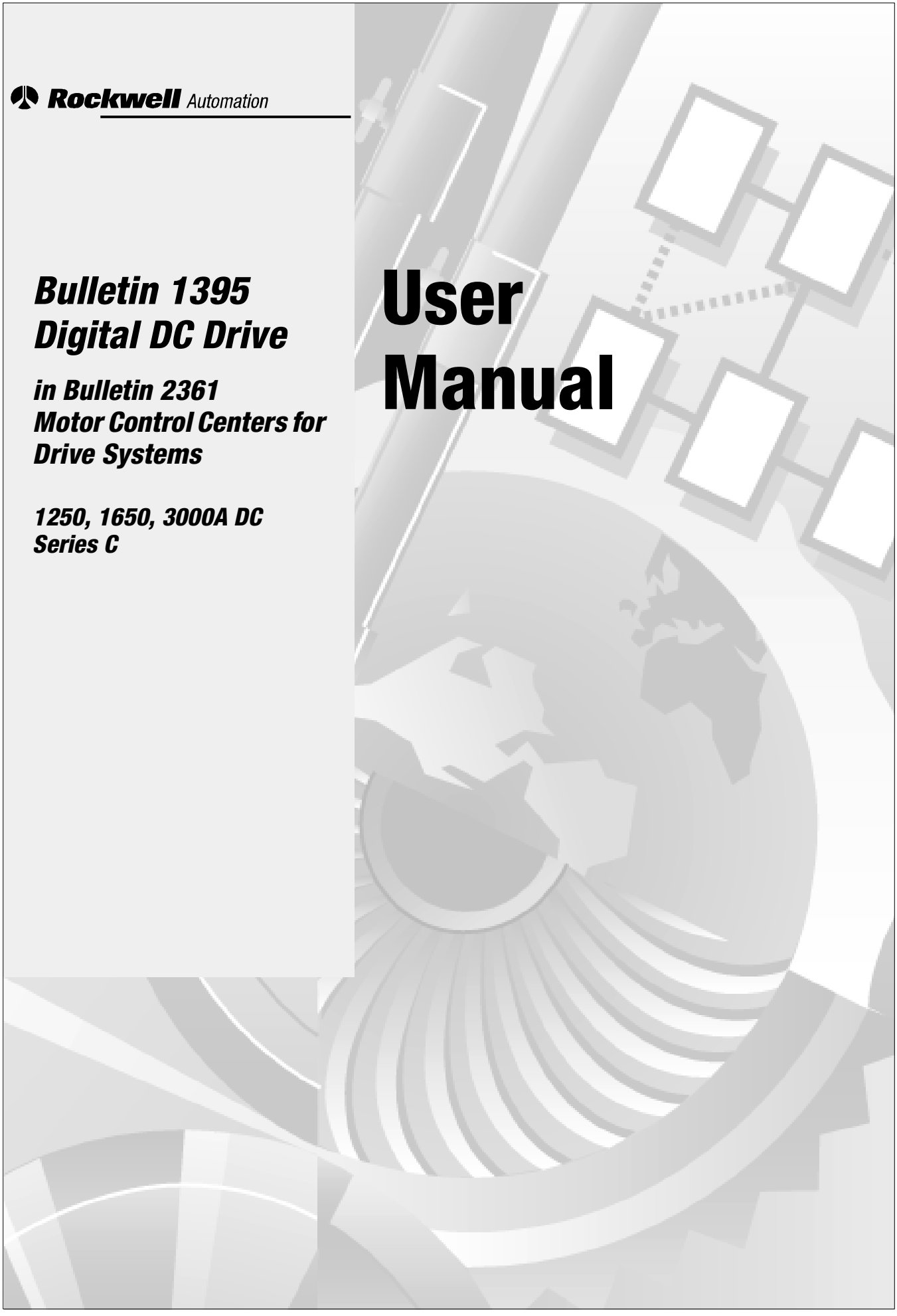
Rockwell Automation

Bulletin 1395 Digital DC Drive

in Bulletin 2361 Motor Control Centers for Drive Systems

1250, 1650, 3000A DC Series C

User Manual



Important User Information

Solid-State equipment has operational characteristics differing from those of electromechanical equipment. *"Safety Guidelines for the Application, Installation and Maintenance of Solid-State Controls"* (Publication SGI-1.1) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation be responsible or liable for indirect or consequential damages resulting from the use of 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, the Rockwell Automation cannot assume responsibility or liability for actual use based on the examples and diagrams.

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

Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attention statements help you to:

- identify a hazard
- avoid a hazard
- recognize the consequences

Chapter 5 Installing Your Drive

Chapter 6 Starting Up Your Drive

Appendix A Drive Specifications

Appendix B

Catalog Numbers and Spare Parts Kits

Preface

Contents

This preface will introduce you to the contents and purpose of this manual. The following topics will be discussed in this preface:

Who Should Use This Manual

This manual is intended for those who are responsible for installing or operating a Rockwell Automation high-horsepower 1395 drive.

If you do not have a basic understanding of this unit, please refer to the drive documentation, or contact your local Rockwell Automation Drive Systems representative for more information before using this product.

Purpose of This Manual

This manual is a supplement to Publication 1395-5.40, titled *1395 Digital DC Drive–User Manual*. This manual will cover:

- hardware overviews
- specifications
- installation instructions
- configuration and setup information
- spare parts

Safety Precautions

The following general precautions apply to Bulletin 2361 drive system lineups:

ATTENTION: Only those familiar with the drive system, the products used in the system, and the associated machinery should plan or implement the installation, startup, and future maintenance of the system. Failure to comply can result in personal injury and/or equipment damage.

ATTENTION: Verify that all sources of AC and DC power are deenergized and locked out or tagged out in accordance with the requirements of ANSI/NFPA 70E, Part II.

ATTENTION: The system may contain stored energy devices. To avoid the hazard of electrical shock, verify that all voltage on capacitors has been discharged before attempting to service, repair, or remove a drive system or its components. You should only attempt the procedures in this manual if you are qualified to do so and are familiar with solid-state control equipment and the safety procedures in ANSI/NFPA 70E.

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

ATTENTION: This drive system contains parts and assemblies that are sensitive to ESD (electrostatic discharge). Static control precautions are required when installing, testing, or repairing this assembly. Component damage can result if ESD control procedures are not followed. If you are not familiar with static control procedures, refer to Rockwell Automation publication 8000-4.5.2, *Guarding Against Electrostatic Damage*, or another adequate handbook on ESD protection.

Contents of this Manual

Chapter	Title	Contents
	Preface	Purpose, background, and scope of this manual
1	Product Overview	Theory of operation, features, and standard options
2	Your 1250A DC Drive	Features, components, and schematics of the 1250A drive (R-frame)
3	Your 1650A DC Drive	Features, components, and schematics of the 1650A drive (S-frame)
4	Your 3000A DC Drive	Features, components, and schematics of the 3000A drive (T-frame)
5	Installing Your Drive	Installation procedures and connection details
6	Starting Up Your Drive	Information for starting up your drive
A	Drive Specifications	Electrical, environmental, and operational specifications
B	Catalog Numbers and Spare Parts Kits	Explanation of catalog numbers and listings of spare part kits

Related Documentation

Several of the following documents will be needed to understand and install your drive and its components. To obtain a copy of any Rockwell Automation publication, please contact your local Rockwell Automation office or distributor.

For	Read This Document	Document Number
Information on the 1395 digital DC drives	Bulletin 1395 Digital DC Drive–User Manual	1395-5.40
Troubleshooting information for 1395 drives	Bulletin 1395 Digital DC Drive–Troubleshooting Manual	1395-5.45
Using the Bulletin 1300 programming terminal	Bulletin 1300 Programming Terminal–User Manual	1300-5.5
PLC-5™ information	PLC-5 Controllers Brochure	1785-1.2
Additional Information on joining and splicing together MCCs	Joining and Splicing Vertical Sections–Instructions	2100-5.1
Details on receiving, handling, and storing MCCs	Receiving, Handling, and Storing Motor Control Centers–Instructions	2100-5.5
Provides procedures for those tasks that need to be done at the customer's site before system start up	Bulletin 2300 Installation Manual	2300-5.1
Information and installation instructions for the 1395 Node Adapter Board	Bulletin 1395 Node Adapter Board–Installation and Operation Manual	1395-5.9
Information and installation instructions for the 1395 Discrete Adapter Board	1395 Discrete Adapter Board–Installation and Operation Manual	1395-5.12
Information and installation instructions for the 1395 ControlNet Communication Board	Bulletin 1395 ControlNet Communication Board–User Manual	1395-5.37
Information and installation instructions for the 1395 Multi-Communication Board	Bulletin 1395 Multi-Communication Board–Hardware/Software Reference Manual	1395-5.33
Information and installation instructions for the 1395 Digital Reference Adapter Board	Bulletin 1395 Digital Reference Adapter Board–Hardware/Software Reference Manual	1395-5.55
A description of DriveTools™ software	DriveTools Software Brochure	9303-1.0
Information on FD86N enclosures	FD86N Drive Systems Enclosure Hardware–Installation Manual	S-3062
Standards for electrical procedures (wiring sizes, grounding, etc.)	National Electrical Code (Published by the National Fire Protection Association of Boston, MA)	ANSI / NFPA 70
An article on safety procedures	Standard for Electrical Safety Requirements for Employee Workplaces	ANSI / NFPA 70E
A complete listing of current documentation, including ordering instructions. Also indicates whether the documents are available on CD-ROM or in multi-languages	Allen-Bradley Publication Index	SD499
A glossary of industrial automation terms and abbreviations	Industrial Automation Glossary	AG-7.1

Style of this Manual

The following conventions are used throughout this manual:

- **'ATTENTION'** statements, preceded with the symbol shown, indicate a circumstance that could could lead to personal injury, death, damage to property, or economic loss
- **'Important**' statements indicate key information for successfully performing procedures and understanding the product

- Reference statements, preceded with the symbol shown, lead you to other resources of information and instruction
- Horsepower ratings are provided at the start of each drive chapter
- Schematic and layout component abbreviations are explained in component reference charts in each drive chapter

Terms and Abbreviations

The following terms and abbreviations are used in this manual:

Term	Definition
armature	rotating part of a motor
bridge	assembly for power (AC/DC) conversion
busbar	a large tin-plated copper conductor, used for high-power input and output
feedback	status signals/voltages sent from components or external devices
gate	an electrical switch
MCC	motor control center, an enclosure for drive systems
MOV	metal-oxide varistor, used for voltage spike protection
SCR	silicon-controlled rectifier, used in power conversion
snubber	a resistor/capacitor assembly, used for limiting excess voltage

Receiving Your Drive System

You, the Customer, are responsible for thoroughly inspecting the equipment before accepting the shipment from the freight company. Check the item(s) that you receive against your purchase order. If any items are obviously damaged, do not accept the delivery until the freight agent has noted the damage on the freight bill. Should you discover any concealed damage during unpacking, you are responsible for notifying the freight agent. In such a case, leave the shipping container intact and request that the freight agent make a visual inspection of the equipment.

Rockwell Automation Support

Rockwell Automation offers support services worldwide, with Sales/ Support Offices, authorized distributors, and authorized Systems Integrators located throughout the United States, plus Rockwell Automation representatives in every major country in the world.

Local Product Support

Please contact your local Rockwell Automation representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

Technical Product Assistance

If you need to contact us for technical assistance, please review the product and troubleshooting information in this manual first.

For the quickest possible response, please have the catalog numbers of your products ready when you call.

Product Overview

Contents

The high-horsepower line of 1395 DC drives are Bulletin 1395 regulator products, with a high-horsepower silicon-controlled rectifier (SCR) bridge, packaged in a Bulletin 2361 CENTERLINE™ motor control center, providing DC power for your high-horsepower applications.

This first chapter will introduce you to the high-horsepower Bulletin 1395 drive covering these topics:

Standard Features

The high-horsepower Bulletin 1395 drive includes the following standard features:

- NEMA Class I construction
- High AIC instantaneous trip circuit breaker or line fuses for the AC input, armature cell fuses, and a DC output contactor
- a six pulse, full-wave rectified armature converter
- 43A single-phase field regulator
- regenerative (1250, 1650, and 3000A) or non-regenerative (1250 and 1650A units only)
- 6:1 constant horsepower range
- digital control for current, velocity, and configuration
- auto tuning for velocity loop, current loop, field flux table

- programmable functions (independent acceleration/deceleration adjustment, preset speeds, current limit, tapered current limit, tach loss recovery, system reset)
- protective features (instantaneous overcurrent, motor overload, feedback loss, field loss, field economy, tach loss recovery, system reset)
- CENTERLINE Bulletin 2361 Motor Control Center enclosure

Standard Options

The following options are available for the high-horsepower 1395 drives:

- 115V AC discrete adapter board
- 24V DC discrete adapter board
- node adapter board
- multi-communications adapter board
- door-mounted DHT or EHT programming terminal
- 'start/running' and 'clear fault/drive faulted' door-mounted illuminated pushbuttons
- 'drive stop', 'hardwired stop', 'jog forward', and 'jog reverse' door-mounted pushbuttons
- 'power on' door-mounted pilot light
- door-mounted speed potentiometer
- 1-2-3 speed selector
- blower starter (NEMA, IEC)
- 90A single-phase field regulator
- control circuit transformer
- top-hat input enclosure (standard for 3000A drive)
- line RC suppressor
- AC power thru bus

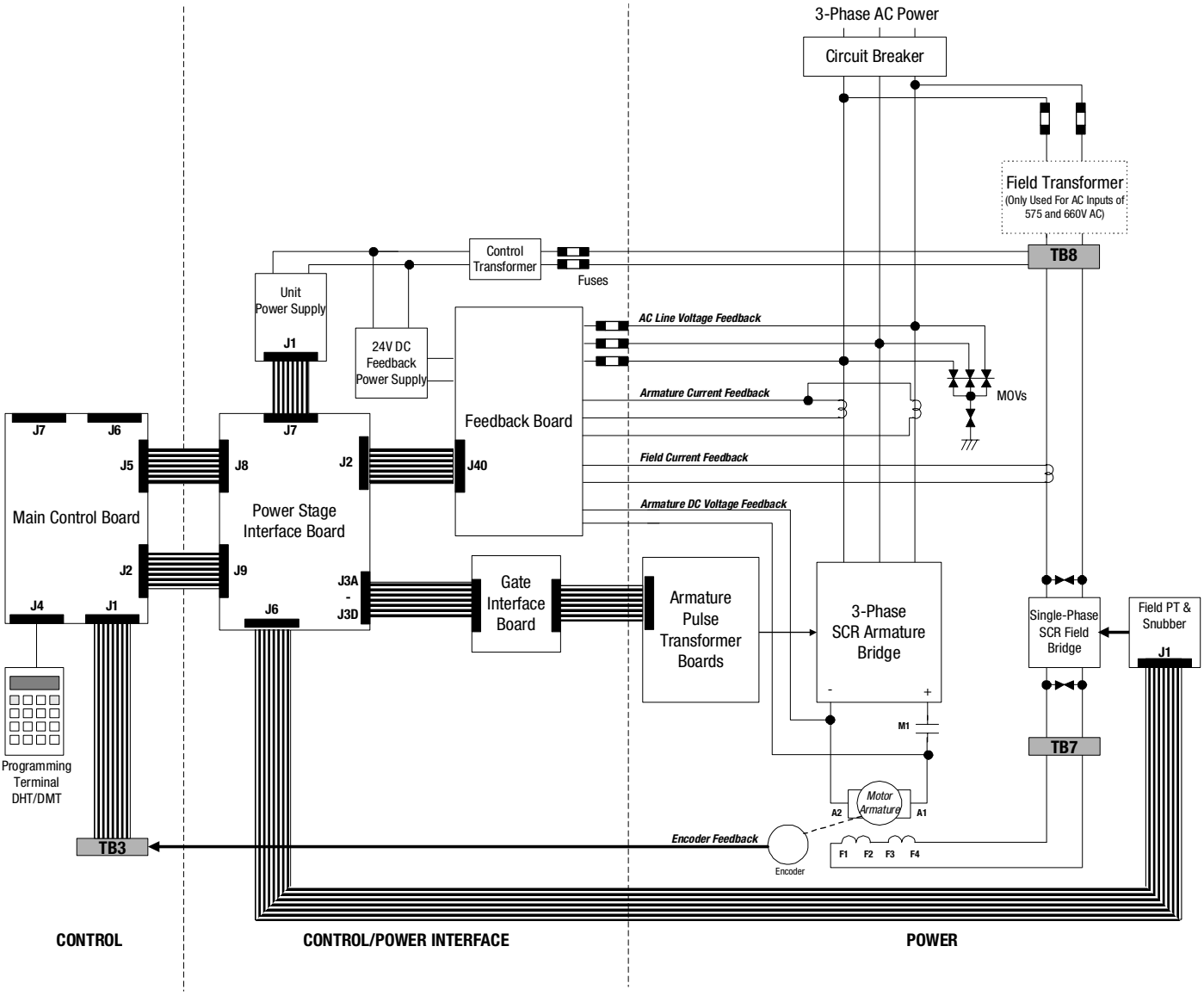
Note: *Additional options are listed in Appendix B.*

Hardware Overview

The hardware components shown in form the high-horsepower 1395 DC drive. These drive components can be broken down into the following three categories:

Hardware	Description
Control	Controls the drive system and interfaces with external devices
Control/Power Interface	Interfaces the control components with the power components
Power	Converts AC input to a DC supply for the motor

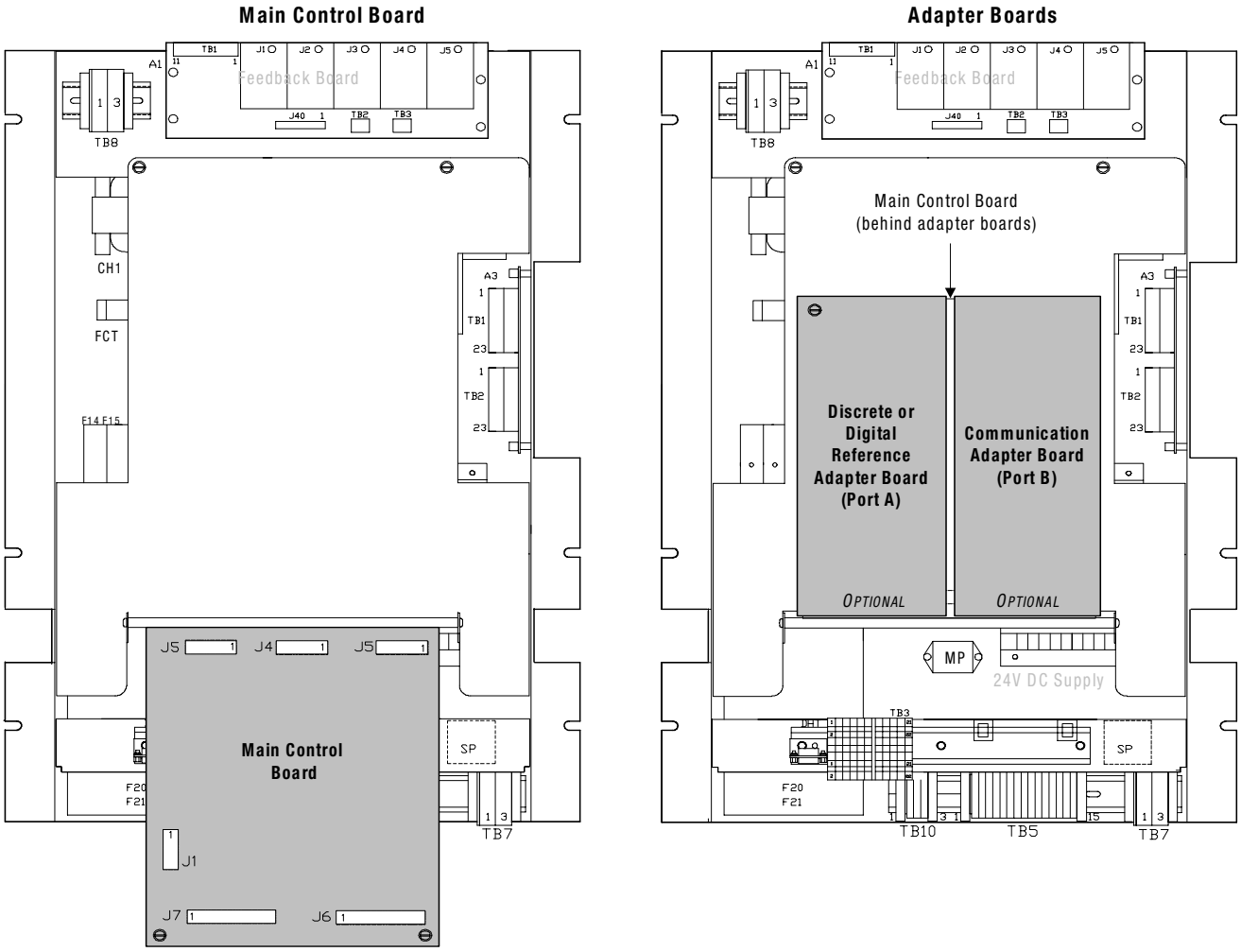
Figure 1.1
Drive Components



Control Boards

The control boards manage and control the system, processing status information from system components and commanding drive components and activities.

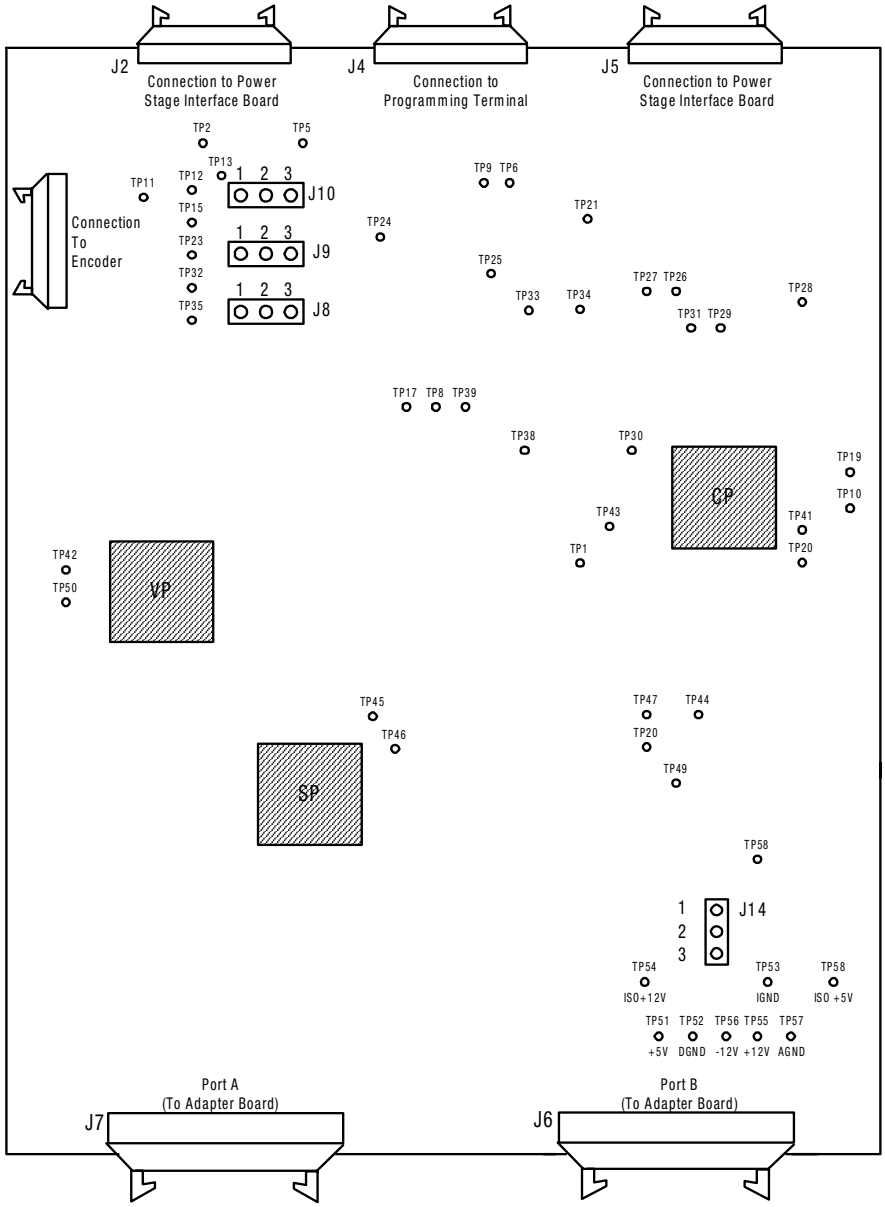
Figure 1.2
Control Boards



Main Control Board

The main control board is the center of the control processing. This board has a number of test points and jumpers that are used during startup and troubleshooting. Refer to the troubleshooting manual for more information on test points and jumpers.

Figure 1.3
Main Control Board



Door-Mounted Programming Terminal

The door-mounted Bulletin 1300 programming terminal is the interface module used to program and control the drive (typically used in standalone applications). This terminal has an LCD screen and a 24-key environment-safe keypad.

Adapter Boards

Optional adapter boards (such as the discrete adapter board, digital reference adapter board, node adapter board, and multi-communication adapter board) connect the drive to networks and provide I/O capabilities.

Adapter board and programming terminal publications are listed in the preface of this manual. Please refer to the appropriate manuals for more information.

Control/Power Interface Boards

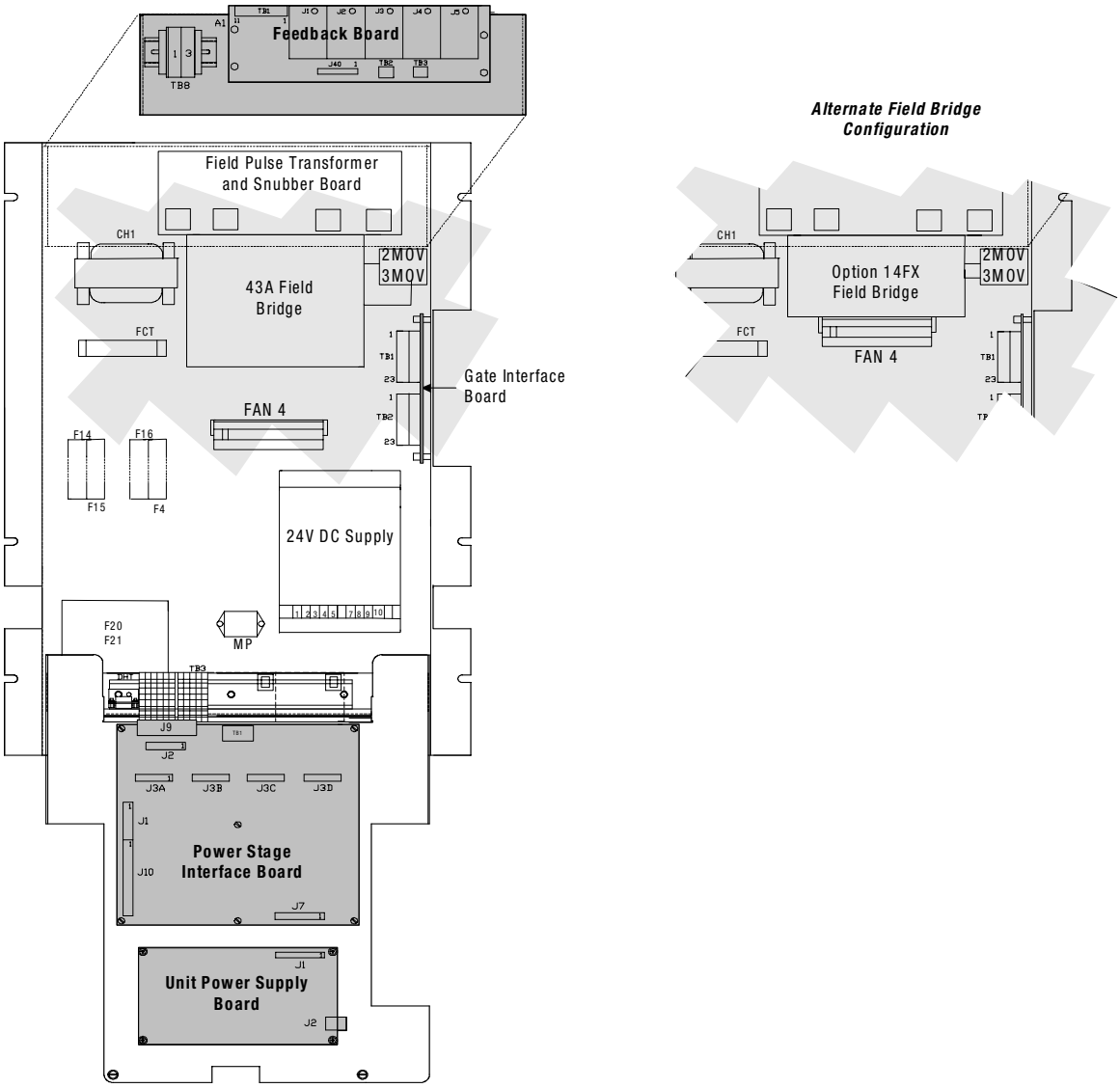
Control/power interface boards are used to provide a link between control boards (which are responsible for managing the drive), and power components (which are closely associated with the actual drive hardware and operations).

The following items are used to provide this interfacing:

- power stage interface board
- unit power supply board
- feedback board

These items are located on the control module in the disconnect bay of the drive, and are arranged as shown below. Accessibility to the power stage interface board and the unit power supply is gained by lowering the front panel.

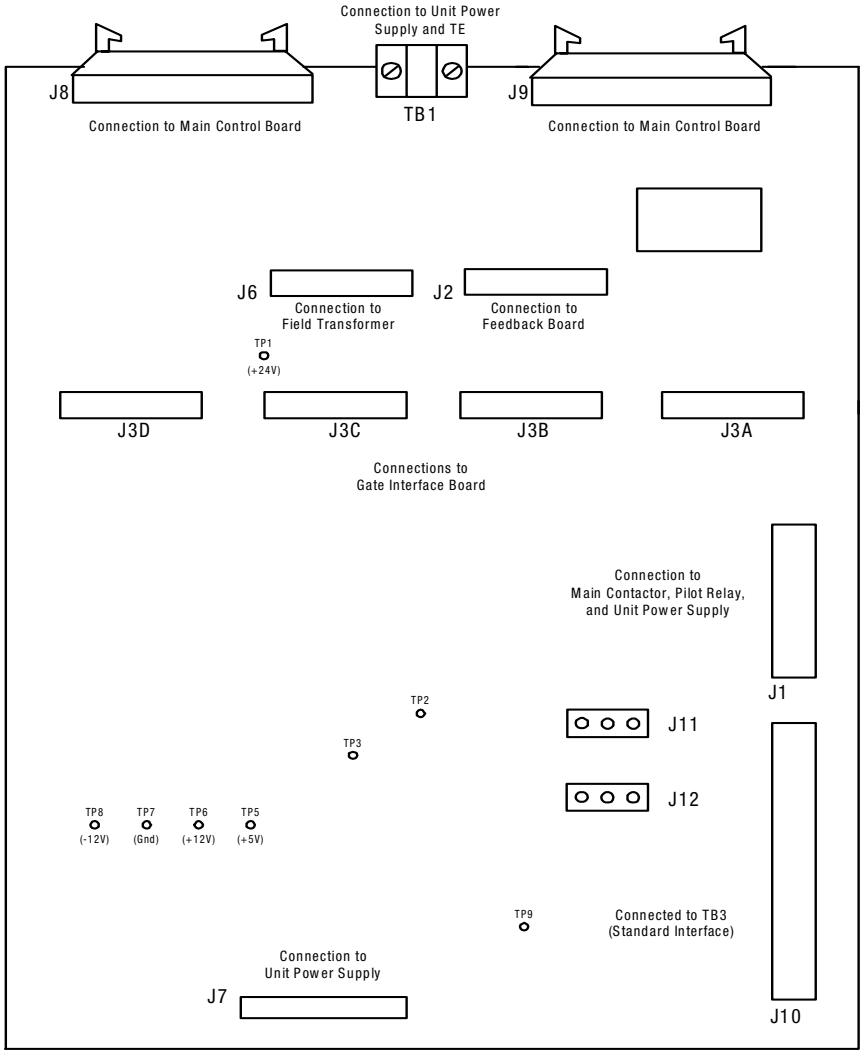
Figure 1.4
Control/Power Interface Boards



Power Stage Interface Board

The power stage interface board is used as the chief interface between the main control board and other boards of the system. This board is responsible for distributing power and control signals to and from the main control board, gate interface board, field-pulse transformer board, feedback board, and unit power supply. Refer to Figure 1.1 to see how this board is connected in the drive.

Figure 1.5
Power Stage Interface Board



The test points and jumpers shown in the diagram are used for startup and troubleshooting procedures. Refer to the troubleshooting manual for more information on test points and jumpers.

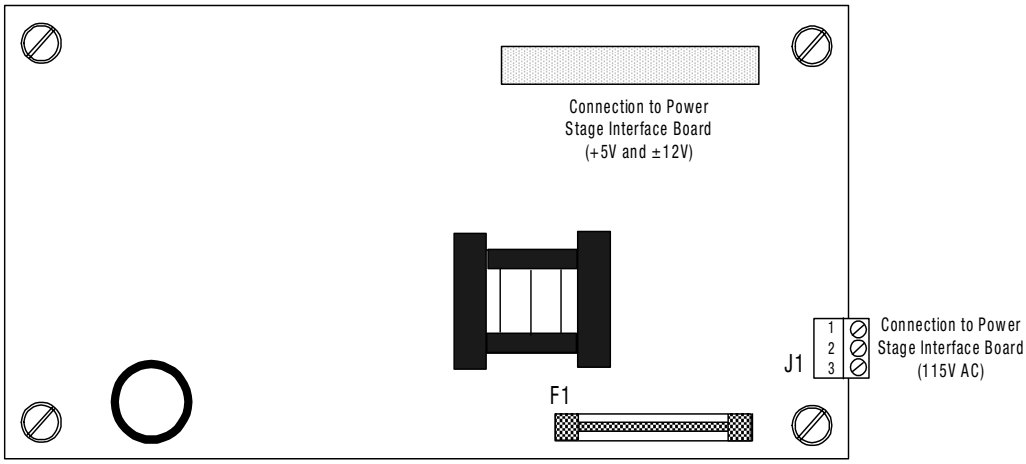
The power stage interface board provides the following services between the main control board and other boards in the system:

- furnishes DC control power to the main control board (from the unit power supply)
- provides 3-phase line synchronization signals to the main control board
- accepts signals from the main control board and produces the logic and drivers for armature and field-pulse transformers
- accepts signals for start/stop logic, protection I/O, and drivers for operating the main DC contactor

Unit Power Supply Board

The unit power supply board converts 115V AC input into regulated +5V DC and ±12V DC control voltages. These control voltages are routed through the power stage interface board to provide power to all the printed circuit boards.

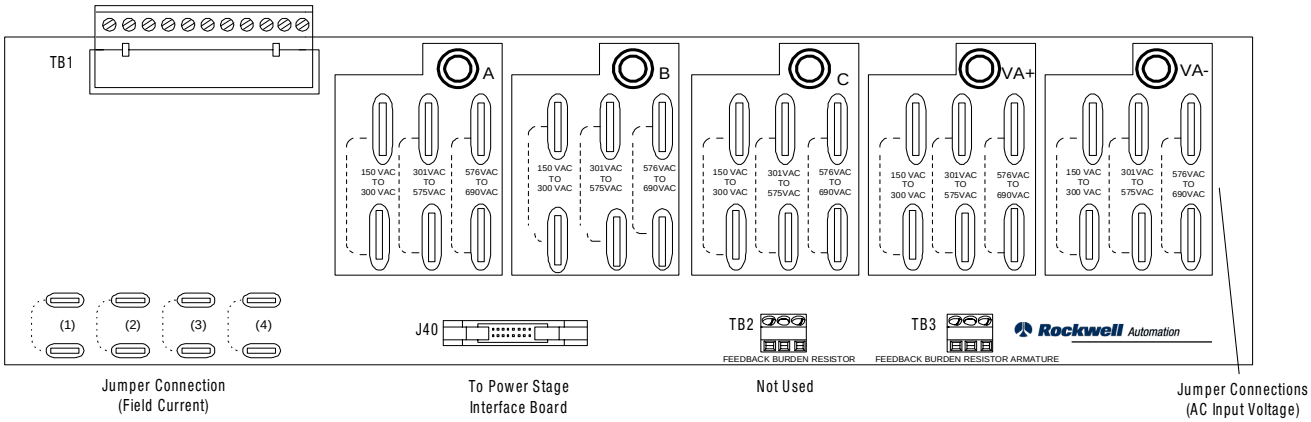
Figure 1.6
Unit Power Supply Board



Feedback Board

The feedback board receives status information from the drive components, scales it to a signal level, and supplies it to the main control board (through the power stage interface board).

Figure 1.7
Feedback Board



The feedback board has terminals for the 3-phase AC inputs (A, B, and C) and for the armature power (VA+ and VA-), a series of jumper connections to adjust for AC input voltage, jumper connections for the field current, a bus connection to the power stage interface board, two terminals blocks for placing burden resistors in parallel to the circuit, and a Phoenix connection terminal block connected to other drive components.

> ***Note:*** *Jumper settings are defined in the installation chapter of this manual.*

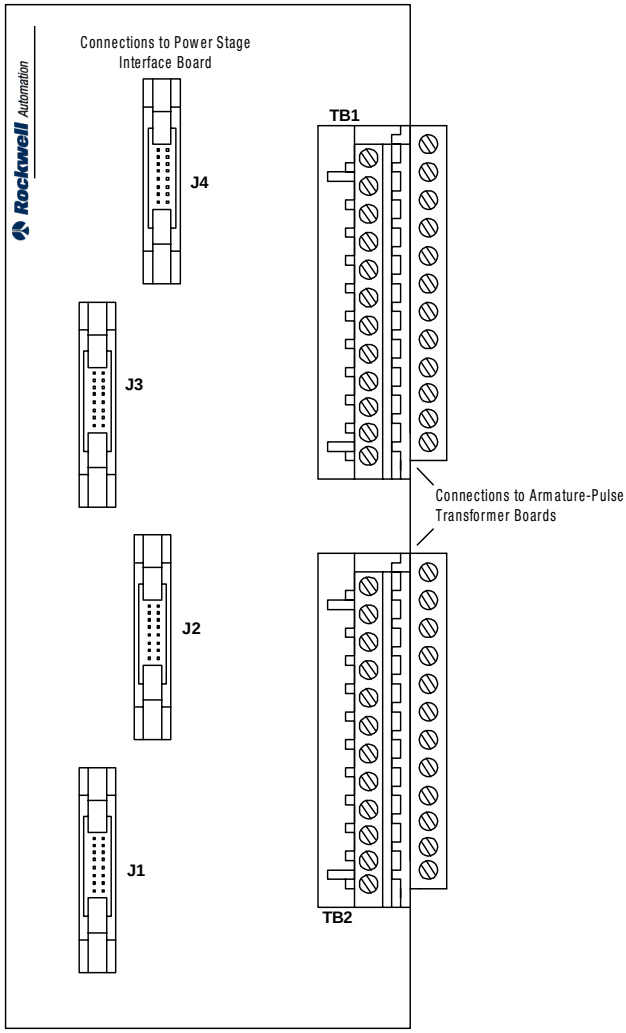
24V DC Power Supply

There are three 24V DC power supply units that may be installed in the drive. There is a feedback board supply, an optional air flow sensor supply, and an optional control board supply (used to power an optional adapter board). These supply units are fed from the 115V AC control power circuit.

Gate Interface Board

The gate interface board is the junction between the power stage interface board and the individual armature-pulse transformer boards. This board has four bus connections to the power stage interface board and four Phoenix terminal blocks distributing signals to the armature-pulse transformer boards.

Figure 1.8
Gate Interface Board



Power Components

This section will break down and define the incoming power, armature power, and field supply components.

Incoming Power Components

Incoming Devices

The 1250 and 1650A DC drives are intended to be used straight from the customer-supplied, power controlled incoming lines, without any additional isolation transformer or line chokes (however, adding either of these would increase isolation to other equipment on the power lines).

The 3000A DC drive does not require an isolation transformer or line reactors if it is the only equipment on the power lines. However, if it shares power with other equipment on the same power lines, it will be necessary to use either line reactors or an isolation transformer ahead of the drive.

The system designer needs to provide proper circuit impedence to limit the short circuit currents according to the breaker derating charts given in Appendix A.

Some drives may require an output inductor in series with the armature, especially for older machines which do not have enough internal inductance for a proper armature commutation process.

AC Input Busbars

Tin plated busbars are supplied for all input connections through the top of the disconnect bay. Busbar dimension diagrams are given in Appendix A.

Main Disconnect (Optional)

A 3-phase circuit breaker can be supplied on the incoming line for each high-horsepower drive. Appendix A lists circuit breaker specifications, and shows diagrams of the circuit breakers settings for the 1250, 1650, and 3000A DC drives.

AC Line Fuses (Optional)

AC line fuses can be supplied for the 3-phase incoming power.

Note: *Units require either a main disconnect or AC line fuses.*

Control and Field Power

The first (L1) and third (L3) phase of the incoming power are tapped off and fused to provide single-phase AC power to the primary of control power transformer (115V AC), field supply circuit (460V AC maximum), and 24V DC power supply.

> ***Note:*** *For drives using a 575 or 660V AC input, a step-down transformer will be required for the field supply circuit (see Figure 1.12).*

AC Line RC Suppressor (Optional)

The optional AC line RC suppressor is a device used for limiting line voltage spikes in drives when the medium voltage source to the primary of the distribution transformer is switched. The option is offered for a distribution transformer primary voltage of 2300V or greater.

Armature Power Components

The armature power components work together to convert the 3-phase AC input to a DC output used for powering your motor armature.

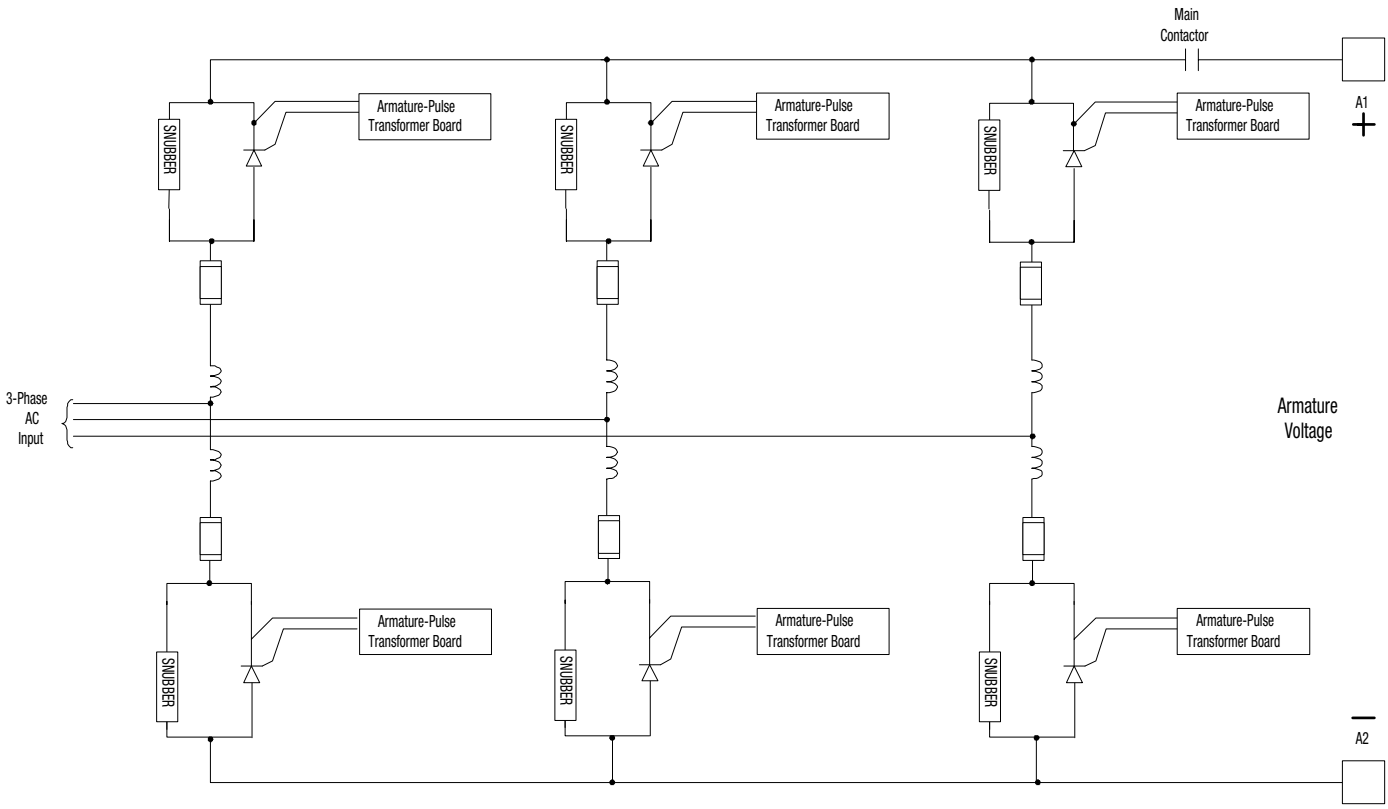
The following items make up the armature power circuitry:

- armature bridge (and its subordinate components)
- cell fuses
- gate boards
- DC contactor

Armature Bridge

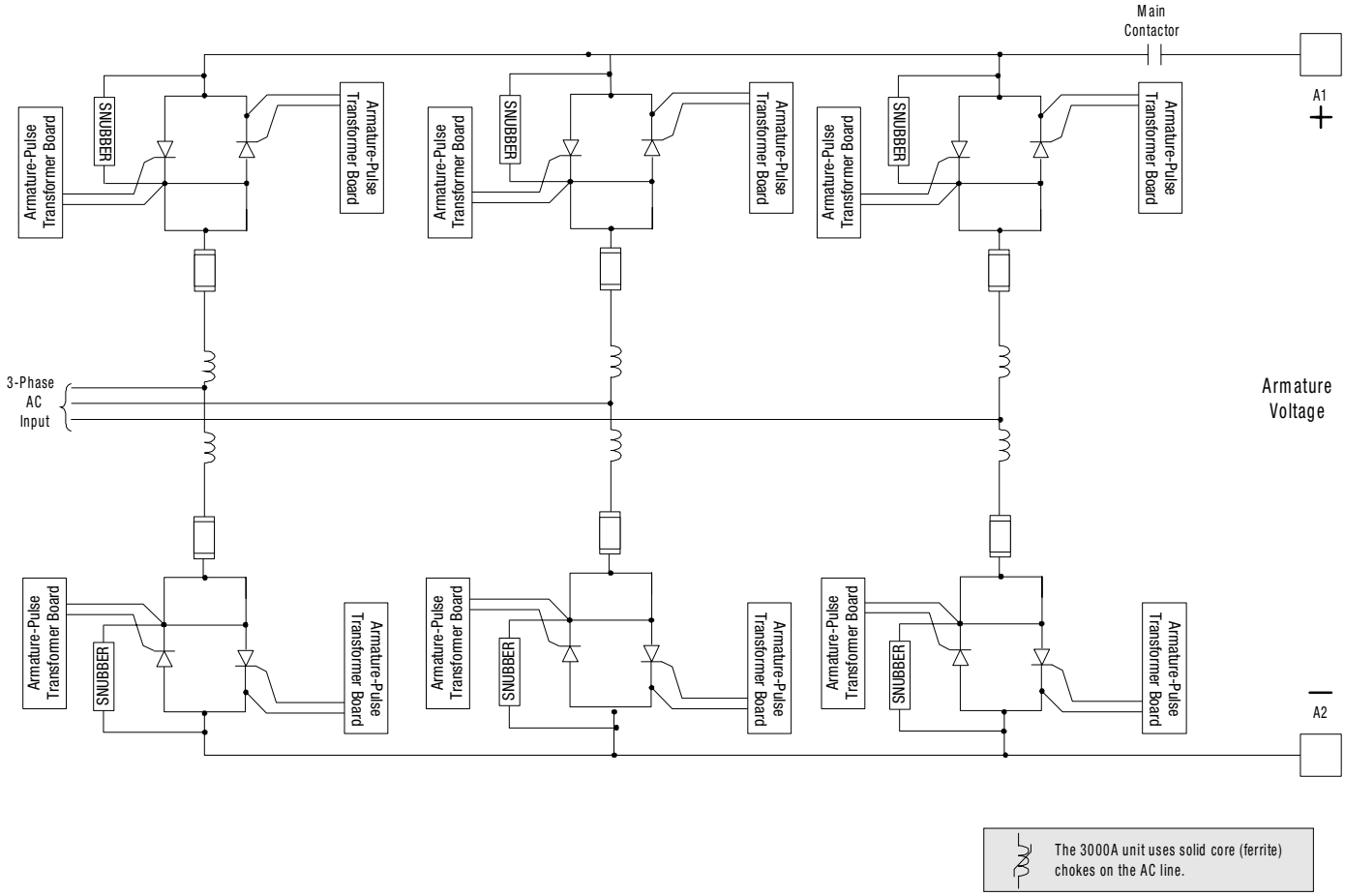
The armature bridge is designed to convert incoming AC power to DC power. The non-regenerative bridge is shown in Figure 1.9. Cell fuses protect the thyristors in the event of a bridge failure.

Figure 1.9
Armature Bridge (Non-Regenerative)



The regenerative bridge, shown in Figure 1.10, allows the bridge to regenerate, or to direct power backwards onto the incoming lines.

Figure 1.10
Armature Bridge (Regenerative)



Silicon-Controlled Rectifiers (SCRs)

Each drive uses silicon-controlled rectifiers (SCRs) in the thyristor bridge to switch the incoming 3-phase AC power to DC output power.

These SCRs allow current to flow from anode to cathode when two conditions are met. First, like a diode, it must be forward biased. Second, an appropriate pulse must be applied to the gate (through the pulse transformer board).

The current will continue through the SCR until the voltage across it reverses and the current drops to zero (called line commutation). Figure 1.11 shows a picture of an SCR, depicting its polarity.

Snubbers

Snubbers (resistor/capacitor assemblies) are installed in parallel with the SCRs, working with the cell reactors to provide adequate voltage suppression when the SCRs switch off.

Armature-Pulse Transformer Boards

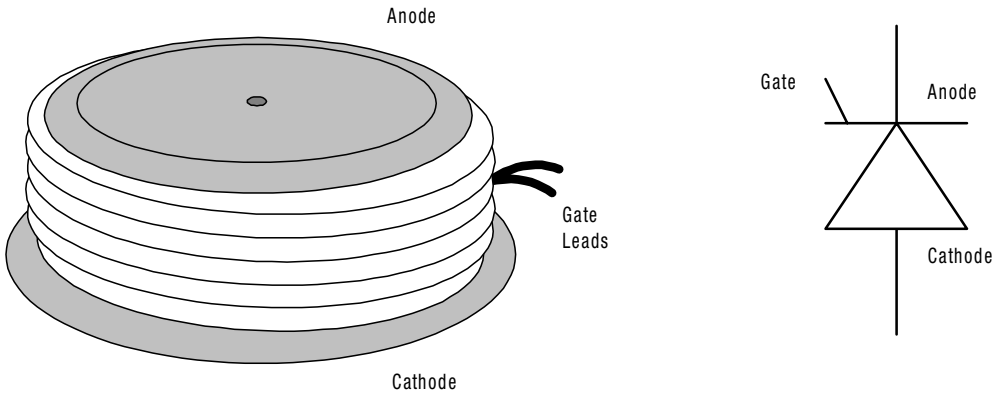
Armature-pulse transformer boards provide the appropriate gate voltage and current to trigger an SCR. In addition, these boards provide gate driver isolation from the control logic. Figure 1.11 shows an armature-pulse transformer board.

DC Contactor

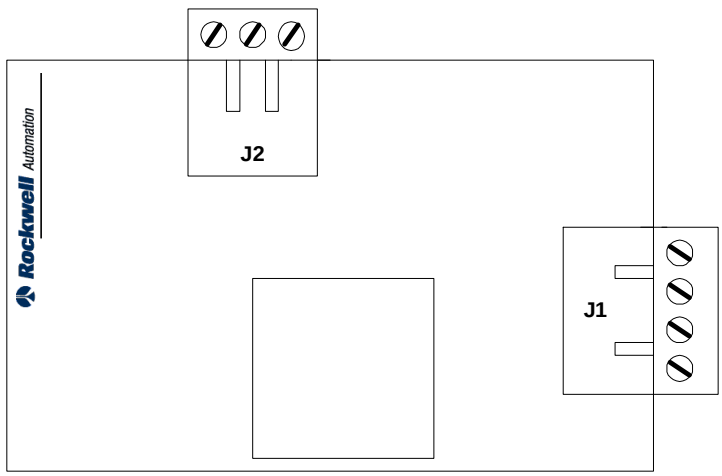
The main DC contactor is used to break the DC current to the motor armature. Coil voltage to the contactor is controlled by contacts from the pilot relay.

Figure 1.11
Armature Bridge Hardware

Silicon-Controlled Rectifier (SCR)



Armature-Pulse Transformer Board



Field Power Components

The field power components work together to convert single-phase AC power to a DC output used for powering your motor field.

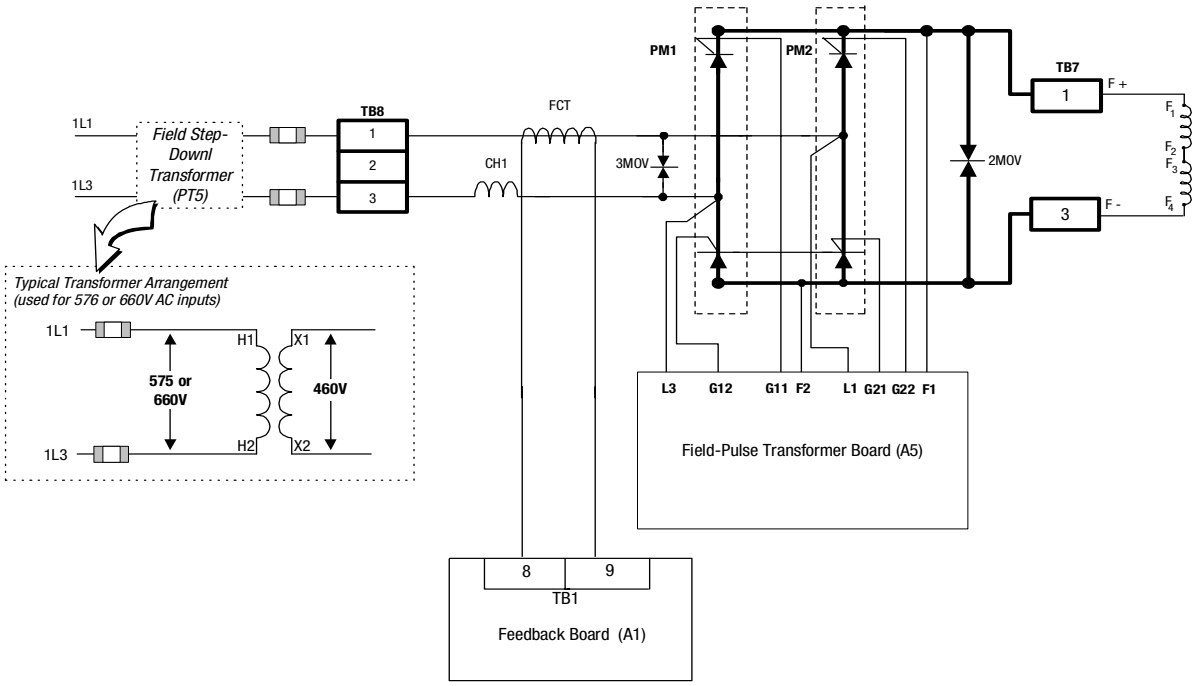
The following items make up the field power circuitry:

- field bridge
- field-pulse transformer board

In addition, fuses, metal-oxide varistors (MOVs), and an inductor, as shown in Figure 1.12, are used to protect the field bridge from extreme current and voltage conditions. The field circuitry is fan-cooled.

> ***Note:*** *The field power components are rated for voltages up to 460V AC. Drives with input voltages of 575 or 660V AC use a single-phase field transformer (PT5) to step down the voltage to 460V AC. PT5, shown in Figure 1.12, is connected at the customer site.*

Figure 1.12
Field Bridge



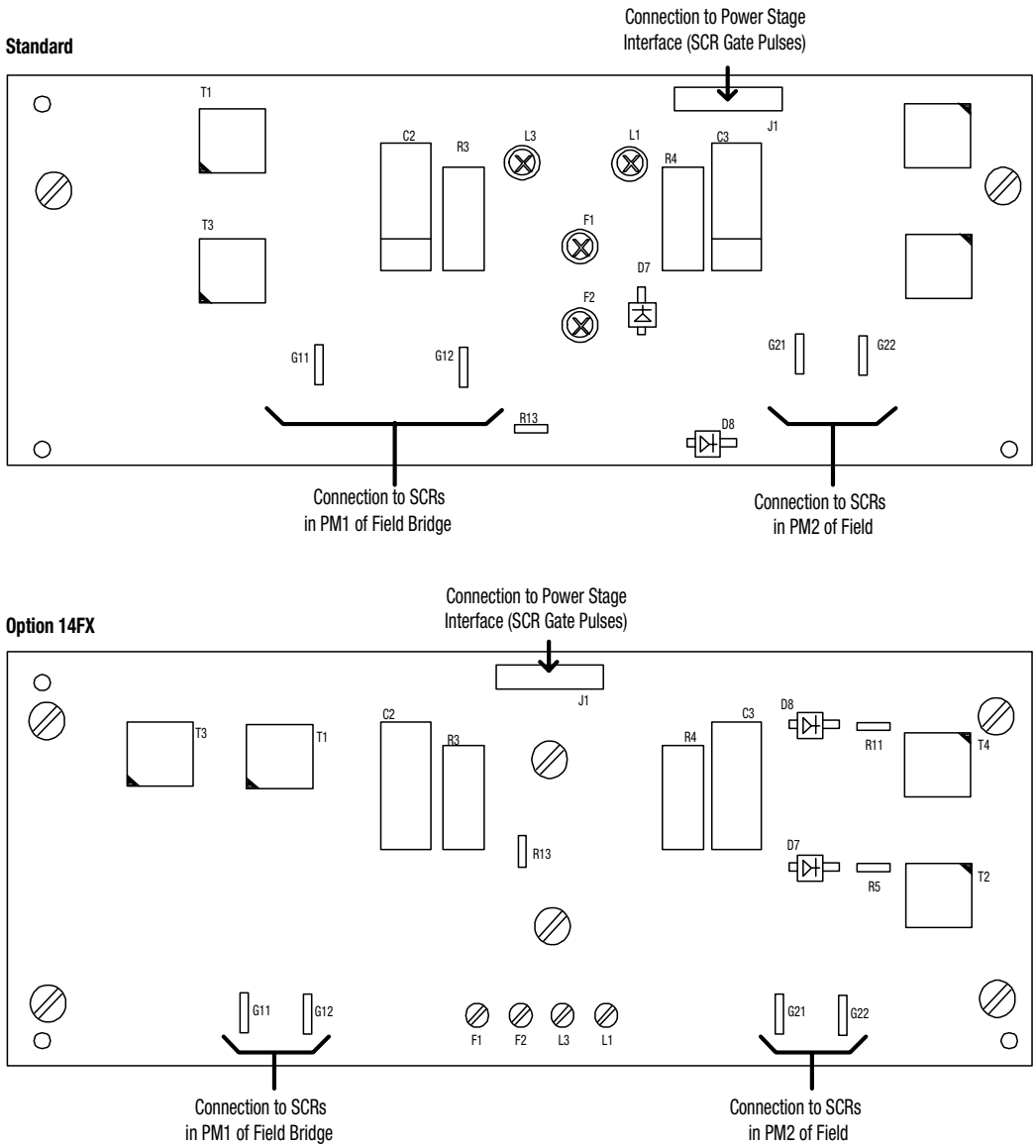
Field Bridge

The field bridge uses four SCRs to convert the single-phase AC power into a DC output. For the SCRs to conduct, they must be forward biased and have a pulse applied to their gates. The SCR gate is enabled by the field-pulse transformer board.

Field-Pulse Transformer Board

The field-pulse tranformer board provides the necessary gate voltage and current to trigger the SCRs on. This board uses a resistor/ capacitor arrangement to protect the SCRs from rapid voltage changes.

Figure 1.13
Field-Pulse Transformer Boards



Input Voltage (V AC)	Nominal Output HP
460	700-750
575	750-900
660	750-1000

Your 1250A DC Drive

Contents

This chapter is designed to help you understand the construction of your 1250A Bulletin 1395 DC drive. The following topics will be covered in this chapter:

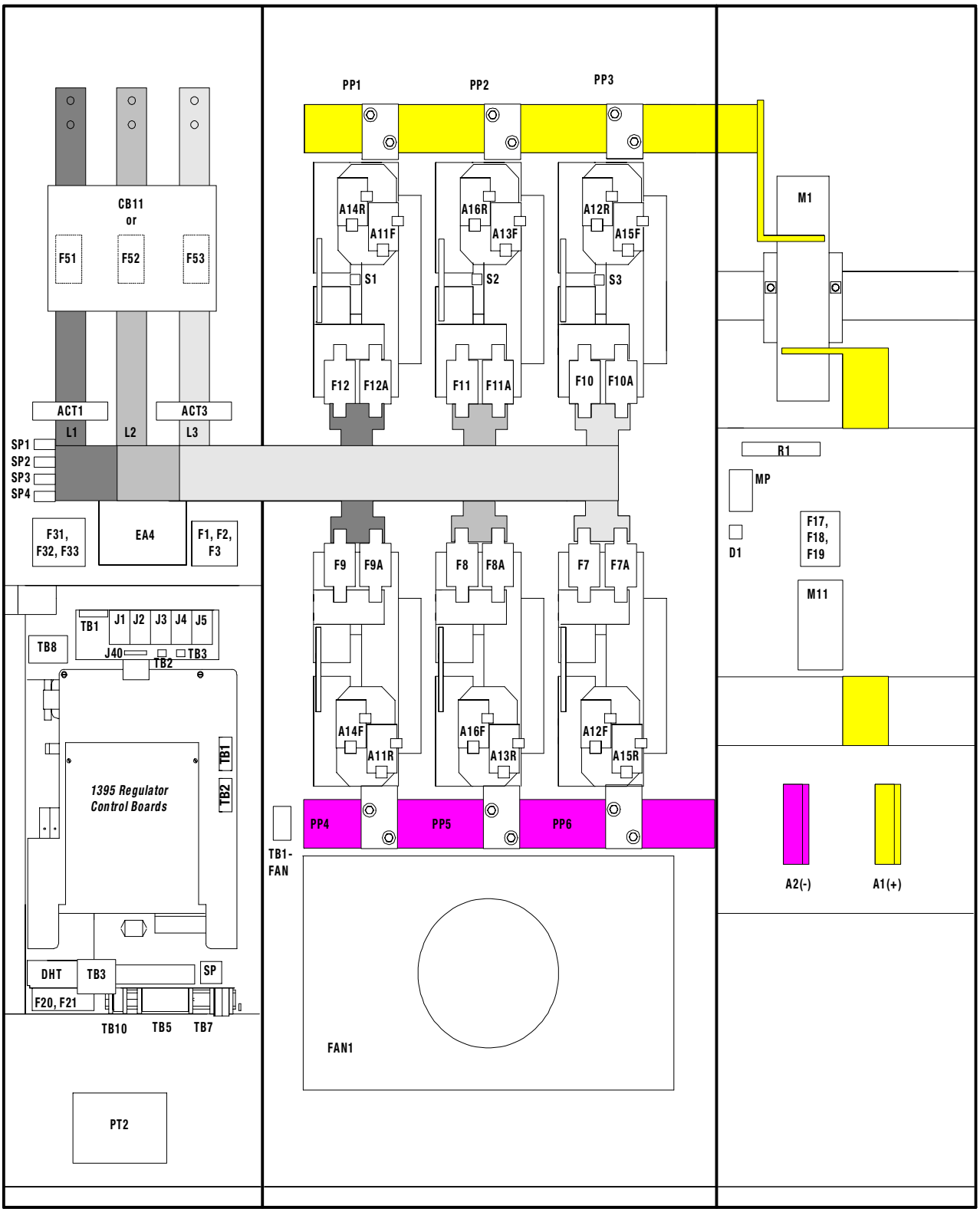
Introduction

Your 1250A DC drive functions with the following features:

- The 1250A drive uses twelve SCRs (regenerative) or six SCRs (non-regenerative) in the armature bridge to convert the 3-phase AC input to a DC output. The SCRs are built into a heatsink assembly and are cooled by the bridge fan.
- The 1250A drive is protected from incoming fault currents with a circuit breaker. The components of your drive (the armature bridge, field bridge, and control components) are protected with fuses, MOVs, snubbers, and/or chokes.
- The 1250A drive is constructed and housed in three bays, the first bay containing the AC input and control hardware, the second bay containing the armature bridge hardware, and the third bay containing the DC output hardware.
- The 1250A drive has an optional top-hat extension available for the AC input bay.
- The 1250A drive can be built with an optional through bus assembly, allowing the 1250A drive and other connected drives to tap off from the same AC input.

Drive Layout

Figure 2.1
1250A DC Drive Layout



Disconnect Bay Bridge Bay Contactor Bay

Drive Schematics

Figure 2.2
1250A DC Drive Electrical Schematic, Sheet 1

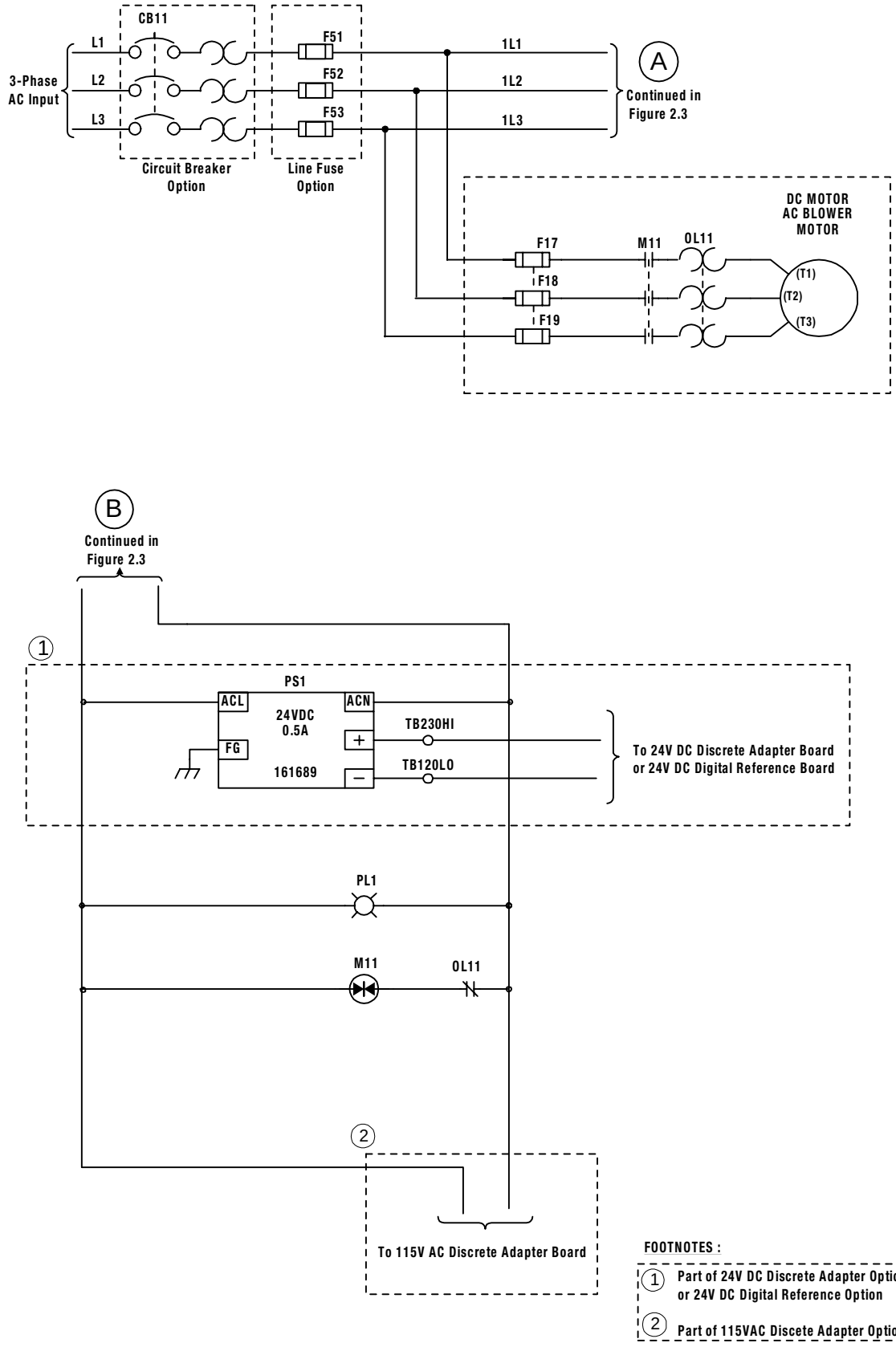
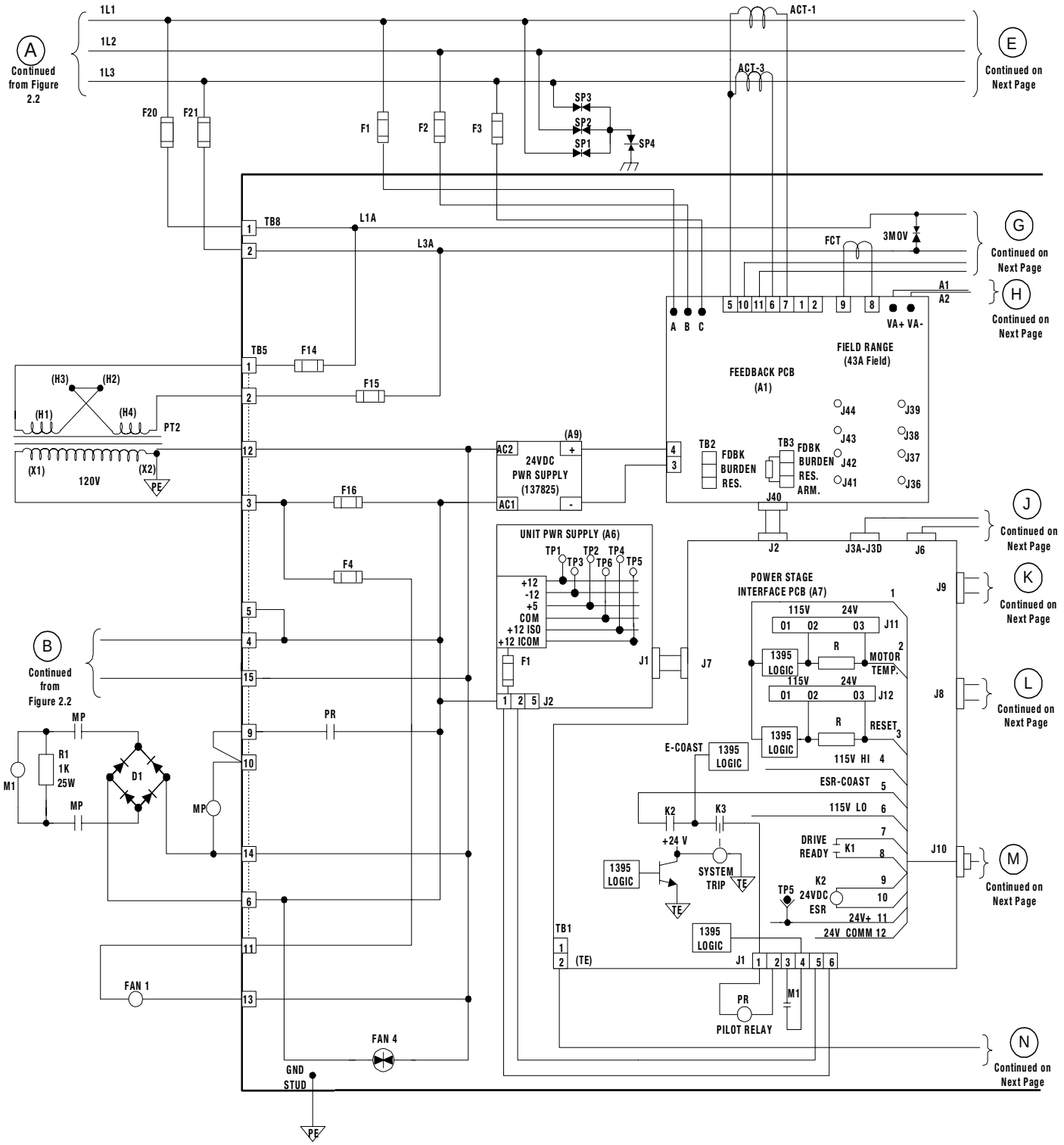
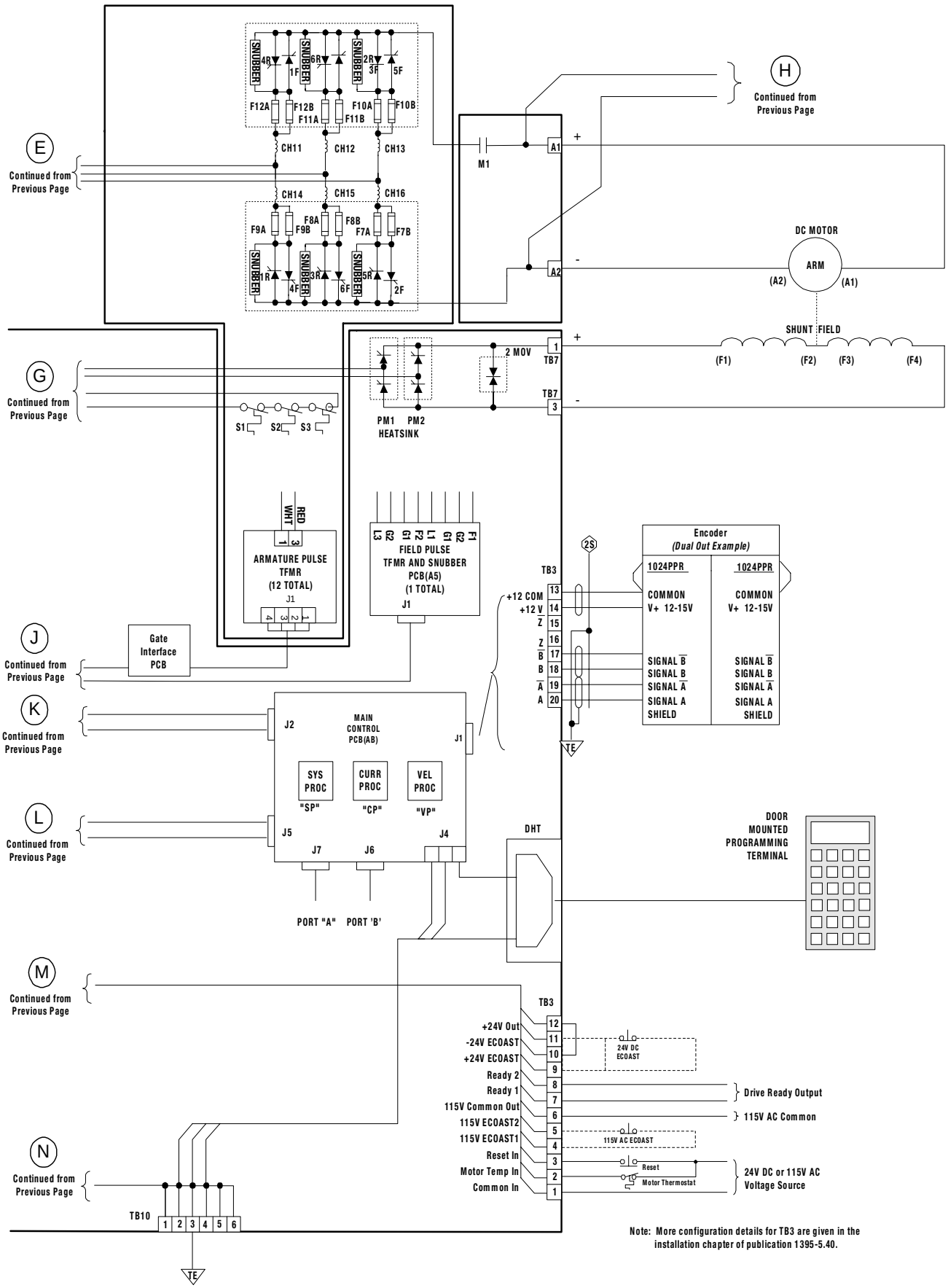


Figure 2.3
1250A DC Drive Schematic, Sheet 2





Note: More configuration details for TB3 are given in the installation chapter of publication 1395-5.40.

Symbol Reference Chart

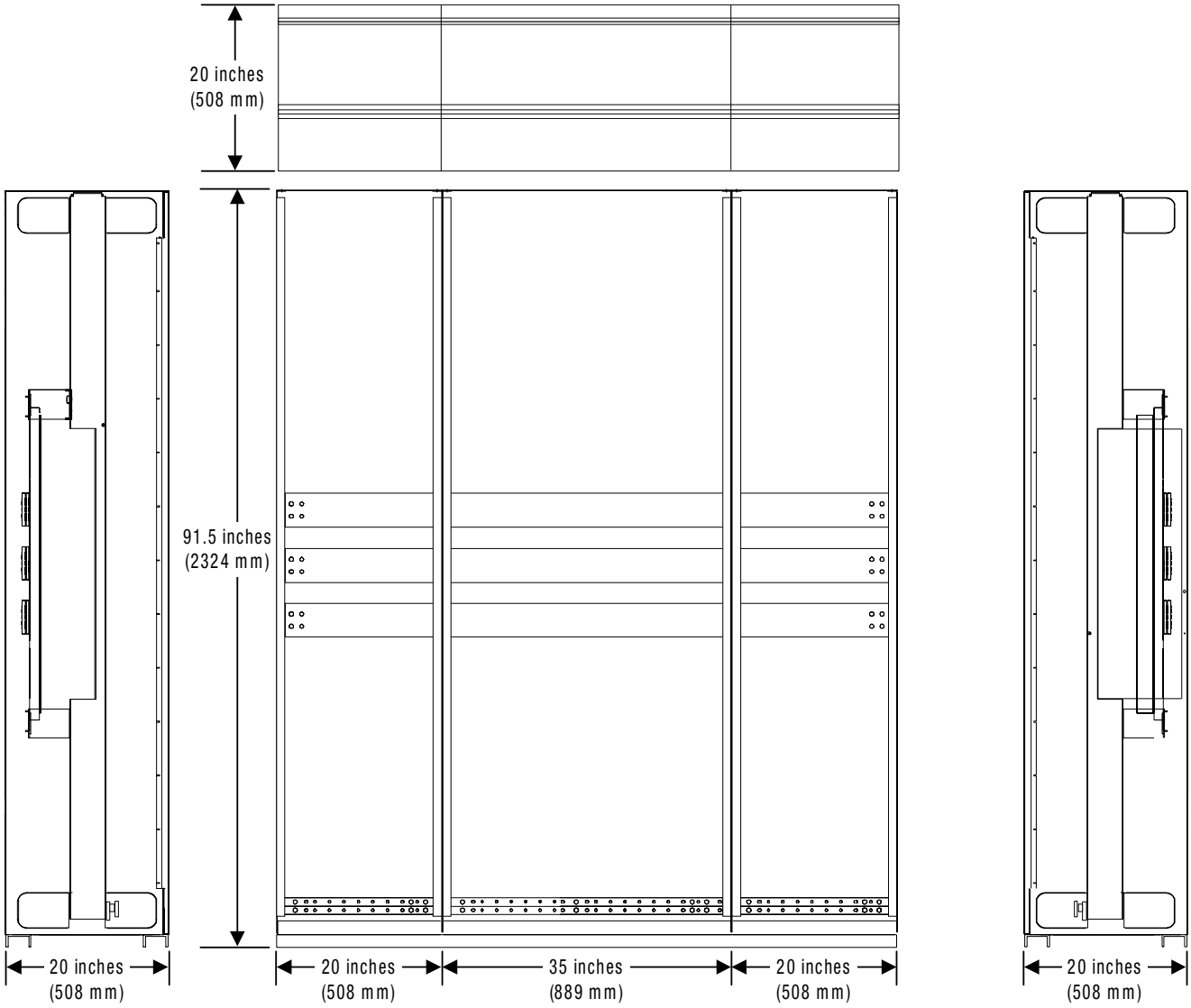
Table 2.A: 1250A DC Drive Symbol-to-Component Reference

Symbol	Description	Option	460V AC	575V AC	660V AC
(A1.RES)	A1 PCB feedback scaling resistor		3.65 ohm, 2 W, 1%		
2 - 3MOV	Field suppressors				
A1	Feedback PCB				
A11F-A16F	Armature pulse transformer PCB				
A11R-A16R	Armature pulse transformer PCB				
A3	Gate interface PCB				
A5	Field pulse transformer PCB				
A6	Unit power supply PCB				
A7	Power stage interface PCB				
A8	Main control PCB				
A9	Feedback PCB power supply				
ACT1, 3	Line current transducer		2000:1		
C1	Armature snubber capacitors		2µF, 2000V		
CB11	Circuit breaker	✓	1200A, N-frame		
CH1	Field choke				
CH11 - 16	Cell chokes		Air-core, 3.5uH, 1017A		
D1	M1 bridge diode				
DHT/DMT	Configuration terminal	✓			
EA2	Tachometer adapter scaling PCB	✓			
EA3	DHT/EHT configuration terminal	✓			
EA4	Line RC suppressor	✓			
EA5	Air flow sensor PCB	✓			
F1 - 3	Control branch / feedback PCB fuses		1A KTK	1A KTK	10A A70P
F14 - 15	PT2 control transformer primary fuses	✓	8A KLDR		
F16	PT2 control transformer secondary fuses		5A KLDR		
F17 - 19	Motor blower fuses		30A 3P (size 1) or 60A 3P (size 2)		
F20 - 21	Field fusing for 460V AC configuration		45A, FRS		
	Field transformer primary fusing for 575V AC configuration with 10kVA transformer		25A, FRS		
	Field transformer primary fusing for 575V AC configuration with 15kVA transformer	✓	30A, FRS		
	Field transformer primary fusing for 575V AC configuration with 20kVA transformer	✓	45A, FRS		
	Field transformer primary fusing for 575V AC configuration with 50kVA transformer	✓	100A, FRS		
	Field transformer primary fusing for 660V AC configuration with 10kVA transformer		25A, 150X		
	Field transformer primary fusing for 660V AC configuration with 15kVA transformer	✓	40A, 150X		
	Field transformer primary fusing for 660V AC configuration with 20kVA transformer	✓	40A, 150X		
	Field transformer primary fusing for 660V AC configuration with 50kVA transformer	✓	100A, 150X		
F31 - 33	Line RC snubber fuses	✓	25A KTK	25A KTK	25A A70P
F4	Terminal block control power fuse		7A KLDR		
F7 - 12, F7A - 12A	Armature bridge fuses		630A, 1250V, 170M		
F51 - 53	AC line fuses	✓	1200A, KRPC		
FAN1-C1	Armature fan capacitor		25µF		
FAN1	Armature bridge fan		2800CFM		
FAN4	Field heatsink fan		145 CFM		
FCT	Field current transducer		1000:1		
J10	DHT/EHT configuration terminal D-shell	✓			

Symbol	Description	Option	460V AC	575V AC	660V AC
M1	DC armature contactor		1800A		
M11	Motor blower starter		27A (size 1) / 45A (size 2)		
MP	Main pilot for pilot relay				
OL11, OL12	Motor blower overload				
PB1	Stop pushbutton	✓	Red EH,1NO/1NC		
PB3	E-stop pushbutton	✓	Red MH P-P, 2NC		
PB4	Jog forward pushbutton	✓	Black FH, 1NO/1NC		
PB5	Jog reverse pushbutton	✓	Black FH, 1NO/1NC		
PBL2	Start / running illuminated pushbutton	✓	Amber, 1NO/1NC		
PBL6	Fault / clear faults illuminated pushbutton	✓	Clear, 1NO/1NC		
PE	Power ground bus				
PL1	Power on pilot light	✓	Red, 115VAC XF-type		
PM1 - 2	Field SCRs		90A, 1200V		
PP1 - 6	Armature power poles				
PR	M1 contactor pilot relay				
PS1	24V DC power supply		24V DC, 0.5A		
PS2	Air flow sensor power supply	✓	24V DC, 0.5A		
PT2	Control transformer	✓	1.5 kVA		
PT5	Field transformer, 18A			10 kVA	
	Field transformer, 28A	✓		15 kVA	
	Field transformer, 40A	✓		20 kVA	
	Field transformer, 70A	✓		50 kVA	
R1	M1, suppressor resistor		1k-ohm, 50 W		
R1 - 2	Armature snubber resistors		40 ohm 240 W		
R11 - 12	Multi-communication channels A & B terminal resistors		150 ohm, 2 W		
RH1	Speed potentiometer	✓	5k-ohm, 2 W		
S1 - 3	Heatsink thermoswitches		165°F		
S5	Air flow sensor	✓	1000FPM		
SCR	SCR		1200A, 1800V		
SCR-R	SCR, (regeneration)		1200A, 1800V		
SP	PR suppressor				
SP1 - 3	Line-to-line MOVs		460J, 320V AC	550J, 385V AC	600J, 420V AC
SP4	Y-to-ground		760J, 680V AC	760J, 680V AC	1050J, 750V AC
SS3	Speed 1 - 2 - 3 selector switch	✓	Std op, 2 NO/ 2 NC		
TAS1	Motor thermoguard				
TB1-FAN	Bridge fan & capacitor terminal block				
TB10	TE shield terminal block				
TB3	Option PCB I/O terminal block				
TB5	Branch power & 115 control terminal block				
TB7	Field DC output terminal block				
TB8	Field AC input terminal block				
TB11	Optional miscellaneous control terminal block				
TE	Zero potential bus				

Drive Structure

Figure 2.4
1250A DC Drive Structure



Conclusion

This chapter covered the components, schematics, and structure of your 1250A DC drive. Unit specifications, derating charts, a power dissipation chart, a circuit breaker illustration, an air baffle diagram, and an input busbar diagram for the 1250A DC drive are all given in Appendix A.

Input Voltage (V AC)	Nominal Output HP
460	800-1000
575	1000-1250
660	1250

Your 1650A DC Drive

Contents

This chapter is designed to help you understand the construction of your 1650A Bulletin 1395 DC drive. The following topics will be covered in this chapter:

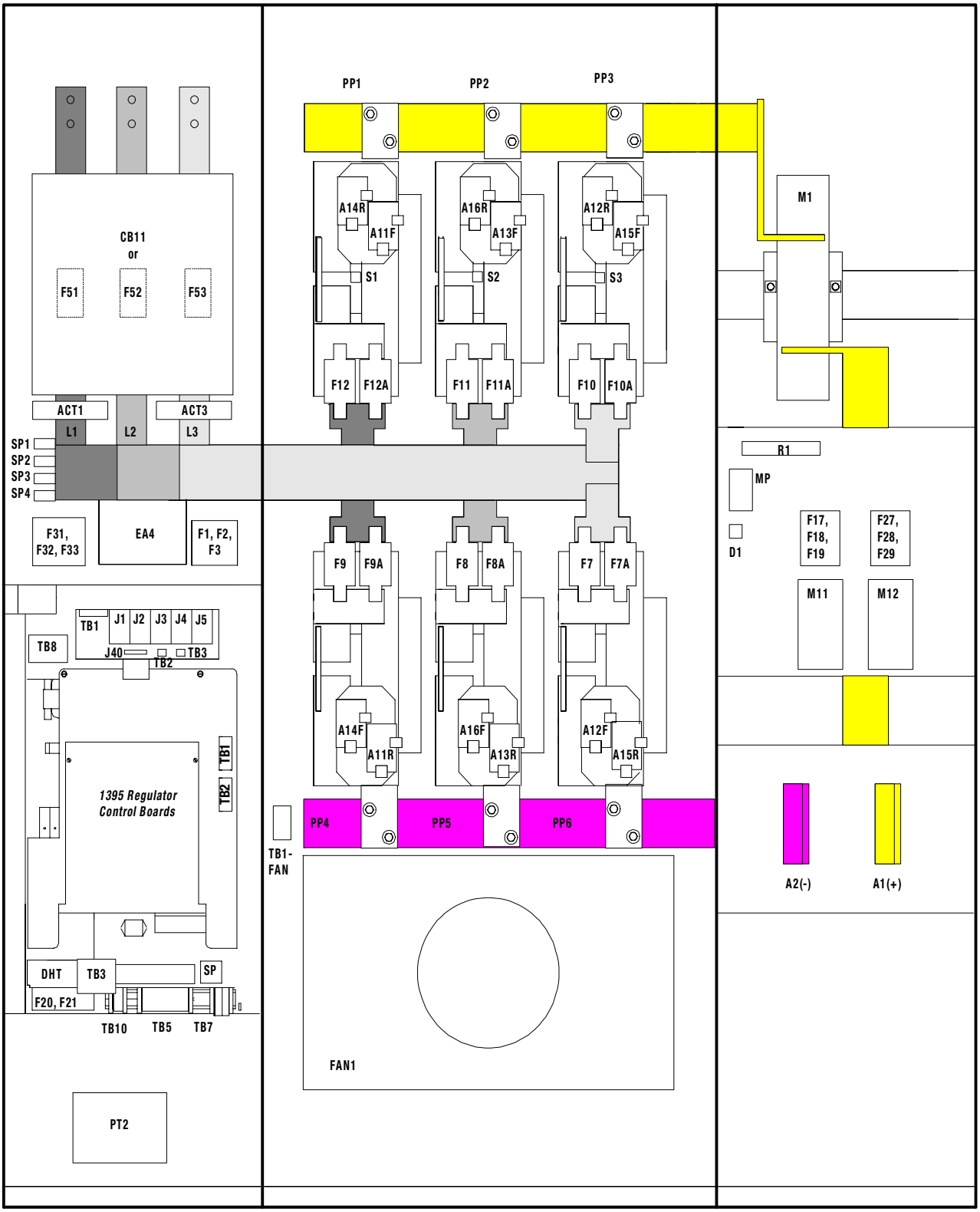
Introduction

Your 1650A DC drive functions with the following features:

- The 1650A drive uses twelve SCRs (regenerative) or six SCRs (non-regenerative) in the armature bridge to convert the 3-phase AC input to a DC output. The SCRs are built into a heatsink assembly and are cooled by the bridge fan.
- The 1650A drive is protected from incoming fault currents with a circuit breaker, and the DC output is protected from fault currents with a DC contactor. The components of your drive (the armature bridge, field bridge, and control components) are guarded with fuses, MOVs, snubbers, and/or chokes.
- The 1650A drive is constructed and housed in three bays, the first bay containing the AC input and control hardware, the second bay containing the armature bridge hardware, and the third bay containing the DC output hardware.
- The 1650A drive has an optional top-hat extension available for the AC input bay.
- The 1650A drive can be built with an optional through bus assembly, allowing the 1650A drive and other connected drives to tap off from the same AC input.

Drive Layout

Figure 3.1
1650A DC Drive Layout



Drive Schematics

Figure 3.2
1650A DC Drive Electrical Schematic, Sheet 1

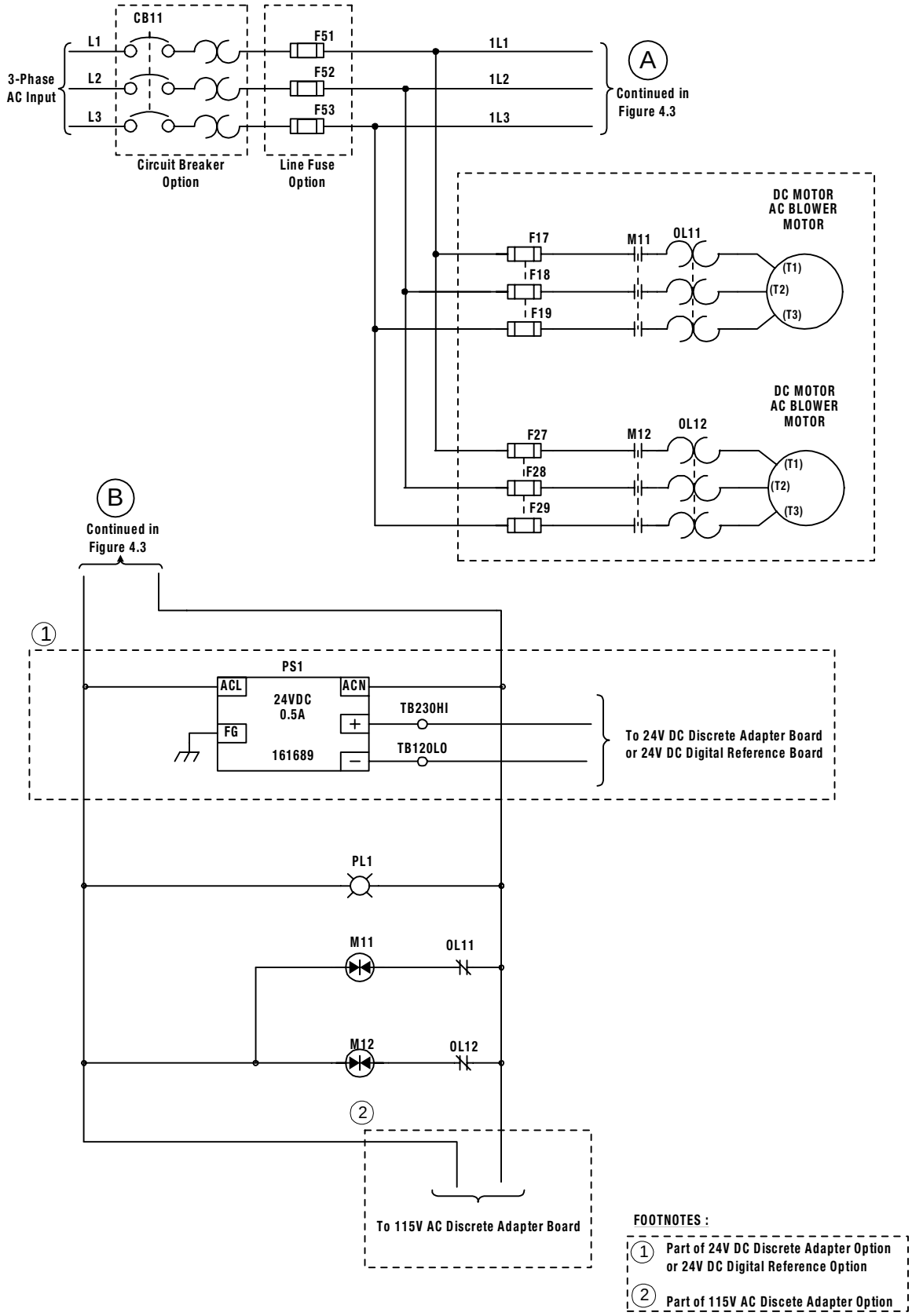
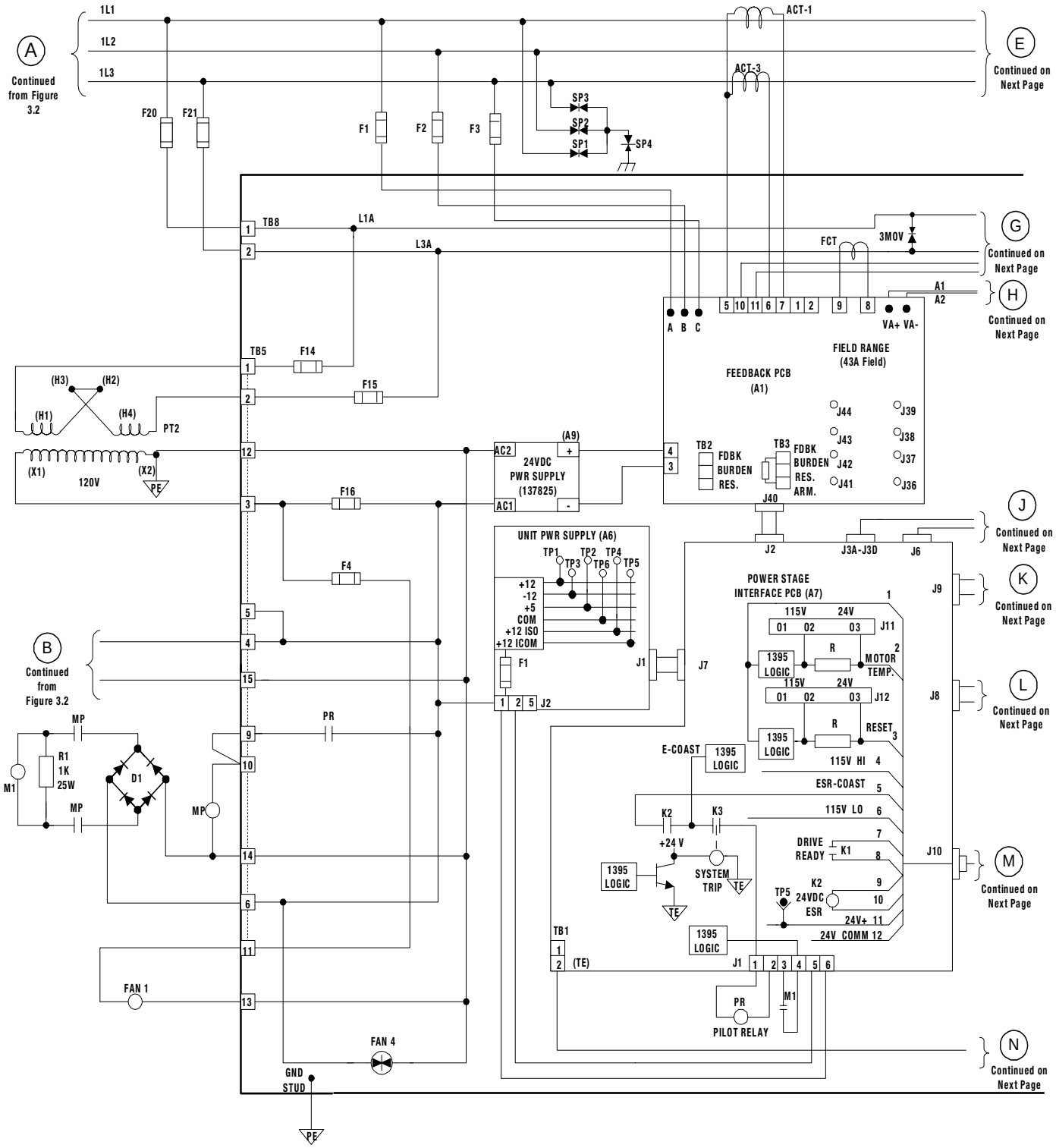
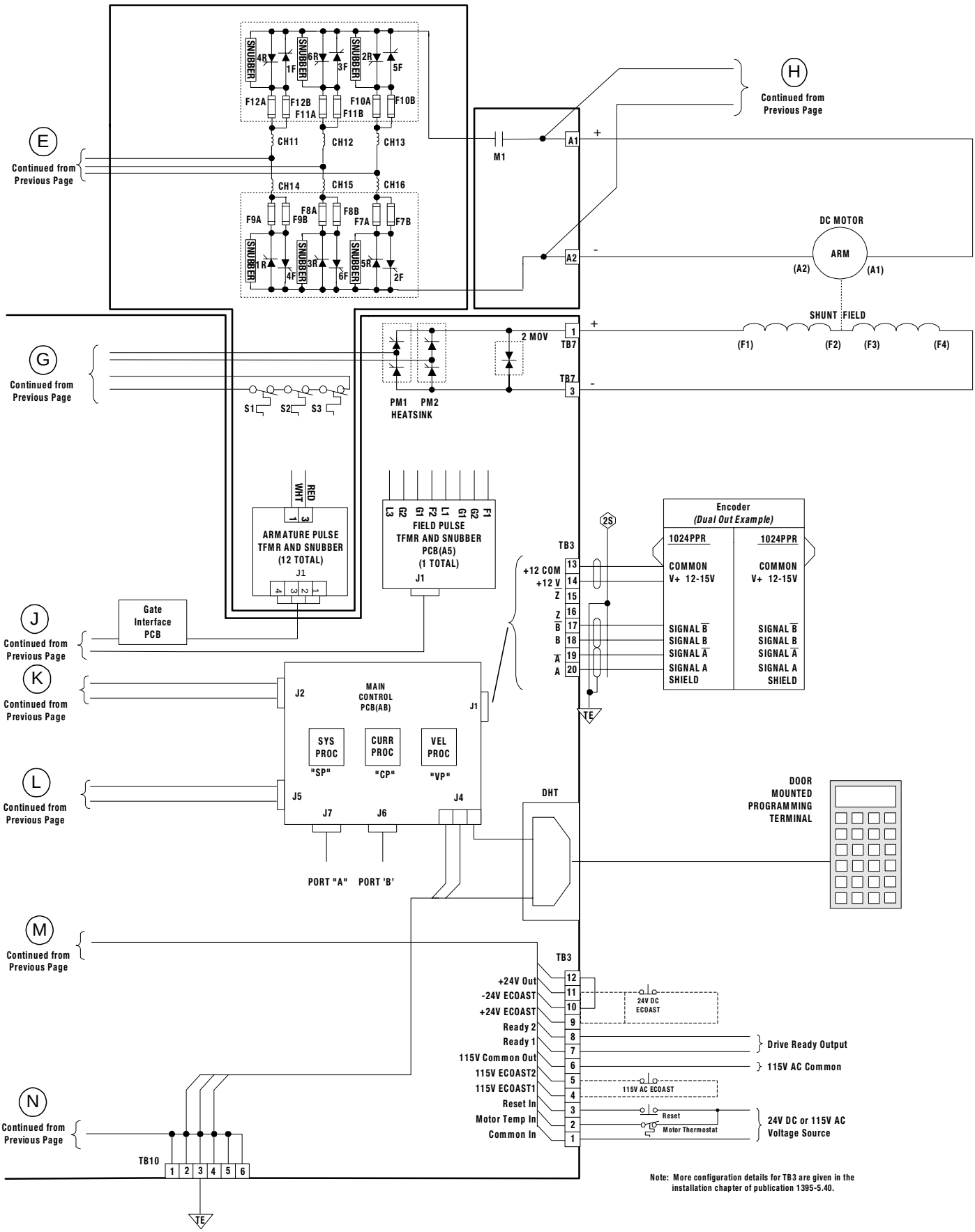


Figure 3.3
1650A DC Drive Schematic, Sheet 2




SNUBBER
4R
1F
6R
3F
2R
5F
F12A
F12B
F11A
F10A
F11B
F10B
CH11
CH12
CH13
CH14
CH15
CH16
F9A
F9B
F8A
F8B
F7A
F7B
1R
4F
3R
6F
5R
2F
E
Continued from Previous Page
M1
A1
A2
+
-
H
Continued from Previous Page
DC MOTOR
ARM
(A2)
(A1)
SHUNT FIELD
(F1)
(F2)
(F3)
(F4)
G
Continued from Previous Page
S1
S2
S3
PM1
PM2
HEATSINK
2 MOV
TB7
1
3
ARMATURE PULSE TFMR AND SNUBBER (12 TOTAL)
RED
WHT
J1
FIELD PULSE TFMR AND SNUBBER PCB(A5) (1 TOTAL)
L3
G2
G1
F2
L1
G1
G2
F1
2S
Encoder
(Dual Out Example)
1024PPR
COMMON
V+ 12-15V
SIGNAL B
SIGNAL A
SHIELD
TB3
+12 COM
+12 V
13
14
15
16
17
18
19
20
TE
J
Continued from Previous Page
Gate Interface PCB
K
Continued from Previous Page
J2
MAIN CONTROL PCB(AB)
J1
SYS PROC
"SP"
CURR PROC
"CP"
VEL PROC
"VP"
L
Continued from Previous Page
J5
J4
J7
J6
PORT "A"
PORT 'B'
DHT
DOOR MOUNTED PROGRAMMING TERMINAL
M
Continued from Previous Page
TB3
+24V Out
-24V ECOAST
+24V ECOAST
Ready 2
Ready 1
115V Common Out
115V ECOAST2
115V ECOAST1
Reset In
Motor Temp In
Common In
12
11
10
9
8
7
6
5
4
3
2
1
24V DC ECOAST
Drive Ready Output
115V AC Common
115V AC ECOAST
Reset
Motor Thermostat
24V DC or 115V AC Voltage Source
N
Continued from Previous Page
TB10
1
2
3
4
5
6
TE
Note: More configuration details for TB3 are given in the installation chapter of publication 1395-5.40.

Symbol Reference Chart

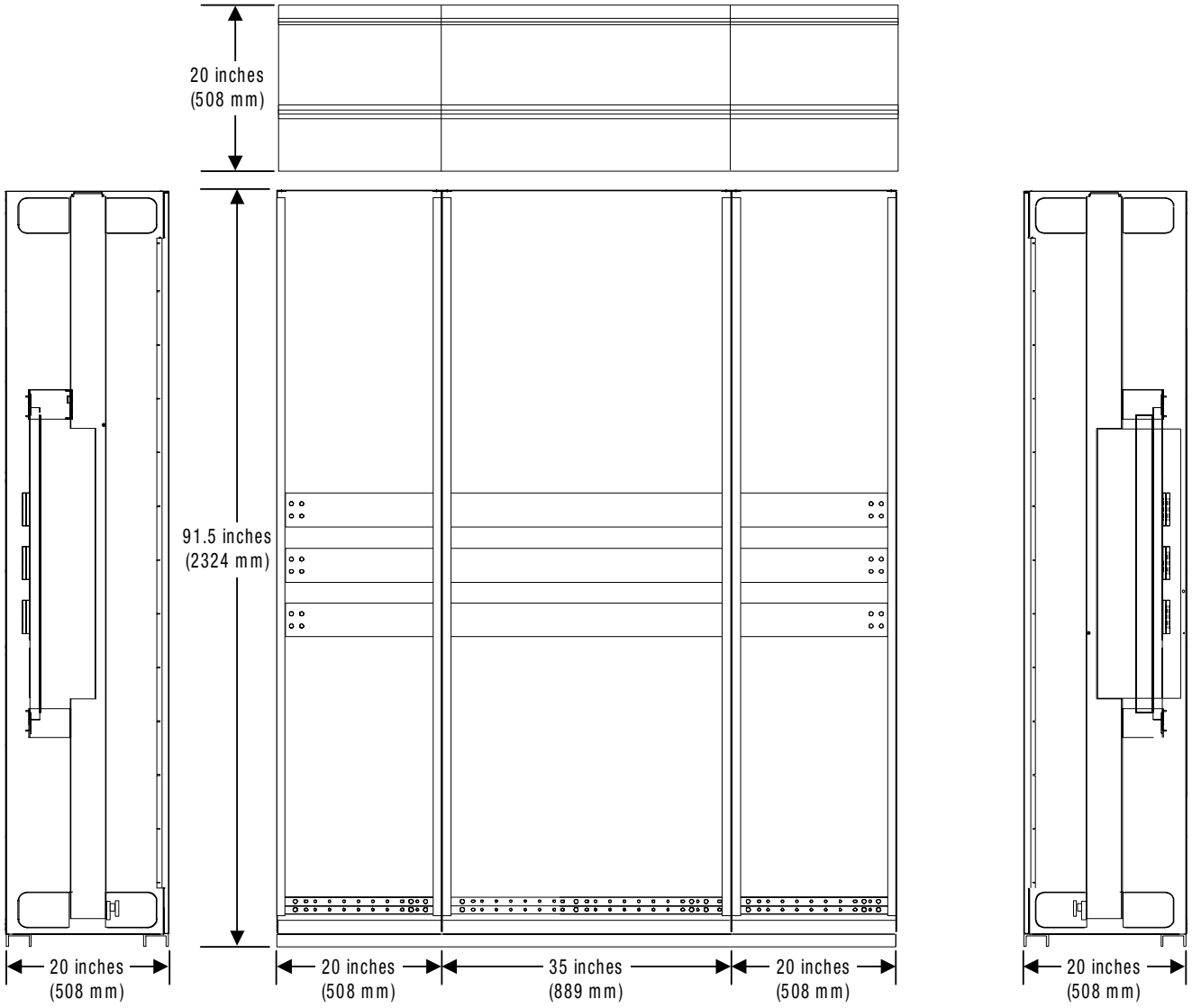
Table 3.A: 1650A DC Drive Symbol-to-Component Reference

Symbol	Description	Option	460V AC	575V AC	660V AC
(A1.RES)	A1 PCB feedback scaling resistor		4.22 ohm, 2 W, 1%		
2 - 3MOV	Field suppressors				
A1	Feedback PCB				
A11F-A16F	Armature pulse transformer PCB				
A11R-A16R	Armature pulse transformer PCB				
A3	Gate interface PCB				
A5	Field pulse transformer PCB				
A6	Unit power supply PCB				
A7	Power stage interface PCB				
A8	Main control PCB				
A9	Feedback PCB power supply				
ACT1 - 3	Line current transducer		3000:1		
C1	Armature snubber capacitors		2µF, 2000V		
CB11	Circuit breaker	✓	1600A, R-frame		
CH1	Field choke				
CH11 - 16	Cell chokes		Air-core, 3.5uH, 1017A		
D1	M1 bridge diode				
DHT/DMT	Configuration terminal	✓			
EA2	Tachometer adapter scaling PCB				
EA3	DHT/EHT configuration terminal	✓			
EA4	Line RC suppressor	✓			
EA5	Air flow sensor PCB	✓			
F1 - 3	Control branch / feedback PCB fuses		1A KTK	1A KTK	10A A70P
F14 - 15	PT2 control transformer primary fuses		8A KLDR		
F16	PT2 control transformer secondary fuses		5A KLDR		
F17 - 19, F27 - 29	Motor blower fuses	✓	30A 3P (size 1) / 60A 3P (size 2)		
F20 - 21	Field fusing for 460V AC configuration		45A, FRS		
	Field transformer primary fusing for 575V AC configuration with 10kVA transformer		25A, FRS		
	Field transformer primary fusing for 575V AC configuration with 15kVA transformer	✓	30A, FRS		
	Field transformer primary fusing for 575V AC configuration with 20kVA transformer	✓	45A, FRS		
	Field transformer primary fusing for 575V AC configuration with 50kVA transformer	✓	100A, FRS		
	Field transformer primary fusing for 660V AC configuration with 10kVA transformer		25A, 150X		
	Field transformer primary fusing for 660V AC configuration with 15kVA transformer	✓	40A, 150X		
	Field transformer primary fusing for 660V AC configuration with 20kVA transformer	✓	40A, 150X		
	Field transformer primary fusing for 660V AC configuration with 50kVA transformer	✓	100A, 150X		
F31 - 33	Line RC snubber fuses	✓	25A KTK	25A KTK	25A A70P
F4	Terminal block control power fuse		7A KLDR		
F7 - 12, F7A - 12A	Bridge fuses		800A, 1250V, 170M		
F51 - 53	AC line fuses	✓	1600, KRPC		
FAN1-C1	Armature fan capacitor		25µF		
FAN1	Armature bridge fans		2800CFM		
FAN4	Field heatsink fan		145 CFM		
FCT	Field current transducer		1000:1		

Symbol	Description	Option	460V AC	575V AC	660V AC
J10	DHT/EHT configuration terminal D-shell	✓			
M1	DC armature contactor		3000A		
M11, M12	Motor blower starter	✓	27A (size 1) / 45A (size 2)		
MP	Main pilot for pilot relay				
OL11, OL12	Motor blower overload	✓			
PB1	Stop pushbutton	✓	Red EH,1NO/1NC		
PB3	E-stop pushbutton	✓	Red MH P-P, 2NC		
PB4	Jog forward pushbutton	✓	Black FH, 1NO/1NC		
PB5	Jog reverse pushbutton	✓	Black FH, 1NO/1NC		
PBL2	Start / running illuminated pushbutton	✓	Amber, 1NO/1NC		
PBL6	Fault / clear faults illuminated pushbutton	✓	Clear, 1NO/1NC		
PE	Power ground bus				
PL1	Power on pilot light	✓	Red, 115VAC XF-type		
PM1 - 2	Field SCRs		90A, 1200V		
PP1 - 6	Armature power poles				
PR	M1 contactor pilot relay				
PS1	24V DC power supply		24V DC, 0.5A		
PS2	Air flow sensor power supply	✓	24V DC, 0.5A		
PT2	Control transformer	✓	1.5 kVA		
PT5	Field transformer, 18A			10 kVA	
	Field transformer, 28A	✓		15 kVA	
	Field transformer, 40A	✓		20 kVA	
	Field transformer, 70A	✓		50 kVA	
R1	M1, suppressor resistor		1k-ohm, 50 W		
R1 - 2	Armature snubber resistors		40 ohm 240 W		
R11 - 12	Multi-communication channels A & B terminal resistors		150 ohm, 2 W		
RH1	Speed potentiometer	✓	5k-ohm, 2W		
S1 - 3	Heatsink thermoswitches		170°F		
S5	Air flow sensor	✓	1000FPM		
SCR	SCR		1800A, 1800V		
SCR-R	SCR, (regeneration)		1800A, 1800V		
SP	PR suppressor				
SP1 - 3	Line-to-line MOVs		460J, 320V AC	550J, 385V AC	600J, 420V AC
SP4	Y-to-ground		760J, 680V AC	760J, 680V AC	1050J, 750V AC
SS3	Speed 1 - 2 - 3 selector switch	✓	Std op, 2 NO/2 NC		
TAS1	Motor thermoguard				
TB1-FAN	Bridge fan & capacitor terminal block				
TB10	TE shield terminal block				
TB3	Option PCB I/O terminal block				
TB5	Branch power & 115 control terminal block				
TB7	Field DC output terminal block				
TB8	Field AC input terminal block				
TB11	Optional miscellaneous control terminal block				
TE	Zero potential bus				

Drive Structure

Figure 3.4
1650A DC Drive Structure



Conclusion

This chapter covered the components, schematics, and structure of your 1650A DC drive. Unit specifications, derating charts, a power dissipation chart, a circuit breaker illustration, an air baffle diagram, and an input busbar diagram for the 1650A DC drive are all given in Appendix A.

Input Voltage (V AC)	Nominal Output HP
460	1250-1750
575	1500-2250
660	1500-2500

Your 3000A DC Drive

Contents

This chapter is designed to help you understand the construction of your 3000A Bulletin 1395 DC drive. The following topics will be covered in this chapter:

Introduction

Your 3000A DC drive functions with the following features:

- The 3000A drive uses twelve SCRs in the armature bridge to convert the 3-phase AC input to a DC output, six for the positive DC output and six for the negative. The SCRs are built into a heatpipe assembly and are cooled by the bridge fan.
- The 3000A drive is protected from incoming fault currents with a circuit breaker, and the DC output is protected from fault currents with a DC contactor. The components of your drive (the armature bridge, field bridge, and control components) are protected with fuses, MOVs, snubbers, and/or chokes.
- The 3000A drive is constructed and housed in four bays, the first bay containing the AC input and control hardware, the second bay containing the fuses, the third bay containing the armature bridge hardware, and the fourth bay containing the DC output hardware.
- The 3000A drive has a standard top-hat extension over the disconnect bay for the AC input.

Drive Layout

Figure 4.1
3000A DC Drive Layout

Drive Schematics

Figure 4.2
3000A DC Drive Electrical Schematic, Sheet 1

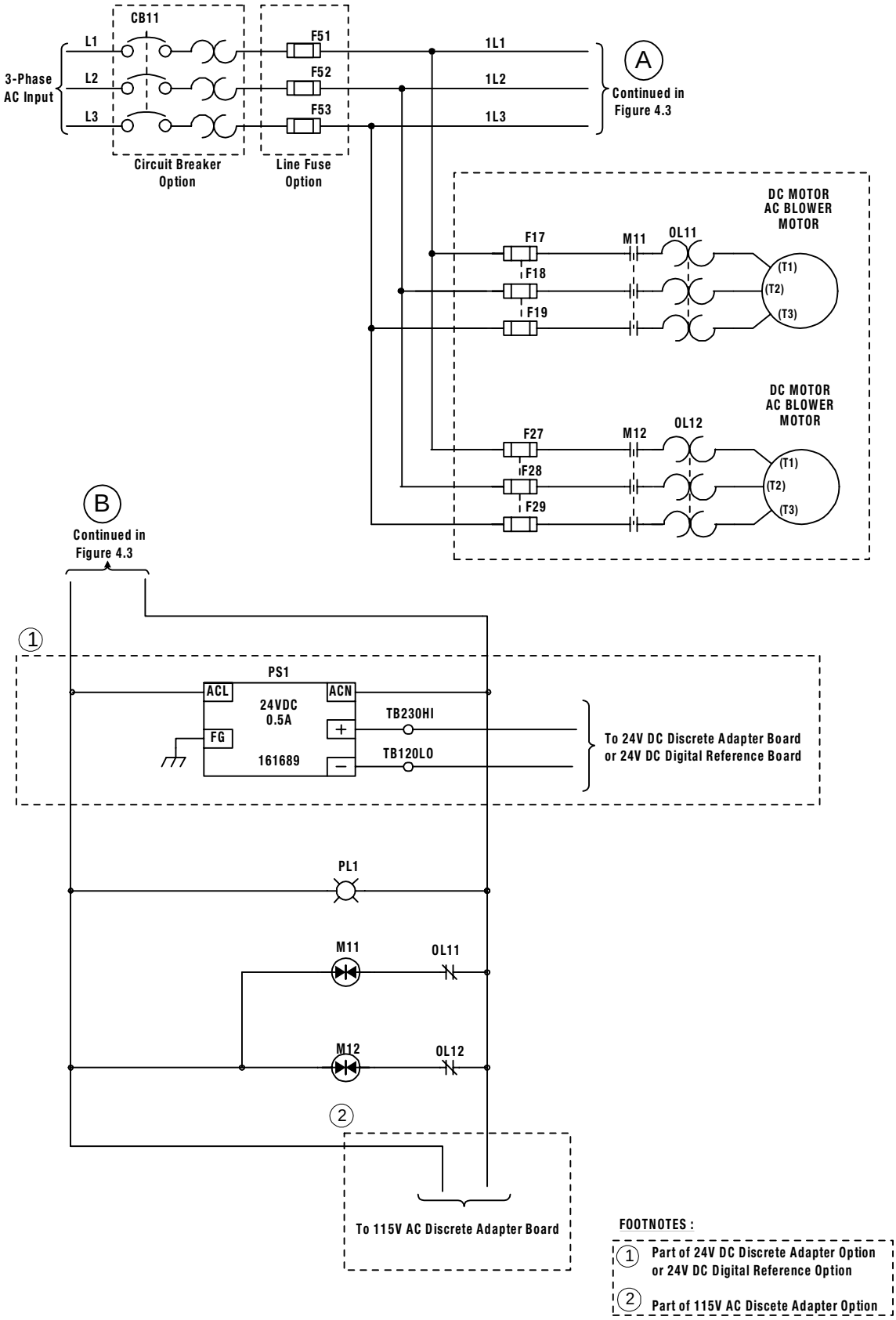
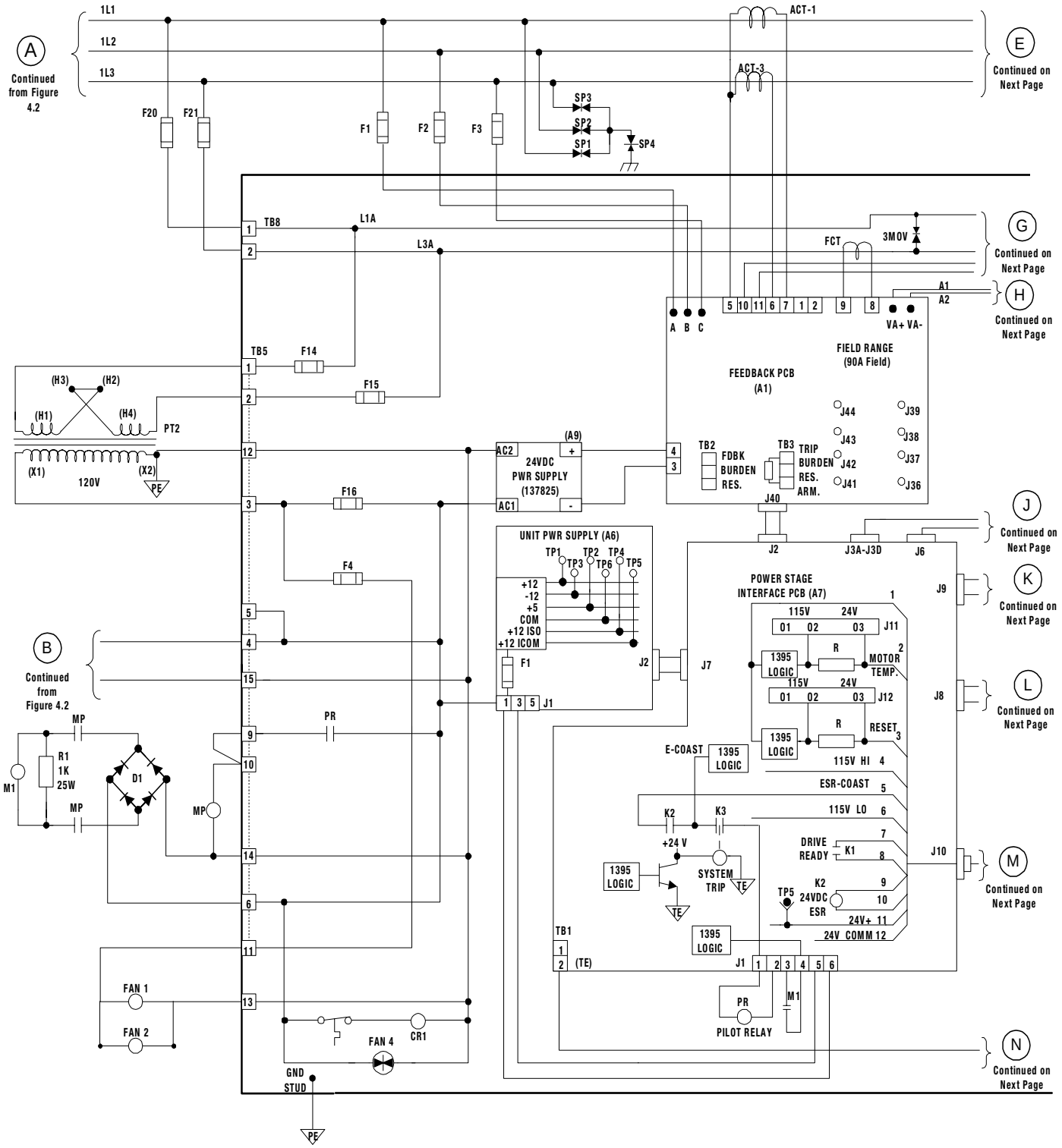
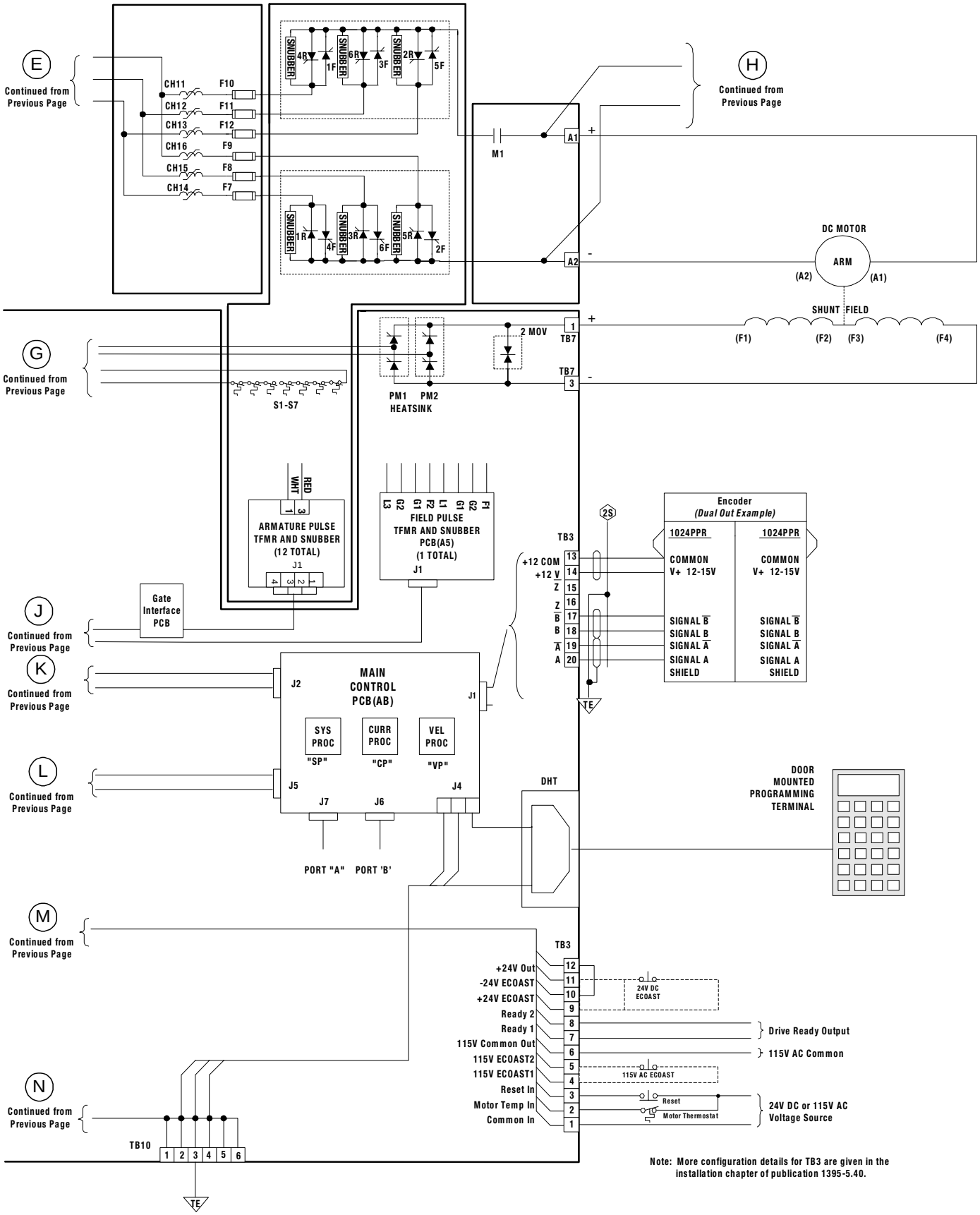


Figure 4.3
3000A DC Drive Schematic, Sheet 2





Note: More configuration details for TB3 are given in the installation chapter of publication 1395-5.40.

Symbol Reference Chart

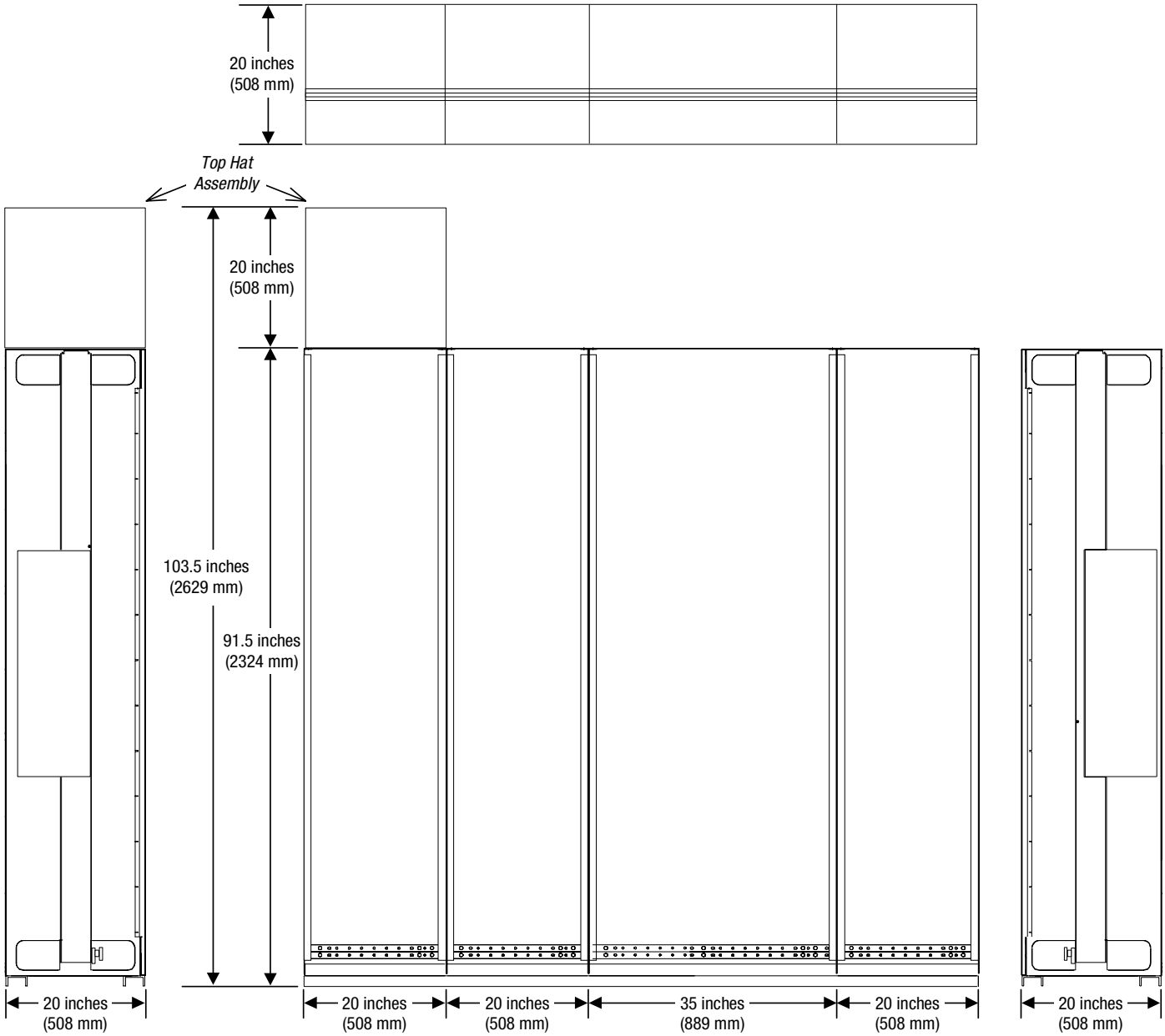
Table 4.A: 3000A DC Drive Symbol-to-Component Reference

Symbol	Description	Option	460V AC	575V AC	660V AC
(A1.RES)	A1 PCB feedback scaling resistor		3.83 ohm, 2 W, 1%		
2 - 3MOV	Field suppressors				
A1	Feedback PCB				
A11F-A16F	Armature pulse transformer PCB				
A11R-A16R	Armature pulse transformer PCB				
A3	Gate interface PCB				
A5	Field pulse transformer PCB				
A6	Unit power supply PCB				
A7	Power stage interface PCB				
A8	Main control PCB				
A9	Feedback PCB power supply				
ACT1 - 3	Line current transducer		5000:1		
AS5 - 6	Air flow sensor	✓	500FPM		
C1	Armature snubber capacitors		4µF, 2000V		
CB11	Circuit breaker	✓	3000A, SPB-frame		
CH1	Field choke				
CH11 - 16	Cell chokes		Solid-core, 3800 nH		
CR1	Field control				
D1	M1 bridge diode				
DHT/DMT	Configuration terminal	✓			
EA2	Tachometer adapter scaling PCB				
EA3	DHT/EHT configuration terminal	✓			
EA4	Line RC suppressor	✓			
EA5	Air flow sensor PCB	✓			
F1 - 3	Control branch / feedback PCB fuses		1A KTK	1A KTK	10A A70P
F4	Terminal block control power fuse		9A KLDR		
F7 - 12, F7A - 12A	Bridge cell fuses		900A, 1250V, 170M		
F14 - 15	PT2 control transformer primary fuses		10A KLDR		
F16	PT2 control transformer secondary fuses		5A KLDR		
F17 - 19, F27 - 29	Motor blower fuses	✓	30A (size 1) / 60A (size 2)		
F20 - 21	Field fusing for 460V AC configuration		45A, FRS		
	Field transformer primary fusing for 575V AC configuration with 10kVA transformer		25A, FRS		
	Field transformer primary fusing for 575V AC configuration with 15kVA transformer	✓	30A, FRS		
	Field transformer primary fusing for 575V AC configuration with 20kVA transformer	✓	45A, FRS		
	Field transformer primary fusing for 575V AC configuration with 50kVA transformer	✓	100A, FRS		
	Field transformer primary fusing for 660V AC configuration with 10kVA transformer		25A, 150X		
	Field transformer primary fusing for 660V AC configuration with 15kVA transformer	✓	40A, 150X		
	Field transformer primary fusing for 660V AC configuration with 20kVA transformer	✓	40A, 150X		
	Field transformer primary fusing for 660V AC configuration with 50kVA transformer	✓	100A, 150X		
F31 - 33	Line RC snubber fuses	✓	25A KTK	25A KTK	25A A70P
F51 - 53	AC line fuses	✓	3000A, KRPC		
FAN1-C1	Armature fan capacitor		40µF		
FAN1	Armature bridge fan		1850 CFM		
FAN2	Slide-fan fan		1589 CFM		

Symbol	Description	Option	460V AC	575V AC	660V AC
FAN4	Field heatsink fan		145 CFM		
FCT	Field current transducer		1000:1		
J10	DHT/EHT configuration terminal D-shell	✓			
M1	DC armature contactor		3000A		
M11, M12	Motor blower starter		27A (size 1) / 45A (size 2)		
MP	Main pilot for pilot relay				
OL11, OL12	Motor blower overload				
PB1	Stop pushbutton	✓	Red EH,1NO/1NC		
PB3	E-stop pushbutton	✓	Red MH P-P, 2NC		
PB4	Jog forward pushbutton	✓	Black FH, 1NO/1NC		
PB5	Jog reverse pushbutton	✓	Black FH, 1NO/1NC		
PBL2	Start / running illuminated pushbutton	✓	Amber, 1NO/1NC		
PBL6	Fault / clear faults illuminated pushbutton	✓	Clear, 1NO/1NC		
PE	Power ground bus				
PL1	Power on pilot light	✓	Red, 115VAC XF-type		
PM1 - 2	Field SCRs		90A, 1200V		
PP1 - 6	Armature power poles				
PR	M1 contactor pilot relay				
PS1	24V DC power supply		24V DC, 0.5A		
PS2	Air flow sensor power supply	✓	24V DC, 1.1A		
PT2	Control transformer	✓	2 kVA		
PT5	Field transformer, 18A			10 kVA	
	Field transformer, 28A	✓		15 kVA	
	Field transformer, 40A	✓		20 kVA	
	Field transformer, 90A	✓		50 kVA	
R1	M1, suppressor resistor		1k-ohm, 50 W		
R1 - 4	Armature snubber resistors		40 ohm 240 W		
R11 - 12	Multi-communication channels A & B terminal resistors		150 ohm, 2 W		
RH1	Speed potentiometer	✓	5k-ohm, 2 W		
S1 - 6	Heatsink thermoswitches		165°F		
S7	Disconnect bay thermoswitch		210°F		
SCR	SCR		2785A, 1800V		
SCR-R	SCR, (regeneration)		2785A, 1800V		
SP	PR suppressor				
SP1 - 3	Line-to-line MOVs		460J, 320V AC	550J, 385V AC	600J, 420V AC
SP4	Y-to-ground		760J, 680V AC	760J, 680V AC	1050J, 750V AC
SS3	Speed 1 - 2 - 3 selector switch	✓	Std op, 2 NO/2 NC		
TAS1	Motor thermoguard				
TB1-FAN	Bridge fan & capacitor terminal block				
TB10	TE shield terminal block				
TB3	Option PCB I/O terminal block				
TB5	Branch power & 115 control terminal block				
TB7	Field DC output terminal block				
TB8	Field AC input terminal block				
TB11	Optional miscellaneous control terminal block				
TE	Zero potential bus				

Drive Structure

Figure 4.4
3000A DC Drive Structure



Conclusion

This chapter covered the components, schematics, and structure of your 3000A DC drive. Unit specifications, derating charts, a power dissipation chart, a circuit breaker illustration, an air baffle diagram, and an input busbar diagram for the 3000A DC drive are all given in Appendix A.

Installing Your Drive

Contents

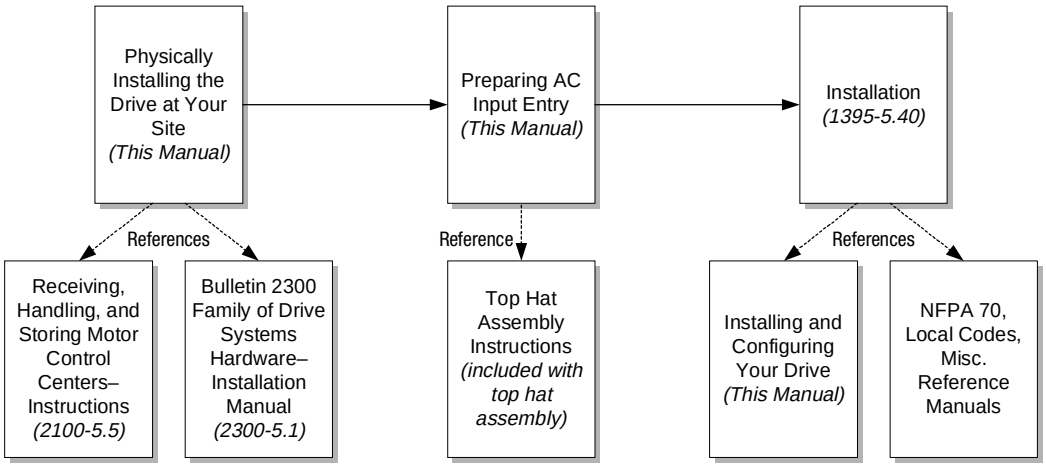
This chapter will guide you in the installation of your new drive. The following topics will be covered:

Resources

To properly install and configure your drive, you will need the following publications:

Publication	Title
2300-5.1	*Bulletin 2300 Family of Drive Systems Hardware–Installation Manual*
2100-5.5	*Receiving, Handling, and Storing Motor Control Centers–Instructions*
1395-5.40	*1395 Digital DC Drive–User Manual*

Plus, you may need to refer to your system schematics, motor/encoder documentation, and other documentation listed in the preface of this manual (for adapter boards and NEC standards).



ATTENTION: Electric shock or equipment damage may occur if the drive is not installed properly. Comply to the provisions listed in the National Electric Code (NEC) and in your local codes to safely install your drive.

Physically Installing the Drive at Your Site

To move and position the unit at your site, you will need to follow the instructions given in Publication 2100-5.5, titled *Receiving, Handling, And Storing Motor Control Centers–Instructions*. This publication will instruct you in the proper handling, moving, and positioning of your new drive.

After the drive is properly positioned, follow the instructions given in Publication 2300-5.1, titled *Bulletin 2300 Family of Drive Systems Hardware–Installation Manual*. This publication will teach you how to splice busbars, how to attach your unit in a multiple drive configuration, and how to join MCC sections together (if necessary).

Inspecting the Air Baffles

Inspect the air baffles and guards according to the air baffle layouts shown in Appendix A.

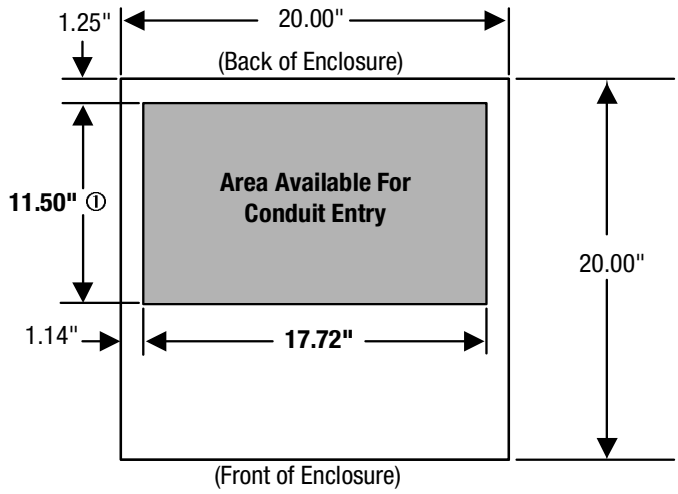
Preparing AC Input Entry

If your drive has an extra input bay installed, you can skip this section.

To prepare input entry, select the ideal hole placement (within the constraints of the following diagram), then follow the installation steps given. The following instructions include directions for a top hat assembly.

> ***Note:*** *When preparing the input entry, you may need to consider the busbar arrangement and the wire sizes. Busbar diagrams are shown in Appendix A, and recommended wire sizes are listed later in this chapter.*

Figure 5.1
Area Available For Conduit Entry (Top View of Disconnect Bay)



① 3000A units allow a depth of **16.75"** for conduit entry.

1. Remove the lifting angle, if it is still attached.
2. Remove the top plate from the disconnect bay. If the drive has a top hat assembly, this plate will not be needed.
3. If the drive has a top hat assembly, mount the assembly to the drive (according to the assembly instructions), and remove the assembly's top plate.

ATTENTION: The top plate must be removed from the drive before any cutting, drilling, tapping, or welding can be done. Failure to do so could result in damage to sensitive components.

4. Punch holes for the AC input into the top plate within the area shown in Figure 5.1. Clean the punched area to ensure that metal shavings will not fall into the drive.
5. Secure the top plate to the drive (or top hat assembly), and replace the lifting angle.

Installing and Configuring Your Drive

Follow the installation instructions given in publication **1395-5.40** to set up your unit, referring to this chapter for information specifically for the 1250, 1650, and 3000A DC drives.

Drive Disconnect

A 3-phase circuit breaker or AC line fuses are included with each drive. For circuit breaker settings and derating, refer to Appendix A.

Wiring Recommendations

The following tables show recommended wiring for the 1250, 1650, and 3000A DC drives, according to NFPA 70, 75ºC wiring. Refer to local codes for wire sizes.

Table 5.A: Typical Wire Selections (AC Input)

DC Bus Current (A DC)	Incoming Wires (For Each Phase or Connection, AWG)
1250	4-500 kcmil
1650	5-500 kcmil
3000	8-500 kcmil

Table 5.B: Typical Wire Selections (Armature Connection)

DC Bus Current (A DC)	Output Wires (AWG)
1250	5-500 kcmil
1650	6-500 kcmil
3000	10-500 kcmil

Table 5.C: Typical Wire Selections (Field Connection)

DC Bus Current (A DC)	Output Lines (43A Field, AWG)	Output Lines (90A Field, AWG)
1250	8	4
1650	8	4
3000	8	4

Drive Grounding

The internal drive components should already be connected to the ground (PE) and zero potential (TE) buses. Connect any additional items to PE and TE (motor, encoder, etc.) as necessary, and connect the PE and TE buses to ground as explained in publication 1395-5.40.

Power Wiring

Table 5.D: Standard Field Voltage Output

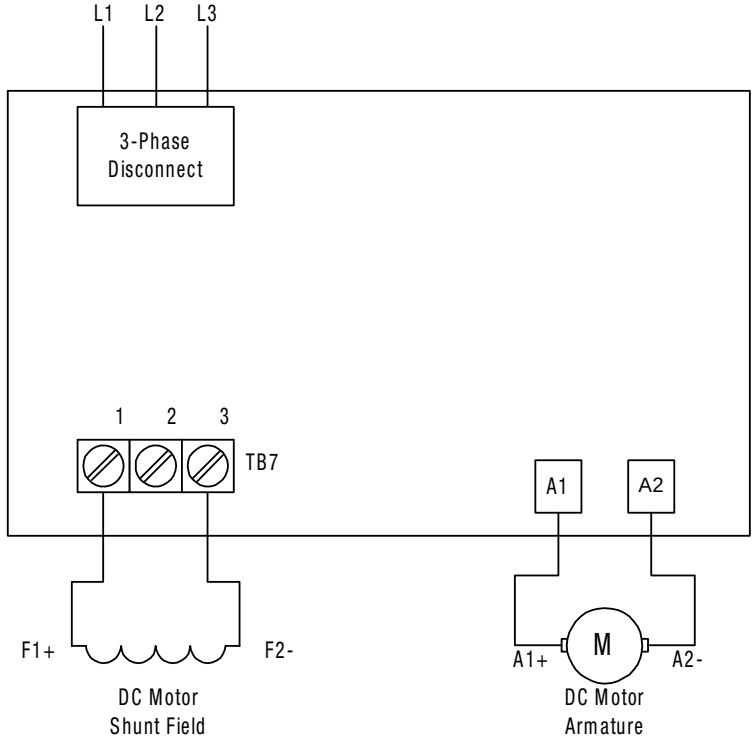
AC Incoming Voltage To Drive (V AC)	DC Supply Output Voltage To Field (V DC)
460	300
575	300
660	300

Table 5.E: Motor Connections for CCW Rotation

Connection	Drive	Drive Terminal Connection	Motor Lead
Motor Field	1250, 1650, 3000A	TB7-1 TB7-3	F1 (+) F2 (-)
Motor Armature	1250, 1650, 3000A	A1 A2	A1 (+) A2 (-)

ATTENTION: The motor field supply is phase sensitive. To guard against possible drive or motor damage, ensure that the connections comply to Figure 5.2.

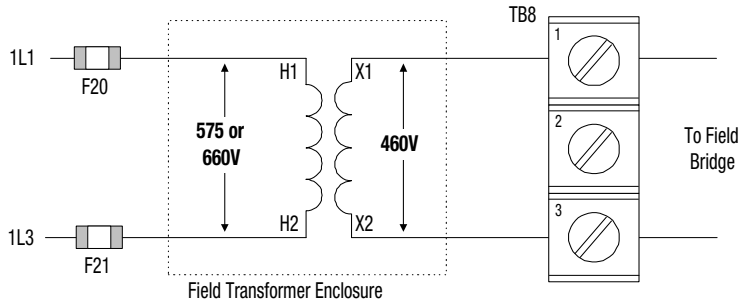
Figure 5.2
Power Connections–Standard Field Voltage



Field Transformer

For high-horsepower units with a 575 or 660V AC input, the field supply requires a transformer to step down the voltage to 460V. Figure 5.3 shows the typical transformer wiring scheme.

Figure 5.3
Field Transformer



Typical Transformer Arrangement
(used for 575V AC inputs or greater)

The following table shows the transformer sizes available, typical wire sizes used, and the corresponding field currents. Refer to local codes for all wiring.

Table 5.F: Field Transformers

Transformer Size (kVA)	Typical Wire Selections (AWG)	Maximum Field Current (A)
10	12	18
15	10	28
20	8	40
50	3	90

Installing the Field Transformer

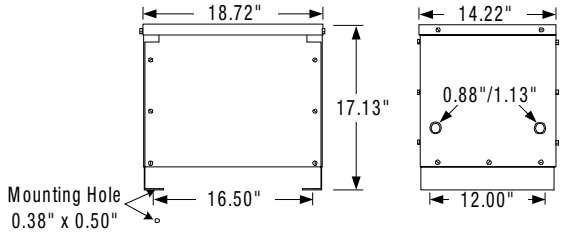
1. Mount the transformer enclosure and remove any input/output knockouts, as necessary (see Figure 5.4 for enclosure details).
2. Ground the enclosure according to local codes.
3. Remove the top plate from the enclosure.
4. Connect the first and third phases to the transformer primary (F20 to H1, F21 to H2).

ATTENTION: The motor field supply is phase sensitive. To guard against possible drive or motor damage, ensure that the connections are made according to Figure 5.3.

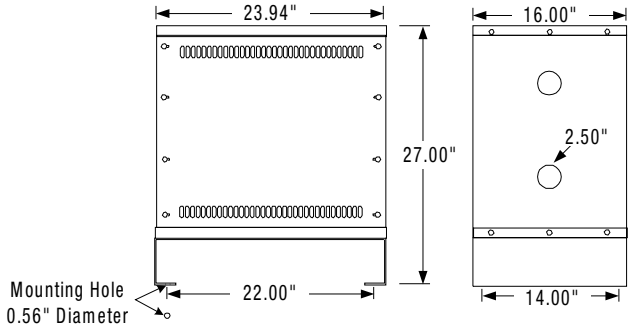
5. Wire the secondary back to drive TB8 (X1 to TB8-1, X2 to TB8-3).
6. Secure the top plate on the enclosure.

Figure 5.4
Field Transformer Enclosures

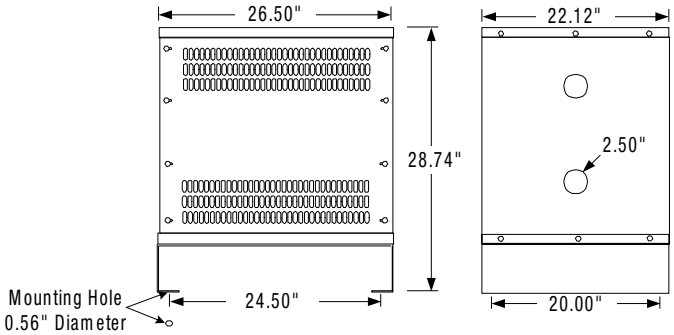
10 and 15kVA Transformer Enclosure



20kVA Transformer Enclosure



50kVA Transformer Enclosure



Circuit Board Jumper Connections

Table 5.G: Feedback Board Jumper Setting (Field Current)

	Motor Field Current	
Jumper Settings	43A Field Bridge	90A Field Bridge
1 (J36 to J41)	1.0 – 2.4	2.0 – 4.9
2 (J37 to J42)	2.5 – 9.8	5 – 17.5
3 (J38 to J43)	9.9 – 18.6	17.6 – 37.1
4 (J39 to J44)	18.7 – 43	37.2 – 86

Table 5.H: Feedback Board Jumper Settings (Input Voltage)

Line Voltage	Jumper Settings				
(V AC)	A	B	C	VA+	VA-
460	J7 to J22	J10 to J25	J13 to J28	J16 to J31	J19 to J34
575	J7 to J22	J10 to J25	J13 to J28	J16 to J31	J19 to J34
660	J8 to J23	J11 to J26	J14 to J29	J17 to J32	J20 to J35

Table 5.J: Power Stage Interface Board Jumper Settings

Jumper	Position	Purpose
J11	1 – 2	115V AC Motor Thermal Input
	2 – 3	24V DC Motor Thermal Input
J12	1 – 2	115V AC Reset Input
	2 – 3	24V DC Reset Input

Table 5.K: Main Control Board Jumper Settings

Jumper	Position	Purpose
J8, J9, and J10	1 – 2	+5V DC Encoder Power
	2 – 3	+12V DC Encoder Power
J14	1 – 2	EE Write Enable
	2 – 3	EE Write Disable

Table 5.L: 115V AC Control Circuit Current Requirements

Current	1250A Drive	1650A Drive	3000A Drive
Total Sealed Current	8A	8A	8A
Total Inrush Current	14A	14A	14A

Figure 5.5
115V AC Input and Contactor Control Connections

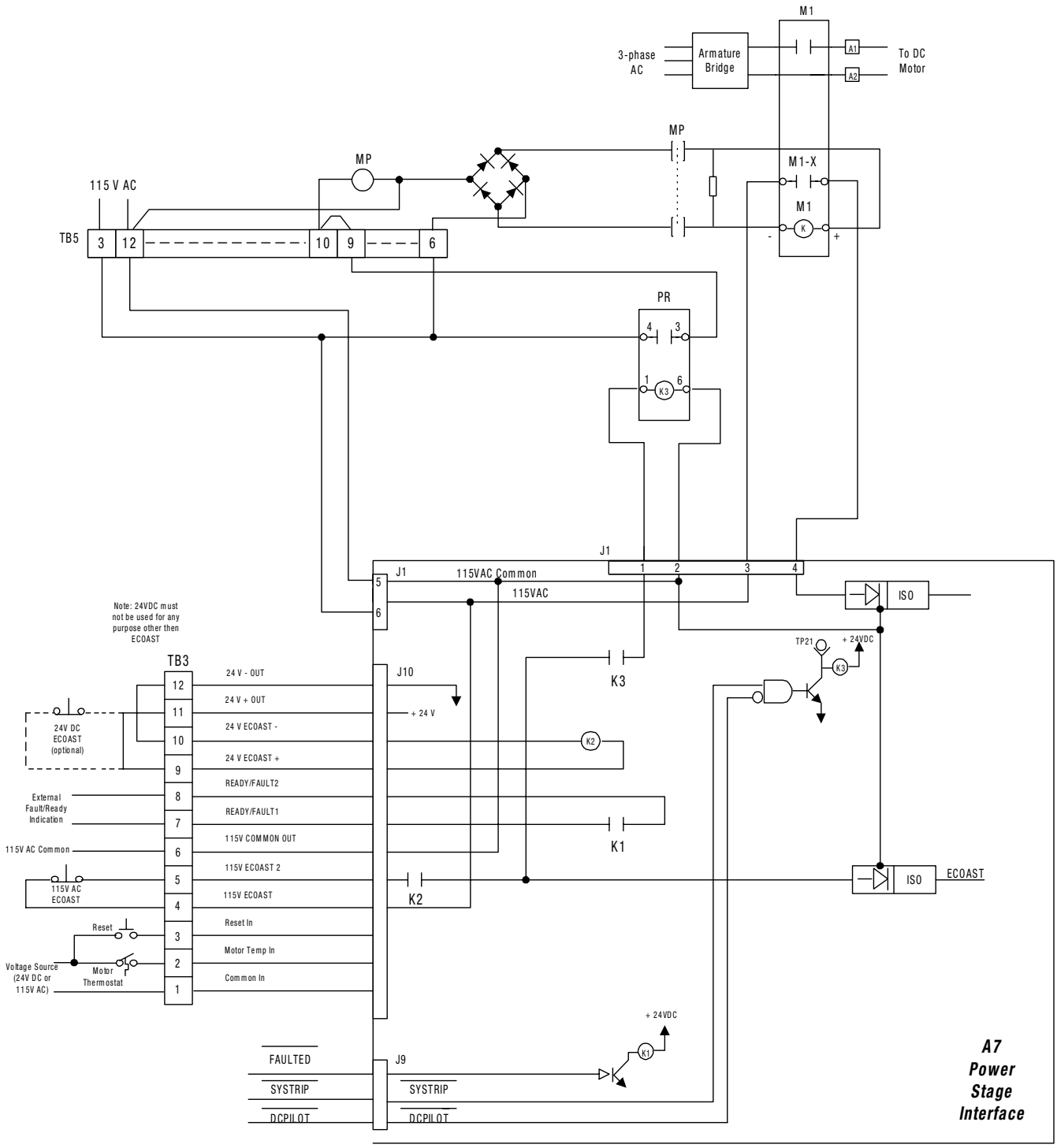


Table 5.M: 115V AC Connections

Rating (A DC)	115V AC Input Connections
1250, 1650, 3000	TB5-5, TB5-14

Table 5.N: Terminals Used for External Control of Contactor

Rating (A DC)	External Control Connections
1250, 1650, 3000	TB5-9 to TB5-10

Note: *If an external control will be used, remove the jumper across the terminals listed in the table above.*

Table 5.P: Torque Values

Connections	Torque
3-phase AC input (L1, L2, L3)	45 lb-ft
DC output (A1, A2)	45 lb-ft

Armature Current Ratings

See Appendix A for electrical specification charts.

Starting Up Your Drive

Contents

This chapter supplements the start-up procedures in the *1395 Digital DC Drive User Manual* with information for your high-horsepower drive. The following information will be covered in this chapter:

Introduction

When you use publication 1395-5.40 to start up your drive, you will need to refer to this chapter for information pertaining to the high-horsepower drives.

Voltage Measurements

Table 6.A: Field AC Voltage Measurements

Drive Rating	Field AC Input Measurement Points
1250, 1650, 3000A	TB8-1, TB8-3

Table 6.B: 115V AC Voltage Measurements

Drive Rating	115V AC Measurement Points
1250, 1650, 3000A	TB5-3, TB5-12

Table 6.C: 24V DC Voltage Measurements

Drive Rating	24V DC Measurement Points
1250, 1650, 3000A	TP1 (+24V DC) to TP7 (gnd) on power stage interface board

Table 6.D: Voltage Measurements (1250, 1650, 3000A Drives)

Test Points	Expected Voltage	Measured Voltage
AC Voltages		
L1 to L2	Rated AC Input	
L2 to L3	Rated AC Input	
L3 to L1	Rated AC Input	
TB8-1 to TB8-2	Rated DC Field Output	
TB5-3 to TB5-12	115V AC (±10%)	
Main Control Board		
TP51 to TP52	+5V DC (±0.15V)	
TP55 to TP57	+12V DC (±0.48V)	
TP56 to TP57	-12V DC (±0.48V)	
TP58 to TP53	+5V DC (±0.15V)	
TP54 to TP53	+12V DC (±0.48V)	
Power Stage Interface Board		
TP1 to TP7	+24V DC (±6V)	

Rated Armature and Field Currents

Armature and field current ratings are listed in the electrical specifications in Appendix A.

Drive Specifications

Contents

This appendix lists specifications for your drive. The following topics are covered in this appendix:

General Specifications

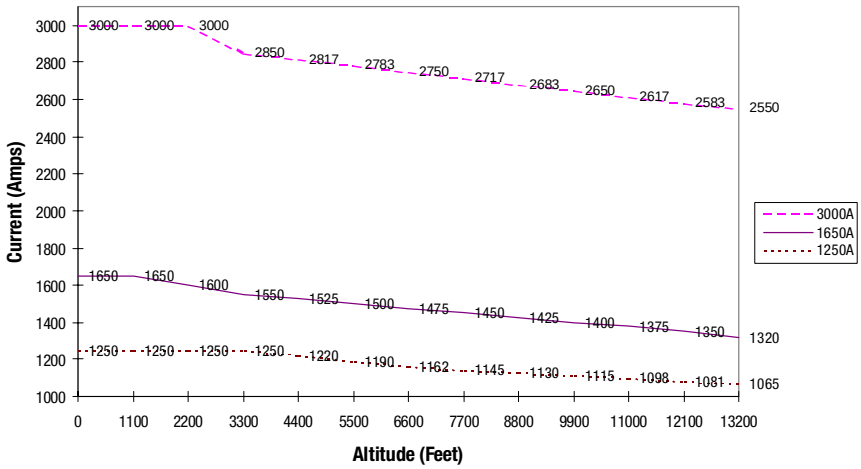
The following table expresses the general specifications for the 1250, 1650, and 3000A drives.

Table A: General Specifications

Subject	Specifications
AC Input Frequency Tolerance	50/60Hz ±3Hz
AC Input Voltage Tolerance	±10%
Overload Capability	150% maximum DC bus current for 60 seconds, 200% for 10 seconds, 260% for 5 seconds following continuous operation
Overload Duty Cycle	1 minute out of 20 minutes at rated load and temperature
Minimum Continuous Load Requirement	33% of rated DC bus continuous current
Operating Altitude	Up to 1000 meters (3,300 feet) ①
Ambient Temperature (Operating)	0 to 40°C (32 to 104°F)
Relative Humidity (Operating/Storage)	5 to 95%, non-condensing
Ambient Temperature (Storage)	-40 to 70°C (-40 to 158°F)

① For altitudes greater than 1000 meters, refer to the altitude derate chart.

Figure 1
Altitude Derating Chart



Unit Specifications

The following specifications apply to the 1250, 1650, and 3000A DC drives with standard options.

Table B: Unit Specifications

Specifications	1250A Drive	1650A Drive	3000A Drive
Height ①	91.5” (2324 mm)	91.5” (2324 mm)	111.5” (2832 mm) ②
Width	75” (1905 mm)	75” (1905 mm)	95” (2413 mm)
Depth	20” (508 mm)	20” (508 mm)	20” (508 mm)
MCC Sections	3	3	4
Shipping Weight	2500 lbs (1134 kg)	2500 lbs (1134 kg)	3500 lbs (1588 kg)
Operating Sound Level	83 dB, wt. A	83 dB, wt. A	82 dB, wt. A

① The height includes a 1.5”-high base channel.

② The height for the 3000A unit includes the enclosure height (90”), the base channel (1.5”), and the the tophat assembly (20”). The top hat assembly is shipped loose from the unit.

Electrical Specifications

Table C: Electrical Specifications (1250A DC Drive)

Input		Output				
Nominal Input Voltage (V AC)	Nominal Input Power (kVA)	Nominal Armature Voltage (V DC)	Nominal Armature Current (A DC)	Maximum Field Voltage (V DC)	Maximum Field Current (A DC)	Nominal HP
460	750	500	1100	300	43 or 90	700
460	848	500	1250	300	43 or 90	750
575	856	600	1000	300	43 or 90	750
575	909	600	1065	300	43 or 90	800
575	1060	600	1250	300	43 or 90	900
660	852	700	860	300	43 or 90	750
660	904	700	915	300	43 or 90	800
660	1011	700	1030	300	43 or 90	900
660	1217	700	1250	300	43 or 90	1000

Table D: Electrical Specifications (1650A DC Drive)

Input		Output				
Nominal Input Voltage (V AC)	Nominal Input Power (kVA)	Nominal Armature Voltage (V DC)	Nominal Armature Current (A DC)	Maximum Field Voltage (V DC)	Maximum Field Current (A DC)	Nominal HP
460	867	500	1280	300	43 or 90	800
460	972	500	1440	300	43 or 90	900
460	1108	500	1650	300	43 or 90	1000
575	1125	600	1330	300	43 or 90	1000
575	1385	600	1650	300	43 or 90	1250
660	1590	700	1650	300	43 or 90	1250

Table E: Electrical Specifications (3000A DC Drive)

Input		Output				
Nominal Input Voltage (V AC)	Nominal Input Power (kVA)	Nominal Armature Voltage (V DC)	Nominal Armature Current (A DC)	Maximum Field Voltage (V DC)	Maximum Field Current (A DC)	Nominal HP
460	1374	500	2000	300	43 or 90	1250
460	1634	500	2400	300	43 or 90	1500
460	2024	500	3000	300	43 or 90	1750
575	1713	600	1995	300	43 or 90	1500
575	1985	600	2330	300	43 or 90	1750
575	2254	600	2660	300	43 or 90	2000
575	2531	600	3000	300	43 or 90	2250
660	1705	700	1715	300	43 or 90	1500
660	1971	700	2000	300	43 or 90	1750
660	2242	700	2290	300	43 or 90	2000
660	2508	700	2575	300	43 or 90	2250
660	2905	700	3000	300	43 or 90	2500

Power Dissipation

The 1250, 1650, and 3000A DC drives dissipate power proportionally to the armature current, as shown in the following figures.

Figure 2
Watts Dissipation vs. Armature Current (1250A DC Drive)

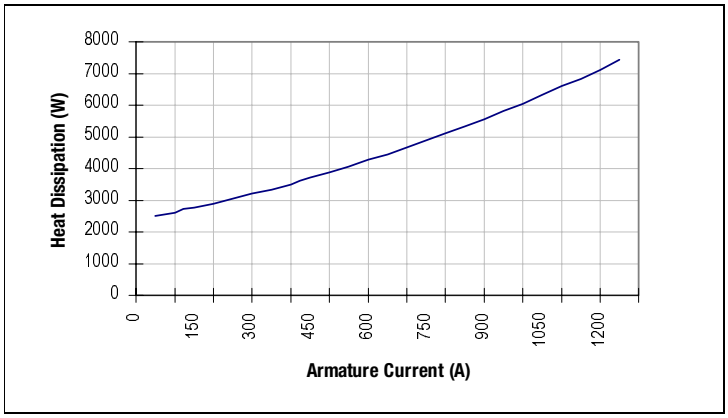


Figure 3
Watts Dissipation vs. Armature Current (1650A DC Drive)

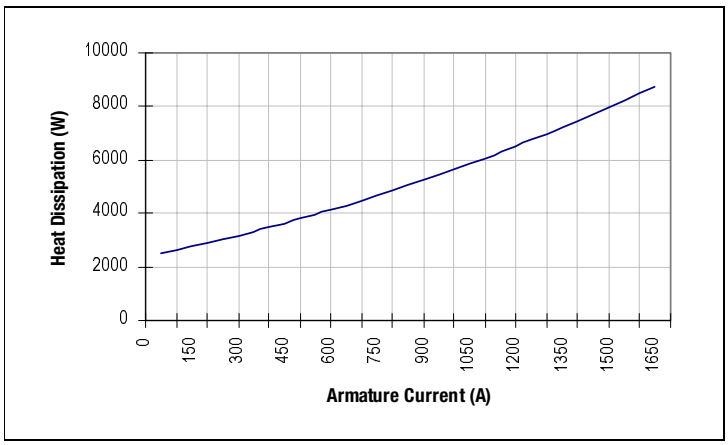
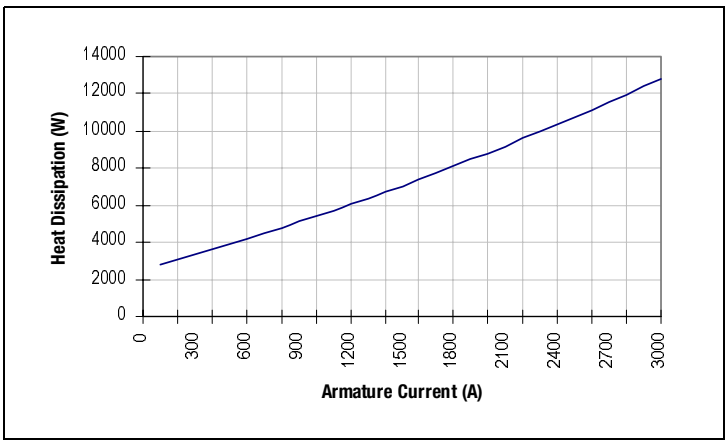


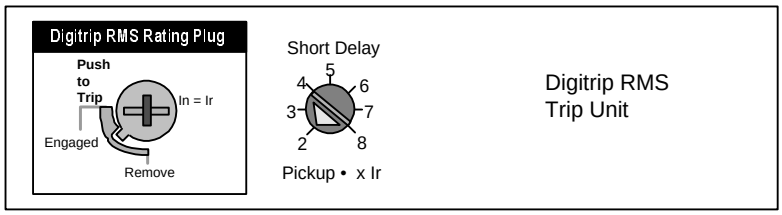
Figure 4
Watts Dissipation vs. Armature Current (3000A DC Drive)



Circuit Breaker Settings

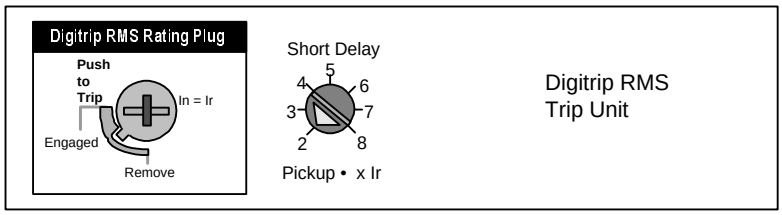
The 1250A DC drive has a 1200A N-frame circuit breaker with a 1200A plug. The circuit breaker should be set as shown in the following diagram.

Figure 5
Recommended Circuit Breaker Settings (1250A DC Drive)



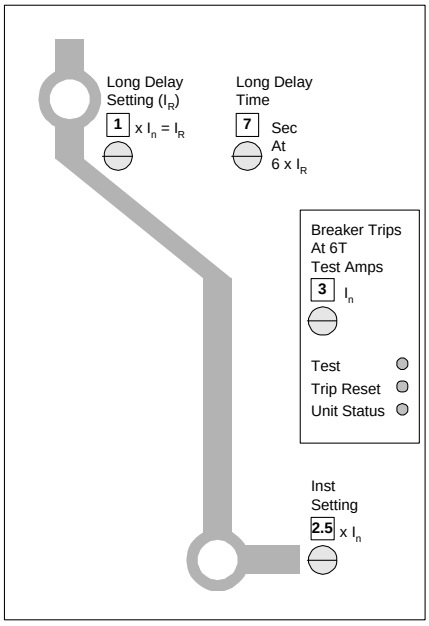
The 1650A DC drive has a 1600A R-frame circuit breaker with a 1600A plug. The circuit breaker should be set as shown in the following diagram.

Figure 6
Recommended Circuit Breaker Settings (1650A DC Drive)



The 3000A DC drive has a 3000A SPB-frame circuit breaker. The circuit breaker should be set as shown in the following diagram.

Figure 7
Recommended Circuit Breaker Settings (3000A DC Drive)



Circuit Breaker Derating

Figure 8
1250A DC Drive Breaker Derating

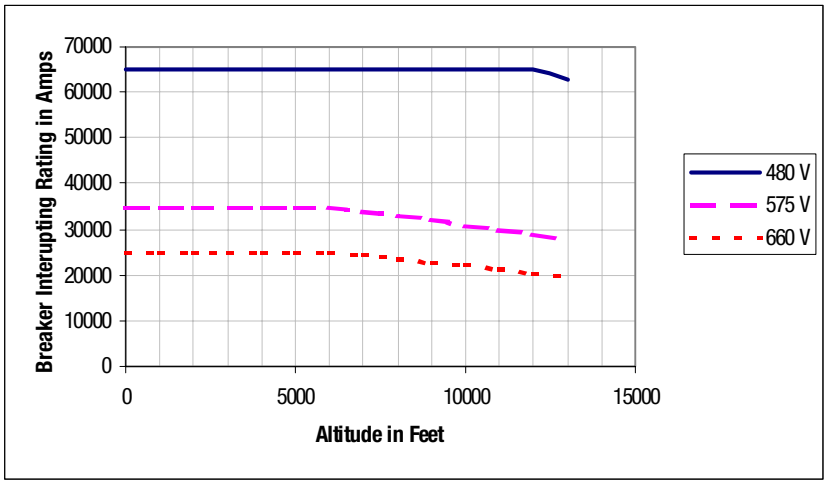


Figure 9
1650A DC Drive Breaker Derating

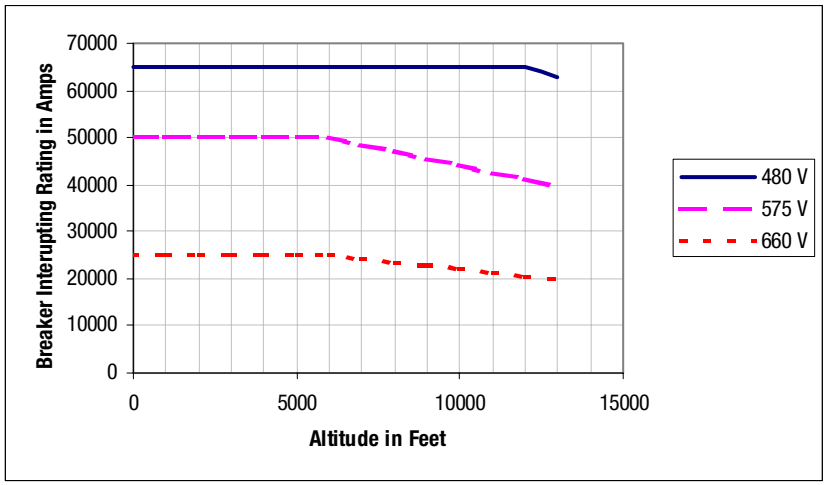
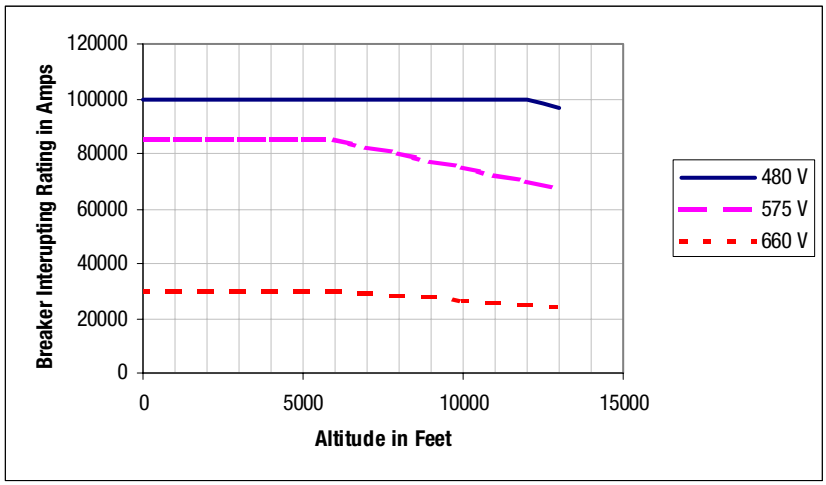


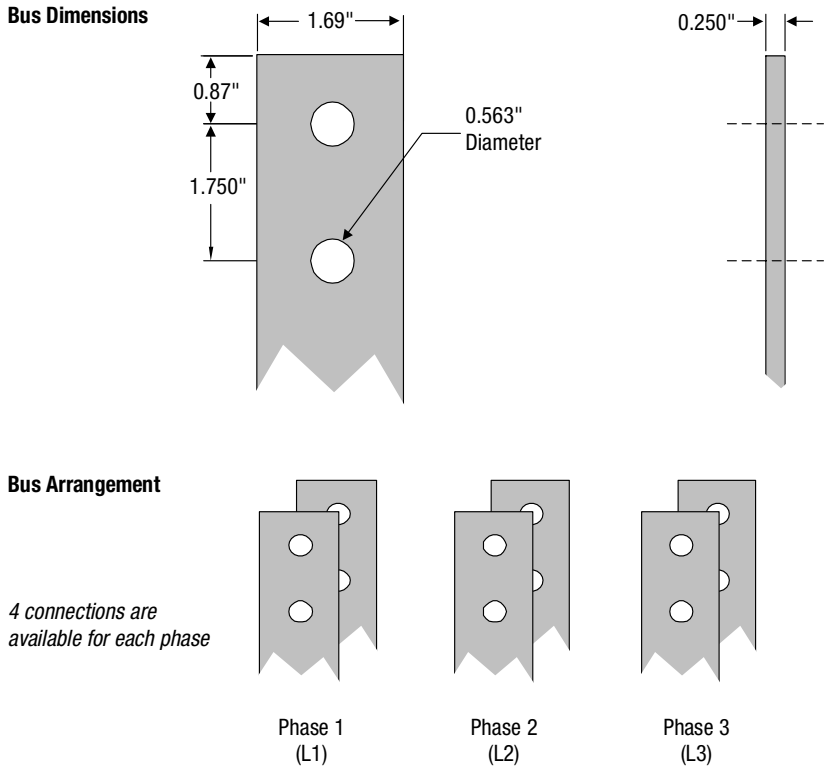
Figure 10
1650A DC Drive Breaker Derating



Input Busbars

The AC input busbars are set up in the 1250, 1650, and 3000A drives as shown in the following figures.

Figure 11
AC Input Busbars (1250A DC Drive)



Important: If the AC line fuse option is selected for a 1250A unit, 1650A busbars (shown in Figure 12) will be equipped with the unit rather than the 1250A busbars.

Figure 12
AC Input Busbars (1650A DC Drive)

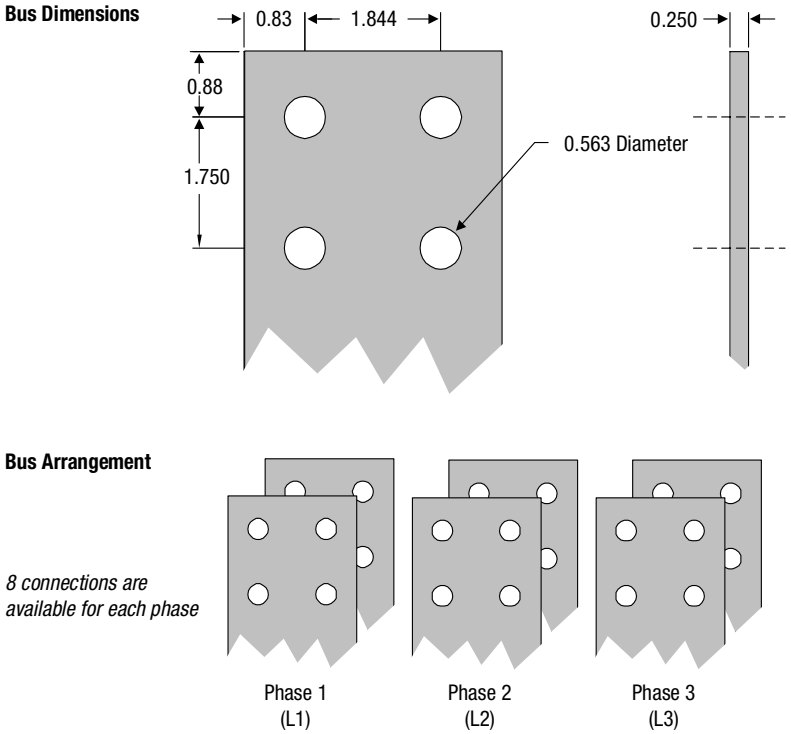
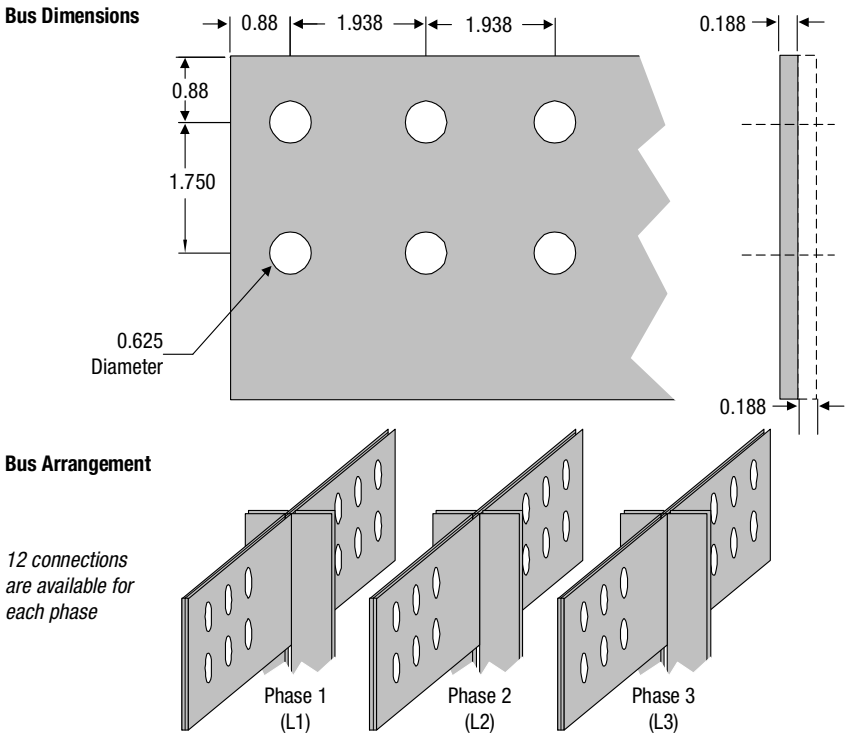


Figure 13
AC Input Busbars (3000A DC Drive)



Air Baffle Layouts

The following diagrams show how the air baffles and guards are arranged in the drives.

ATTENTION: Air baffles are designed to distribute air to cool drive components. Ensure that the baffles are in place when operating the drive to provide the proper airflow and to prevent the thermoswitches or optional airflow sensor from intermittently shutting down the drive.

ATTENTION: Guards are designed to direct airflow in the drive and to prevent injury. Ensure that the guards are in place when operating the drive.

Figure 14
Air Baffle Layout (1250 and 1650A Units)

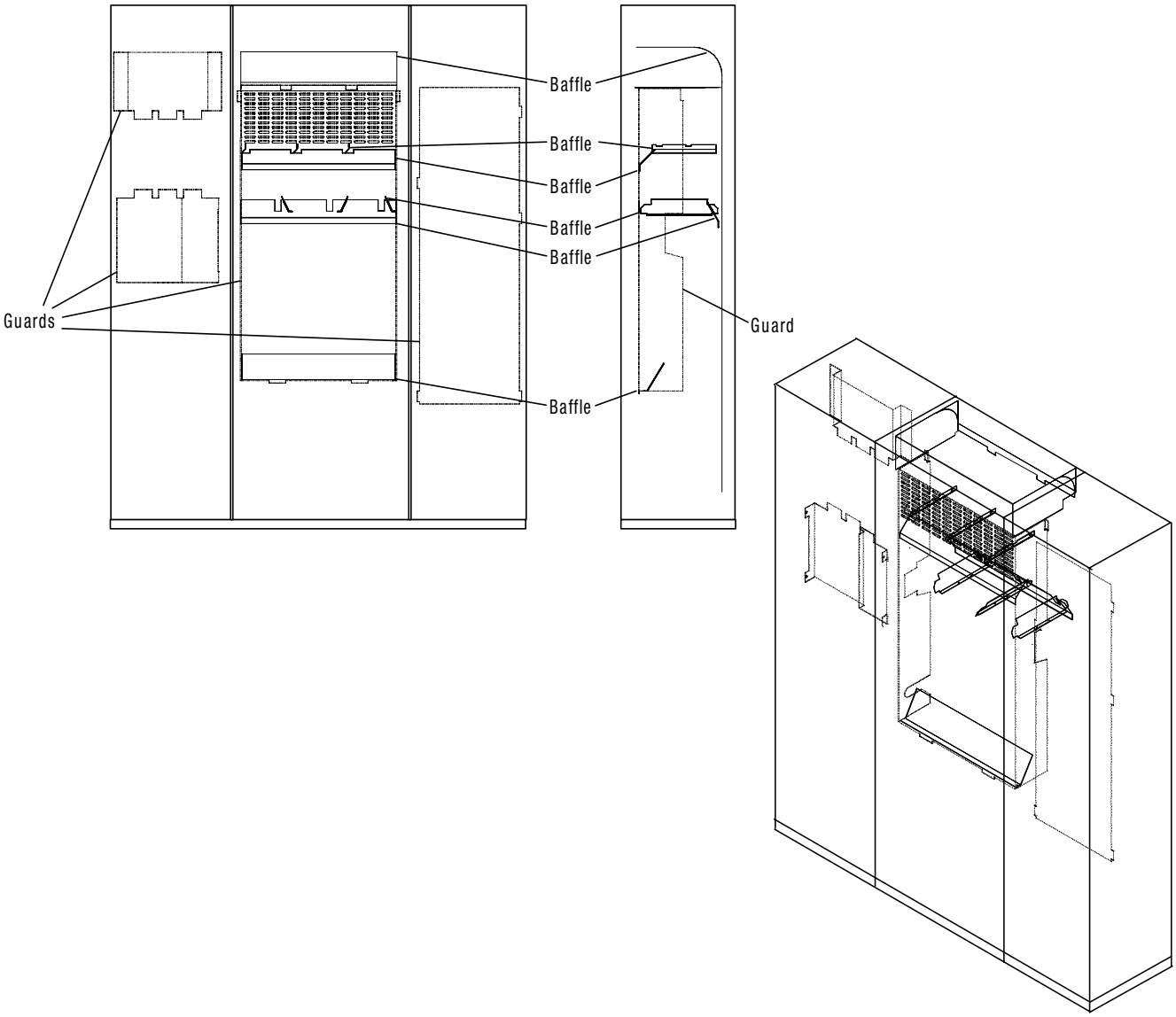
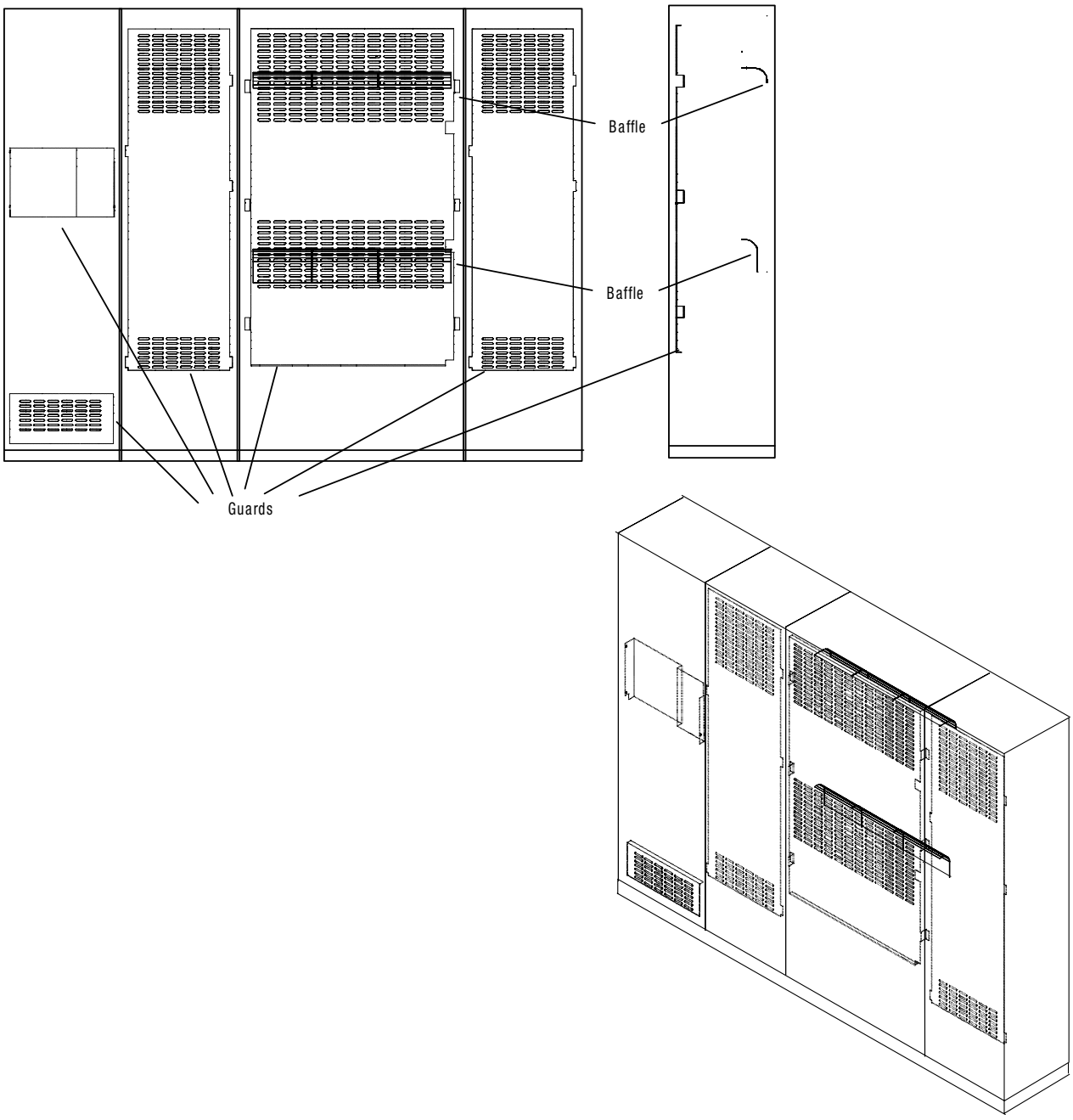


Figure 15
Air Baffle Layout (3000A Units)



Catalog Numbers and Spare Parts Kits

Contents

This appendix provides a description of catalog numbers and lists available spare parts kits.

Understanding Catalog Numbers

Catalog numbers consist of various components that are used in a drive. Each character of the catalog number helps identify a specific drive. The first four numbers represent the family of products (for example, 2361). The remaining characters define a specific version or options.

Determining Catalog Numbers

To help you to understand, we will provide an example of how to determine a catalog number for a DC drive.

The beginning portion of the catalog number for high-horsepower 1395 DC drive units would be 2361E or 2361F (E for regenerative, F for non-regenerative). The remaining portion of the catalog number will represent the options for which you need to make a selection.

The catalog number must appear in this order:

2361	*Regenerative Option*	*Wiring Type*	—	*Module Size*	*Enclosure*	*AC Input Line Voltage*	—	*HP*	*Trip Device*	—	*Options*

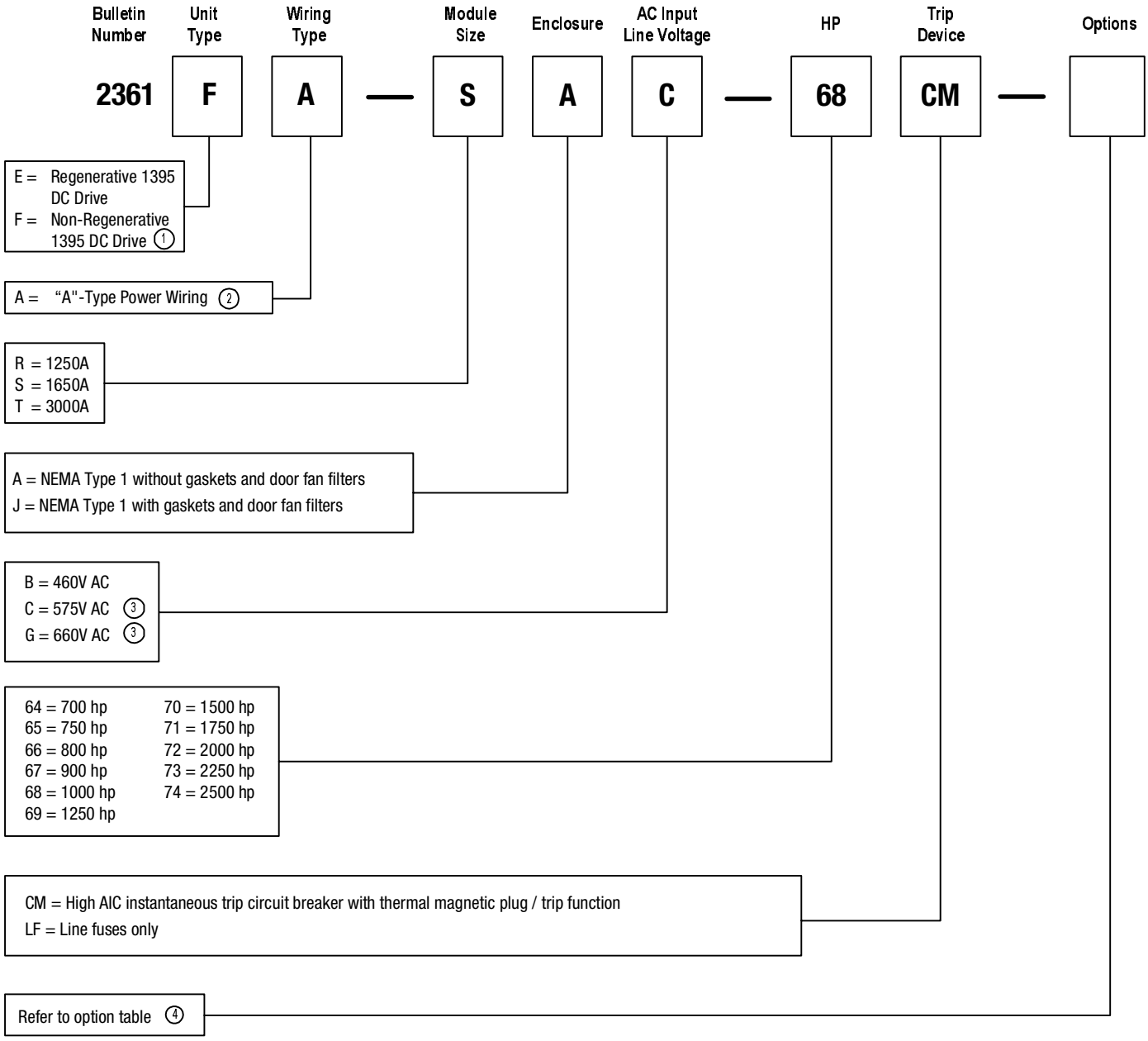
For example, if you were to use the table on the following page to select a drive that:

- is a regenerative unit
- supplies 1000 HP
- 3-phase AC input of 460V AC
- has a NEMA Type 1 enclosure without gaskets and door fan filters
- has a high instantaneous trip circuit breaker
- includes the options:
    - ControlNet™ communication board
    - 115V AC discrete adapter board
    - emergency stop

The catalog number would be:

2361EA-SAB-68CM-14CN-14DAA-1B

DC Drive Catalog Numbers



Options

Door-Mounted Pilot Lights (5)	4R = Power-on
Door-Mounted Pushbuttons (5)	1B = Drive stop (6) 1JF = Jog forward (6) 1JR = Jog reverse (6) 1ES = Hardwared stop interface
Door-Mounted Illuminated Pushbuttons (5)(6)	5G = Start / Running (7) 5A = Clear faults / Drive faulted
Door-Mounted Switches (5)(6)	3 = Speed 0-1-2 selector 760A = Single-turn speed pot
Drive Port A Cards (8)	14DAA = Discrete adapter, 115V AC 14DAD = Discrete adapter, 24V DC with 0.5A, 24V power supply 14DRA = Digital reference adapter, 24V DC with 0.5A, 24V power supply
Drive Port B Cards (8)	14CN = ControlNet adapter 14NA = Node adapter 14MCA = Multi-communications adapter
Tachometer Feedback Scaling Boards (9)	14T033 = Scaling board for resolvers with output voltages of 0-33V DC 14T046 = Scaling board for resolvers with output voltages of 34-46V DC 14T070 = Scaling board for resolvers with output voltages of 47-70V DC 14T125 = Scaling board for resolvers with output voltages of 71-125V DC 14T178 = Scaling board for resolvers with output voltages of 126-178V DC 14T250 = Scaling board for resolvers with output voltages of 179-250V DC
Configuration Terminals (10)	766 = Door-mounted D-shell connector 766A = Door-mounted DHT (Standard Terminal) 766B = Door-mounted EHT (Enhanced Terminal)
Control Power Source (11)	6P = Standard capacity control transformer with primary fusing 6TB = 115V AC control power, factory wired from 115V AC control bus to drive unit 6SC = 115V AC control power supplied by others
Dynamic Braking Contactor (12)	14DB = Dynamic braking contactor option
Unit Door Nameplates (11)	M3EW = White background with black lettering; phenolic label N3EB = Black background with white lettering; phenolic label N3ER = Red background with white lettering; phenolic label
Auxiliary Contacts	989X = (2) Normally open and (2) normally closed contactors mounted internally if 1250/1650A *OR* (4) Normally open and (4) normally closed contactors mounted internally if 3000A unit
Blower Starters (10)	14BN = (1) NEMA size 1 FVNR starter assembly with 30A fuse blocks mounted within the drive unit 14B2N = (2) NEMA size 1 FVNR starter assembly with 30A fuse blocks mounted within the drive unit 14B2NX = (2) NEMA size 2 FVNR starter assembly with 60A fuse blocks mounted within the drive unit 14BI = (1) IEC, 24A starter assembly mounted with 30A fuse blocks within the drive unit 14B2I = (2) IEC, 24A starter assembly mounted with 30A fuse blocks within the drive unit 14B2IX = (2) IEC, 30A starter assembly mounted with 60A fuse blocks within the drive unit
Protection	14LSP = Line RC suppressor module (13) 14AFL = Air flow loss switches
Input Option (14)	14HBC = AC power input is wired from the horizontal thru-bus to the circuit breaker
Field Supply Upgrade (15)	14FX = Field supply upgrade for fields requiring 43 to 90A
Field Voltage Step-Down Options for Units with 575 or 660V AC Inputs (3)	14SD28 = Field transformer for field currents up to 28A 14SD40 = Field transformer for field currents up to 40A 14SD90 = Field transformer for field currents up to 90A
Miscellaneous	14WLBL = Brady Databb ™ wire labels (16) J12 = 115V DC, 15A duplex receptacle, customer-wired (17) J11 = Audio phone jack

Footnotes

(1) Non-regenerative units not offered for 3000A modules.

(2) Units accommodate top entry and bottom exit. An additional section is required for bottom entry and a separate additional section is required for top exit.

(3) Units configured for 575 or 660V AC inputs require field transformers. The field supply modules require an input voltage of 460V AC and the field transformer is utilized to step-down 575 or 660V AC inputs to 460V AC. The base unit price of a 575 or 660V AC input drive includes a field transformer (and fusing) that provides up to 18A to the field supply module. Select a field transformer upgrade option when you need to supply more current to the field supply module. All field transformers come standard in a NEMA Type 1 enclosure. Nominal field currents based on 85% efficiency, unit control power usage, and a 300V field supply.

(4) Add option codes here and separate option code with dashes.

(5) Devices are 800T-type.

(6) If selected, you must select (1) *Drive Port A Card. If you select 5+ input devices or 3+ output devices, you must select Drive Port A Card "14DRA."*

(7) If selected, you must also select option "1B."

(8) Maximum number of cards allowed is one for Port A, and one for Port B.

(9) If your motor has a DC tachometer, select the appropriate scaling board.

(10) You may select up to one option from this group.

(11) You must select one option from this group.

(12) For 1250 to 3000A modules, you may select option "14DB." This option includes a dynamic braking contactor mounted in a separate 20" MCC section

(13) The line RC suppressor is recommended for installations where the primary of the distribution transformer is 2300V AC or greater.

(14) This option is only valid for 1250A and 1650A DC drives. You must specify a AC thru bus option with a current capacity larger than the continuous input current rating of the drive unit.

(15) Units come standard with a field supply module rated to supply field currents up to 43A. This field supply option allows you to supply up to 90A to the motor field. If you are selecting a 575 or 660V AC input and this field supply option, you must select field voltage step-down option "14SD90".

(16) Units come standard with cloth wire labels. Datab labels offer the added protection of a clear plastic cover on top of the labels.

(17) Customer supplies 115V AC control power and wiring to the duplex receptacle.

DC Drive Spare Parts Kits

These spare parts kits are designed to provide you with the necessary parts to repair and maintain your drive.

What Does a Spare Parts Kit Include?

A spare parts kit includes the items in the quantities described in Tables A, B, and C. Each spare parts kit also contains installation instructions.

Which Table Do I Use?

For a drive with an input voltage of:	Refer to:
460V AC	Table A
575V AC	Table B
660V AC	Table C

Significance of Level Numbers

Level numbers are used to recommend stocking locations for the various spare parts kits. Level descriptions are as follows:

Level Number	Level Description	Recommended Stocking Location(s)
1	Major Assemblies	Large users, OEMs, distributors, and GTS
2	Minor Assemblies	Distributors and GTS
3	Discrete Components	GTS

Definition of Terms Used to Describe "Qty in Kit"

The column "Qty in Kit" in Tables A, B, and C represents how many components you can expect to find as follow:

Level Number	Example “Qty in Kit”	Kit Contains
Kits containing one item	1	The specified quantity of the item described
Kits containing multiple items	1 each	The specified quantity of each item described
	1 PCB / 4 fuses	The specified quantity of each item, as described
	1 set	The quantity of the specified items required for one drive (per set)

Catalog Number Description

2361	**-**	**SP**	**A**	**01**	**A**
Bulletin Number		*Spare Part Designator*	*Spare Part Type*	*Kit Number*	*Revision Letter*

Table A: Spare Parts Kits for Drives with 460V AC Inputs

Level	Catalog Number	Description	Qty in Kit
1	2361-SPE01A	Control Fuses, 1250 - 3000A DC units	2 sets
1	2361-SPE12A	Line Fuses, 1250A DC units	1 set
1	2361-SPE13A	Line Fuses, 1650A DC units	1 set
1	2361-SPE14A	Line Fuses, 3000A DC units	1 set
1	2361-SPM01A	Feedback Board, 1250 - 3000A DC units	1
1	2361-SPM03A	Armature-Pulse Transformer Board, 1250 - 3000A DC units	1
1	2361-SPM04A	Field Pulse Transformer Board for Option 14FX, 1250 - 3000A DC units	1
2	2300-SPB01A	Line RC Suppressor (Option 14LSP), 1250 - 3000A DC units	1 PCB / 2 sets of fuses
2	2300-SPJ02A	Line MOVs, 1250 - 3000A DC units	1 set
2	2300-SPP01A	Air Flow Switch PCB Kit (Option 14AFL), 1250 - 1650A DC units	1 PCB / 1 power supply (.5A)
2	2300-SPP02A	Air Flow Switch PCB Kit (Option 14AFL), 3000A units	1 PCB / 1 power supply (1.1A)
2	2361-SPA01A	Positive (Top) Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA02A	Negative (Bottom) Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA03A	Positive (Top) Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA04A	Negative (Bottom) Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA05A	Positive (Top) Regenerative Armature Assemblies, 3000A DC units	1
2	2361-SPA06A	Negative (Bottom) Regenerative Armature Assemblies, 3000A DC units	1
2	2361-SPA07A	Field SCR Module for Option 14FX, 1250 - 3000A DC units	1
2	2361-SPA08A	Positive (Top) Non-Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA09A	Negative (Bottom) Non-Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA10A	Positive (Top) Non-Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA11A	Negative (Bottom) Non-Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPB01A	Snubber Assembly, 1250 - 1650A DC units	1
2	2361-SPB02A	Snubber Assembly, 3000A DC units	1
2	2361-SPE08A	Individual Power Fuses, 1250A DC units	2
2	2361-SPE09A	Individual Power Fuses, 1650A DC units	2
2	2361-SPE10A	Individual Power Fuses, 3000A DC units	3
2	2361-SPE11A	Power Fuse Assembly, 3000A DC units	1 assembly / 3 fuses
2	2361-SPG01A	Armature SCRs, 1250A DC units	2
2	2361-SPG02A	Armature SCRs, 1650A DC units	2
2	2361-SPG03A	Armature SCRs, 3000A DC units	2
2	2361-SPK01A	Additional Control Board Stack Power Supply, 1250 - 3000A DC units	1
2	2361-SPM02A	Gate Interface Board, 1250 - 3000A DC units	1
3	2361-SPH01A	Bridge Fan and Capacitor, 1250 - 1650A DC units	1 each
3	2361-SPH02A	Bridge Fan and Capacitor, 3000A DC units	1 each
3	2361-SPH03A	Slide-In Fan and Capacitor, 3000A DC units	1 each

Table B: Spare Parts Kits for Drives with 575V AC Inputs

Level	Catalog Number	Description	Qty in Kit
1	2361-SPE01A	Control Fuses, Option 14SD40, 1250 - 3000A DC units	2 sets
1	2361-SPE02A	Control Fuses, No Field Voltage Step Down Option, 1250 - 3000A DC units	2 sets
1	2361-SPE03A	Control Fuses, Option 14SD28, 1250 - 3000A DC units	2 sets
1	2361-SPE04A	Control Fuses, Option 14SD90, 1250 - 3000A DC units	2 sets
1	2361-SPE12A	Line Fuses, 1250A DC units	1 set
1	2361-SPE13A	Line Fuses, 1650A DC units	1 set
1	2361-SPE14A	Line Fuses, 3000A DC units	1 set
1	2361-SPM01A	Feedback Board, 1250 - 3000A DC units	1
1	2361-SPM03A	Armature-Pulse Transformer Board, 1250 - 3000A DC units	1
1	2361-SPM04A	Field Pulse Transformer Board, Option 14FX, 1250 - 3000A DC units	1
2	2300-SPB01A	Line RC Suppressor (Option 14LSP), 1250 - 3000A DC units	1 PCB / 2 sets of fuses
2	2300-SPJ03A	Line MOVs, 1250 - 3000A DC units	1 set
2	2300-SPP01A	Air Flow Switch PCB Kit (Option 14AFL), 1250 - 1650A DC units	1 PCB / 1 power supply (.5A)
2	2300-SPP02A	Air Flow Switch PCB Kit (Option 14AFL), 3000A units	1 PCB / 1 power supply (1.1A)
2	2361-SPA01A	Positive (Top) Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA02A	Negative (Bottom) Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA03A	Positive (Top) Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA04A	Negative (Bottom) Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA05A	Positive (Top) Regenerative Armature Assemblies, 3000A DC units	1
2	2361-SPA06A	Negative (Bottom) Regenerative Armature Assemblies, 3000A DC units	1
2	2361-SPA07A	Field SCR Module for Option 14FX, 1250 - 3000A DC units	1
2	2361-SPA08A	Positive (Top) Non-Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA09A	Negative (Bottom) Non-Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA10A	Positive (Top) Non-Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA11A	Negative (Bottom) Non-Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPB01A	Snubber Assembly, 1250 - 1650A DC units	1
2	2361-SPB02A	Snubber Assembly, 3000A DC units	1
2	2361-SPE08A	Individual Power Fuses, 1250A DC units	2
2	2361-SPE09A	Individual Power Fuses, 1650A DC units	2
2	2361-SPE10A	Individual Power Fuses, 3000A DC units	3
2	2361-SPE11A	Power Fuse Assembly, 3000A DC units	1 assembly / 3 fuses
2	2361-SPG01A	Armature SCRs, 1250A DC units	2
2	2361-SPG02A	Armature SCRs, 1650A DC units	2
2	2361-SPG03A	Armature SCRs, 3000A DC units	2
2	2361-SPK01A	Additional Control Board Stack Power Supply, 1250 - 3000A DC units	1
2	2361-SPM02A	Gate Interface Board, 1250 - 3000A DC units	1
3	2361-SPH01A	Bridge Fan and Capacitor, 1250 - 1650A DC units	1 each
3	2361-SPH02A	Bridge Fan and Capacitor, 3000A DC units	1 each
3	2361-SPH03A	Slide-In Fan and Capacitor, 3000A DC units	1 each

Table C: Spare Parts Kits for RGUs with 660V AC Inputs

Level	Catalog Number	Description	Qty in Kit
1	2361-SPE05A	Control Fuses, No Field Voltage Step Down Option, 1250 - 3000A DC units	2 sets
1	2361-SPE06A	Control Fuses, Option 14SD28, 1250 - 3000A DC units	2 sets
1	2361-SPE06A	Control Fuses, Option 14SD40, 1250 - 3000A DC units	2 sets
1	2361-SPE07A	Control Fuses, Option 14SD90, 1250 - 3000A DC units	2 sets
1	2361-SPE12A	Line Fuses, 1250A DC units	1 set
1	2361-SPE13A	Line Fuses, 1650A DC units	1 set
1	2361-SPE14A	Line Fuses, 3000A DC units	1 set
1	2361-SPM01A	Feedback Board, 1250 - 3000A DC units	1
1	2361-SPM03A	Armature-Pulse Transformer Board, 1250 - 3000A DC units	1
1	2361-SPM04A	Field Pulse Transformer Board for Option 14FX, 1250 - 3000A DC units	1
2	2300-SPB02A	Line RC Suppressor (Option 14LSP), 1250 - 3000A DC units	1 PCB / 2 sets of fuses
2	2300-SPJ03A	Line MOVs, 1250 - 3000A DC units	1 set
2	2300-SPJ04A	Air Flow Switch PCB Kit (Option 14AFL), 3000A units	1 PCB / 1 power supply (1.1A)
2	2300-SPP01A	Air Flow Switch PCB Kit (Option 14AFL), 1250 - 1650A DC units	1 PCB / 1 power supply (.5A)
2	2361-SPA01A	Positive (Top) Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA02A	Negative (Bottom) Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA03A	Positive (Top) Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA04A	Negative (Bottom) Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA05A	Positive (Top) Regenerative Armature Assemblies, 3000A DC units	1
2	2361-SPA06A	Negative (Bottom) Regenerative Armature Assemblies, 3000A DC units	1
2	2361-SPA07A	Field SCR Module for Option 14FX, 1250 - 3000A DC units	1
2	2361-SPA08A	Positive (Top) Non-Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA09A	Negative (Bottom) Non-Regenerative Armature Assemblies, 1250A DC units	1
2	2361-SPA10A	Positive (Top) Non-Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPA11A	Negative (Bottom) Non-Regenerative Armature Assemblies, 1650A DC units	1
2	2361-SPB01A	Snubber Assembly, 1250 - 1650A DC units	1
2	2361-SPB02A	Snubber Assembly, 3000A DC units	1
2	2361-SPE08A	Individual Power Fuses, 1250A DC units	2
2	2361-SPE09A	Individual Power Fuses, 1650A DC units	2
2	2361-SPE10A	Individual Power Fuses, 3000A DC units	3
2	2361-SPE11A	Power Fuse Assembly, 3000A DC units	1 assembly / 3 fuses
2	2361-SPG01A	Armature SCRs, 1250A DC units	2
2	2361-SPG02A	Armature SCRs, 1650A DC units	2
2	2361-SPG03A	Armature SCRs, 3000A DC units	2
2	2361-SPK01A	Additional Control Board Stack Power Supply, 1250 - 3000A DC units	1
2	2361-SPM02A	Gate Interface Board, 1250 - 3000A DC units	1
3	2361-SPH01A	Bridge Fan and Capacitor, 1250 - 1650A DC units	1 each
3	2361-SPH02A	Bridge Fan and Capacitor, 3000A DC units	1 each
3	2361-SPH03A	Slide-In Fan and Capacitor, 3000A DC units	1 each

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