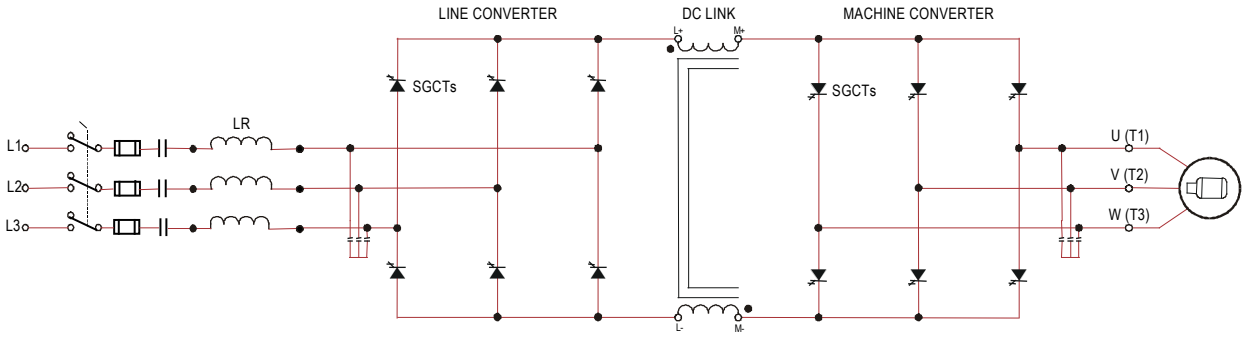
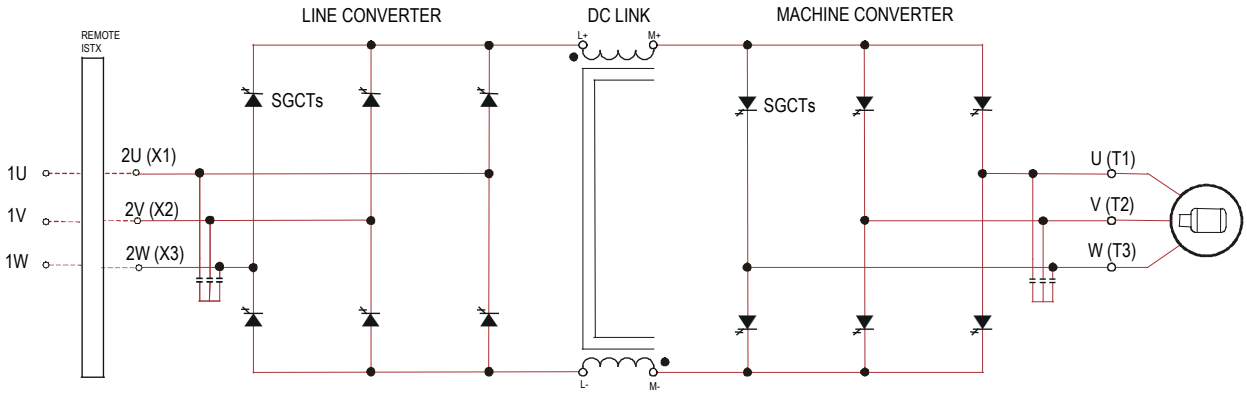


Figure 1.3 – Motor waveform @ full load, full speed

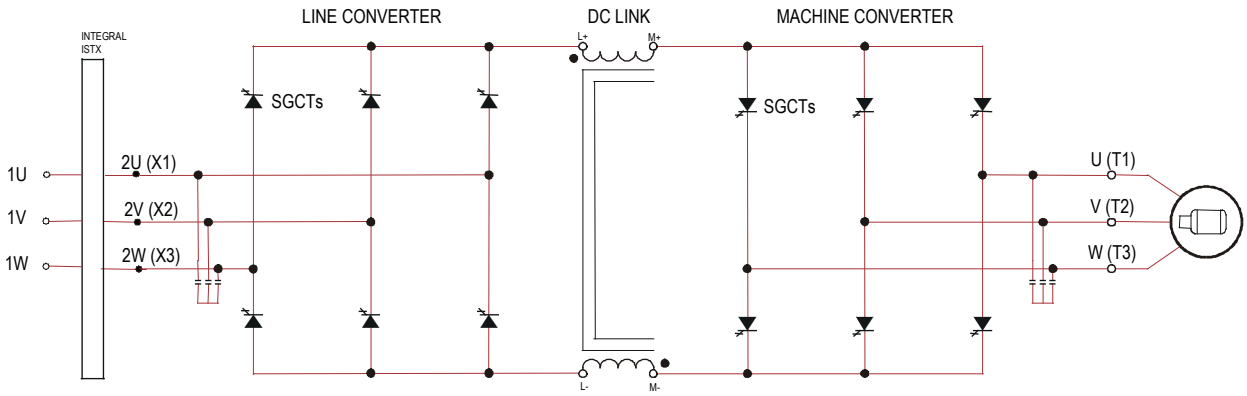
Simplified Electrical Drawings – 2400V with AFE Rectifier



2400 Volt – AFE Rectifier, Configuration #1 – Direct-to-Drive
(Configurations without Integral Input Starter are available)

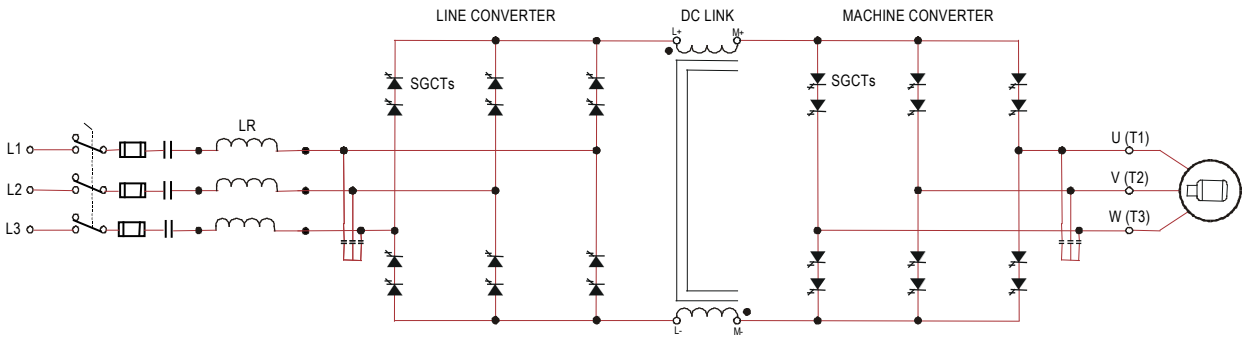


2400 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

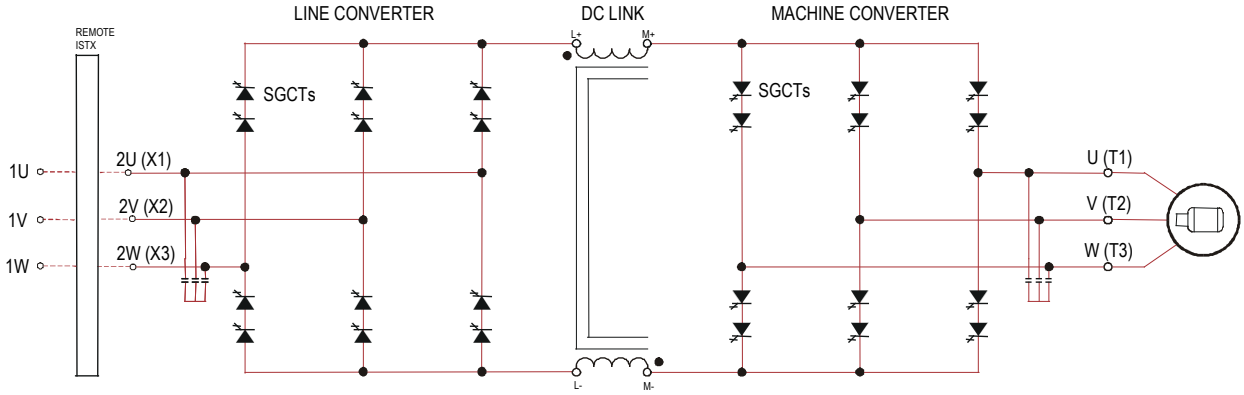


2400 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

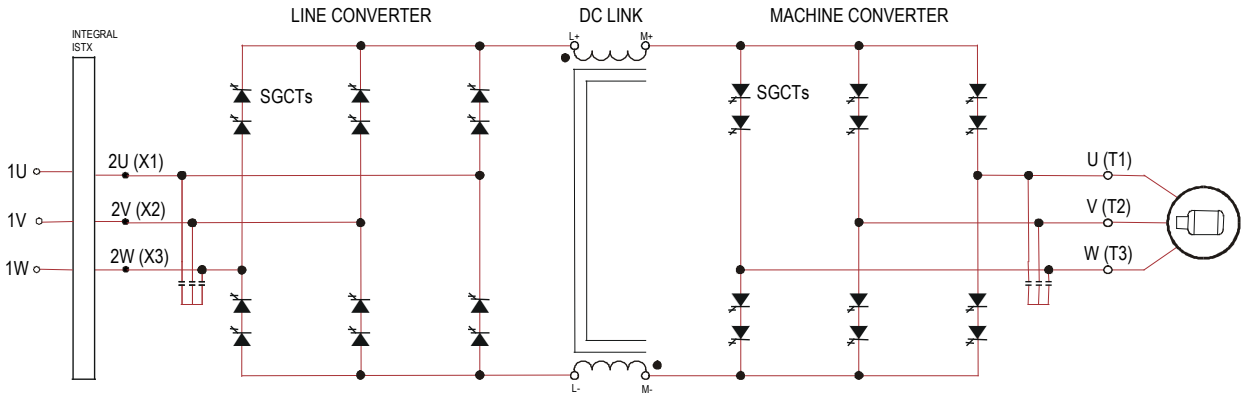
Simplified Electrical Drawings – 3300/4160V with AFE Rectifier



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

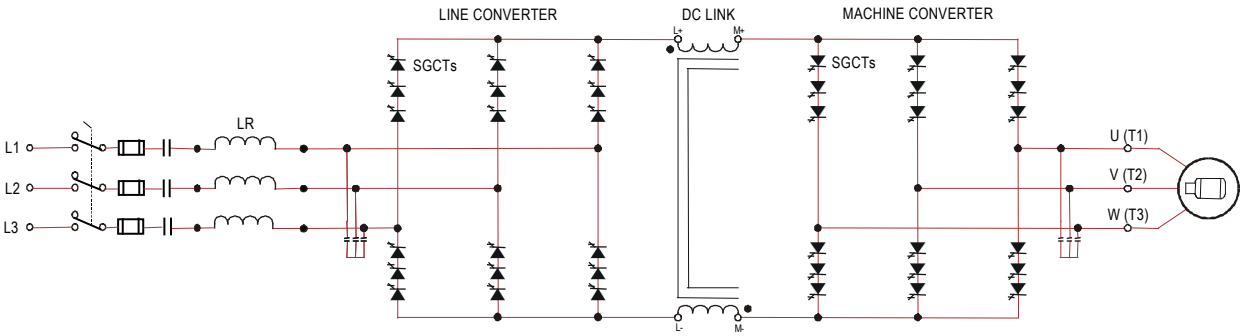


3300/4160 Volt – AFE Rectifier, Configuration #2 – Separate Isolation Transformer

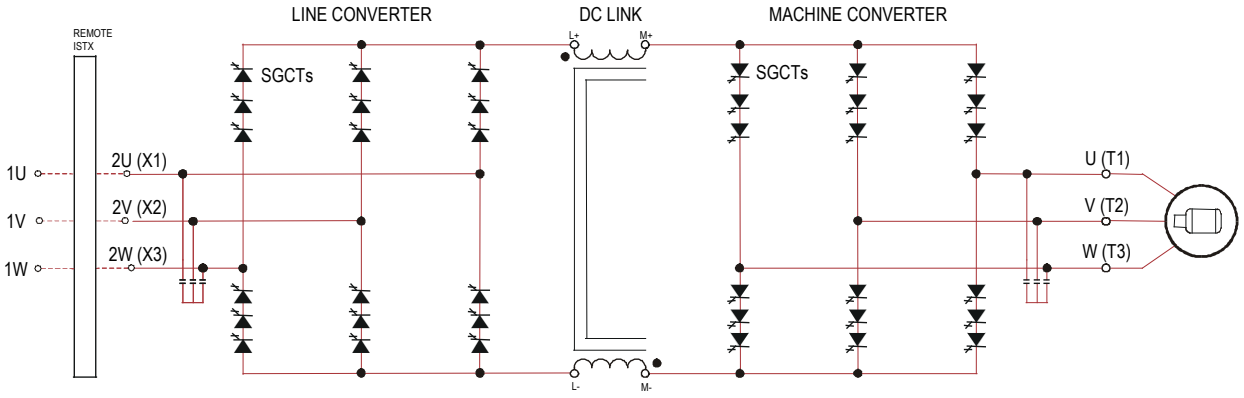


3300/4160 Volt – AFE Rectifier, Configuration #3 – Integral Isolation Transformer

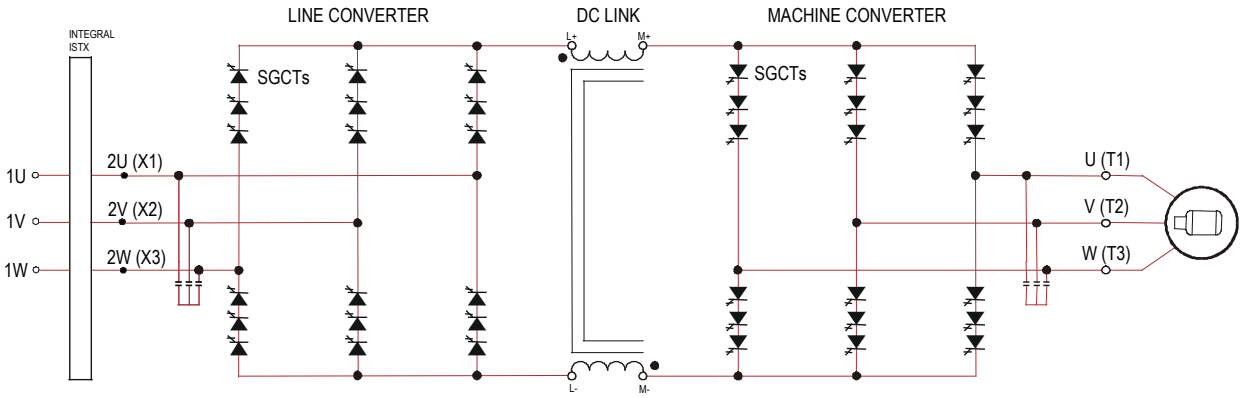
Simplified Electrical Drawings – 6600 V with AFE Rectifier



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



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



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

Operator Interface

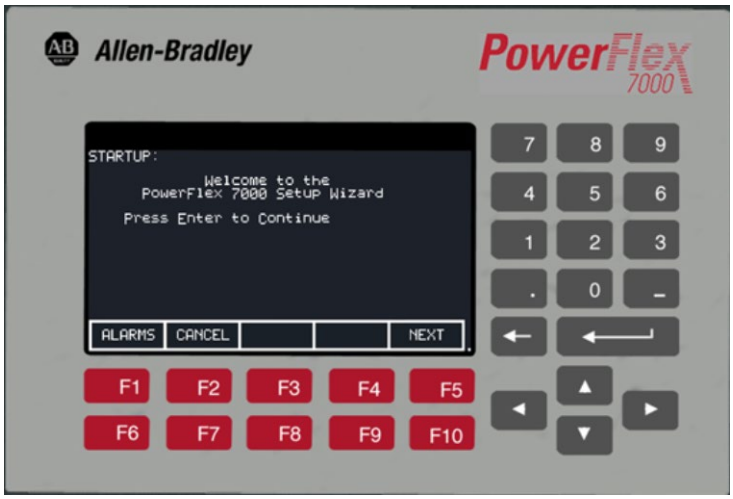


Figure 1.4 – PowerFlex 7000 Operator interface terminal

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

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

Drive Installation

Safety and Codes

WARNING

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

General Handling Procedures

Refer to "General Handling Procedures for PowerFlex 7000 Medium Voltage Drives", publication no. 7000-IN002 supplied in the drive shipment (affixed to the drive). Additional copies can be ordered through your local Rockwell Automation Sales office.

Drive Storage

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

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

Siting of the Drive

Site Considerations

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

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

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

The equipment requires the following site conditions:

(A) Indoor installation only, no dripping water or other fluids

(B) Clean air for cooling requirements

(C) Level floor for anchoring the equipment. Refer to dimension drawings for the location of the anchoring points.

(D) The room in which the equipment is located must allow for full opening of the doors of the equipment, typically 1200 mm (48 inches). Also, allowances have to be made for clearance for fan removal. This fan allowance must be greater than 700 mm (27.5 inches) above the drive.

or

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

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

(F) The room in which the equipment is located must be large enough to accommodate the thermal losses of the equipment since air conditioning may be required; the ambient temperature must not exceed that for which the equipment is rated. The heat created by the drive is directly proportional to the power of the motor being driven and the efficiency of equipment within the room. If thermal load data is required contact the Rockwell Automation Sales office.

(G) The area in which the drive is located should be free of radio frequency interference such as encountered with some welding units. This may cause erroneous fault conditions and shut down the drive.

(H) The equipment must be kept clean. Dust in the equipment decreases system reliability and inhibits cooling.

(I) Power cable lengths to the motor are virtually unlimited due to the near sinusoidal voltage and current waveforms. Unlike voltage source drives, there are no capacitive coupling, dv/dt, or peak voltage issues that can damage the motor insulation system. The topology utilized in the PowerFlex 7000 medium voltage AC drive does not produce dv/dt or peak voltage problems, and has been tested with motors located up to 15 kilometers from the drive.

(J) Only personnel familiar with the function of the drive should have access to the equipment.

(K) The drive is designed for front access and should be installed with adequate and safe clearance to allow for total door opening. The back of the unit may be placed against a wall although some customers prefer back access also.

ATTENTION

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

Generator Note:

ATTENTION

Verify that the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

Installation

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

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

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

Install and tighten the anchor bolts. (M12 or ½" hardware required). Engineering bolt systems are required for seismic requirements. Consult factory.

Remove the top lifting angles, retain the hardware.

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

Installation of Exhaust Air Hood

On the top of the cabinet with the cooling fan, a sheet metal exhaust hood is to be installed. The components to make up the exhaust hood have been packaged and shipped with the drive. (For drives with an acoustic hood, the components are shipped assembled. See Figure 2.2)

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

Secondly, loosely assemble the two L-shaped panel components shipped with the drive as per Figure 2.1.

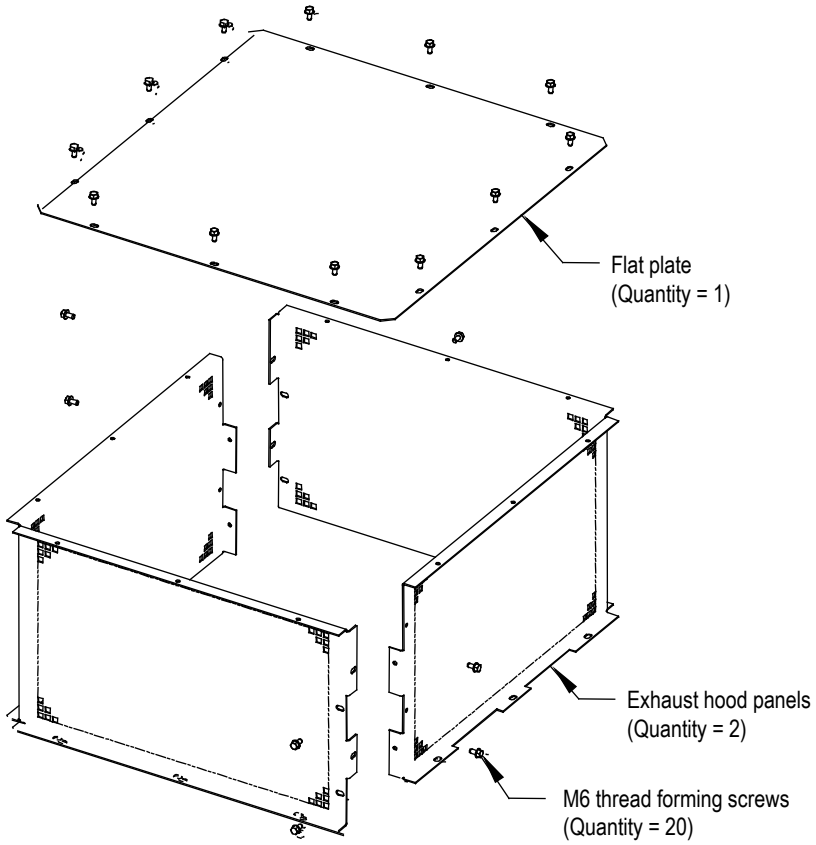


Figure 2.1 – Fan Hood Assembly

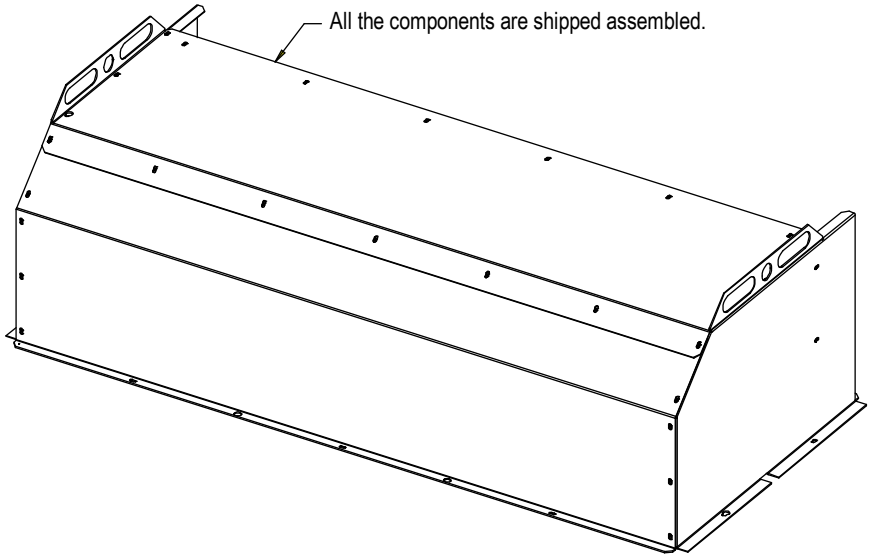


Figure 2.2 – Acoustic Fan Hood Assembly

Installation (cont.)

Locate the exhaust hood on top of the cabinet per Figure 2.3 and re-install the original cover plate previously set aside. (Care must be taken that the notches on the bottom flange are oriented toward the sides of the drive). Affix assembly to the drive top plate. Tighten all hardware.

For drives with an acoustic hood (shown in Figure 2.2), locate the exhaust hood (refer to Figure 2.4).

ATTENTION

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

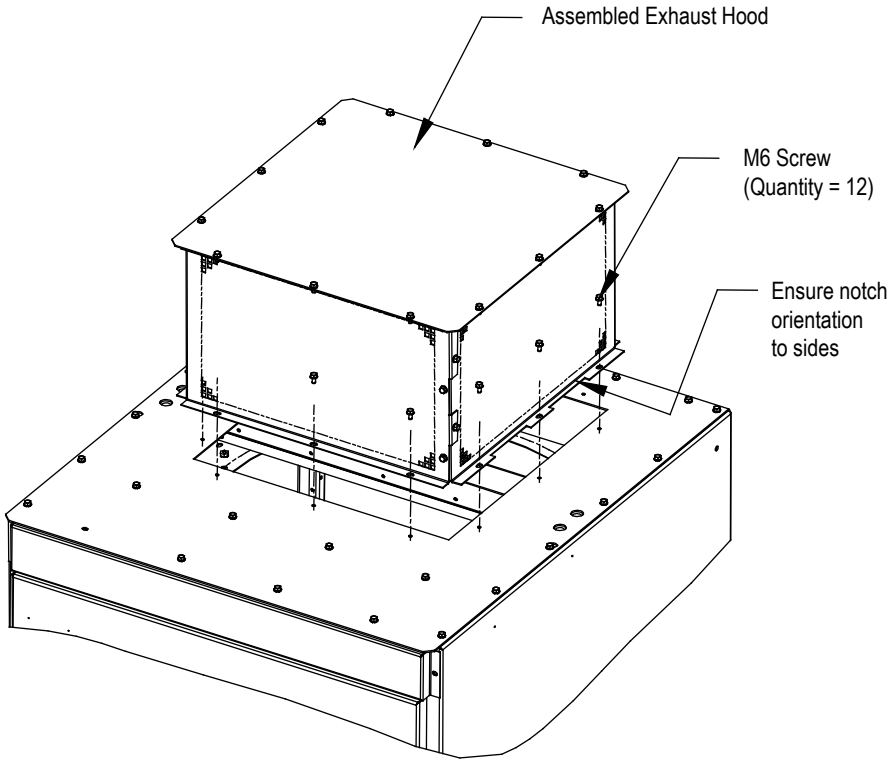


Figure 2.3 – Fan Hood Installation

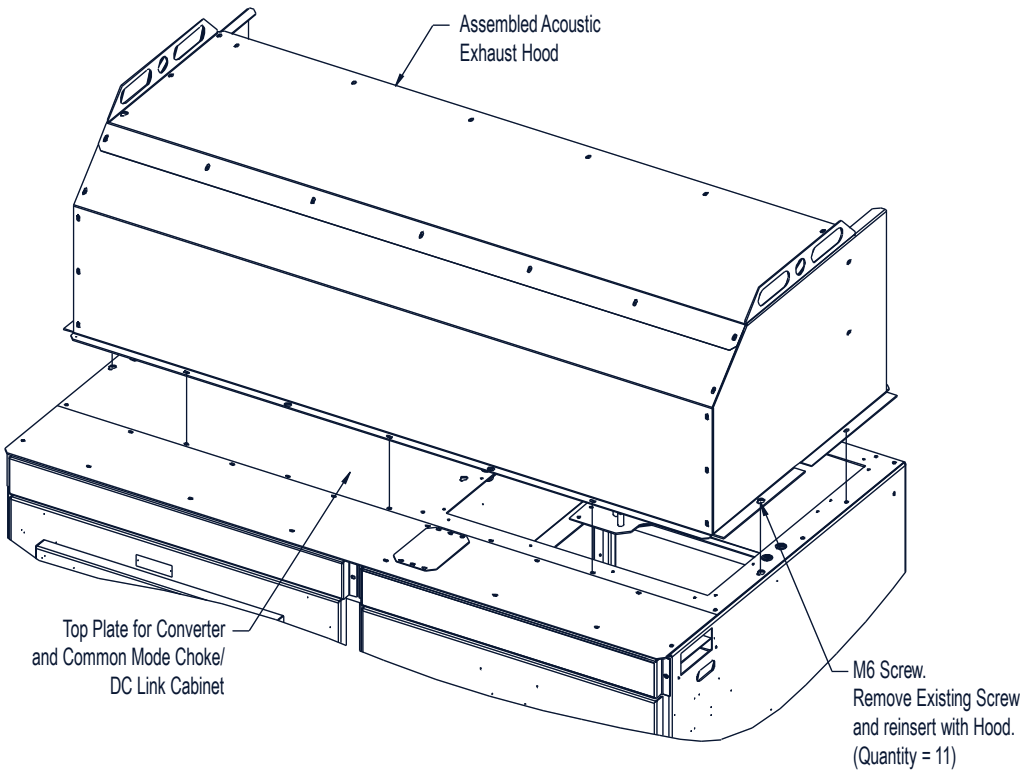


Figure 2.4 – Acoustic Fan Hood Installation

Installation (cont.)

Installation of Integral Transformer Cooling Fan

1. Remove the protective plate covering the fan opening on the top of Isolation Transformer cabinet and discard.

2. Locate the cooling fan on top of the cabinet. Position it over the opening and align the mounting holes and wire harness connections.

3. Affix the fan to the drive top plate with the M6 thread forming screws provided.

4. Connect the fan wire harness to fan.

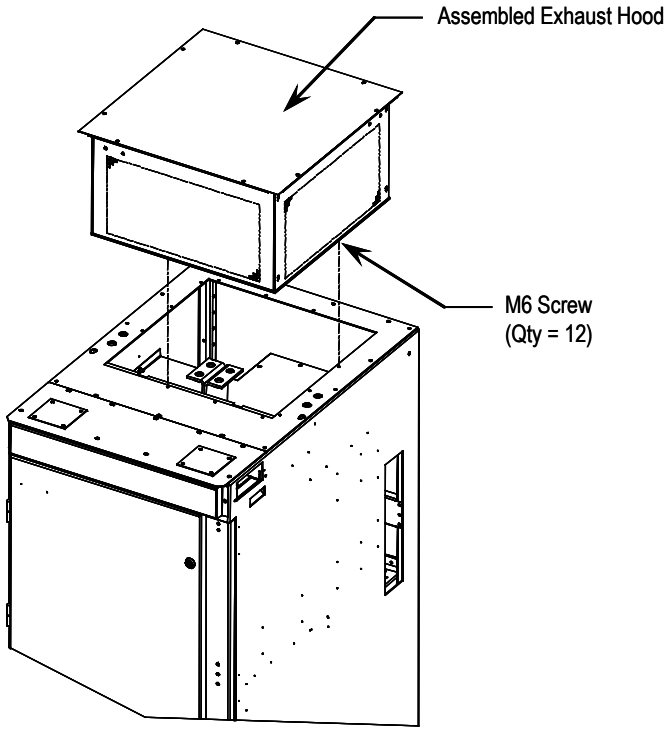


Figure 2.5 – Fan Installation for Integral Isolation Transformer

Neutral Resistor Assembly

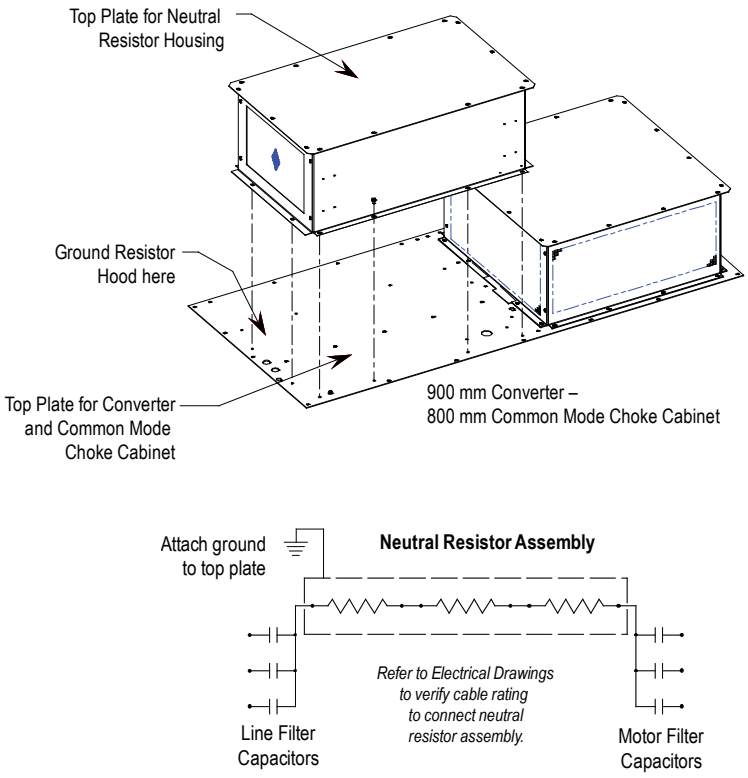


Figure 2.6 – Hood Assembly for Neutral Resistor

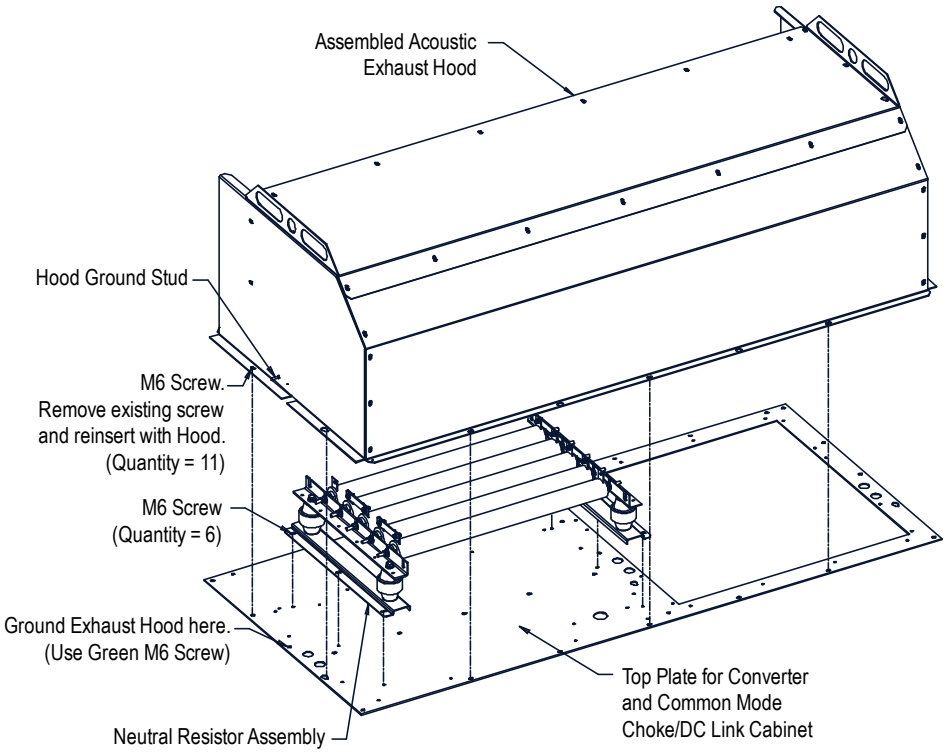


Figure 2.7 – Acoustic Hood Assembly for Neutral Resistor

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

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

1. Locate the resistor assembly on top of the cabinet as shown in Figure 2.6. (For acoustic hood assembly, refer to Figure 2.7.)
2. Affix the assembly to the top plate using M6 thread forming screws provided.
3. Remove the top plate of the resistor assembly to permit access to the wiring connection points.
4. Connect the resistor wiring and per the electrical diagram provided with the drive, a typical connection diagram is shown in Figure 2.6. Ensure that the resistor wiring is routed through the hole having a plastic bushing to protect the wire insulation. The neutral resistor assembly housing has a ground connection that is to be connected to the top plate of the drive.
5. Re-install the top plate of the neutral resistor housing.

Cabinet Layout and Dimensional Drawings of Drive

The following dimension drawing is a sample and may not accurately detail your drive. It is provided here to give you a general overview of a typical drive.

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

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

The **FLOOR PLAN** shows:

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

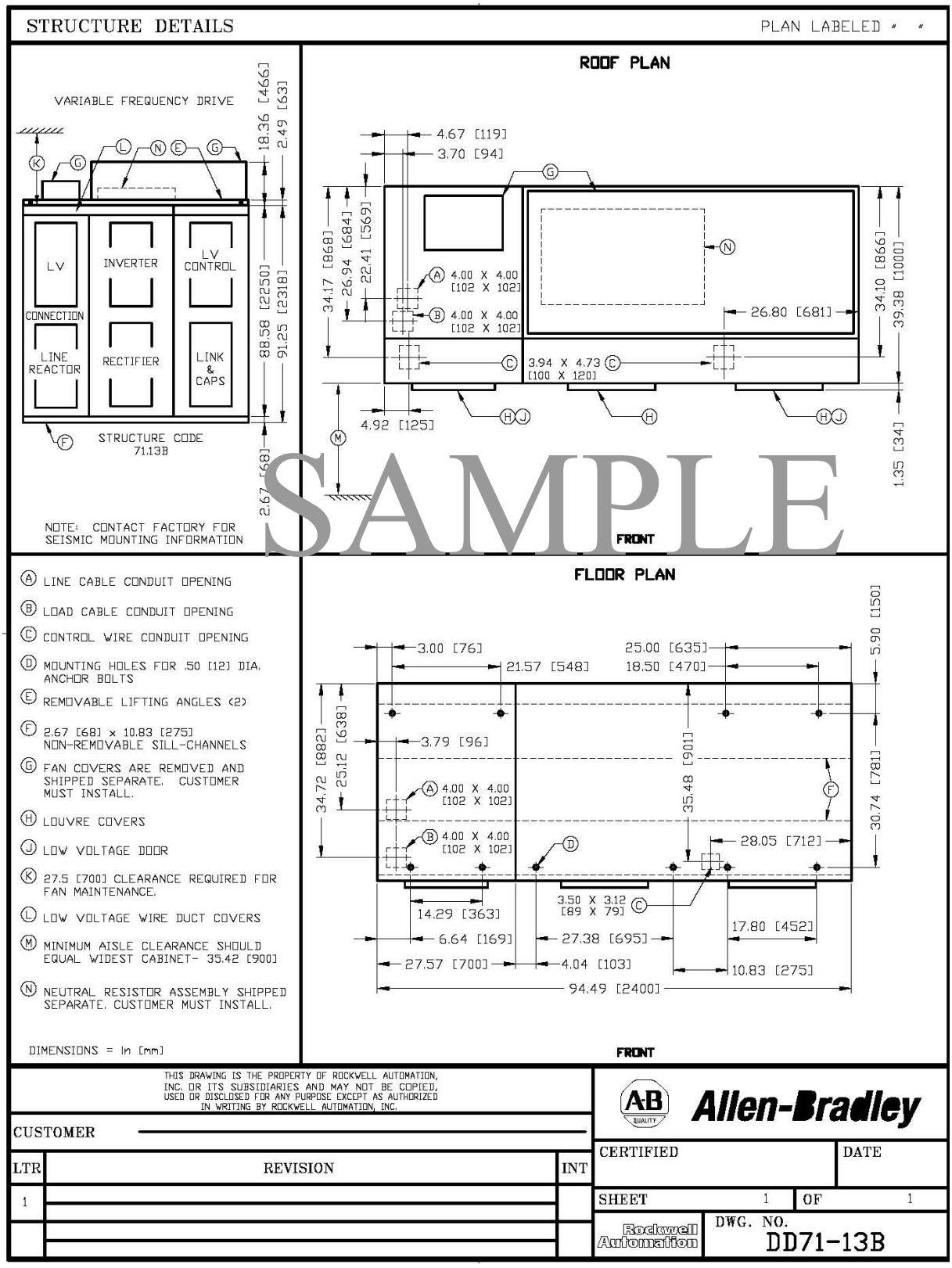
The **ROOF PLAN** shows:

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

The **Front View** shows:

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

PowerFlex 7000 “A” Frame Dimensional Drawing



Note: Contact Factory for Seismic Mounting Information.

Drive Layout

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

Configuration #1

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

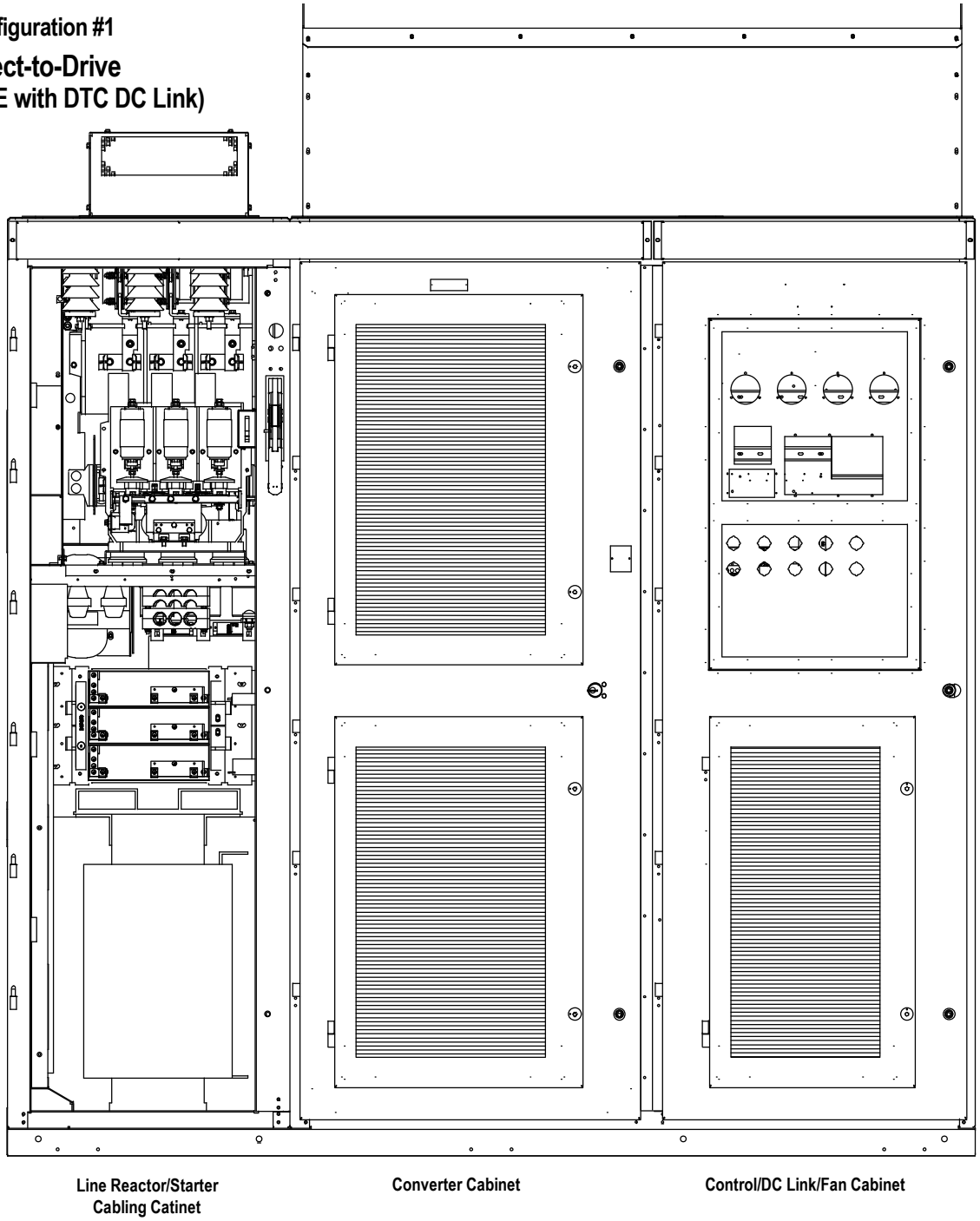


Figure 2.8 – Direct-to-Drive (AFE with DTD DC Link)

Configuration #2

AFE Rectifier
(Separate Isolation Transformer)

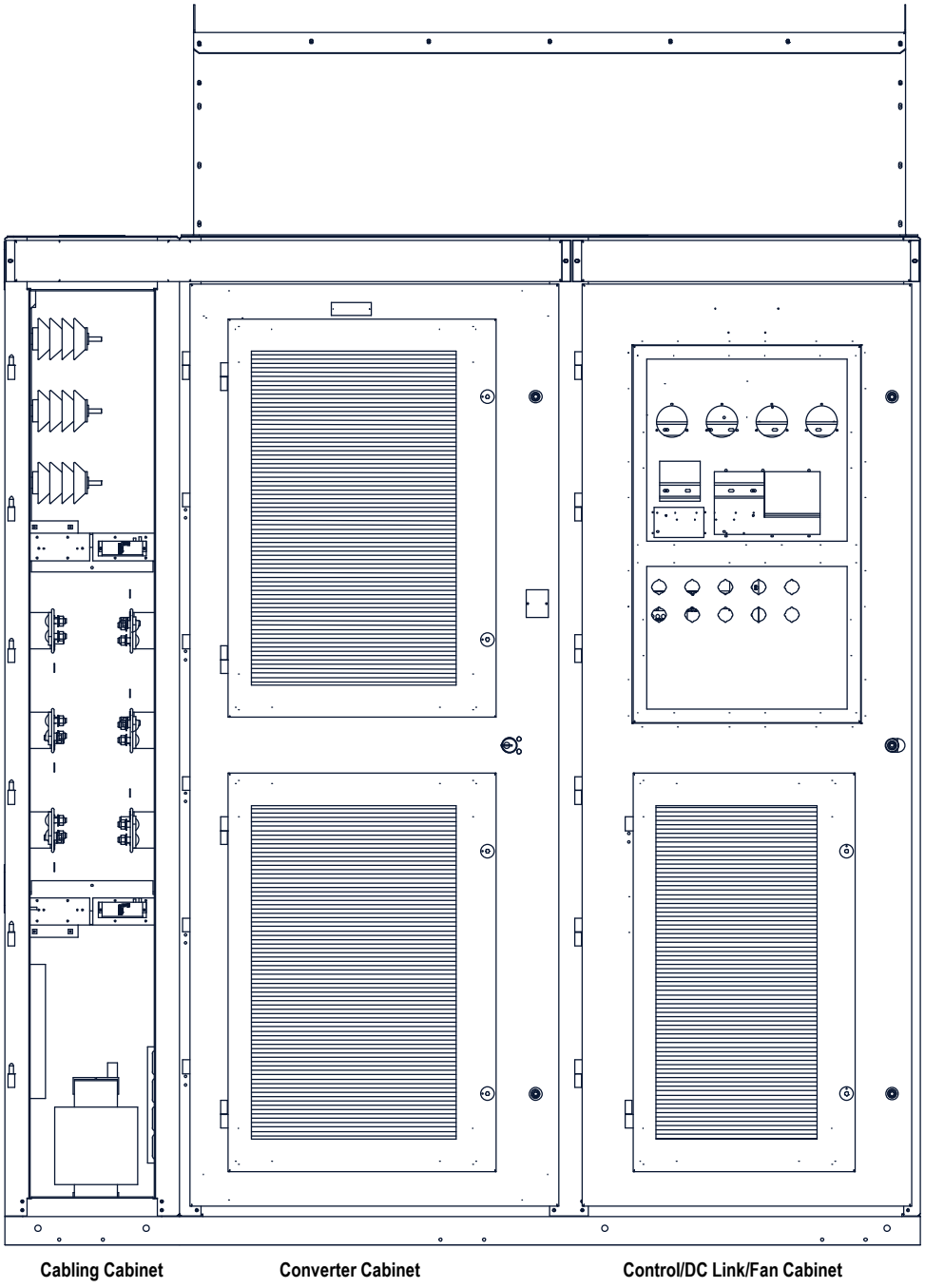


Figure 2.9 – AFE Rectifier (Separate Isolation Transformer)

Configuration #3

AFE Rectifier
(Integral Isolation Transformer)

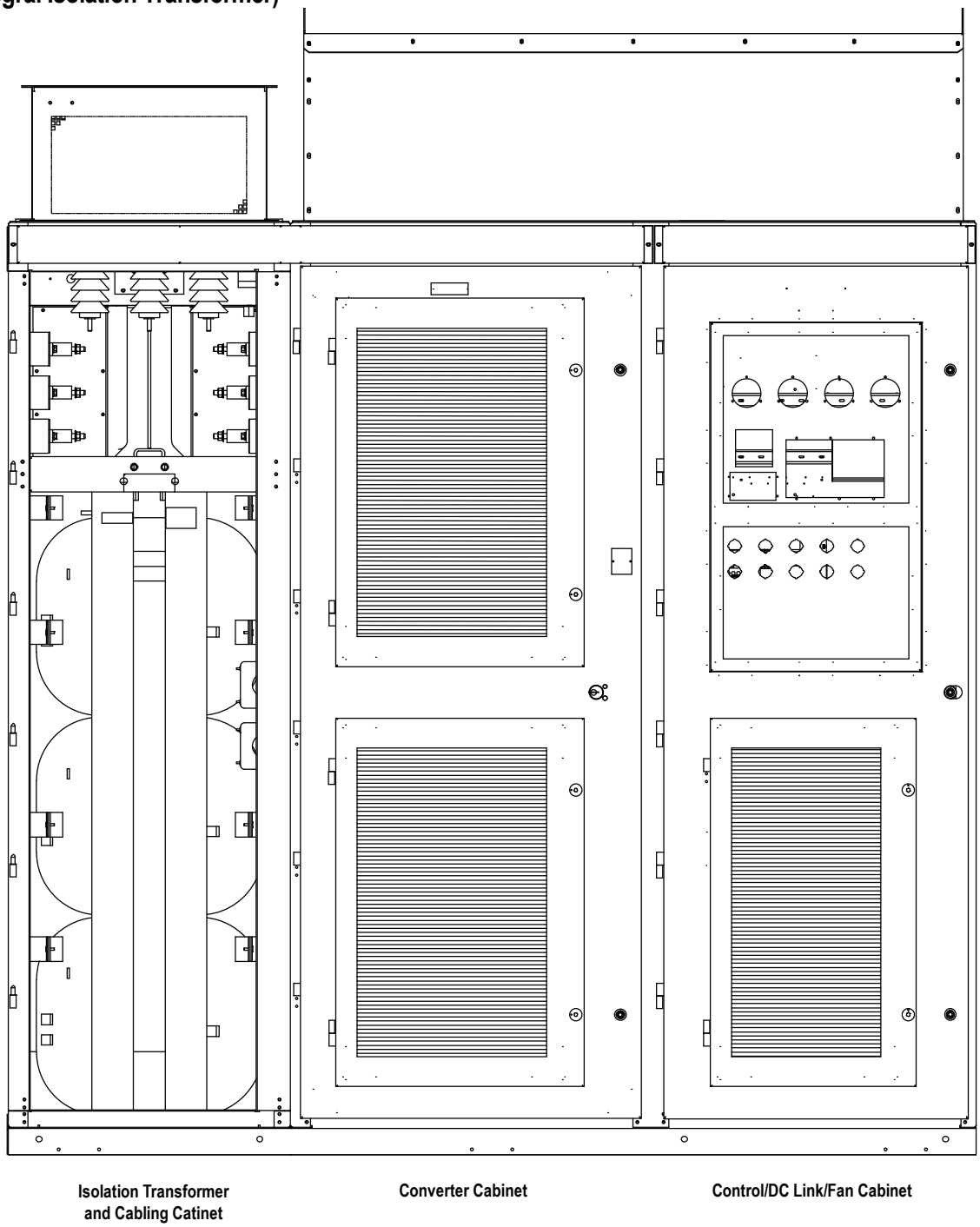


Figure 2.10 – AFE Rectifier (Integral Isolation Transformer)

Cabling Cabinet #1

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

Note: This cabinet is also available *without* integral starter (see Figure 2.13). The width of the cabinet changes as a function of the drive voltage ratings.

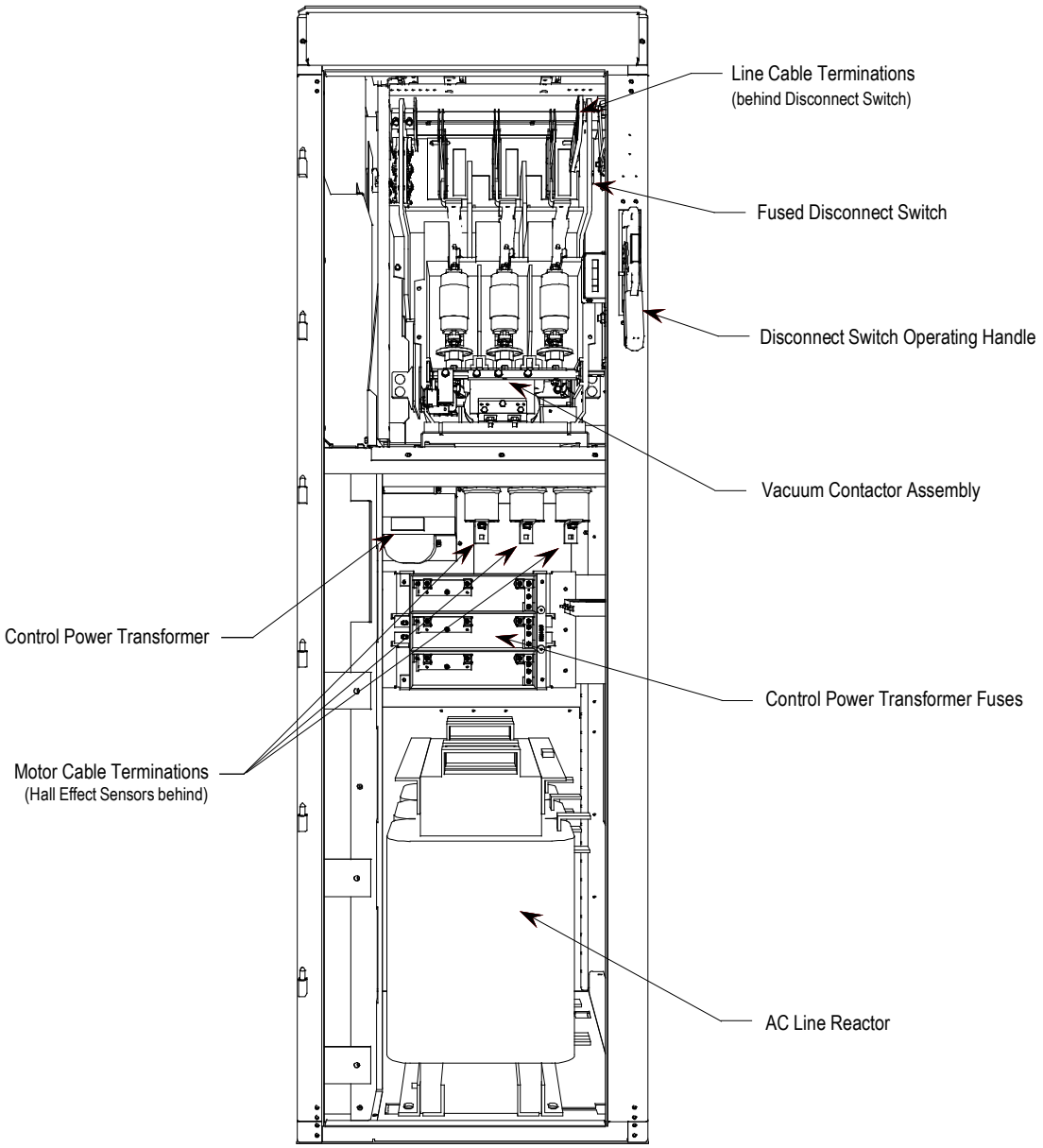


Figure 2.11 – Cabling Cabinet for Configuration #1 *with* Input Starters

Cabling Cabinet #1

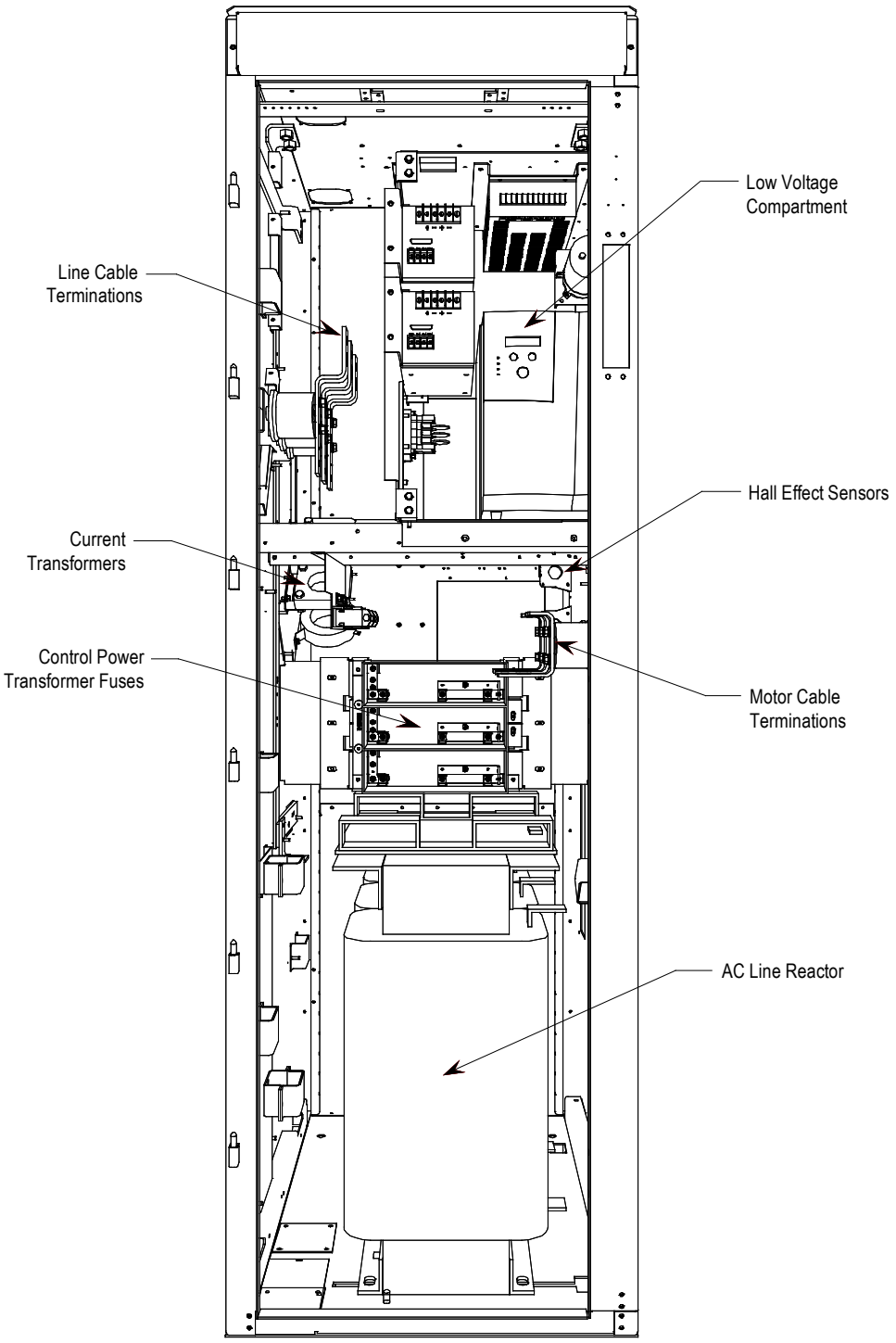


Figure 2.12 – Cabling Cabinet for Configuration #1 *without* Input Starters

Cabling Cabinet #2

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

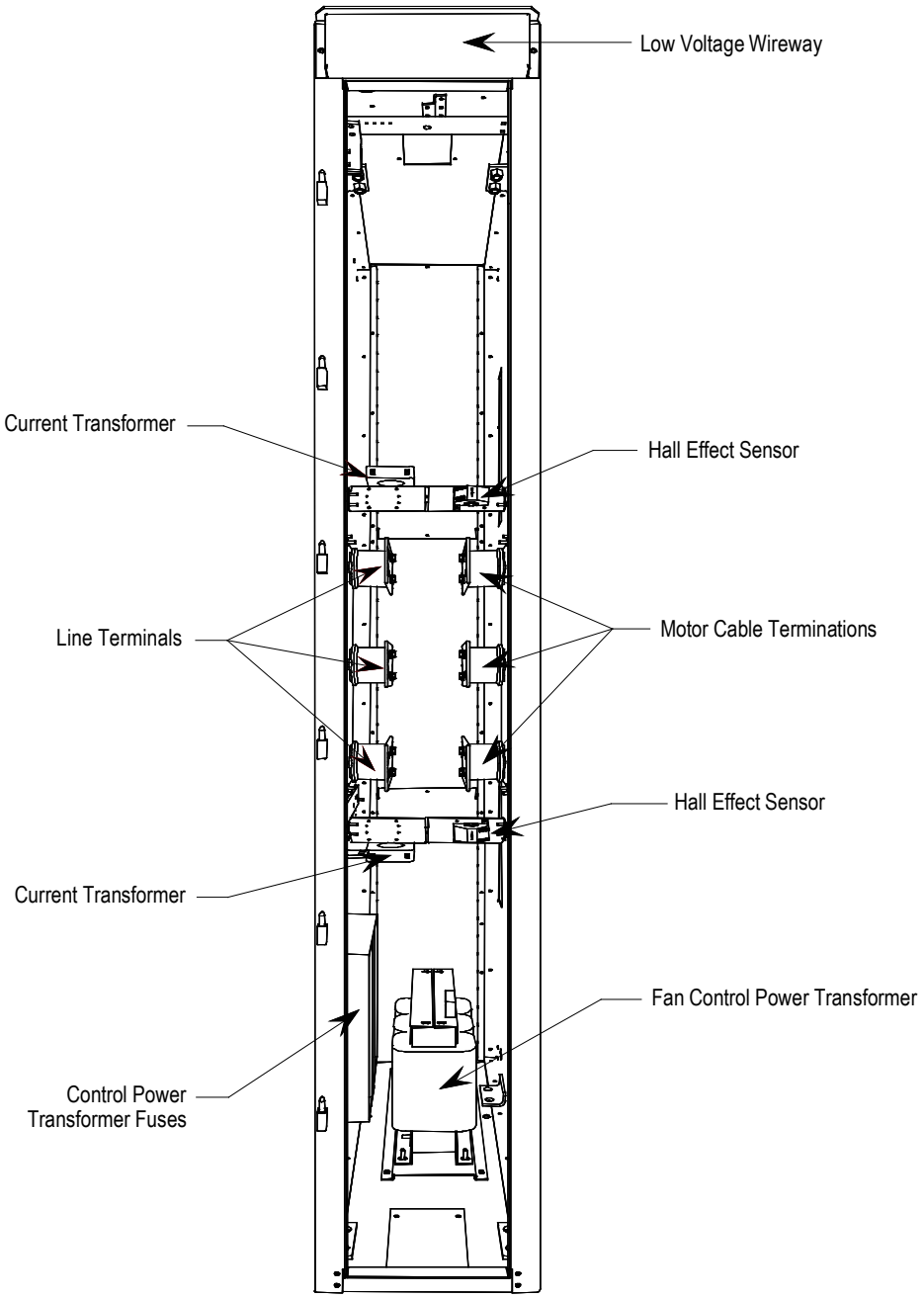


Figure 2.13 – Cabling Cabinet for Configuration #2

Cabling Cabinet #3

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

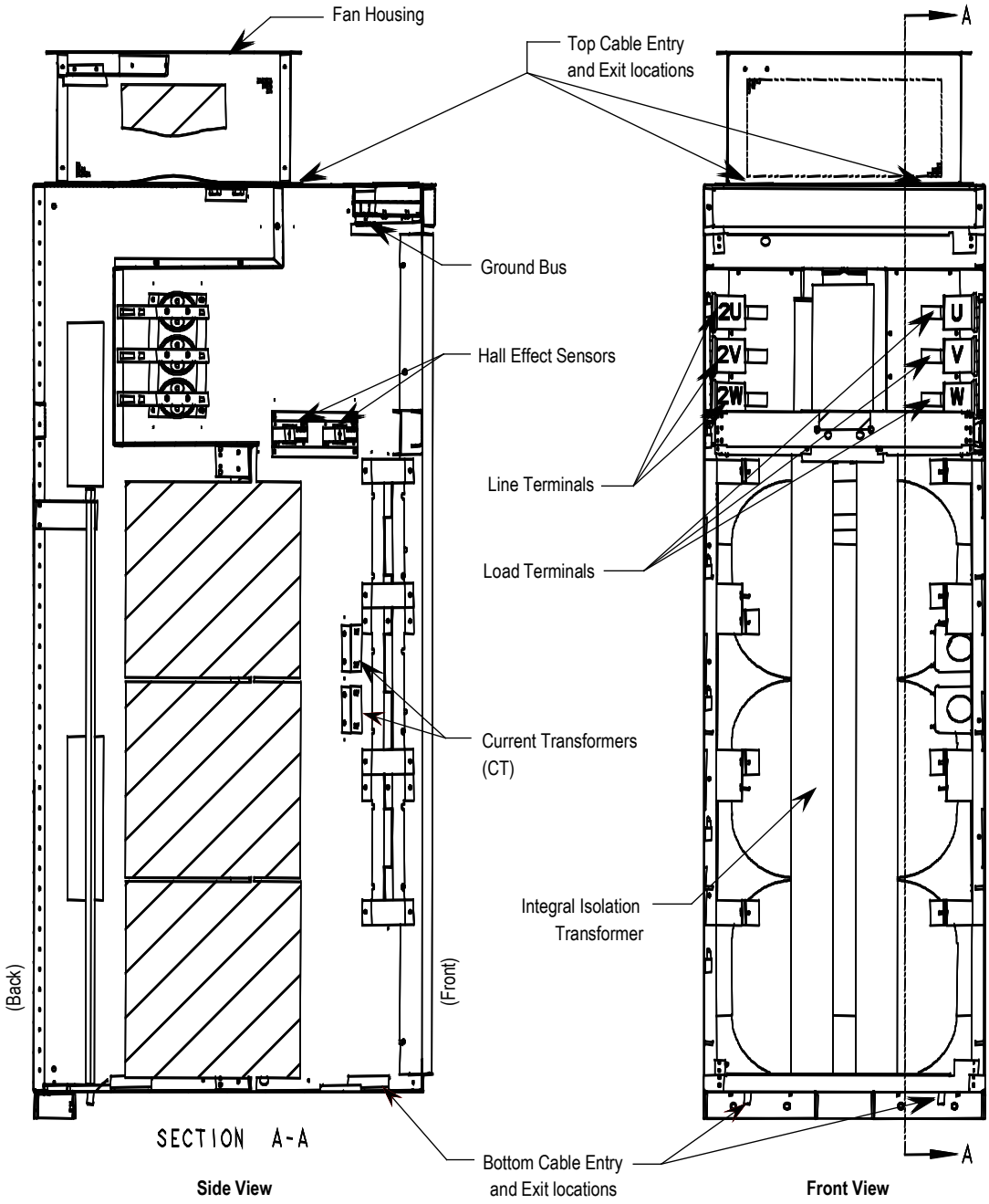


Figure 2.14 – Cabling Cabinet for Configuration #3

Converter Cabinet

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

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

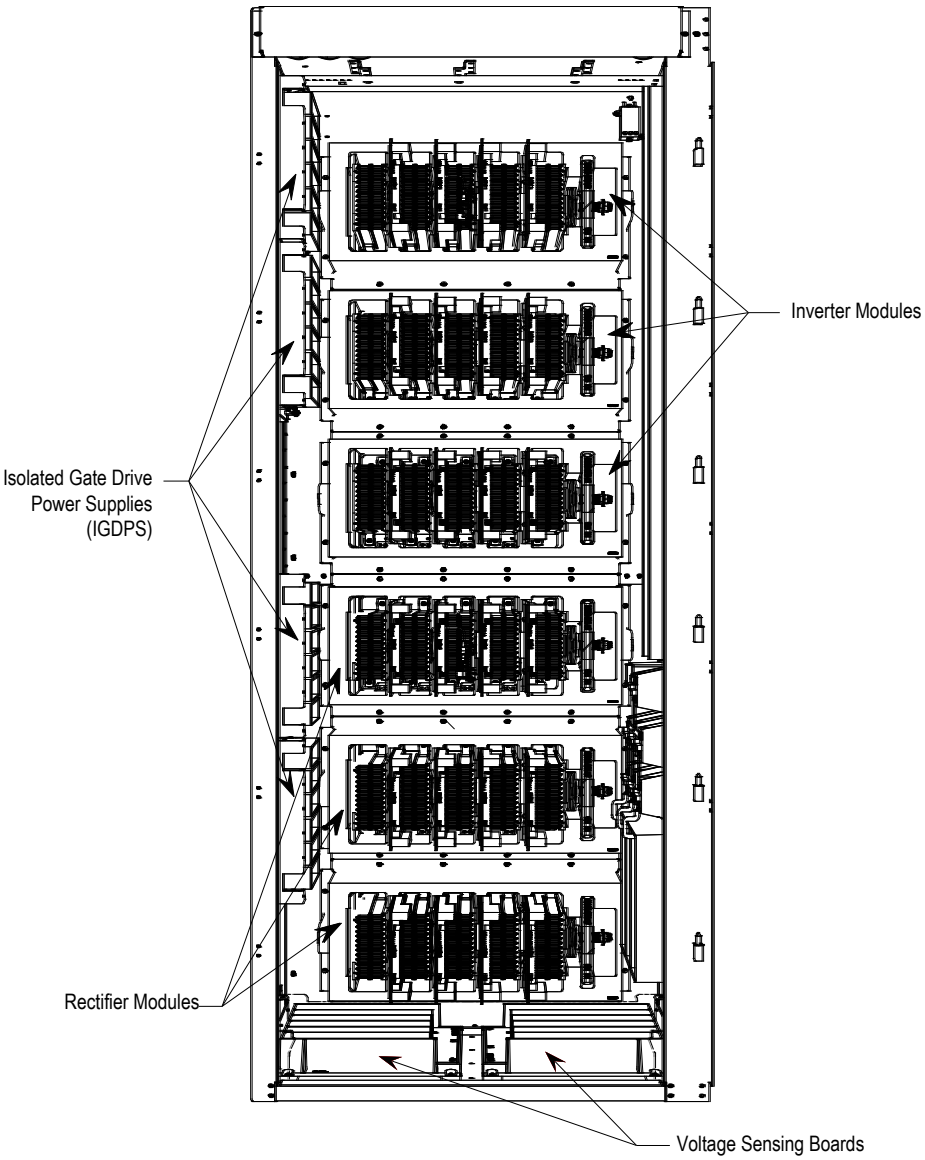


Figure 2.15 – Major Components of the Converter Cabinet (3300/4160V version shown)

Control / DC Link / Fan Cabinet

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

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

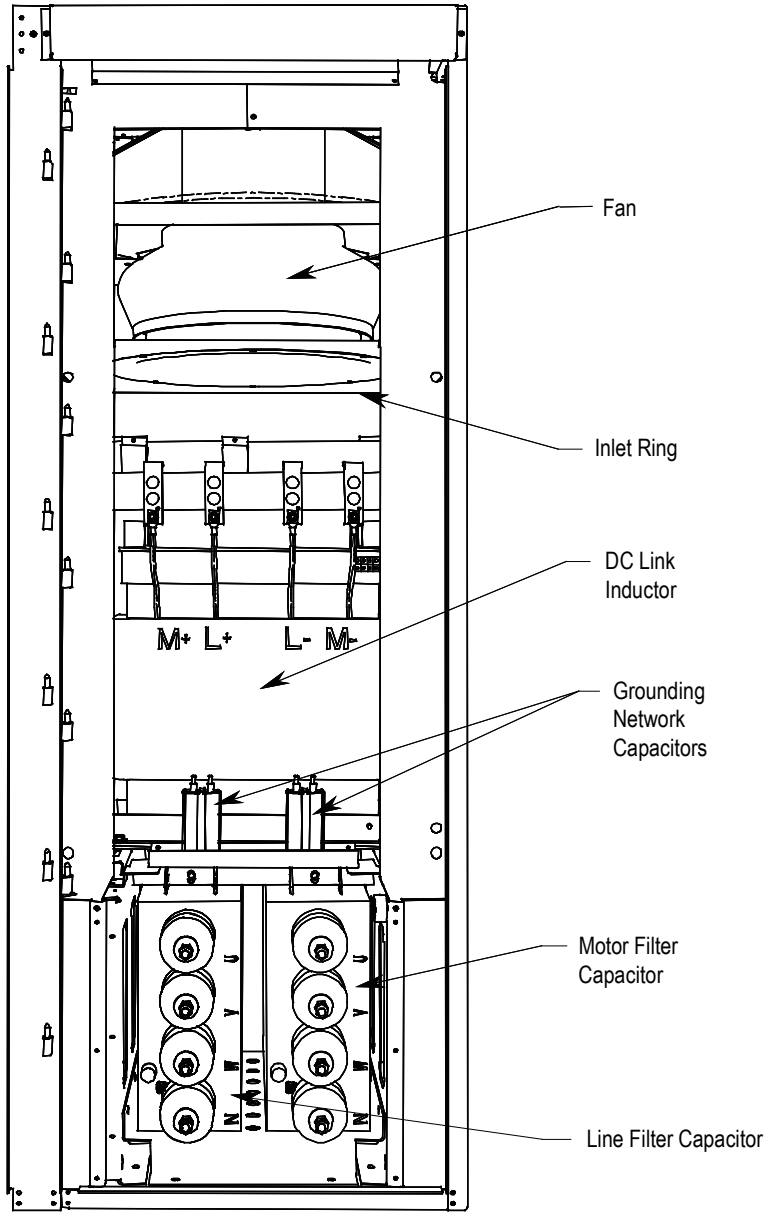


Figure 2.16 – Major Components of Control / DC Link / Fan Cabinet (with low voltage control tub removed)

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

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

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

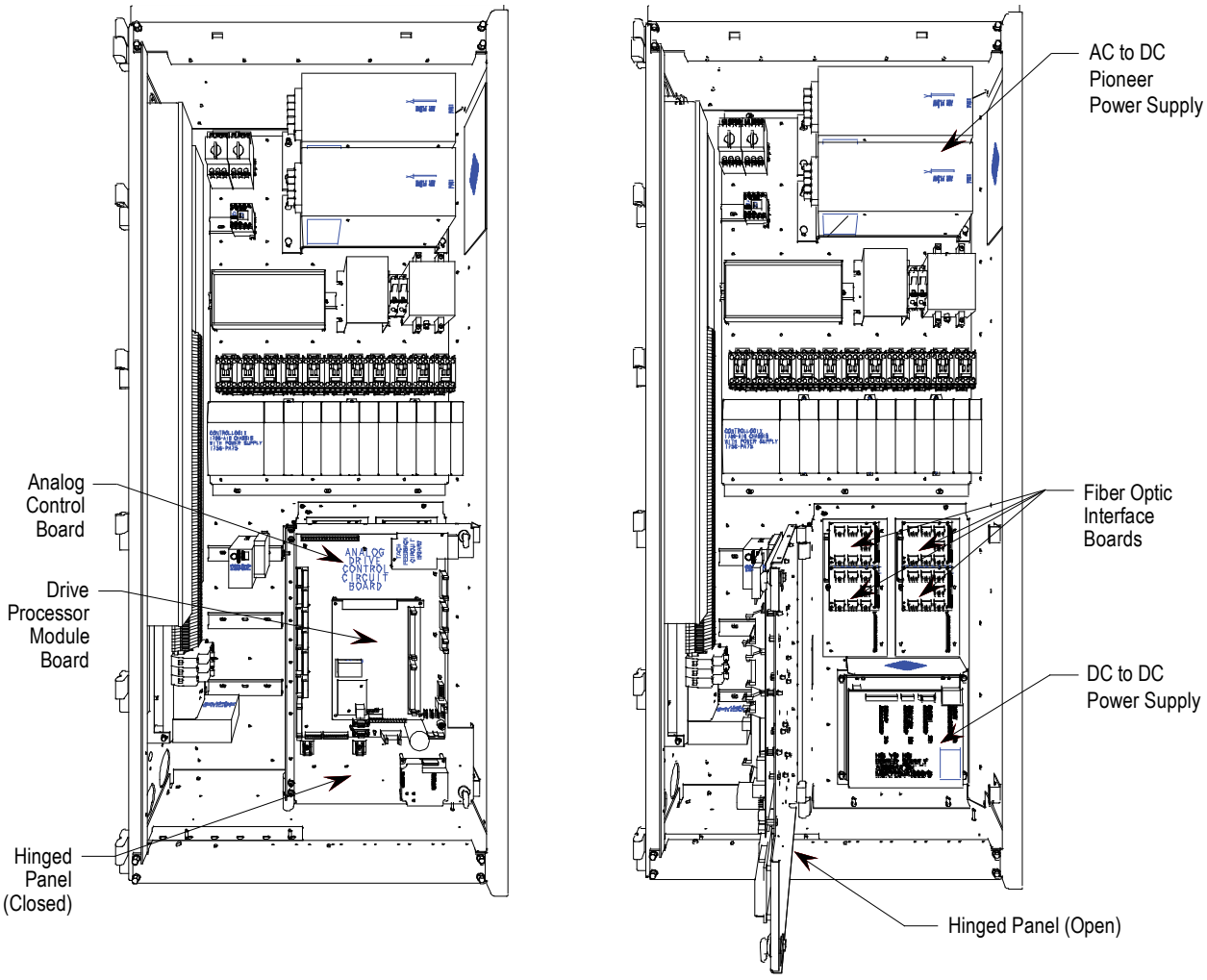


Figure 2.17 – Location of Low Voltage Control Tub (Pioneer Power Supply)

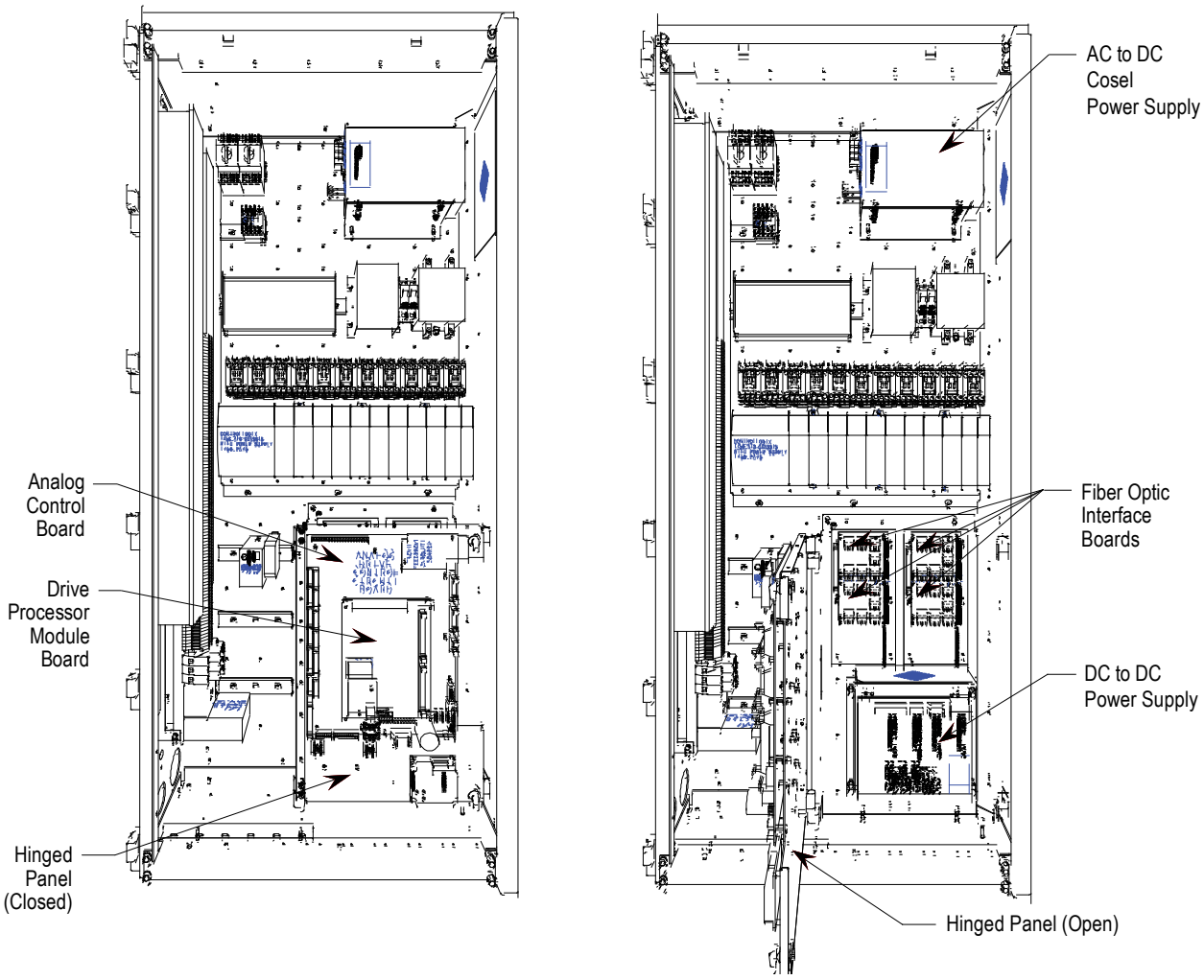


Figure 2.18 – Location of Low Voltage Control Tub (Cosel Power Supply)

IEC Component and Device Designations

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

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

Power Wiring Selection

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

General Notes:

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

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

Cable Insulation

The cable insulation requirements for the PowerFlex 7000 “A” Frame drive are given in the tables below.

ATTENTION

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

Cable Insulation Requirements for AFE Drives with Separate Isolation Transformer

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

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

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

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

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

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

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

Note 1: Steel conduit or cable tray may be used for all PowerFlex 7000 "A" Frame Drive power or control wiring, and steel conduit is required for all PowerFlex 7000 "A" Frame Drive signal wiring. All input and output power wiring, control wiring or conduit should be brought through the drive conduit entry holes of the enclosure. Use appropriate connectors to maintain the environmental rating of the enclosure. The steel conduit is REQUIRED for all control and signal circuits, when the drive is installed in European Union countries. The connection of the conduit to the enclosure shall be on full 360 degree and the ground bond at the junction shall be less than 0.1 ohms. In EU countries this is a usual practice to install the control and signal wiring.
Note 2: Spacing between wire groups is the recommended minimum for parallel runs of 61 m (200 feet) or less.
Note 3: The customer is responsible for the grounding of shields. On drives shipped after November 28/02, the shields are removed from the drive boards. On drives shipped prior to November 28/02, all shields are connected at the drive end and these connections must be removed before grounding the shield at the customer end of the cable. Shields for cables from one enclosure to another must be grounded only at the source end cabinet. If splicing of shielded cables is required, the shield must remain continuous and insulated from ground.
Note 4: AC and DC circuits must be run in separate conduits or trays.
Note 5: Voltage drop in motor leads may adversely affect motor starting and running performance. Installation and application requirements may dictate that larger wire sizes than indicated in IEC / NEC guidelines are used.

Table 2.A – Wire Group Numbers

The wire sizes must be selected individually, observing all applicable safety and CEC, IEC or NEC regulations. The minimum permissible wire size does not necessarily result in the best operating economy. The minimum recommended size for the wires between the drive and the motor is the same as that used with an across-the-line starter. The distance between the drive and motor may affect the size of the conductors used.

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

Power Cabling Access

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

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

To access the customer power cable terminations

Cable connections are located behind the medium voltage door of the Connection/Cabling cabinet. Location of power terminals for various drive configurations are as indicated in Figures 2.21, 2.19 and 2.22.

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

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

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

Power Connections

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

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

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

Line/Motor Terminations

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

Power Cabling Installation Requirements

To determine cable distance from top or bottom of input cabinet to termination points, refer to Figures 2.21, 2.19 and 2.22.

The installer is responsible for ensuring that power connections are made with appropriate torque. (Refer to Appendix B "**Torque Requirements**" in back of manual.)

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

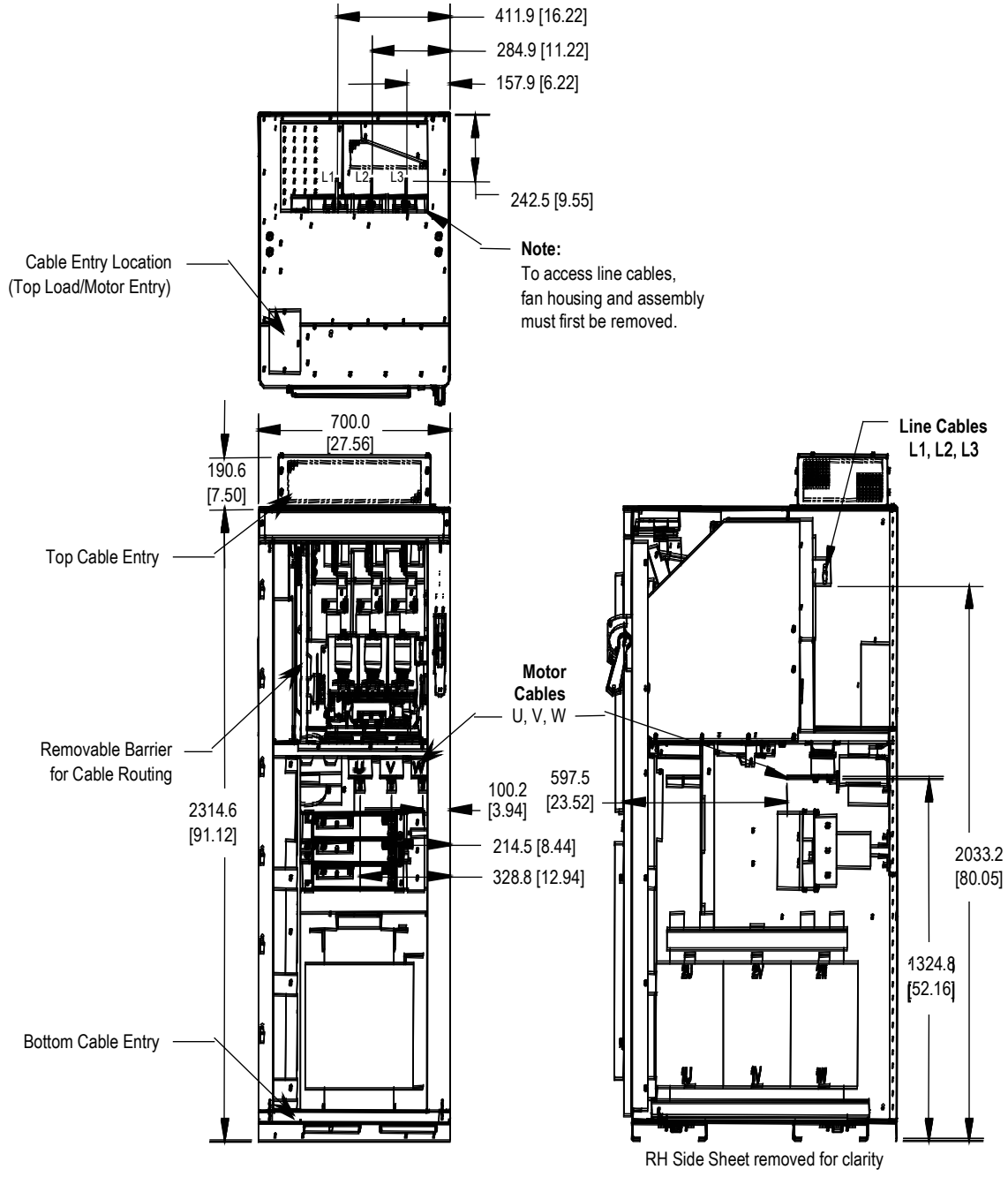


Figure 2.19 – Dimension Views of Cabling Cabinet for Configuration #1 *with* Input Starter

Power Connections (cont.)

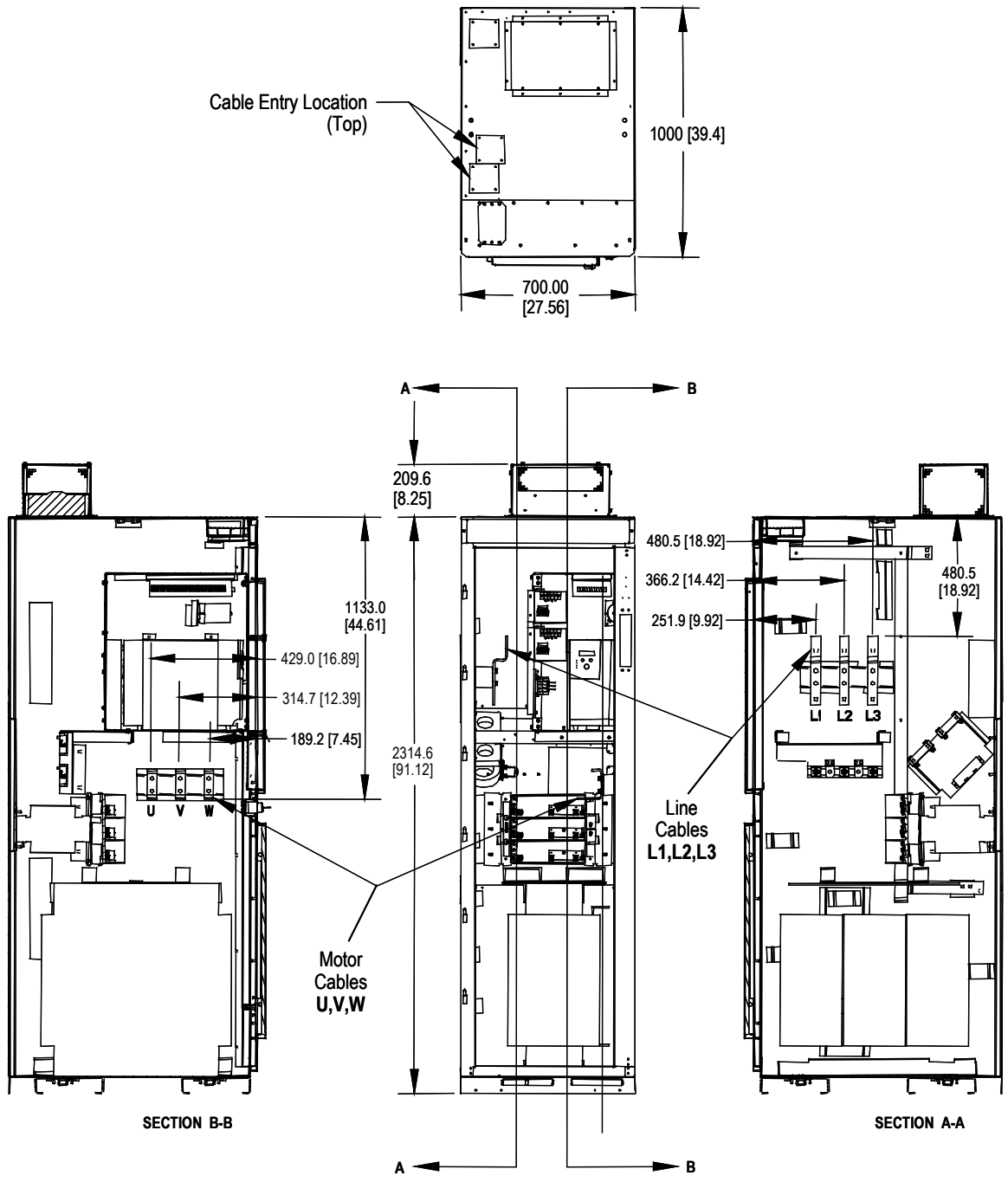


Figure 2.20 – Dimension Views of Cabling Cabinet for Configuration #1 *without* Input Starter

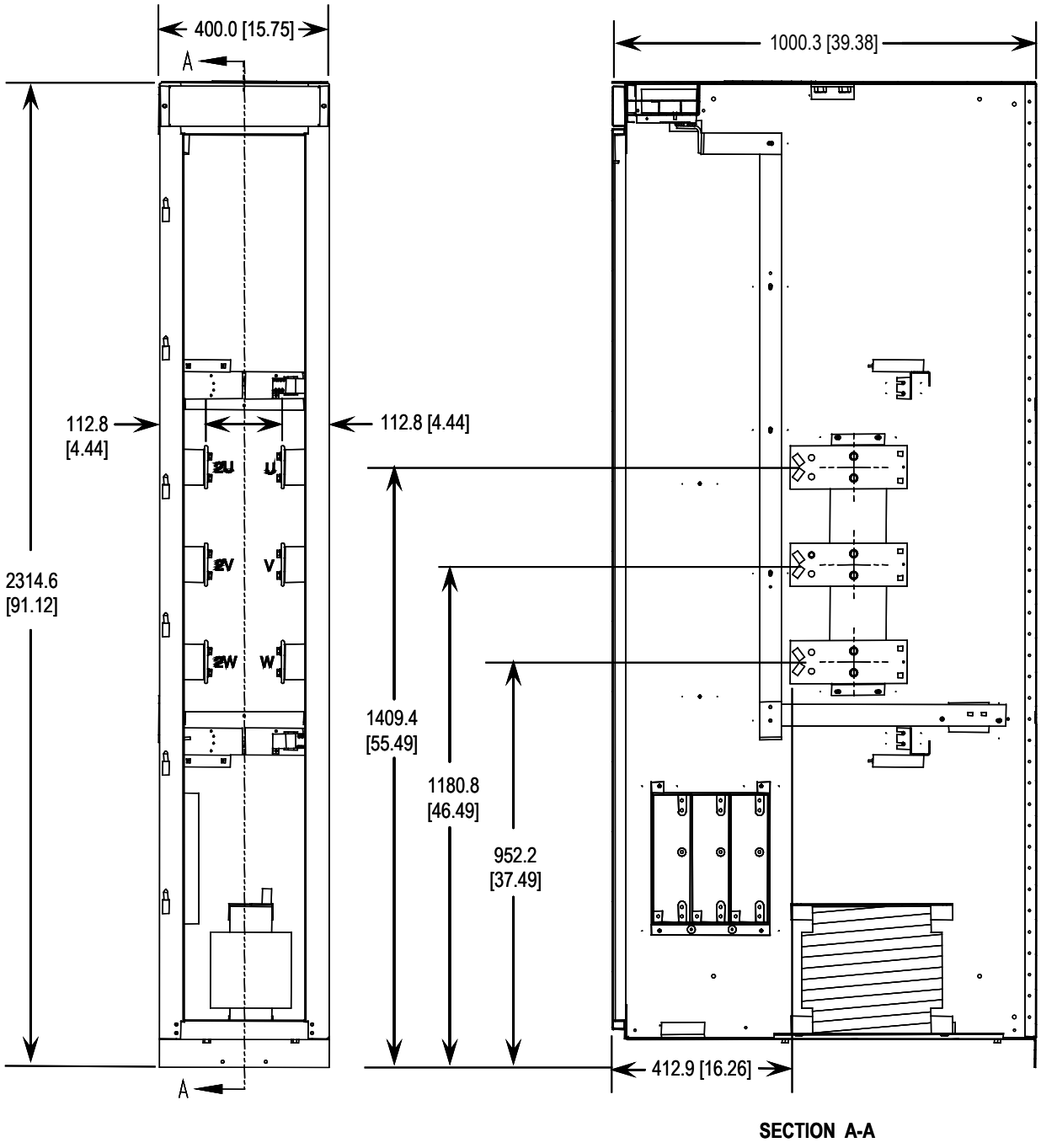


Figure 2.21 – Dimension Views of 400 mm Cabling Cabinet for Confiuguration #2 Line and Load Motor Terminals

Power Connections (cont.)

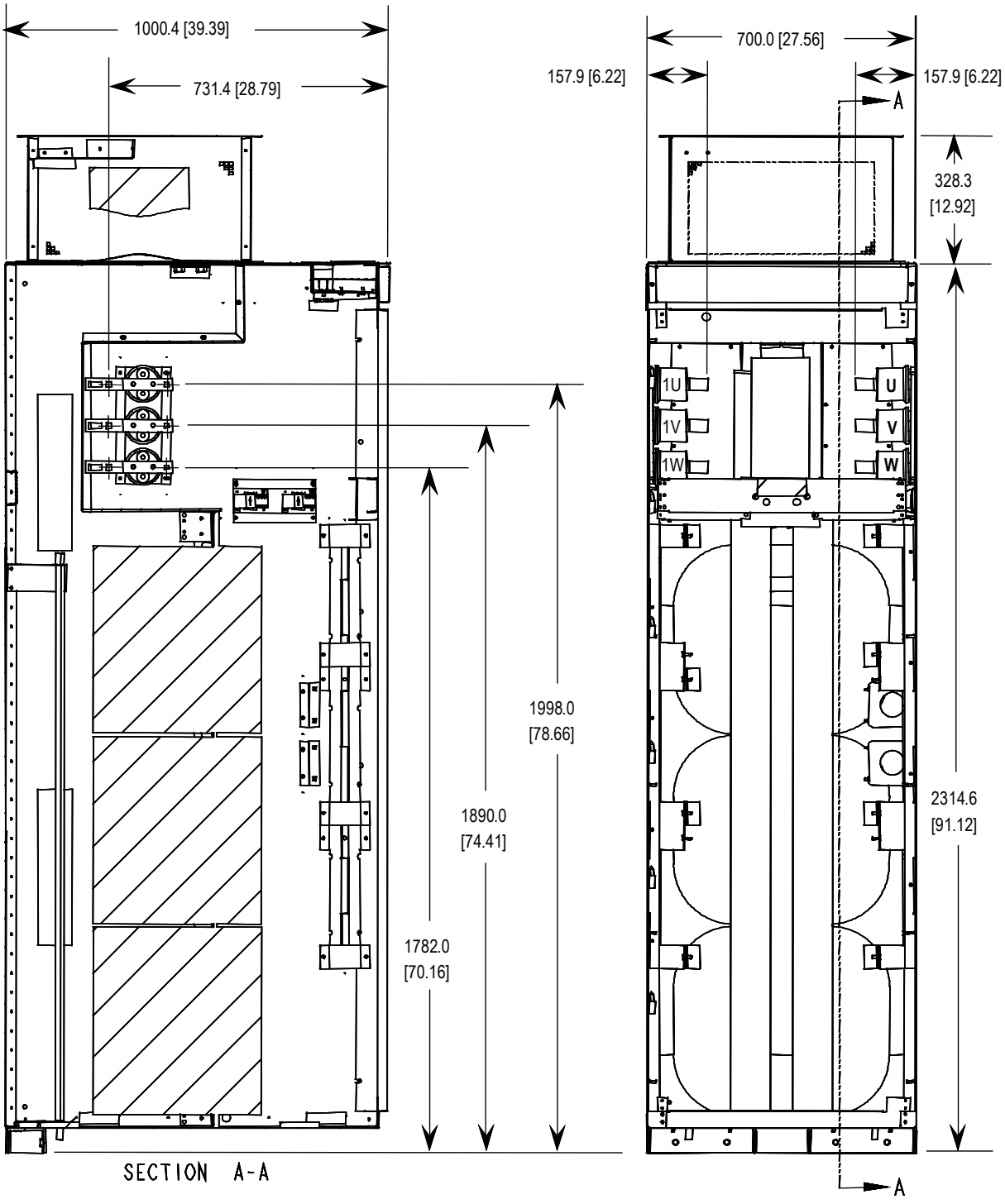


Figure 2.22 – Dimension Views of Cabling Cabinet for Configuration #3

Power and Control Wiring

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

Control Cables

Control cable entry/exit should be located near the terminal block 'TBC' – the customer's connections are to be routed along the empty side of the TBC terminals. These terminals are sized to accept a maximum #14 AWG. The low voltage signals (includes 4-20mA) are to be connected using twisted shielded cable, with a minimum #18 AWG.

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

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

Grounding Practices

The purpose of grounding is to:

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

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

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

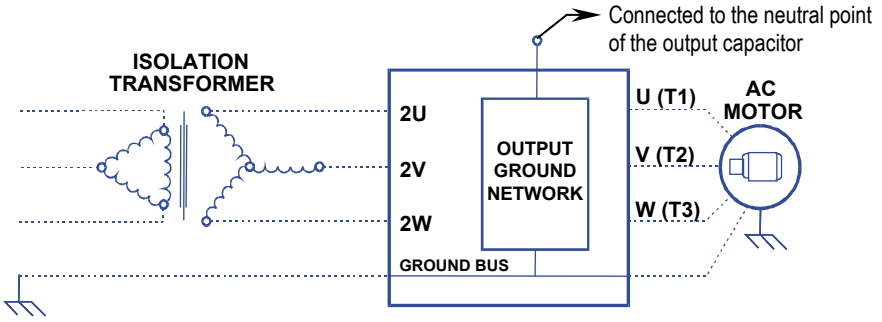


Figure 2.23 – Ground Connection Diagram with Isolation Transformer

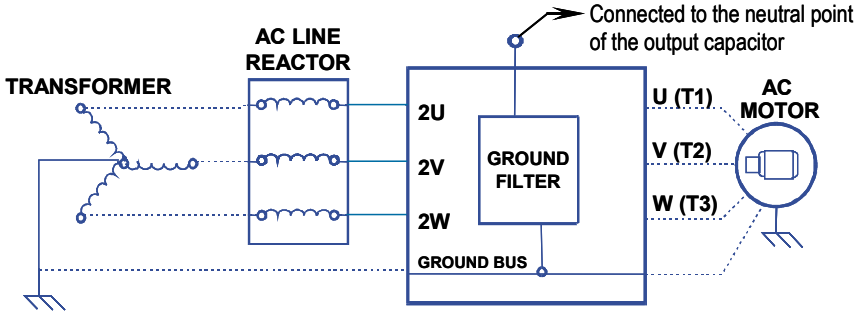


Figure 2.24 – Ground Connection Diagram with Line Reactor

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

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

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

Grounding Guidelines and Practices for Drive Signal and Safety Grounds

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

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

  or

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

Grounding Practices (cont.)

Grounding Requirements and Grounding Specification for Customers and Power Integrators

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

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

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

- do not damage the grounding circuit,

or

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

Identification of Types of Electrical Supplies – Grounded and Ungrounded Systems

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

Ground Bus

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

Interlocking

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

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

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

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

Notes:

Operator Interface

Chapter Objectives

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

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

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

Terminology

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

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

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

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

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

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

XIO – the e**X**ternal **I**nputs and **O**utput adapters used by the drive to interface hardwired signals to the drive.

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

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

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

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

Overview

The operator interface used on the PowerFlex 7000 Medium Voltage Drive is that of the PanelView™ 550 terminal (Figure 3.1). This terminal however does not behave as a PanelView, as only the hardware for the operator interface has been utilized. The PanelView software has been replaced with unique software to tailor it to the requirements of the Medium Voltage Drive, and its faceplate has been modified (Figure 3.1).

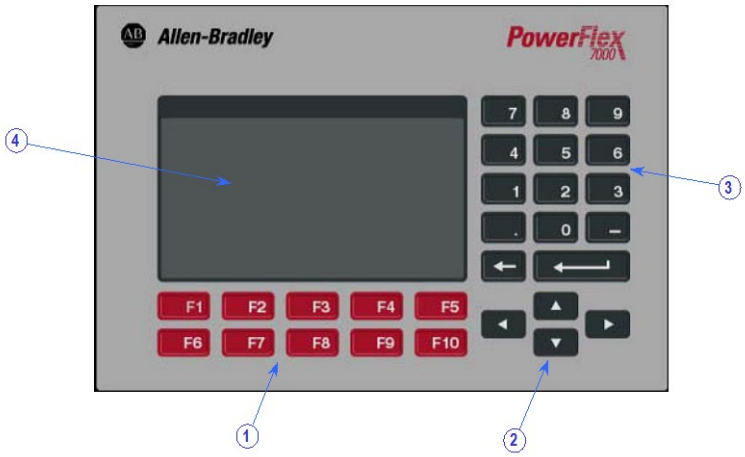


Figure 3.1– PowerFlex 7000 Drive Operator Interface Terminal

Keypad

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

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

Function (Softkeys) Keys

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

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

Cursor (Selection) Keys

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

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

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

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

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

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

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

Data Entry Keys

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

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

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

What is a Screen?

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

Components

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

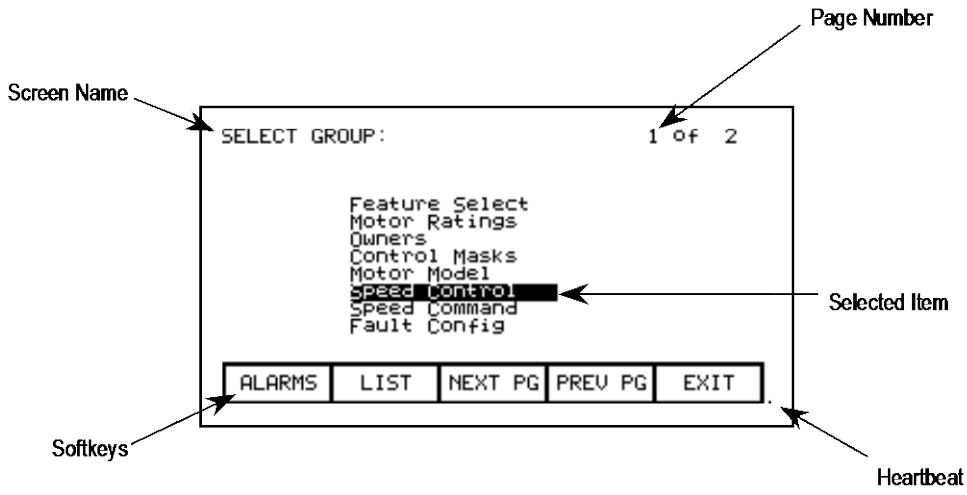


Figure 3.2 – Screen Components

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

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

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

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

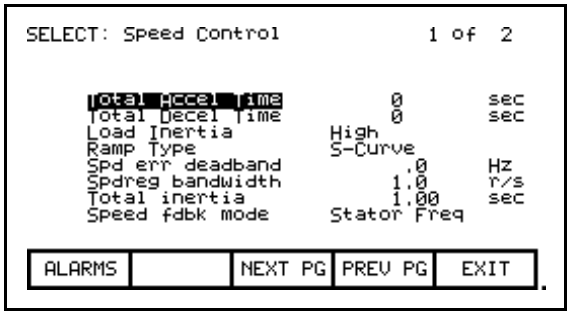


Figure 3.3 – Screen Name & Item

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

Information Windows

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

Accessing/Writing to Drive

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

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

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

Communication Error

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

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

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

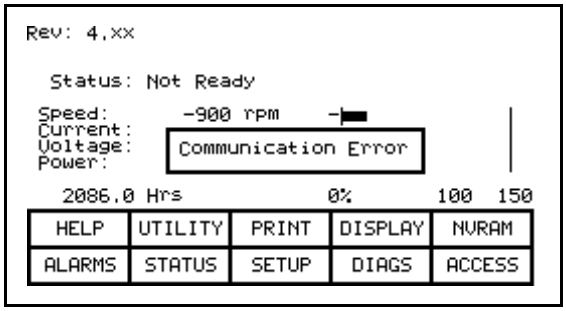


Figure 3.4 – Communications Error

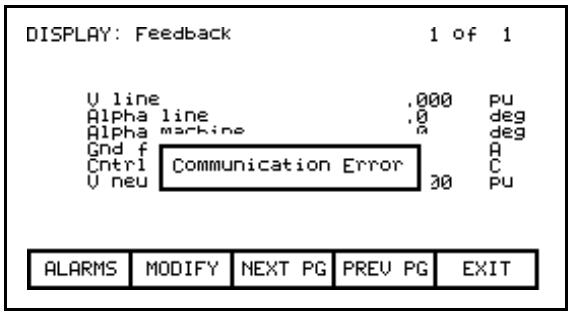


Figure 3.5 – Communications Error

Language Changing

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

General Operation

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

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

F1 - Help

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

F6 - Alarms

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

F8 - Next Page

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

F9 - Previous Page

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

F10 - Exit

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

Operator Interface Power-up Sequence

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

a) **Linking to Drive** - During this phase the operator interface is establishing communications with the drive communications board. The screen will also show information about the software product contained in the PowerFlex operator interface, such as:

- software part number and revision level
- date and time stamp of program creation

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

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

a) On an unconfigured drive, the operator interface will enter the 'Setup Wizard' mode. Until the user has gone through the entire 'Setup Wizard', this will be the default mode to power up in. The 'Setup Wizard' can be cancelled at any time by pressing the appropriate softkey.

b) Once the drive has been configured through the 'Setup Wizard', the Top Level Menu, will be displayed from this point forward. The 'Setup Wizard' can be re-entered via the Setup Menu.

Top Level Menu

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

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

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

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

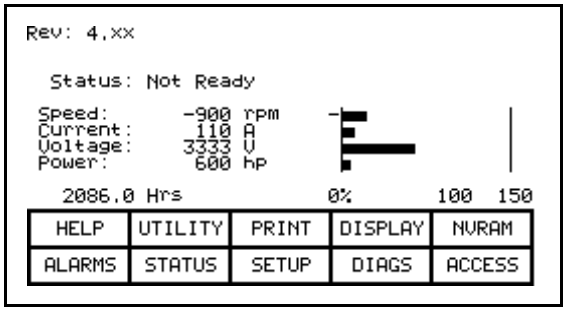


Figure 3.6 – Top Level Menu

How To:

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

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

Obtain Help

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

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

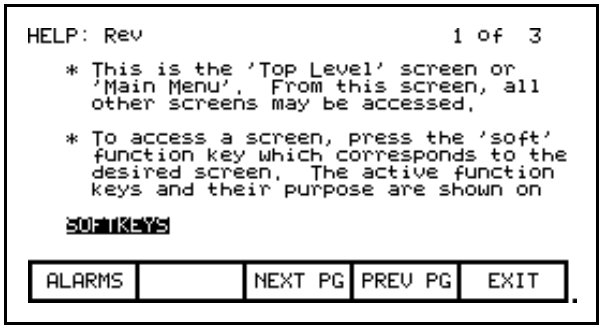


Figure 3.7 – Typical Help Screen

Related Topics

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

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

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

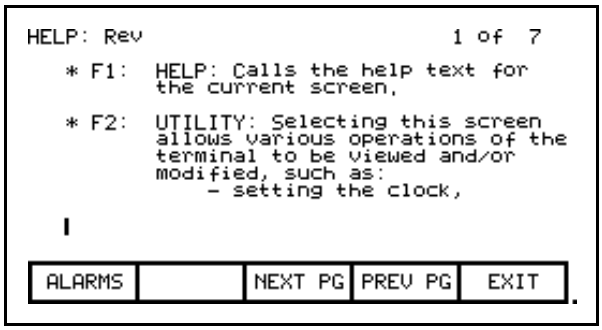


Figure 3.8 – Help on Related Topic (Softkey)

Help on Help

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

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

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

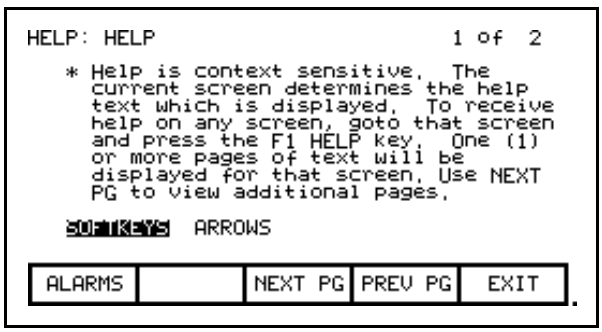


Figure 3.9 – Help on Help

Modify Operator Interface Operation (Utility)

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

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

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

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

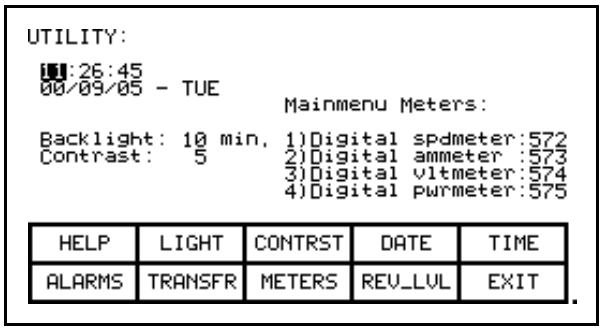


Figure 3.10 – Utility Operation Screen

Changing Backlight Delay

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

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

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

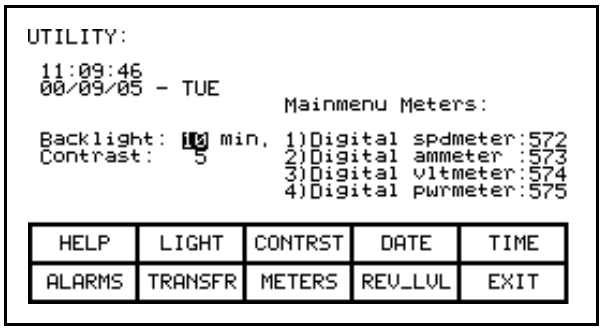


Figure 3.11 – Utility Light

Changing Contrast

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

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

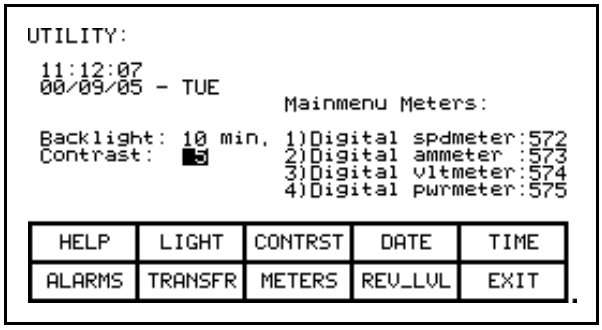


Figure 3.12 – Utility Contrast

Setting Time

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

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

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

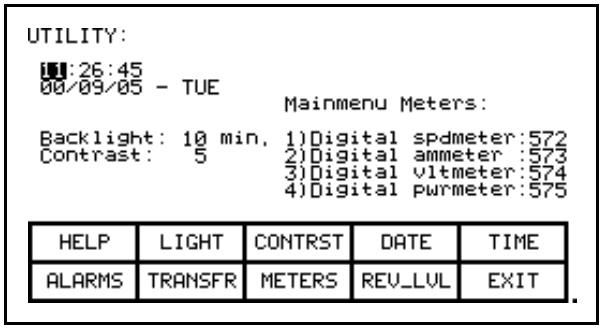


Figure 3.13 – Utility Time

Setting Date

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

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

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

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

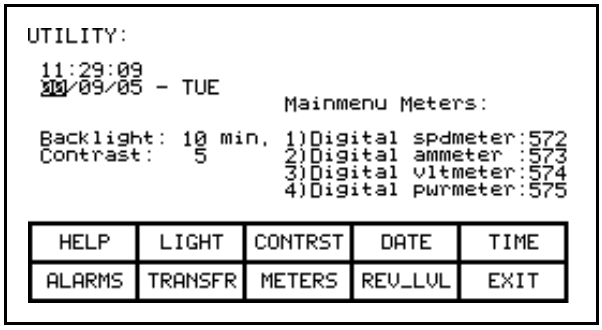


Figure 3.14 – Utility Date

Selecting Meters

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

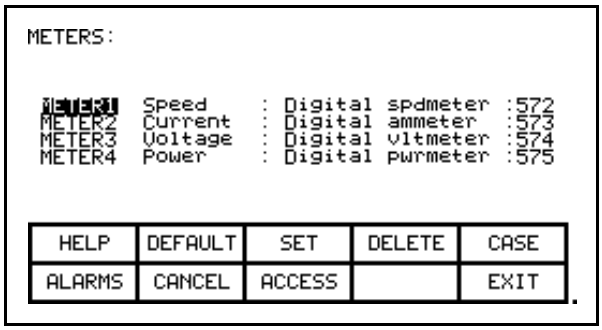


Figure 3.15 – Utility Meter

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

This will begin the selection process of a tag as described in the section entitled "**Select a Parameter**". When you have completed the selection process, the selected tag will be assigned to the meter (i.e. V Line). The name of the meter will have been changed to a default string as shown in Figure 3.16 for meter 2.

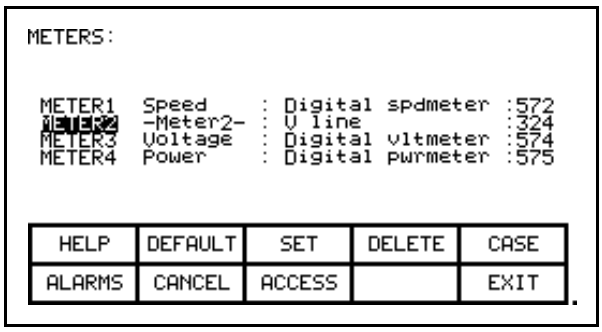


Figure 3.16 – Utility Meter V Line

The text consists of 8 characters. This text is displayed on the Top Level Menu along with the value and units of the tag. Select the meter that you wish to modify via the [cursor up] and [cursor down] keys. To modify the text, press the [cursor right] key. (If nothing happens then you have not gained the required access to make changes. Press the [F8] key in order to gain access and refer to the section entitled **Enter/Modify an Access Level** .

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

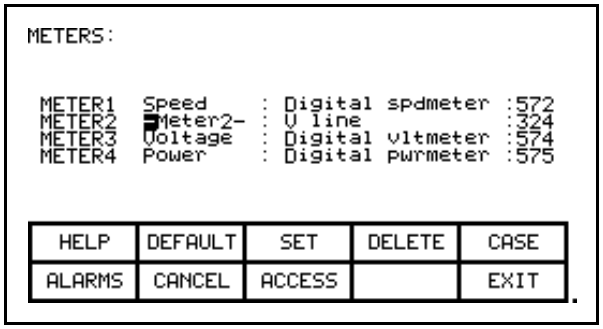


Figure 3.17 – Edit the Text

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

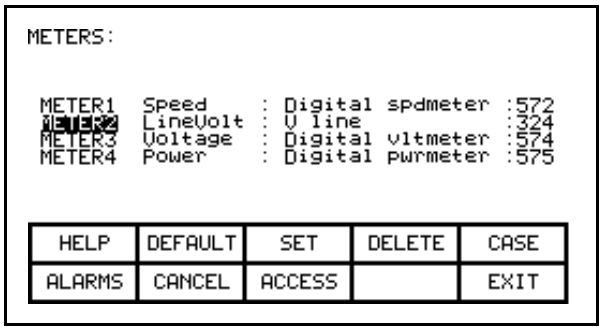


Figure 3.18 – Editing Completed

The operator interface contains a default set of meters. This default set is selected by pressing the [F2] key any time the 'Meters' screen is displayed. This results in the default text and tags as shown in Figure 3.15.

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

The result of selecting the V Line tag for meter 2 (in our example) is shown in Figure 3.19 after the METERS screen was exited.

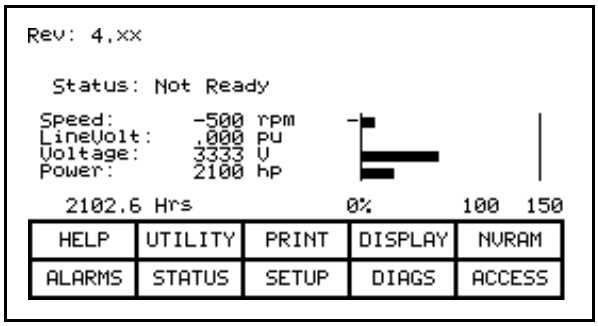


Figure 3.19 – Top Level Meter Modified

Viewing Revision Levels

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

A screen typical of Figure 3.20 shows:

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

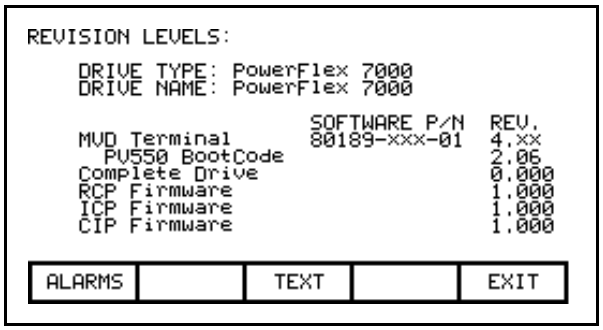


Figure 3.20 – Utility Rev Level

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

A screen typical of Figure 3.21 will be displayed. To modify the text refer to the section entitled "Edit Text", noting the following exception. When the text has been entered (as in Figure 3.22) the enter key has no effect. Simply press the exit key [F10] to accept the edited string.

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

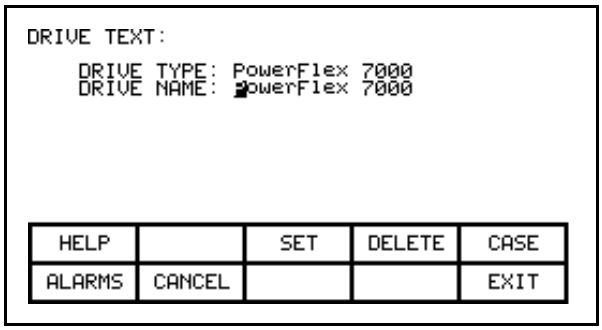


Figure 3.21 – Edit the Drive Name

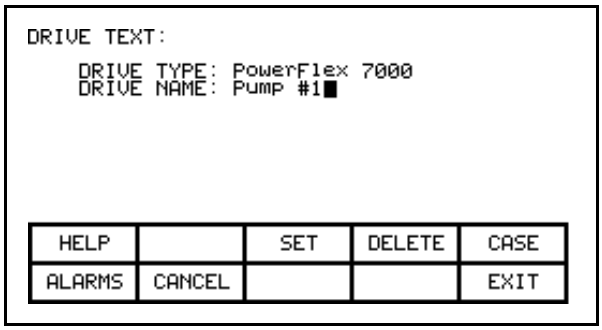


Figure 3.22 – Editing Completed

Transfer Data in Memory

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

In order to transfer information from the two forms of memory, press the [F7] key. This displays a new screen (Figure **Error! Reference source not found.**) from which all flash memory operations are performed. Refer to the section entitled “Flash Memory Transfers” for instructions on these features.

Picking an Access Level

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

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

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

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

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

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

Refer to **Enter/Modify an Access Level** for complete information on the use of Access Levels.

Select a Parameter

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

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

Via Groups

This is the default screen (Figure 3.23) used in the selection of a parameter. It shows all the groups that are accessible for the operation currently being performed. For example: if you are selecting a parameter, any groups that are showing read-only parameters only will not be shown. The current access level will also affect the number of groups that are currently viewable, and can be selected from. If more

than one page of groups exist, press the [F8] and [F9] keys to view the other pages.

Press the [cursor up] or [cursor down] keys to select the desired group, (i.e. reverse video the group name). Press the [enter] key. The SELECT screen (Figure 3.24) is displayed showing the members of the selected group. The name of the selected group currently being displayed is shown after the screen name, i.e. Motor Ratings. Again using the [cursor up] or [cursor down] keys, and if required the [F8] and [F9] keys to change the page, select the desired tag. Press the [enter] key and the selected tag will be used to continue the operation for which the selection process was being used.

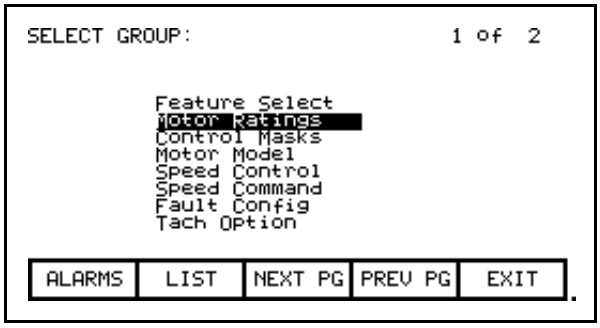


Figure 3.23 – Selecting a Group

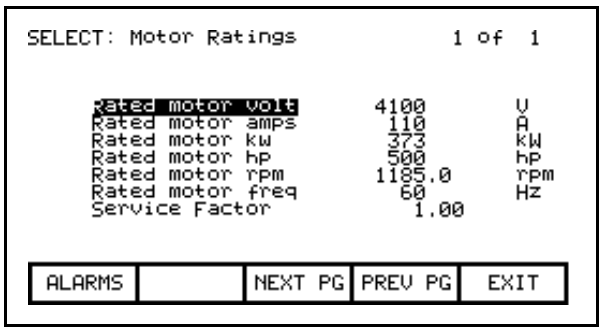


Figure 3.24 – Selecting a Member of a Group

From the SELECT GROUP screen (Figure 3.23), the tag can also be selected via its name by pressing the [F7] key.

Via Name

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

Selecting via a name is initiated from the SELECT GROUP screen (Figure 3.23) by pressing the [F7] key. This displays the SELECT LETTER screen shown in Figure 3.25.

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

All tags which begin with that letter, and are appropriate for the operation on which the selection is being performed, will be displayed as in Figure 3.26. Using the [cursor up] or [cursor down] keys, and if required the [F8] and [F9] keys to change the page, select the desired tag. Press the [enter] key and the selected tag will be used to continue the operation for which the selection process was being used.

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

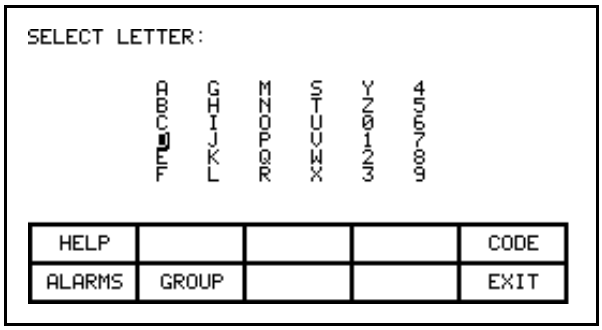


Figure 3.25 – Selecting via a Letter (Step 1)

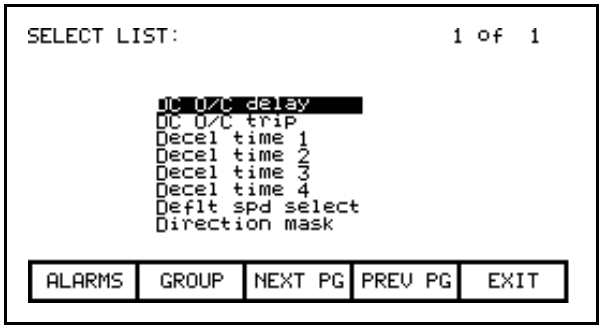


Figure 3.26 – Selecting Name via List (Step 2)

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

Via Code

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

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

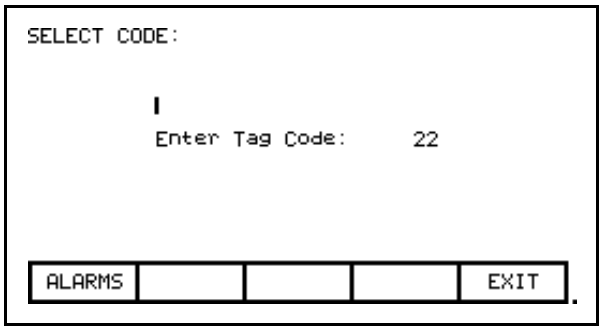


Figure 3.27 – Select via Code (Step 1)

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

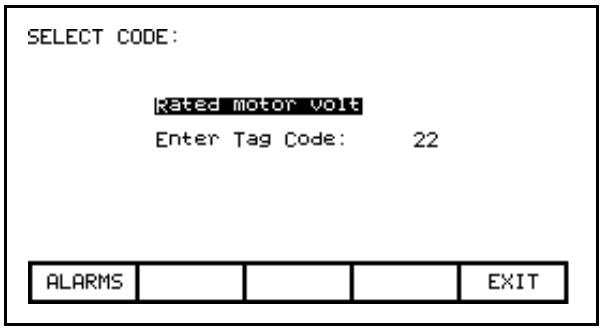


Figure 3.28 – Valid Tag Code

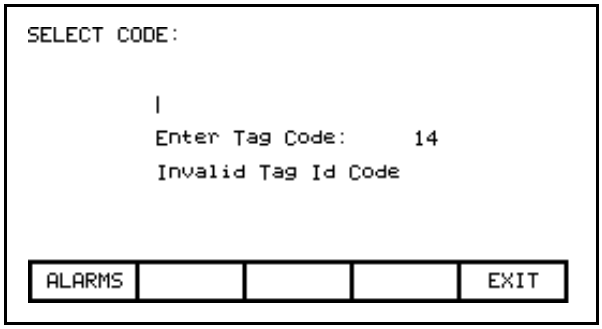


Figure 3.29 – Invalid Tag Code

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

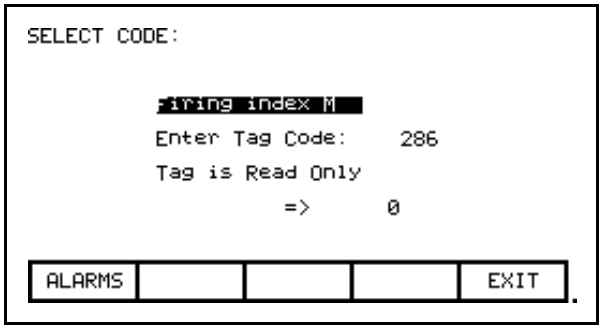


Figure 3.30 – Selected Tag Inappropriate

Edit Text

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

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

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

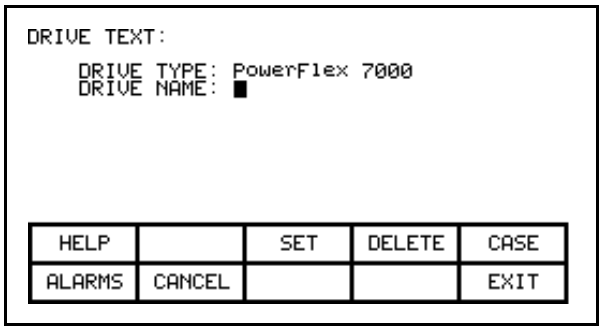


Figure 3.31 – Typical Text Edit Screen

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

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

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

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

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

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

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

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

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

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

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

Configure the Drive

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

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

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

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

Enter/Modify an Access Level

The drive is protected from unauthorized changes via passwords consisting of a number between 0 and 65535. These passwords are

associated with Access Levels. Each Access Level, (except for the first one 'Monitor') has its own password number (PIN). These values can be unique or all can be set to the same value.

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

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

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

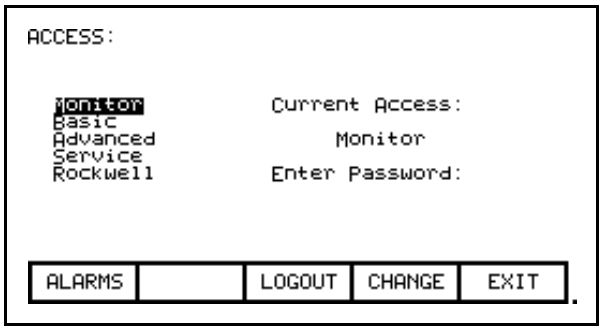


Figure 3.32 – Access Screen

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

Figure 3.33 – Pin Entry

The value may be edited by using the [backspace] key. When the value has been typed in, press the [enter] key. If the correct PIN was entered, the access level of the operator interface will change as shown in Figure 3.34 . If the incorrect value was entered, the operator interface will remain at the current access level.

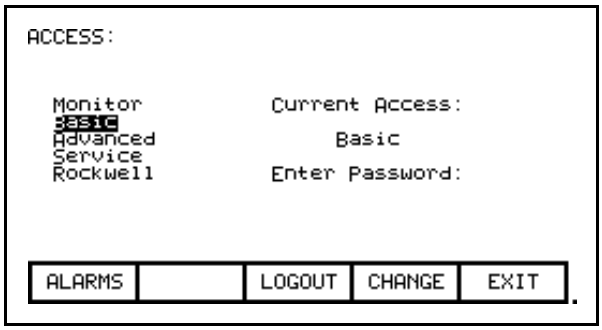


Figure 3.34 – Access Level Changed

When the desired operations have been completed, the operator interface should be placed back to the 'Monitor' level in order to protect against unauthorized modifications. From this screen press the [F8] key. The level will change back to 'Monitor' as shown in Figure 3.32.

The default value for the password (PIN) of the 'Basic' and 'Advanced' levels is zero (0), or simply pressing the [enter] key. This value can be changed from the ACCESS screen. First use the up/down cursor keys to select the level for which you wish to modify the PIN. Press the [F9] key. The typical PASSWORD CHANGE screen shown in Figure 3.35 is displayed, showing the Access Level for which the new PIN will be applied to.

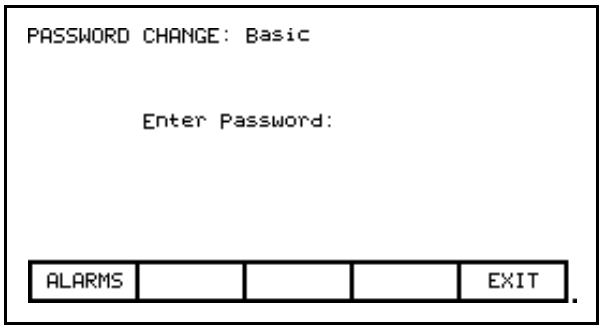


Figure 3.35 – PIN Change

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

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

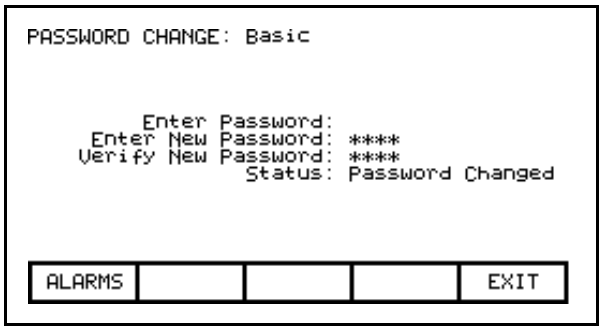


Figure 3.36 – PIN Change Completed

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

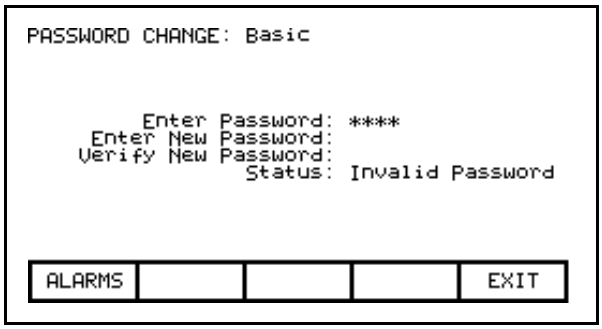


Figure 3.37 – Invalid PIN

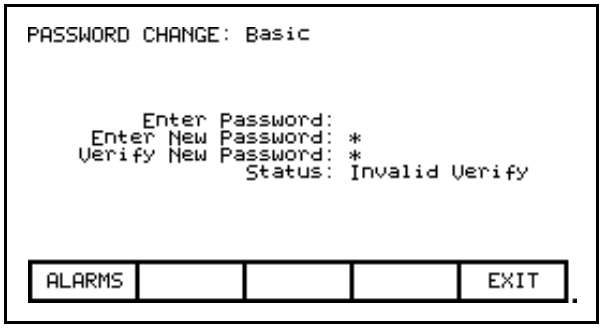


Figure 3.38 – Invalid PIN Verification

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

Drive Setup

This section describes how to:

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

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

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

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

Figure 3.39 – Setup Screen

Figure 3.40 – Basic Access Level

Language Selection

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

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

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

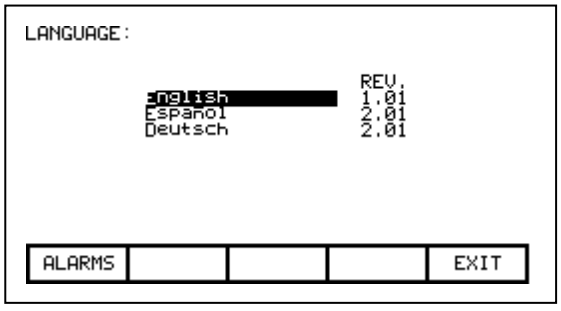


Figure 3.41 – Language Selection

Modify Parameters

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

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

Numerical Value

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

– the name of the parameter for which you are making the changes (i.e. Rated motor volt).

– the tag code for the parameter, (i.e. 22).

– the minimum and maximum allowable limits to which the parameter must be set, (i.e. 4000 to 4160).

– the units in which the parameter data is being displayed

– the actual value of the parameter contained in the drive.

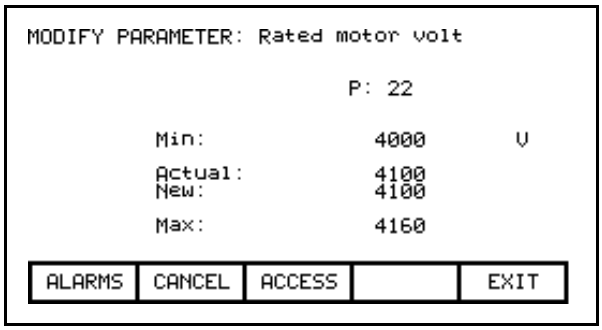


Figure 3.42 – Parameter Data Entry

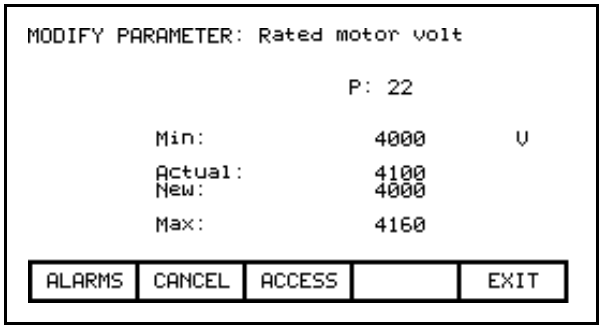


Figure 3.43 – Modify Numerical Value

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

Having gained access, use the data entry keys [0]-[9] to enter the new value. The [-] key can be typed at any time to enter a negative value. The [.] key is used to enter a decimal point for fractional values. The entered new value can be edited by pressing the [backspace] key. This key will delete the right most character (i.e. number, decimal point or negative sign) shown on the screen. Press the [enter] key to accept the new value as shown in Figure 3.43. If the new value that you entered is outside the limits defined, the new value will not change. For example: If you entered 900 when the minimum value was 4000, the new value will still show 4100.

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

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

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

Enumerated Value

When the parameter is an enumerated value, the MODIFY PARAMETER screen typical of Figure 3.44 will be displayed. This screen shows:

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

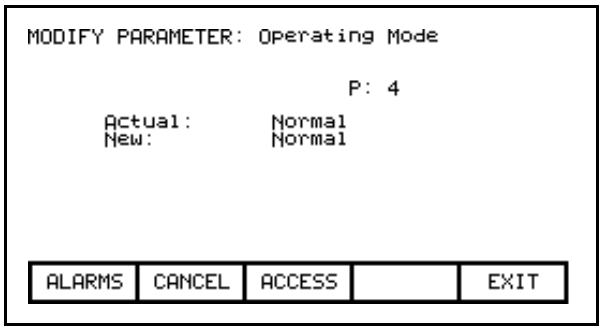


Figure 3.44 – Modify Enumerated Value

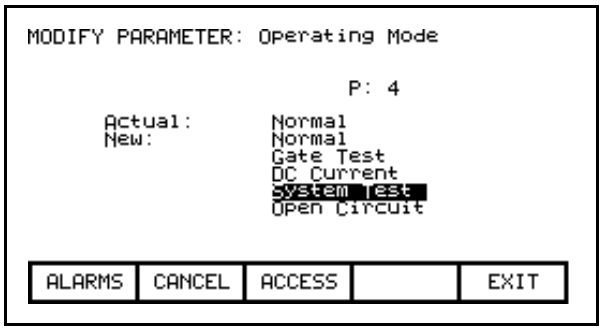


Figure 3.45 – Option List Viewed on Single Page

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

Having gained access, press the up or down cursor keys to obtain a list of possible options to select from. Use the up/down arrow keys to move the highlighting to the desired option (Figure 3.45). If more

options exist then what can be displayed on a single screen, a triangle or inverted triangle symbol will indicate in which direction the list can be expanded (Figure 3.46).

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

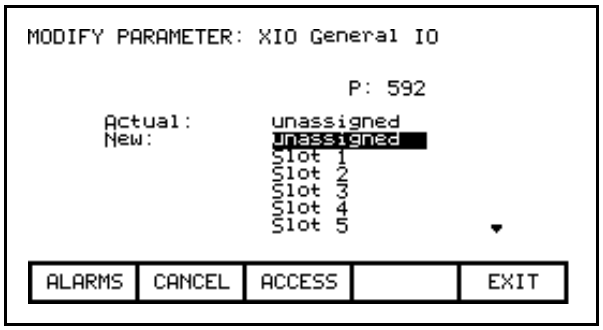


Figure 3.46 – Option List Viewed on Multiple Pages

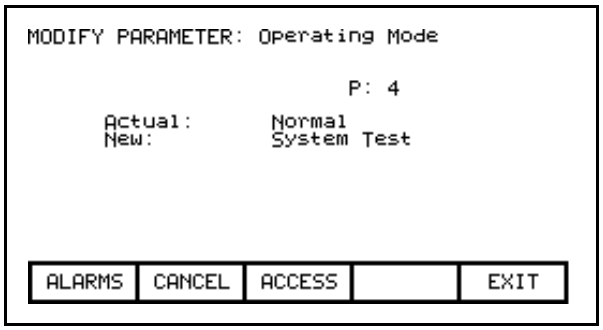


Figure 3.47 – Modification Completed

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

Bit Encoded Value

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

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

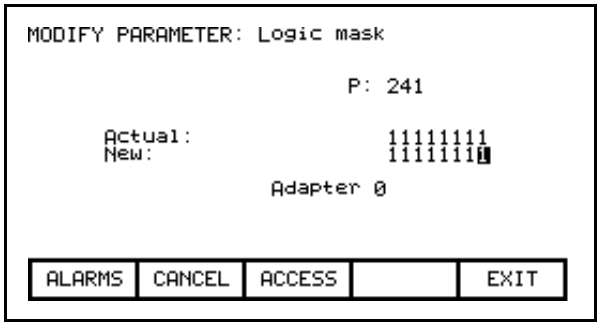


Figure 3.48 – Modify Bit Encoded Value

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

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

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

Analog Ports

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

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

Figure 3.49 – Analog Setup

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

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

Fault Masks

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

A typical screen as shown in Figure 3.50 shows all of the user maskable faults. Associated with each fault is the state of the mask. If OFF, it means the fault is disabled and will not occur. The normal state is ON or enabled.

To change the state of the mask, use the [cursor up] or [cursor down] keys to select the desired fault and press the [enter] key. Each press of the [enter] key will toggle the state of the mask as shown in Figure 3.51. (If nothing happens, you do not have proper access to the drive. Exit to the SETUP screen and refer to the section entitled **Enter/Modify an Access Level** to gain access).

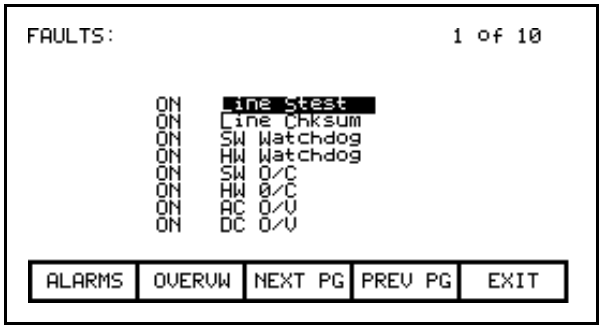


Figure 3.50 – Fault Screen

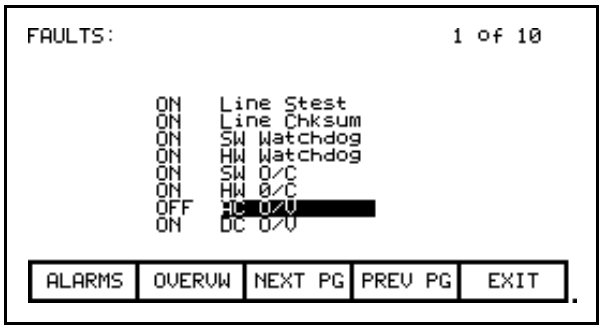


Figure 3.51 – Fault Mask OFF

Figures 3.50 and 3.51 show all fault masks regardless of their current state. The fault masks can be viewed according to their state by pressing the [F7] key on the FAULTS SETUP screen. This will display the FAULTS OVERVIEW screen, typical of Figures 3.52 and 3.53.

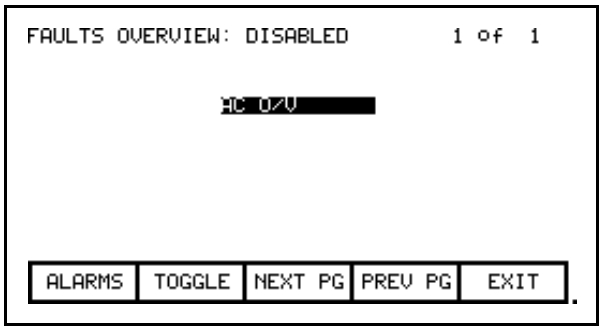


Figure 3.52 – AC O/V, Disabled

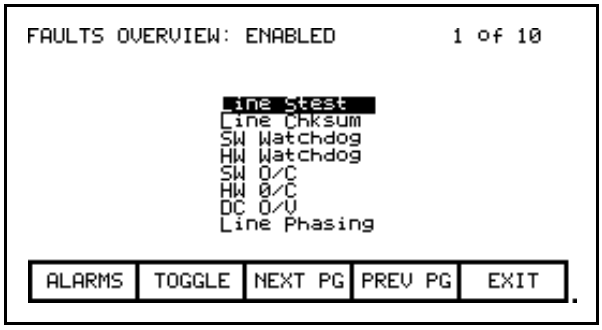


Figure 3.53 – Fault Overview, Enabled

The state of the fault masks which you are currently viewing is defined to the right of the screen name, i.e. FAULTS OVERVIEW: DISABLED or FAULTS OVERVIEW: ENABLED. To change the

state of fault masks currently displayed, press the [F7]. Each press of the [F7] key will toggle the screen to show the masks in the other state.

To change the state of a mask on the FAULTS OVERVIEW screen, use the [cursor up] and [cursor down] keys to select the desired mask and press the [enter] key. In the example of Figure 3.52, the "AC O/V" is currently disabled and is selected. When [enter] is pressed its mask is enabled, thus removing the fault from this screen as shown in Figure 3.54. Pressing [F7] toggles the screen to show the enabled faults, which the AC O/V is one of (Figure 3.55). (If nothing happens, you do not have proper access to the drive. Exit to the SETUP screen and refer to the section entitled **Enter/Modify an Access Level** to gain access).

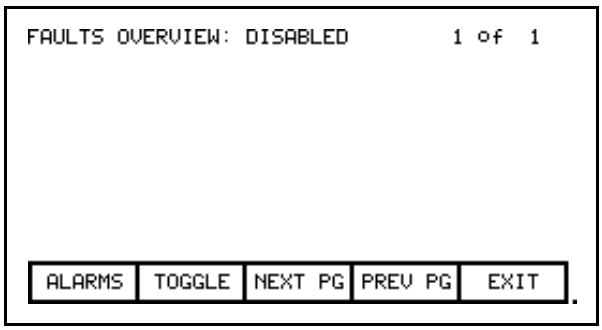


Figure 3.54 – AC O/V Removed From List

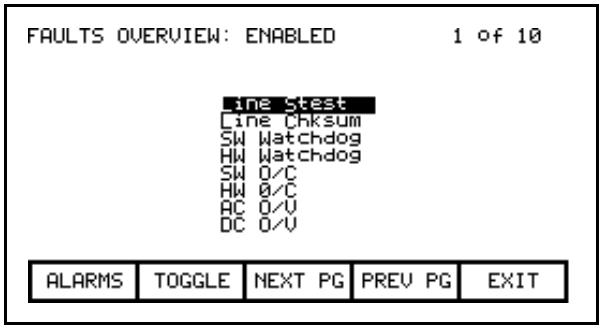


Figure 3.55 – AC O/V Now Enabled

The changes to the fault masks do not take effect until the screen is exited via the [F10] key, i.e. exiting the FAULTS OVERVIEW will change the masks in the drive as will exiting the FAULTS SETUP screen. In our example, exiting the FAULTS OVERVIEW screen and returning to the FAULTS SETUP screen now shows the "AC O/V" mask as being ON (Figure 3.56).

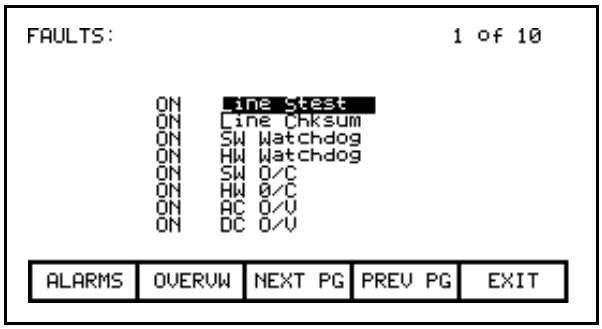


Figure 3.56 – AC O/V Mask is ON

User Definable External Text

The drive contains a number of external fault inputs. You can custom define the text associated with these inputs, which will be used on the alarm screen and the fault mask screens. To define the text, use the up/down arrow keys on the SETUP screen to select the 'External Text' option and press the [enter] key. A screen typical of Figure 3.57 will be seen.

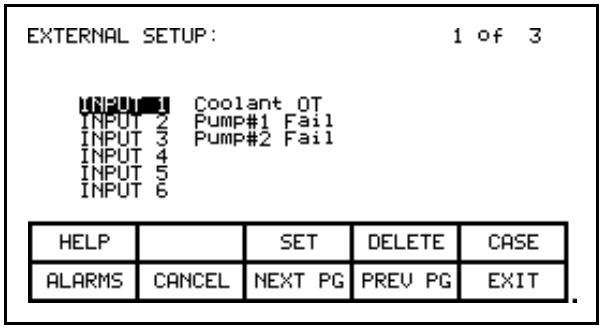


Figure 3.57 – External Setup Text

To modify the text attached to a particular fault input, use the [cursor up] and [cursor down] keys to select the desired input. To modify the text, press the [cursor right] key. (If nothing happens then you have not gained the required access to make changes. Exit to the SETUP screen and refer to the section entitled **Enter/Modify an Access Level** to gain access). The first character position of the string will be in reverse video as shown in Figure 3.58. Refer to the section entitled "Edit Text". When editing is complete, the screen will appear as in Figure 3.59.

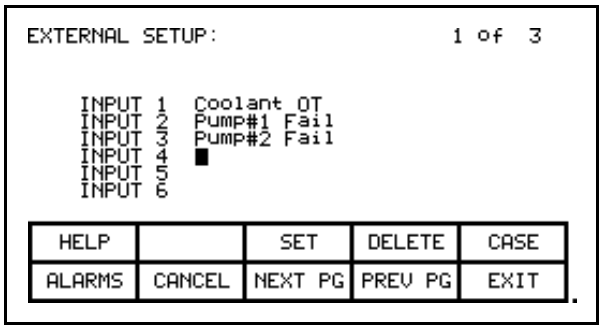


Figure 3.58 – Modify Text

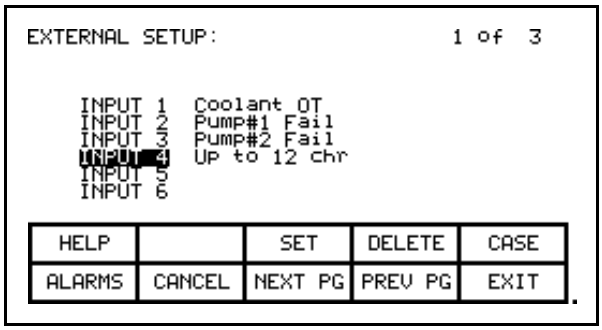


Figure 3.59 – Modification Completed

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

PLC

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

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

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

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

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

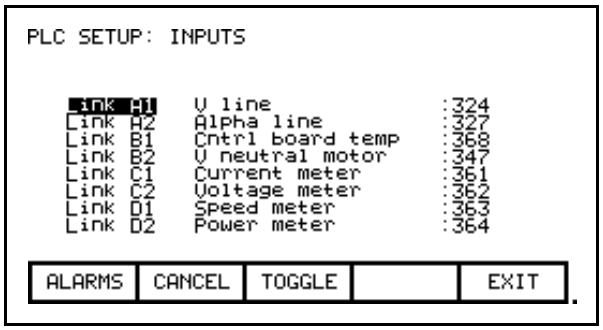


Figure 3.60 – PLC Input Links

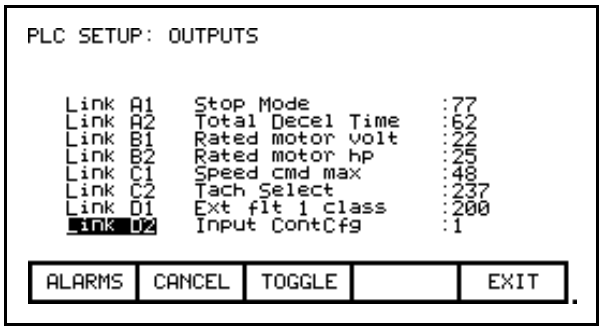


Figure 3.61 – PLC Output Links

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

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

XIO

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

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

Message Prompting

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

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

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

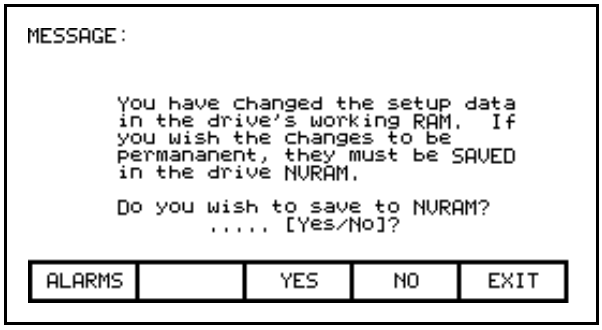


Figure 3.62 – Message Prompt Screen

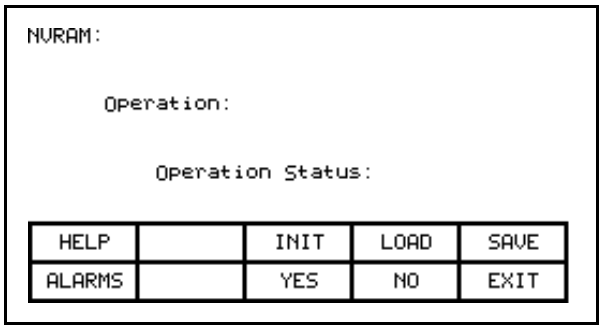


Figure 3.63 – NVRAM Screen

Store/Retrieve Configuration (NVRAM)

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

Initialize

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

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

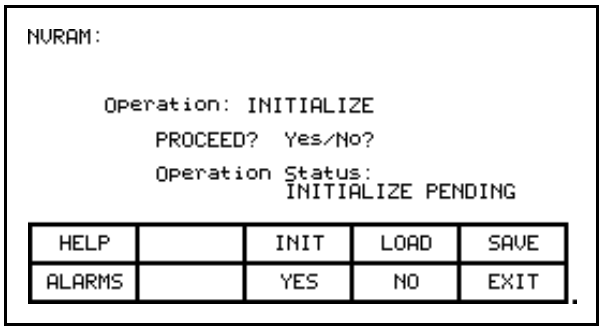


Figure 3.64 – Initialize Operation

Save

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

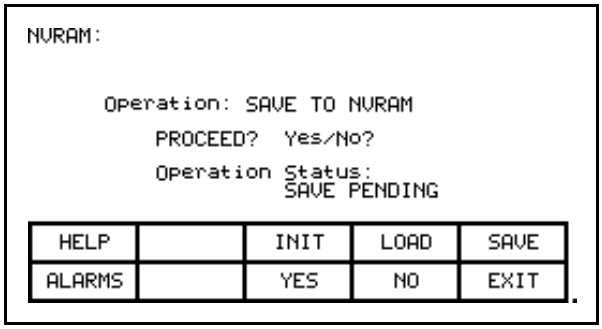


Figure 3.65 – Save Operation

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

Load

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

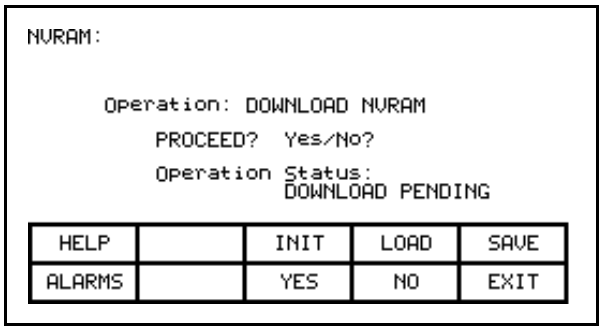


Figure 3.66 – Load Operation

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

Display Parameters

The parameters of the drive can be displayed, continually showing the value contained in the drive. From the Top Level Menu, press the [F4] key. The DISPLAY GROUP screen of Figure 3.67 is displayed.

The screen shows one or more pages of groups that can be displayed. The number of groups displayed depends on the current access level. Using the [cursor up] and [cursor down] keys select the group you wish to display and press the [enter] key (Figure 3.68).

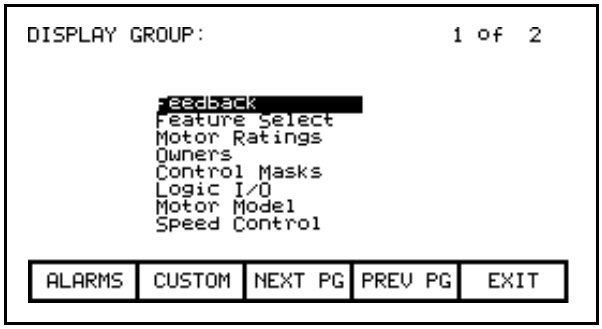


Figure 3.67 – Display Screen

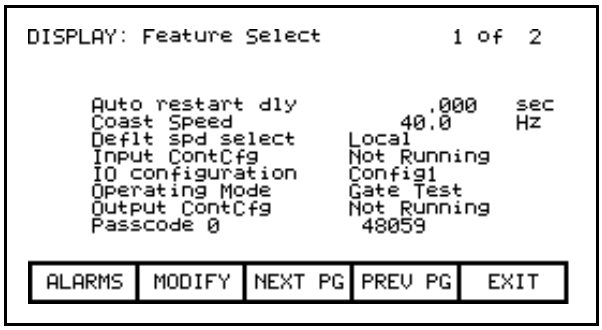


Figure 3.68 – Feature Select Group Chosen

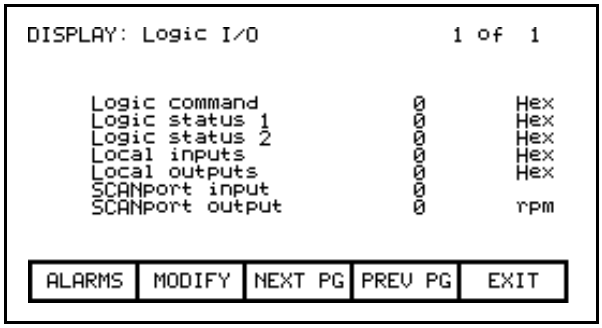


Figure 3.69 – Bit Encoded Parameter

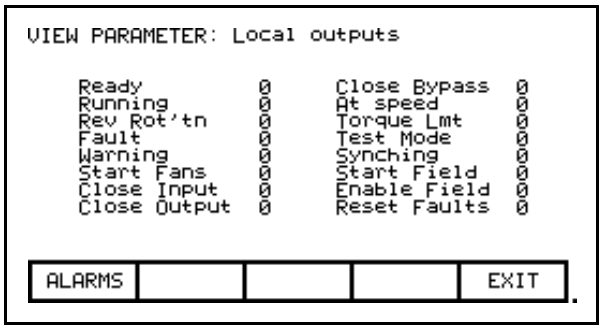


Figure 3.70 – Bit Description for Local Outputs

The DISPLAY screen, typical of Figure 3.68, is displayed. The screen shows the name of the group being displayed to the right of the screen name ("FEATURE SELECT"). One or more pages of the members in the group are displayed along with the value for this tag in the drive and its unit of measurement. Values that are bit encoded will show a hex value for the parameter value. Use the up/down cursor keys to select the parameter which is bit encoded and then press the [enter] key (Figures 3.69 and 3.70). The VIEW PARAMETER screen will then show that parameter as it is decoded per bit as shown in Figure 3.70.

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

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

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

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

Custom Group

From the DISPLAY GROUP screen (Figure 3.67) you can select a group which you have custom defined by pressing the [F7] key. This custom group contains selected tags from one or more other groups, arranged by you onto a single screen for more convenient viewing (Figure 3.71).

To assign a tag to the display, use the [cursor up] and [cursor down] keys to highlight the desired item position and press the [enter] key. This will begin the selection process of a tag as described in the section entitled "**Select a Parameter**". When you have completed the selection process, the selected tag will be assigned to the item, as in Figure 3.72. To remove a tag from the highlighted item, press the [delete] (Backspace) key.

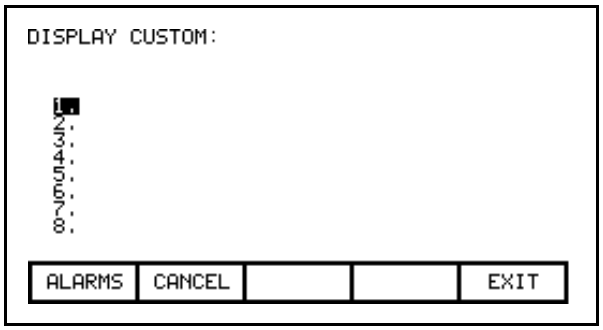


Figure 3.71 – Display Custom Screen

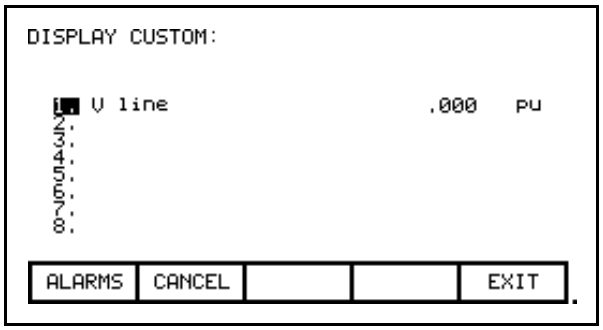


Figure 3.72 – V Line Assigned

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

View Drive Status

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

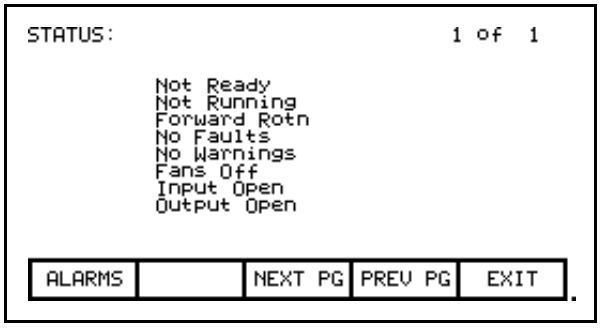


Figure 3.73 – Status Screen

View and Reset Alarms

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

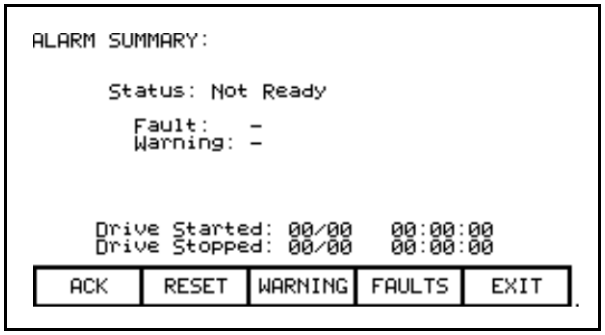


Figure 3.74 – Alarm Summary Screen

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

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

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

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

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

A screen typical of Figure 3.75 will be shown. The screen shows all faults in chronological order as they have occurred. A timestamp gives the date and time that the fault occurred. The most recent fault occurs at the top of the list. Use the [F8] and [F9] keys to shift to other pages if required. Entries are not removed from the queue until the queue is cleared with the [F7] key. If the queue becomes full, the oldest entries are discarded to make room for newer faults.

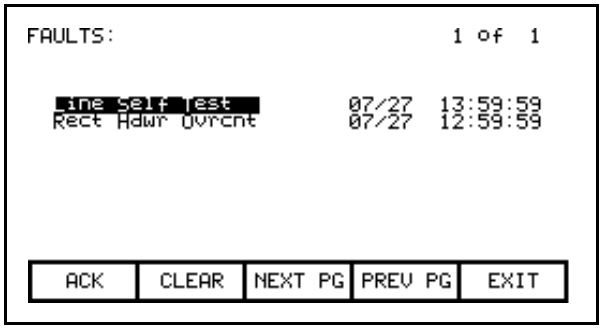


Figure 3.75 – Fault Queue

Help for Alarms

When viewing the fault or warning queue, help text may be associated with the alarm entry. Use the up/down cursor keys to highlight the alarm in question and press the [enter] key. An ALARM HELP screen, typical of that shown in Figure 3.76 will be shown for that alarm. Not all alarms will have this additional help text. For those alarms the screen shown in Figure 3.77 is displayed.

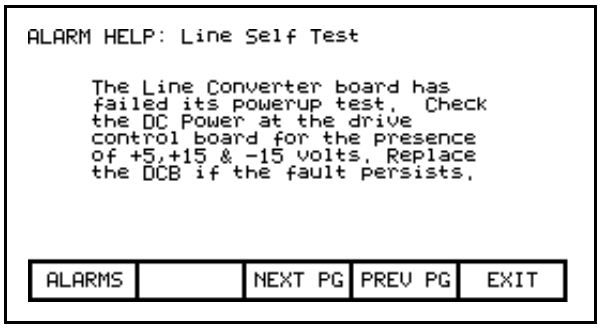


Figure 3.76 – Alarm Help

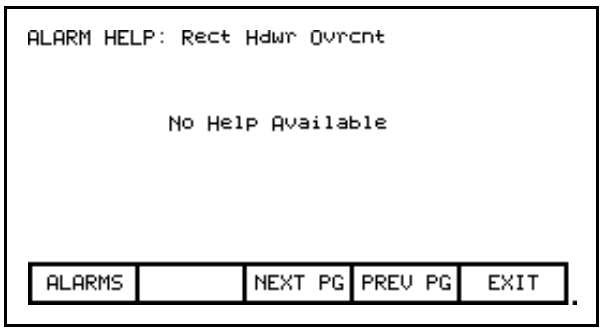


Figure 3.77 – No Alarm Help

Request Printouts

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

The screen typical of Figure 3.78 is displayed. It shows the current status of the printer (A-B part #80025-290-01) and the type of reports that are available. (Refer to the "Syntest SP401 Thermal Printer User Manual" for information regarding the use of the printer hardware and a description of the various reports available.) Using the [cursor up] and [cursor down] keys, select the desired report and press the [enter] key. The report will be sent to the printer.

The printer can automatically print out the alarms as they occur. This feature is selected as one of the report formats. In the Figure 3.78, the "AUTO - ON" indicates that this feature is currently enabled. To disable the feature, use the [cursor down] key to select the text, and press the [enter] key. The text will change to "AUTO - OFF" (if a printer is attached). The automatic alarm printout feature is now disabled. Pressing the [enter] key again while selected will enable the feature.

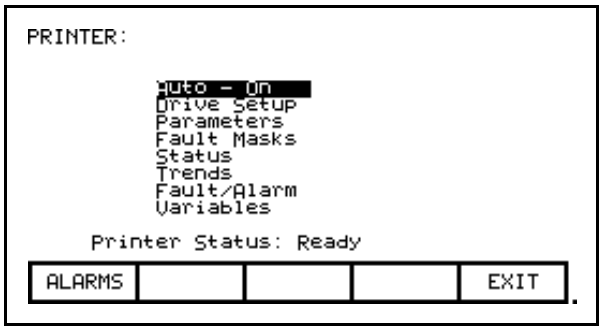


Figure 3.78 – Typical Printer Screen

Loading Programs (Firmware)

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

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

b) The user can select from one or more .FMW files on the card and load the selected firmware into the operator interface. This is the method that will be described here.

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

When the filename has been obtained, the TRANSFER: PROGRAM screen such as that in Figure 3.79 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

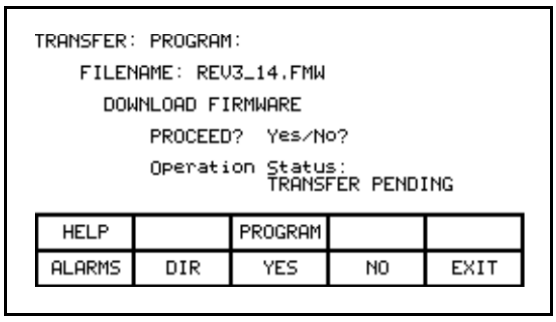


Figure 3.79 – Load New Firmware

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

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

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

- ***Flashing Green*** - indicates that all is healthy and the transfer is proceeding.
- ***Solid Red*** - the transfer has failed. Firmware must be loaded via the method described in a) above. This is achieved by cycling power to the operator interface or simultaneously pressing the [cursor left] [cursor right] and [Enter] key at the same time while the flash card is inserted. If more than one firmware file exists on the card, the first one will be loaded and this process will need to be repeated in order to select the firmware file you desire.

When the transfer completes successfully, the new firmware will automatically begin operation. Refer to the section **Operator Interface Power-up Sequence**.

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

Parameter Transfers

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

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

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

To transfer parameters, press the [F4] key from the TRANSFER screen. The screen shown in Figure 3.80 will be displayed. (If nothing happens, then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled **Enter/Modify an Access Level** to gain access). Within this screen it is possible to perform four different parameter transfers.

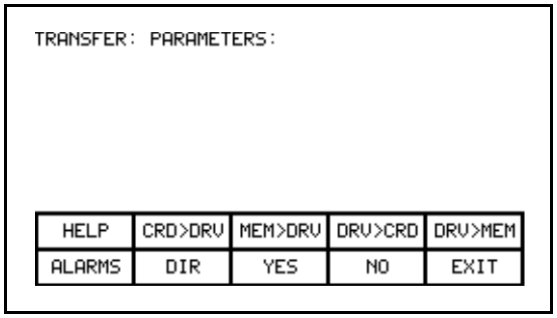


Figure 3.80 – Transfer Parameters Menu

Upload to Operator Interface

The parameters are read from the drive and stored in the operator interface by pressing the [F5] key. The screen will appear as in Figure 3.81, indicating the operation you are about to perform. The screen will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort. Performing a "DRIVE TO MEMORY" transfer will overwrite any previous parameters stored within the operator interface.

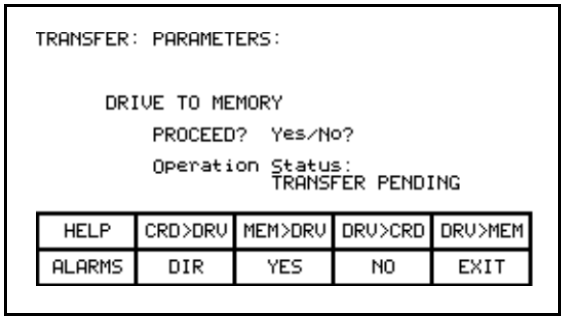


Figure 3.81 – Transfer Stored Parameters

Download from Operator Interface

The parameters stored in the operator interface are downloaded to the drive by pressing the [F3] key. A screen similar to that shown in Figure 3.81 will be shown (except the operation will show "MEMORY TO DRIVE"). To confirm the operation, press the [F8] key to proceed, or the [F9] key to abort. Performing a "MEMORY TO DRIVE" transfer will overwrite the active parameters in the drive. It will not affect the parameters stored within the drive's NVRAM.

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

Upload to Memory Card

The parameters are read from the drive and stored on a memory card by pressing the [F4] key. The operator interface will enter the DIRECTORY screen in which a parameter filename can be entered. Refer to the section entitled "**Enter a filename**". When the filename has been obtained, the TRANSFER: PARAMETERS screen such as that in Figure 3.82 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

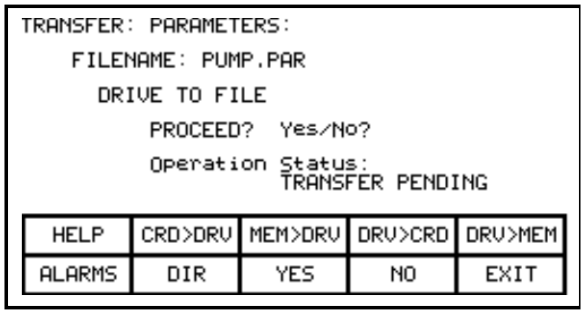


Figure 3.82 – Transfer File Parameters

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

Download from Memory Card

The parameters are read from a memory card and written to the drive by pressing the [F2] key. The operator interface will enter the DIRECTORY screen from which an existing parameter filename can be selected or entered. Refer to the sections entitled "**Select a filename**" and "**Enter a filename**". When the filename has been obtained, the TRANSFER: PARAMETERS screen similar to that shown in Figure 3.82 (except the operation will show "FILE TO DRIVE") will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

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

Parameter File Format

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

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

a) First Line:
   - a revision number followed by a semi-colon (;). Number is not important.
   - the date followed by a semi-colon, i.e. 01/01/1996. Date is not important.
   - the time followed by a semi-colon, i.e. 12:01:01. Time is not important.

b) Remaining Lines:
   - each line contains one parameter. The line consists of the linear parameter number followed by a semi-colon, and the parameter value followed by a semi-colon. i.e.

```
1;0;
2;0;
5;2;
```

Loading Language Modules

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

From the TRANSFER screen, press the [F5] key. The operator interface will enter the DIRECTORY screen, from which an existing language module filename can be selected or entered, Figure 3.83. Refer to the sections entitled “Select a filename” and “Enter a filename”. (If nothing happens then you have not gained the required access to modify the flash memory. Exit to the TRANSFER screen and refer to the section entitled **Enter/Modify an Access Level** to gain access).

When the filename has been obtained, the TRANSFER: LANGUAGE screen such as that in Figure 3.84 will be displayed, showing the filename, indicating the operation you are about to perform and showing the current status of the operation.

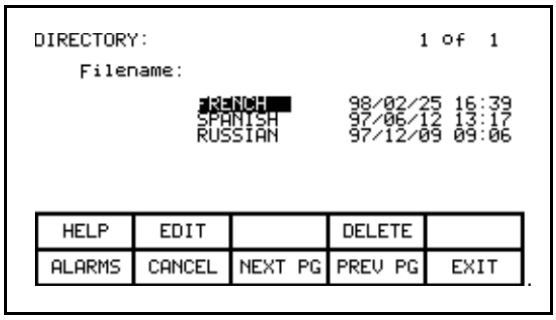


Figure 3.83 – Language Directory

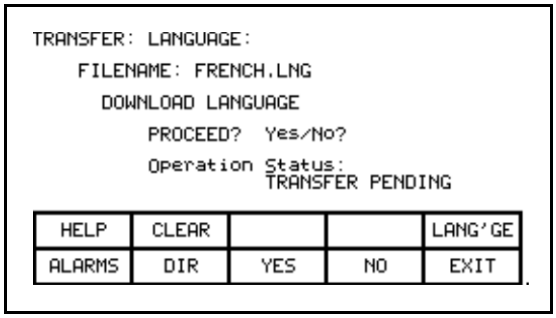


Figure 3.84 – Transfer Language Module

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

In order to download a newer version of a language, all languages in the operator interface must first be cleared (this is a characteristic of flash memory) by pressing the [F2] key on the TRANSFER:LANGUAGE screen. The screen as in Figure 3.85 will then ask you to confirm the operation. Press the [F8] key to proceed, or the [F9] key to abort.

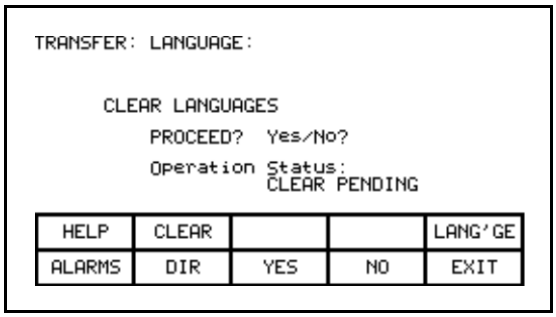


Figure 3.85 – Clear Languages

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

System Programming

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

Operator Interface Menu Hierarchy Chart

The screens of the operator interface are used to form a menu driven system to access the various operations in the drive. The hierarchy of this menu system is shown in Figures 3.86 and 3.87.

What does it show?

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

How do you read it?

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

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

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

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

Example

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

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

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

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

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

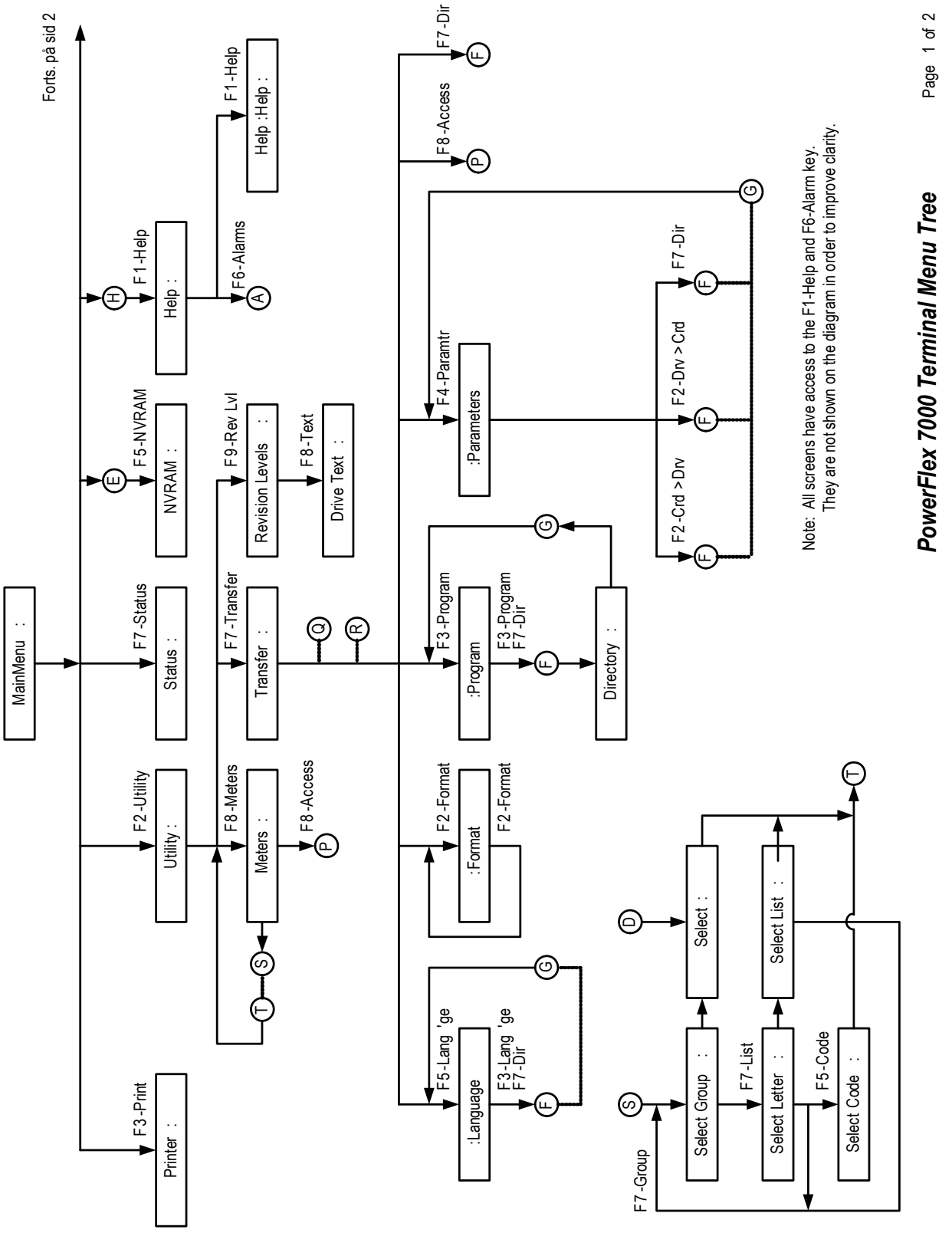


Figure 3.86 – Menu Hierarchy

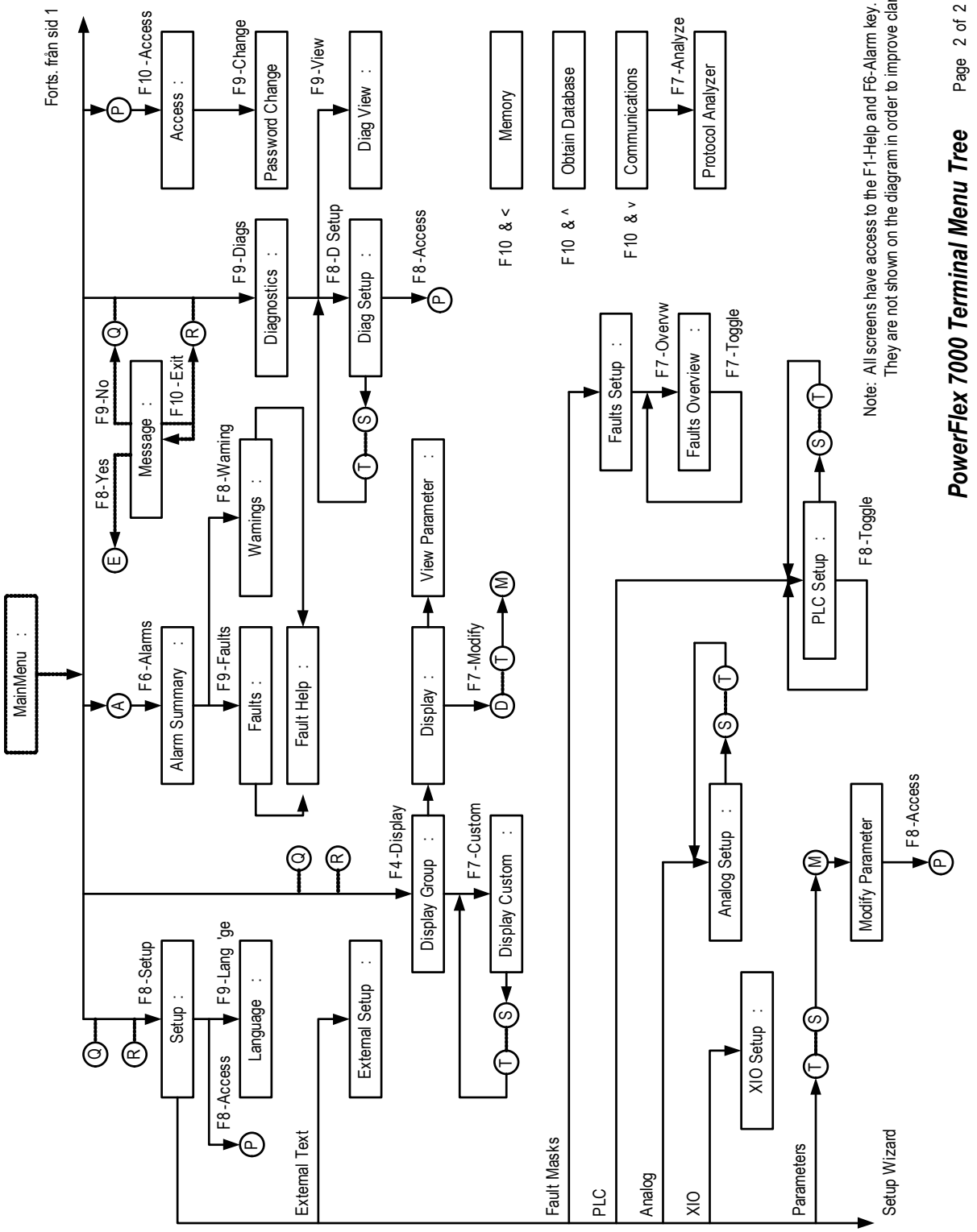


Figure 3.87 – Menu Hierarchy

PCMCIA Memory Card Installation Data

Description

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

WARNING

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

WARNING

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

Installing the Memory Card

1. Locate the vertical card slot on the back of the operator interface. See Figure 3.88.

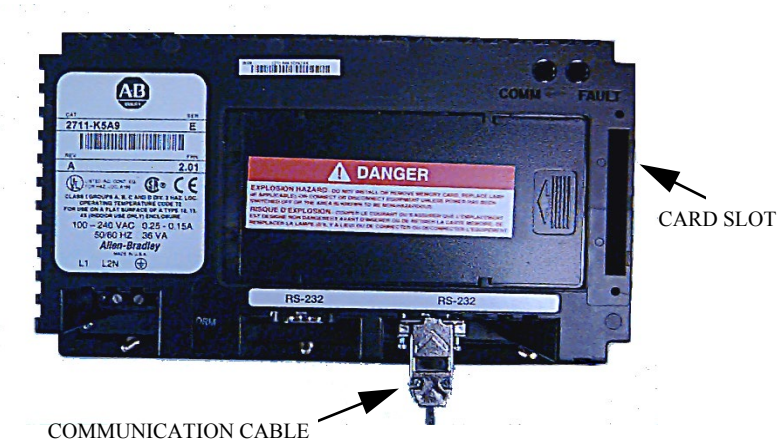


Figure 3.88 – Rear View of Operator Interface

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

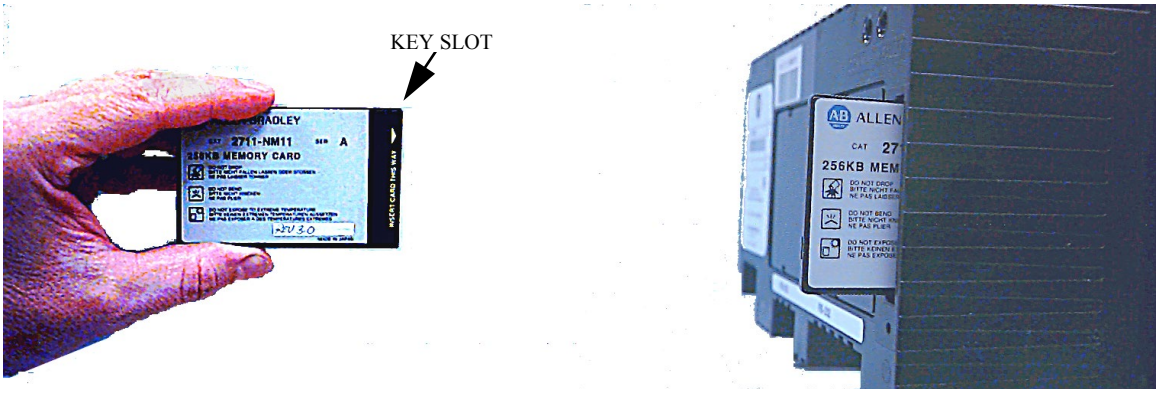


Figure 3.89 – Key Slot Orientation

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

WARNING

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

Component Definition and Maintenance

Cabling Cabinet Components

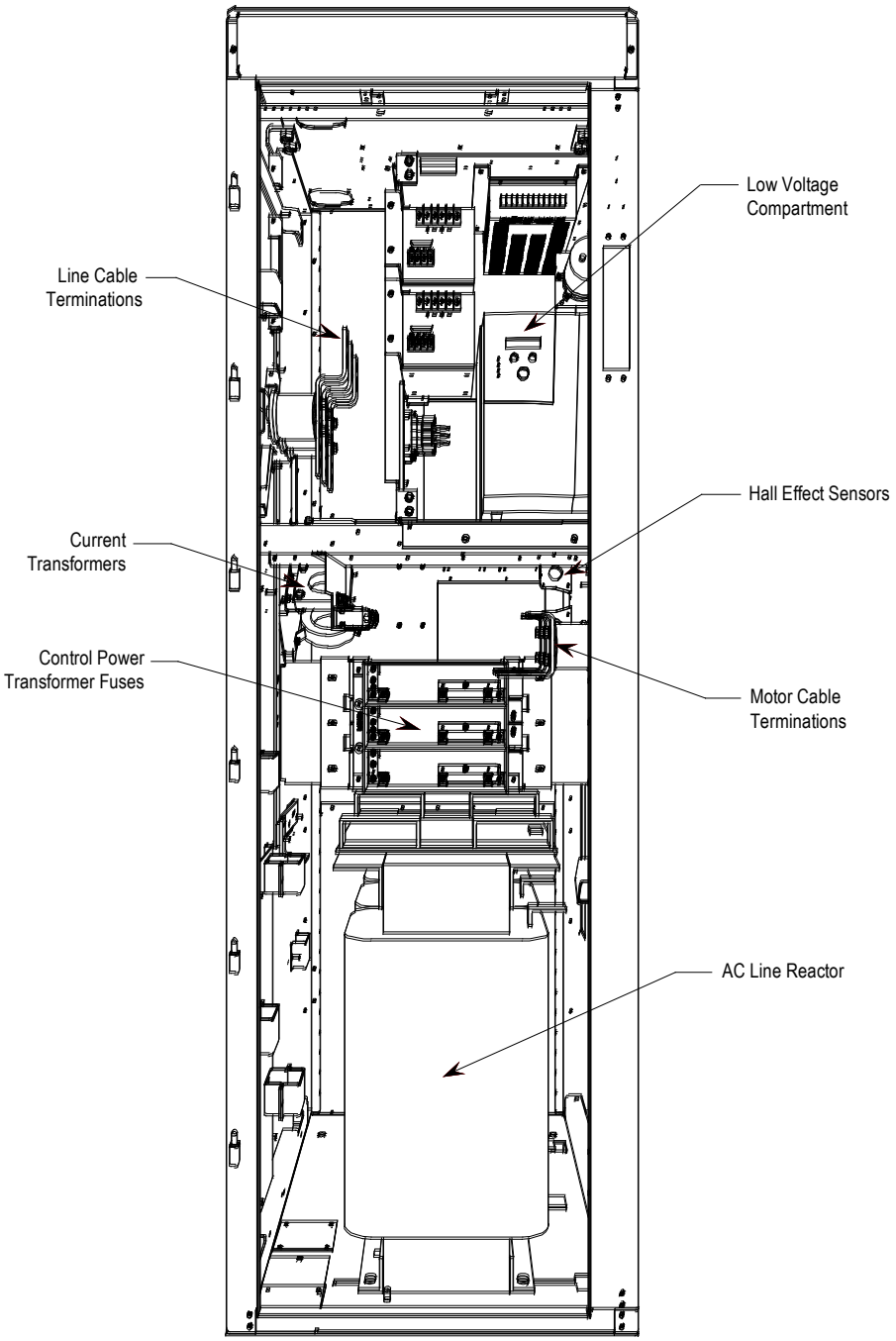


Figure 4.1 – Cabling Cabinet for Configuration #1 (Direct-to-Drive)

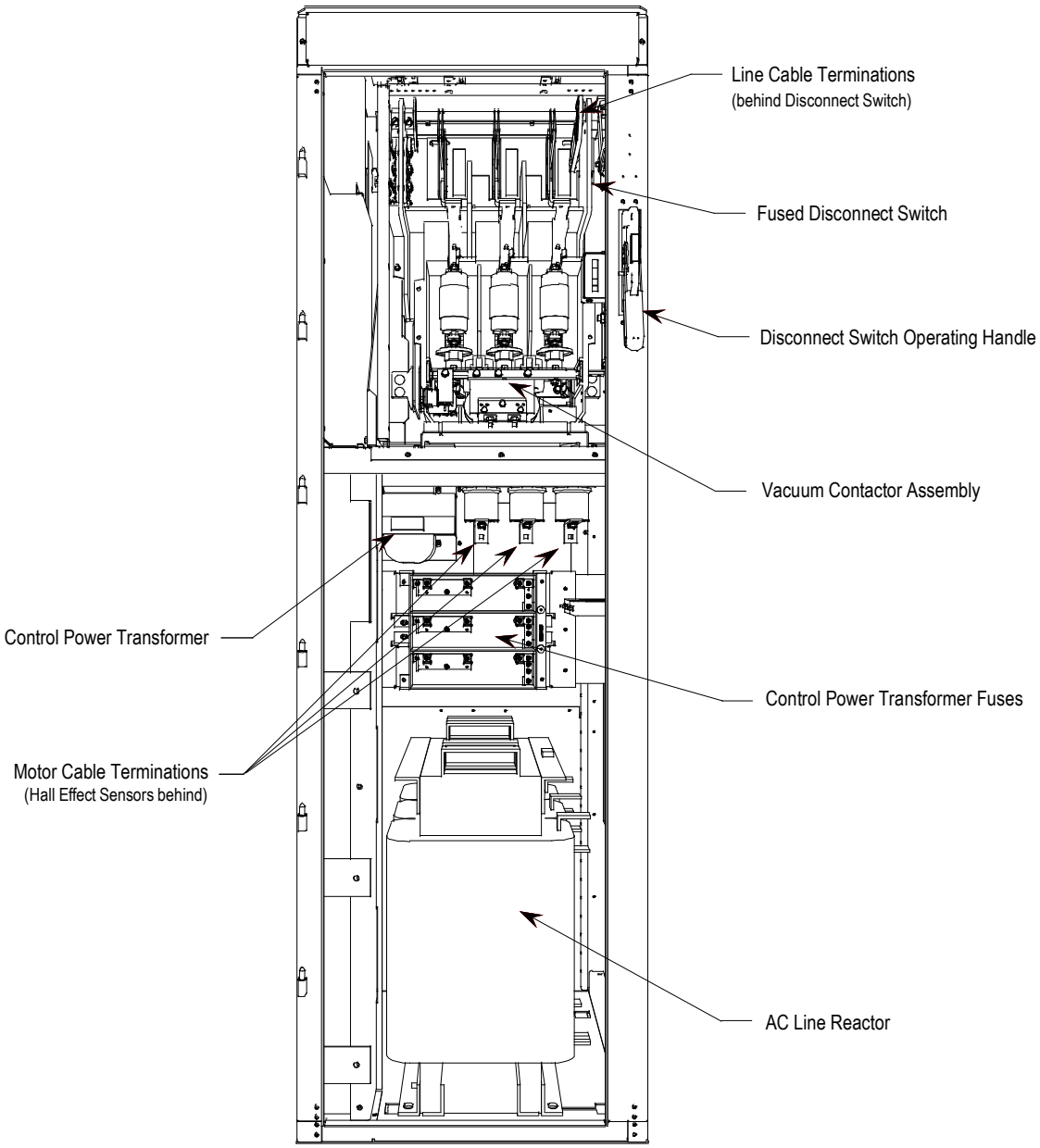


Figure 4.2 – Cabling Cabinet for Configuration #1
(Direct-to-Drive, optional input starter shown)

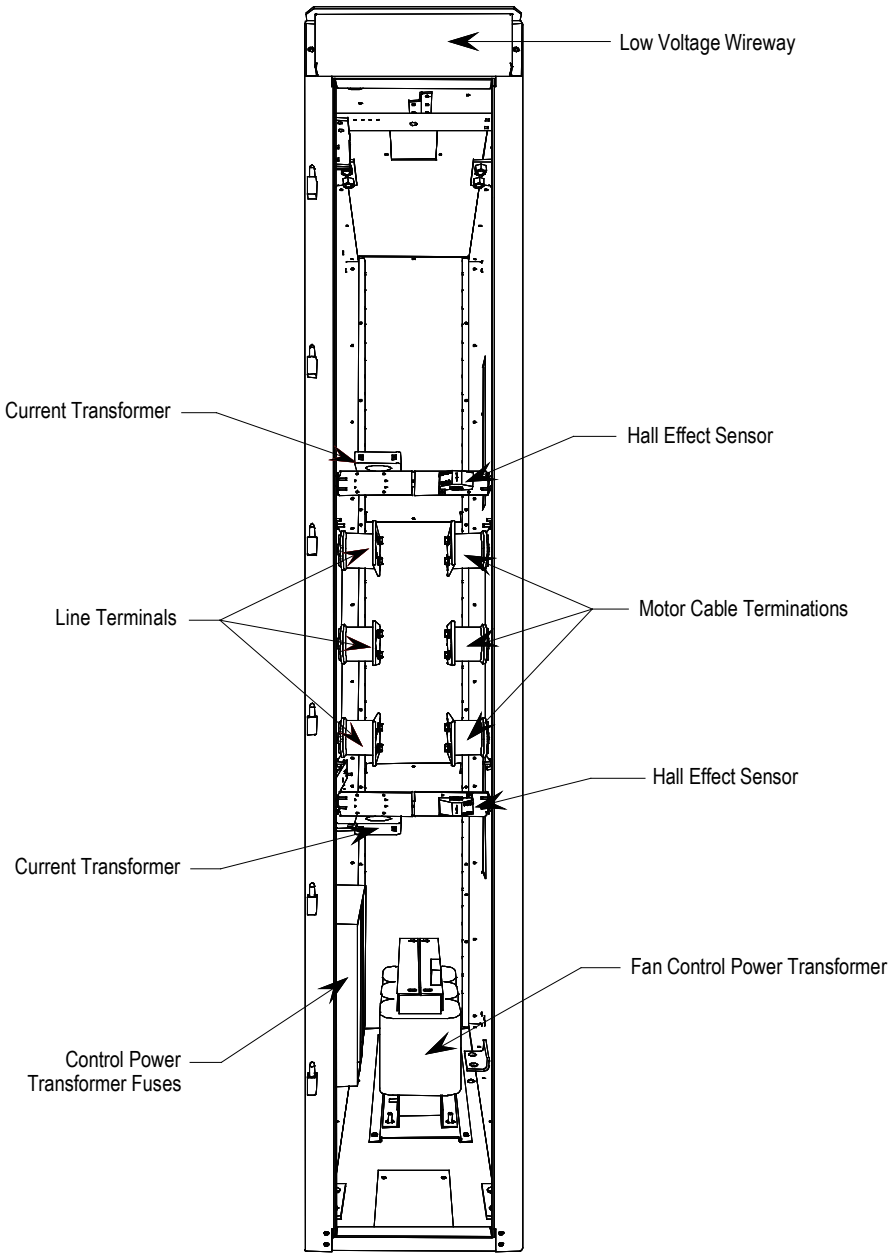


Figure 4.3 – Cabling Cabinet for Configuration #2
(AFE Rectifier with Separate Isolation Transformer)

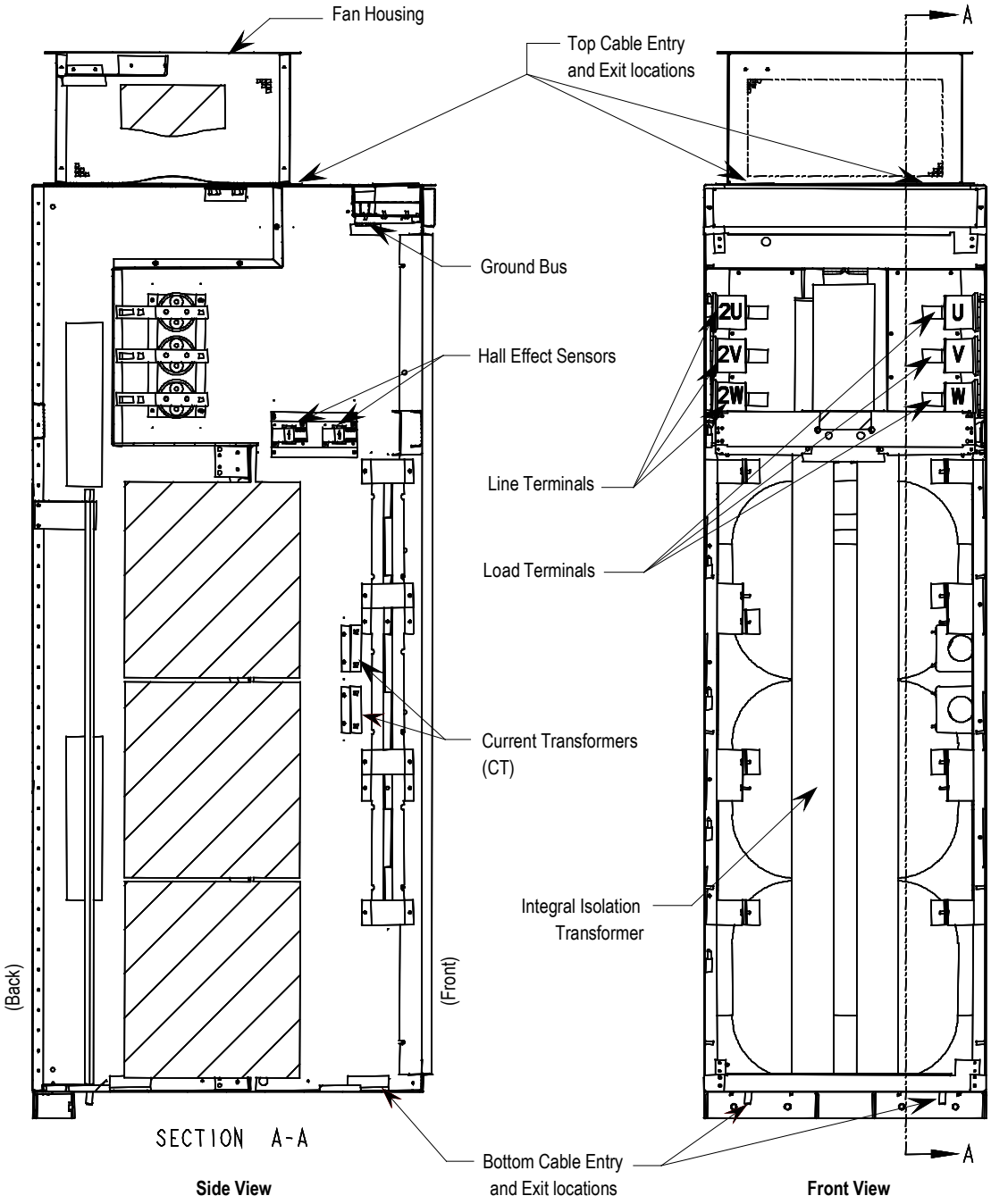


Figure 4.4 –Cabling Cabinet for Configuration #3
(AFE Rectifier with Integral Isolation Transformer)

Converter Cabinet Components

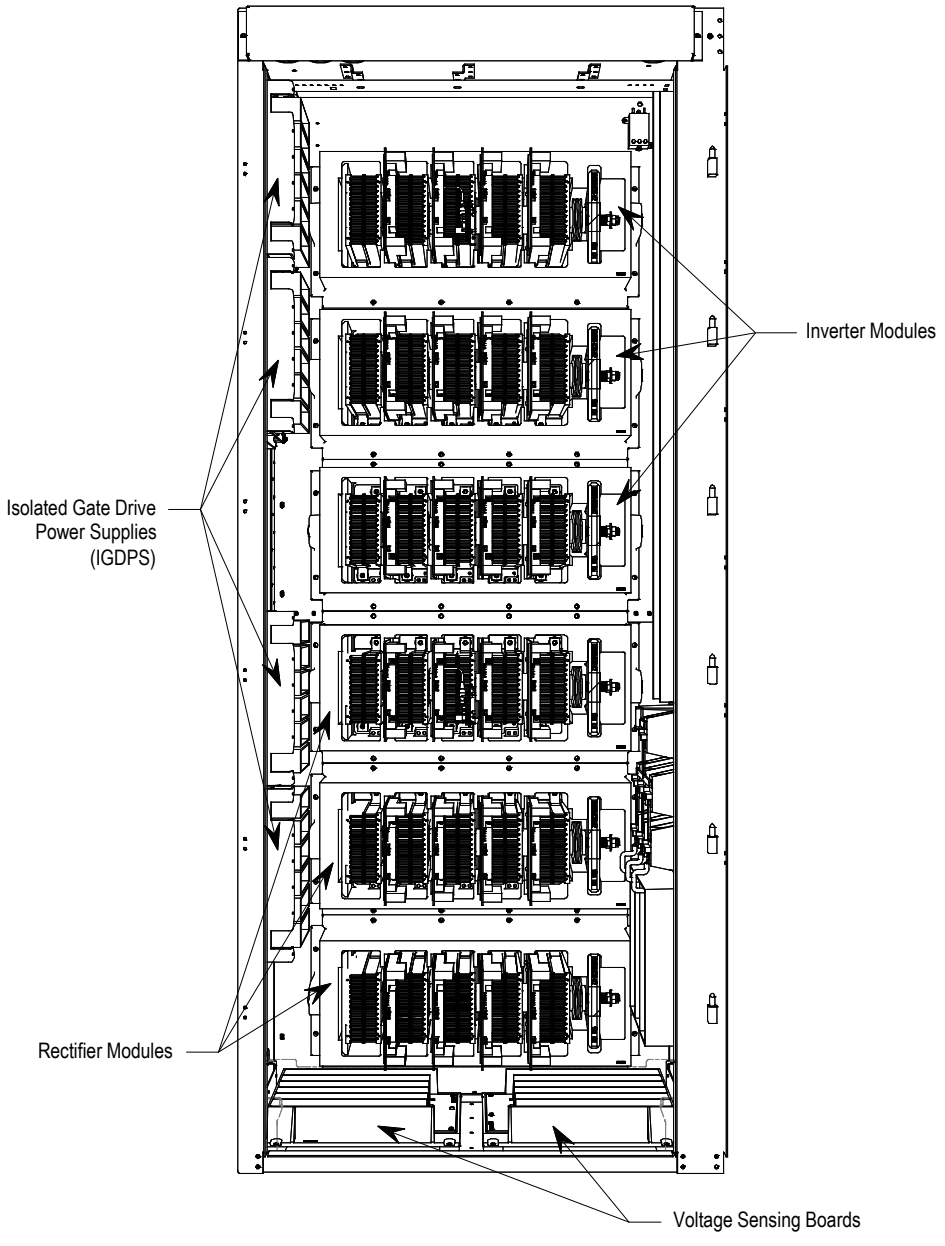


Figure 4.5 – Converter Cabinet Components (3300/4160 V version)

Converter Cabinet

The converter cabinet contains three rectifier modules and three inverter modules. Figure 4.5 shows a 3300/4160 V converter with a PWM Rectifier.

Isolated Gate Driver Power Supplies (IGDPS) are mounted on the cabinet's right side sheet (6600 V, 2400 V Drives) and on the cabinet's left side sheet (3300 V, 4160 V Drives).

Thermal sensors are installed on the top module of the inverter and rectifier. The exact location depends on the drive configuration.

Surge Arresters

Description

Heavy duty distribution class surge arresters are used for transient overvoltage protection in the drives with AFE rectifiers. The arresters are certified as per ANSI/IEEE Std C62.11-1993.

The surge arresters are basically MOVs, with or without an air gap in series, packed in sealed housing. They provide overvoltage protection similar to what the TSN module does. They differ from the TSN in that fusing is not required for the operation of surge arresters.

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

Drive voltage	2.4 kV	3.3 kV	4.16kV, 4.8 kV	6.0-6.9 kV
Arrester rating (RMS)	3 kV	6 kV		9 kV
Arrester MCOV (RMS)	2.55	5.10		7.65

The most severe temporary overvoltage occurs when one phase is grounded in an ungrounded system. The full line-to-line voltage is applied to the arrester in this case. The arresters are designed to operate under this condition continuously without any problems as shown by their Maximum Continuous Operating Voltage (MCOV) rating.

There are three Y-connected surge arresters attached to the incoming MV lines. The neutral point of the arresters is connected to the ground bus.

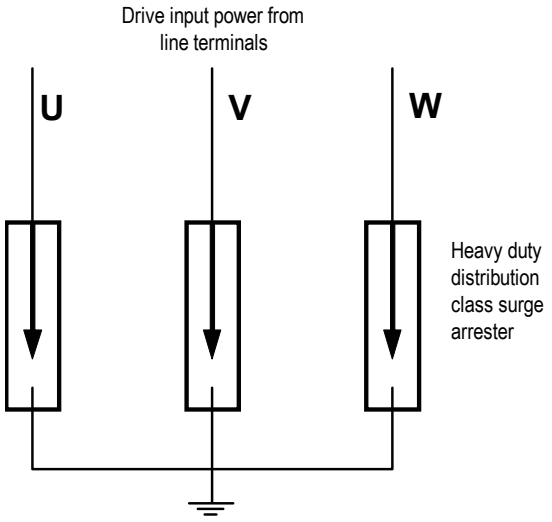


Figure 4.6 – Surge Arresters

Operation

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

The arresters are able to withstand or ride through most commonly seen bus transients within their capability. However, caution should be taken if there is a harmonic filter on the MV bus to which PF7000 is connected. The filter should satisfy relevant international or local standards, such as IEEE Std 1531— Clause 6.4, to avoid high inrush currents.

The surge arrester is certified as per ANSI/IEEE Std C62.11-1993. Certification tests include high current short duration tests, low current long duration tests and fault current withstand tests. The fault current withstand tests consist of different combinations of kA and number of cycles, including a 20kA 10-cycle test, under which the arresters are non-fragmenting and without expelling any internal components.

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

Field Test and Care

No field testing is necessary. The arresters do not require special care. However at very dusty sites, it is suggested to clean the arrester when the whole drive is cleaned.

PowerCage™

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

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

Each drive consists of three PowerCage rectifier modules and three PowerCage inverter modules.

AFE type rectifiers use SGCTs as semi-conductors.

All inverter modules use SGCTs as semi-conductors.

The size of the PowerCage will vary depending on the system voltage.

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

Configuration	Inverter SGCTs	Rectifier SGCTs	Rectifier SCRs
2400V, AFE	6	6	0
3300/4160V, AFE	12	12	0
6600V, AFE	18	18	0

ATTENTION

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

ATTENTION

The SGCT circuit board is sensitive to static charges. It is important that these boards should not be handled without proper grounding.

ATTENTION

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

The inverter module is the module that contains the SGCT power device necessary for producing the motor voltages and currents. There are three inverter modules in each drive; the number of SGCTs per module depends on the voltage rating of the motor. To understand a module, a description of a single SGCT and its peripheral equipment is all that is required.

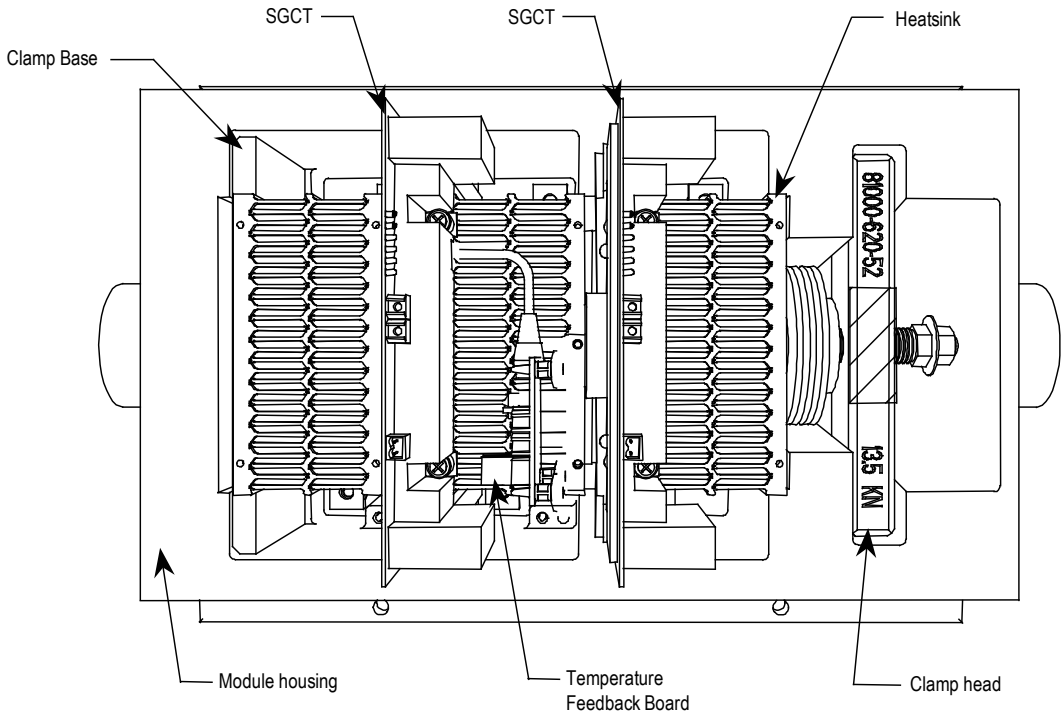


Figure 4.7 – 2-Device PowerCage

PowerCage™ (cont.)

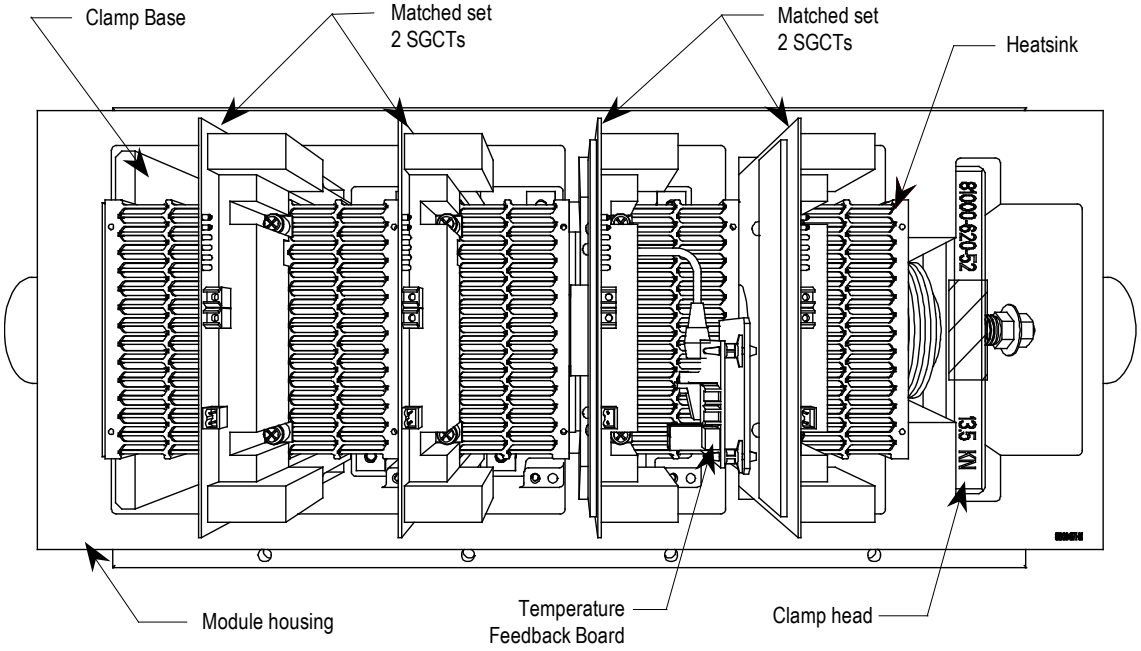


Figure 4.8 – 4-Device PowerCage

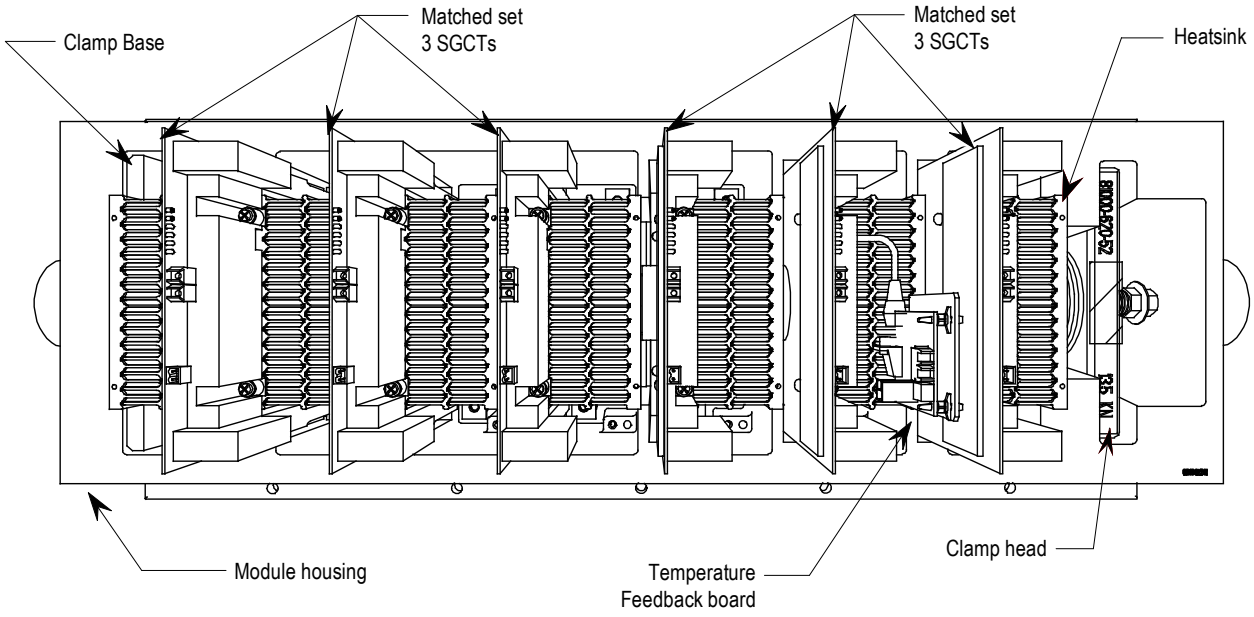


Figure 4.9 – 6-Device PowerCage

SGCT and Snubber Circuit

As with all power semi-conductor or thyristors, the SGCT must have a snubber circuit. The snubber circuit for the SGCT is comprised of a snubber resistor in series with a snubber capacitor.

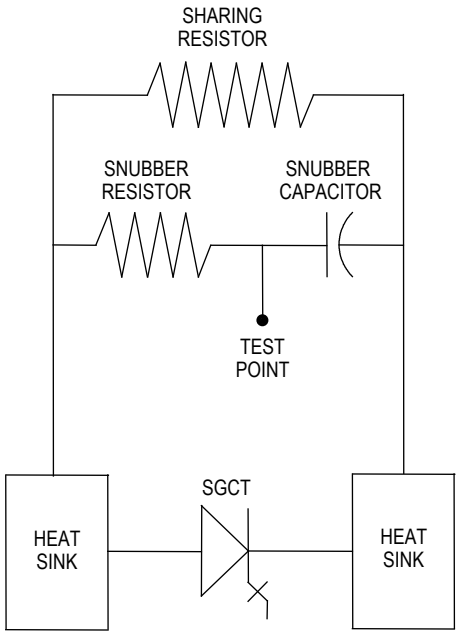


Figure 4.10 – SGCT and snubber circuit

In addition to the snubber circuit, a sharing resistor is connected in parallel with the SGCT. The function of the sharing resistor is to ensure the voltage is shared equally among the SGCTs when connected in series. SGCTs are connected in series to increase the total reverse voltage blocking (PIV) capacity as seen by the electrical circuit. A single SGCT has a PIV rating of 6500 V. This single device will provide sufficient design margin for electrical systems with 2400 V medium voltage supply. At 4160 V, 2 SGCTs must be connected in series to provide a net PIV of 13000 V to achieve the necessary design margin. Similarly, three SGCTs must be connected in series at 6600 V, providing a net PIV of 19500 V to achieve the necessary design margin.

The cooling requirements of the SGCT are achieved by placing the SGCT between two forced air-cooled heatsinks, one heatsink on the anode and the other heatsink on the cathode. The clamp assembly on the right hand side of the inverter module generates these forces.

SGCT	Device Diameter	Clamp Force
400 A SGCT	38 mm	8.6 kN
800 A SGCT	47 mm	13.5 kN
1500 A SGCT	63 mm	20 kN

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

This design directs external filtered air through the heatsink slots to dissipate heat from the SGCTs. The door filter is necessary to ensure the slots on the heatsinks do not get plugged with dust particles.

Uniform Clamping Pressure

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

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

Checking Clamping Pressure

Periodically, the clamping force in the PowerCage should be inspected. Ensure there is no power to the equipment.

ATTENTION

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

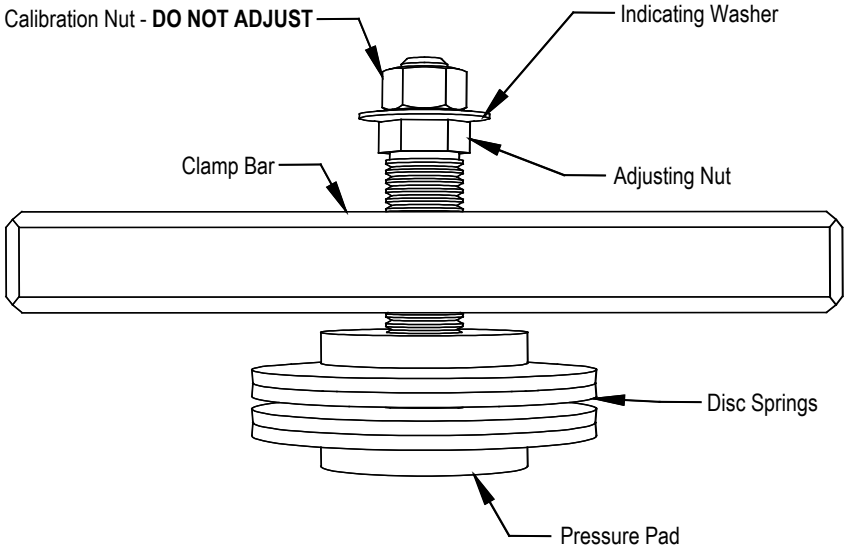


Figure 4.11 – Clamp Head Illustration

If proper force (as designated on the clamp head block) is applied to the clamping assembly, the indicating washer should just be able to rotate with fingertip touch. The indicating washer should not rotate freely. Some force will need to be applied with your fingertips.

Clamping Pressure Adjustment

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

IMPORTANT Never rotate the calibration nut located outside the indicating washer at the end of the threaded rod. The rotation of the outer nut will affect the torque calibration, which is factory set. Only adjust the inside nut. (See Figures 4.11 and 4.12.)

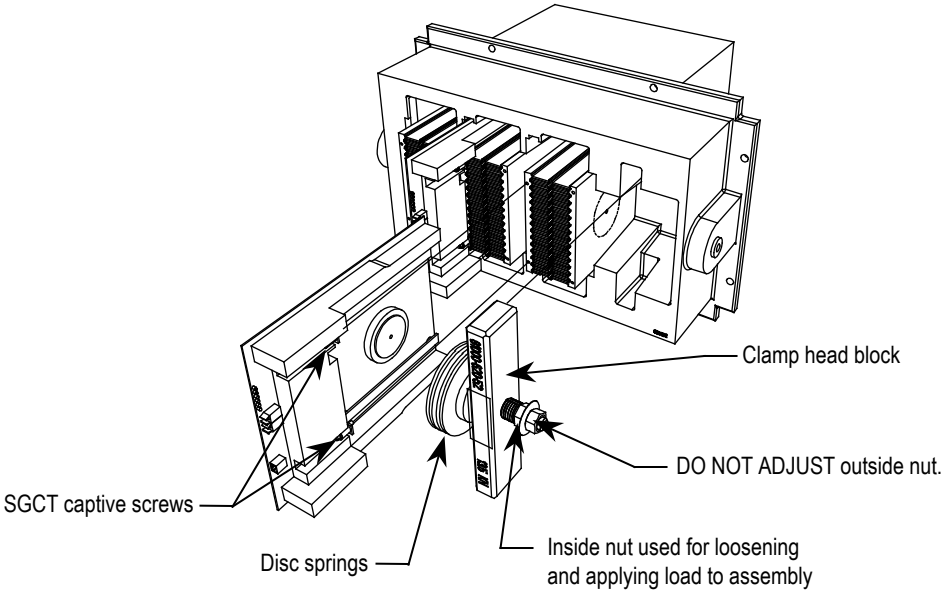


Figure 4.12 – Detail of the clamping assembly

Temperature Sensing

Thermal sensors are located on heatsinks in the converter. The thermal sensor is mounted on the heatsink with the temperature feedback board.

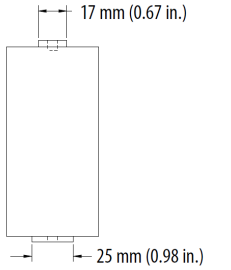
Snubber Capacitor Replacement

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

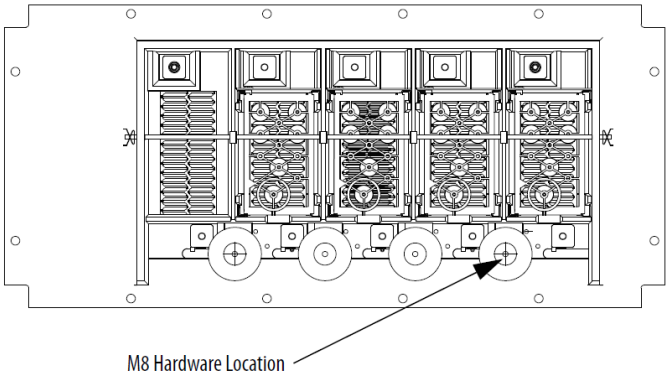
IMPORTANT If the drive can be accessed from the rear, the snubber capacitors can be removed and replaced from the rear, with the PowerCage modules in place.
If the drive cannot be accessed from the rear, the PowerCage modules must be removed to access the snubber capacitors.
Replace the capacitors one at a time. Do not remove all at once.

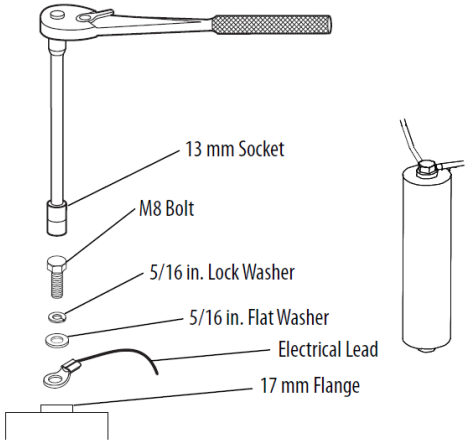
1. Using a 13 mm socket wrench, remove the M8 bolt on the end of the capacitor and retain hardware.
2. Hand rotate the capacitor counter-clockwise to unscrew it from the threaded stud connecting it to the PowerCage module.
3. Apply a drop of Loctite 425 to the thread of the 25 mm flange side of the replacement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

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



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





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

Symmetrical Gate Commutated Thyristor Replacement

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

SGCTs must be replaced in matched sets:
- 3300V and 4160V systems use sets of 2
- 6600V systems use sets of 3

The SGCT and associated control board are a single component. There will never be a time when the device or the circuit board will be changed individually. There are 4 LEDs on the SGCT, and the following table describes their functions:

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

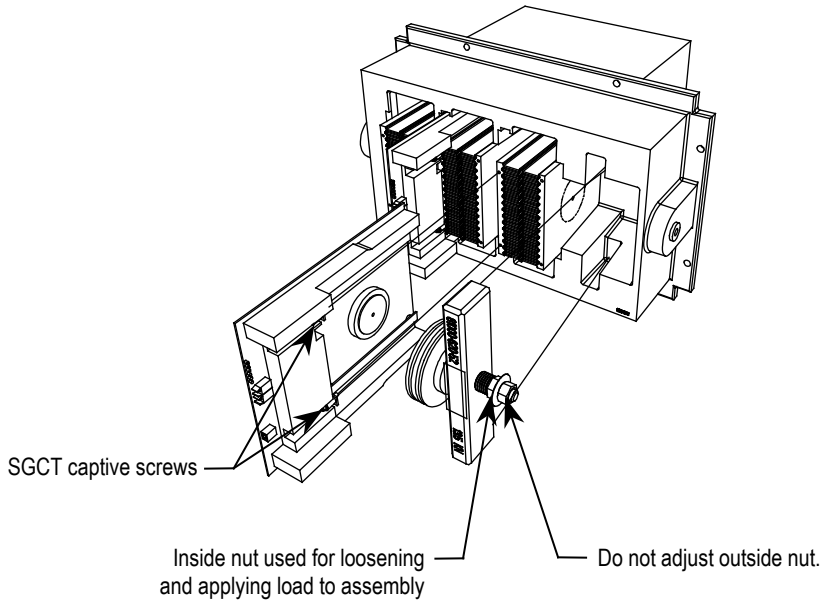


Figure 4.13 – Replacing the SGCT

Symmetrical Gate Commutated Thyristor Replacement (cont.)

1. Ensure there is no power to the equipment.

ATTENTION

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

2. Note the position of the fiber optic cables for assembly.
3. To remove the SGCT, it is necessary to remove the gate driver power cable and fiber optic cables. Exceeding the minimum bend radius (50 mm [2 in.]) of the fiber optic cables may result in damage.

ATTENTION

The fiber optic cables can be damaged if struck or bent sharply. The minimum bend radius is 50 mm (2 inches). The connector has a locking feature that requires pinching the tab and gently pulling straight out. The component on the printed circuit board should be held to prevent damage.

4. Remove the load on the clamp head assembly as described on page 6-19.
5. Two brackets secure the board to the heatsink. Loosen the captive screws until the circuit board is free. It may be necessary to adjust the position of the heatsinks to allow free movement of the SGCT.
6. Slide the circuit board straight out.

ATTENTION

The SGCT can be destroyed or damaged by static charges. Personnel must be properly grounded before removing the replacement SGCT from the protective anti-static bag that it is supplied in. Use of damaged circuit boards may also damage related components. A grounding wrist strap is recommended for handling sensitive circuit boards.

IMPORTANT

Replacement SGCTs will be supplied, grouped in matched sets. This means that all of the SGCTs in a leg have been grouped together based on their electrical performance. Grouping similarly matched devices ensures balanced load sharing of a leg of devices. When replacing the device, it is necessary to replace all the SGCTs in a matched set, even if only one has failed.

7. Clean the heatsink with a soft cloth and rubbing alcohol.

8. While grounded, remove the SGCT from the anti-static bag it is supplied in.

9. Apply a thin layer of Electrical Joint Compound (Alcoa EJC No. 2 or approved equivalent) to the contact faces of the new SGCTs to be installed. The recommended procedure is to apply the compound to the pole faces using a small brush, and then gently wipe the pole face with an industrial wipe so that a thin film remains. Examine the pole face before proceeding to ensure that no brush bristles remain.

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

10. Slide the SGCT into place until the mounting brackets contact the surface of the heatsink.

11. Tighten the captive screws located in the brackets.

12. Follow procedure “Uniform Clamping Pressure” to ensure the heatsinks are clamped to a uniform pressure.

13. Connect the power cable and fiber optic cables (ensure the bend radius is not exceeded).

Snubber Resistors

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

Testing Snubber Resistors

Access to the snubber resistor is not required to test its resistance. Located within the PowerCage under the heatsink is a snubber circuit test point. For each device, there is one test point.

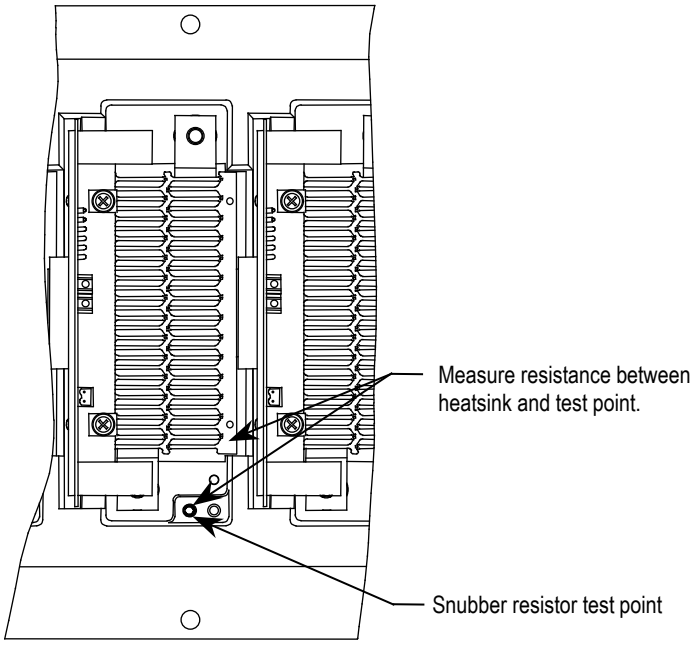


Figure 4.14 – Testing the Snubber Resistor

Fiber Optic Cabling

The equipment is provided with fiber optic cabling as a means of interfacing the low voltage control to the medium voltage circuits. The user of the equipment should never need to change the routing of the fiber optic cables.

Each end of a fiber optic cable is provided with a connector that plugs and latches into its respective location on a circuit board. To disconnect a fiber optic cable, depress the ridged plastic tab at the end connector and pull. To install a fiber optic cable insert the fiber optic port of the circuit board so that the plastic tab latches into place.

Air Pressure Sensor

An air pressure sensor is located in both the converter cabinet and the integral rectifier transformer cabinet (if applicable). In both cases, it is located in the upper left-hand quadrant of the cabinet.

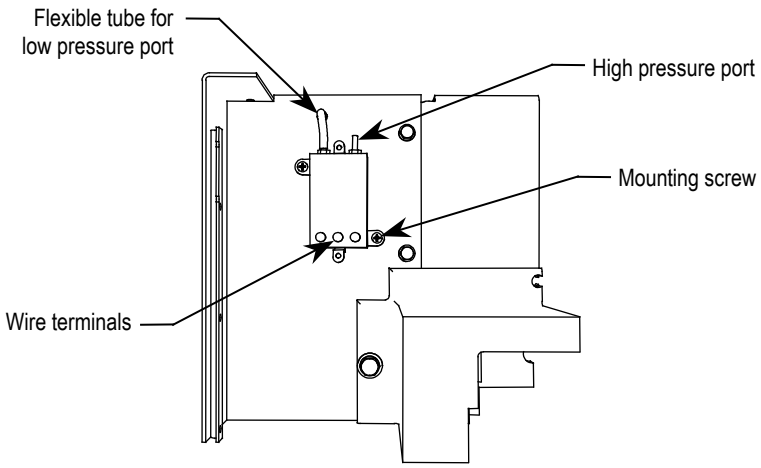


Figure 4.15 – Air Pressure Sensor

The air pressure sensor measures the difference in air pressure between the front and rear of the converter modules/integral rectifier transformer. A small direct current voltage signal is transmitted to the control circuits.

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

If, as a result of blockage or fan failure, flow becomes so reduced that there is a risk of thermal damage for either the converter or transformer, a fault signal will cause drive shutdown.

D.C. Link / Fan / Control Components

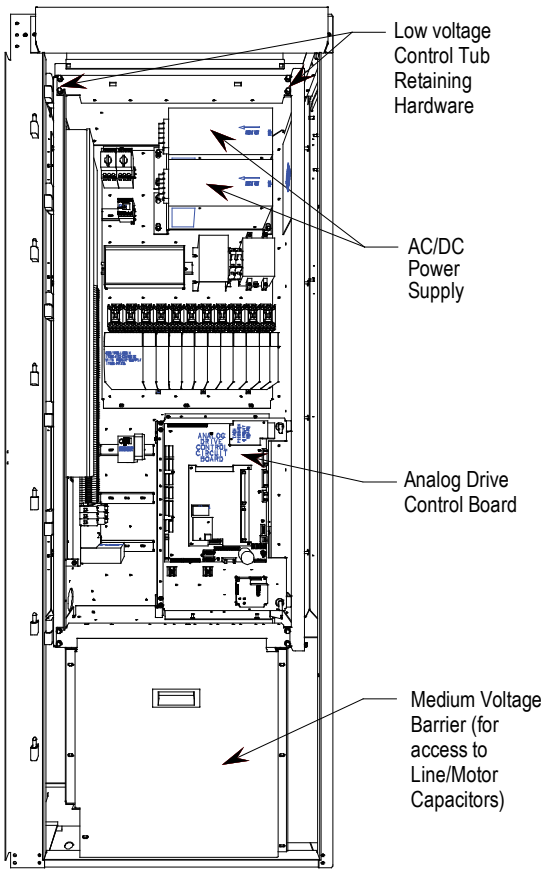


Figure 4.16 – DC Link and Fan cabinet with low voltage control tub shown

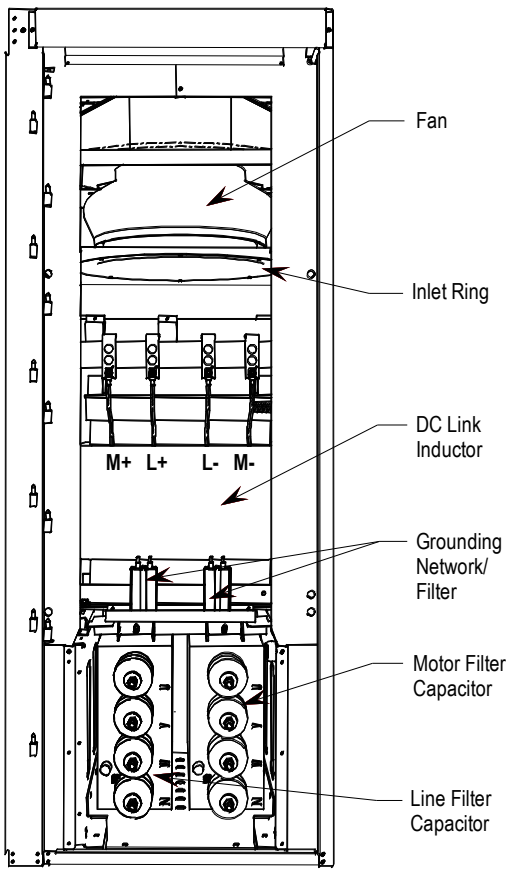


Figure 4.17 – DC Link and Fan Cabinet with low voltage control tub removed

When the door is opened, control components are accessible. Behind the low voltage swing-out panel is the medium voltage compartment where the DC link and fan are located.

The D.C. link is mounted on the floor plate of the cabinet above the capacitors.

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

The D.C. link is equipped with thermal protection for the windings.

There is a current sensor on the M+ conductor.

Above the D.C. link is the fan.

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

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

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

Filter Capacitors

Filter capacitors are used on the motor side for all drives. The AFE rectifier option also includes filter capacitors on the line side. Refer to Figure 4.17 (DC Link and Fan Cabinet with control panel removed).

The filter capacitors are three-phase four-bushing units and “oil-filled”. The three-phase capacitors are comprised of internal single-phase units that are connected in a Y configuration. The neutral point of the Y is connected to the fourth bushing, which is accessible and can be used for neutral point voltage measurement or other protection/diagnostics purposes. Depending on the drive configuration, the fourth bushing may or may not be connected to circuitry. The metal cases of the capacitors are grounded through a stud on the capacitor housing.

The capacitors are equipped with internal “bleeding resistors” to discharge the capacitor and reduce its voltage below 50V in 5 minutes when left disconnected. A typical three-phase capacitor is shown below:

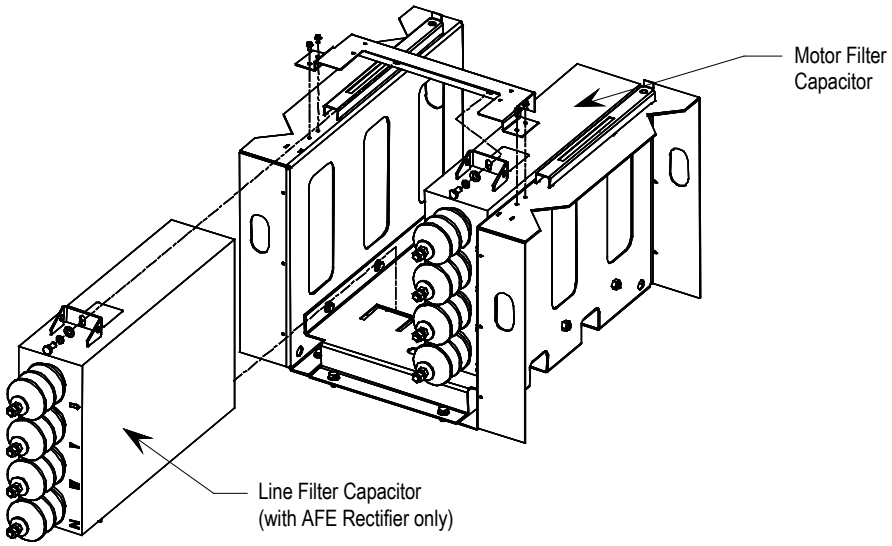


Figure 4.18 – Motor Filter Capacitor

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.

Generator Note:

WARNING

Verify that the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

Filter Capacitor Replacement

1. Ensure there is no power to the equipment.

ATTENTION

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

ATTENTION

Verify the load is not turning due to the process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Remove medium voltage barrier below the low voltage panel to access capacitor. (See Figure 4.16).
3. Short all four bushings together and to ground on both capacitors before handling the connections.
4. Note the location of all the cables and mark them accordingly.
5. Remove the 4 power connections to the terminals, and the single ground connector from the drive to the capacitor frame.
6. Remove the grounding network and top bracket that holds the capacitor in place. At the bottom of the capacitor, there is no hardware securing the capacitor; it fits into a slot in the assembly.
7. Remove the capacitor from the drive. THESE CAPACITORS CAN WEIGH AS MUCH AS 100 kg (220 lbs), SO YOU WILL REQUIRE TWO PEOPLE TO REMOVE A CAPACITOR.

IMPORTANT **Do not lift capacitor by bushings. Doing so may damage bushings and result in oil leakage.**

8. Install the new capacitor, sliding it back until it fits into the slot. Fasten the top bracket and grounding network.
9. Reconnect all the power cables and the ground connection. These use M14 hardware, but should only be tightened to 30 Nm (22 ft-lbs.) due to capacitor mechanical constraints.
10. Remove any shorting/grounding conductors.
11. Reinstall the sheet metal that was removed, and complete one final check to ensure connections are secure and correct.

Testing Filter Capacitors

Two methods of testing/checking the capacitors are explained below. The first method is simple, easy, and takes least amount of time to check the capacitors. In this method, you would need a digital multimeter (**DMM**) to measure the capacitance in micro-Farad (μF) across each phase-to-neutral of the capacitors. It is recommended that you should use this method since it avoids the chance of creating re-torque issues because you don't have to disconnect the capacitors unless the readings are off by 15% or more. For accurate measurements, Rockwell recommends that you should use one of the DMMs given in Figure 4.19.

The second method involves disconnecting all capacitors from the circuit, and testing each capacitor individually by applying 120V across each phase-to-neutral and measuring the current in each phase. This method is most accurate and can be used to confirm the integrity of the capacitor when the readings from the first method appear to be unsatisfactory.

First Method

1. Ensure there is no power to the equipment before testing the capacitor.

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

ATTENTION 	Verify the load is not running due to process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Follow appropriate safety steps to isolate the equipment from medium voltage.
3. Verify that there is no voltage present on the capacitor by using a hot stick or any other appropriate voltage-measuring device.
4. Perform visual inspection to verify there is no oil leak or bulge in any of the capacitors.
5. Using a DMM measure the capacitance across each phase-to-neutral of capacitors without removing any connections. If the difference between the highest and the lowest readings is below 15% then all capacitors are in good condition.
6. If the difference between the highest and the lowest readings is off by 15% or more, then you might have a bad capacitor.
7. Before disconnecting the capacitors, note the location of all the cables and mark them accordingly.
8. Disconnect power cables/bus bars from the capacitor terminals on all four bushings and isolate them from the capacitor. (Refer to “Filter Capacitor Replacement” guidelines in the Classic User Manual - Component Definition and Maintenance chapter (chapter 6) for using proper torque when reconnecting the capacitors)

Second Method

1. Ensure there is no power to the equipment before testing the capacitor.

ATTENTION

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

ATTENTION

Verify the load is not running due to process. A freewheeling motor can generate voltage that will be back-fed to the equipment being worked on.

2. Follow appropriate safety steps to isolate the equipment from medium voltage.

3. Verify that there is no voltage present on the capacitor by using a hot stick or any other appropriate voltage-measuring device.

4. Perform visual inspection to verify there is no oil leak or bulge in any of the capacitors.

5. Note the location of all the cables and mark them accordingly.

6. Disconnect power cables from the capacitor terminals on all four bushings and isolate them from the capacitor. (Refer to “Filter Capacitor Replacement” guidelines in the Classic User Manual - Component Definition and Maintenance chapter (chapter 6) for using proper torque when reconnecting the capacitors)

7. Connect a low voltage single-phase test power, for instance 110V or 220V, across a phase and the neutral of the capacitor. Switch on the test power and measure the test voltage and current drawn by the capacitor. Repeat the test for all three phases and note down the test voltage and current.

ATTENTION

The capacitor will charge during this test so care must be taken to prevent a shock or injury. When moving the test connections from one phase to the next, wait for at least five minutes until the capacitor is discharged. Using a hot stock or other voltage-measuring device, verify that the capacitor is fully discharged before touching it.

8. Now, calculate the capacitance from the measured values of test voltage and current. For a good capacitor, the calculated capacitance value for each of the three readings should be within ±15% of the capacitor nameplate micro-Farad. If it is outside this range then the capacitor must be replaced.

Example: An example is given below to illustrate how the capacitance value is calculated.

e.g. - the capacitor under test is rated at 400 kVAR, 6600V, 50Hz, 29.2 µF. You are using 200V, 50Hz test power and have recorded the values of voltage and current for each test as given in the table below.

Phase - Neutral	**L1-N**	**L2-N**	**L3-N**
Test Voltage	200V	200V	200V
Measured Current	1.87A	1.866A	1.861A

Let us calculate the capacitance using the first reading. In this case:

V = 200V, I = 1.87 for L1-N

Xc = V/I = 200/1.87 = 106.95

$$C = {1}/{2\pi f Xc}$$

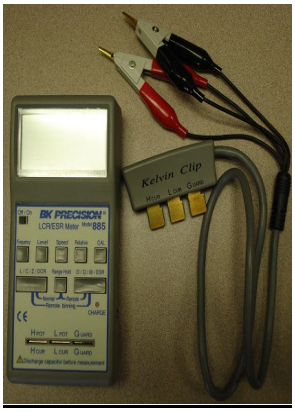
$$C = {1}/{2 \times 3.14 \times 50 \times 106.95}$$

$$C = 29.7 \mu F$$

Where, f = *frequency of the applied voltage.*

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

Recommended Digital Multimeters (DMM) to be used for checking filter capacitors



BK Precision LCR/ESR Meter, Model 885

Fluke 179

Fluke 12

Fluke 29

Fluke 87V

Figure 4.19 – Recommended Digital Multimeters (DMM)

Fan Replacement

There are several models of cooling fans used in PowerFlex drives. Differing fan types may be used in the various locations throughout the drive.

DC Link Section

The fan consists of a motor impeller assembly. To replace the fan, it is necessary to remove the fan exhaust hood. See Figure 4.20.

ATTENTION

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

Safety Notes

Fan replacement requires working at a significant height from the floor. Care should be taken to make a suitable platform from which to work.

The fan motor weighs approximately 45 kg (100 lbs) and will require suitable lifting provision. Ensure that fan power is locked out during fan maintenance.

Remove the eight nuts that secure the motor frame to the side sheets of the cabinet. Disconnect the power leads to the motor. Note the terminal locations so that proper fan rotation is maintained.

To extract the fan, lifting hooks are placed in the holes of the motor mounting brackets and the assembly is withdrawn vertically from the cabinet. Do not support the assembly on the impeller or damage may result.

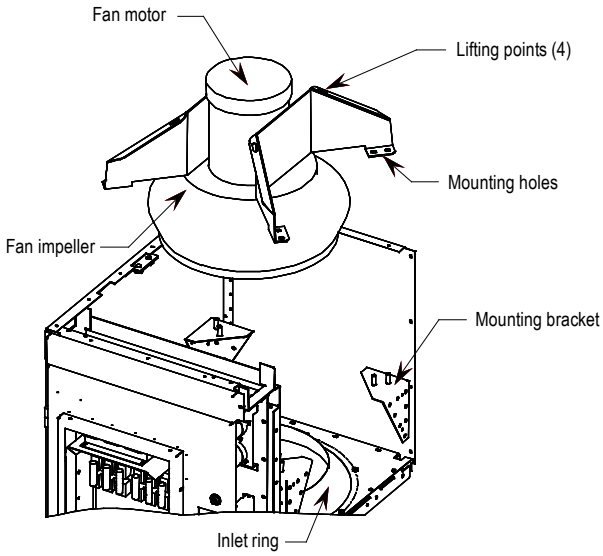


Figure 4.20 – Fan Removal

Fan Installation

Care must be taken in handling of the fan as its balance could be affected by poor handling.

Fan installation is performed in the reverse order of its removal. Upon completion of installation, rotate the impeller by hand to ensure that there is no contact with the inlet ring.

Top of Integral Isolation Transformer Section

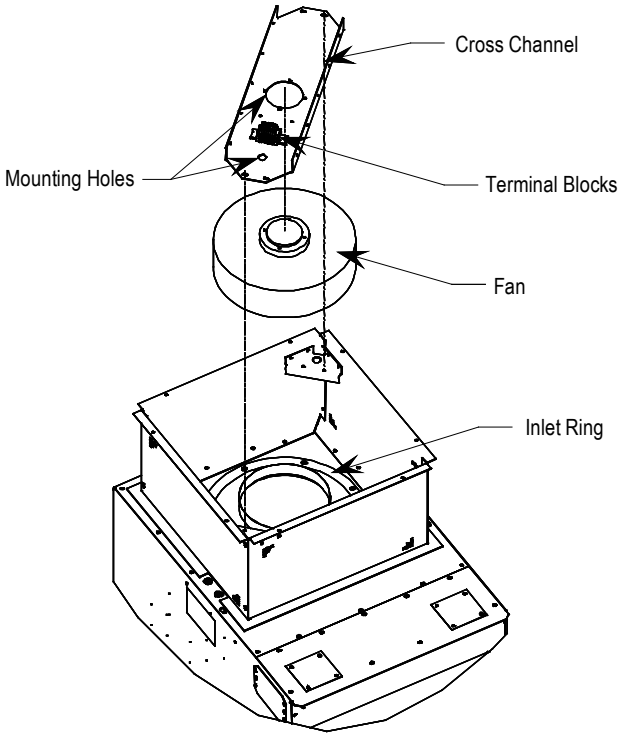


Figure 4.21 – Isolation Transformer Fan Removal

1. Remove the top plate of the ventilation housing and label fan supply leads before disconnecting.

2. Remove the bolts retaining the cross channel and withdraw the fan and channel from housing.

3. Disassemble and replace the fan.

4. Reassemble in the reverse order of removal.

Fan Replacement (cont.)

Top of Integral Line Reactor and Input Starter Section

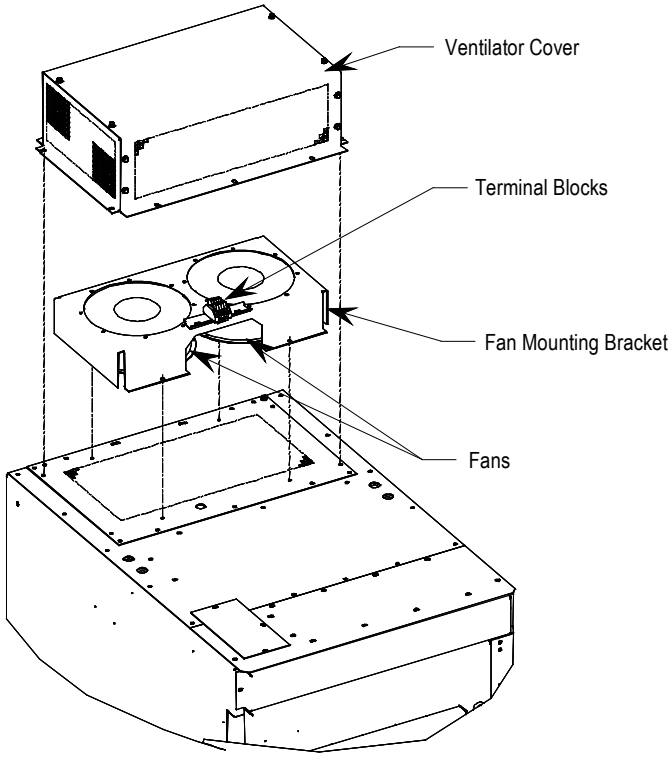


Figure 4.22 – Starter/Line Reactor Cabinet Fan Removal

1. Remove the top ventilation cover from the exterior of the cabinet.
2. Remove mounting screws and invert fan mounting bracket to expose fan mounting hardware.
3. Unplug or disconnect fan leads from terminal blocks and replace fan.
4. Reassemble in the reverse order of removal.

Impeller Maintenance (DC Link / Fan Section)

Impeller Removal from Motor Shaft

The fan impeller is held onto the motor shaft with a split tapered bushing. This bushing is positioned on the motor shaft and through the center of the impeller. Two cap screws, when tightened to 10.2 N-m (7.5 ft-lbs.), lock the bushing onto the motor shaft and the impeller to the bushing.

Safety notes

The impeller is fragile. Do not allow the impeller to support the weight of the motor.

If vertical, the impeller and bushing may fall when loosening cap screws. Physical injury or component damage may result.

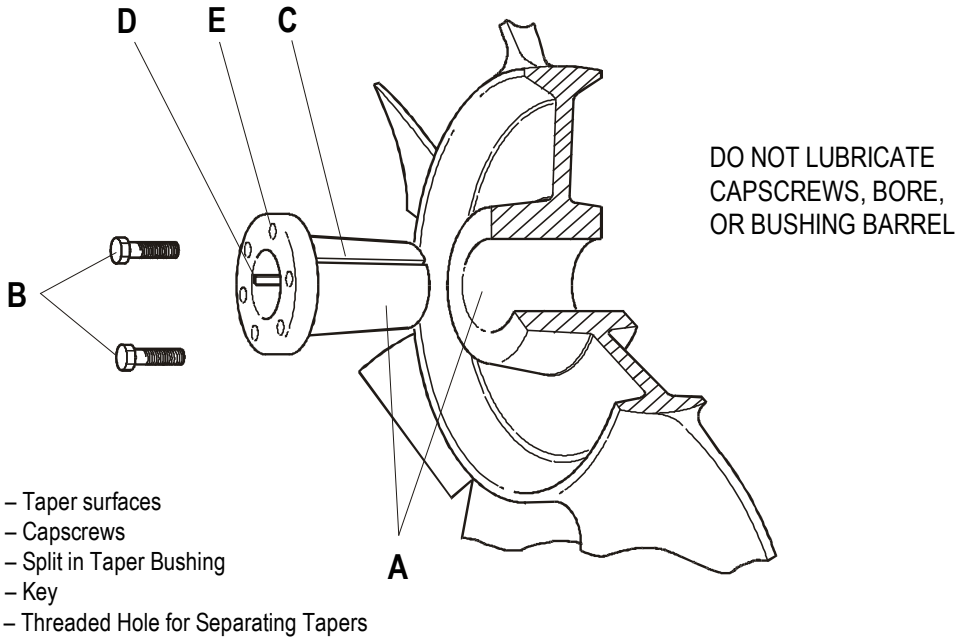


Figure 4.23 – Cutaway View of Fan Impeller and Bushing

Impeller Maintenance (DC Link / Fan Section) (cont.)

1. Record the distance from the end of the motor shaft to the bushing. The new impeller must be installed in the same location. Failure to do so will result in gaps between the impeller and the intake ring resulting in loss of air flow, or rubbing of the impeller against the inlet ring or motor assembly during operation.

2. Remove both cap screws from the bushing. The impeller or bushing may fall as screws are loosened.

3. Thread the cap screws by hand into the two threaded holes in the bushing flange.

4. Tighten each bolt part of a turn successively, to push the impeller off the bushing. Screwing down the cap screws into these holes will force the bushing away from the impeller hub, releasing the compression on the shaft. Be careful that the impeller does not fall as the clamping force is released.

5. Pull the bushing off the shaft and remove the impeller. If the assembly has been in place for some time, it may be necessary to use a wheel puller to remove the bushing. Never use a wheel puller on the impeller.

NOTE: DO NOT LUBRICATE CAPSCREWS, BORE, OR BUSHING BARREL, AS THIS WILL HINDER CLAMPING FORCE OF THE BUSHING ON THE SHAFT AND THE IMPELLER BORE

Installation of Impeller Assembly onto Motor Shaft

The fan impeller is held onto the motor shaft with a split tapered bushing. This bushing is positioned on the motor shaft and through the center of the impeller. Cap screws, when tightened to 10.2 N-m (7.5 ft-lbs.), lock the bushing onto the motor shaft and the impeller to the bushing.

The bushing barrel and the bore of the impeller are tapered which assures concentric mounting and keeps the impeller running evenly.
The cap screws, when tightened, lock the bushing in the impeller and over the motor shaft.

The bushing is split down the middle, so that when the locking cap screws force the bushing into the tapered bore in the impeller assembly, the bushing will grip the shaft with a positive clamping fit.

The impeller and bushing assembly have keyways that line up with the shaft and are held in place with compression.

To Assemble:

1. Make sure the shaft and keyway are clean and smooth. Clean the shaft and bore with rubbing alcohol or non oily solvent. Check the key size with both the shaft and bushing keyways.

2. Put the cap screws through the clearance holes in the bushing and put the bushing loosely into the impeller, lining up the screws with the threaded holes on the impeller hub. **Do not** press, drive or hammer the bushing into the bore.

3. Start the cap screws by hand, turning them just enough to engage the threads. Do not use a wrench at this time. The bushing should be loose enough in the impeller to move freely.

4. Slide the impeller and bushing assembly onto the motor shaft, ensuring the same distance from the end of the shaft to the bushing as in step 1 of impeller removal.

5. Fit the key into keyway. Do not force impeller and bushing onto shaft. If they do not fit easily, check the shaft, bushing and key sizes.

6. Tighten the cap screws progressively with a wrench. Do this evenly as though mounting an automobile wheel. Turn one a quarter turn, then the next a quarter turn, then go back and turn the other a quarter turn and so on. Torque to 10.2 N-m (7.5 ft-lbs.)

7. Peen the end of the motor shaft at the keyway with a chisel or center punch to prevent the key from falling out of position.

Fan Balance

Fan impellers are statically and dynamically balanced within acceptable tolerances at the factory. Damage in shipping or from poor handling or installation may upset the unit's balance. An impeller that is not properly balanced can lead to excessive vibration causing undue wear on the entire unit.

If vibration is excessive, shut down the fan and determine the cause.

Common causes of excessive vibration:

- Support structure not sufficiently rigid or level. Vibration amplified by resonance in duct work or support structure.
- Bearing locking collar or mounting bolts loose. Impeller or bushing loose.
- Material accumulation on impeller.
- Wheel rubbing on inlet ring.

Impeller Maintenance

Isolation Transformer Cooling Fan

The isolation transformer fan motor and impeller is an integral unit and cannot be serviced separately.

Inlet Ring Removal and Replacement

The inlet ring is the large circular part located beneath the fan impeller. It is positioned such that the impeller sits outside but does not touch the ring. The ring sits inside the impeller 10 mm (0.40 inches). Refer to the cutaway view of fan impeller and bushing (Figure 4.23).

Safety Notes

This procedure will require coming in contact with the internal electrical connectors and devices. **It is EXTREMELY important that ALL POWER BE REMOVED FROM THE DRIVE! Failing to do so may result in serious injury or death.**

Precautions must be taken to prevent the inlet ring from falling after all of the bolts have been removed.

ATTENTION

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

DC Link / Fan Section

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

Procedure

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

1. Remove bolts and swingout low voltage panel (see Fig. 4.16).
2. Remove bolts from the inlet ring being careful not to allow the ring to fall.
3. Remove inlet ring via the bottom access panel by moving it around the DC link and diagonally out the door. Shifting of the DC link may be required.

4. To install the new ring, reverse the above procedure. Rotate the fan impeller by hand to ensure that there is no contact with the inlet ring. Move the ring and retighten bolts to eliminate interference.
5. Replace all panels and barriers opened or removed during inlet ring replacement.

Top of Integral Isolation Transformer Section

1. Remove fan as described in "Fan Replacement".
2. Disassemble bolts and remove inlet ring.
3. To install new ring, reverse the above procedure. Rotate the fan impeller by hand to ensure that there is no contact with the inlet ring. Move the ring and retighten bolts to eliminate interference.
4. Replace all panels and barriers opened or removed during inlet ring replacement.

Replacement of Air Filters

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

It is necessary to periodically remove and clean, or remove and replace the filter material. The frequency with which the filters are renewed depends on the cleanliness of the supplied cooling air.

It is possible to renew the filters while the drive is running, but the procedure is easier to perform while the drive is shut down.

Procedure (see Figure 4.24):

- Using an 8 mm (5/16") Hex key, loosen the ¼ turn fasteners and swing open the hinged grill assembly.
- Remove filter material.

Note that if the drive is running, the filter must be replaced as soon as possible so that foreign material is not drawn into the drive.

Care must be taken in removing the filter, to prevent dirt that has accumulated on the inlet side of the filter from being sucked into the drive. It may be difficult to remove the filter material without tearing it due to the suction at the air inlet.

Replacement of Air Filters (cont.)

Recommended cleaning method of filters:

1. **Vacuum Clean** – A few passes of a vacuum cleaner on the inlet side of the filter will remove accumulated dust and dirt in seconds.
2. **Blow with Compressed Air –** point compressed air nozzle in opposite direction of operating air flow (Blow from exhaust side toward intake side)
3. **Cold Water Rinse –** Under normal conditions the foam media used in the filters, require no oily adhesives. Collected dirt is washed away quickly and easily using just a standard hose nozzle with plain water. **(Ensure filter is completely dry before reinstalling)**
4. **Immersion in Warm Soapy Water** – Where stubborn air-borne dirt is present, the filter may be dipped in a solution of warm water and mild detergent. Then simply rinse in clear clean water, **let stand until completely dry and free of moisture, and return to service.**

When replacing with a new filter, the filter must be provided by Rockwell Automation or approved for use by Rockwell Automation. Replacement of the filters is performed in the reverse order of its removal. Check that there are no openings that would allow foreign matter to enter the drive.

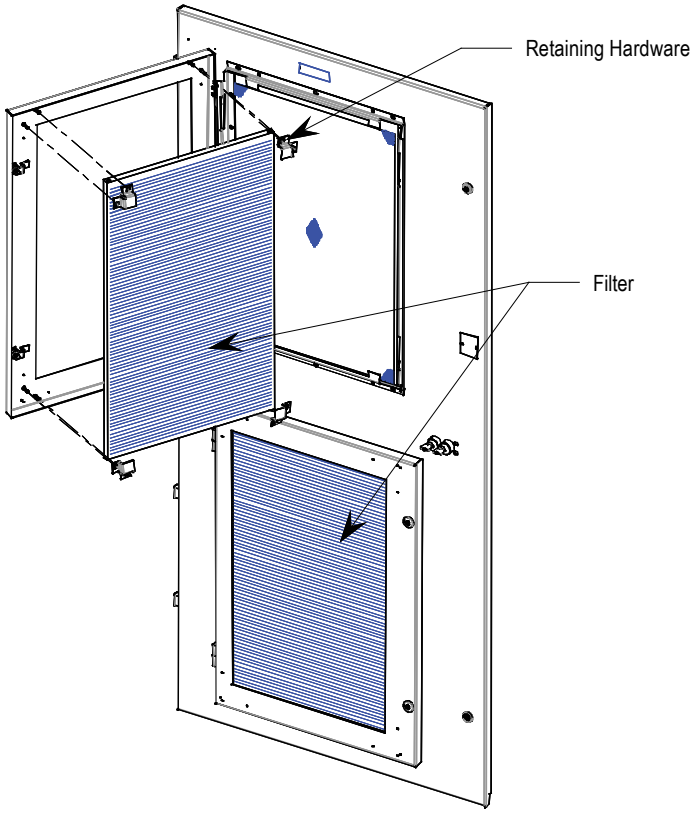


Figure 4.24 – Filter Replacement

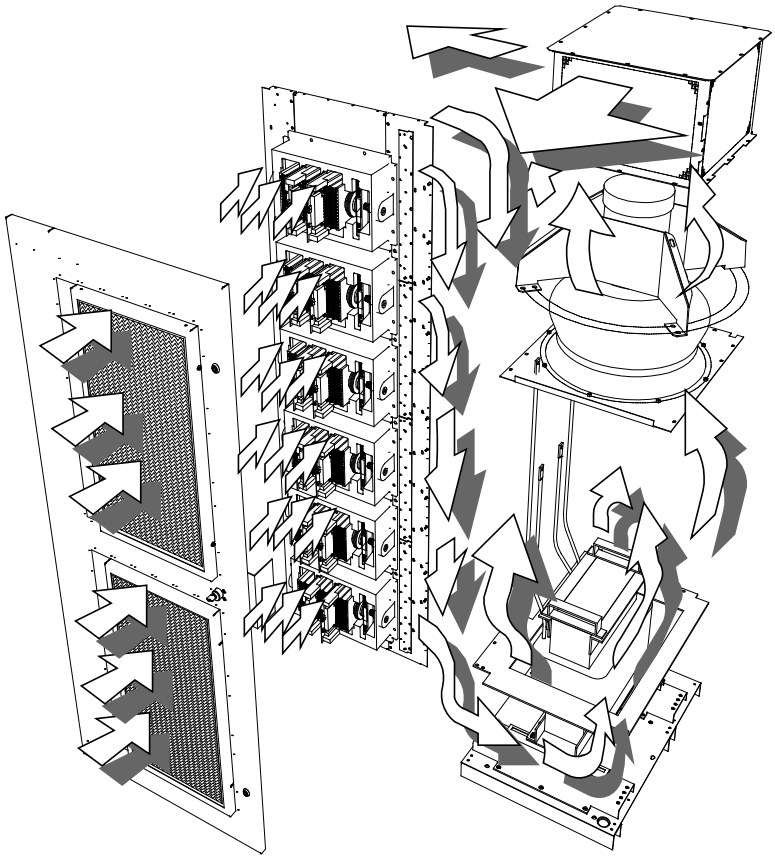


Figure 4.25 – Air Flow Pattern for Drive Cooling

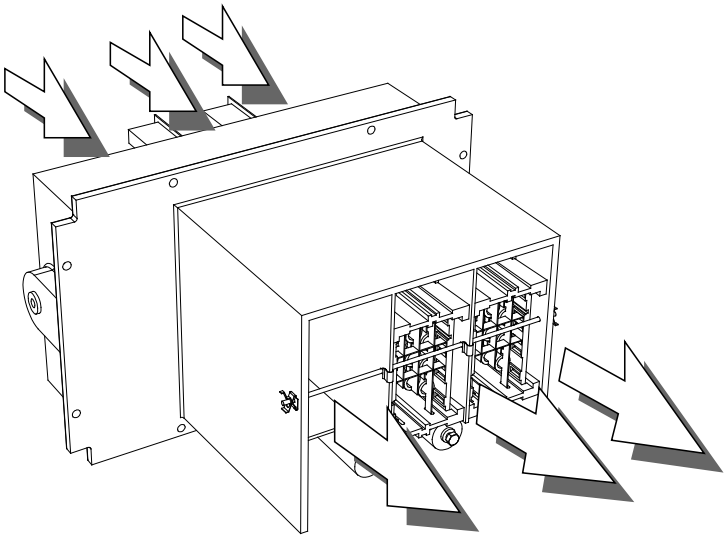


Figure 4.26 – Air flow through PowerCage

Control Power Components

There are two configurations in which control power will be distributed for the drive. The different methods are dependent on what drive option the customer has chosen:

1. AFE Rectifier with DTD DC Link – Conf. #1 (refer to Figure 4.27)
2. AFE Rectifier with Separate Isolation Transformer – Config. #2 (refer to Figure 4.28)
3. AFE Rectifier with Integral Isolation Transformer – Config. #3 (refer to Figure 4.29)

Ride-Through

Standard controls with 5 cycle ride-through – The drive main control boards will remain energized for a total of 5 cycles after control power is interrupted. If control power is not restored during the 5 cycles, a controlled shutdown will occur.

Figure 4.27 illustrates the control power distribution for AFE drives with integral starter/line reactor.

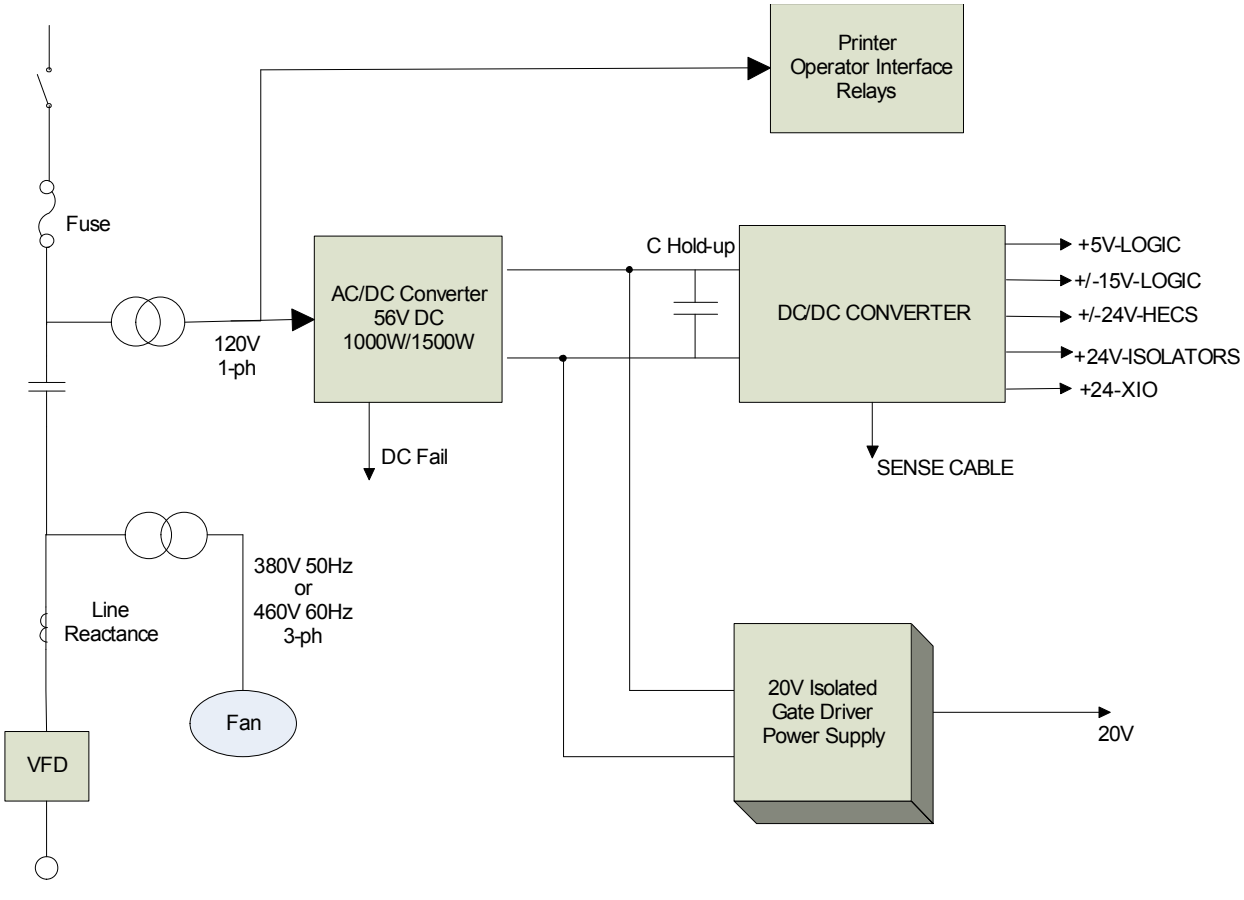


Figure 4.27 – AFE Rectifier with DTD DC Link (Configuration #1)

Figure 4.28 illustrates the control power distribution for AFE drives with remote transformer/starter (A) or integrated line reactor with remote starter (B).

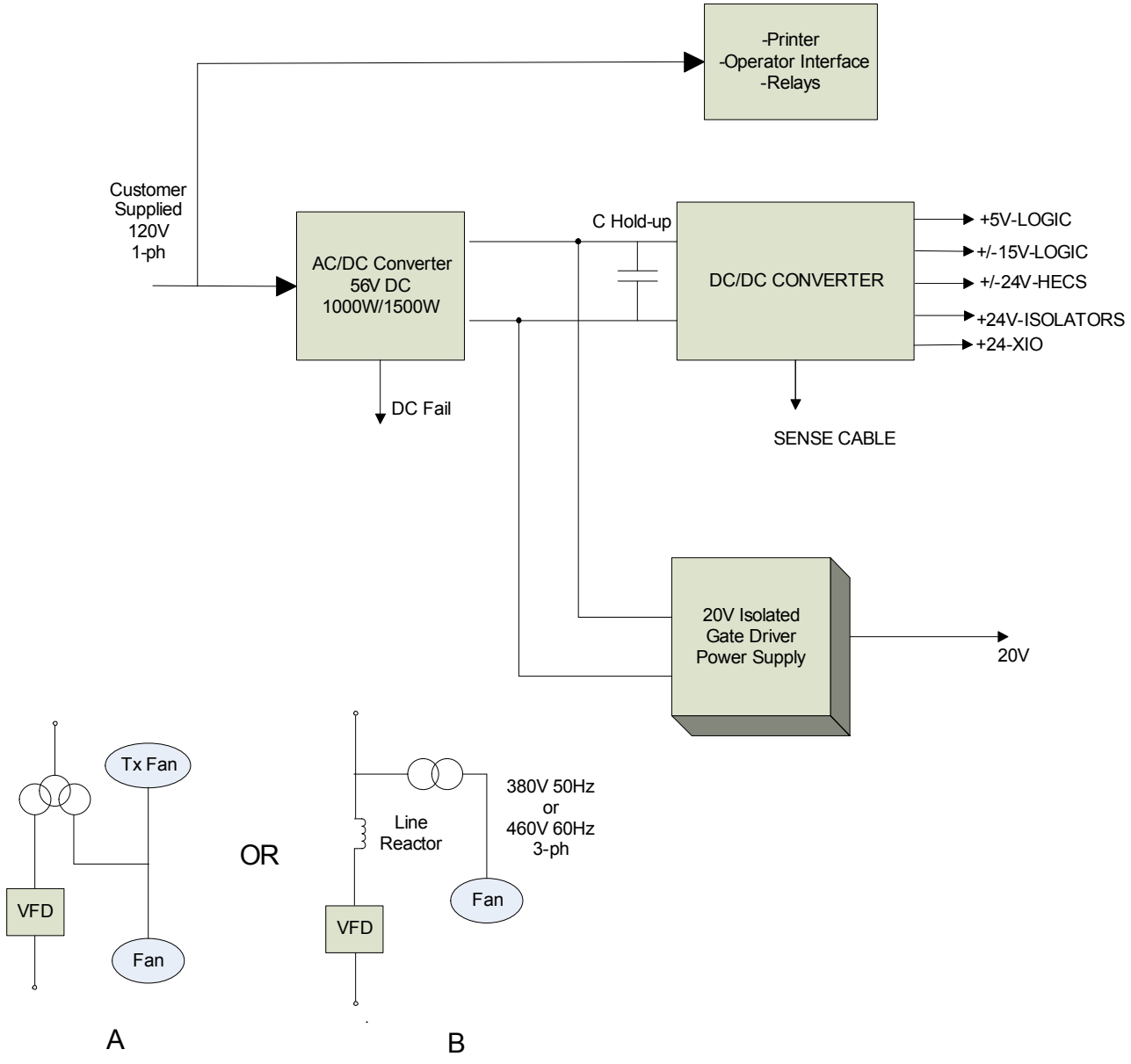


Figure 4.28 – AFE Rectifier with Separate Isolation Transformer (Configuration #2)

Control Power Components (cont.)

Figure 4.29 illustrates the control power distribution for AFE drives with integral transformer and remote starter.

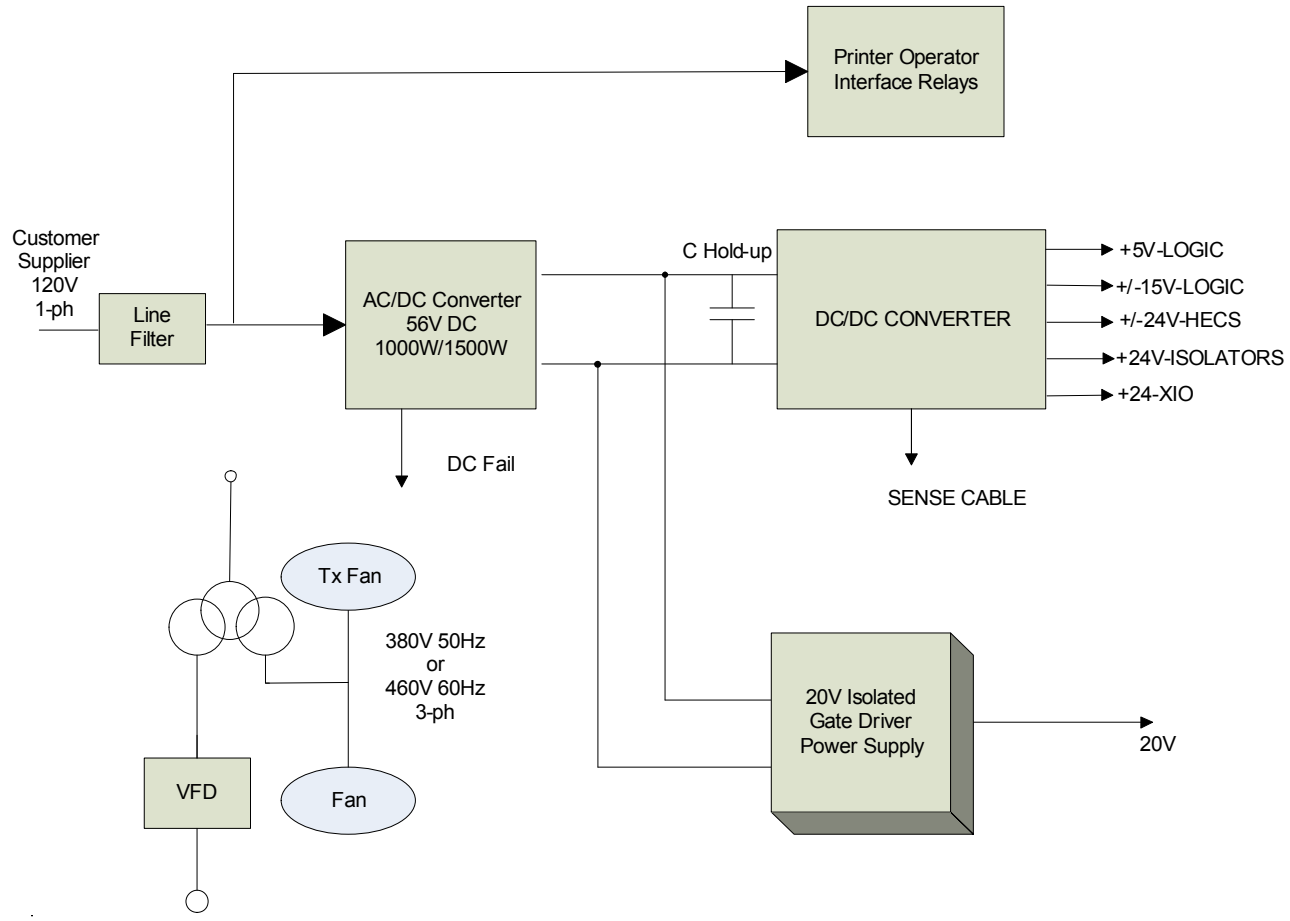


Figure 4.29 – AFE Rectifier with Integral Isolation Transformer (Configuration #3)

AC/DC Power Supply

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

Description

The AC/DC power supply accepts single phase voltage and produces a regulated 56V DC output for the DC/DC power supply and the HV IGDPS modules that power the SGCTs. The input and output voltages are monitored and fail signals are annunciated upon either voltage going below a pre-set level.

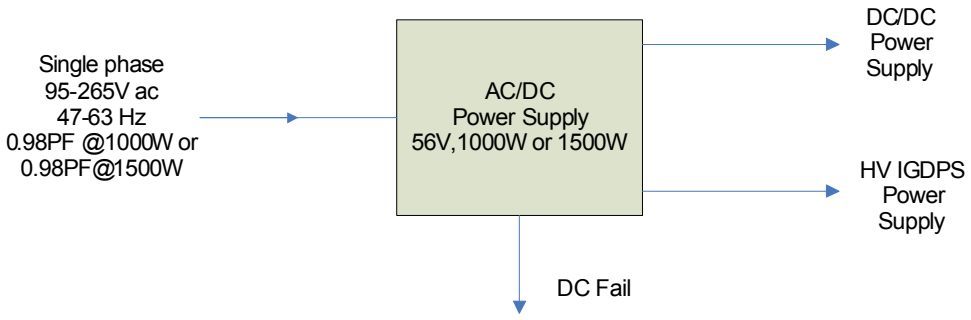


Figure 4.30 – AC/DC Converter Power Supply

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

AC/DC Power Supply (cont.)

Location

The AC/DC power supply is located in the low voltage panel at the top right-hand section of the drive. A typical low voltage compartment is shown in Figure 4.31.

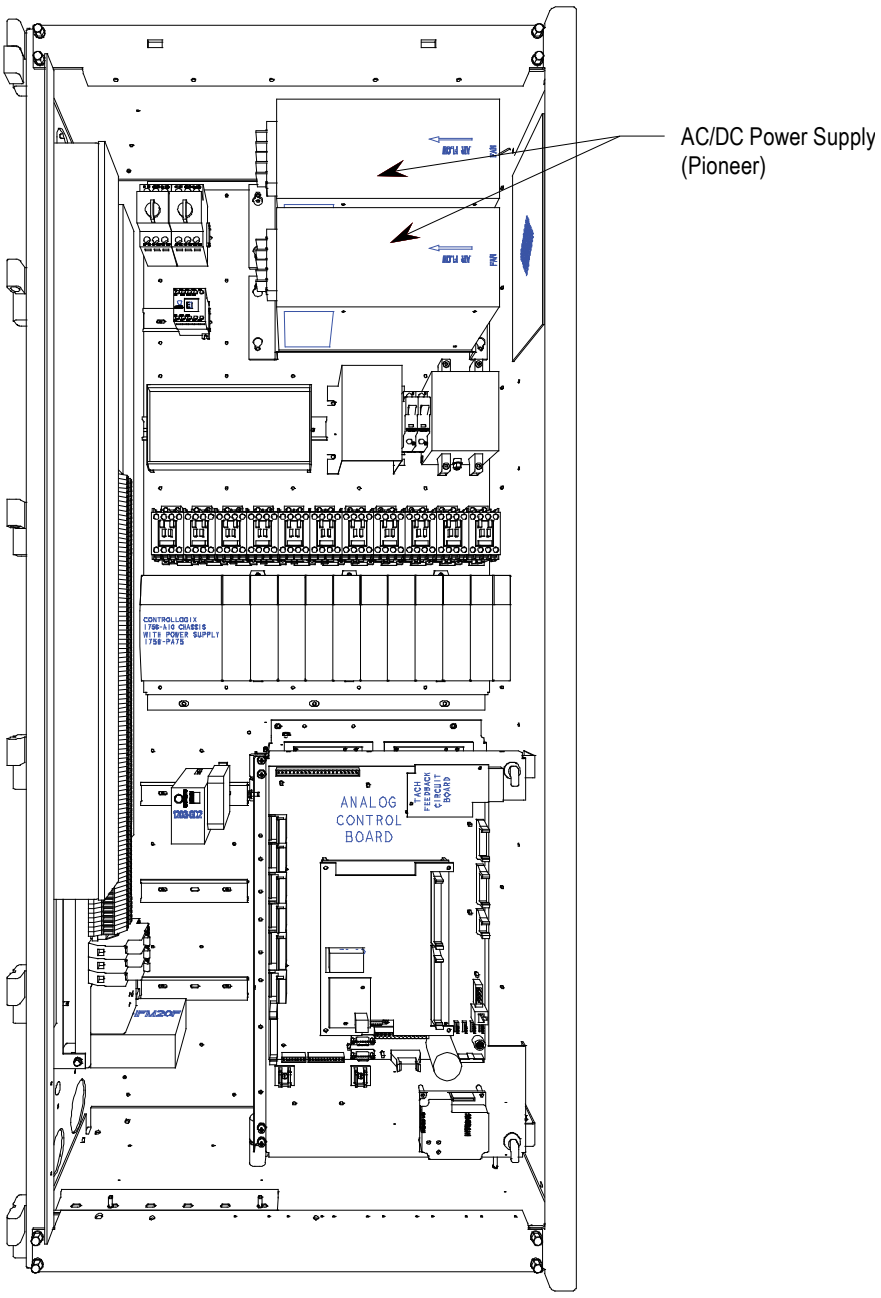


Figure 4.31 – Location of AC/DC Pioneer Power Supply on Low Voltage Panel

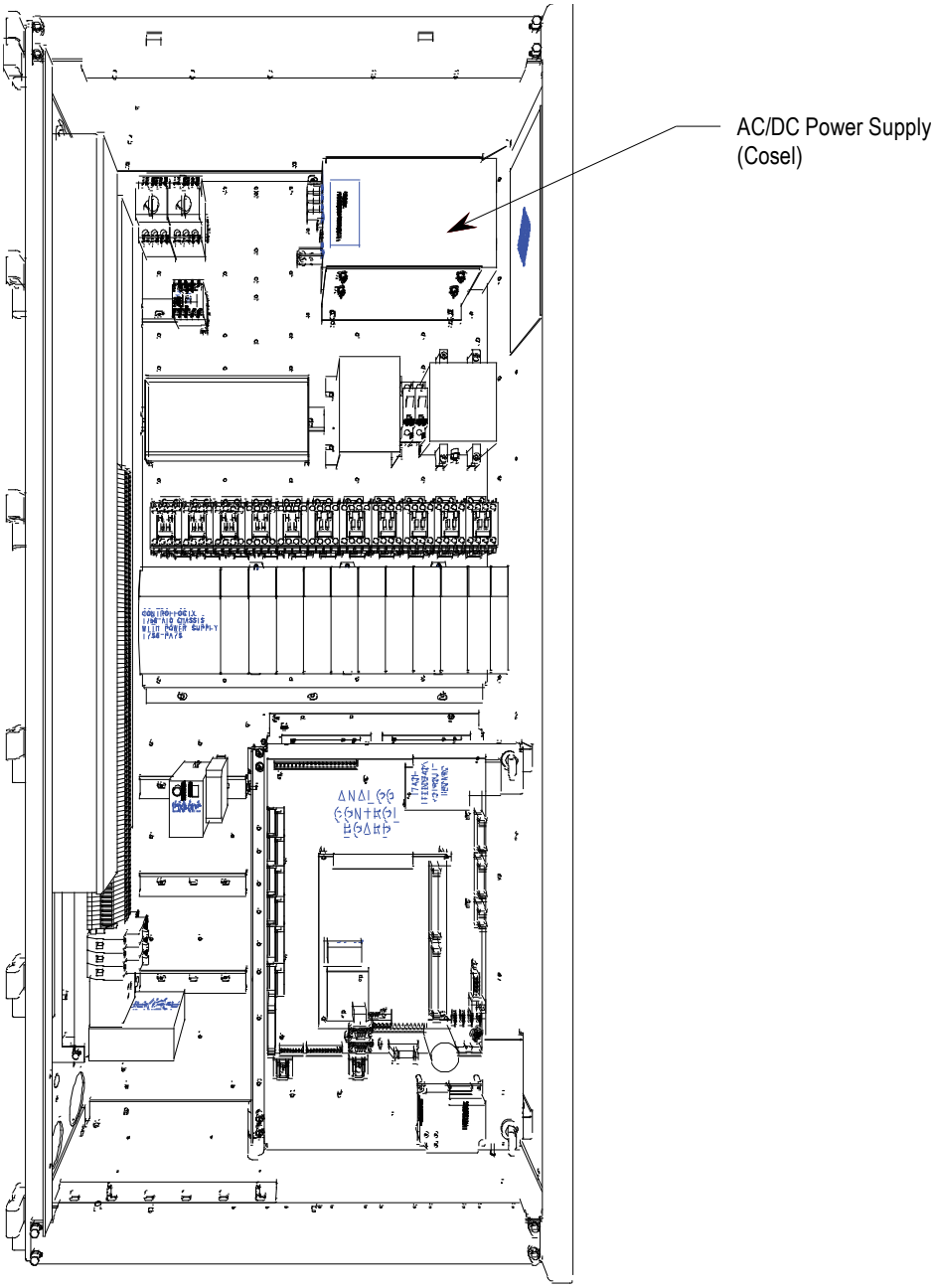


Figure 4.32 – Location of AC/DC Cosel Power Supply on Low Voltage Panel

Low Voltage Control Section

The low voltage control section houses all of the control circuit boards, relays, Operator Interface Terminal, DC/DC power supply, and most other low voltage control components. Refer to Figure 4.33 for a generic representation of a low voltage tub arrangement.

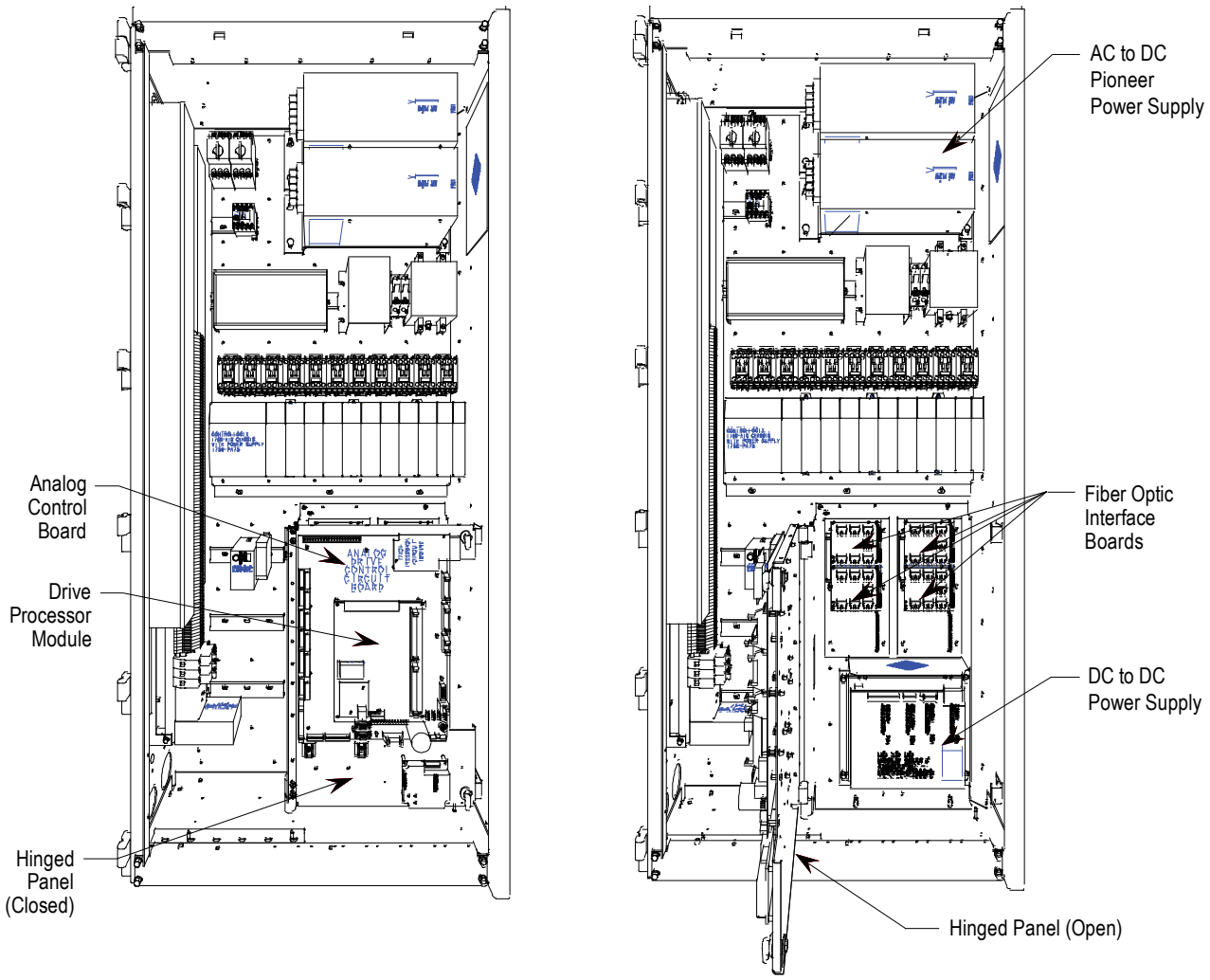


Figure 4.33 – Low Voltage Tub Compartment (Pioneer Power Supply)

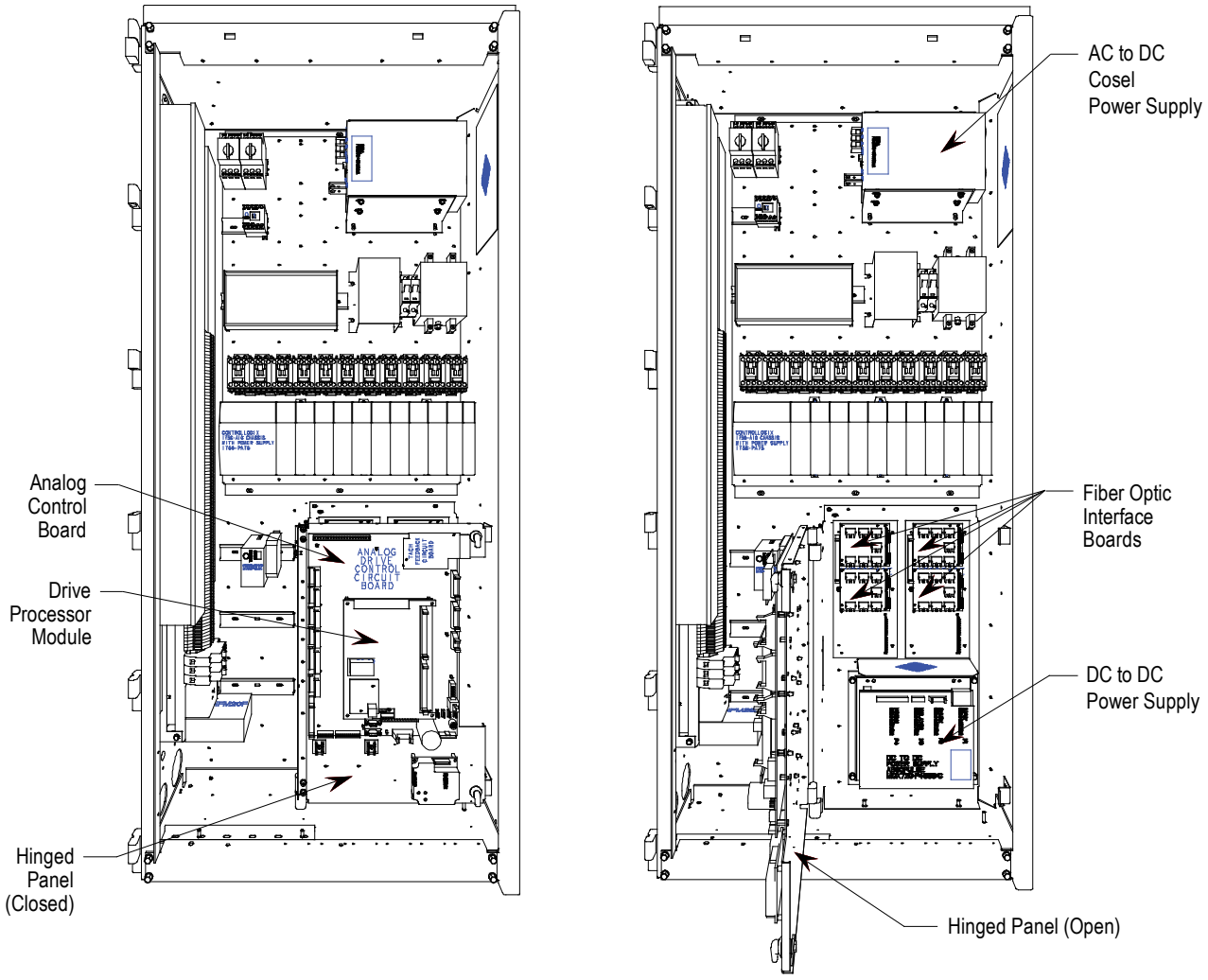


Figure 4.34 – Low Voltage Tub Compartment (Cosel Power Supply)

DC/DC Power Supply

Description

The DC/DC power supply is used as a source of regulated DC voltages for various logic control boards and circuits. The input to this power supply is from a regulated 56V DC source.

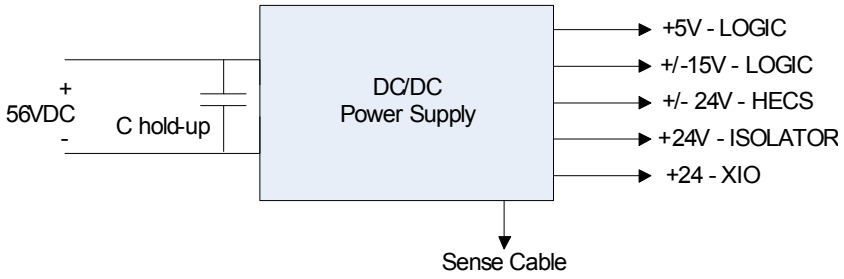


Figure 4.35 – DC/DC converter power supply

The capacitor at the input terminals is for power dip ride-through purposes. Upon loss of the 56V input, the capacitors (C hold-up) will maintain the voltage level. This component is not required in all configurations.

Due to the critical nature of the ACB/DPM Logic power source, the DC/DC power supply has been designed to provide redundancy for the +5V rail. There are two separate +5V outputs, each capable of powering the logic boards. In the event of one failing, the other power supply will be automatically switched in to provide the output power.

IO Connectors on Control Boards

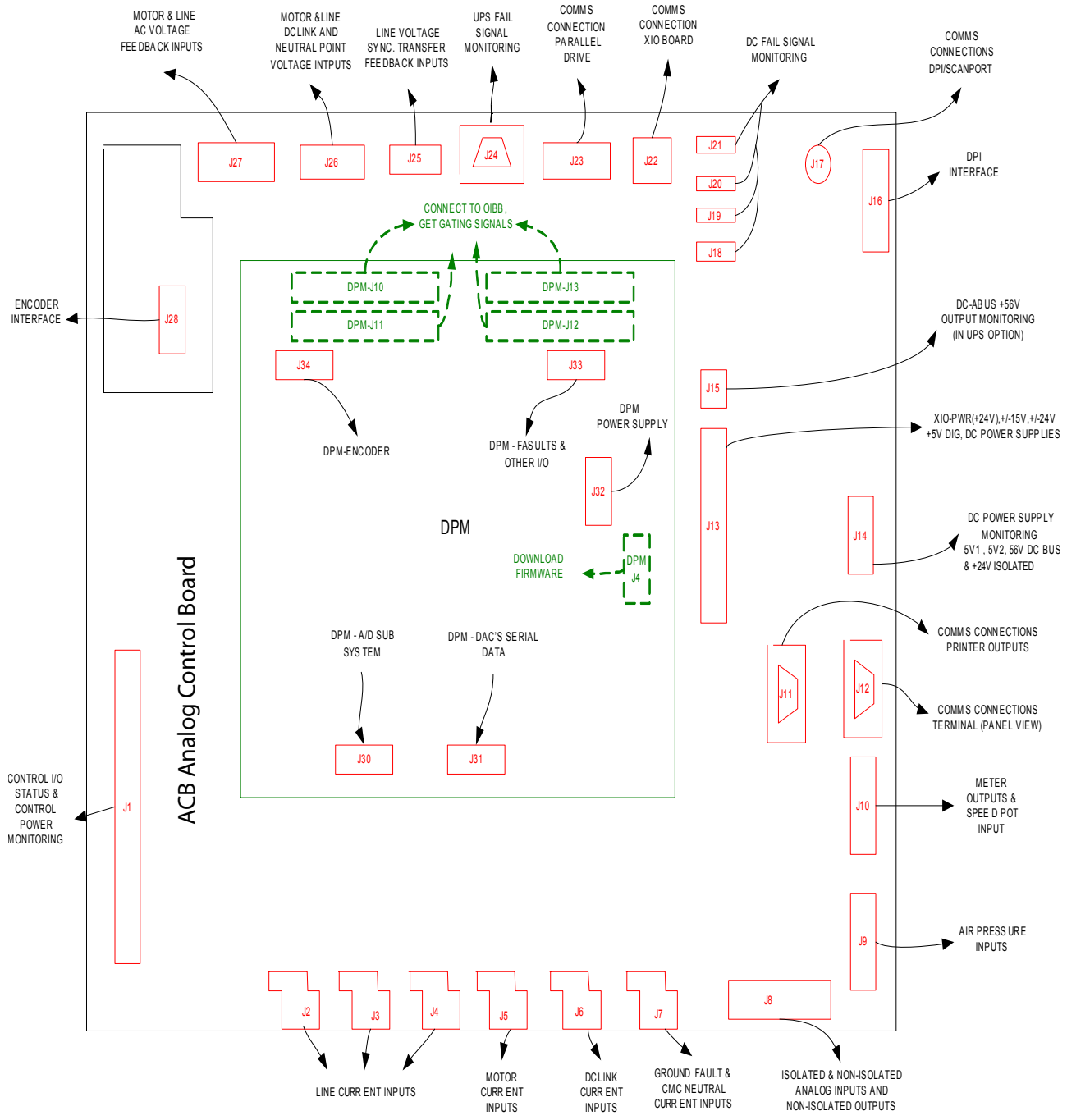


Figure 4.36 – IO Connectors on Control Boards

Drive Processor Module

This board contains the control processors. It is responsible for all the drive control processing and stores all of the parameters used for the drive control.

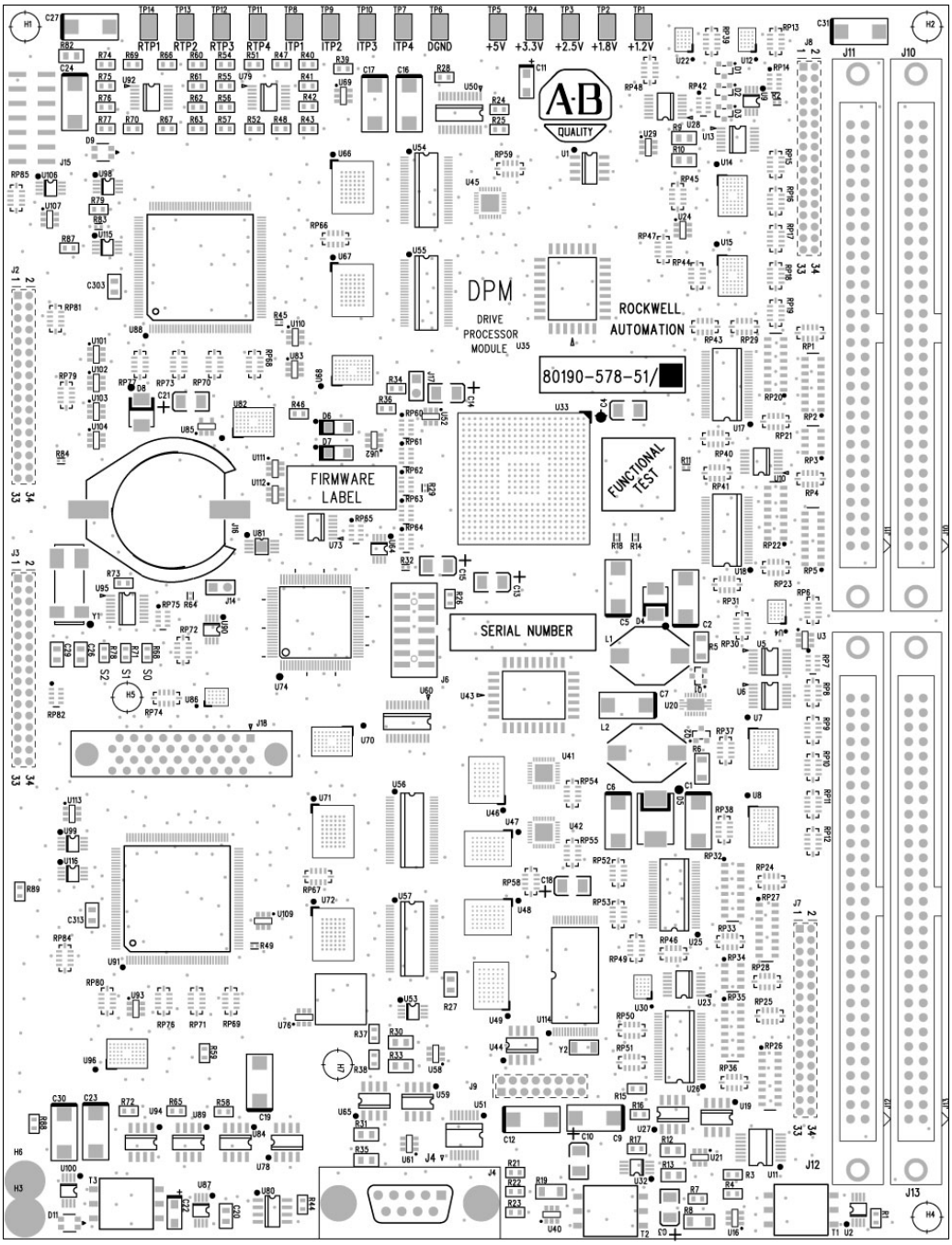


Figure 4.37 – Drive Processor Module (DPM)

ACB Analog Control Board

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

Figure 4.38 – ACB Analog Control Board

ACB Analog Control Board (cont.)

Interface Module (IFM)

The Interface Module is used to make all customer useable connections to the ACB. The pin numbers listed on the following pages refer to IFM pin numbers.

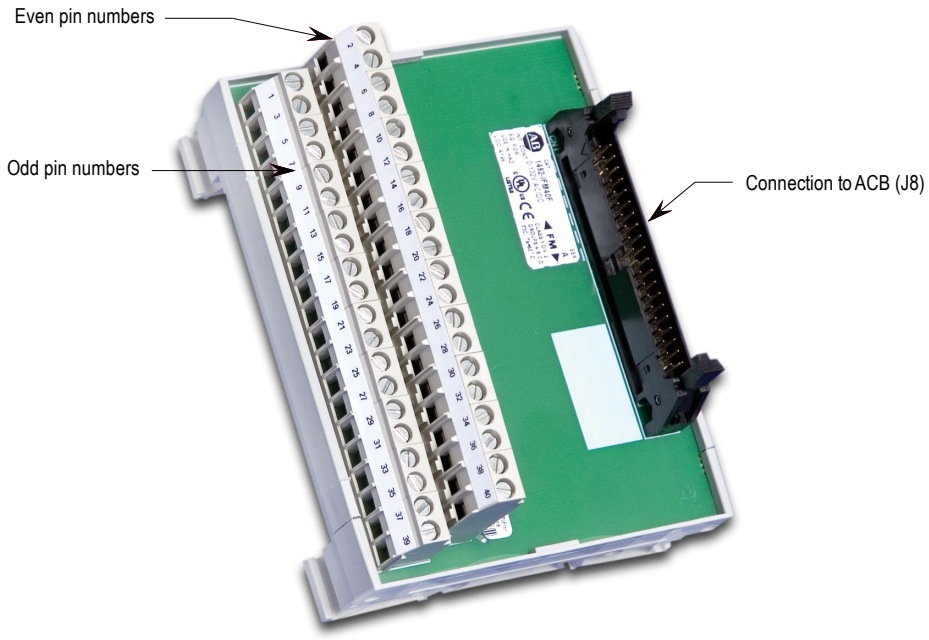


Figure 4.39 – Interface Module

Analog Inputs and Outputs

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

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

The following information will show the connections for each input and output.

External Input/Output Boards

The External Input/Output (XIO) Boards are connected through a network cable (CAN Link) to the Analog Control Board (ACB). This cable may be connected to either XIO Link A (J4) or XIO Link B (J5). The XIO board handles all external Digital Input and Output signals and sends them to the ACB through the cable. There are 16 Isolated Inputs and 16 Isolated Outputs on the card, and they are used for Runtime I/O including Start, Stop, Run, Fault, Warning, Jog, and External Reset signals. The boards also handle the standard drive fault signals (Transformer/Line Reactor Overtemperature, DC Link Overtemperature, etc.) and several spare configurable fault inputs. There is an option in software to assign each XIO a specific function (General IO, External IO or Liquid Cooling).

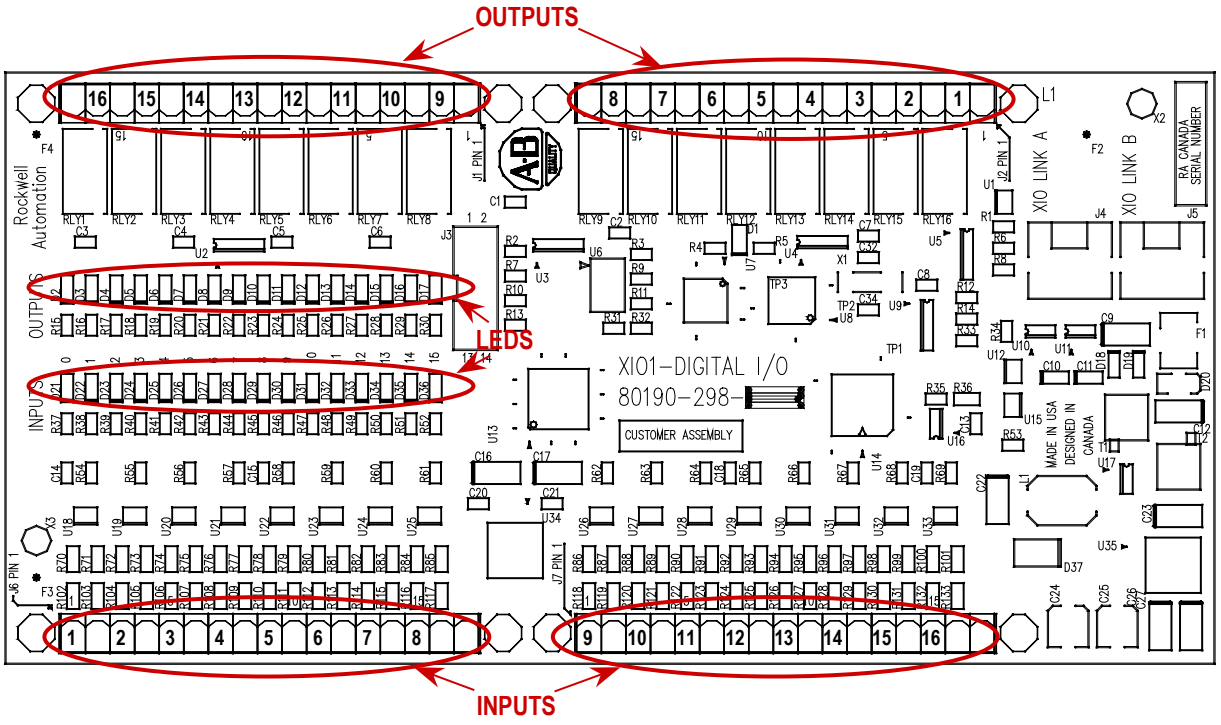


Figure 4.40 – XIO Board

The standard drive comes with one XIO board; additional boards (up to 5) can be daisy chained together from XIO Link B (J5) on the first board to XIO Link A (J4) on the second board, for a total of 6 XIO cards. However, at this time the drive only supports the use of addresses 1 to 3, depending on the drive's features and application. U6 on the XIO board displays the board's address which is automatically calculated from the XIO board's position in the network.

XIO Link A and B ports are interchangeable but it may make wiring easier to follow if Link A is used for "upstream", that is, closest to the ACB, and Link B is used for "downstream" or farthest from the ACB.

LED D1 and display U6 indicate the status of the board. The following table illustrates the possible states for D1.

LED Status	Description
Solid Green	Normal Operation
Solid Red	Board Failure
Alternate Flashing of Red and Green	No Communication Available to ACB board (Normal during boot-up or unprogrammed)

Status of U6 Display

Display	Description	Explanation
—	No valid address found	– More than 6 XIO cards on network – XIO cable failure – XIO card failure – ACB failure
0	Card in “Master” mode	– 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

Optical Interface Boards

The Optical Interface (OIB) Boards are the interface between the DPM and the Gate Driver circuitry. The drive control decides which device to fire, and sends an electrical signal to the OIB boards. The OIB board converts that electrical signal to an optical signal, which is transmitted via fiber optics to the gate driver cards. Typically, the Transmit ports are Grey and the Receive ports are Blue. The gate driver accepts that signal and turns the device on and off accordingly. The diagnostic fiber optic signals work the same way, but the source is the gate driver boards and the destination is the drive control boards. Each OIB contains one extra fiber optic receiver (RX7), which is used for temperature measurement.

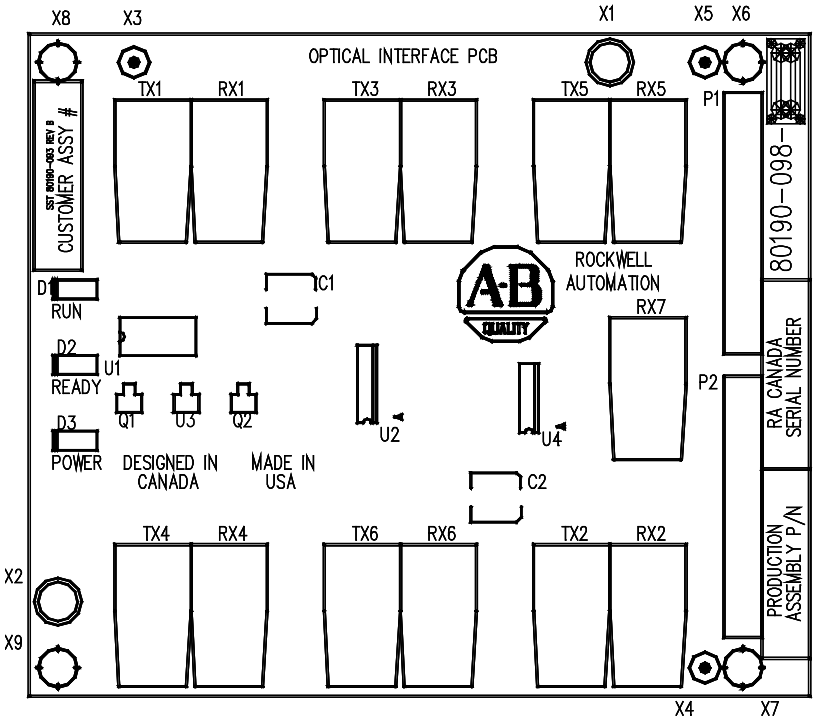


Figure 4.41 – Optical Interface Board

The OIB boards are mounted directly on the Optical Interface Base Board (OIBB) using two parallel 14-pin connectors for the electrical connection, and plastic clips to provide the mechanical strength. There is one OIBB for the inverter, and one OIBB for the rectifier device. The OIBBs are interfaced to the DPM using two ribbon cables to connect to J11 and J12.

Each OIB board can handle the Firing and Diagnostic duplex fiber optic connector for 6 devices, whether they are SCRs or SGCTs. Physically, on the OIBBs, there is provision for 18 devices for the inverter and the rectifier. This is enough capacity to handle the highest rated drive that we currently produce. The top OIB board on the OIBB is for the ‘A’ devices, the middle OIB board on the OIBB is for the ‘B’ devices, and the bottom OIB board on the OIBB is for the ‘C’ devices.

Optical Interface Boards (cont.)

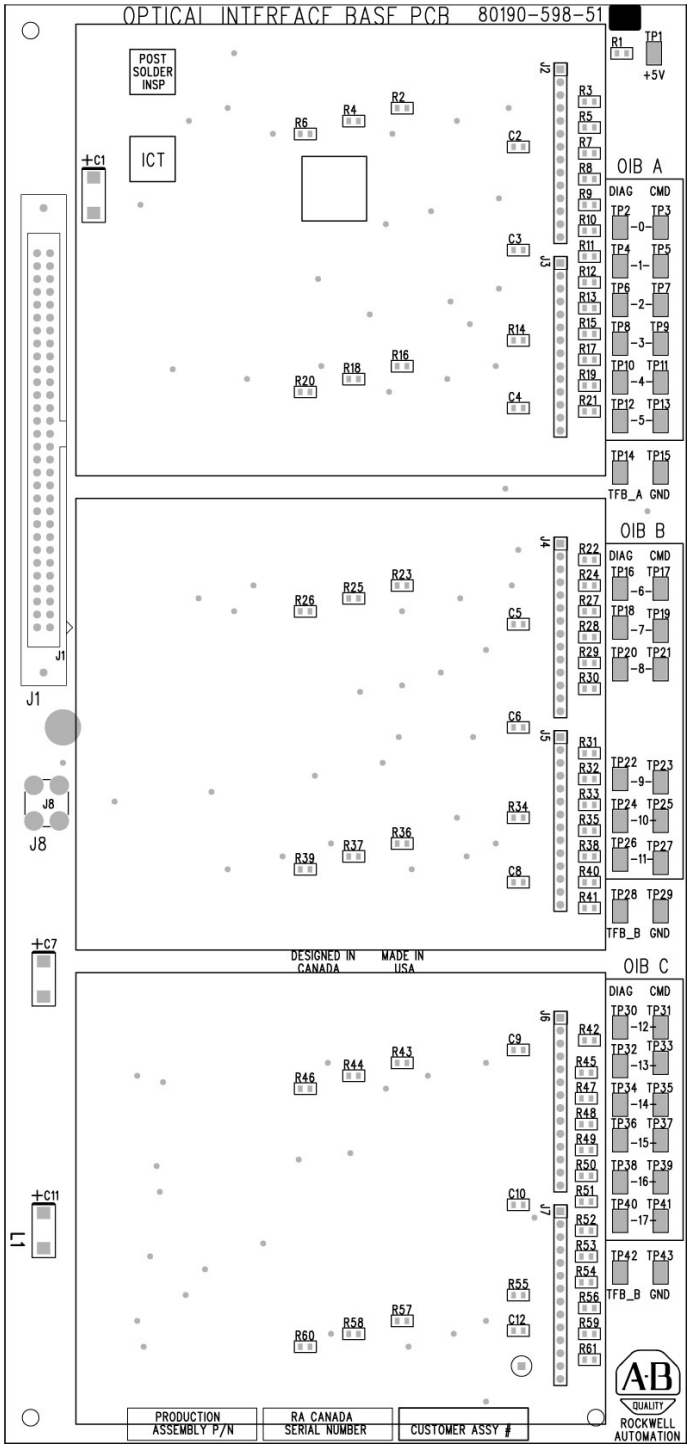


Figure 4.42 – Optical Interface Base Board (OIBB)

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

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

LED	Status	Description
D1	Red – On	Run – The OIB has received an Enable signal. The drive control software is in control of all gating.
D2	Yellow – On	Ready –The OIB power supply is sufficient for proper operation.
D3	Green – On	Power – The OIB has received a voltage signal greater than 2V.

Environmental Considerations

Hazardous materials

Environmental protection is a top priority for Rockwell Automation. The facility that manufactured this medium voltage drive operates an environmental management system that is certified to the requirements of ISO 14001. As part of this system, this product was reviewed in detail throughout the development process to ensure that environmentally inert materials were used wherever feasible. A final review has found this product to be substantially free of hazardous material.

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

Environmental Consideration (cont.)

- **Capacitor Dielectric Fluid**

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

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

- **Printed Circuit Boards**

  Most of the printed circuit boards utilize lead-based solder. Shipping and handling of these boards is not restricted under any regulations, however, lead is considered a hazardous substance. Circuit boards must be disposed of according to local regulations and must not be disposed of with general landfill refuse.

- **Lithium Batteries**

  This drive contains one small 3V lithium battery on the DPM board. The battery part # 346567-Q01 or BR2335 contains approximately 0.09 g of lithium metal. These batteries meet shipping regulations at the time of publication, however there are specific marking and packaging requirements. Properly packaged single, spare or expired batteries may be shipped consigned as UN3090 PI 968 Part 1. A maximum of two spare cells may be packaged with the DPM, provided they are mechanically separated from each other during shipment. Shipping cartons shall bear the warning: "Primary Lithium Batteries – Forbidden for transport aboard passenger aircraft."

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

- **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 chromate plated parts is not restricted under any regulations, however, chromate is considered a hazardous substance. Chromate plated parts must be disposed of according to local regulations and must not be disposed of with general landfill refuse.

- **In Case Of Fire**

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

Disposal

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

Commissioning

Start-up Commissioning Services

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

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

Rockwell Automation recommends the following:

Drive Commissioning

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

Start-up Commissioning Services (cont.)

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

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

Catalog Number Explanation for PowerFlex 7000 Variable Frequency Drives

First Position	Second Position	Third Position	Fourth Position	Fifth Position	Sixth Position	Seventh Position
7000	– A	40	D	A	– RPDTD	– 1 - ... etc.
Bulletin Number	**Service Duty/ Altitude Code**	**Current Rating**	**Enclosure Type**	**Line and Control Voltages**	**Rectifier Configuration/ Line Impedance Type**	**Options** (Refer to PowerFlex 7000 Medium Voltage Drives Global Price List)

Code	Description
7000A	"A" Frame (Air Cooled)
7000	"B" Frame (Air Cooled)
7000L	"C" Frame (Liquid Cooled)

Code	Description
A	Normal Duty, 0-1000 m Altitude Maximum 40°C Ambient
B	Normal Duty, 1001-5000 m Altitude Reduced Ambient (from 40°C offering) 1001 – 2000 m = 37.5°C 2001 – 3000 m = 35°C 3001 – 4000 m = 32.5°C 4001 – 5000 m = 30°C
C	Heavy Duty, 0-1000 m Altitude Maximum 40°C Ambient
D	Heavy Duty, 0-5000 m Altitude Reduced Ambient (from 40°C offering) – Same as 'B' above
E	Normal Duty, 0-1000 m Altitude Maximum 35°C Ambient
F	Normal Duty, 1001-5000 m Altitude Reduced Ambient (from 35°C offering) 1001 – 2000 m = 32.5°C 2001 – 3000 m = 30°C 3001 – 4000 m = 27.5°C 4001 – 5000 m = 25°C
G	Heavy Duty, 0-1000 m Altitude Maximum 35°C Ambient
J	Normal Duty, 0-1000 m Altitude Maximum 50°C Ambient
L	Heavy Duty, 0-1000 m Altitude Maximum 50°C Ambient
N	Normal Duty, 0-1000 m Altitude Maximum 20°C Ambient
Z	Custom Configuration (Contact Factory)

Code	Description
D	Type 1 w/gasket (IP21)
T	Type 1 w/gasket (IP21) – Seismic rated
K	Type 12 w/vents and filters (IP42)
U	Type 12 w/vents and filters (IP42) – Seismic rated

Code	Description
40	40 Amp
46	46 Amp
53	53 Amp
61	61 Amp
70	70 Amp
81	81 Amp
93	93 Amp
105	105 Amp
120	120 Amp
140	140 Amp
160	160 Amp
185	185 Amp
215	215 Amp
250	250 Amp
285	285 Amp
325	325 Amp
375	375 Amp
430	430 Amp
495	495 Amp
575	575 Amp
625	625 Amp
657	657 Amp
720	720 Amp

Not all amperages are available at all ambient/ altitude configurations. Refer to Price Lists for exact offering.

Code	Description
RPDTD	AFE Rectifier with Integral Line Reactor and Direct-to-Drive DC Link
RPTX	AFE Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)
RPTXI	AFE Rectifier with integral Isolation Transformer (standard DC Link)
RPLR	AFE Rectifier with Integral Line Reactor and Standard DC Link (No longer offered for sale)
R6TX	6-pulse Rectifier with provision for connection to separate Isolation transformer (standard DC Link) (No longer offered for sale)
R18TX	18-pulse Rectifier with provision for connection to separate Isolation Transformer (standard DC Link)

See Table B-1

Table B-1 – Supply Voltage, Control Voltage, Frequency and Control Power Transformer Selection

Voltage		Frequency (Hz)	Modification Number	
Nominal Line	Control		With a C.P.T. ⊇	Without a C.P.T. ⊄
2400	120	60	**A**	**AD**
	120-240		**AA**	**—**
3300	110	50	**CY**	**CDY**
	220		**CP**	**CDP**
4160	110	50	**EY**	**EDY**
	220		**EP**	**EDP**
	120	60	**E**	**ED**
	120-240		**EA**	**—**
6600	110	50	**JY**	**JDY**
	220		**JP**	**JDP**
	110-220		**JAY**	**—**

⊇ A Control Power Transformer modification must be selected (6, 6B ...etc.) to size the transformer.
⊄ Control Circuit Power is supplied from a separate/external source.

PowerFlex 7000 Drive Selection Explanation

The PowerFlex 7000 medium voltage AC drive selection tables are based on two (2) types of drive service duty ratings:

1) **Normal Duty (110% overload for one (1) Minute, once every 10 minutes)** – used for Variable Torque (VT) applications only.

   Drives with this rating are designed for 100% continuous operation, with 110% overload for one (1) minute, once every 10 minutes.

2) **Heavy Duty (150% overload for one (1) Minute, once every 10 minutes)** – used for Constant Torque (CT) applications only.

   Drives with this rating are designed for 100% continuous operation with 150% overload for one (1) minute, once every 10 minutes.

Service Duty Rating, Continuous Current Rating & Altitude Rating Code

There are different codes that define service duty and altitude in the drive catalog number (see page B-1).

For example,

Catalog number 7000A – **A105**DED-R6TXI, has a continuous current rating of 105 amps, with a "normal duty" service rating up to 1000 meters altitude.

Catalog number 7000A – **B105**DED-R6TXI has a continuous rating of 105 amps with a "normal duty" service rating up to 5000 meters altitude.

Please note that the ambient temperature rating of the drive is reduced at higher altitudes. If 40°C ambient is required at 1001-5000 meters altitude, then a rating code of **Z** is required.

When is a tachometer required?

A tachometer is required under the following conditions:

1. When speed regulation accuracy must be between 0.01 – 0.02% of nominal speed.
2. When the zero speed breakaway torque needed is greater than 90% of continuous running torque.
3. When continuous running speed is greater than or equal to 0.1 Hz, but less than 6 Hz.
4. For minimizing restart times using the flying start capability in forward or reverse direction.

Table B-2 –Power Flex Speed Regulation

Tachometer	Frequency Output		
	< 6 Hertz	6 – 15 Hertz	Above 15 Hertz
Without Tachometer	Not applicable	0.1 %	0.1 %
With Tachometer	0.02 %	0.01%	0.01%

Notes:

- Speed Regulation is based on % of motor synchronous speed.
- Tachometer to be mounted on the AC machine
- Operational 15 V DC Power Supply mounted in drive to power the tachometer as a standard option with the tachometer feed back card.
- Customer is responsible for providing and mounting of tachometer
- Sleeve bearing motors require the tachometer to have an axial movement tolerance.
- Recommended tachometers are the shaft mounting type, examples are the Avtron 585 and 685 models or the Northstar (Lakeshore) RIM Tach HS85, 12 to 15V models or equivalent. Magneto resistive models are more adaptable to harsh environments.
- When installing, the tachometer body and electronics must be isolated from ground (options available from the tachometer manufacturer to accomplish this).
- When cable lengths exceed 305 m (1000 ft.) for the Northstar or 610 m (2000 ft.) for the Avtron, consult the factory.

Table B-3 – Tachometer Selection

Recommended Tach PPR	
Motor RPM	Tach ppr
3600	600
3000	600
1800	1024
1500	1024
1200	2048
1000	2048
900	2048
720	2048
600	2048

PowerFlex 7000 Performance (Torque Capabilities)

The PowerFlex 7000 drives have been tested on a dynamometer to verify performance under locked rotor, accelerating, and low speed-high torque conditions. Table B-4 below shows the PowerFlex 7000 drive torque capabilities as a percent of motor rated torque, independent of the drive's momentary overload conditions.

Table B-4 – PowerFlex 7000 Drive Torque Capabilities

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

** Drive will require over sizing to achieve greater than 100% continuous torque.

Glossary of Terms

Breakaway Torque: Torque required to start a machine from standstill.

Accelerating Torque: Torque required to accelerate a load to a given speed, in a certain period of time. The following formula may be used to calculate the average torque to accelerate a known inertia (WK^2):

$$\mathbf{T = (WK^2 \times change\ in\ RPM) / 308t}$$

where, **T** = acceleration torque in (lb-ft).
WK^2 = total system inertia (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 B-5 – Typical Application Load Torque Profiles *

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

*** NOTE**: PowerFlex 7000 “A” Frame suitable only for normal duty service rating.

Torque Requirements for threaded fasteners

Unless otherwise specified the following values of torque are to be used in maintaining the equipment.

DIAMETER	PITCH	MATERIAL	Torque (N-m)	Torque (lb.-ft.)
M2.5	0.45	Steel	0,43	0.32
M4	0.70	Steel	1,8	1.3
M5	0.80	Steel	3,4	2.5
M6	1.00	Steel	6,0	4.4
M8	1.25	Steel	14	11
M10	1.50	Steel	29	21
M12	1.75	Steel	50	37
M14	2.00	Steel	81	60
¼ “	20	Steel S.A.E. 5	12	9.0
3/8”	16	Steel S.A.E. 2	27	20

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 7000A

ATTENTION

Use caution when performing a Megger test. High voltage testing is potentially hazardous and may cause severe burns, injury or death. Where appropriate, the cause of the test equipment should be connected to ground.

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

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

ATTENTION

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

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

Equipment Required

- Torque Wrench and 7/16 inch socket
- Phillips Screwdriver
- 2500/5000 Volt Megger

Procedure

1. Isolate and Lock Out the Drive System from High Voltage

Disconnect any incoming power sources, medium voltage sources should be isolated and locked out and all control power sources should be turned off at their respective circuit breaker(s).

Verify with a potential indicator that power sources have been disconnected, and that the control power in the drive is de-energized.

2. Isolate the Power Circuit from System Ground (Float the drive)

It is necessary to remove the grounds on the following components within the drive (Refer to the electrical diagrams provided with the equipment to assist in determining the points which need to be disconnected):

- Voltage Sensing Boards (VSB)
- Output Grounding Network (OGN)

Voltage Sensing Boards

Remove all ground connections from all of the VSBs in the drive. This has to be done at the screw terminals on the VSB rather than the ground bus. There are two grounds on each board marked “GND 1”, and “GND 2”.

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

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

Output Grounding Network

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

Note: Injecting a high voltage on the ground cable during a Megger test will degrade the cable insulation.

3. Disconnect Connections between Power Circuit and Low Voltage Control

Voltage Sensing Boards

The connections between the low voltage control and the power circuit are made through ribbon cable connectors. The cables will be plugged into connectors on the Voltage Sensing Board marked “J1”, “J2”, and “J3”, and terminate on the Signal Conditioning Boards. Every ribbon cable connection made on the VSBs should be marked for identification from the factory. Confirm the marking matches the connections, and disconnect the ribbon cables and move them clear of the VSB. If these ribbon cables are not removed from the VSB, then high potential will be applied directly to the low voltage control through the SCBs, and cause immediate damage to those boards.

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

Potential Transformer Fuses

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

Transient Suppression Network

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

4. Meggering the Drive

Note: Verify the drive and any connected equipment is clear of personnel and tools prior to commencing the Megger test. Barricade off any open or exposed conductors. Conduct a walk-around inspection before commencing the test.

All three phases on the line and machine sides of the drive are connected together through the DC Link and Snubber Network. Therefore a test from any one of the input or output terminals to ground will provide all the sufficient testing required for the drive.

Note: Be sure the Megger is discharged prior to disconnecting it from the equipment.

Connect the Megger to the drive following the specific instructions for that model. If the Megger has a lower voltage setting (normally 500V or 1000V), apply that voltage for 5 seconds as a precursor for the higher voltage rating. This may limit the damage if you forgot to remove any grounds. If the reading is very high, apply 5kV from any drive input or output terminal to ground. Perform a Megger test at 5 kV for 1 minute and record the result.

The test should produce a reading greater than the minimum values listed below. If the test results produced a value lower than these values start segmenting the drive system down into smaller components and repeat the test on each segment to identify the source of the ground fault. This implies isolating the line side of the drive from the machine side by removing the appropriate cables on the DC Link reactor.

The DC Link reactor may have to be completely isolated from the drive, at which point all four of its power cables must disconnected. It is imperative to ensure the electrical components to be meggered are electrically isolated from ground. Items that may produce lower than expected readings are surge capacitors at the motor terminals, motor filter capacitors at the output of the drive. The meggering procedure must follow a systematic segmentation of electrical components to isolate and locate a ground fault.

Type of Drive	Minimum Megger Value
Liquid Cooled Drive	200 M Ohms
Air Cooled Drive	1k M Ohm
Drive with input/output Caps Disconnected	5k M Ohm
Isolation Transformer	5k M Ohm
Motor	5k M Ohm

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

Note: Humidity and dirty standoff insulators may also cause leakage to ground because of tracking. You may have to clean a 'dirty' drive prior to commencing the Megger test.

5. Reconnecting Connections between Power Circuit and Low Voltage Control

Reconnect the ribbon cables “J1”, J2” and “J3” in all the VSBs. Do not cross the cable connections. Mixing the feedback cables may result in serious damage to the drive.

6. Reconnect the Power Circuit to the System Ground

Voltage Sensing Boards

Securely reconnect the two ground conductors on the VSBs.

The two ground connections on the VSB provide a reference point for the VSB and enable the low voltage signal to be fed to the SCBs. If the ground conductor was not connected, the monitored low voltage signal could then rise up to medium voltage potential which is a serious hazard that must be avoided at all times. You must always ensure the ground conductors on the VSB are securely connected before applying medium voltage to the drive.

ATTENTION

Failure to connect both ground connections on the voltage sensing board will result in high potential in the Low Voltage cabinet within the drive which will result in damage to the drive control and possible injury or death to personnel.

Output Grounding Network

Reconnect the ground connection on the OGN capacitor. The bolt connection should be torque down to 3.4 Nm (30 lb-in). Exceeding the torque rating of this connection may result in damage to the capacitor.

ATTENTION

Failure to reconnect the OGN ground may result in the neutral voltage offset being impressed on the motor cables and stator, which may result in equipment damage. For drives that did not originally have the OGN connected (or even installed), this is not a concern.

Preventative Maintenance Schedule

Preventive Maintenance Check List

The preventive maintenance activities on the PF7000 Air-Cooled Drive ("A" Frame or "B" Frame) can be broken down into two categories:

- Operational Maintenance – can be completed while the drive is running.
- Annual Maintenance – should be completed during scheduled downtime.

Refer to the Tools/Parts/Information Requirements at the end of this section for a list of documentation and materials needed to properly complete the preventive maintenance documents.

Operational Maintenance

This process really involves only one task: Changing or Cleaning the Air Filters. The PF7000 drives require consistent, unrestricted airflow to keep the power devices cool. The air filter is the main source of blockage in the air path.

The drive will provide an air filter alarm whenever the pressure differential across the devices drops to a drive-specific level. Referring to the Air Filter Block parameter, this can be anywhere from 7% to 17% blocked, depending on the heatsink and device configuration. This may seem like a small number, but it takes significant blockage to begin to lower the voltage from the pressure sensor. The percentage is a measure of voltage drop, and should not be viewed as a percentage of the opening that is covered. They are not related linearly.

- Once you receive an Air Filter Warning, you should immediately make plans to change or clean the filter. You should still have days or weeks until the drive reaches an Air Filter Fault, but this is dependent on site-specific particle conditions.

This can be done while the drive is running. Refer to User Manual, Chapter 4 – Component Definition and Maintenance for a detailed description of the process.

Annual Maintenance

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

Initial Information Gathering

Some of the important information to be recorded includes:

- Print Drive Setup
- Print Fault/Warning Queues
- Save Parameters to NVRAM
- Save Parameters to Operator Interface
- Circuit Board Part Numbers / Serial Numbers / Revision Letters* (* This only needs to be recorded if parts have been modified or changed since the last Preventive Maintenance activities)

WARNING

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

Physical Checks (NO Medium Voltage and NO Control Power)

➢ **Power Connection Inspection**

- Inspect PF7000 drive, input/output/bypass contactor sections, and all associated drive components for loose power cable connections and ground cable connections: torque them to the required torque specifications.
- Inspect the bus bars and check for any signs of overheating / discoloration and tighten the bus connections to the required torque specifications.
- Clean all cables and bus bars that exhibit dust build-up.
- Use torque sealer on all connections.

➢ **Carry out the integrity checks on the signal ground and safety grounds.**

- **Check for any visual/physical evidence of damage and/or degradation of components in the low voltage compartments.**
  - This includes Relays, Contactors, Timers, Terminal connectors, Circuit breakers, Ribbon cables, Control Wires, etc.; Causes could be corrosion, excessive temperature, or contamination.
  - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.

- **Check for any visual/physical evidence of damage and/or degradation of components** in the medium voltage compartments (inverter/rectifier, cabling, DC Link, contactor, load break, harmonic filter, etc).
  - This includes main cooling fan, power devices, heatsinks, circuit boards, insulators, cables, capacitors, resistors, current transformers, potential transformers, fuses, wiring, etc.; Causes could be corrosion, excessive temperature, or contamination.
  - Verify torque on heatsink bolts (electrical connections to bullet assemblies) is within specifications (13.5 N-m).
  - Clean all contaminated components using a vacuum cleaner (DO NOT use a blower), and wipe clean components where appropriate.
  - NOTE: An important component to check for contamination is the heatsink. The fine grooves in the aluminum heatsinks can capture dust and debris.

- **Carry out the physical inspection and verification for the proper operation of the contactor/isolator interlocks, and door interlocks.**

- Carry out the physical inspection and verification for the proper operation of the key interlocks.
- Physical verification of the additional cooling fans mounted in the AC Line Reactor cabinet, Harmonic Filter cabinet for mounting and connections.
- Carry out the cleaning of the fans and ensure that the ventilation passages are not blocked and the impellers are freely rotating without any obstruction.
- Carry out the insulation meggering of the drive, motor, isolation transformer/line reactor, and the associated cabling.
- Refer to User's Manual, **Appendix D** for meggering procedure.
- Check clamp head indicator washers for proper clamp pressure, and adjust as necessary.
  - Refer to page 5-17, "Uniform Clamping Pressure" and "Checking Clamping Pressure" for details on proper clamp pressure.

Annual Maintenance (cont.)

Control Power Checks (No Medium Voltage)

- Apply Control power to the PowerFlex drive, and test power to all of the vacuum contactors (input, output, and bypass) in the system, verifying all contactors can close and seal in.
  - Refer to Publication **1502-UM050_-EN-P** for a detailed description of all contactor maintenance.
- Verify all single-phase cooling fans for operation.
  - This includes the cooling fans in the AC/DC Power supplies and the DC/DC converter.
- Verify the proper voltage levels at the CPT (if installed), AC/DC Power Supplies, DC/DC converter, isolated gate power supply boards.
  - Refer to Chapter 4 – Commissioning in Reference Manual (Publication 7000A-RM001_-EN-P) for appropriate procedures/voltage levels for the above checks.
- Verify the proper gate pulse patterns using Gate Test Operating Mode.
- If there have been any changes to the system during the outage, place the drive in System Test Operating Mode and verify all functional changes.

Final Power Checks before Restarting

- Ensure all cabinets are cleared of tools, and all component connections are back in place and in the running state.
- Put all equipment in the normal operating mode, and apply medium voltage.
- If there were any input or output cables removed, verify the input phasing, and bump the motor for rotation.
- If there were any changes to the motor, input transformer, or associated cabling, you will have to retune the drive to the new configuration using Autotuning.
- Save all parameter changes (if any) to NVRAM.
- Run the application up to full speed/full load, or to customer satisfaction.
- Capture the drive variables while running, in the highest access level if possible.

Additional Tasks During Preventive Maintenance

- Investigation of customer's concerns relating to drive performance
  - Relate any problems found during above procedures to customer issues.
- Informal instruction on drive operation and maintenance for plant maintenance personnel
  - Reminder of safety practices and interlocks on MV equipment, and on specific operating concerns
  - Reminder of the need to properly identify operating conditions
- Recommendation for critical spare parts which should be stocked in-plant to reduce production downtime
  - Gather information on all spare parts on site, and compare that with factory-recommended critical spares to evaluate whether levels are sufficient.
  - Contact MV Spare Parts group for more information.
- Vacuum Bottle Integrity Testing using a Vacuum Checker or AC Hipot
  - Refer to Publication **1502-UM050_-EN-P** for a detailed description of all contactor maintenance.

Final Reporting

- A complete, detailed report on all steps in the Preventive Maintenance procedures should be recorded to identify changes.
  - A completed copy of this checklist should be included.
  - A detailed description of ALL ADJUSTMENTS AND MEASUREMENTS that were taken during the process should be included in an addendum (Interlock Adjustments, Loose Connections, Voltage Readings, Megger Results, Parameters, etc.)
- THIS INFORMATION SHOULD BE COMMUNICATED TO MV PRODUCT SUPPORT SO THAT FUTURE SUPPORT ACTIVITIES WILL HAVE THE LATEST SITE INFORMATION AVAILABLE.
  - This can be faxed to (519) 740-4756, or
  - E-mailed to: MVSupport_Technical@ra.rockwell.com

Annual Maintenance (cont.)

Time Estimations

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

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

Tool / Parts / Information Requirements

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

Tools

- 100 MHz Oscilloscope with minimum 2 Channels and memory
- 5kV DC Megger
- Digital Multimeter
- Torque Wrench
- Laptop Computer with Relevant Software and Cables
- Assorted Hand Tools (Screwdrivers, Open Ended Metric Wrenches, Metric Sockets, etc.)
- 5/16 Allen Keys
- Speed Wrench
- Feeler Gauge
- Vacuum Bottle Checker or AC-Hipot
- Minimum of 15kV Hotstick / Potential Indicator
- Minimum of 10kV Safety Gloves
- Vacuum Cleaner with Anti-static hose
- Anti-static Cleaning Cloth
- No. 30 Torx Driver

Documentation

- PF7000 User's Manual – Publication 7000-UM151_-EN-P
- PF7000 Parameters Manual – Publication 7000-TD002_-EN-P
- 400A Vacuum Contactor Manual – Publication 1502-UM050_-EN-P
- Drive-Specific Electrical and Mechanical Prints
- Drive-Specific Spare Parts List

Materials

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

PowerFlex 7000 Maintenance Schedule

Rockwell recognizes that following a defined maintenance schedule will deliver the maximum product availability. By rigorously following this maintenance schedule, the Customer can expect the highest possible uptime. This Annual Preventative Maintenance Program includes a visual inspection of all drive components visible from the front of the unit, resistance checks on the power components, power supply voltage level checks, general cleaning and maintenance, checking of all accessible power connections for tightness, and other tasks. For more details, please refer to Chapter 5 (Component Definition and Maintenance) of this User Manual.

I – Inspection

This indicates that the component should be inspected for signs of excessive accumulation of dust/dirt/etc. or external damage (e.g. looking at Filter Capacitors for bulges in the case, inspecting the heatsinks for debris clogging the air flow path, etc.).

M – Maintenance

This indicates a maintenance task that is outside the normal preventative maintenance tasks, and can include the inductance testing of Line Reactors/DC Links, or the full testing of an isolation transformer.

R – Replacement

This indicates that the component has reached its mean operational life, and should be replaced to decrease the chance of component failure. It is very likely that components will exceed the design life in the drive, and that is dependent on many factors such as usage, heating, etc.

C – Cleaning

This indicates the cleaning of a part that can be reused, and refers specifically to the door-mounted air filters in the liquid-cooled drives and some air-cooled drives.

Rv – Review

This refers to a discussion with Rockwell Automation to determine whether any of the enhancements/changes made to the Drive Hardware and Control would be valuable to the application.

RFB/R – Refurbishment/Replacement

The parts can be refurbished at lower cost OR the parts can be replaced with new ones.

Rockwell Automation PowerFlex 7000 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.

General Notes

Maintenance of Medium Voltage Motor Control Equipment

ATTENTION

Servicing energized Medium Voltage Motor Control Equipment can be hazardous. Severe injury or death can result from electrical shock, bump, or unintended actuation of controlled equipment. Recommended practice is to disconnect and lockout control equipment from power sources, and release stored energy, if present.

For countries following NEMA standards, refer to National Fire Protection Association Standard No. NFPA70E, Part II and (as applicable) OSHA rules for Control of Hazardous Energy Sources (Lockout/Tagout) and OSHA Electrical Safety Related Work Practices safety related work practices, including procedural requirements for lockout-tagout, and appropriate work practices, personnel qualifications and training requirements, where it is not feasible to de-energize and lockout or tagout electric circuits and equipment before working on or near exposed circuit parts.

For countries following IEC standards, refer to local codes and regulations.

Periodic Inspection

Medium Voltage Motor control equipment should be inspected periodically. Inspection intervals should be based on environmental and operating conditions and adjusted as indicated by experience. An initial inspection within 3 to 4 months after installation is suggested. Refer to the following standards for general guidelines for setting-up a periodic maintenance program.

For countries following NEMA standards, refer to National Electrical Manufacturers Association (NEMA) Standard No. ICS 1.1 (Safety Guidelines for the Application, Installation, and Maintenance of Solid-Sate Control) for MV Drives and ICS 1.3 (Preventive Maintenance of Industrial Control and Systems Equipment) for MV Controllers.

For countries following IEC standards, refer to IEC 61800-5-1 Sec. 6.5 for MV Drives and IEC 60470 Sec. 10, IEC 62271-1 Sec. 10.4 for MV Controllers.

General Notes (cont.)

Contamination

If inspection reveals that dust, dirt, moisture or other contamination has reached the control equipment, the cause must be eliminated. This could indicate unsealed enclosure openings (conduit or other) or incorrect operating procedures. Replace any damaged or embrittled seals and repair or replace any other damaged or malfunctioning parts (e.g., hinges, fasteners, etc.). Dirty, wet or contaminated control devices must be replaced unless they can be cleaned effectively by vacuuming or wiping. Compressed air is not recommended for cleaning because it may displace dirt, dust, or debris into other parts or equipment, or damage delicate parts.

High Voltage Testing

High voltage insulation resistance (IR) or dielectric withstanding voltage (megger) tests should not be used to check solid-state control equipment. When meggering electrical equipment, such as transformers or motors, solid-state devices must be bypassed before performing the test. Even though no damage may be readily apparent after a megger test, the solid-state devices are degraded and repeated application of high voltage can lead to failure.

Maintenance after a Fault Condition

Opening of the short circuit protective device (such as fuses or circuit breakers) in a properly coordinated motor branch circuit is an indication of a fault condition in excess of operating overload. Such conditions can cause damage to medium voltage motor control equipment. Before restoring power, the fault condition must be corrected and any necessary repairs or replacements must be made to restore the medium voltage motor control equipment to good working order. Refer to NEMA Standards Publication No. ICS-2, Part ICS2-302 for procedures. Use only replacement parts and devices recommended by Allen-Bradley to maintain the integrity of the equipment. Ensure the parts are properly matched to the model, series and revision level of the equipment. After maintenance or repair of the equipment, always test the control system for proper functioning under controlled conditions (that avoid hazards in the event of a control malfunction). For additional information, refer to NEMA ICS 1.3, PREVENTIVE MAINTENANCE OF INDUSTRIAL CONTROL AND SYSTEMS EQUIPMENT, published by the National Electrical Manufacturers Association, and NFPA70B, ELECTRICAL EQUIPMENT MAINTENANCE, published by the National Fire Protection Association.

Part-specific Notes

Cooling Fans

Inspect fans used for forced air cooling. Replace any that have bent, chipped, or missing blades, or if the shaft does not turn freely. Apply power momentarily to check operation. If unit does not operate, check and replace wiring, fuse, or fan motor as appropriate. Clean or change air filters as recommended in the Users Manual.

Operating Mechanisms

Check for proper functioning and freedom from sticking or binding. Replace any broken, deformed or badly worn parts or assemblies according to individual product User Manuals. Check for and securely retighten any loose fasteners. Lubricate, if specified in individual product instructions. Many devices are factory lubricated. If lubrication during use or maintenance of these devices is needed, it will be specified in their individual product instructions and/or User Manual. Note: Allen-Bradley magnetic starters, contactors and relays are designed to operate without lubrication. Do not lubricate these devices, because oil or grease on the pole faces (mating surfaces) of the operating magnet may cause the device to stick in the "ON" mode.

Contacts

Check contacts for excessive wear and dirt accumulations. Vacuum or wipe contacts with a soft cloth if necessary to remove dirt. Contacts are not harmed by discoloration and slight pitting. Contacts should never be filed, as dressing only shortens contact life. Contact spray cleaners should not be used as their residues on magnet pole faces or in operating mechanisms may cause sticking and can interfere with electrical continuity. Contacts should only be replaced after contact face material has become badly worn. Always replace contacts in complete sets to avoid misalignment and uneven contact pressure.

Vacuum Contactors

Contacts of vacuum contactors are not visible, so contact wear must be checked indirectly. Vacuum bottles should be replaced when:
1. The contactor wear indicator line shows need for replacement, or
2. The vacuum bottle integrity tests show need for replacement.

Replace all vacuum bottles in the contactor at the same time to avoid misalignment and uneven contact wear. If the vacuum battles do not require replacement, check and adjust overtravel to the value listed in the product User Manual.

Part-specific Notes (cont.)

Power Cable and Control Wire Terminals

Loose connections in power circuits can cause overheating that can lead to equipment malfunction or failure. Loose connections in control circuits can cause control malfunctions. Loose bonding or grounding connections can increase hazards of electrical shock and contribute to electromagnetic interference (EMI). Check the tightness of all terminals and bus bar connections and tighten securely any loose connections. Replace any parts or wiring damaged by overheating, and any broken wires or bonding straps. Refer to the User Manual for torque values required for power cable and bus hardware connections.

Coils

If a coil exhibits evidence of overheating (cracked, melted or burned insulation), it must be replaced. In that event, check for and correct overvoltage or undervoltage conditions, which can cause coil failure. Be sure to clean any residue of melted coil insulation from other parts of the device or replace such parts.

Batteries

Replace batteries periodically as specified in product manual or if a battery shows signs of electrolyte leakage. Use tools to handle batteries that have leaked electrolyte; most electrolytes are corrosive and can cause burns. Dispose of the old battery in accordance with instructions supplied with the new battery or as specified in the product manual.

Pilot Lights

Replace any burned out lamps or damaged lenses. Do not use solvents or cleaning agents on the lenses.

Solid-State Devices

ATTENTION

Use of other than factory recommended test equipment for solid-state controls may result in damage to the control or test equipment or unintended actuation of the controlled equipment. Refer to paragraph titled HIGH VOLTAGE TESTING.

Solid-state devices require little more than a periodic visual inspection. Discolored, charred or burned components may indicate the need to replace the component or circuit board. Necessary replacements should be made only at the PC board or plug-in component level. Printed circuit boards should be inspected to determine whether they are properly seated in the edge board connectors. Board locking tabs should also be in place. Solid-state devices must also be protected from contamination, and cooling provisions must be maintained – refer to paragraphs titled CONTAMINATION and COOLING DEVICES. Solvents should not be used on printed circuit boards.

Locking and Interlocking Devices

Check these devices for proper working condition and capability of performing their intended functions. Make any necessary replacements only with Allen-Bradley renewal parts or kits. Adjust or repair only in accordance with Allen-Bradley instructions found in the product User Manuals.

Notes:

Specifications

Specifications

Description	Specifications	
Power Rating (Air Cooled)	200 to 1250 hp (150 to 933 kW)	
Motor Type	Induction or Synchronous	
Input Voltage Rating	2400V, 3300V, 4160V, 6600V	
Input Voltage Tolerance	± 10% of Nominal	
Voltage Sag ❶	-30%	
Control Power Loss Ride-Through	5 Cycles (Std)	
Input Protection	Surge Arrestors	
Input Frequency	50/60 Hz, +/- 5%	
Power Bus Short-circuit Current Withstand	5 Cycle	
3300 V – 6000 V ❷	25 kA RMS SYM	
Basic Impulse Level ❸	50 kV (0 – 1000 m)	
Power Bus Design	Copper – Tin plated	
Ground Bus	Copper – Tin plated 6 x 51 mm (¼ x 2 in.)	
Customer Control Wire Way	Separate and Isolated	
Input Power Circuit Protection	Vacuum Contactor with Fused Isolating Switch (optional)	
Input Impedance Device	Isolation Transformer or AC Line Reactor	
Output Voltage	0 – 2300 V 0 – 3300 V 0 – 4000 V 0 – 6000 or 6300 V	
Inverter Design	PWM	
Inverter Switch	Symmetrical Gate Commutated Thyristor (SGCT)	
Inverter Switch Failure Mode	Non-rupture, Non-arc	
Inverter Switch Failure Rate (FIT)	100 per 1 Billion Hours Operation	
Inverter Switch Cooling	Double Sided, Low Thermal Stress	
Inverter Switching Frequency	420-540 Hz	
Number of Inverter SGCTs	Voltage	SGCTs (per phase)
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
SGCT PIV Rating (Peak Inverse Voltage)	Voltage	PIV
	2400 V	6500 V
	3300 V	6500 V
	4160 V	6500 V
	6600 V	6500 V
Rectifier Designs	AFE (Active Front End)	
Rectifier Switch	SGCT	
Rectifier Switch Failure Mode	Non-rupture, Non-arc	
Rectifier Switch Failure Rate (FIT)	100 (SGCT) per 1 Billion Hours Operation	
Rectifier Switch Cooling	Double Sided, Low Thermal Stress	

❶ Voltage Sag tolerance is reduced to -25% when control power is supplied from medium voltage via CPT.
❷ Short-circuit fault rating based on input protection device (contactor or circuit breaker).
❸ BIL rating based on altitudes < 1000 m (3,300 ft.) Refer to factory for derating on altitudes >1000 m).

Specifications (cont.)

Description	Specifications	
Number of Rectifier Devices per phase	Voltage	AFE
	2400 V	2
	3300 V	4
	4160 V	4
	6600 V	6
Output Waveform to Motor	Sinusoidal Current / Voltage	
Medium Voltage Isolation	Fiber Optic	
Modulation Techniques	SHE (Selective Harmonic Elimination) Synchronous Trapezoidal PWM Asynchronous and Synchronous SVM (Space Vector Modulation)	
Control Method	Digital Sensorless Direct Vector Full Vector Control with Tach Feedback (Optional)	
Tuning Method	Auto Tuning via Setup Wizard	
Speed Regulator Bandwidth	5-25 Radians / Second	
Torque Regulator Bandwidth	15-50 Radians / Second	
Speed Regulation	0.1% without Tachometer Feedback 0.01-0.02% with Tachometer Feedback	
Acceleration/Deceleration Range	Independent Accel/Decel – 4 x 1200 sec.	
Acceleration/Deceleration Ramp Rates	4 x Independent Accel/Decel	
S Ramp Rate	Independent Accel/Decel – 2 x 1200 sec.	
Critical Speed Avoidance	3 x Independent with Adjustable Bandwidth	
Stall Protection	Delay / Speed	
Load Loss Detection	Adjustable level, delay, speed set points	
Control Mode	Speed or Torque	
Current Limit	Adjustable in Motoring and Regenerative	
Output Frequency Range	0.2-75 Hz	
Service Duty Rating Overload Rating	Normal Duty	Heavy Duty
	110% Overload for 1 minute every 10 minutes (Variable Torque Load)	150% Overload for 1 minute every 10 minutes (Constant or Variable Torque Load)
Typical VFD Efficiency	> 97.5% Contact Factory for Guaranteed Efficiency of Specific Drive Rating	
Input Power Factor	0.98 minimum, 30 – 100% Load	
IEEE 519 Harmonic Guidelines ⊆	IEEE 519 Compliant	
VFD Noise Level	< 85 dB(A) per OSHA standard 3074	
Regenerative Braking Capability	Inherent – No Additional Hardware or Software Required	
Flying Start Capability	Yes – Able to Start into and Control a Spinning Load in Forward or Reverse Direction	
Operator Interface	40-character, 16-line formatted text	
Languages	English French Spanish	German Chinese

❹ Under certain conditions, power system analysis will be required.

Description	Specifications
Control Power	220/240 V or 110/120 V, 1 phase – 50/60 Hz (20 Amp)
External I/O	16 Digital Inputs, 16 Digital Outputs
External Input Ratings	50/60 Hz AC or DC 120-240 V – 1 mA
External Output Ratings	50-60 Hz AC or DC 30-260 V – 1 amp
Analog Inputs	(3) Isolated, 4-20mA or 0-10 V
Analog Resolution	• Analog input 12 Bit (4-20 mA) • Analog input 13 Bit (0-10V)
Analog Outputs	• (1) Isolated, 4-20 mA • (8) Non-isolated, 0-10 V
Communication Interface	DPI
Scan Time	Internal DPI – 2 ms min., 4 ms max.
Communications Protocols (Optional)	R I/O DeviceNet Ethernet Profibus Modbus Interbus ControlNet Lon Works CAN open RS485 HVAC RS485 DF1 RS232 DF1 USB
Enclosure	NEMA 1, IP21
Lifting Device	Standard / Removable
Mounting Arrangement	Mounting Sill Channels
Structure Finish	Epoxy Powder – Paint Exterior Sandtex Light Grey (RAL 7038) – Black (RAL 8022) Internal – Control Sub Plates – High Gloss White (RAL 9003)
Interlocking	Key provision for customer input Disconnecting Device
Corrosion Protection	Unpainted Parts (Zinc Plates / Bronze Chromate)
Fiber Optic Interface	Rectifier – Inverter – Cabinet (Warning/Trip)
Door Filter	Painted Diffuser with Matted Filter Media
Door Filter Blockage	Air Flow Restriction Trip/Warning
Ambient Temperature	0° to 40°C (32°F to 104°F) 0° to 50°C (32°F to 122°F) Optional
Storage and Transportation Temperature Range	-40°C to 70°C (-40°F to 158°F)
Relative Humidity	95% Non-Condensing
Altitude (Standard)	0 to 3300 ft. (0 to 1000 m)
Altitude (Optional)	0 to 16400 ft. (1001 to 5000 m)
Seismic (UBC Rating)	1, 2, 3, 4
Standards	NEMA, IEC, CSA, UL, ANSI, IEEE

Dimensions / Weights

Nominal Line Voltage	Drive Type	VFD Maximum Current	Total Width		Approx. Weight lb (kg)
			Millimeters	Inches	
2400V 60 Hz *or* 3300V 50 Hz *or* 4160V 50/60 Hz	Configuration #1 – Direct-to-Drive	140	2100	82.67	4300 (1955)
	Configuration #2 – AFE Rectifier with separate isolation transformer	160	2400	94.49	8300 (3765)
	Configuration #3 – AFE Rectifier with Integral isolation transformer	160	2400	94.49	9800 (4455)
6600V 50/60 Hz	Configuration #1 – Direct-to-Drive	93	2400	94.49	6500 (2955)
	Configuration #2 – AFE Rectifier with separate isolation transformer	105	2800	110.24	10000 (4545)
	Configuration #3 – AFE Rectifier with integral isolation transformer	105	2800	110.24	7500 (3410)

Note: Total Depth = 1000 mm (39.37 in.)
Total Height without fan shroud = 2318 mm (91.25 in.)
Total Height with fan shroud = 2643 mm (104.05 in.)

Nominal Power Ratings

Nominal Line Voltage	VFD Current Range (Amps)	Nominal HP Range	Nominal kW Range
2400V 60 Hz	46 – 160	200 – 700	150 – 522
3300V 50 Hz	46 – 160	250 – 1000	187 – 750
4160V 50/60 Hz	46 – 160	350 – 1250	260 – 933
6600V 50/60 Hz	40 – 105	500 - 1250	400 – 933

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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