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Distributed Power System
SD3000/SF3000
3-Phase DC Power Modules

2 - 15 HP @ 230 - 460 VAC (27 Amps DC)
16 - 60 HP @ 230 - 460 VAC (100 Amps DC)

Instruction Manual S-3037

RELIANCE ELECTRIC

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WARNING

THE USER MUST PROVIDE AN EXTERNAL, HARDWIRED EMERGENCY STOP CIRCUIT OUTSIDE OF THE DRIVE CIRCUITRY. THIS CIRCUIT MUST DISABLE THE SYSTEM IN CASE OF IMPROPER OPERATION. UNCONTROLLED MACHINE OPERATION MAY RESULT IF THIS PROCEDURE IS NOT FOLLOWED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

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1.0 INTRODUCTION

The SD3000/SF3000 DC Power Modules convert fixed voltage and frequency three-phase AC power to adjustable voltage DC power, which can be used to supply the armature or field of a DC motor. These Power Modules operate within the AutoMax Distributed Power System (DPS) environment, and are controlled by the AutoMax Programming Executive software. The SD3000 configuration provides adjustable-voltage armature control of DC motors, rated 2 to 60 HP at 500 VDC. The SF3000 configuration (see Appendix E) operates under a different control algorithm to provide a three-phase field supply.

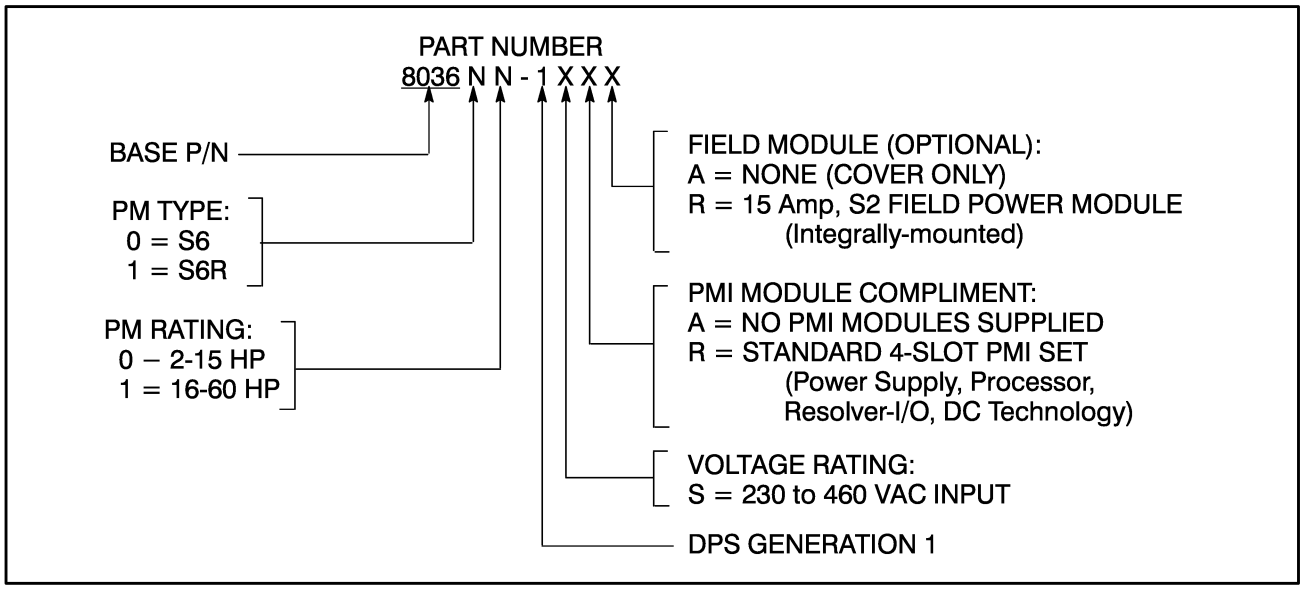
These Power Modules employ a three-phase SCR power bridge. Regenerative and non-regenerative versions of the Power Modules are available in two power ratings, 2-15 HP and 16-60 HP, as listed in table 1.1. Power Module part numbering is described in table 1.2.

Table 1.1 - SD3000/SF3000 Power Modules

Power Module Part Number	Horse-power *	AC Input	Description	Wiring Diagram (W/D)
803600-1xxx	2-15	230 - 460VAC	Non-Regenerative (S6)	30300-1
803601-1xxx	16-60	230 - 460VAC	Non-Regenerative (S6)	30301-1
803610-1xxx	2-15	230 - 460VAC	Regenerative (S6R)	30310-1
803611-1xxx	16-60	230 - 460VAC	Regenerative (S6R)	30311-1

* HP ratings based on 460 VAC input / 500 VDC output.

Table 1.2 - Power Module Part Numbering



When the SD3000 Power Module is used for armature control, a single-phase Field Power Module can be added to provide the motor field excitation. The optional non-reversing (S2) 15 amp Field Power Module, #805405-S, is designed to be integrally mounted within the SD3000 Power Module chassis. If this Field Power Module does not meet the requirements of the application, a panel-mounted single-phase field supply can be used instead.

Single-phase Field Power Modules are rated 15 or 60 amps at 120/460 VAC, and are available in the configurations listed in table 1.3. The Field Power Module's AC input lines are connected to the 181/L1 and 183/L3 inputs of the SD3000. All systems operate on three-phase 50/60 Hz., 230 to 460 VAC.

Table 1.3 - Single-Phase SD3000 Compatible Field Power Modules

Part No.	Amps	AC Input	Description	Mounting
805405-S	15	120 / 460VAC	Non-Reversing (S2)	Integral
805405-1R *	15	120 / 460VAC	Non-Reversing (S2)	Panel Mounted
805405-3R *	15	120 / 460VAC	Reversing (S2R)	Panel Mounted
805405-5R *	60	120 / 460VAC	Reversing (S2R)	Panel Mounted

* For application information see instruction manual S-3060.

1.1 Standard Features

The SD3000/SF3000 2-60 HP DC Power Modules have the following features:

- Input power supplied from a three-phase AC line
- Short-circuit protection
- AC line filter
- Electronic motor overload protection
- SCR power semiconductors
- Power cube dv/dt protection
- Protection against unequal current sharing among SCRs
- Protection from AC line dips and transients
- Fiber-optic communication with the Distributed Power System Universal Drive Controller (UDC) module
- UR Listed/CUR Certified

The optional non-reversing 15 amp Field Power Module has the following features:

- Electrically-isolated power cube design
- Single voltage design for use with all Power Module voltage ratings
- Line phasing from Power Module armature phasing transformer via armature supply PMI
- Internal AC line fuses
- Self-firing clamp for protection against inductive voltage kick resulting from current interruption
- DC current sensing for current regulation and field loss detection
- Power cube dv/dt protection
- Plug-in design, integrated into the armature assembly
- UR Listed/CUR Certified

1.2 Related Publications

Additional information about using SD3000/SF3000 Power Modules as part of a Distributed Power System is found in the instruction manuals, prints, and other documentation shipped with each drive system. Always consult the prints shipped with the drive system for specific mounting and connecting information about your drive system.

Other instruction manuals located in binder S-3000, Distributed Power System DC Drive, describe PMI rack hardware, software, and communications. It is assumed that the user is familiar with these other manuals in S-3000 before reading this instruction manual:

- S-3005 AutoMax Distributed Power System Overview
- S-3006 SD3000 Drive Configuration and Programming
- S-3007 Universal Drive Controller Module

- S-3008 Power Module Interface Rack and Modules
- S-3009 Fiber Optic Cabling
- S-3011 Diagnostics, Troubleshooting and Start-up Guidelines
- S-3036 SF3000 Drive Configuration and Programming
- S-3060 Panel-Mounted Single-Phase Field Power Modules

1.3 Related Hardware and Software

The following related DPS hardware is available separately:

- Single-Phase Field Power Module
- Fiber-Optic Cable
- Universal Drive Controller Module

1.4 Terms Used in this Manual

The terms listed in this section have the specific meanings given below when they appear in this manual.

2-15 HP Power Modules - Refers to both regenerative and non-regenerative DPS DC Power Modules (460 VAC input / 500 VDC output ratings).

16-60 HP Power Modules - Refers to both regenerative and non-regenerative DPS DC Power Modules (460 VAC input / 500 VDC output ratings).

Application - The process for which the combination of hardware and control software is being used.

Armature assembly - a module containing the three-phase SCR power bridge and related hardware components normally used to control the armature current.

Diagnostic - a software routine or hardware circuit specifically designed to check for error conditions.

Drive - the combination of a UDC, a PMI, and a Power Module as a means or apparatus for transmitting motion to a machine or machine part.

Drive warning - a potentially hazardous or undesirable operating condition checked for by the PMI operating system. Drive warnings are reported in register 203/1203 in the UDC. A drive warning will not shut down the drive. System response is determined by the application task.

Error - any operating condition other than the desired one.

Drive fault - an error, specifically checked for by the PMI Processor operating system, that will shut down the drive. Drive faults are reported in register 202/1202 in the UDC.

Field assembly - a Field Power Module that is integrally-mounted as a component of the 2-60 HP Power Module.

Field Power Module - an optional single-phase power unit, used to supply the motor or generator field. The Field Power Module may be a component assembly of the 2-60 HP Power Module or it may be housed in an enclosed chassis and mounted on a separate panel.

Non-regenerative drive - a drive capable of motoring operation only (S6 configuration).

Power Module - The combination of armature rectifier assembly, PMI rack and modules, field rectifier assembly (if used), fan, PMI cables, and all associated component assemblies that comprise a 2-60 HP DC Power Module.

Regenerative drive - a drive capable of motoring or regenerating operation, forward or reverse (S6R configuration).

2.0 MECHANICAL / ELECTRICAL DESCRIPTION

This chapter provides information on the Power Modules' mechanical and electrical characteristics. Refer to figures 2.1 and 2.3 (for non-regenerative Power Modules) or figures 2.2 and 2.4 (for regenerative Power Modules) while reading this chapter.

2.1 Mechanical Description

The SD3000/SF3000 2-60 HP Power Modules are of modular design to allow for fast, easy component replacement. The Power Module chassis provides mounting attachments for all Power Module component assemblies and cables. All power conversion devices are contained in a protective steel enclosure.

The Power Modules have the following main component assemblies:

- **AC Input Module**

  Three-phase incoming AC power terminals (181/L1, 182/L2, 183/L3) are located at the top of the Power Module panel. Incoming line fuses (1 FU, 2 FU, 3 FU) provide short circuit protection. A phasing transformer is mounted on the backplane to provide AC line phase sequencing and zero-crossing information for each input phase.

  Line reactors (ferrite cores) are used to ensure a minimum AC line input impedance. These reactors help provide di/dt protection for the SCRs and function as part of the thyristor dv/dt protective circuitry. They also provide a minimum input impedance for the AC line transient spike filter.

  Two current transformers sense AC line current and provide current feedback to the PMI rack for armature current regulation.

- **Multipurpose PC Board**

  This board contains voltage divider networks for the incoming line voltage (terminals 281, 282, 283) and the armature voltage (terminals 45 and 47). These voltages are scaled down and routed to the PMI rack for use in the various control algorithms. The multipurpose board also contains a line voltage rectifier circuit and discharge resistors for filtering high voltage spikes.

- **Armature Assembly**

  The armature assembly is integrally-mounted below the AC input assembly and above the optional field assembly. Non-regenerative (S6) Power Modules contain a single three-phase power bridge, consisting of six SCRs, gate driver circuitry, and a heatsink. Regenerative Power Modules contain two anti-parallel three-phase power bridges and related circuitry (12 SCRs total). All SCRs are paired in replaceable thyristor cubes.

- **Snubber Assembly**

  The Snubber Assembly R-C circuitry provides dv/dt protection for each bridge thyristor.

- **Field Assembly**

  The optional 15 amp, non-reversing (S2) Field Power Module can be integrally mounted within the Power Module chassis, below the armature assembly. See Chapter 5 of this manual for information about the integrally-mounted field assembly.

- **Fan Assembly**

  The plug-in fan assembly operates on 120 VAC provided by the PMI rack control power. The fan provides cooling air flow for the integrally-mounted PMI rack, the armature assembly, and the optional field assembly. Fan loss is detected by an air flow sensor, located in the PMI Power Supply module.

- **Power Module Interface (PMI) Rack**

  The PMI rack is integrally-mounted below the fan assembly. It contains the PMI Power Supply module, PMI Processor module, Resolver I/O module, and DC Technology module. Refer to

instruction manual S-3008, Power Module Interface Rack and Modules, for further information on the PMI rack and modules.

- **PMI Cables**

  Multi-conductor cables connect the Power Module assemblies to the PMI rack's DC Technology module. These cables provide armature feedback through the multipurpose board, armature forward gate control, armature reverse gate control (regenerative models only), and field feedback and gate control when the Field Power Module option is used.

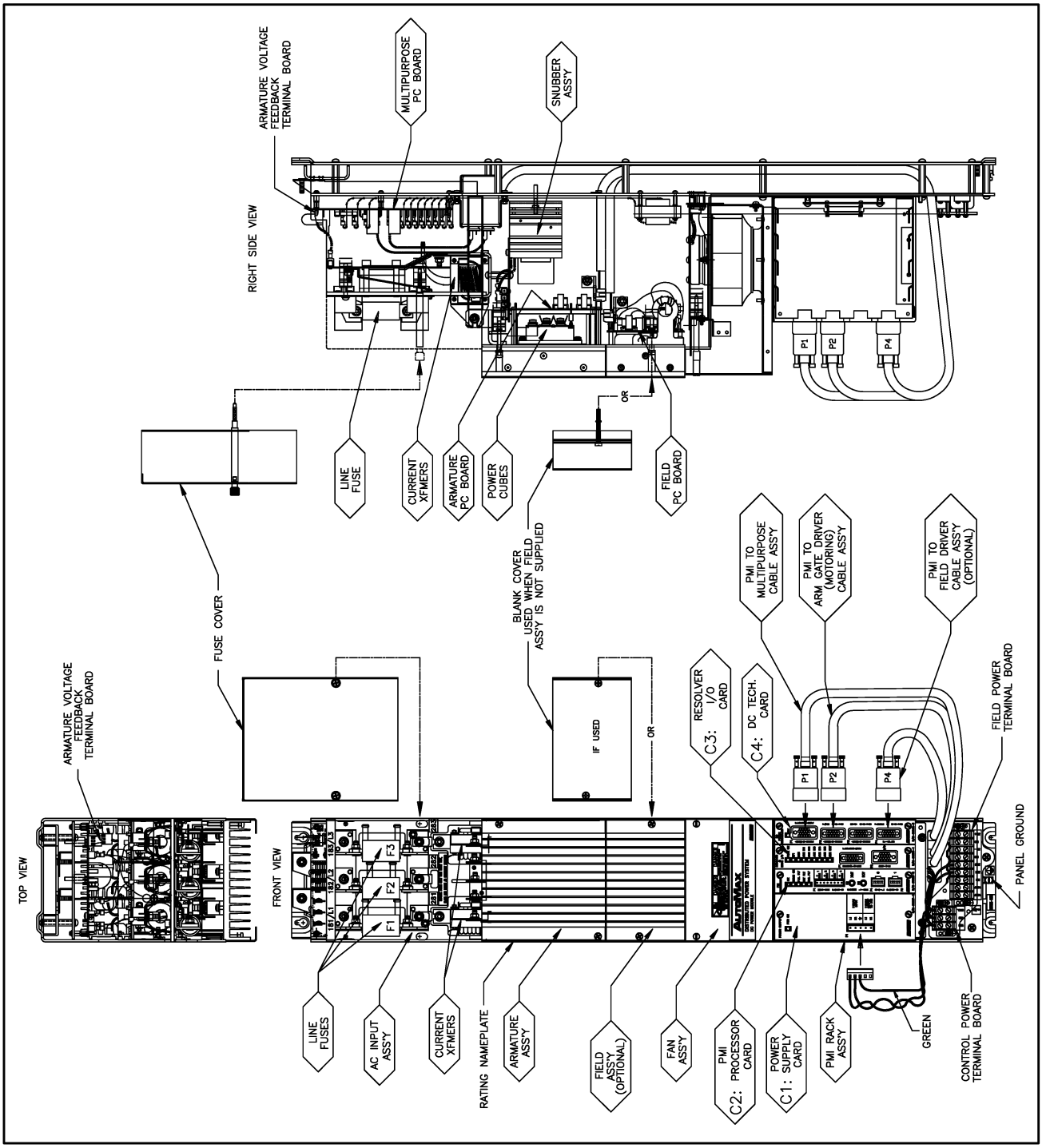


Figure 2.1 - Non-Regenerative (S6) Power Module Components

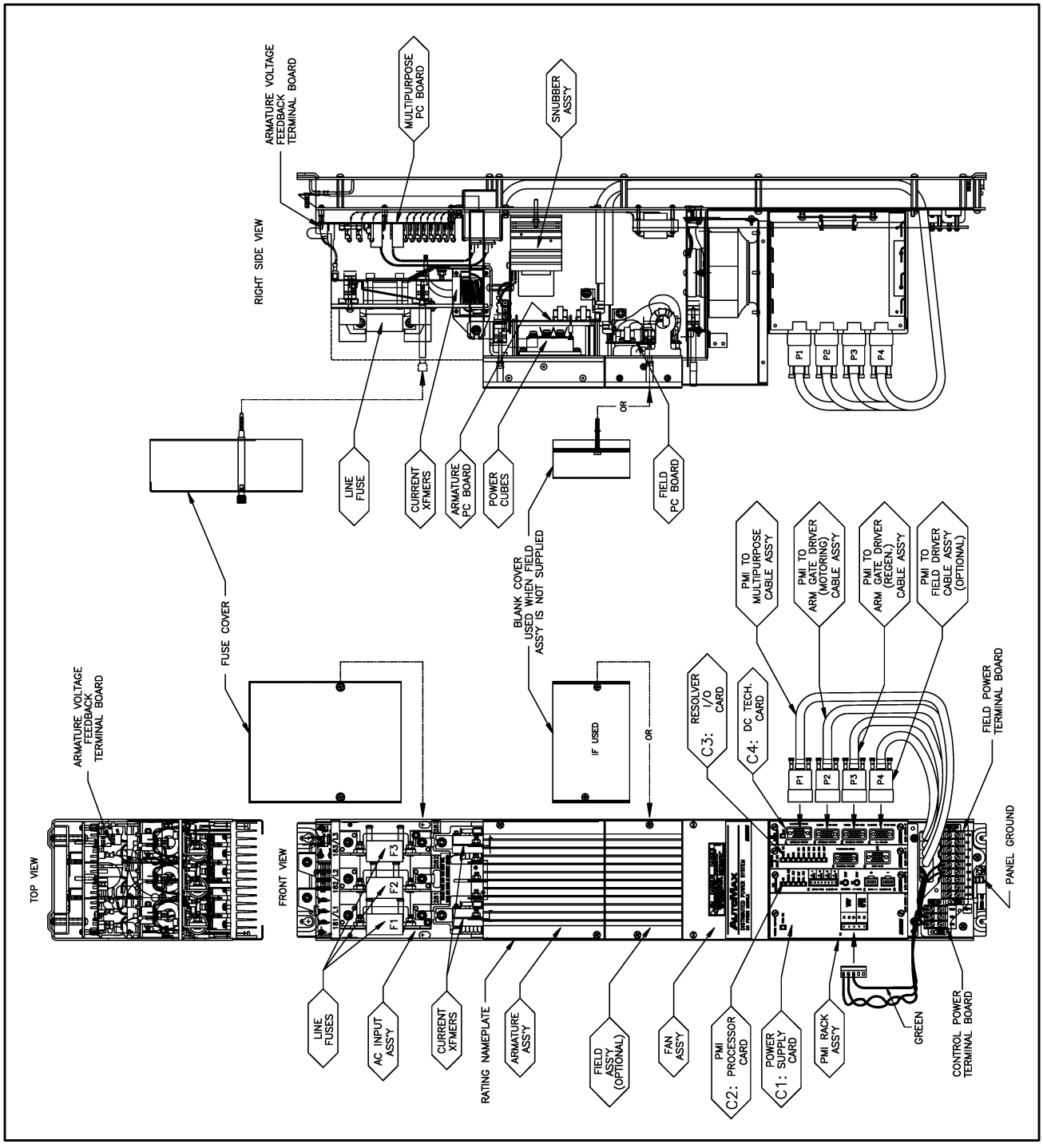


Figure 2.2 - Regenerative (S6R) Power Module Components

2.2 Electrical Description

The SD3000/SF3000 DC Power Modules convert fixed voltage and frequency three-phase AC power to adjustable voltage DC power for motor armatures, fields, or other applications that require controlled DC power. Power Module operation is programmed and controlled in the UDC module in the AutoMax rack and the PMI Processor in the PMI rack.

Incoming power is supplied from a three-phase AC line through Power Module terminals 181/L1, 182/L2, and 183/L3. A phasing transformer provides AC line sequencing and zero-crossing information for each input phase to determine when SCRs should be fired. The Power Module is capable of auto-phasing under software control and can adapt to ABC or ACB phase rotation.

The non-regenerative Power Module rectifier consists of 6 SCRs, configured in a full-wave power bridge. The regenerative Power Module rectifier consists of 12 SCRs in two full-wave bridges, connected in anti-parallel. Snubber circuits provide dv/dt protection for the SCRs in each bridge leg.

The firing angle for each SCR is determined by the current regulation algorithm executing in the PMI Processor. SCR gating signals are provided by the DC Technology module, under the control of the PMI Processor. The gating signals and firing angles are synchronized with the AC line. The PMI Processor regulates the current for the application by varying the point in the AC line cycle at which forward SCR conduction begins. The PMI Processor receives the current reference from the UDC module in the AutoMax rack. The UDC runs the application task that provides overall control of the drive.

The three-phase SCR power bridge in a non-regenerative Power Module controls forward rotation (motoring) only. Torque is in the same direction as rotation.

The two anti-parallel SCR power bridges in a regenerative Power Module control the direction of motor rotation and the direction of torque, in both forward (motoring) and reverse (regenerating) directions. The regenerative Power Module converts the motor's mechanical energy back into electrical energy under conditions of overhauling loads. The generated DC is inverted by the reverse SCR bridge into a "chopped" AC waveform and transferred back to the AC line when the line voltage is lower than the generated voltage.

The optional Field Power Module is powered by single-phase AC, which must be taken from the Power Module's 181/L1 and 183/L3 input lines. The Field Power Module can be operated independently of the armature supply. The integrally-mounted Field Power Module is described in Chapter 5 of this manual.

The output of the Power Module can be also be used as a three-phase motor or generator field supply (SF3000 operation). See Appendix E for information on SF3000 operation of the Power Module.

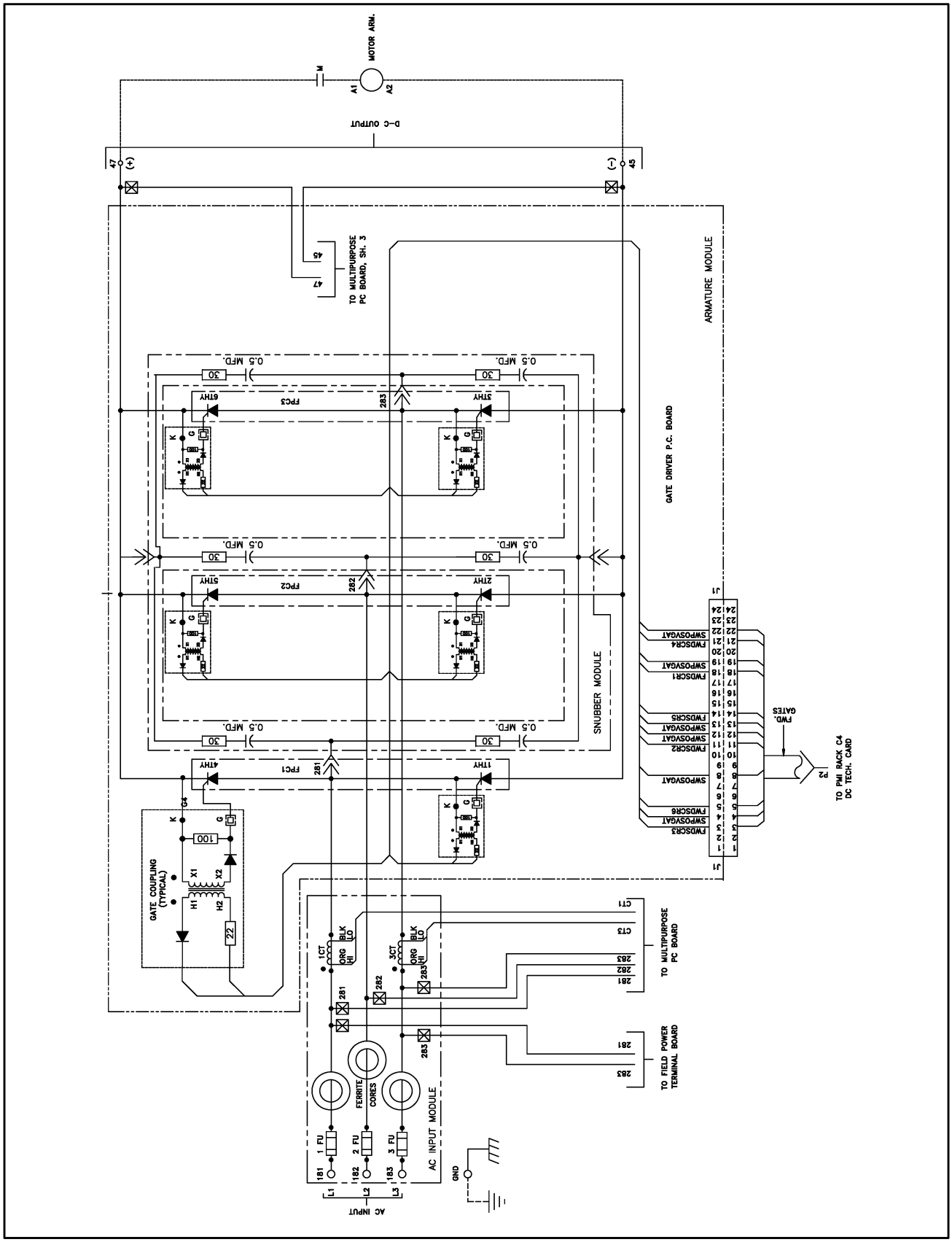


Figure 2.3 - Non-Regenerative (S6) Power Module Circuitry

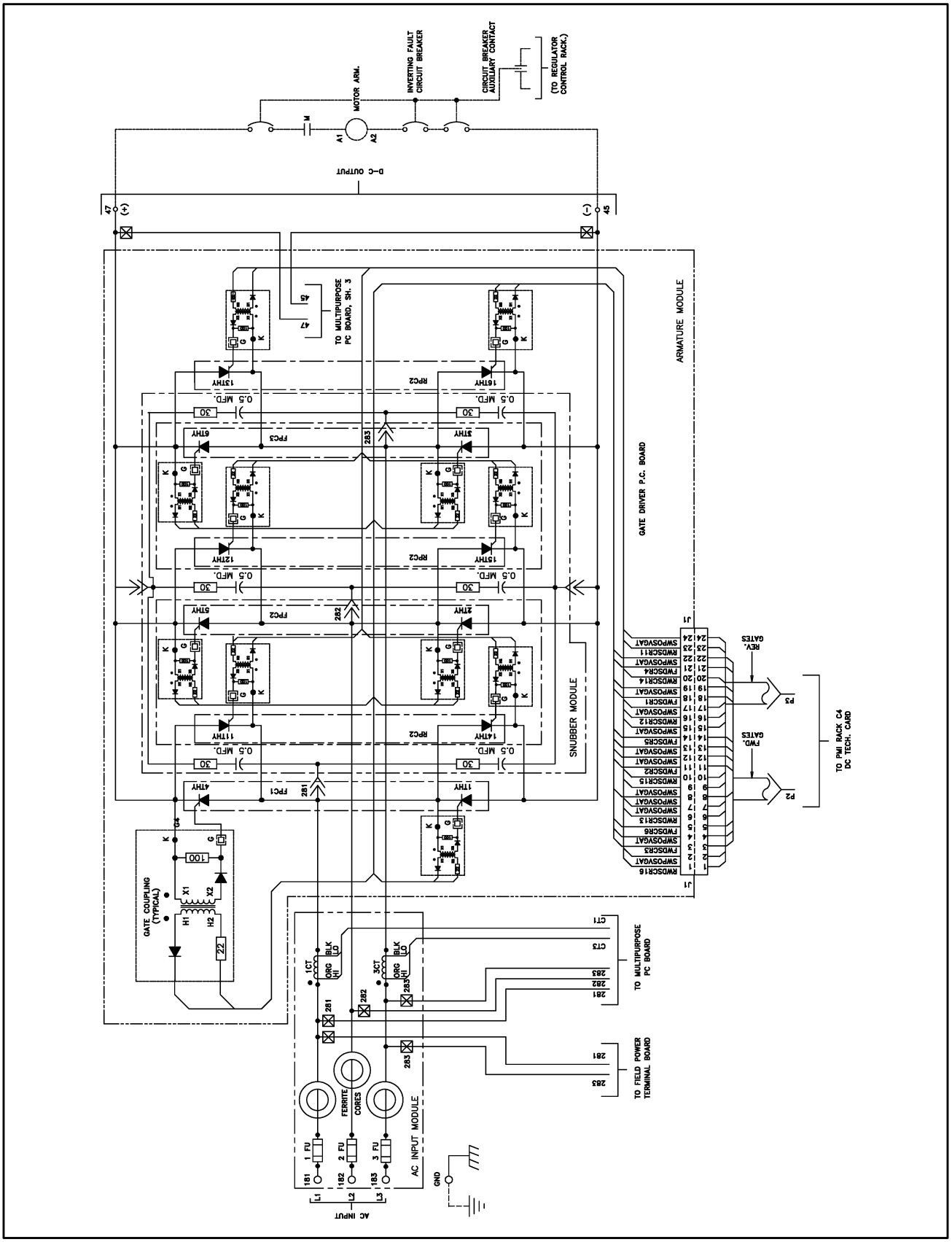


Figure 2.4 - Regenerative (S6R) Power Module Circuitry

3.0 INSTALLATION GUIDELINES

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This chapter describes the guidelines and wiring recommendations to be followed when installing the 2-60 HP DC Power Modules. Installation of the optional integrally-mounted Field Power Module is described in Chapter 5.

3.1 Planning the Installation

Use the following guidelines when planning your Power Module installation:

- Mount the Power Module vertically in an enclosure where it will be kept clean and dry and away from oil, coolants, or other airborne contaminants.
- Check that the enclosure will provide sufficient ventilation for the Power Module. The Power Module's fan pulls in air from the bottom of the chassis and exhausts it from the top. Position the Power Module at least 2 cm (0.8") from the sides and 10 cm (4") from the top and bottom of the cabinet. Allow at least 4 cm (1.6") between Power Modules mounted next to each other. Do not mount Power Modules directly above each other. The temperature within the enclosure must remain between 0 and 55º C (32º F to 131º F).
- Be sure surrounding components do not block service access to the Power Module.
- Verify that the relative humidity will be between at 5 and 95% (non-condensing).
- Do not install the Power Module above 1000 meters (3300 feet) without derating. For every 91.4 meters (300 feet), the Power Module's current rating is derated 1%.

3.2 Using an Isolation Transformer

The use of an isolation transformer on the AC input lines is optional. Using an isolation transformer provides the following advantages:

- Permits the Power Module to continue operating in the event of a ground fault in the windings of the motor.
- Provides a larger source impedance for the snubbers to operate against.
- Protects other circuits sharing the same power source from inductive kick in the event of a power outage.
- Provides source impedance to guarantee SCR protection in the event of a short circuit.

3.3 Installing the Power Module

DANGER

THE DRIVE IS AT LINE VOLTAGE WHEN CONNECTED TO INCOMING AC POWER. DISCONNECT, LOCKOUT, AND TAG ALL INCOMING LINE POWER AND CONTROL POWER TO THE DRIVE BEFORE PERFORMING THE FOLLOWING PROCEDURES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

Perform the following steps to install the Power Module. For more specific information, refer to the sections referenced in parentheses at the end of each step.

Step 1. Disconnect, lockout, and tag all sources of AC input power and control power.

Step 2. Mount the Power Module vertically on a flat mounting surface. Allow room for input and output connections. Add I/O device control connections, including limit switches and feedback signals, as required by the installation. See figure 3.1 for Power Module mounting dimensions.

Step 3. Install an appropriate disconnecting means and overcurrent protection according to local standards and codes. (section 3.4.1)

Step 4. Install an optional DC output “M” contactor (section 3.4.2).

Step 5. If required, add impedance to the AC line supplying the Power Module to limit current in the event of a fault (section 3.4.3).

Step 6. Connect the three-phase AC input lines (three wire 230-460V) to terminals 181/L1, 182/L2, and 183/L3 of the Power Module (section 3.4.4).

Step 7. Connect the armature motor leads to armature output terminals 47 (+) and 45 (−) (section 3.4.4).

Step 8. Connect the Power Module chassis’ ground lug to earth ground (section 3.4.5).

Step 9. Wire the 120 VAC control power to the PMI rack (section 3.4.6).

Step 10. Connect the Power Module’s PMI cables to the DC Power Technology Module (section 3.4.7).

Step 11. Remove the lockout and tag from the incoming power.

Step 12. Observe the precautions given in section 3.5, Starting the Power Module, when first powering up the system.

NOTE: *Power Modules are normally supplied with all necessary cables connected and the Field Power Module installed.*

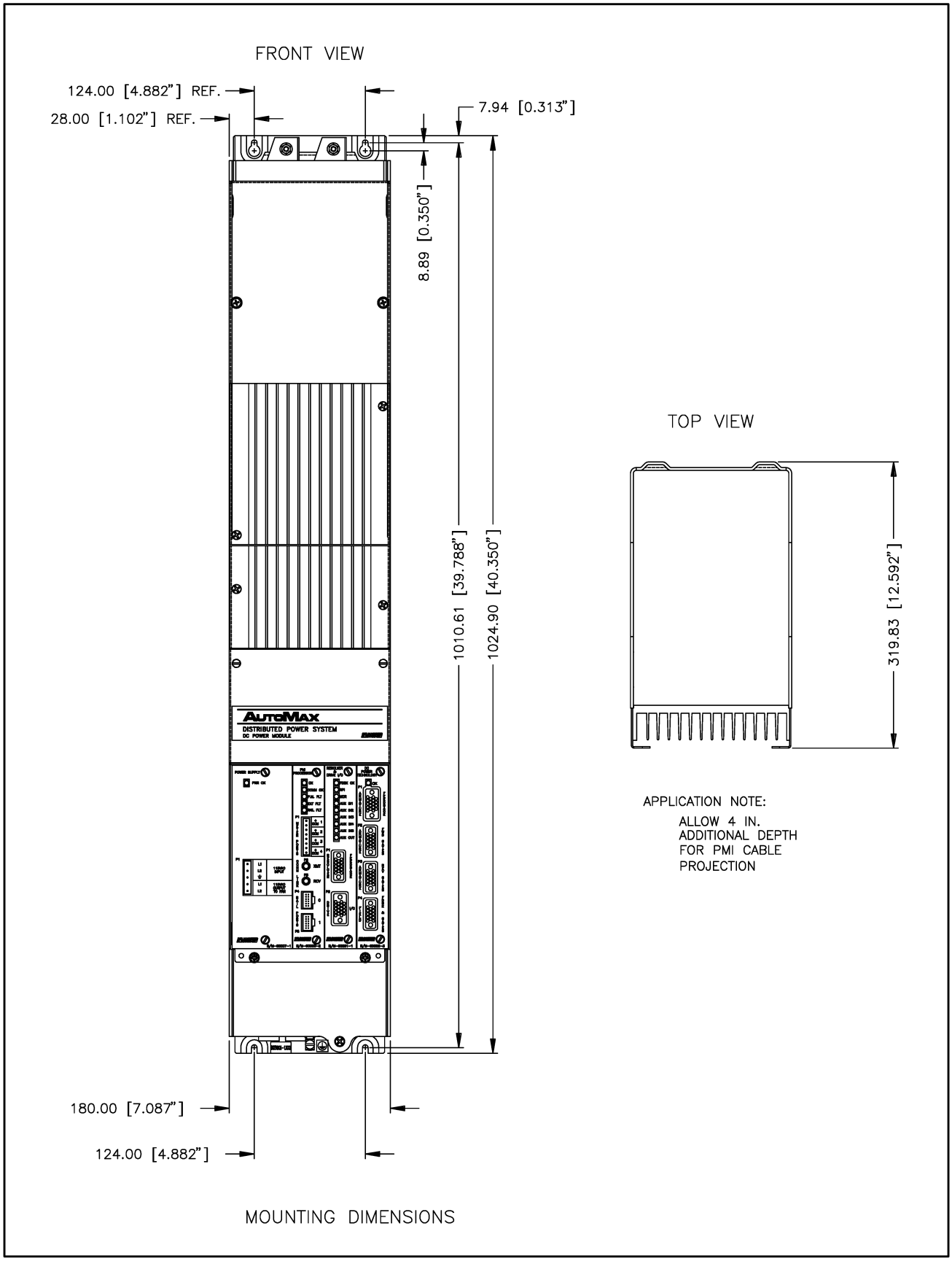


Figure 3.1 - Power Module Mounting Dimensions

3.4 Wiring the Power Module

CAUTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

CAUTION: The NEC/CEC requires that upstream branch circuit protection be provided to protect input power wiring. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

System wiring is to be done according to the supplied wiring diagrams (W/Es), which are application-specific. Refer to figure 2.1 or figure 2.2 for component and terminal locations.

Take precautions to separate AC and DC power leads from signal leads, such as resolver or tach wiring, to minimize electromagnetic interference. Wiring should comply with ANSI/IEEE Standard 518. Follow the instructions on separating wiring found in the wiring diagrams and in Reliance Instruction Manual D2-3115.

Sections 3.4.1 to 3.4.7 provide additional information on wiring and connecting an AC input disconnect, output or input contactors, an AC input inductor, input and output terminals, ground, control power, and PMI cables.

3.4.1 Installing an AC Input Disconnect

DANGER

THE NEC, CEC, AND IEC REQUIRE THAT AN INPUT DISCONNECT MUST BE PROVIDED IN THE INCOMING POWER LINE. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

An AC input disconnect, which can be padlocked in the off position, must be installed in the incoming AC power line. It must be capable of handling at least 115% of full load current at the rated line voltage.

3.4.2 Installing an Optional DC Output Contactor or AC Input Contactor

A DC output contactor, an AC input contactor, or no contactor may be used with the drive. All three options are supported in the drive setup software. A contactor is used to provide a positive disconnect of the motor from the Power Module and/or the AC line.

The DC output contactor, commonly referred to as an “M” contactor, may be either a single- or double-pole contactor, and may be rated for full-load current breaking, or less. A three-pole AC input contactor may also be used.

Mounting must conform to the contactor manufacturer’s recommendations. The contactor must be equipped with a normally open (NO) control contact for feedback to the PMI rack for control sequencing. Contactor rating should be selected for the required full load current rating. The contactor may have a dynamic braking normally closed (NC) contact included in the assembly. This contact should be rated for the dynamic braking current required.

3.4.3 Adding Impedance to Protect the AC Input Power Circuit

DANGER

IF THE DISTRIBUTION SYSTEM CAPACITY EXCEEDS THE DRIVE’S MAXIMUM SYMMETRICAL FAULT SHORT-CIRCUIT CURRENT OF 10,000 AMPS, ADDITIONAL IMPEDANCE SHOULD BE ADDED TO THE AC LINE SUPPLYING THE DRIVE TO LIMIT AVAILABLE CURRENT IN THE EVENT OF A FAULT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

If the distribution system capacity exceeds the Power Module's maximum permitted short circuit current of 10 kA, additional impedance should be added to the AC line supplying the Power Module to limit the available current in the event of a fault. This protection is normally required when multiple Power Modules are fed from a common isolation transformer that has a fault current capability exceeding the fault current rating of any of the individual Power Modules.

The nominal value of additional impedance that should be added is a minimum of 2% of the AC line impedance. The impedance can be added either in the form of a three-phase line inductor or an isolation transformer.

3.4.4 Wiring the Input and Output Terminals

Input and output terminal wiring must be installed in conformance with NEC/CEC and all applicable local, national, or international codes. Input and output connections and maximum rated currents for the Power Module are listed in table 3.1. AC Input terminals are located at the top front of the drive. DC outputs are at the top rear.

Table 3.1 - Input and Output Connections and Current Ratings

Terminal #	Connection	Maximum Amps	
Inputs		**2-15 HP Modules ***	**16-60 HP Modules ****
181/L1	AC Line 1	25	91
182/L2	AC Line 2	25	91
183/L3	AC Line 3	25	91
Outputs		**2-15 HP Modules ***	**16-60 HP Modules ****
47 (+)	Motor Armature (+)	27	100
45 (−)	Motor Armature (−)	27	100

* Power Modules 803600-1 and 803610-1
** Power Modules 803601-1 and 803611-1

3.4.5 Grounding the Power Module

DANGER

UNGROUNDED EQUIPMENT PRESENTS A SHOCK HAZARD. CONNECT THE POWER MODULE'S GROUND TERMINALS TO EARTH GROUND USING PROPERLY-SIZED GROUND WIRES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

The Power Module should be grounded to the control panel and to the cabinet, and the cabinet should be grounded. A ground lug is provided at the bottom of the Power Module chassis. The grounding conductor must be supplied by the user and must be adequately sized in accordance with NEC/CEC and all applicable local, national, or international codes. Refer to figure 2.1 or figure 2.2 for the location of the Power Module's ground lug.

3.4.6 Wiring the Control Power Terminal Strip

The control power terminal strip, at the bottom of the drive, provides the means to connect the 115 VAC control power for PMI rack and fan operation. The source of control power must be limited to less than 10,000 VA. Terminal 188 is connected to the AC hot input line. Terminal 189 is connected to the AC neutral input line. Refer to figure 3.2 or 3.3 and to table 3.2.

The ground terminal must be connected to earth ground in addition to the ground wire connected to the Power Module's grounding lug.

Refer to the Power Module Interface Rack and Modules manual (S-3008) for further information about the PMI rack and its power requirements.

Table 3.2 - Control Power Terminal Strip:

Terminal #	User Connections
188	115 VAC Input (hot)
189	115 VAC Input (neutral)
GND	Earth Ground.

3.4.7 Connecting the PMI Cables

The Power Module is supplied with multi-conductor signal cables that connect to the DC Technology module in the PMI rack. These cables carry the signals for armature feedback and armature forward gate control (figure 3.2). Regenerative versions of the Power Module have an additional cable for reverse gate signals (figure 3.3). If the Field Power Module option is added, a fourth cable provides the Field Power Module current feedback and gate signals. Refer to Chapter 5 for information on the Field Power Module PMI cable.

Additional information about the PMI cables is contained in Instruction Manual S-3008.

Table 3.3 - 20-Pin Multipurpose Card Connector

Pin	Cable P1 Signal	Pin	Cable P1 Signal
1	Current Transformer 2 (−) - CT2 LO	11	AGND1
2	Current Transformer 2 (+) - CT2 HI	12	Resistor Scaled Line Connection 181
3	Current Transformer 1 (−) - CT1 LO	13	Resistor Scaled Armature Lead 45 (−)
4	Current Transformer 1 (+) - CT1 HI	14	AGND
5	Phasing Transformer Comm - XFRMRET	15	Resistor Scaled Armature Lead 47 (+)
6	X3/183 From Phasing Transformer	16	GND (ARM CT SIG) - Test Point
7	X2/182 From Phasing Transformer	17	ARM CT SIG - Test Point
8	X1/181 From Phasing Transformer	18	N/C
9	Resistor Scaled Line Connection 183	19	N/C
10	Resistor Scaled Line Connection 182	20	N/C

Table 3.4 - 24-pin Gate Driver Card Connector

	Cable Signal			Cable Signal	
Pin	P2	P3*	Pin	P2	P3*
1	—	Reverse SCR 16	13	+18 V	—
2	—	+18 V	14	Forward SCR 5	—
3	Forward SCR 3	—	15	—	+18 V
4	+18 V	—	16	—	Reverse SCR 12
5	Forward SCR 6	—	17	—	+18 V
6	—	Reverse SCR 13	18	Forward SCR 1	—
7	—	+18 V	19	+18 V	—
8	+18 V	—	20	—	Reverse SCR 14
9	—	+18 V	21	Forward SCR 4	—
10	—	Reverse SCR 15	22	+18 V	—
11	Forward SCR 2	—	23	—	Reverse SCR 11
12	+18 V	—	24	—	+18 V

*NOTE: Cable P3 is used only on regenerative Power Modules, 803610-1 and 803611-1.

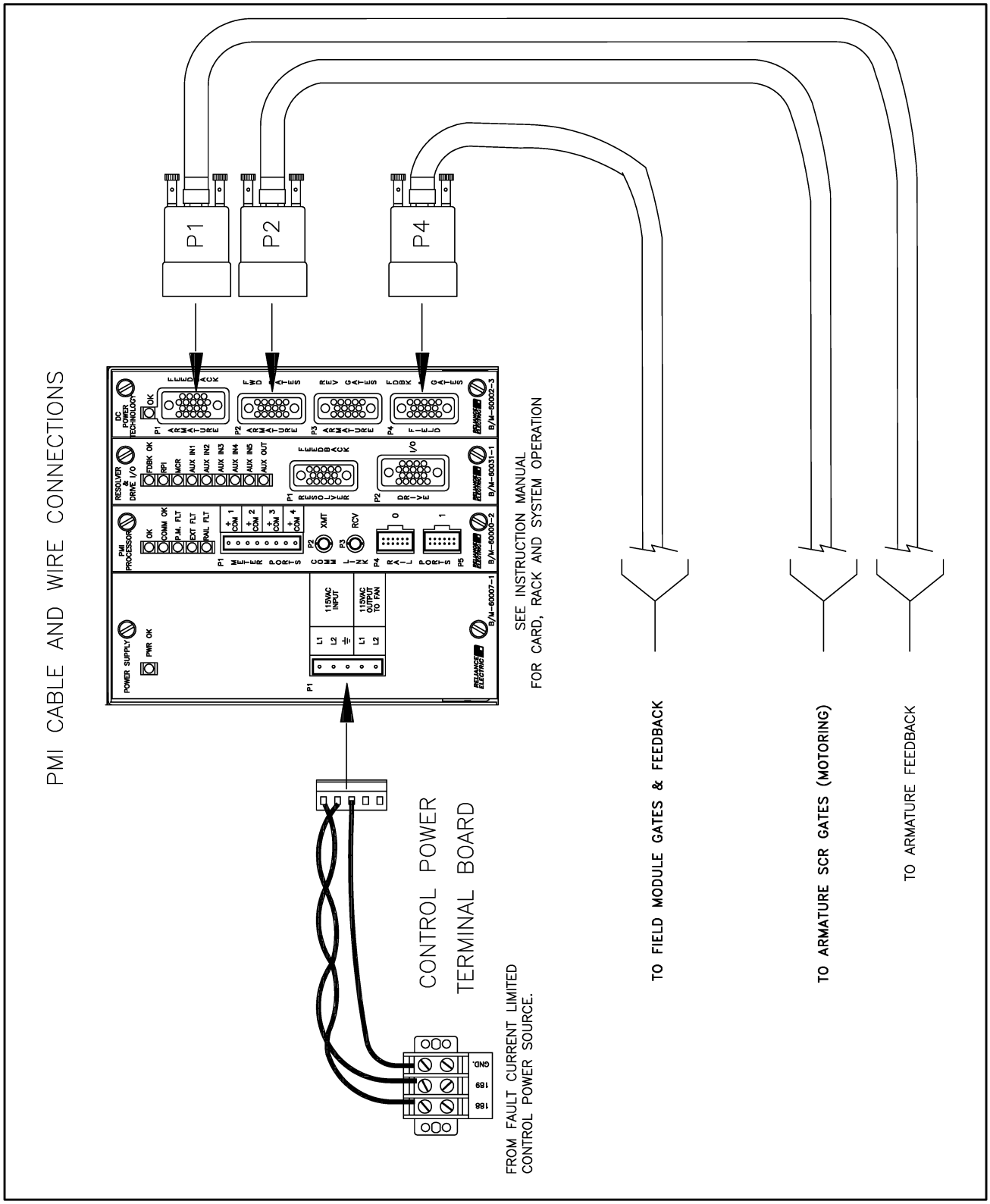


Figure 3.2 - Non-Regenerative Power Module Cable and Control Power Connections

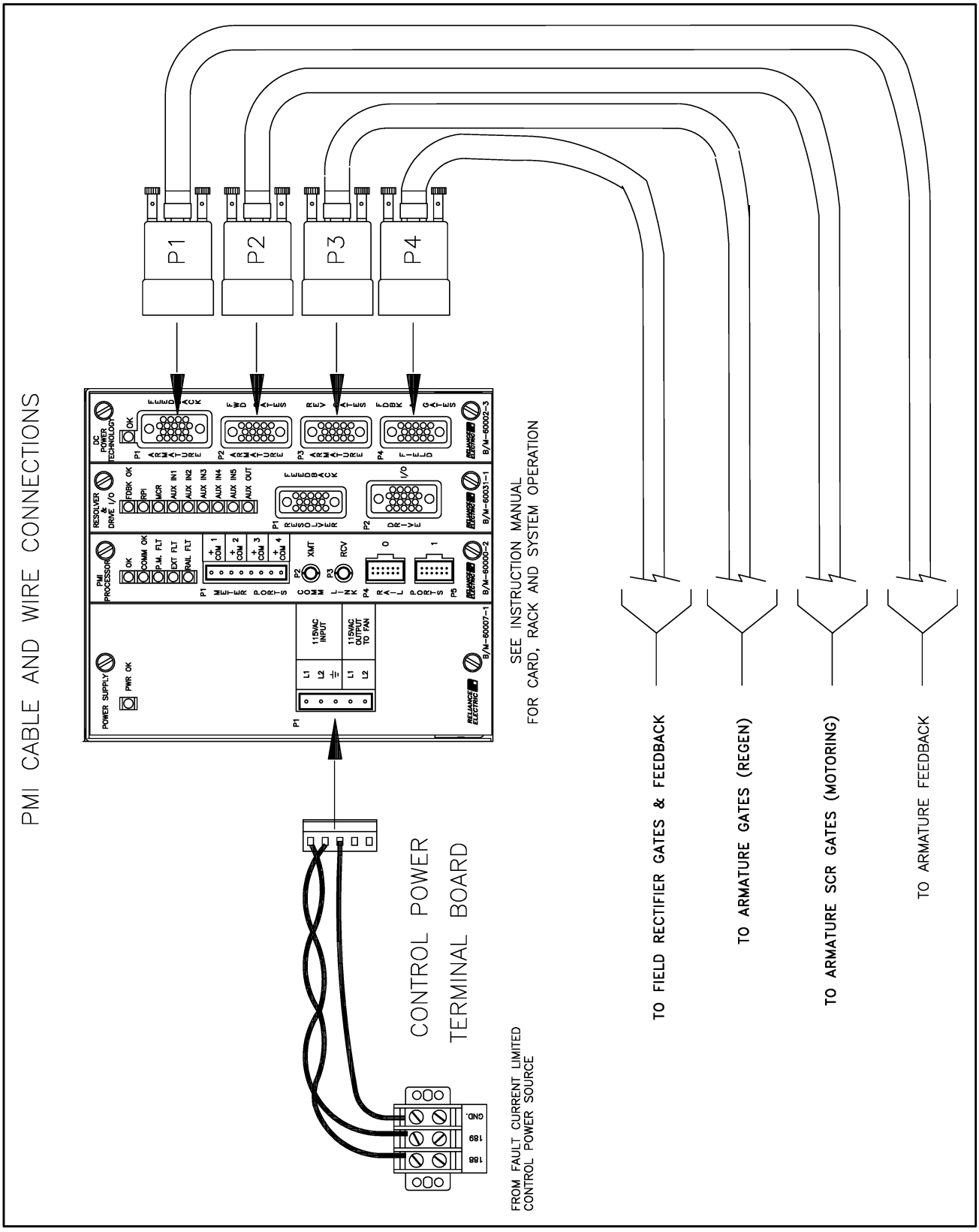


Figure 3.3 - Regenerative Power Module Cable and Control Power Connections

3.5 Starting the Power Module

This section describes the precautions that should be taken when first powering up the Power Module. Please refer to the following chapter, Power Module Maintenance and Troubleshooting, for information on the test equipment that might be required.

DANGER

DANGEROUS VOLTAGES ARE PRESENT WHENEVER AC LINE VOLTAGE IS PRESENT, WHETHER OR NOT THE DRIVE IS OPERATING. DO NOT TOUCH ANY POWER CIRCUITS OR WIRING WHEN LINE VOLTAGE IS ON. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

DURING INITIAL START-UP AND ADJUSTMENTS, BE PREPARED TO STOP THE DRIVE IN CASE INCORRECT SETUP OF THE FIELD OR TACHOMETER CAUSES UNCONTROLLED ACCELERATION OF THE MOTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Start-Up Checklist:

Before AC power is applied:

- Visually inspect the wiring of the armature and field for proper polarity.

After AC power is applied, but before starting the drive:

- Check that AC line voltage is within the rated input voltage.
- Check that voltage is present at the field terminals.
- Check that the Field Power Module phasing is correct.
- Check that field current feedback is correct.

4.0 MAINTENANCE AND TROUBLESHOOTING

DANGER

EQUIPMENT IS AT LINE VOLTAGE WHEN AC POWER IS CONNECTED TO THE POWER MODULE. ALL PHASES OF THE AC POWER LINE AND CONTROL POWER MUST BE DISCONNECTED FROM THE POWER MODULE BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

CAUTION: The Power Module contains printed circuit boards that are static-sensitive. Do not touch the boards' components, connectors, or leads. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Routine maintenance should include the periodic checking of all electrical power connections into and out of the Power Module. The Power Module, its enclosure, and the PMI rack should be kept clean. Any air filters should be checked and cleaned or replaced as needed. Adequate cooling air must be provided to the Power Module whenever the unit is operating.

4.1 Recommended Test Equipment

WARNING

THE POWER MODULE'S COMMON IS NOT ISOLATED FROM EARTH GROUND. THE TEST INSTRUMENTS USED TO MEASURE POWER MODULE SIGNALS MUST BE ISOLATED FROM GROUND THROUGH AN ISOLATION TRANSFORMER, UNLESS THEY ARE BATTERY POWERED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

An oscilloscope can be used to check the current feedback and the output voltage waveform. An isolated or portable volt/ohmmeter is also needed for continuity and ground checks and to test output voltage.

The oscilloscope should have an impedance of at least 8 M ohms, a 1:10 probe for signal circuits, and a 1:100 probe for power circuits. An ungrounded oscilloscope with differential inputs and two 1:10/1:100 probes is recommended. All measuring devices that are AC line powered must be connected through an isolation transformer. There must be no ground connection through the transformer.

CAUTION: If a megohmmeter (megger) is used, make certain that all leads are disconnected between the rotating equipment and the drive. This will prevent damage to electronic circuitry (Power Modules and their associated circuitry, etc.) due to the high voltage generated by the megger. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

The Power Module may be checked with an ohmmeter for continuity and grounds. Do not test the Power Module or associated circuitry with a megohmmeter (megger). Disconnect all leads to the motor if the motor is to be ground-checked with a megger. Failure to follow proper procedure when using a megger may cause damage to the Power Module.

4.2 System Diagnostics

Operation of the Power Module is monitored by the PMI Processor. Fault and warning registers (202/1202 and 203/1203) in the UDC must be used when the system detects a fault or a warning.

The fault conditions reported in the Drive Fault register result in turning off the drive. The UDC task is not stopped automatically when a drive fault occurs unless it is specifically instructed to do so in an

application task. The user must ensure that the AutoMax application task tests register 202/1202 and takes appropriate action if a fault occurs.

The warnings indicated by the Drive Warning register cause no action by themselves. Any resulting action is determined by the application task. The user must ensure that the AutoMax application task monitors register 203/1203 and takes appropriate action if any of these conditions occurs.

The user should refer to instruction manuals S-3006 (SD3000 Drive Configuration and Programming) and S-3036 (SF3000 Drive Configuration and Programming) for further details on the Drive Fault and Drive Warning registers.

4.2.1 Power Module Faults

The following Power Module faults will cause the drive to shutdown by commanding zero current and will stop firing the SCRs. Most faults are signaled by an LED indicator on the PMI Processor module. The bits in the Drive Fault register (202/1202) should be examined to determine the cause of the fault. When a fault occurs the identifying bit will be set. The fault will also be recorded in the error log for the UDC task in which it occurred.

4.2.1.1 Shorted SCR Fault (Bit 0)

LED indicator: PM FLT

UDC Error Code: 1000

The PMI Processor will not be permitted to enter the run mode if a shorted SCR is detected. Check register 204/1204 to identify the SCR that has shorted. Refer to Instruction Manual S-3006.

4.2.1.2 AC Line Synchronization Fault (Bit 3)

LED indicator: EXT FLT

UDC Error Code: 1003

AC line voltage is missing for more than 2 seconds. The system will immediately go idle when this fault is detected. NOTE: A temporary loss of AC line voltage will set bit 3 in Drive Warning Register 202/1202.

4.2.1.3 Instantaneous Overcurrent Fault (Bit 4)

LED indicator: EXT FLT

UDC Error Code: 1004

The armature current feedback value (SD3000 operation) or three-phase field current feedback value (SF3000 operation) is greater than the Max Current Limit value (plus 75%) entered as a configuration parameter. The system will immediately go idle when this fault is detected.

4.2.1.4 Conduction Timeout Fault (Bit 5)

LED indicator: N/A

UDC Error Code: 1005

Discontinuous conduction has not been detected within 2 seconds of CML_RUN (register 100/1100, bit 0) being turned off.

4.2.1.5 Loss of Field Fault (Bit 6)

LED indicator: PM FLT

UDC Error Code: 1006

The field current feedback value is less than the Field Loss Trip Point parameter value. Refer to S-3006 or S-3036 for specific information regarding the occurrence of this fault in SD3000 operation and in SF3000 operation.

4.2.2 Power Module Warnings

The following Power Module warnings cause the identifying bit in the UDC Drive Warning Register (203/1203) to be set. The bits in this register should be examined to determine the cause of the warning. Any resulting action is determined by the application task. No LED indicator or UDC error code is provided for drive warnings.

4.2.2.1 Three-phase Bridge SCR Not Firing Warning (Bit 0)

Check the SCR Diagnostic register (204/1204) to determine which SCR is not working properly. Refer to the Drive Configuration and Programming manual (S-3006) for further information.

4.2.2.2 Low Line Voltage/Phase Missing Warning (Bit 1)

The system has detected that the AC line voltage is less than 85% of the nominal value entered as a configuration parameter. This can be caused by a low line condition or a missing phase. The system will automatically adjust the phase angle to give the correct current amount and will continue to fire SCRs as long as zero crossings are detected. If zero crossings are no longer detected, a fault condition will result.

4.2.2.3 Synchronization Loss Fault Avoided Warning (Bit 3)

The system has continued to operate through a temporary loss of AC line voltage. Refer to section 4.2.1.2 for more information.

4.2.2.4 Current Reference Limit Warning (Bit 4)

The current reference has exceeded the value entered as the Max Current Limit configuration parameter.

4.2.2.5 Identification Test Error Warning (Bit 5)

An armature identification or field identification test has failed. (This bit is also set when the resolver balance calibration test fails or yields unexpected results.)

4.2.2.6 Field Power Module Overcurrent Warning (Bit 6)

The Field Power Module's field current feedback value is greater than 1.5 times the Hot Field Amps parameter for one second. This condition can cause errors during the field ID test or when the field is turned on. These errors can be caused by miswiring of the 181/L1 and 183/L3 AC lines to the Field Power Module.

4.2.2.7 Fan Loss Warning (Bit 12)

A fan loss is detected by the air flow switch located in the PMI power supply module. Normally, the drive should be stopped in a reasonably short time by the application task to prevent damage to the unit. Check that the fan is running and that the air passages are clear and clean.

4.3 Component Replacement

The 2-60 HP SD3000/SF3000 Power Modules have a modular design that permits fast and easy component replacement. When the Power Modules are critical to the application process, repairs to malfunctioning components in the removed assemblies can be made at a convenient time and place.

The following components and modules are easily replaced:

- AC input fuses
- Armature assembly
- Current transformers
- AC input module (including fuses and current transformers)
- PMI modules
- PMI rack

- S2 Field Power Module
- Snubber module
- Multipurpose PC board
- Fan assembly

The following components are replaceable, but require additional time for disassembly:

- Interconnecting cables and wire harnesses
- Line filter capacitor
- Phasing transformer

4.4 Disassembling the Power Module

DANGER

DO NOT ATTEMPT TO DISASSEMBLE THE POWER MODULE WITH POWER APPLIED TO THE DRIVE. DISCONNECT, LOCKOUT, AND TAG ALL SOURCES OF INCOMING LINE POWER AND CONTROL POWER BEFORE ATTEMPTING SUCH WORK. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

The following disassembly procedures describe a complete tear-down of the Power Module. Refer to figures 2.1 and 2.2 for component locations and figures 2.3 and 2.4 for wiring details.

Do not attempt to disassemble the Power Module with power applied to the drive. Before proceeding:

- Disconnect, lockout, and tag all sources of incoming AC line power and control power.
- Verify that there is no voltage at the Power Module's AC input terminals (181/L1, 182/L2, and 183/L3) and on the control power terminal strip (188 and 189).

4.4.1 Replacing the PMI Modules and PMI Rack

The PMI modules and the PMI rack are serviced by removing the damaged modules or by replacing the complete PMI rack. The PMI rack is attached to the Power Module by 4 retaining screws through the backplane and a ground lead to the panel ground. Refer to Instruction Manual S-3008, Power Module Interface Rack and Modules, for further technical information regarding the PMI rack and modules.

NOTE: *The PMI rack used on the 2-60 HP assembly does not come with its own fan. PMI rack cooling is provided by the Power Module fan*.

4.4.2 Replacing Individual Assemblies

The assemblies described in sections 4.4.2.1 and 4.4.2.2 may be replaced without other disassembly of the Power Module.

4.4.2.1 Replacing the Fan Assembly

Remove the two captive mounting screws in the front edge of the fan assembly and pull the assembly out of the Power Module.

When replacing, check that the connector on the backplane mates correctly with the power connector on the replacement fan. If the fan power connectors do not align, replace the backplane assembly as well as the fan assembly to ensure proper mating.

4.4.2.2 Replacing the Field Assembly

The field assembly may be removed without disassembly of the Power Module. See Chapter 5 in this manual for more details on replacing and servicing the field assembly.

NOTE: *Removal of the armature assembly may make replacement of the field assembly more convenient or may be required when reconnecting the field assembly.*

4.4.3 Replacing Interconnected Assemblies

Interconnected assemblies are accessed by the following disassembly procedure. The steps of the disassembly procedure should be performed in the order listed. The procedure may be stopped upon removal of the damaged module or component. After replacing the defective module, reassemble the Power Module by reversing the disassembly steps that were performed.

4.4.3.1 Replacing the AC Input Line Fuses

Step 1. Remove the fuse cover by loosening the two thumb screws on the sides of the cover.

Step 2. Pull the cover forward until it comes off the guide pins. On replacement, be sure that the insulation flaps are inside the cover.

Step 3. If the AC input line fuses are blown, replace them by removing the 10 mm. washer nuts that fasten them to the bus bars. Replace blown fuses only with fuses of the same type and rating. Refer to table 4.1 for fuse ratings and to the Replacement Parts List in Appendix D to order fuses from Reliance.

Table 4.1 - AC Input Fuse Ratings

Power Module Part No.	Fuse Number	Fuse Ratings	Fuse Current Interrupt Rating
803600-1 803610-1	1FU, 2 FU, 3FU	70A, 700V	200 kA
803601-1 803611-1	1FU, 2 FU, 3FU	200A, 700V	200 kA

NOTE: *Torque fasteners to 5 to 6 N-m (45 to 55 lb-in).*

4.4.3.2 Replacing the Armature Assembly

The armature assembly must be removed in order to remove the AC input assembly and the snubber module. Replacement of the current transformers will be more convenient if the AC input assembly is removed.

Step 4. Remove the two retaining screws at the front edges of the armature assembly.

Step 5. Loosen the five bus bar connections at the top of the assembly by running the washer nuts to the ends of the pem studs. Do not remove the washer nuts from the pem studs.

Step 6. Pull the armature assembly out of the chassis.

Due to the complexity of component realignment, it is recommended that the armature assembly be sent to Reliance to be repaired.

4.4.3.3 Replacing the Current Transformers

Step 7. After removing the armature assembly, remove the rear 10 mm. washer nuts.

Step 8. Disconnect the current transformer secondary connector(s).

Step 9. Pull the current transformer(s) completely out of the AC input module.

4.4.3.4 Replacing the AC Input Assembly and Snubber Assembly

Step 10. Remove the two retaining screws at the sides of the AC input assembly.

Step 11. Loosen the two snubber retaining screws from the bottom of the assembly.

Step 12. Swing the snubber assembly down, or remove the snubber by pulling the unit out of the chassis after disengaging the keyhole slots from the washer screws in the bottom of the AC input module.

Step 13. If the snubber assembly is to be removed, disconnect terminals 45 and 47 from the snubber assembly or the bus bars.

Step 14. Lift the AC input assembly up to clear the bottom rear slot and then pull it out over the guide posts.

Step 15. With the AC input assembly free, disconnect the fastons and the current transformer connectors.

NOTE: *All connections are labeled and the connectors keyed for easy reassembly.*

4.4.3.5 Replacing the Multipurpose PC Board

The AC input assembly, the armature assembly, and the snubber assembly must removed in order to access the multipurpose PC board. The three small AC line fuses on the multipurpose board can be replaced without removing the multipurpose board. However, it is recommended that the PC board be replaced in case the line suppressor rectifier bridge has been damaged by excessive line transients.

4.4.3.6 Replacing Cables/Phasing Transformer/Line Suppressor Capacitor

If cabling, the phasing transformer, or the line suppressor capacitor is to be replaced, the field assembly and the PMI rack should be removed to allow replacement of the backplane assembly. Check that the connectors on the backplane and the fan assembly align. If the connectors do not align, replace the backplane assembly as well as the fan assembly to ensure proper mating with the fan power connector.

4.5 Reassembling the Power Module

Reverse the disassembly procedure to reassemble the Power Module. Make certain that all PC board connectors are fully seated. Take care not to pinch any wires or cables. There are four cable connectors, one each for the multipurpose PC board and the field assembly (if used), and two for the armature assembly. All cables and wires are clearly marked.

5.0 FIELD POWER MODULE

This chapter describes the operation, installation, and maintenance of the optional 15 amp non-reversing (S2) Field Power Module (#805405-S). This Field Power Module is integrally mounted within the chassis of the 2-60 HP Power Module as the Field Assembly.

5.1 Description

The integrally-mounted Field Power Module (figure 5.1) has a single-phase power bridge and contains all power devices, suppressors, and feedback elements required to control the motor field within the Distributed Power System environment. AC power is connected in phase with inputs 181/L1 and 183/L3 of the 2-60 HP Power Module. The incoming AC may optionally be supplied through an isolation transformer. Operation is programmed and controlled in the UDC module in the AutoMax rack and the PMI Processor in the PMI rack. A Hall effect device is used to monitor the DC output current.

The non-reversing Field Power Module rectifier consists of 4 SCRs, configured in a full-wave power bridge. Snubber protection is provided to permit operation on a common bus with other Power Modules.

The firing angle for each SCR is determined by the field current regulation algorithm executing in the PMI Processor. The field SCR gating signals are provided by the DC Drive Technology module, under the control of the PMI Processor. The firing angle for each SCR is synchronized with the AC line feeding it. The PMI Processor regulates the amount of motor field current by varying the point in the AC line cycle at which forward conduction begins. The PMI Processor receives the field current reference from the UDC module in the AutoMax rack. The UDC runs the application task that provides overall control of the application.

A field clamp assembly constantly monitors the voltage between the Field Power Module's output terminals, 37 (+) and 35 (-). If an overvoltage condition occurs, a sensor in the Field Clamp fires a "crowbar" SCR. The crowbar SCR places a short across the field terminals before voltage has risen to a dangerous level, safely dissipating the energy in the field.

The Field Power Module interfaces with the DC Technology module the PMI rack. A single multi-conductor cable carries the field feedback and gate firing signals. No other special electronic or electrical devices or wiring is needed for normal operation.

If required by the application, the integrally-mounted Field Power Module may be replaced by a panel-mounted S2 or S2R Field Power Module. Refer to instruction manual S-3060, Panel-Mounted Single-Phase Field Power Modules, for further information.

NOTE: *The integrally-mounted Field Power Module cannot be used for generator control. A panel-mounted, reversing (S2R), 15 or 60 amp Field Power Module must be used.*

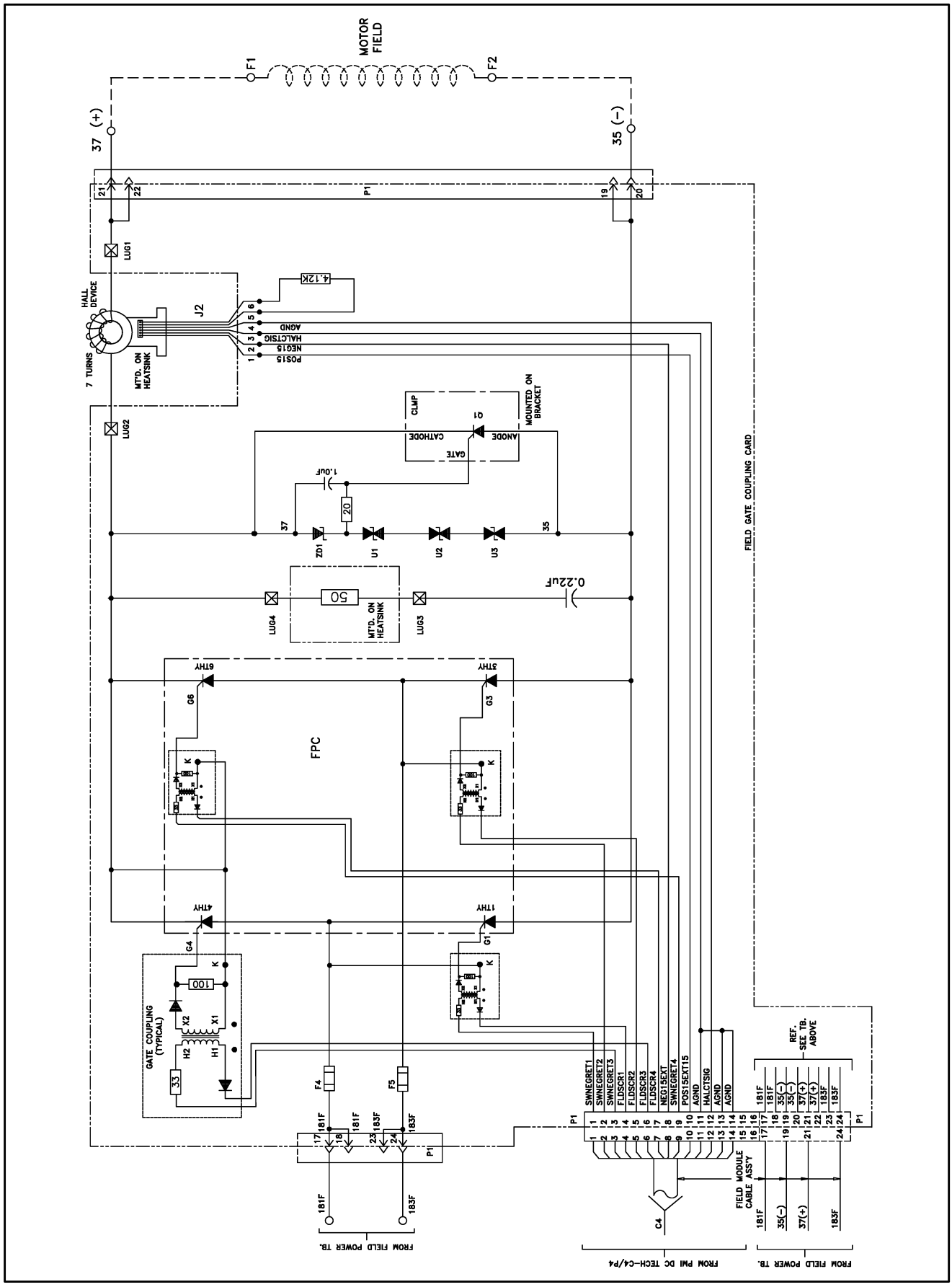


Figure 5.1 - Field Power Module Circuitry

5.2 Installation Guidelines

DANGER

ONLY QUALIFIED ELECTRICAL PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THIS EQUIPMENT AND THE HAZARDS INVOLVED SHOULD INSTALL, ADJUST, OPERATE, OR SERVICE THIS EQUIPMENT. READ AND UNDERSTAND THIS MANUAL AND OTHER APPLICABLE MANUALS IN THEIR ENTIRETY BEFORE PROCEEDING. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

DANGER

THE DRIVE IS AT LINE VOLTAGE WHEN CONNECTED TO INCOMING AC POWER. DISCONNECT, LOCKOUT, AND TAG ALL INCOMING AC LINE POWER AND CONTROL POWER TO THE DRIVE BEFORE PERFORMING THE FOLLOWING PROCEDURES. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

The 2-60 HP SD3000 Power Module is normally supplied with the integrally-mounted Field Power Module installed. This section describes the recommendations to be followed when installing the Field Power Module as a replacement or addition. To install the Field Power Module, perform the following steps. For more specific information, refer to the sections referenced in parentheses at the end of the step.

NOTE: *Refer to instruction manual S-3060 for information on installing a panel-mounted Field Power Module for use with the 2-60 HP SD3000 Power Module.*

Step 1. Disconnect, lockout, and tag all sources of incoming AC line power and control power.

Step 2. Verify that there is no voltage at the Power Module's AC input terminals (181/L1, 182/L2, and 183/L3) and on the control power terminal board (188 and 189).

Step 3. Remove the fan assembly. Removal of the armature assembly may also be required (section 4.4)

Step 4. Install the Field PMI cable under the Power Module backplane and connect the cable to the DC Power Technology module (section 5.2.1).

Step 5. Remove and discard the cover (if supplied) from the Field Power Module compartment in the Power Module chassis. Insert the Field Power Module, and engage the cable connector. Bolt the module in place using the two mounting holes on either side.

Step 6. If no isolation transformer is being used, Field Power Module AC input terminals 181F and 183F must be connected to Armature Power Module terminals 281 and 283 (section 5.2.2).

If an optional single-phase isolation transformer is to being used, remove the jumpers connecting terminals 181F to 281 and 183F to 283. Connect terminal H1 of the isolation transformer primary to terminal 281, and terminal H3 of the isolation transformer primary to terminal 283. Connect transformer secondary terminals X1 to 181F and X2 to 183F. **Be careful not to invert the transformer winding polarity** (section 5.2.3)

Step 7. Connect the motor field leads to terminals 37 (+) and 35 (−) on the Field Power Module terminal strip (section 5.2.2).

Step 8. Replace the fan assembly and the armature assembly (if removed).

Step 9. Remove the lockout and tag from the incoming power.

Step 10. Observe the precautions given in section 5.3, Starting the Field Power Module, when powering up the system.

5.2.1 Connecting the Control Signal Cable

The Field Power Module is supplied with a multi-conductor signal cable that connects to the DC Technology module in the PMI rack. The cable carries the gate firing and field feedback signals as listed in table 5.1. The cable should be run beneath the Power Module's backplane and brought up to the Field Feedback and Gates connector on the DC Technology module's faceplate.

Table 5.1 - 16-pin Field Gate Coupling Card Connector

Pin	Cable P4 Signal	Pin	Cable P4 Signal
1	PCOM	9	PCOM
2	PCOM	10	+15 V
3	PCOM	11	ACOM
4	Field SCR 1	12	HALCTSIG
5	Field SCR 2	13	ACOM
6	Field SCR 3	14	ACOM
7	Field SCR 4	15	N/C
8	−15 V	16	N/C

5.2.2 Wiring the Input and Output Terminals

WARNING

PHASE CONTROL FOR THE FIELD POWER MODULE IS DETERMINED BY THE ARMATURE POWER MODULE PMI. FIELD POWER MODULE AC INPUT TERMINALS 181F AND 183F MUST BE CONNECTED TO POWER MODULE TERMINALS 281 AND 283. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

CAUTION: The user is responsible for conforming with all applicable local, national, and international codes. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Field Power Module input and output terminal wiring must be installed in conformance with NEC/CEC and all applicable local, national, or international codes. When routing conductors, take care not to pinch any cables or wires. Keep the signal and power cables physically separated to reduce shock hazard and electrical noise on the low voltage signals.

Maximum rated Field Power Module input and output currents are listed in table 5.2.

Table 5.2 - Field Power Module Current Ratings

Field Power Module Part Number	AC Input Current	Rated DC Output Current
805405-S	15 A	15 A

The integrally-mounted Field Power Module receives its incoming AC power directly from the 2-60 HP DC Power Module. Phase control for the single-phase Field Power Module is determined by the three-phase Power Module's PMI. For correct operation, the Field Power Module's AC input terminals, 181F and 183F, must be properly connected to Armature Power Module terminals 281 and 283.

The 2-60 HP SD3000 Power Module is equipped with a Field Power Terminal Strip for connecting the AC inputs and DC outputs of the integrally-mounted Field Power Module. Refer to figure 5.2 and table 5.3.

Table 5.3 - Input and Output Connections

Terminal #	User Connection
AC Line Inputs	
181F	Terminal 281
183F	Terminal 283
DC Outputs	
37 (+)	Motor Field F1 (+)
35 (−)	Motor Field F2 (−)

5.2.3 Using a Field Isolation Transformer

The use of a field isolation transformer on the AC input lines is optional. Using an isolation transformer provides the following advantages:

- Permits the Field Power Module to continue operating in the event of a ground fault in the field windings of the motor.
- Provides a larger source impedance for the snubbers to operate against.
- Protects other circuits sharing the same power source from inductive kick in the event of a power outage.
- Provides source impedance to guarantee SCR protection in the event of a short circuit.

If an optional single-phase isolation transformer is used, remove the jumpers connecting Field Power Module terminals 181F and 183F to Armature Power Module terminals 281 and 283. Wire the field isolation transformer as shown in figure 5.2 and listed in table 5.5.

Table 5.4 - Field Isolation Transformer Wiring

Jumper Connections *	
281/L1 to H1	Power Module 281/L1 to Field Isolation Transformer Primary
283/L3 to H2	Power Module 283/L3 to Field Isolation Transformer Primary
X1 to 181F	Field Isolation Transformer Secondary to Field Module AC input
X2 to 183F	Field Isolation Transformer Secondary to Field Module AC input

* NOTE: *Do not invert the isolation transformer winding polarity.*

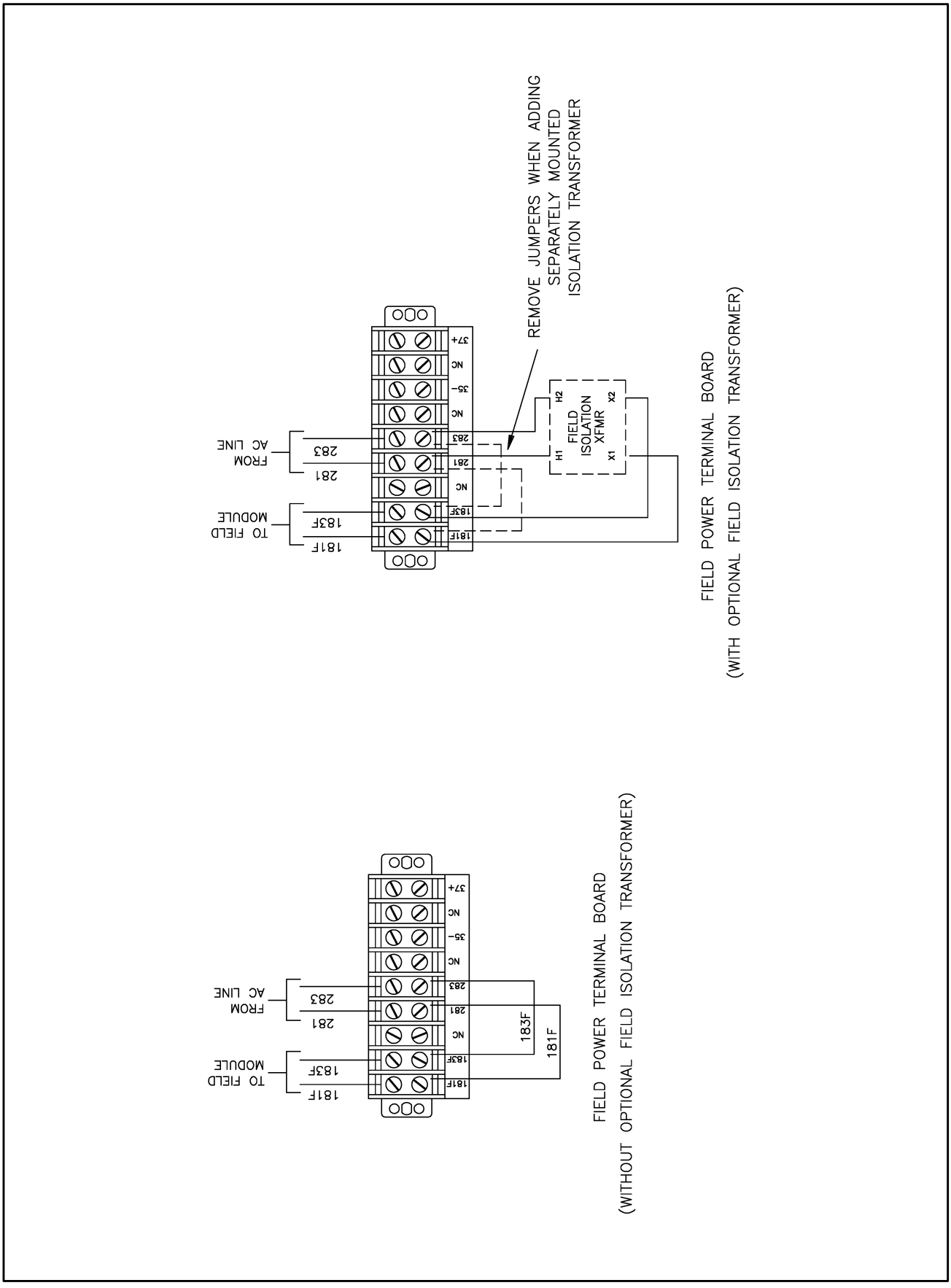


Figure 5.2 - Field Power Terminal Wiring

5.3 Starting the Field Power Module

This section describes the precautions that should be taken when first powering up the Field Power Module. Please refer to the following section, Field Power Module Maintenance and Troubleshooting, for information on the test equipment that might be required.

DANGER

DANGEROUS VOLTAGES ARE PRESENT WHENEVER AC VOLTAGE IS PRESENT, WHETHER OR NOT THE DRIVE IS OPERATING. DO NOT TOUCH ANY POWER CIRCUITS OR WIRING WHEN LINE VOLTAGE IS ON. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

WARNING

DURING INITIAL START-UP AND ADJUSTMENTS, BE PREPARED TO STOP THE DRIVE IN CASE INCORRECT SETUP OF THE FIELD OR TACHOMETER CAUSES UNCONTROLLED ACCELERATION OF THE MOTOR. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

Start-Up Checklist:

Before AC power is applied:

- ✓ Visually inspect the wiring of the armature and field for proper polarity.

After AC power is applied, but before starting the drive:

- ✓ Check that AC line voltage is within the rated input voltage.
- ✓ Check that voltage is present at the field terminals.
- ✓ Check that the Field Power Module phasing is correct.
- ✓ Check that field current feedback is correct.

5.4 Field Power Module Maintenance and Troubleshooting

DANGER

EQUIPMENT IS AT LINE VOLTAGE WHEN AC POWER IS CONNECTED TO THE POWER MODULE. ALL PHASES OF THE AC POWER LINE AND CONTROL POWER MUST BE DISCONNECTED FROM THE POWER MODULE BEFORE IT IS SAFE TO TOUCH ANY INTERNAL PARTS OF THIS EQUIPMENT. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN SEVERE BODILY INJURY OR LOSS OF LIFE.

CAUTION: The Field Power Module contains a printed circuit board that is static sensitive. Do not touch the board's components, connectors, or leads. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Routine maintenance should include the periodic checking of all electrical power connections into and out of the Field Power Module. The Field Power Module and PMI rack should be kept clean. Any air filters should be checked and cleaned or replaced as needed. Adequate cooling air must be provided to the Field Power Module whenever the unit is operating.

5.4.1 Recommended Test Equipment

WARNING

THE FIELD POWER MODULE'S COMMON IS NOT ISOLATED FROM EARTH GROUND. THE TEST INSTRUMENTS USED TO MEASURE FIELD POWER MODULE SIGNALS MUST BE ISOLATED FROM GROUND THROUGH AN ISOLATION TRANSFORMER UNLESS THEY ARE BATTERY POWERED. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

An oscilloscope can be used to check the current feedback and the output voltage waveform. Field power output voltage can be measured between terminals 37 (+) and 35 (−) on the Field Power terminal board. An isolated or portable volt/ohmmeter is also needed for continuity and ground checks and to test output voltage.

The oscilloscope should have an impedance of at least 8 M ohms, a 1:10 probe for signal circuits, and a 1:100 probe for power circuits. An ungrounded oscilloscope with differential inputs and two 1:10/1:100 probes is recommended. All measuring devices that are AC line powered must be connected through an isolation transformer. There must be no ground connection through the transformer.

CAUTION: If a megohmmeter (megger) is used, make certain that all leads are disconnected between the rotating equipment and the drive. This will prevent damage to electronic circuitry (Field Power Modules and their associated circuitry, etc.) due to the high voltage generated by the megger. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

The Field Power Module can be checked with an ohmmeter for continuity and grounds. Do not test the Field Power Module or associated circuitry with a megohmmeter (megger). Disconnect all leads to the motor if the motor is to be ground-checked with a megger. Failure to follow proper procedure when using a megger may cause damage to the Field Power Module.

5.4.2 Replacing the AC Input Line Fuses

Recommended input fuse values are provided in Table 5.5. Replace Field Power Module fuses only with fuses of the same type and rating as those originally supplied. Refer to the Replacement Parts List in Appendix D for Reliance part numbers.

Table 5.5 - Field Power Module Input Fuse Ratings

Field Power Module Part Number	Fuse Number	Fuse Rating	Fuse Current Interrupt Rating
805405-S	F4, F5	20A, 600V	200 kA

5.4.3 System Diagnostics

Operation of the Field Power Module is monitored by the PMI Processor. Fault and warning registers (202/1202 and 203/1203) in the UDC must be used when the system detects a fault or a warning.

The fault conditions reported in the Drive Fault register result in turning off the drive. The UDC task is not stopped automatically when a drive fault occurs unless it is specifically instructed to do so in an application task. The user must ensure that the AutoMax application task tests register 202/1202 and takes appropriate action if a fault occurs.

The warnings indicated by the Drive Warning register cause no action by themselves. Any resulting action is determined by the application task. The user must ensure that the AutoMax application task monitors register 203/1203 and takes appropriate action if a warning occurs.

The user should refer to instruction manual S-3006 (SD3000 Drive Configuration and Programming) for further details on UDC handling of drive faults and warnings.

5.4.3.1 Loss of Field (Drive Fault Register, Bit 6)

LED indicator: PM FLT

UDC Error Code: 1006

The drive will shutdown and the Loss of Field Fault bit in the Drive Fault Register (202/1202) will be set when the field current feedback value falls below the Field Loss Trip Point parameter value. This fault will also be recorded in the error log for the UDC task. The PM FLT indicator on the PMI Processor module will light to signal the detection of the fault.

5.4.3.2 Identification Test Error (Drive Warning Register, Bit 5)

The Identification Test Error bit in the Drive Warning Register (203/1203) will be set when a field identification test has failed. Any resulting action is determined by the application task. (This bit is also set when an armature or three-phase field identification test has failed or when the resolver balance calibration test fails or yields unexpected results.)

5.4.3.3 Field Power Module Overcurrent (Drive Warning Register, Bit 6)

The Field Power Module Overcurrent Warning bit in the Drive Warning Register (203/1203) will be set when the field current feedback value is greater than 1.5 times the Hot Field Amps parameter for one second. Any resulting action is determined by the application task. This condition can cause errors during the field ID test or when the field is turned on. These errors can be caused by miswiring of the AC input connections to Field Power Module terminals 181F and 183F.

5.4.4 Removing/Replacing the Field Power Module

To remove the integrally-mounted Field Power Module from the 2-60 HP DC Power Module, the fan assembly should be removed first. Refer to section 4.4 of this manual for Power Module Disassembly Procedures.

5.4.5 Replacing Field Power Module Components

Field Power Module components, including the gate driver PC board, snubber PC board, and field clamp assembly, can be replaced. Due to the complexity of alignment, it is recommended that the Field Power Module be returned to Reliance for repair and/or replacement of components.

Appendix A

Power Module Technical Specifications

Ambient Conditions

- Storage temperature: −40º C to 85º C (−104º F to 185º F)
- Operating temperature: 0º C to 40º C (32º F to 104º F)
- Humidity: 5 to 95%, non-condensing
- Altitude: Do not install above 1000 meters (3300 feet) without derating output power. For every 91.4 meters (300 feet) above 1000 meters, derate the output current 1%.

Enclosure

- Black painted steel of U-channel form, with key-hole top and slotted bottom mounting provisions. Mounting attachments for all Power Module component assemblies, cables, and bus bar.

Dimensions

- Height: 1024.90 mm (40.350 inches)
- Width: 180.00 mm (7.087 inches)
- Depth: 319.83 mm (12.592 inches)

Cooling Fan

- Type: Centrifugal Blower
- Part Number: 69739-46R
- Capacity: 170 CFM
- Voltage: 115VAC
- Power: 40 W

Input Ratings

- AC Line Voltage: 230 to 460 VAC +/– 10% continuous operation
- AC Line Frequency: 48 to 62 Hz.
- Source Rating: 2 KVA to 30 KVA
- Maximum AC line input current: 2 - 15 HP units: 25A RMS
16 - 60 HP units: 91A RMS
- Maximum short-circuit current: 10 kA
- AC Input Fuse Ratings: 2 - 15 HP units: 70A, 700V
16 - 60 HP units: 200A, 700V
- One Minute Overload: 150% of Maximum Current (once per hour)
- Maximum number of DC drives sharing the AC line on the primary side of the source transformer: 4

Appendix A

(Continued)

Output Ratings

Part Number	AC Input	Maximum Rated Power	Rated Current @ 40°C*
803600-1 (S6)	230V	7.5HP	27A
803610-1 (S6R)	460V	15HP	27A
803601-1 (S6)	230	30HP	100A
803611-1 (S6R)	460	60HP	100A

* Maximum cabinet ambient temperature with a 15° C internal maximum temperature (Maximum Power Module ambient temperature: 55° C).

Appendix B

Field Power Module Technical Specifications

Ambient Conditions

- Storage temperature: –40º C to 85º C (–104º F to 185º F)
- Operating temperature: 0º C to 40º C (32º F to 104º F)
- Humidity: 5 to 95%, non-condensing
- Altitude: Do not install above 1000 meters (3300 feet) without derating output power. For every 91.4 meters (300 feet) above 1000 meters, derate the output current 1%.

Enclosure

- Mounted below the armature assembly and above the fan assembly within the 2-60 HP DC Power Module. All circuits are covered and protected.

Cooling

- Forced air using Power Module fan.

Input Ratings

- AC Line Voltage: 115 to 460 VAC +/– 10%, continuous operation
- AC Line Frequency: 48 to 62 Hz.
- Source Rating: 2 kVA to 30 kVA
- Maximum short circuit current: 10kA
- Internal Line Fuse Rating: 20A, 600V
- One Minute Overload: 150% of Maximum Current (once per hour)

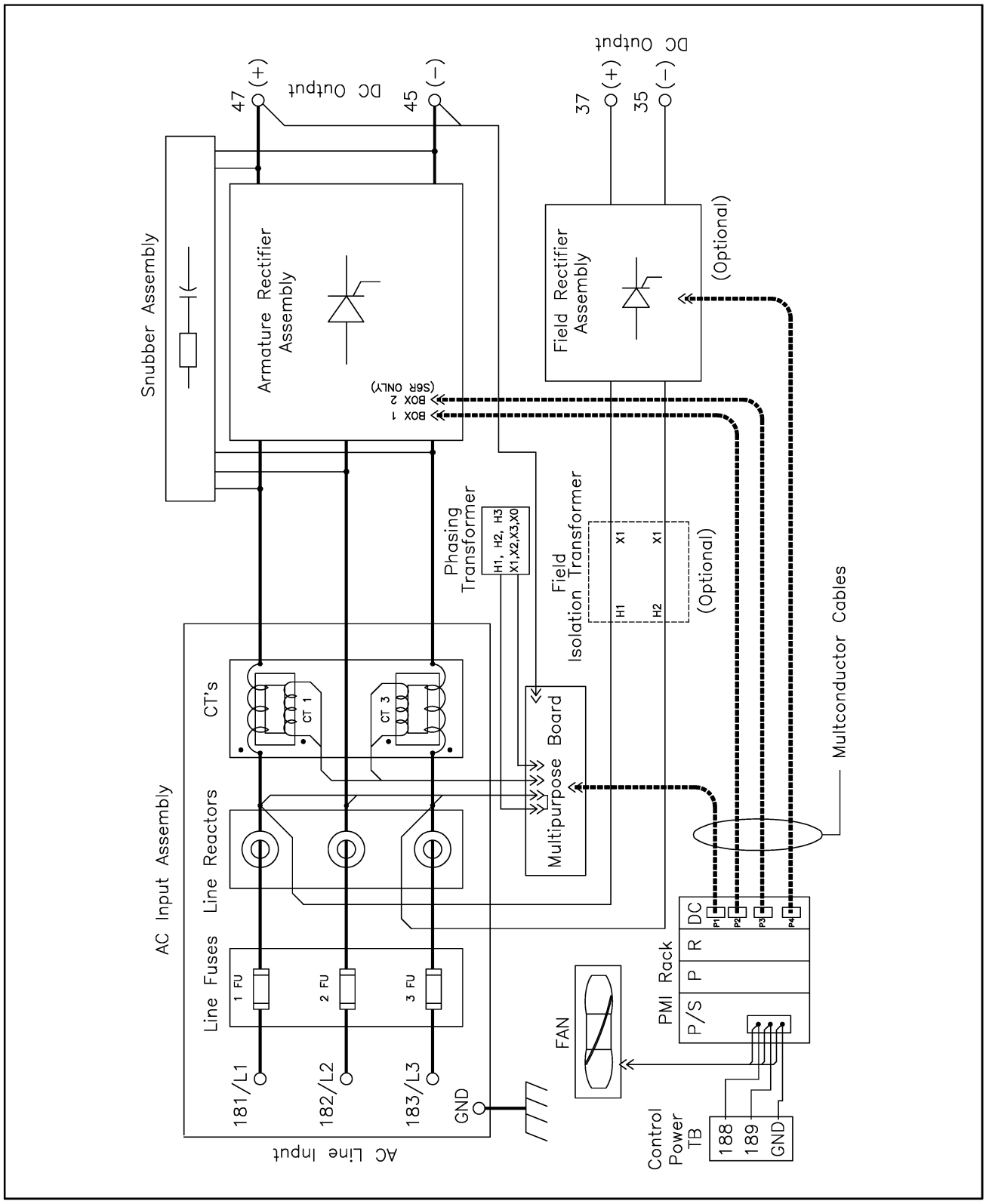
Output Ratings

AC Input	Maximum Rated Power	Rated Current @ 40º C *
230V	7.5kW	15A

* Maximum cabinet ambient temperature with a 15º C internal maximum temperature (Maximum Power Module ambient temperature: 55º C).

Appendix C

Power Module Block Diagram



Appendix D

Replacement Parts

Power Module Replacement Parts

Description	Reliance Part Number
Line Fuses 1FU, 2FU, 3FU: 200 A, 700 V (16-60HP Models, S6 & S6R)	64676-120AXX
Line Fuses 1FU, 2FU, 3FU: 70 A, 700 V (2-15HP Models, S6 & S6R)	64676-120AQX
Fasteners: AC Input, DC Output and Fuses (M6 x 1)	419063-201SJ
AC Input Assembly (16-60HP Models, S6 & S6R)	805407-10R
AC Input Assembly (2-15HP Models, S6 & S6R)	805407-10S
Current Transformers (2) - (16-60HP Models, S6 & S6R)	709351-13R
Current Transformers (2) - (2-15HP Models, S6 & S6R)	709351-13S
Snubber Assembly	805402-3R
Armature Assembly - (S6R Models, 2-15HP, 16-60HP)	805409-1R
Armature Assembly - (S6 Models, 2-15HP, 16-60HP)	805409-R
Field Assembly (if used)	805405-S
Fan Assembly	805407-5S
PMI Rack Assembly (with backplane)	805401-R
PMI Rack - Power Supply module	C1: B/M O-60007-*
PMI Rack - PMI Processor module	C2: B/M O-60021-*
PMI Rack - Resolver - I/O module	C3: B/M O-60031-*
PMI Rack - DC Technology module	C4: B/M O-60002-*
Armature Power Cube	701819-201AW
Field Power Cube (Quad Pack)	701819-303AW
Field Clamp SCR(Stud Mount)	410403-75AW
Thermo Pad for Power Cube (or Thermo Grease)	48525-19AA
Armature Gate Driver Circuit Board - (S6R Models, 2-15HP, 16-60HP)	B/M O-60016-*
Armature Gate Driver Circuit Board - (S6 Models, 2-15HP, 16-60HP)	B/M O-60018-*
Multipurpose Circuit Board	B/M O-60017-*
Field Circuit Board	B/M O-60015-*
C.B. Fuse, 4 Amp, 500 Volt	64676-68X
Cable P1: Multipurpose PC Board to PMI	612409-50W
Cable P2/P3: Armature Module to PMI - (S6R Models, 2-15HP, 16-60HP)	612410-50W
Cable P2/P3: Armature Module to PMI - (S6 Models, 2-15HP,16-60HP)	612410-51W
Cable P4: Field Power Module to PMI (if used)	602418-50W
Armature Module Bus Bar Nuts (M6 x 1)	419063-201SJ
Power Cube Mounting Screws (M5x0.8x12mm)	419062-1PHH
Power Cube Busbar Mounting Screws (M5x0.8x10mm)	419062-1PHG
Armature Module Retaining Screws (M5x50mm)	419062-2PHS

* Use latest revision level.

Field Power Module Replacement Parts

Description	Reliance Part Number
AC Input Line Fuses (3)	64676-30L
Power Cubes (5)	701819-303AW (Quad Pack) 410403-75AW (Stud Mount)
Field Gate Coupling Card	B/M 60015-*
PMI Cable	602418-50W

* Use latest revision level.

Appendix E

SF3000 Operation

The 2-60 HP DC Power Module's three-phase power bridge may be used to supply a motor or generator field. The 2-60 HP Power Module can supply a field up to its continuous current rating, which can be as high as 100A @ 500 VDC for a 60 HP Power Module. (The single-phase Field Power Module can supply a motor field of up to 15A @ 500 VDC.)

In SF3000 applications the Power Module's outputs (terminals 45 and 47) are connected to the motor or generator field windings. The Power Module and PMI rack hardware remain the same as in SD3000 operation. The control algorithm for SF3000 drives is slightly different. The Power Module must be programmed in the UDC for operation as a field supply. All reference calculations and generation is performed in the application software. The registers and bits used for armature control in SD3000 operation are used for field control in SF3000 operation.

The information in this manual can be applied to describe SF3000 three-phase Field Power Modules by replacing the term "armature" with "three-phase field." Note that whenever the word "field" appears in this manual, it refers to the optional single-phase Field Power Module.

Related Publications

Please refer to the following manuals for more detailed information on SF3000 operation of the 2-60 HP DC Power Modules:

- Distributed Power System SF3000 Drive Configuration and Programming (Instruction Manual S-3036).
- Distributed Power System SD3000/SF3000 Power Module Interface Rack and Modules (Instruction Manual S-3008), Appendix G.

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