Allen-Bradley

8510 AC Spindle Drive System

User Manual

Rockwell Automation

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 available from your local Allen-Bradley Sales Office or online at **http://www.ab.com/manuals/gi**) 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 the Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits, equipment, or software described in this manual.

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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.

Attentions help you:

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

Important: Identifies information that is especially important for successful application and understanding of the product.

Shock Hazard labels may be located on or inside the drive to alert people that dangerous voltage may be present.

Chapter 1

Introduction

Chapter Objectives

Chapter 1 provides information on the general intent of this manual, gives an overall description of the 8510 AC Spindle Drive System, and provides a detailed description of the key features of this drive. This information will help the reader to understand both the basic capabilities and the advanced features of the 8510 drive system and recognize opportunities to use these features to improve machine performance.

Manual Objectives

This publication provides planning, installation, wiring and diagnostic information for the 8510 AC Spindle Drive System.

To assure successful installation and operation, the material presented must be thoroughly read and understood before proceeding. Particular attention must be directed to the Attention and Important statements contained within.

Important Information about this Manual
This manual has been prepared primarily to support the installation of 8510 AC Spindle Drive System. It is a standard document that is intended to help the user understand some of the operating characteristics and limitations of this equipment, including hazards associated with equipment handling, installation, and wiring procedures. Note the following points:

- This equipment has been designed to meet the requirements of a component in an integrated system.
- It must be noted that special considerations are to be given to characteristics of other peripheral solid-state control equipment and the cumulative impact on safety.
- Manufacturers and engineering groups responsible for specification or design of electrical control equipment must refer to applicable industry standards and codes for specific safety guidelines and interface requirements.
- In the actual factory environment, the user is responsible to assure compliance with applicable machine and operator safety codes or regulations which are beyond the scope and purpose of this document.

General Precautions

In addition to the precautions listed throughout this manual, the following statements which are general to the system must be read and understood.

ATTENTION: Only personnel familiar with the 8510 AC Drive System and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

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

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

Drive Overview

The Allen-Bradley Series 8510 AC Spindle Drive System is designed to meet the requirements of world-class machine tools. The 8510 consists of a rugged, AC spindle motor and a state-of-the-art digital AC drive. The system has been optimized to provide the highest level of performance combined with outstanding reliability.

The 8510 is fully microprocessor controlled and has the features required by modern, high capacity machine tools including:

- Four quadrant, line regenerative operation for high cycle rate applications.
- Extremely high dynamic performance for smooth operation under widely varying machining conditions.
- A “wireless” power structure maximizes reliability.
- High frequency IGBT power devices minimize audible motor noise.
- Through-the-wall heat sinks remove most drive heat from the cabinet.
- Universal analog and discrete I/O interface adapts easily to CNC systems.

1327A AC Motor Overview

The 1327A AC Spindle Motors have been specifically designed to meet the needs of modern machine tools. To cover the variety of application requirements, both a standard series and a dual winding series are available. Some of the key features of these motors include:

- Small Size – Advanced electromagnetic and cooling system designs provide extremely compact motors.
- High Speeds – In the standard series, 8,000 rpm maximum speed is available up to 5.5 kW (7.5 HP) and 6,000 rpm through 22 kW (30 HP) continuous output. All motors are 1,500 rpm base speed.
- Precision Balance – For high precision machine tools, precision balance to less than 3 micron (0.00012") peak to peak vibration is standard.
- Wide Constant Power Range – With the dual winding motors, 12:1 constant power ranges can be obtained. Constant power speed ranges of 500 to 6,000 rpm or 400 to 4,800 rpm can frequently eliminate the need for multi-speed spindle headstocks.
- High Reliability – The resolver feedback eliminates all electronics from the high temperature motor environment to significantly increase motor ruggedness and reliability. This is combined with bearings designed for a 15,000 hour B10 life, a high voltage insulation system tested to 1,500 volts, and the precision rotor balance to assure a superior motor life.
- Mounting Versatility – Metric foot mount and flange mount motors are available for either horizontal or vertical mounting.

Drive Design Features

The following design features are standard on the Series 8510 AC Spindle Drive System.

Multiple Control Modes

To provide the flexibility and control capability to meet the demands of increasingly sophisticated machine tools and other types of automation equipment, the 8510 provides multiple operating modes. Through discrete inputs, the user can instantaneously switch the 8510 drive between Spindle Mode, Servo Mode, and Torque Mode operation. Each mode has a unique set of programmable drive configuration, input scaling, and control loop tuning parameters to allow optimized performance in each operating mode.

Spindle Mode – provides smooth, quiet operation over the wide constant power range required for normal machining. In typical machine tool spindle applications, this is the only operating mode that is required. The drive can operate from analog or digital speed commands with programmable acceleration ramp rate generators and provides a traditional PI type velocity control loop. During lightly loaded operation, the motor flux is reduced to minimize motor heating.

Spindle mode assumes that the drive is operating as an open loop speed controlled drive without an external position control loop closed around the drive.

Servo Mode – configures the drive to be used as a velocity servo in a closed position loop system. Whenever the CNC is operating the spindle drive in a closed position loop, such as during spindle orient or when performing C-axis machining on a turning center, this operating mode should be used. In servo mode, only analog speed commands can be used, the acceleration rate ramp generators are disabled, and a maximum integrator gain clamp is added to guard against limit cycle conditions in high friction applications. The analog input scaling can be set for a different maximum speed in servo mode than is used in spindle mode. An optional high speed, high linearity A/D converter can be added for contouring and high bandwidth applications. The 8510 has ample dynamic performance to allow using it as a high power axis servo.

Torque Mode – configures the drive to function as a torque controlled drive rather than a speed controlled drive. When this mode is active, the analog input is commanding a level of motor torque rather that a specific motor speed. The connected load or an external control loop must provide the speed control or the motor will be accelerated to maximum speed and the drive will shut down on an overspeed condition. A single digital input can instantaneously switch the drive between torque control and speed control modes. Torque mode allows the drive to operate as the torque follower in leader/follower or anti-backlash dual drive configuration. Some motion control systems close both the position and velocity loops from a single feedback device and output torque commands to the drive amplifier. In torque mode, the 8510 can be used with these motion control systems.

Optimized Performance For Multi-Speed Gear Boxes

Many multi-speed spindle gear boxes provide very different drive loading or have different performance requirements in each gear range. Some directly driven spindles may have large differences in load inertia or performance requirements in certain situations. To provide optimum performance in each of these different situations, the 8510 drive can store totally independent sets of all drive configuration and tuning parameters for up to four different gear ranges or sets of operating conditions. Two binary coded digital inputs allow the CNC or other control system to select the appropriate parameter set while the drive is running. Changeover takes only about 30 milliseconds.

Since all configuration parameters can be changed for each data set, this feature could be used to select multiple preset orient positions, change the maximum speed at maximum command scaling, or change any of the preset speed or load detectors in addition to optimizing the dynamic response of the drive. This flexibility can help eliminate the need for making performance compromises in different operating conditions.

High Resolution Velocity Control

Optimum velocity control and smoothness is provided by a 14 bit A/D converter for the command, and a multi-pole resolver with 16 bit resolution for velocity feedback. For C axis operation in Servo Mode, the input can be rescaled to achieve full 14 bit resolution over both the rapid traverse and the feed speed ranges. An optional 16 bit parallel digital input can be used to provide a 4 digit BCD or 16 bit binary digital speed command input when operating in Spindle Mode.

High Response Control Loops

To provide the dynamic response required by state of the art machine tools, the 8510 delivers up to a 50 Hz velocity loop bandwidth. For improved response, feedback is sampled every 0.4 ms, and Servo Mode command is sampled every 0.8 ms.

Spindle Orient

The spindle orient function can be provided by a CNC that can close a position loop around the spindle drive or by a spindle orient capability that is part of the spindle drive itself. With the 8510, spindle orient using either an optical encoder or a high resolution magnetic feedback device is a standard feature. The user provided feedback device must be mounted with a direct 1:1 ratio to the spindle shaft that is to be oriented. If an optical encoder is used, the resolution is 360/(4 x encoder lines) degrees.

A special high resolution magnetic feedback device is available. This consists of a fine pitch, very accurate ring gear that must be mounted directly to the spindle shaft and a sensor that picks up signals as each gear tooth passes. The ring gears are available with between 225 and 500 teeth (pitch diameters of 90 mm to 200 mm (3.5 to 7.9 in.)). Within the 8510 drive, each tooth is resolved into 1000 parts giving resolutions of 225,000 to 500,000 parts per revolution. With the 500 tooth gear, absolute accuracy of 0.015 degrees can be achieved with precision mounting of the gear to the spindle.

Orient is to a single preset orient position or, with the optional 16 bit digital command input, an external 4 digit BCD or 16 bit binary orient position command can be given. After reaching orient position, the drive can be programmed to hold the spindle in that position or to remove motor torque and allow free movement of the spindle.

Control Of Dual Winding Motors
A 12:1 constant power range can be obtained by using dual winding motors. AC motors are usually wired internally into either a Δ or a Y winding configuration. With the dual winding motors, a pair of externally mounted contactors are used to reconfigure the motor windings between Δ or Y connections while the motor is running. This winding reconfiguration shifts the base speed operating point of the motor and effectively extends the overall constant power operating range. These externally mounted contactors are directly controlled by the 8510 drive. A single digital input to the 8510 commands either the low speed or the high speed winding to be selected. Within about 250 milliseconds, the drive will turn off the motor current, open one contactor, close the other contactor, turn on the motor current, and give an output back to the control system to indicate that the winding has been changed. To prevent excessive speed changes during the winding change operation, the motor should be running at no load.

With dual winding motors, totally independent parameter sets are stored for each motor winding to assure optimum performance in each speed range. When these motors are used, the gear range data sets are limited to three instead of four. This gives a total of six unique sets of drive parameters (2 motor windings in each of 3 gear ranges).

Power Structure Design
Internal discrete wiring has been nearly eliminated by the use of a printed circuit board to interconnect the entire power structure. Use of a circuit board maximizes reliability and simplifies maintenance. The 8510 uses high frequency, low loss IGBT power devices. The high switching frequency minimizes motor noise and reduces motor heating. To remove much of the heat from the drive cabinet, the 8510 heat sink extends through the rear of the cabinet. As an option, the drive can be mounted inside the cabinet and cooling air can be ducted out any side of the enclosure.

Programming and Diagnostics
An integral 2 line by 16 character display and 4 button keypad is used for all programming and diagnostic displays. The menu driven programming system is powerful yet simple to use. Diagnostic features include a digital meter, I/O status, and fault displays. Programmed parameters are stored in EEPROM. In addition, an offline programming system and a file upload/download utility are available.

Simple Drive Tuning Procedures
All performance adjustments are digital parameters. Analog inputs are self-zeroing. Scaling of zero and maximum command requires only the push of a button. All velocity loop gains can be set with the drive operating.

Programmable Analog Outputs
The user can configure two analog outputs to provide any of eight different output signals. These include motor or spindle rpm, % load, % maximum power, and orient error.

I/O Options

The 8510 AC Drive I/O can be configured in several ways as explained below.

Standard I/O - Drive Model 8510A-Axx-Ax
This is the standard drive I/O and includes the functionality required for normal spindle operations on conventional machine tools.

Drive Model 8510A-Axx-Bx
In this version, the standard I/O is expanded to include the 16 bit parallel digital input that can be used for either a digital spindle speed command or an external spindle orient position command. The inputs can be configured as either a 16 bit binary or a 4 digit BCD command.

Drive Model 8510A-Axx-Cx
To the standard I/O, this version adds the high speed, high linearity 14 bit A/D converter for use in continuous path contouring applications. This I/O option should be used when the 8510 will be used for C-axis, solid tapping, and large servo axis applications or will operate in Torque Mode.

Drive Model 8510A-Axx-Dx
This version combines the features of both Option B and Option C. It would be used for lathe applications requiring C-axis operation and multi-position orient or indexing with external position commands.

System Accessories

Various accessories are available for the 8510 to facilitate system installation or to support the drive system.

- **Mating Connector Kits** – All signal interconnections to the 8510 utilize Honda multi-pin connectors. Mating connector kits are available for all the Honda connectors. A mating connector kit is also available for the AMP connector used for feedback from the motor.

- **I/O Termination Panels and Cables –** As an alternative to terminating all signal wiring to the Honda connectors, termination panels with cables are available to fan out the connections to conventional barrel type terminal blocks. Cables in various lengths with a Honda connector on one end are also available for termination directly to the machine control panels.

- **High Resolution Spindle Position Feedback –** The high resolution magnetic feedback, consisting of a precision ring gear and a pickup unit, can be used for high accuracy spindle orient. This system can provide resolutions of 225,000 to 500,000 parts per revolution with an absolute accuracy down to 0.015 degrees.

- **Mounting Adapters** – For installations where it is difficult to extend the 8510 heat sinks through the rear of the enclosure, a special mounting adapter can be provided to allow the drive to be mounted within the enclosure. A version to allow ducting the cooling air to the side or top of the enclosure is also available.

- **AC Line Fuse and Fuse Block Kit** – Incoming AC line fuses or circuit breakers are not included in the basic 8510. A kit that includes the necessary fuse blocks and fuses is available.

- **Transformers** – Both autotransformers and isolation transformers are available to match the main AC line voltage to the 200/230V AC drive input requirement.

Chapter 2

Specifications

Chapter Objectives

Chapter 2 provides the specifications for the 8510 AC Spindle Drive System. Specifications have been grouped by type of motor.

Standard Single Speed 1327AC Motor & 8510 Drive

Motor	**1327AC -**	**AFM-02**	**AFM-04**	**AFM-06**	**AFL-08**	**AFL-11**
Output Power Rating	S1 - Continuous - kW (HP) S2 - 30 Minute - kW (HP)[1] S6 - 60% Duty - kW (HP)[2] 1 Minute Peak - kW (HP)	2.2 (3) 3.7[3] (5)[3] 2.6 (3.4) 4.5 (6)	3.7 (5) 5.5 (7.5) 4.3 (5.8) 6.7 (9)	5.5 (7.5) 7.5 (10) 6.6 (8.8) 9 (12)	7.5 (10) 11 (15) 9 (12) 13.5 (18)	11 (15) 15 (20) 13.5 (18) 18 (24)
Rated Speed	Base RPM Maximum RPM Constant Power/Speed Range	1500 8000 5.33:1	1500 8000 5.33:1	1500 8000 5.33:1	1500 6000 4:1	1500 6000 4:1
Rated Torque	Continuous N-m (lb-ft)	14.2 (10.5)	23.7 (17.5)	35.6 (26.3)	47.5 (35.0)	71 (52.5)
Rated Current	30 Minute Output Amperes	27	33	43	59	91
Rotor Inertia	kg-m^2 (lb.-in.-s^2)	0.0093 (0.0819)	0.0213 (0.1881)	0.2750 (0.2438)	0.0550 (0.4867)	0.0700 (0.6195)
Bearing Load	Max. Radial - kg (lb)	133 (292)	165 (364)	167 (368)	313 (688)	335 (737)
Motor Weight	kg (lbs.)	38 (84)	59 (130)	67 (147)	94 (207)	108 (238)
Electrical Design		Single winding configuration for single speed range				
Vibration		Peak-to-peak vibration less than 3 microns (0.00012 inches)				
Audible Noise		Less than 75dB (A Scale)				
Feedback Device		8 pole brushless resolver – 65,536 counts/revolution				
Rated Ambient Temperature		0° to 40° C (+32° to +104° F)				
Possible Mounting Methods		Horizontal or vertical. Foot or flange mounting available[4]				
Drive Model Number	**8510A -**	**A04**	**A04**	**A06**	**A11**	**A11**
AC Input Voltage		200 to 220V AC (±10%) at 50/60 Hz. (±1 Hz) and 230V AC (±10%) at 60 Hz. (±1 Hz)				
Required AC Input	30 Minute Rating-kVA	6	9	12	17	22
Rated Output Current	30 Minute-Amperes	27	33	43	59	91
Power Control Method		PWM inverter using IGBT power devices				
Motor Braking Method		Power regeneration to the AC line				
Input Command		±10V DC, 0-10V DC with Fwd/Rev input, 16 bit binary or BCD digital command				
Speed Control Range		0 to 30,000 rpm, velocity resolution greater than 1:2,000,000				
Speed Regulation		Transient change < 0.4% of max speed, steady state change < 0.025% (load: 10%-100%)				
Velocity Loop Bandwidth		Up to 50 Hz (load and motor dependent)				
Programming System		Integral 2 line by 16 character backlit LCD display and 4 button keypad				
Drive Enclosure Type		Open style (IP-00) for mounting in another enclosure, heat sinks extend outside enclosure				
Drive Weight	kg (lb)	14 (31)	14 (31)	15 (33)	26 (57)	26 (57)
Allowable Vibration		Less than 0.5 G				
Rated Ambient Temperature		0 to 55° C (32 to 131° F) inside enclosure, 0 to 40° C (32 to 104° F) at heat sinks				
Storage Temperature		0 to 65° C (32 to 149° F)				

Notes: see page 2

Standard Single Speed 1327AB Motor & 8510 Drive

Motor	**1327AB -**	**AFL-15**	**AFL-19**	**AFL-22**
Output Power Rating	S1 - Continuous - kW (HP) S2 - 30 Minute - kW (HP)[1] S6 - 60% Duty - kW (HP)[2] 1 Minute Peak - kW (HP)	15 (20) 18.5 (25) 18.5 (25) 22 (30)	18.5 (25) 22 (30) 22 (30) 26.5 (36)	22 (30) 30 (40) 27 (36) 36 (48)
Rated Speed	Base RPM Maximum RPM Constant Power/Speed Range	1500 6000 4:1	1500 6000 4:1	1500 6000 4:1
Rated Torque	Continuous N-m (lb-ft)	95 (70)	119 (87.5)	142 (105)
Rated Current	30 Minute Output Amperes	112	135	153
Rotor Inertia	kg-m^2 (lb.-in.-s^2)	0.0925 (0.8186)	0.1150 (1.018)	0.1325 (1.173)
Bearing Load	Max. Radial - kg (lb)	356 (784)	373 (820)	384 (844)
Motor Weight	kg (lbs.)	130 (286)	150 (330)	166 (365)
Electrical Design		Single winding configuration for single speed range		
Vibration		Peak-to-peak vibration less than 3 microns (0.00012 inches)		
Audible Noise		Less than 75dB (A Scale)		
Feedback Device		8 pole brushless resolver – 65,536 counts/revolution		
Rated Ambient Temperature		0° to 40° C (+32° to +104° F)		
Possible Mounting Methods		Horizontal or vertical. Foot or flange mounting available[4]		
Drive Model Number	**8510A -**	**A22**	**A22**	**A22**
AC Input Voltage		200 to 220V AC (±10%) at 50/60 Hz. (±1 Hz) and 230V AC (±10%) at 60 Hz. (±1 Hz)		
Required AC Input	30 Minute Rating-kVA	26	32	40
Rated Output Current	30 Minute-Amperes	112	135	153
Power Control Method		PWM inverter using IGBT power devices		
Motor Braking Method		Power regeneration to the AC line		
Input Command		±10V DC, 0-10V DC with Fwd/Rev input, 16 bit binary or BCD digital command		
Speed Control Range		0 to 30,000 rpm, velocity resolution greater than 1:2,000,000		
Speed Regulation		Transient change < 0.4% of max speed, steady state change < 0.025% (load: 10%-100%)		
Velocity Loop Bandwidth		Up to 50 Hz (load and motor dependent)		
Programming System		Integral 2 line by 16 character backlit LCD display and 4 button keypad		
Drive Enclosure Type		Open style (IP-00) for mounting in another enclosure, heat sinks extend outside enclosure		
Drive Weight	kg (lb)	52 (114)	52 (114)	52 (114)
Allowable Vibration		Less than 0.5 G		
Rated Ambient Temperature		0 to 55° C (32 to 131° F) inside enclosure, 0 to 40° C (32 to 104° F) at heat sinks		
Storage Temperature		0 to 65° C (32 to 149° F)		

1 30 minutes starting with cold motor.

2 Loaded for 60% of a 10 minute cycle.

3 15 minute rating for 1327AB-AFM-02 motor.

4 1327AB-AFM-02 and 1327AD-ACL-08 only available as flange mount and 1327AD-ABL-08 only available as foot mount.

Dual Winding Type 1327AD Motor & 8510 Drive

Motor	**1327AD -**	**ABL-04**	**ABL-06**	**ACL-08**	**ABL-08**
Output Power Rating	S1 - Continuous - kW (HP) S2 - 30 Minute - kW (HP)[1] S6 - 60% Duty - kW (HP)[2] 1 Minute Peak - kW (HP)	3.7 (5) 5.5 (7.5) 4.5 (6) 6.7 (9)	5.5 (7.5) 7.5 (10) 6.7 (9) 9 (12)	7.5 (10) 11 (15) 9 (12) 13.5 (18)	7.5 (10) 11 (15) 9 (12) 13.5 (18)
Rated Speed	Base RPM Maximum RPM Constant Power/Speed Range	500 6000 12:1	500 6000 12:1	600 6000 10:1	500 6000 12:1
Rated Torque	Continuous N-m (lb-ft)	71 (52)	105 (77)	119 (88)	142 (105)
Rated Current	30 Minute Output Amperes	34	45	68	68
Rotor Inertia	kg-m^2 (lb.-in.-s^2)	0.0725 (0.6416)	0.1000 (0.885)	0.1200 (1.062)	0.1380 (1.221)
Bearing Load	Max. Radial - kg (lb)	300 (660)	310 (682)	360 (792)	380 (836)
Motor Weight	kg (lbs.)	105 (231)	120 (264)	140 (308)	170 (374)
Electrical Design		Reconfigurable winding for two speed ranges			
Vibration		Less than 5 microns (0.0002 inches)			
Audible Noise		Less than 75dB (A Scale)			
Feedback Device		8 pole brushless resolver – 65,536 counts/revolution			
Rated Ambient Temperature		0° to 40° C (+32° to +104° F)			
Possible Mounting Methods		Horizontal or vertical. Foot or flange mounting available[4]			
Drive Model Number	**8510A -**	**A04**	**A06**	**A11**	**A11**
AC Input Voltage		200 to 220V AC (±10%) at 50/60 Hz. (±1 Hz) and 230V AC (±10%) at 60 Hz. (±1 Hz)			
Required AC Input	30 Minute Rating-kVA	9	12	17	17
Rated Output Current	30 Minute-Amperes	34	45	68	68
Power Control Method		PWM inverter using IGBT power devices			
Motor Braking Method		Power regeneration to the AC line			
Input Command		±10V DC, 0-10V DC with Fwd/Rev input, 16 bit binary or BCD digital command			
Speed Control Range		0 to 30,000 rpm, velocity resolution greater than 1:2,000,000			
Speed Regulation		Transient change < 0.4% of max speed, steady state change < 0.025% (load: 10%-100%)			
Velocity Loop Bandwidth		Up to 50 Hz (load and motor dependent)			
Programming System		Integral 2 line by 16 character backlit LCD display and 4 button keypad			
Drive Enclosure Type		Open style (IP-00) for mounting in another enclosure, heat sinks extend outside enclosure			
Drive Weight	kg (lb)	14 (31)	15 (33)	26 (57)	26 (57)
Allowable Vibration		Less than 0.5 G			
Rated Ambient Temperature		0 to 55° C (32 to 131° F) inside enclosure, 0 to 40° C (32 to 104° F) at heat sinks			
Storage Temperature		0 to 65° C (32 to 149° F)			

1 30 minutes starting with cold motor.

2 Loaded for 60% of a 10 minute cycle.

3 15 minute rating for 1327AB-AFM-02 motor.

4 1327AB-AFM-02 and 1327AD-ACL-08 only available as flange mount and 1327AD-ABL-08 only available as foot mount.

Dual Winding Type 1327AD Motor & 8510 Drive *(continued)*

Motor	**1327AD -**	**AAK-11**	**AAK-15**	**AAK-19**
Output Power Rating	S1 - Continuous - kW (HP) S2 - 30 Minute - kW (HP)[1] S6 - 60% Duty - kW (HP)[2] 1 Minute Peak - kW (HP)	11 (15) 15 (20) 13.5 (18) 18 (24)	15 (20) 18.5 (25) 18.5 (25) 22 (30)	18.5 (25) 22 (30) 22 (30) 27 (36)
Rated Speed	Base RPM Maximum RPM Constant Power/Speed Range	400 4800 12:1	400 4800 12:1	400 4800 12:1
Rated Torque	Continuous N-m (lb-ft)	261 (193)	357 (263)	440 (325)
Rated Current	30 Minute Output Amperes	87	102	110
Rotor Inertia	kg-m^2 (lb.-in.-s^2)	0.338 (2.991)	0.473 (4.186)	0.548 (4.850)
Bearing Load	Max. Radial - kg (lb)	580 (1276)	600 (1320)	610 (1342)
Motor Weight	kg (lbs.)	260 (572)	355 (781)	405 (891)
Electrical Design		Reconfigurable winding for two speed ranges		
Vibration		Less than or equal to 10 microns (0.0004 inches)		
Audible Noise		Less than 80dB (A Scale)		
Feedback Device		8 pole brushless resolver – 65,536 counts/revolution		
Rated Ambient Temperature		0° to 40° C (+32° to +104° F)		
Possible Mounting Methods		Horizontal or vertical. Foot or flange mounting available[4]		
Drive Model Number	**8510A -**	**A11**	**A22**	**A22**
AC Input Voltage		200 to 220V AC (±10%) at 50/60 Hz. (±1 Hz) and 230V AC (±10%) at 60 Hz. (±1 Hz)		
Required AC Input	30 Minute Rating-kVA	22	26	32
Rated Output Current	30 Minute-Amperes	87	102	110
Power Control Method		PWM inverter using IGBT power devices		
Motor Braking Method		Power regeneration to the AC line		
Input Command		±10V DC, 0-10V DC with Fwd/Rev input, 16 bit binary or BCD digital command		
Speed Control Range		0 to 30,000 rpm, velocity resolution greater than 1:2,000,000		
Speed Regulation		Transient change < 0.4% of max speed, steady state change < 0.025% (load: 10%-100%)		
Velocity Loop Bandwidth		Up to 50 Hz (load and motor dependent)		
Programming System		Integral 2 line by 16 character backlit LCD display and 4 button keypad		
Drive Enclosure Type		Open style (IP-00) for mounting in another enclosure, heat sinks extend outside enclosure		
Drive Weight	kg (lb)	26 (57)	52 (114)	52 (114)
Allowable Vibration		Less than 0.5 G		
Rated Ambient Temperature		0 to 55° C (32 to 131° F) inside enclosure, 0 to 40° C (32 to 104° F) at heat sinks		
Storage Temperature		0 to 65° C (32 to 149° F)		

1 30 minutes starting with cold motor.

2 Loaded for 60% of a 10 minute cycle.

3 15 minute rating for 1327AB-AFM-02 motor.

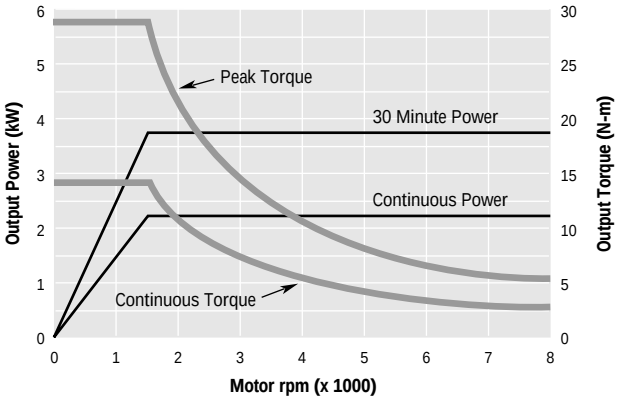
4 1327AB-AFM-02 and 1327AD-ACL-08 only available as flange mount and 1327AD-ABL-08 only available as foot mount.

Motor Curves

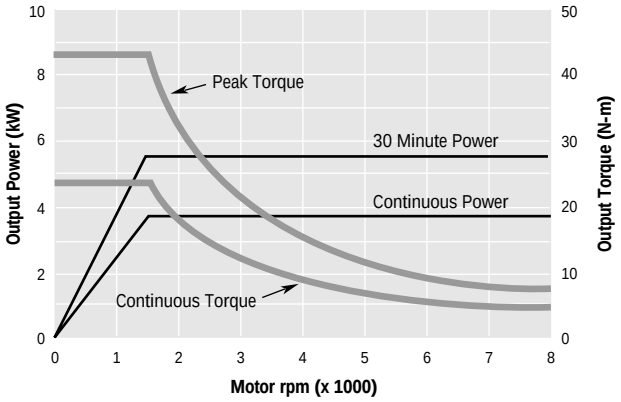
Typical speed/torque curves for the 1327 AC Motors are shown on the following pages.

Figure 2.1
Motor Curves

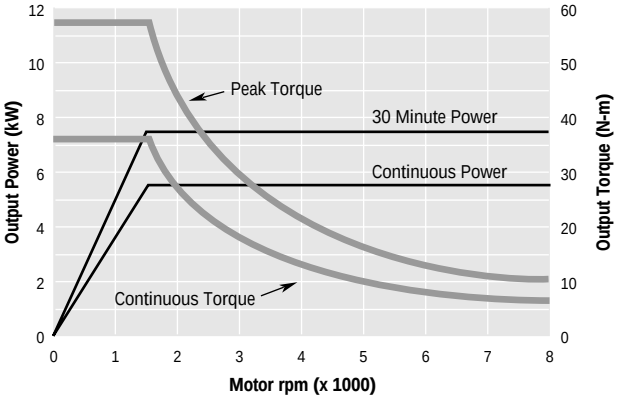
1327AC-AFM-02-F
8510A-A04-x1



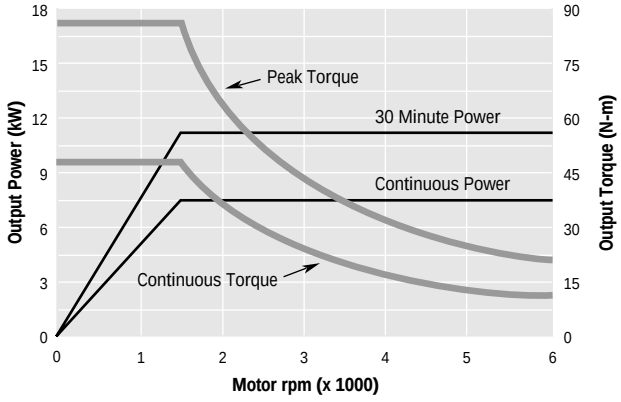
1327AC-AFM-04-x
8510A-A04-x1



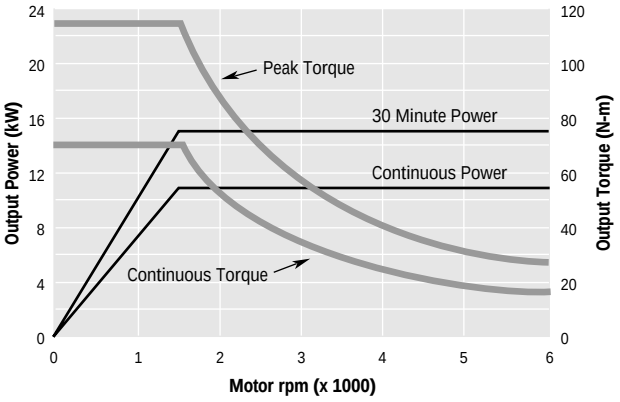
1327AC-AFM-06-x
8510A-A06-x1



1327AC-AFL-08-x
8510A-A11-x2



1327AC-AFL-11-x
8510A-A11-x2



1327AB-AFL-15-x
8510A-A22-x2

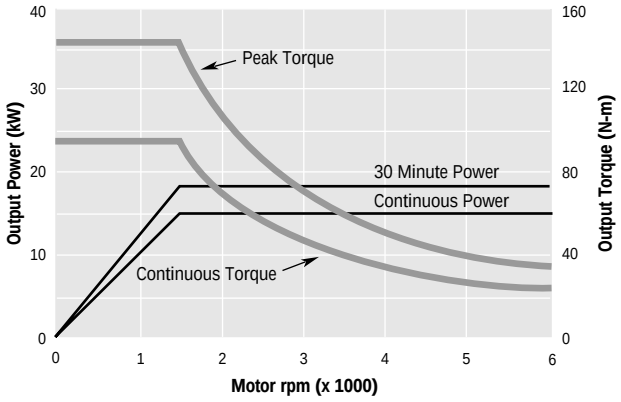
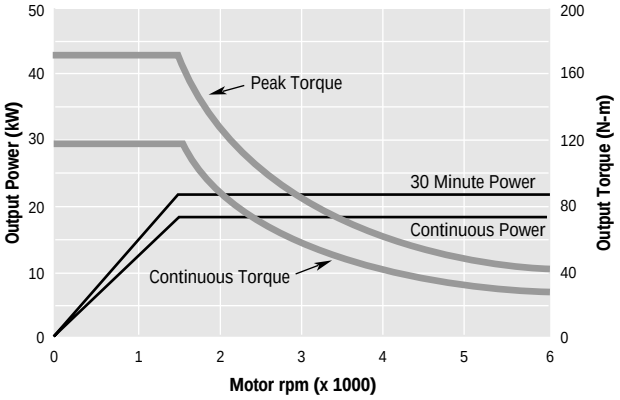
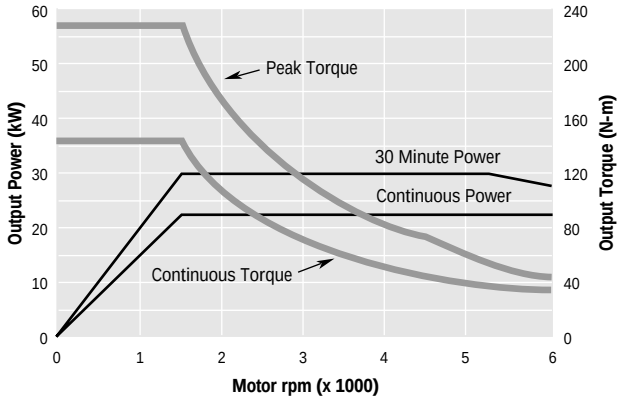


Figure 2.1 *(continued)*
Motor Curves

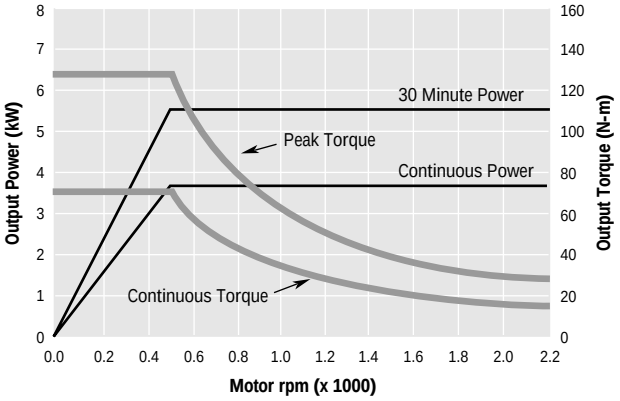
1327AB-AFL-19-x
8510A-A22-x2



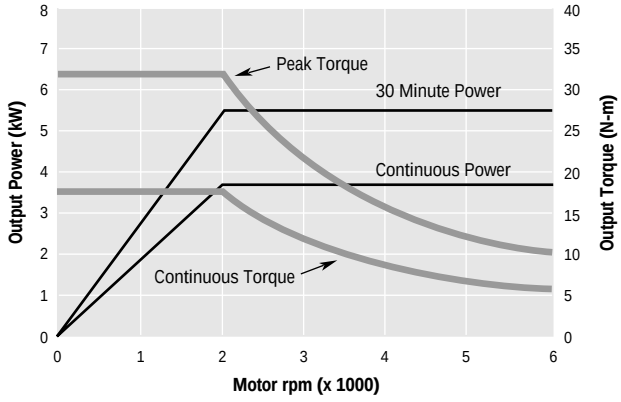
1327AB-AFL-22-x
8510A-A22-x2



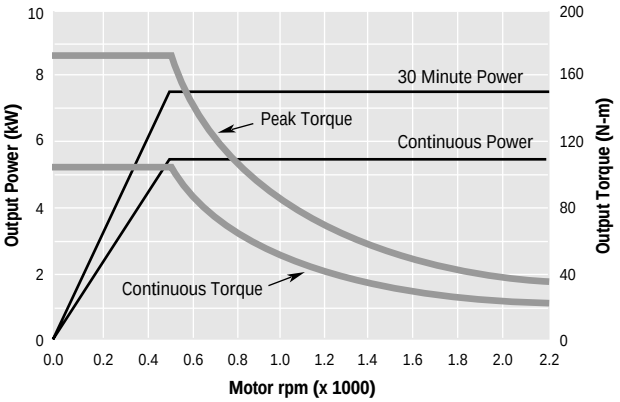
1327AD-ABL-04-x (low speed winding)
8510A-A04-x1



1327AD-ABL-04-x (high speed winding)
8510A-A04-x1



1327AD-ABL-06-x (low speed winding)
8510A-A06-x1



1327AD-ABL-06-x (high Speed winding)
8510A-A06-x1

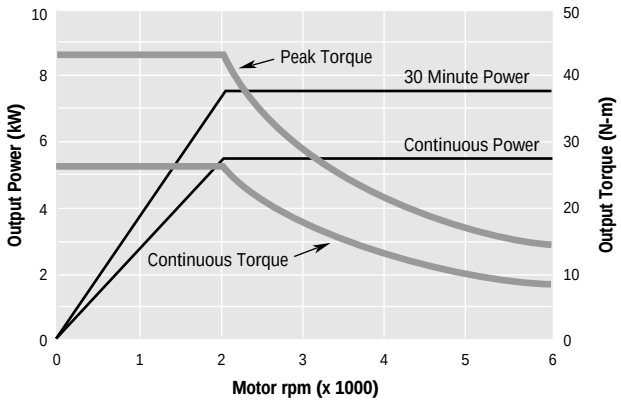
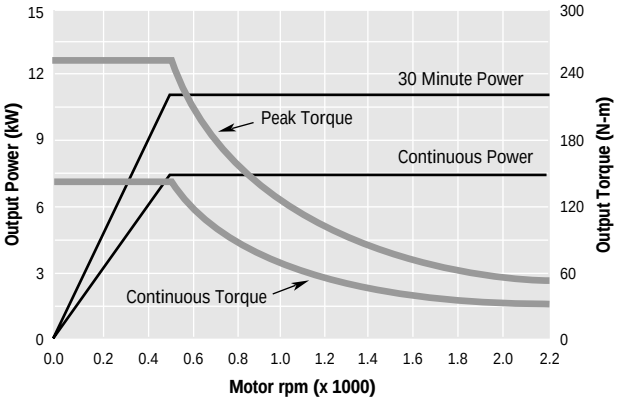
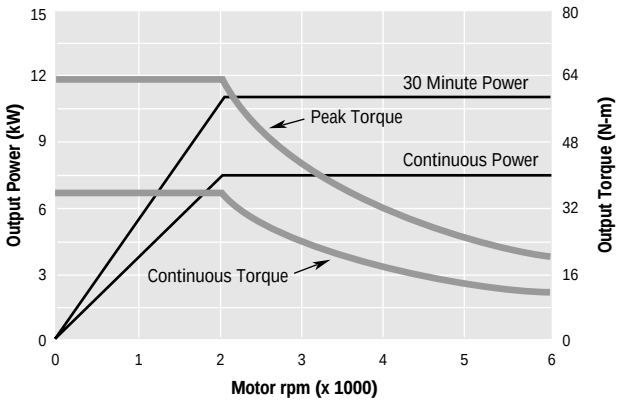


Figure 2.1 *(continued)*
Motor Curves

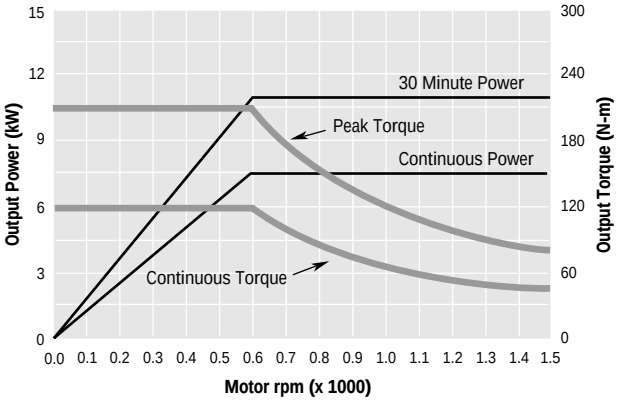
1327AD-ABL-08-E (low speed winding)
8510A-A11-x2



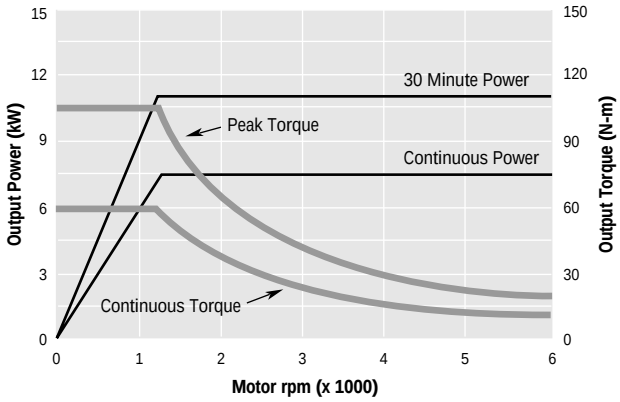
1327AD-ABL-08-E (high speed winding)
8510A-A11-x2



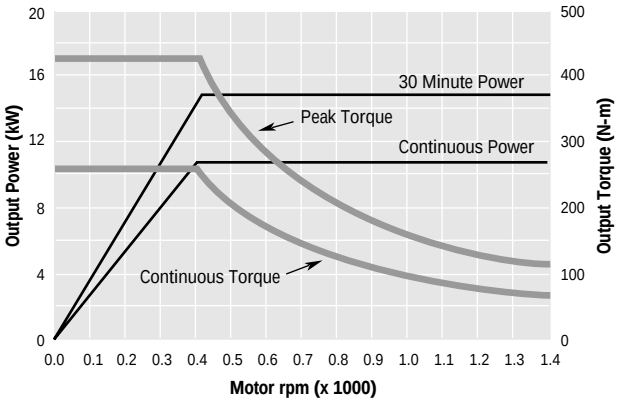
1327AD-ACL-08-F (low speed winding)
8510A-A11-x2



1327AD-ACL-08-F (high speed winding)
8510A-A11-x2



1327AD-AAK-11-x (low speed winding)
8510A-A11-x2



1327AD-AAK-11-x (high speed winding)
8510A-A11-x2

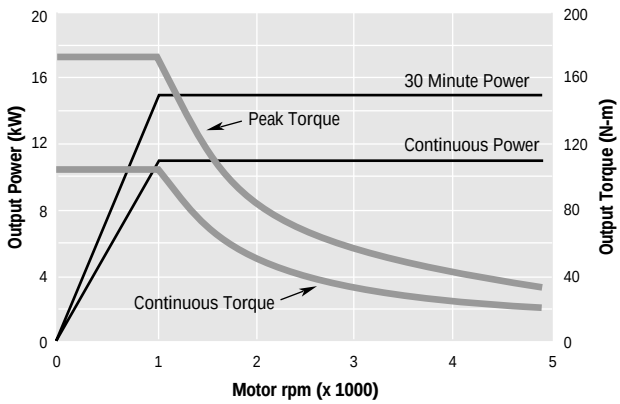
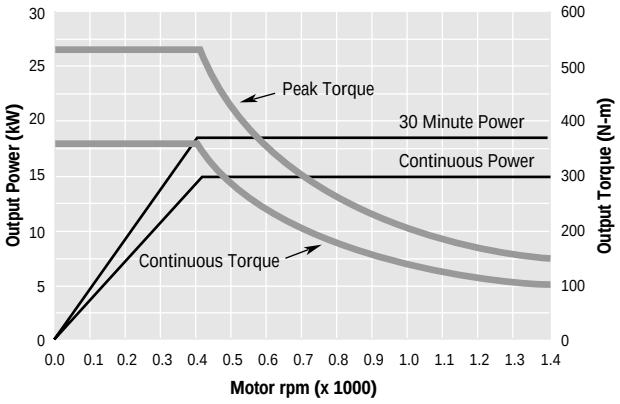
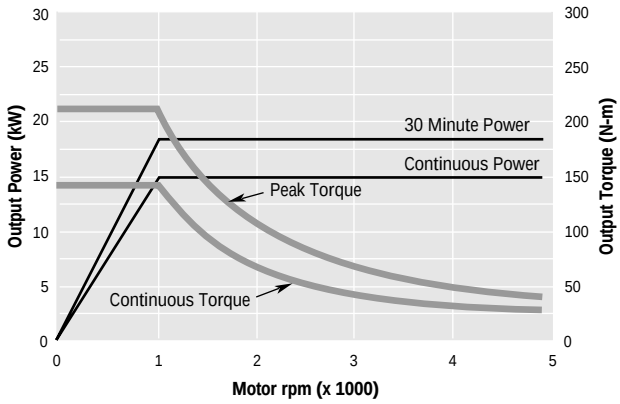


Figure 2.1 *(continued)*
Motor Curves

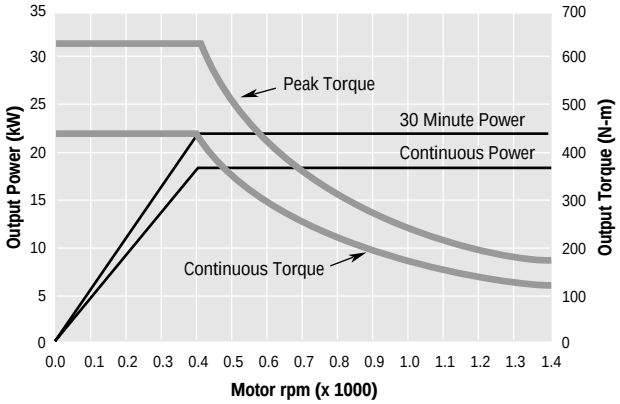
1327AD-AAK-15-x (low speed winding)
8510A-A22-x2



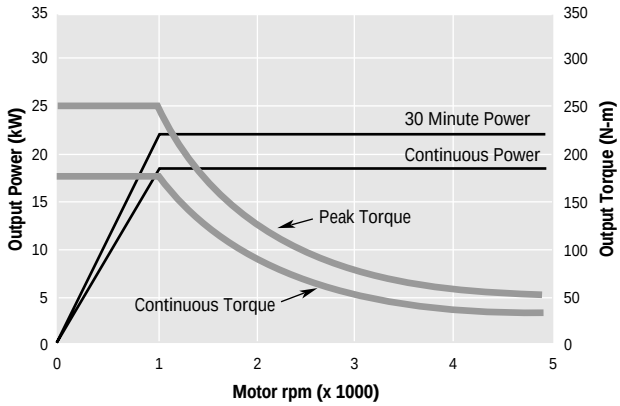
1327AD-AAK-15-x (high speed winding)
8510A-A22-x2



1327AD-AAK-19-x (low speed winding)
8510A-A22-x2



1327AD-AAK-19-x (high speed winding)
8510A-A22-x2



Chapter 3

Dimensions

Chapter Objectives

Dimensions for the 8510 system components are detailed on the following pages. Refer to the listing below for help in locating the desired drawing.

Please note that dimensions are in millimeters, unless otherwise stated.

Figure 3.1
8510 Drive – A04

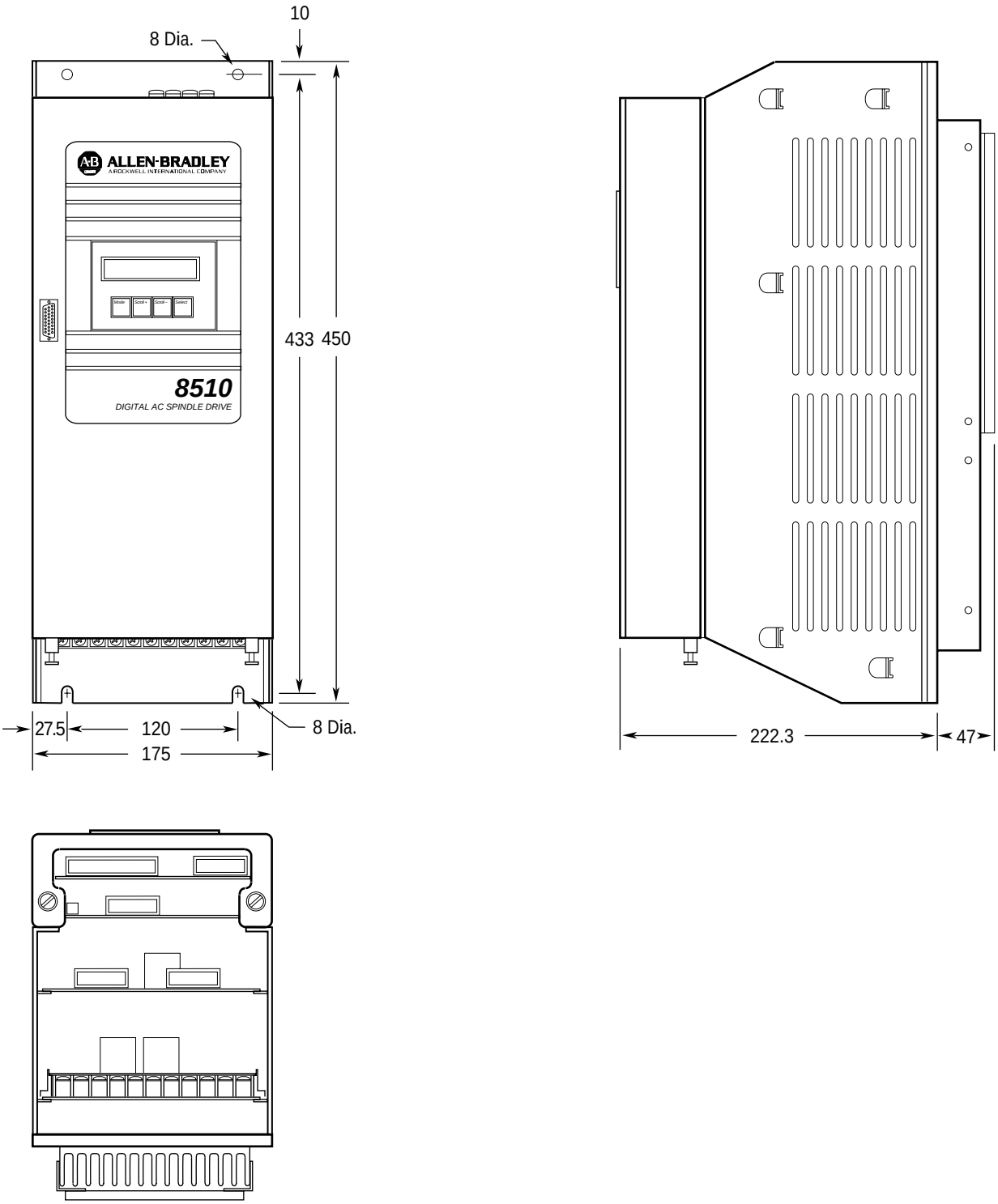


Figure 3.2
8510 Drive – A04 Mounting

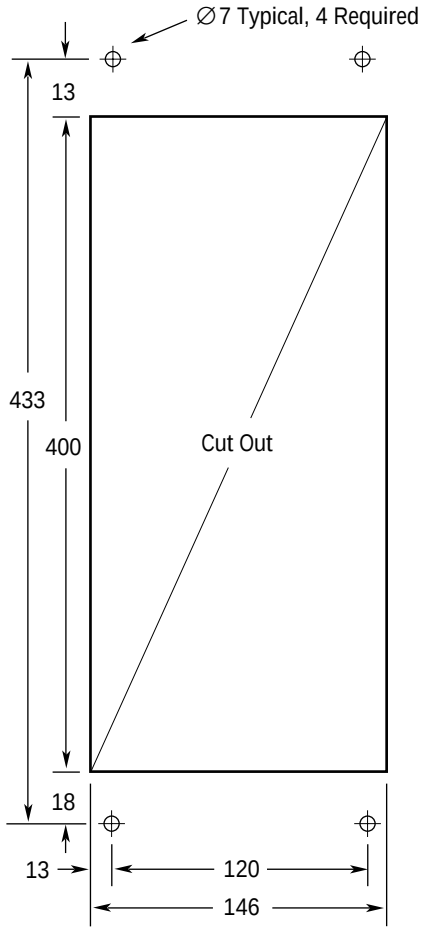


Figure 3.3
8510 Drive – A06

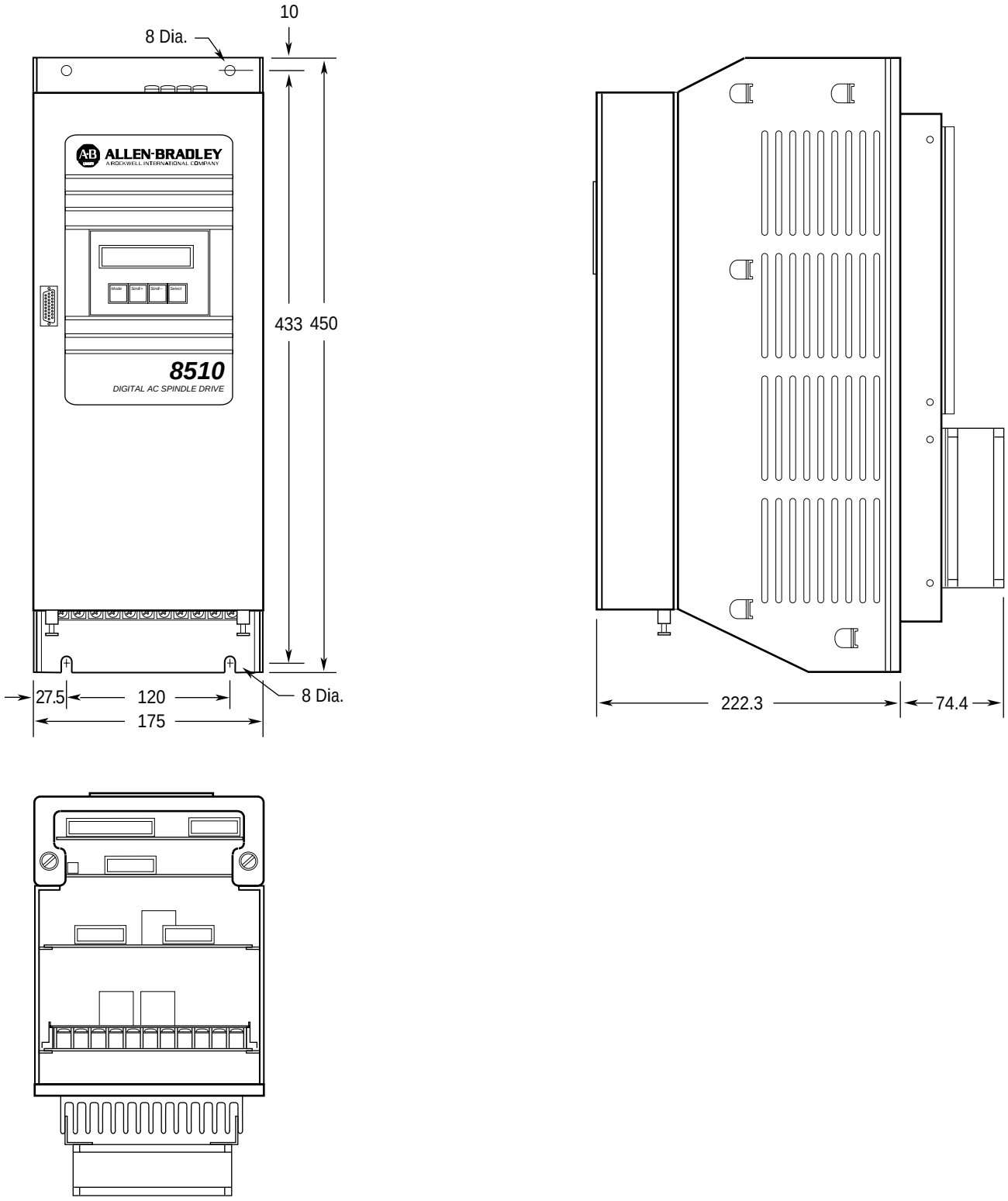


Figure 3.4
8510 Drive – A06 Mounting

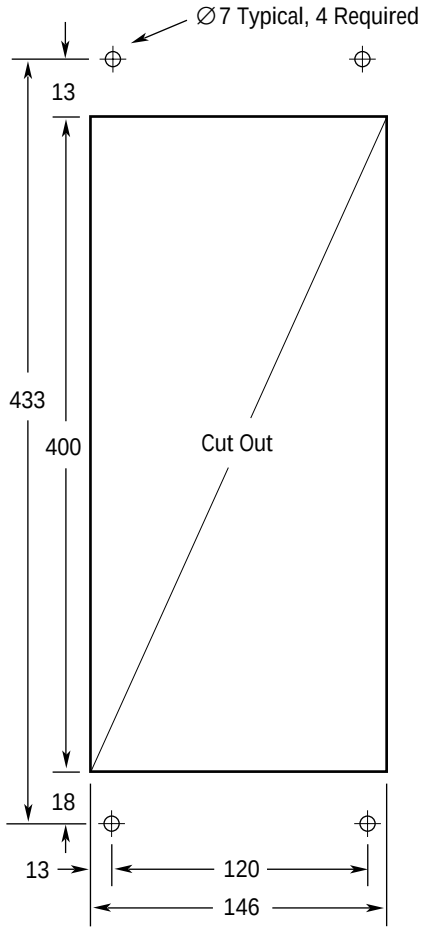
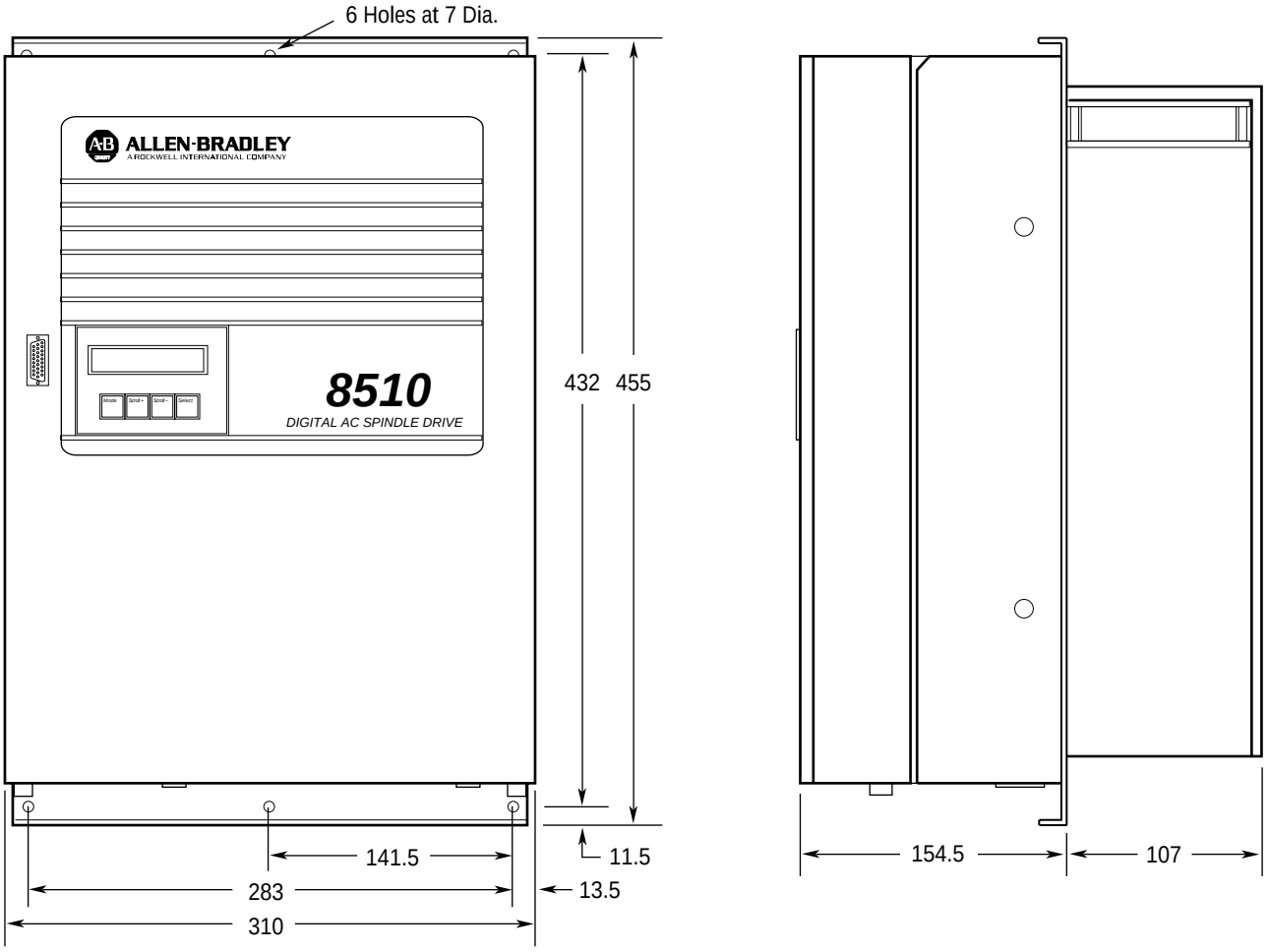


Figure 3.5
8510 Drive – A11



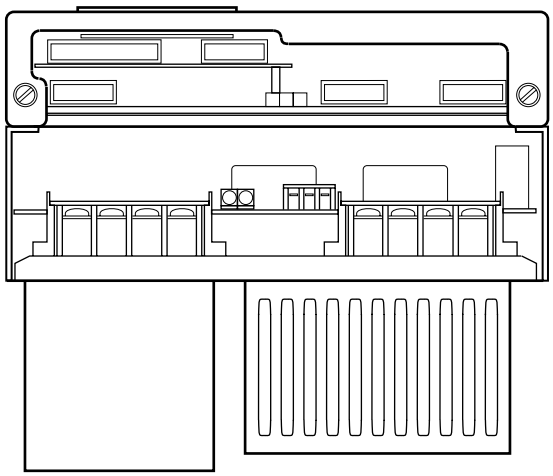


Figure 3.6
8510 Drive – A11 Mounting

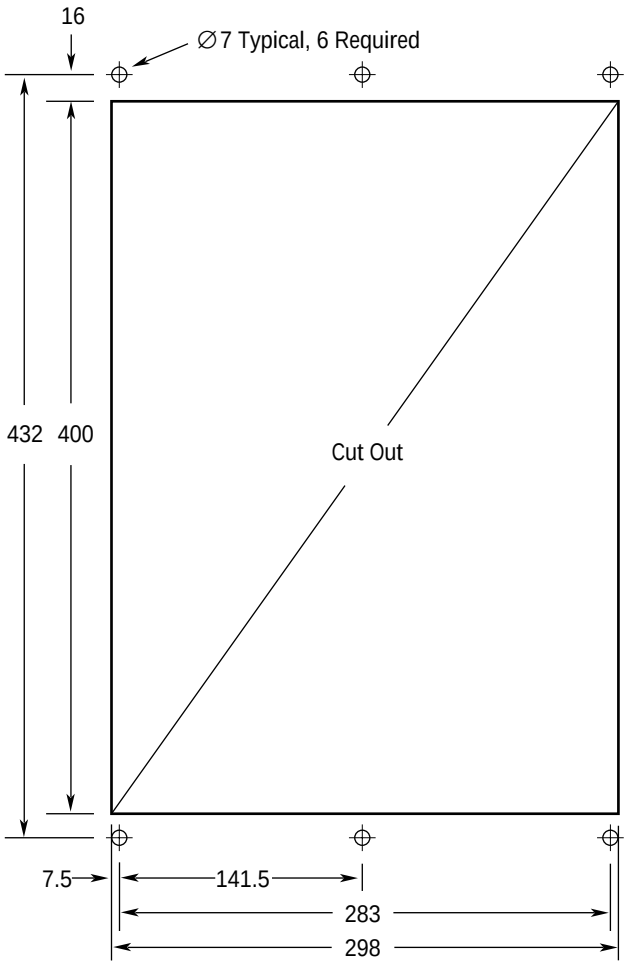


Figure 3.7
8510 Drive – A22

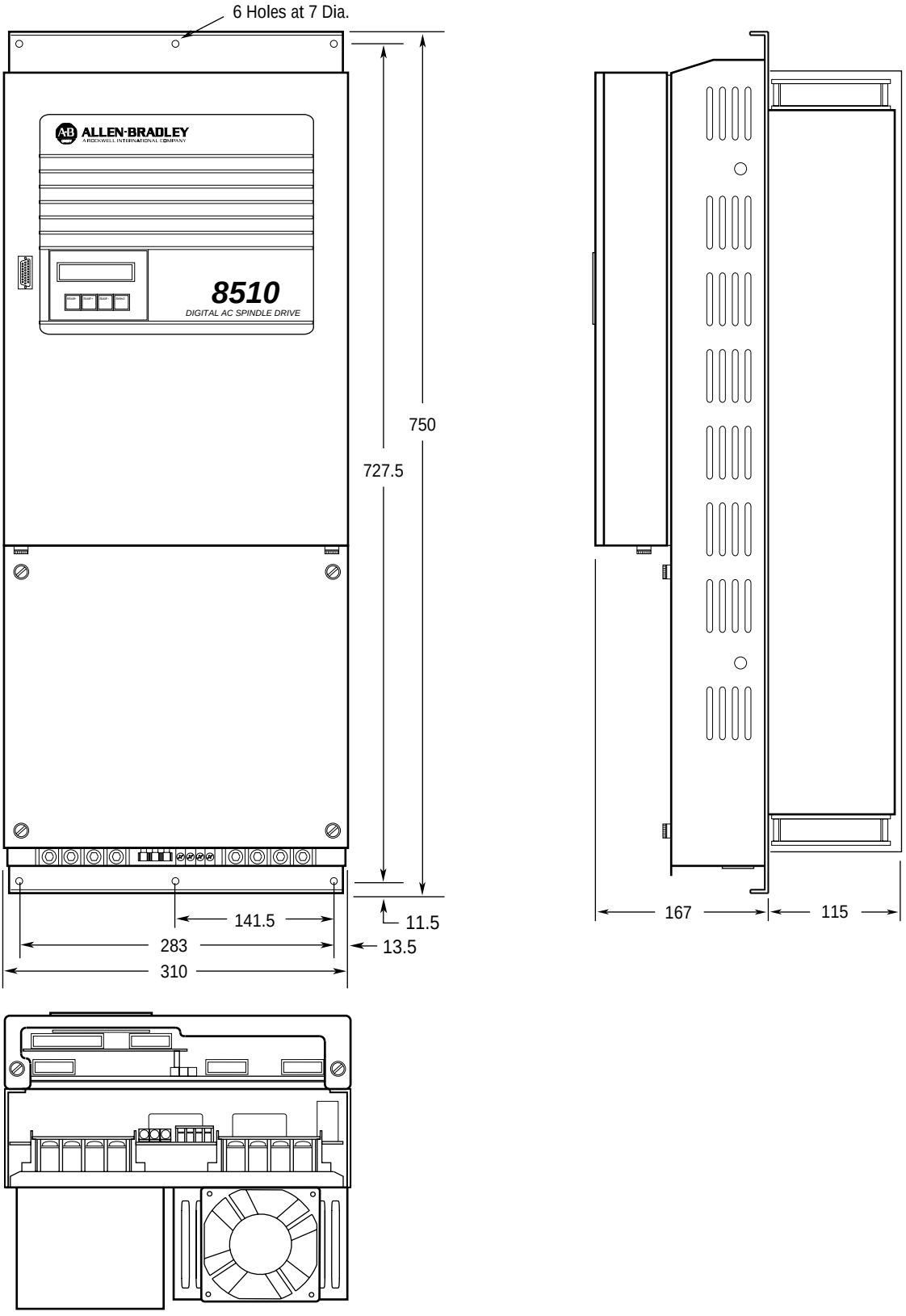


Figure 3.8
8510 Drive – A22 Mounting

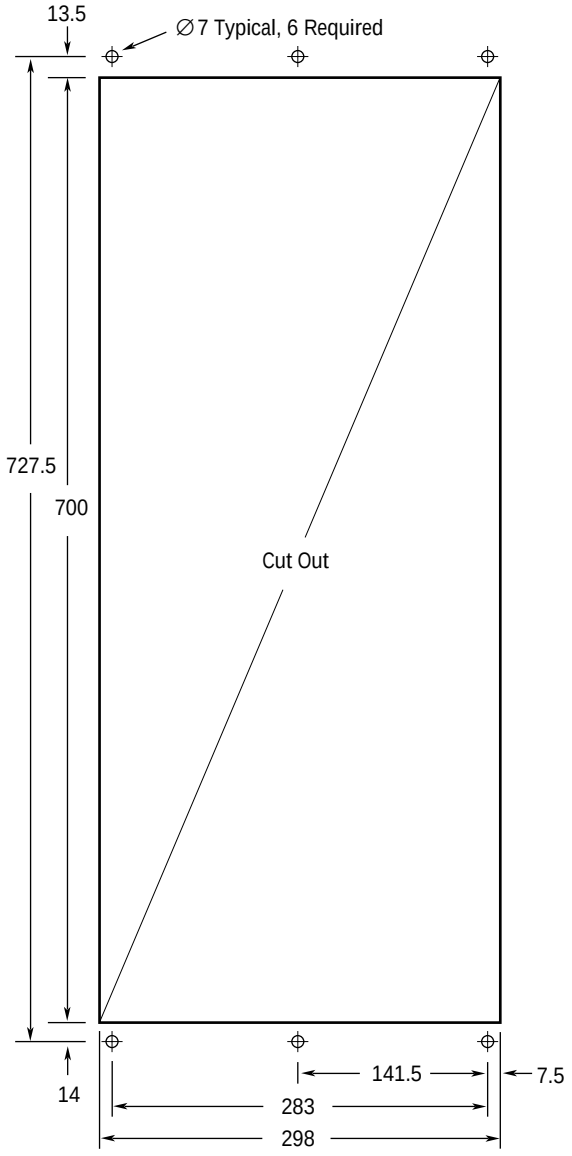
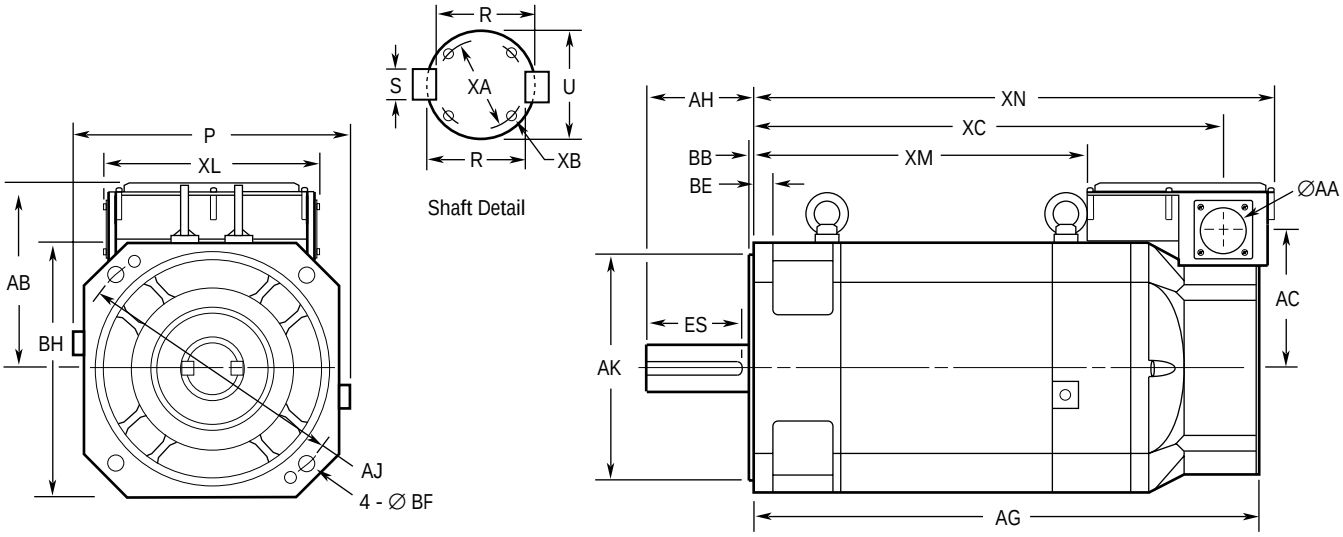


Figure 3.9
1327AB and 1327AD Series A Flange Mount Motor

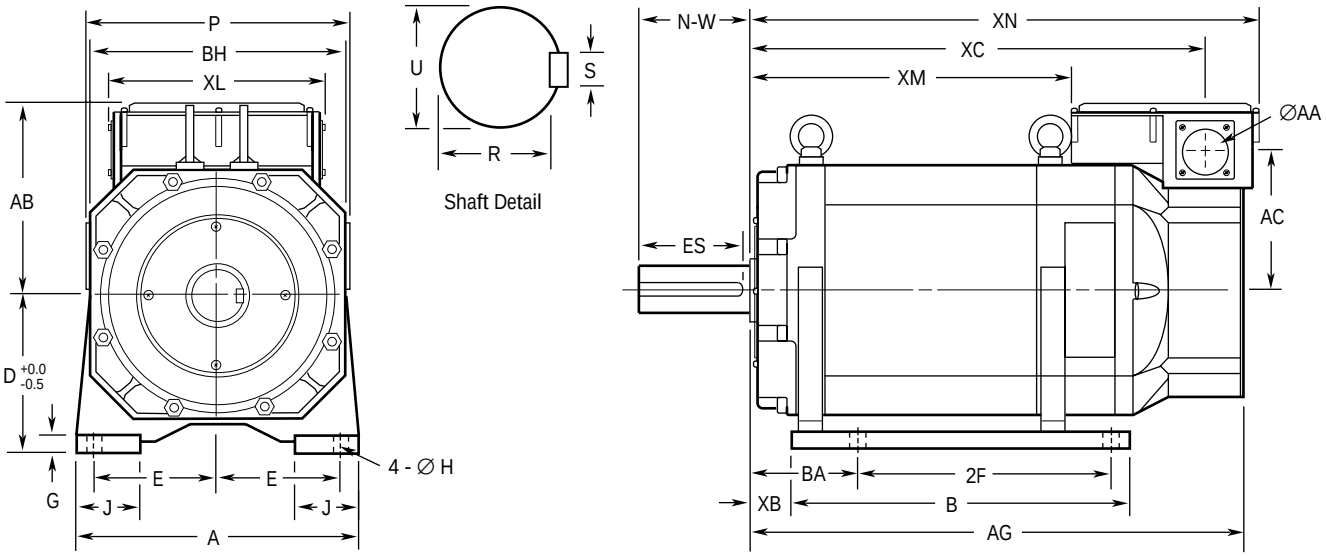


Flange Mount Motor (Dimensions are in millimeters)

		Overall			Conduit Box							Flange				
Catalog Number	**Series**	**P**	**AG**	**BH**	**AA**	**AB**	**AC**	**XC**	**XL**	**XM**	**XN**	**AJ**	**AK**	**BB**	**BE**	**BF**
1327AB-AFM-02-F	A	174	359	174	35	149	106	343	194	215	385	185	150 h7 (+0.000/–0.040)	5	15	11
1327AB-AFM-04-F	A	214	407	204	51	178	126	376	214	235	425	215	180 h7 (+0.000/–0.040)	5	18	15
1327AB-AFM-06-F	A	214	447	204	51	178	126	416	214	275	465	215	180 h7 (+0.000/–0.040)	5	18	15
1327AB-AFL-08-F	A	270	418	250	51	202	150	383	214	243	433	265	230 h7 (+0.000/–0.046)	5	20	15
1327AB-AFL-11-F	A	270	458	250	51	202	150	423	214	283	473	265	230 h7 (+0.000/–0.046)	5	20	15
1327AB-AFL-15-F	A	250	508	250	51	207	152	496.5	241	331	551	265	230 h7 (+0.000/–0.046)	5	20	15
1327AB-AFL-19-F	A	250	560	250	63	207	152	546.5	241	381	601	265	230 h7 (+0.000/–0.046)	5	20	15
1327AB-AFL-22-F	A	250	600	250	63	207	152	586.5	241	421	641	265	230 h7 (+0.000/–0.046)	5	20	15
1327AD-ABL-04-F	A	250	453	250	49	183	131	398	320	265	441	265	230 h7 (+0.000/–0.046)	5	18	15
1327AD-ABL-06-F	A	250	491	250	49	183	131	436	320	303	479	265	230 h7 (+0.000/–0.046)	5	18	15
1327AD-ACL-08-F	A	250	539	250	49	183	131	484	320	351	527	265	230 h7 (+0.000/–0.046)	5	18	15
1327AD-AAK-11-F	A	330	687	310	61	212	158	667	330	491	722	350	300 h7 (+0.000/–0.052)	5	20	19
1327AD-AAK-15-F	A	384	666	380	61	280	216	628	385	430	687	400	350 h7 (+0.000/–0.057)	5	22	24
1327AD-AAK-19-F	A	384	716	380	61	280	216	678	385	480	737	400	350 h7 (+0.000/–0.057)	5	22	24

		Shaft and Key								
Catalog Number	**Series**	**U**	**AH**	**ES**	**R**	**S**	**Key - W**	**Key - H**	**XA**	**XB**
1327AB-AFM-02-F	A	28 j6 (+0.009/–0.004)	60	-	-	-	-	-	-	-
1327AB-AFM-04-F	A	28 h6 (+0.000/–0.013)	60	49	24 (0.0/–0.2)	8 P9 (–0.015/–0.051)	8 h9 (+0.0/–0.036)	7 h11 (+0.0/–0.09)	16	2 – M6 x 10 deep
1327AB-AFM-06-F	A	32 h6 (+0.000/–0.016)	80	75	27 (0.0/–0.2)	10 P9 (–0.015/–0.051)	10 h9 (+0.0/–0.036)	8 h11 (+0.0/–0.09)	22	4 – M5 x 10 deep
1327AB-AFL-08-F	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AB-AFL-11-F	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AB-AFL-15-F	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AB-AFL-19-F	A	55 h6 (+0.000/–0.019)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)	45	4 – M5 x 10 deep
1327AB-AFL-22-F	A	55 h6 (+0.000/–0.019)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)	45	4 – M5 x 10 deep
1327AD-ABL-04-F	A	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AD-ABL-06-F	A	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AD-ACL-08-F	A	55 h6 (+0.000/–0.019)	110	90	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)	45	4 – M5 x 10 deep
1327AD-AAK-11-F	A	60 h6 (+0.000/–0.019)	140	110	53 (0.0/–0.2)	18 P9 (–0.018/–0.061)	18 h9 (+0.0/–0.043)	11 h11 (+0.0/–0.11)	50	4 – M6 x 10 deep
1327AD-AAK-15-F	A	70 h6 (+0.000/–0.019)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)	60	4 – M6 x 10 deep
1327AD-AAK-19-F	A	70 h6 (+0.000/–0.019)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)	60	4 – M6 x 10 deep

Figure 3.10
1327AB and 1327AD Series A Foot Mount Motor

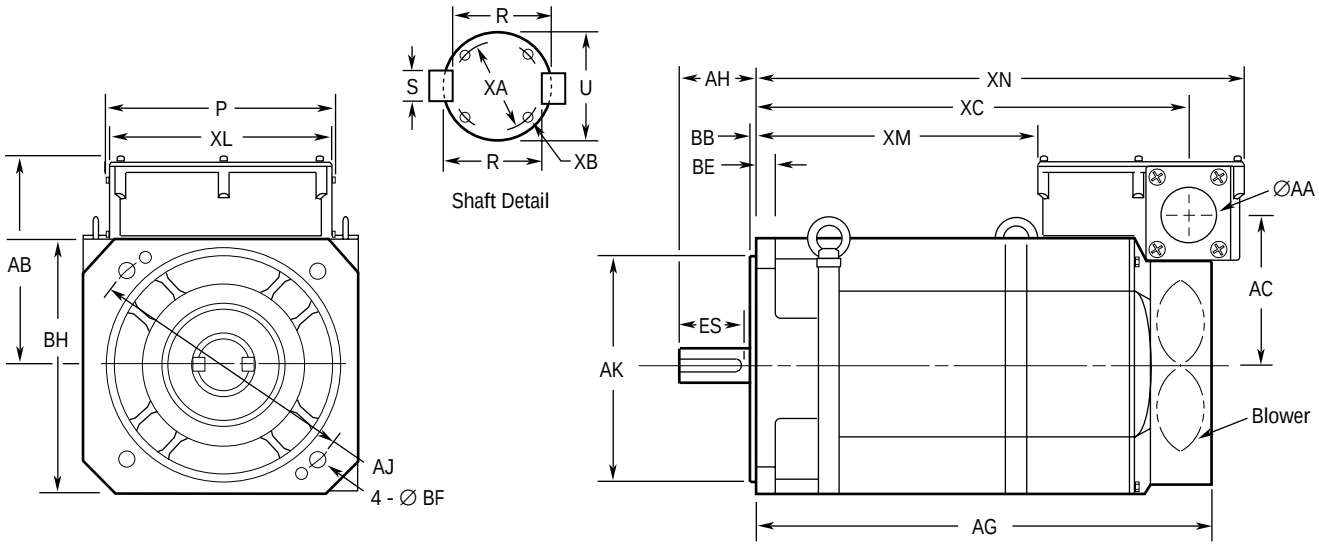


Foot Mount Motor (Dimensions are in millimeters)

		Overall				Conduit Box							Mounting Feet								
Catalog Number	**Series**	**P**	**AG**	**D**	**BH**	**AA**	**AB**	**AC**	**XC**	**XL**	**XM**	**XN**	**A**	**E**	**G**	**H**	**J**	**B**	**2F**	**BA**	**XB**
1327AB-AFM-04-E	A	211	406	112	204	51	178	126	365	214	225	415	220	95	11	12	44	198	100	70	27.5
1327AB-AFM-06-E	A	211	435	112	204	51	178	126	405	214	265	455	220	95	10	12	44	238	140	70	27.5
1327AB-AFL-08-E	A	258	408	160	250	51	202	150	372	214	232	422	290	127	18	15	65	235	140	108	43
1327AB-AFL-11-E	A	258	448	160	250	51	202	150	412	214	272	462	290	127	18	15	65	261	178	108	43
1327AB-AFL-15-E	A	250	498	160	250	51	207	152	487.5	241	322	542	290	127	18	14.5	65	340	254	108	43
1327AB-AFL-19-E	A	250	549	160	250	63	207	152	537.5	241	372	592	290	127	18	14.5	65	365	279	108	43
1327AB-AFL-22-E	A	250	589	160	250	63	207	152	577.5	241	412	632	290	127	18	14.5	65	404	318	108	43
1327AD-ABL-04-E	A	250	454	160	250	49	183	131	399	320	266	442	290	127	16	15	47	244	178	108	59
1327AD-ABL-06-E	A	250	492	160	250	49	183	131	437	320	304	480	290	127	16	15	55	278	210	108	59
1327AD-ABL-08-E	A	250	569	160	250	49	183	131	513.5	320	380.5	556.5	290	127	16	15	55	375	305	108	59
1327AD-AAK-11-E	A	310	643	180	310	61	212	158	623	330	447	678	320	139.5	16	19	55	390	254	121	50
1327AD-AAK-15-E	A	380	661.5	225	380	61	280	216	623.5	385	425.5	682.5	420	178	21	24	75	425	311	149	73
1327AD-AAK-19-E	A	380	711.5	225	380	61	280	216	673.5	385	475.5	732.5	420	178	21	24	75	465	349	149	73

		Shaft and Key						
Catalog Number	**Series**	**U**	**N-W**	**ES**	**R**	**S**	**Key - W**	**Key - H**
1327AB-AFM-04-E	A	28 h6 (+0.000/–0.013)	60	49	24 (0.0/–0.2)	8 P9 (–0.015/–0.051)	8 h9 (+0.0/–0.036)	7 h11 (+0.0/–0.09)
1327AB-AFM-06-E	A	32 h6 (+0.000/–0.016)	80	70	27 (0.0/–0.2)	10 P9 (–0.015/–0.051)	10 h9 (+0.0/–0.036)	8 h11 (+0.0/–0.09)
1327AB-AFL-08-E	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AB-AFL-11-E	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AB-AFL-15-E	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AB-AFL-19-E	A	55 m6 (+0.030/+0.011)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)
1327AB-AFL-22-E	A	55 m6 (+0.030/+0.011)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)
1327AD-ABL-04-E	A	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AD-ABL-06-E	A	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AD-ABL-08-E	A	55 m6 (+0.030/+0.011)	110	90	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)
1327AD-AAK-11-E	A	60 m6 (+0.030/+0.011)	140	110	53 (0.0/–0.2)	18 P9 (–0.018/–0.061)	18 h9 (+0.0/–0.043)	11 h11 (+0.0/–0.11)
1327AD-AAK-15-E	A	70 m6 (+0.030/+0.011)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)
1327AD-AAK-19-E	A	70 m6 (+0.030/+0.011)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)

Figure 3.11
1327AB Series B, 1327AC Series A and 1327AD Series B Flange Mount Motor

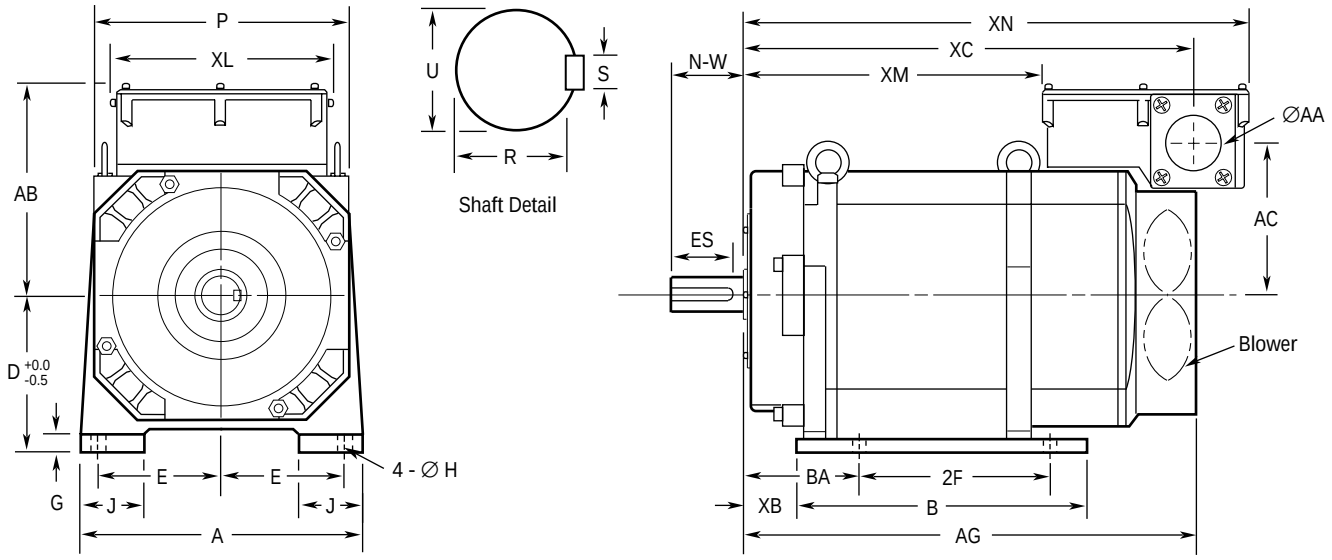


Flange Mount Motor (Dimensions are in millimeters)

		Overall			Conduit Box							Flange				
Catalog Number	**Series**	**P**	**AG**	**BH**	**AA**	**AB**	**AC**	**XC**	**XL**	**XM**	**XN**	**AJ**	**AK**	**BB**	**BE**	**BF**
1327AC-AFM-02-F	A	174	337	174	35	148	104	318	192	190	360	185	150 h7 (+0.000/–0.040)	5	15	11
1327AC-AFM-04-F	A	204	408	204	51	176	124	376	212	236	426	215	180 h7 (+0.000/–0.040)	5	18	14.5
1327AC-AFM-06-F	A	204	448	204	51	176	124	416	212	276	466	215	180 h7 (+0.000/–0.040)	5	18	14.5
1327AC-AFL-08-F	A	250	410	250	51	199	147	384	212	244	434	265	230 h7 (+0.000/–0.046)	5	20	14.5
1327AC-AFL-11-F	A	250	450	250	51	199	147	424	212	284	474	265	230 h7 (+0.000/–0.046)	5	20	14.5
1327AB-AFL-15-F	B	250	500	250	51	206	151	493.5	242	328	548	265	230 h7 (+0.000/–0.046)	5	20	14.5
1327AB-AFL-19-F	B	250	550	250	63	206	151	543.5	242	378	598	265	230 h7 (+0.000/–0.046)	5	20	14.5
1327AB-AFL-22-F	B	250	590	250	63	206	151	583.5	242	418	638	265	230 h7 (+0.000/–0.046)	5	20	14.5
1327AD-ABL-04-F	B	250	453	250	49	183	131	398	320	265	441	265	230 h7 (+0.000/–0.046)	5	18	15
1327AD-ABL-06-F	B	250	491	250	49	183	131	436	320	303	479	265	230 h7 (+0.000/–0.046)	5	18	15
1327AD-ACL-08-F	B	250	539	250	49	183	131	484	320	351	527	265	230 h7 (+0.000/–0.046)	5	18	15
1327AD-AAK-11-F	B	330	687	310	61	212	158	667	330	491	722	350	300 h7 (+0.000/–0.052)	5	20	19
1327AD-AAK-15-F	B	384	666	380	61	280	216	628	385	430	687	400	350 h7 (+0.000/–0.057)	5	22	24
1327AD-AAK-19-F	B	384	716	380	61	280	216	678	385	480	737	400	350 h7 (+0.000/–0.057)	5	22	24

		Shaft and Key								
Catalog Number	**Series**	**U**	**AH**	**ES**	**R**	**S**	**Key - W**	**Key - H**	**XA**	**XB**
1327AC-AFM-02-F	A	28 j6 (+0.009/–0.004)	60	-	-	-	-	-	-	-
1327AC-AFM-04-F	A	28 h6 (+0.000/–0.013)	60	49	24 (0.0/–0.2)	8 P9 (–0.015/–0.051)	8 h9 (+0.0/–0.036)	7 h11 (+0.0/–0.09)	16	2 – M6 x 10 deep
1327AC-AFM-06-F	A	32 h6 (+0.000/–0.016)	80	75	27 (0.0/–0.2)	10 P9 (–0.015/–0.051)	10 h9 (+0.0/–0.036)	8 h11 (+0.0/–0.09)	22	4 – M5 x 10 deep
1327AC-AFL-08-F	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AC-AFL-11-F	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AB-AFL-15-F	B	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AB-AFL-19-F	B	55 h6 (+0.000/–0.019)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)	45	4 – M5 x 10 deep
1327AB-AFL-22-F	B	55 h6 (+0.000/–0.019)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)	45	4 – M5 x 10 deep
1327AD-ABL-04-F	B	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AD-ABL-06-F	B	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)	38	4 – M5 x 10 deep
1327AD-ACL-08-F	B	55 h6 (+0.000/–0.019)	110	90	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)	45	4 – M5 x 10 deep
1327AD-AAK-11-F	B	60 h6 (+0.000/–0.019)	140	110	53 (0.0/–0.2)	18 P9 (–0.018/–0.061)	18 h9 (+0.0/–0.043)	11 h11 (+0.0/–0.11)	50	4 – M6 x 10 deep
1327AD-AAK-15-F	B	70 h6 (+0.000/–0.019)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)	60	4 – M6 x 10 deep
1327AD-AAK-19-F	B	70 h6 (+0.000/–0.019)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)	60	4 – M6 x 10 deep

Figure 3.12
1327AB Series B, 1327AC Series A and 1327AD Series B Foot Mount Motor

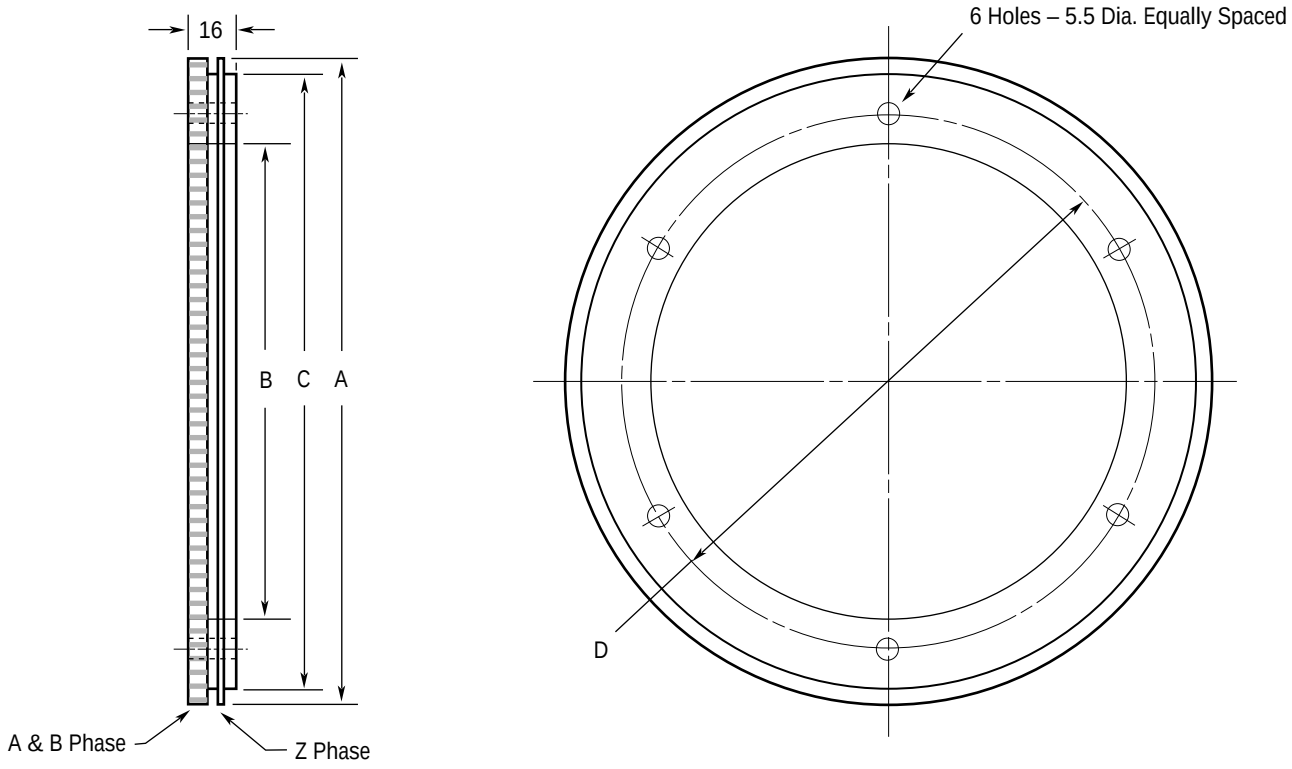


Foot Mount Motor (Dimensions are in millimeters)

		Overall			Conduit Box							Mounting Feet								
Catalog Number	**Series**	**P**	**AG**	**D**	**AA**	**AB**	**AC**	**XC**	**XL**	**XM**	**XN**	**A**	**E**	**G**	**H**	**J**	**B**	**2F**	**BA**	**XB**
1327AC-AFM-04-E	A	204	395	112	51	176	124	363	212	223	413	220	95	11	12	44	198	100	70	30.5
1327AC-AFM-06-E	A	204	435	112	51	176	124	403	212	263	453	220	95	10	12	44	237	140	70	30.5
1327AC-AFL-08-E	A	250	401	160	51	199	147	375	212	235	425	290	127	18	14.5	65	235	140	108	43
1327AC-AFL-11-E	A	250	441	160	51	199	147	415	212	275	465	290	127	18	14.5	65	261	178	108	43
1327AB-AFL-15-E	B	250	491	160	51	206	151	484.5	242	319	539	290	127	18	14.5	65	340	254	108	43
1327AB-AFL-19-E	B	250	541	160	63	206	151	534.5	242	369	589	290	127	18	14.5	65	365	279	108	43
1327AB-AFL-22-E	B	250	581	160	63	206	151	574.5	242	409	629	290	127	18	14.5	65	404	318	108	43
1327AD-ABL-04-E	B	250	454	160	49	183	131	399	320	266	442	290	127	16	15	47	244	178	108	59
1327AD-ABL-06-E	B	250	492	160	49	183	131	437	320	304	480	290	127	16	15	55	278	210	108	59
1327AD-ABL-08-E	B	250	569	160	49	183	131	513.5	320	380.5	556.5	290	127	16	15	55	375	305	108	59
1327AD-AAK-11-E	B	310	643	180	61	212	158	623	330	447	678	320	139.5	16	19	55	390	254	121	50
1327AD-AAK-15-E	B	380	661.5	225	61	280	216	623.5	385	425.5	682.5	420	178	21	24	75	425	311	149	73
1327AD-AAK-19-E	B	380	711.5	225	61	280	216	673.5	385	475.5	732.5	420	178	21	24	75	465	349	149	73

		Shaft and Key						
Catalog Number	**Series**	**U**	**N-W**	**ES**	**R**	**S**	**Key - W**	**Key - H**
1327AC-AFM-04-E	A	28 h6 (+0.000/–0.013)	60	49	24 (0.0/–0.2)	8 P9 (–0.015/–0.051)	8 h9 (+0.0/–0.036)	7 h11 (+0.0/–0.09)
1327AC-AFM-06-E	A	32 h6 (+0.000/–0.016)	80	70	27 (0.0/–0.2)	10 P9 (–0.015/–0.051)	10 h9 (+0.0/–0.036)	8 h11 (+0.0/–0.09)
1327AC-AFL-08-E	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AC-AFL-11-E	A	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AB-AFL-15-E	B	48 h6 (+0.000/–0.016)	110	97	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AB-AFL-19-E	B	55 m6 (+0.030/+0.011)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)
1327AB-AFL-22-E	B	55 m6 (+0.030/+0.011)	110	98	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)
1327AD-ABL-04-E	B	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AD-ABL-06-E	B	48 h6 (+0.000/–0.016)	110	90	42.5 (0.0/–0.2)	14 P9 (–0.018/–0.061)	14 h9 (+0.0/–0.043)	9 h11 (+0.0/–0.09)
1327AD-ABL-08-E	B	55 m6 (+0.030/+0.011)	110	90	49 (0.0/–0.2)	16 P9 (–0.018/–0.061)	16 h9 (+0.0/–0.043)	10 h11 (+0.0/–0.09)
1327AD-AAK-11-E	B	60 m6 (+0.030/+0.011)	140	110	53 (0.0/–0.2)	18 P9 (–0.018/–0.061)	18 h9 (+0.0/–0.043)	11 h11 (+0.0/–0.11)
1327AD-AAK-15-E	B	70 m6 (+0.030/+0.011)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)
1327AD-AAK-19-E	B	70 m6 (+0.030/+0.011)	140	110	62.5 (0.0/–0.2)	20 P9 (–0.022/–0.074)	20 h9 (+0.0/–0.052)	12 h11 (+0.0/–0.11)

Figure 3.13
High Resolution Magnetic Feedback – Detecting Gear



Detecting Gear Catalog Number	**# of Teeth**	**A**	**B**	**C**	**D**
8510SA-PG225	225	90.8 h6 (0.0/–0.022)	52 H6 (+0.019/0.0)	82	67 (+0.1/–0.1)
8510SA-PG256	256	103.2 h6 (0.0/–0.022)	65 H6 (+0.019/0.0)	92	80 (+0.1/–0.1)
8510SA-PG300	300	120.8 h6 (0.0/–0.025)	85 H6 (+0.022/0.0)	112	100 (+0.1/–0.1)
8510SA-PG400	400	160.8 h6 (0.0/–0.025)	120 H6 (+0.022/0.0)	152	135 (+0.1/–0.1)
8510SA-PG500	500	200.8 h6 (0.0/–0.029)	150 H6 (+0.025/0.0)	192	165 (+0.1/–0.1)
8510SA-PG500P	500	200.8 h6 (0.0/–0.029)	150 H6 (+0.025/0.0)	192	165 (+0.1/–0.1)

Figure 3.14
High Resolution Magnetic Feedback – Sensing Head

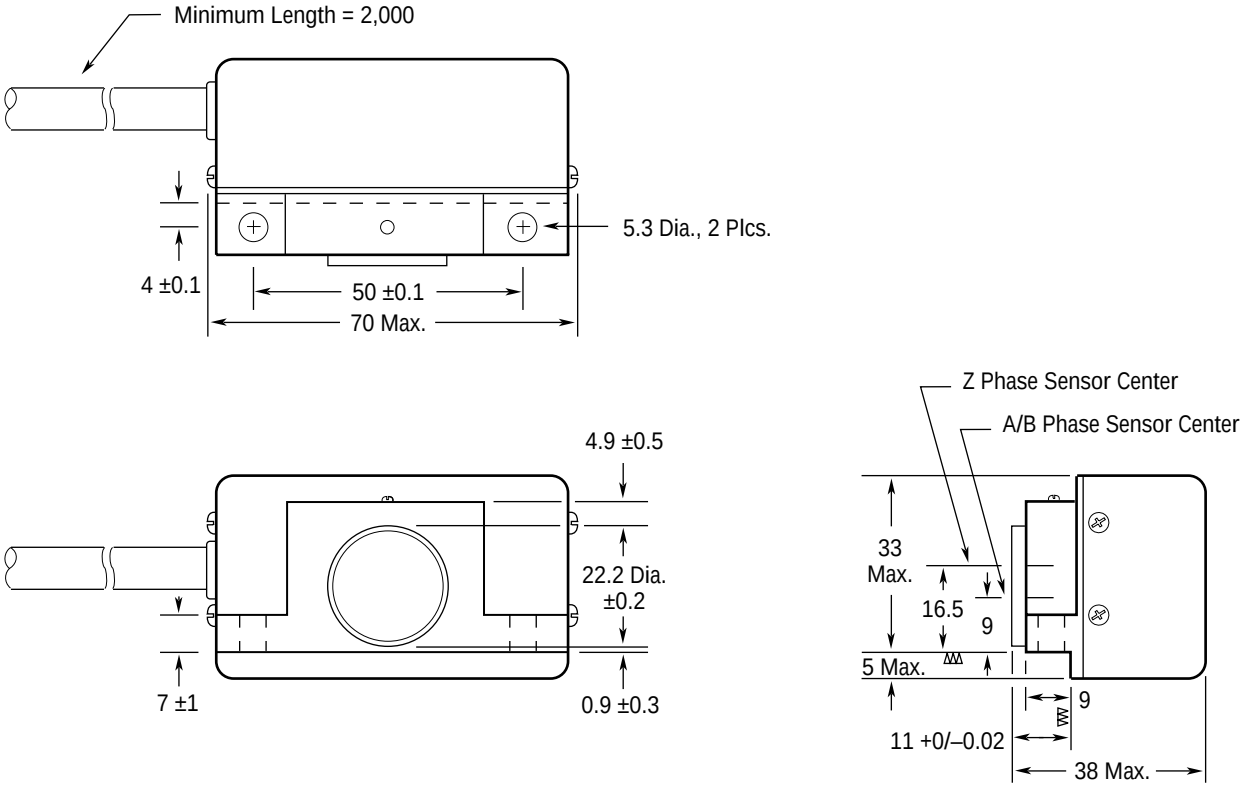
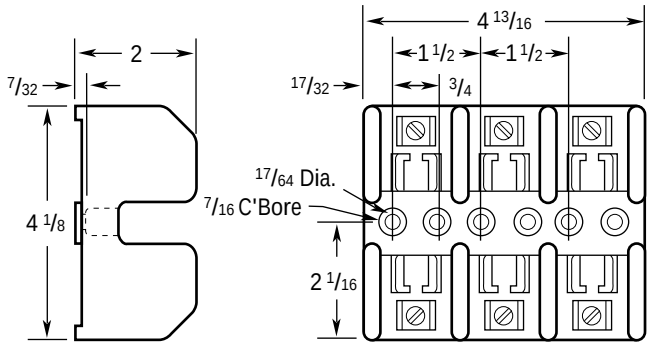
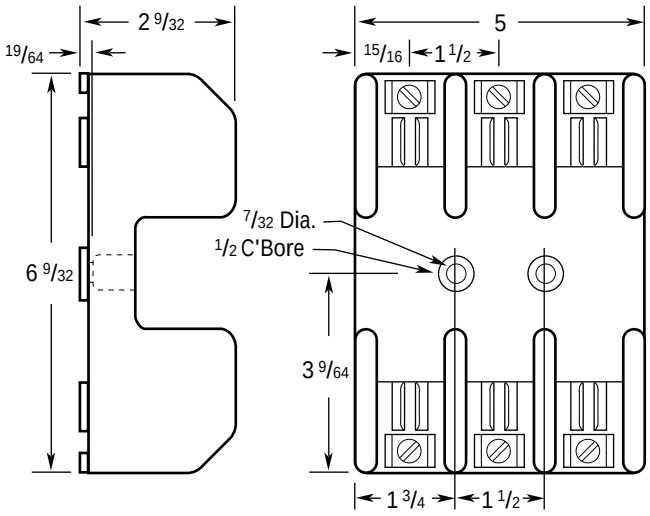


Figure 3.15
AC Line Fuse Kits – *Dimensions are in Inches*

8510SA-FA04
8510SA-FA06



8510SA-FA11



8510SA-FA22

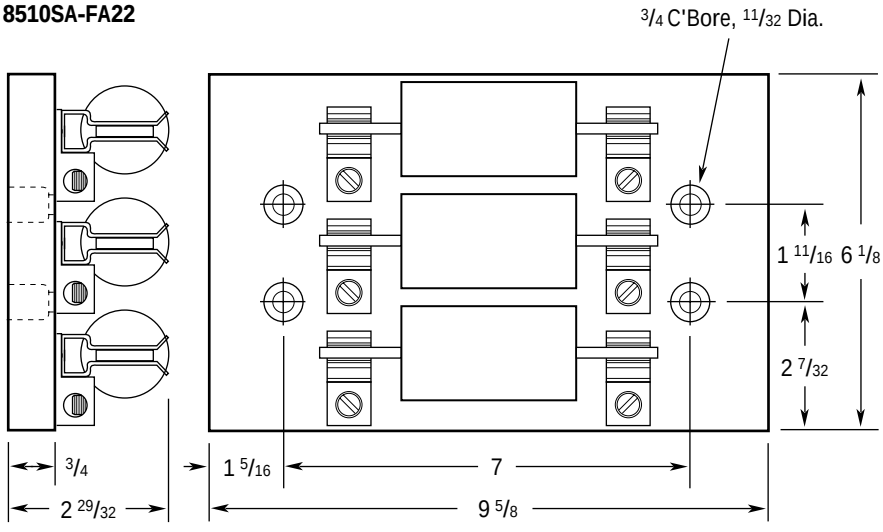
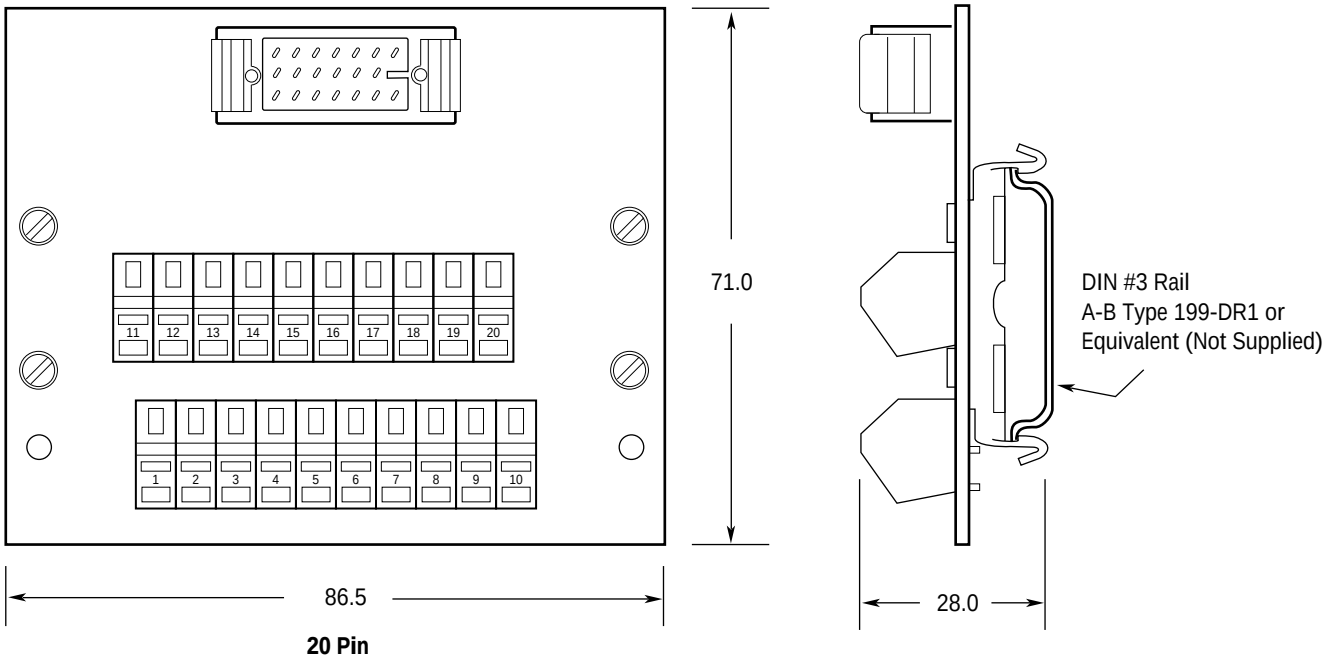
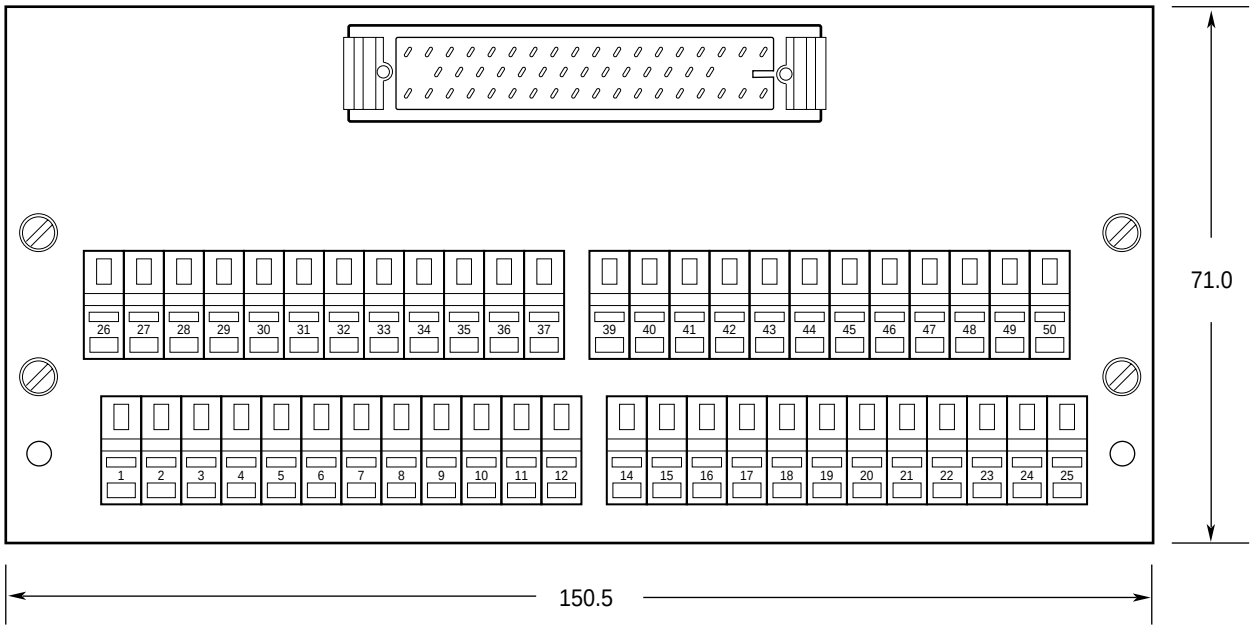


Figure 3.16
Termination Panels



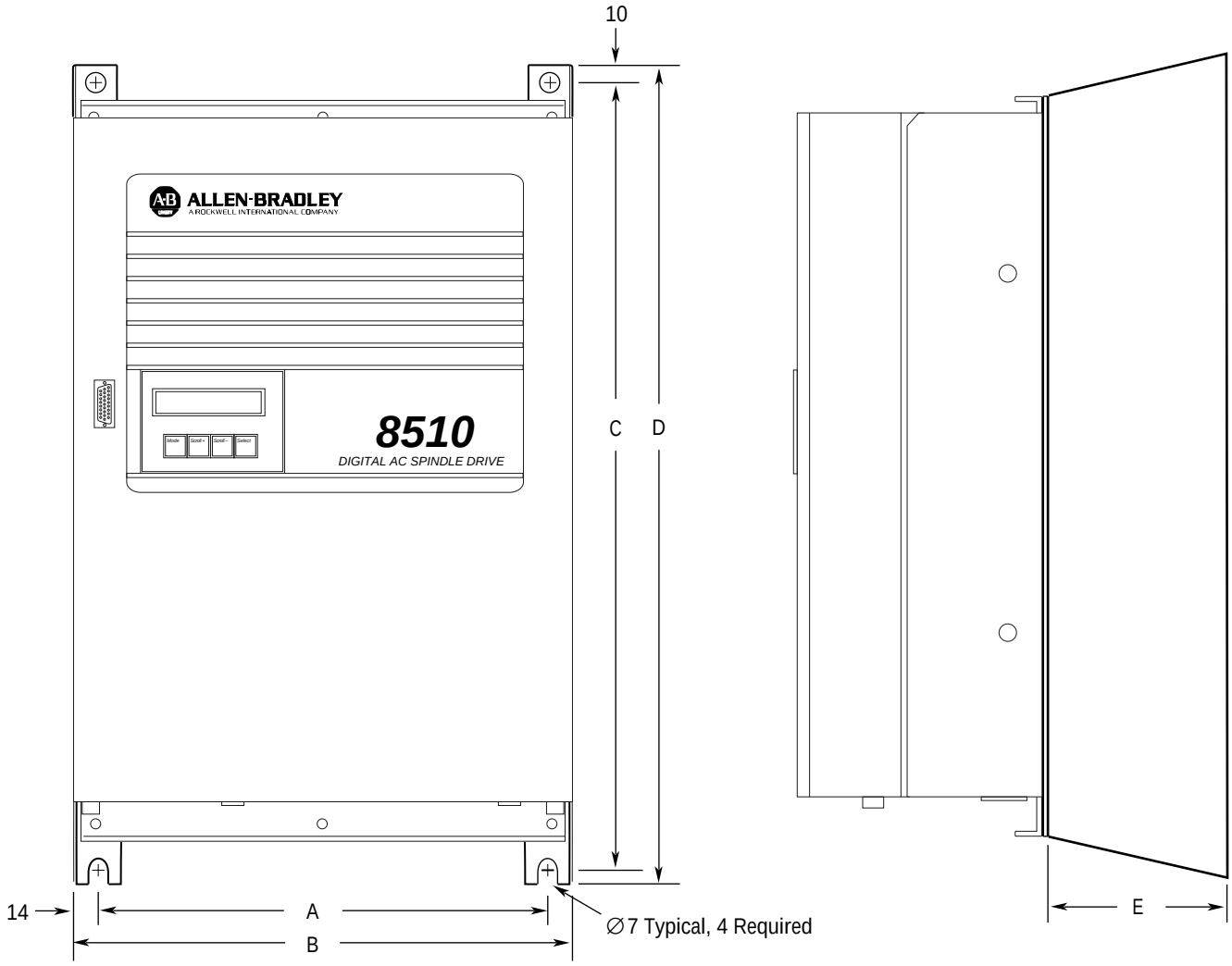
20 Pin

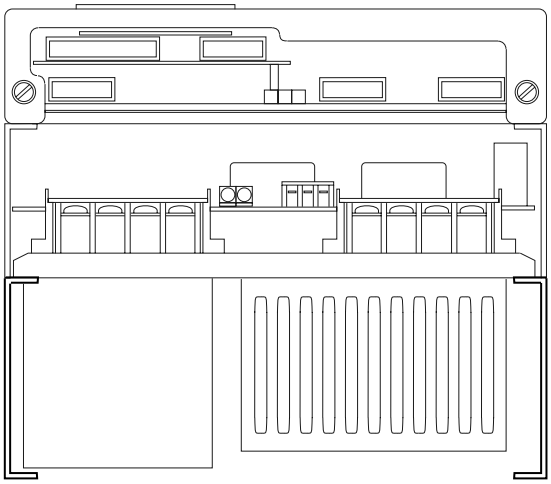
Note:
Includes 1.5 m Cable
with Connectors on Both Ends



50 Pin

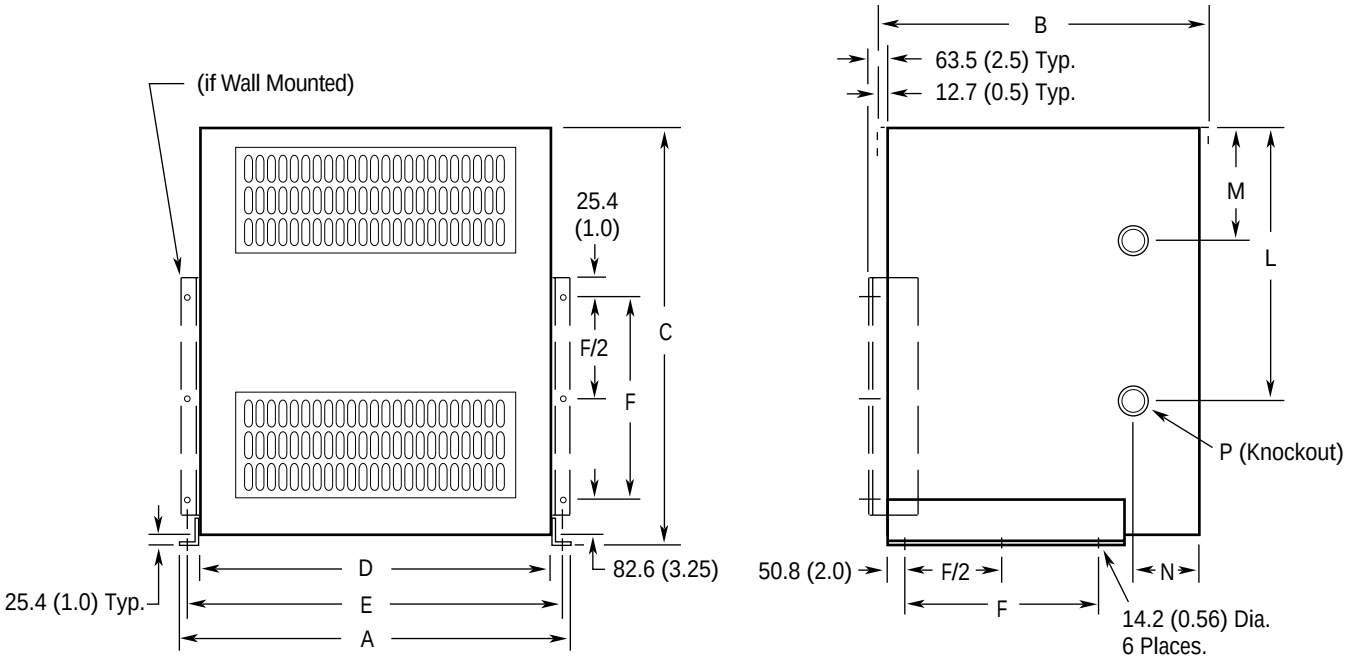
Figure 3.17
Drive Panel Mounting





Drive Catalog Number	A	B	C	D	E
8510A-A04-x	145	174	485	504	100
8510A-A06-x	145	174	485	504	100
8510A-A11-x	282	310	485	506	113
8510A-A22-x	282	310	780	800	120

Figure 3.18
AC Power Transformer – *Dimensions are in millimeters and (inches)*



Catalog Number	A	B	C	D	E	F	L	M	N	P (Knockout)	Weight *kg (lb.)*
8510T-AA006-BA	438	286	356	375	419	178	241	51	25	19 & 25	30 (65)
8510T-AA009-BA	(17.25)	(11.25)	(14.00)	(14.75)	(16.50)	(7.00)	(9.50)	(2.00)	(1.00)	(0.75 & 1.00)	39 (85)
8510T-AA012-BA											50 (110)
8510T-AA006-EA											45 (100)
8510T-AA009-EA											52 (115)
8510T-AA012-EA											60 (133)
8510T-IA006-BA											50 (110)
8510T-AA017-BA	495	419	483	419	470	254	254	51	64	25 & 32	68 (150)
8510T-AA022-BA	(19.50)	(16.50)	(19.00)	(16.50)	(18.50)	(10.00)	(10.00)	(2.00)	(2.50)	(1.00 & 1.25)	75 (165)
8510T-AA026-BA											80 (175)
8510T-AA032-BA											91 (200)
8510T-AA017-EA											66 (145)
8510T-AA022-EA											77 (170)
8510T-AA026-EA											84 (185)
8510T-AA032-EA											98 (215)
8510T-IA009-BA											59 (130)
8510T-IA012-BA											73 (160)
8510T-IA017-BA											77 (170)
8510T-AA040-BA	622	521	622	546	597	254	305	64	64	25 & 51	114 (250)
8510T-AA040-EA	(24.50)	(20.50)	(24.50)	(21.50)	(23.50)	(10.00)	(12.00)	(2.50)	(2.50)	(1.00 & 2.00)	116 (255)
8510T-IA022-BA											118 (260)
8510T-IA026-BA											123 (270)
8510T-IA032-BA											132 (290)
8510T-IA040-BA											159 (350)

End of Chapter

Chapter 4

Receiving, Unpacking and Inspection

Chapter Objectives

Chapter 4 provides the information needed to unpack, properly inspect and if necessary, store the 8510 and related equipment. The section entitled *Inspection* provides a complete explanation of the 8510 catalog numbering system.

Receiving

It is the responsibility of the user to thoroughly inspect the equipment before accepting the shipment from the freight company. Check the item(s) received against the purchase order. If any items are obviously damaged, it is the responsibility of the user not to accept delivery until the freight agent has noted the damage on the freight bill. Should any concealed damage be found during unpacking, it is again the responsibility of the user to notify the freight agent. The shipping container must be left intact and the freight agent should be requested to make a visual inspection of the equipment.

Unpacking

Retain all of the instruction manuals found on top of the packing material for use during installation, start-up, and maintenance of the drive. Remove the top half of the protective foam shell from the drive. Using the mounting flanges near the bottom of the drive, lift the drive from the bottom half of the protective shell. Remove the plastic bag that encloses the drive. The drive is now ready for installation.

Important: Before the installation and start-up of the system, a general inspection of mechanical integrity (i.e. loose parts, wires, connections, packing materials, etc.) must be made.

Inspection

After unpacking, check the item(s) nameplate catalog number against the purchase order. An explanation of the catalog numbering system is included on the following pages as an aid for nameplate interpretation. The drive nameplate is located on the back side of the cover. Refer to Chapter 5 for drive cover removal information.

Storing

The drive should remain in its shipping container prior to installation. If the equipment is not to be used for a period of time, it must be stored according to the following instructions:

- Store in a clean, dry location.
- Store within an ambient temperature range of 0 to 65° C (32 to 149° F).
- Store within a relative humidity range of 5% to 95%, non-condensing.
- Do not store equipment where it could be exposed to a corrosive atmosphere.
- Do not store equipment in a construction area.

8510 Drive

8510 A – A 04 – A 1

First Position — Bulletin Number

Second Position — Series

Letter	Description
A	Series A Design

Third Position — Maximum AC Input Voltage

Letter	Voltage
A	200 - 220V AC, ±10%, 50/60 Hz. and 230V AC input, ±10%, 60 Hz

Fourth Position — Approx. Continuous Power Output

No.	Description
04	Up to 3.7 kW (5 hp)
06	Up to 5.5 kW (7.5 hp)
11	Up to 11 kW (15 hp)
22	Up to 22 kW (30 hp)

Fifth Position — I/O Board Version

Letter	Description
A	Standard I/O for normal spindle use
B	Option A plus 16 bit digital input for digital speed command or orient position command
C	Option A plus high linearity A/D converter for continuous path contouring (C-axis)
D	Options B and C

Sixth Position — I/O Board Size

No.	Description
1	for A04 & A06 drives
2	for A11 & larger drives

1327 Motor

1327 D – A A K – 15 – E A

First & Second Position — Bulletin Number

Motor Type

Letter	Type
B	Standard Type
C	Standard Type
D	Dual Winding Type[1]

Third Position — Rated Voltage

Letter	Volts
A	200-230 V AC Input

Fourth & Fifth Position — Base Speed / Max. Speed

Letter	rpm
A	≤ 425
B	426 -550
C	551-725
D	726-950
E	951-1200
F	1201-1500

Letter	rpm
K	4001-5000
L	5001-6000
M	6001-8000
N	8001-10000
P	10001-12000

Sixth Position — Approx. Continuous Power Output

Code	kW (hp)
02	2.2(3)
04	3.7 (5)
06	5.5 (7.5)
08	7.5 (10)
11	11 (15)
15	15 (20)
19	18.5 (25)
22	22 (30)

Seventh Position — Mounting Type

Letter	Description
E	JIS Metric Foot Mount
F	JIS Metric Flange Mount

[1] A user supplied contactor is required to switch the high and low speed windings.

Transformer

8510T – A A 012 – B A

First Position: Bulletin Number

Second Position: Type

Letter	Description
A	Autotransformer
I	Isolation Transformer

Third Position: Enclosure Type

Letter	Description
A	NEMA Type 1
O	Open core and coil

Fourth Position: Continuous kVA Rating

No.	kVA
006	6
009	9
012	12
017	17
022	22
026	26
032	32
040	40

Fifth Position: Primary Voltage & Frequency

Letter	Description
B	460V AC, three-phase, 60 Hz
E	380/415/460V AC, three-phase, 50/60 Hz

Sixth Position: Secondary Voltage

Letter	Description
A	220V AC, three-phase

I/O Termination Panels

8510SA – TP50S

First Position: Bulletin Number

Second Position: Type

Code	Description
TP50S	Termination panel for 50 pin standard I/O connector – includes 1.5 m (5 ft) cable
TP20D	Termination panel for 20 pin digital speed/position input connector – includes 1.5 m (5 ft) cable
TP20E	Termination panel for 20 pin optical encoder orient feedback connector – includes 1.5 m (5 ft) cable
TP20M	Termination panel for 20 pin high resolution magnetic orient feedback connector – includes 1.5 m (5 ft) cable
TP20R	Termination panel for 20 pin motor resolver feedback connector – includes 1.5 m (5 ft) cable
TP20W	Termination panel for 20 pin dual winding contactor control connector – includes 1.5 m (5 ft) cable

Cable Assemblies

8510SA– CA 20D – 10

First Position	Second Position	Third Position		Fourth Position	
Bulletin Number	Cable Assembly	Connector and Cable Type		Cable Length	
		Code	Description	Letter	Description
		20D	20 pin connector with cable for digital speed/position input	10	Length in meters – allowable lengths are 5, 10, 15, 20 meters The 20E, 20M and 20R are also available in 30 and 40 meter lengths
		20E	20 pin connector with cable for optical encoder orient feedback		
		20M	20 pin connector with cable for high resolution magnetic orient feedback		
		20R	20 pin connector with cable for motor resolver feedback		
		20W	20 pin connector with cable for winding change contactor control. – used with 1327AD series motors		
		50S	50 pin connector with cable for standard analog and discrete I/O		

Mating Connector Kits

8510SA– C 50 S

First Position	Second Position	Third Position		Fourth Position	
Bulletin Number	Connector Kit	Connector Purpose		Connector Termination Types	
		Code	Description	Letter	Description
		50	50 pin Honda type for standard I/O on drive	S	Solder type (20 & 50 pin Honda type only)
		20	20 pin Honda type for motor feedback, spindle orient feedback, dual winding motor control or digital velocity/position input on drive	C	Crimp type (AMP Mate-N-Lok type only)
		AB	AMP Mate-N-Lok connector used on 1327AB series motors for resolver feedback		
		AD	AMP Mate-N-Lok connector used on 1327AD series motors for resolver feedback		

AC Line Fuse Kits

8510SA – F A04

First Position	Second Position	Third Position
Bulletin Number	Fuse & Fuse Block	Fuse Ratings

Code	Description
A04	Fuses & fuse blocks for A04 drive
A06	Fuses & fuse blocks for A06 drive
A11	Fuses & fuse blocks for A11 drive
A22	Fuses & fuse blocks for A22 drive

Drive Mounting Adapters

8510SA– M P11

First Position	Second Position	Third Position
Bulletin Number	Mounting Adapter	Adapter Components

Code	Description
P04	Brackets to panel mount the A04 drive inside an enclosure
P06	
P11	Brackets to panel mount the A06 drive inside an enclosure
P22	
V04	Brackets to panel mount the A11 drive inside an enclosure
V06	Brackets to panel mount the A22 drive inside an enclosure
V11	Panel mounting brackets plus adapter to allow ducting cooling air from side of enclosure to an A04 drive
V22	Panel mounting brackets plus adapter to allow ducting cooling air from side of enclosure to an A06 drive
	Panel mounting brackets plus adapter to allow ducting cooling air from side of enclosure to an A11 drive
	Panel mounting brackets plus adapter to allow ducting cooling air from side of enclosure to an A22 drive

High Resolution Magnetic Feedback

8510SA – P G225

First Position	Second Position	Third Position
Bulletin Number	High Resolution Magnetic Feedback	Feedback Elements

Code	Description
G225	Standard class 225 tooth feedback gear
G256	Standard class 256 tooth feedback gear
G300	Standard class 300 tooth feedback gear
G400	Standard class 400 tooth feedback gear
G500	Standard class 500 tooth feedback gear
G500	Precision class 500 tooth feedback gear
PSA	Sensing head with analog output

Offline Programming Software

8510SA – SSDC

First Position	Second Position
Bulletin Number	Type

Code	Description
SSDC	Spindle Drive Configuration software for use with ODS
SFTU	File Transfer Utility for IBM® compatible PCs

Chapter 5

Drive Installation

Chapter Objectives

Drive installation information including environmental conditions and mounting requirements are presented in this chapter. The information presented will serve as a guideline in planning the installation of the drive.

Environment

Mounting	To a flat, rigid, vertical surface.
Enclosure Type	Sealed enclosure that will prevent drive from being subjected to moisture, oil mist, dust, corrosive vapors, etc. Drive heat sinks normally extend through the enclosure wall.
Ambient Temperature	
Control Ambient	0° to 55° C (32° to 131° F) around drive control structure.
Heat Sink Ambient	0° to 40° C (32° to 104° F) at cooling air inlet to heat sinks.
Allowable Humidity	5% to 95% non-condensing.
Allowable Vibration	Not to exceed 0.5 g during normal operation.
Installation Altitude	Up to 1,000 m (3,300 ft.), derate 3% for each additional 300 m (1,000 ft.) altitude. Consult Allen-Bradley for installations above 3,000 m (10,000 ft.).

Mounting

In order to maintain proper cooling, the drive must be mounted in a vertical position. The recommended clearances for all drive ratings are 150 mm (6 inches) on the top and 75 mm (3 inches) on the bottom.

ATTENTION: The drive must be mounted in the vertical position to assure proper cooling airflow. Failure to observe this mounting practice could result in overheating of the drive.

Two methods of mounting the 8510 in an enclosure are available:

1. Enclosure Wall Method – the drive chassis is located inside the enclosure with the heat sink extended through the back wall of the enclosure.
2. Panel Method – the drive chassis and heat sink are inside the enclosure. This method requires the optional panel mount brackets.

Selection of the mounting method is the responsibility of the user and is dependent on the application. Mounting guidelines and instructions are provided for both methods.

ATTENTION: The installation of the drive must be planned such that all cutting, drilling, tapping and welding can be accomplished with the drive removed from the enclosure. The drive is of the open type construction and any metal debris must be kept from falling into the drive. Metal debris or other foreign matter that becomes lodged in the drive circuitry frequently results in significant drive damage when power is applied.

Enclosure Wall (through-the-wall) Mounting

The following procedure provides the steps needed to properly mount the 8510 through the enclosure wall.

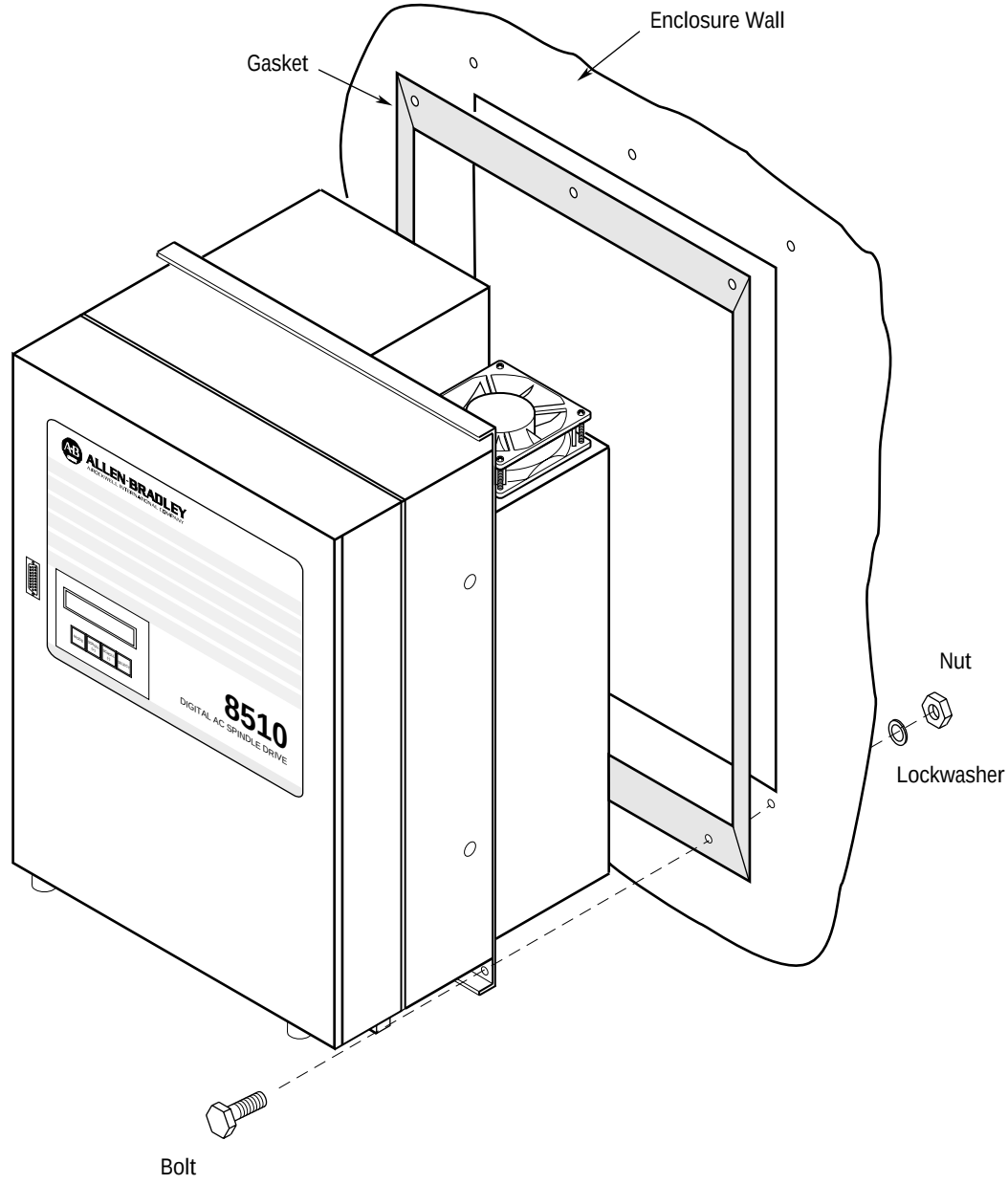
1. Locate the area that the drive is to be mounted, leaving at least 75 mm (3 inches) of clearance on all sides and 150 mm (6 inches) on the top.
2. Prepare the enclosure using the panel cutout information provided in Chapter 3. All holes must be deburred inside and outside the enclosure. Remove any sharp edges that may be present around the cutout.
3. Unfold the gasket and position (paper side toward drive) around the drive. Remove the protective paper from the adhesive on the top side of the gasket. Carefully align the gasket holes with the drive mounting holes and press the gasket into place. Repeat this procedure for the remaining sides. See Figure 5.1.
4. Securely bolt the drive (and gasket) into the enclosure. Use 6 mm (or 1/4 in.) bolts with lockwashers. Alternately tighten the nuts to assure uniform compression of the sealing gasket. Torque to 5.5 N-m (50 lb.-in.).

   To assist in handling larger size drives, there are holes on the sides of the drive that can be used to attach lifting hooks from a properly rated lifting device. The lifting hooks should extend no more than 12.5 mm (0.5 in.) inside the drive or they may damage internal drive components.

ATTENTION: To guard against drive damage and/or personal injury when using a lifting device, assure that the device is operated per manufacturers instructions.

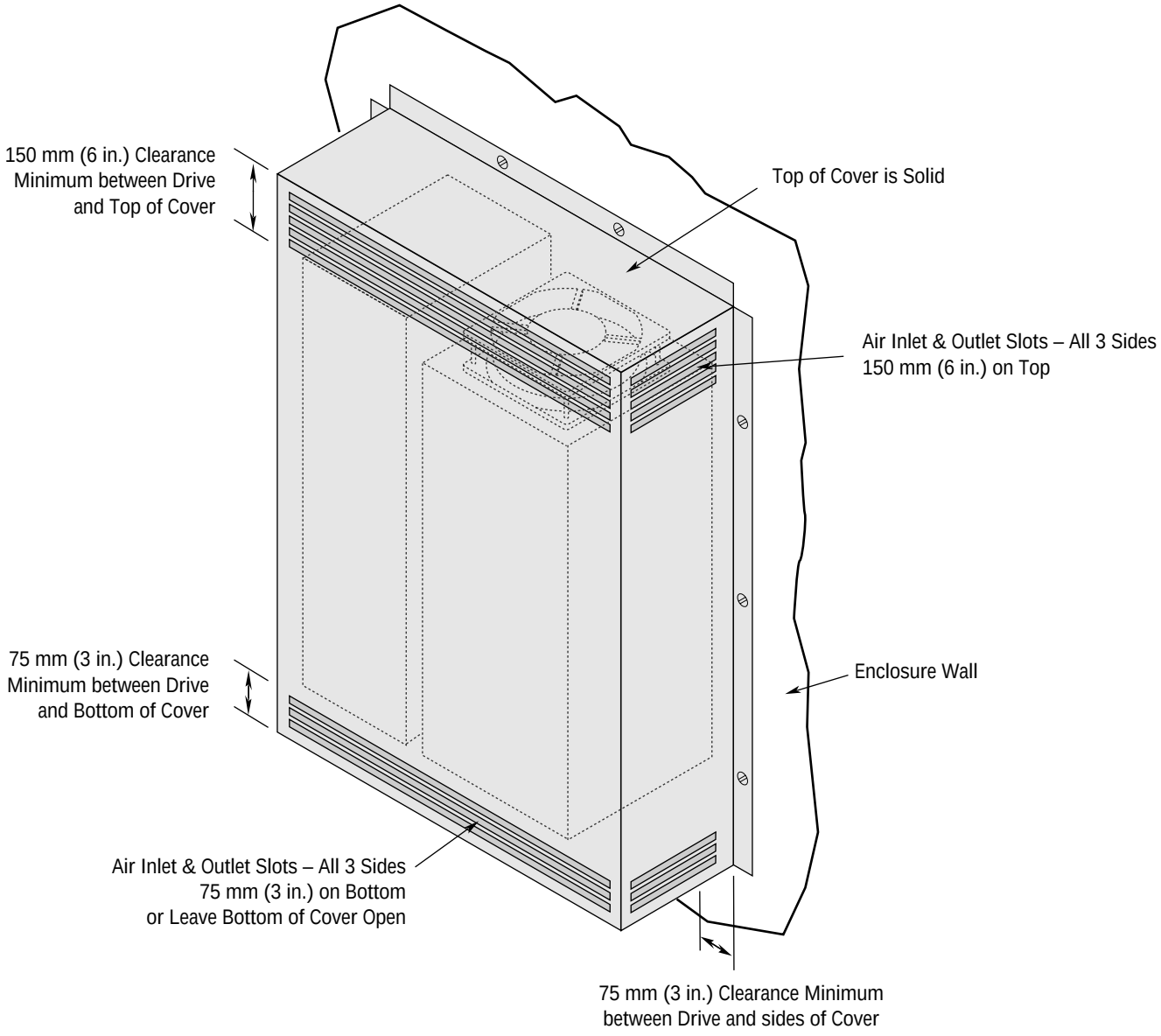
ATTENTION: During heavy regenerative load operations, the flat metal resistor element attached to the back of the heat sink may become very hot (in excess of 125° C or 257° F) and could cause burns if touched. Use of the heat sink cover described below and shown in Figure 5.2 would help guard against accidental touching of this resistor.

Figure 5.1
Gasket Assembly



5. To protect the heat sink from an excessive build up of dirt which will reduce the heat transfer efficiency, a simple sheet metal cover should be placed over the heat sink. Ample air inlet and outlet slots or openings must be provided near the top and bottom of this cover to allow unrestricted flow of cooling air. See Figure 5.2 for a typical cover configuration.

Figure 5.2
Heat Sink Cover

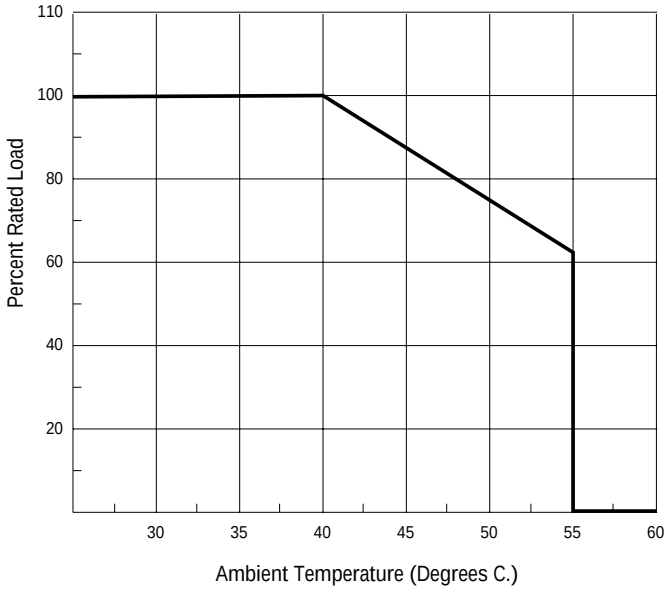


Panel Mounting

Panel mounting allows the entire drive to be mounted inside an enclosure without extending the heat sink through the enclosure wall. The drive is mounted inside the enclosure using the panel mounting brackets (Cat. No. 8510SA-Mxxx) that can be supplied as an accessory. Care must be taken to provide the required clearances at the top and bottom of the drive to assure that the airflow across the heat sink is not obstructed. Mounting dimensions can be found in Chapter 3.

ATTENTION: The drive is designed to provide its rated continuous output when the heat sinks are in a 40° C (104° F) ambient temperature. To obtain the rated continuous output of the drive amplifier, the temperature of the air entering the heat sink must be maintained at 40° C (104° F) or less. If the temperature of the air entering the heat sink exceeds 40° C (104° F), the drive amplifier must be derated in accordance with the curve shown in Figure 5.3.

Figure 5.3
Percent Rated Load vs. Ambient Temperature Over Heat Sinks



Heat Dissipation

The drive must always be mounted in a sealed metal enclosure with the heat sinks extending through the enclosure wall, or by using the optional panel mounting brackets (with the heat sinks completely inside the enclosure). In either case the enclosure must be sized to provide adequate surface area to allow the heat generated inside the enclosure (by the drive and other devices) to be dissipated through convection cooling. If this is not possible, a properly rated enclosure cooling unit must be added to cool the enclosure.

Typically a nonventilated convection cooled enclosure should be sized such that 10 watts of power are dissipated for each 1 square foot of enclosure surface. This area should not include the enclosure bottom or surfaces of the enclosure mounted against a wall. If smaller enclosures are desired, an air conditioner or an air to air heat exchanger may be required.

The heat dissipated inside the enclosure is directly related to the power that is being delivered to the motor. The following table gives the drive thermal dissipation for different motor power ratings.

Important: For very heavy regenerative load applications, the heat dissipated inside the enclosure for panel mounted drives may increase by up to 15%.

Table 5.A
Watts Dissipated Inside Enclosure

Motor Power Rating *kW / HP*	**Enclosure Wall Mounted**	**Panel Mounted**
2.2 / 3	100 W	290 W
3.7 / 5	115 W	430 W
5.5 / 7.5	135 W	610 W
7.5 / 10	150 W	720 W
11 / 15	180 W	970 W
15 / 20	200 W	1110 W
18.5 / 25	230 W	1360 W
22 / 30	260 W	1380 W

Drive Accessory Mounting

Assure that sufficient cabinet space is available to mount the required drive accessories. All wiring is to the bottom of the drive. Provide the necessary clearances for wiring access and wire ways at the bottom of the drive.

Fuse Blocks
The 8510 does not include the incoming AC line fuses inside the drive for drive component short circuit protection. An optional fuse kit is available that includes the fuse block and fuses. Make provisions for mounting the fuse block inside the enclosure. See Figure 3.15 for dimensions of the optional fuse kits.

Termination Panels
Signal connections to the drive are through multi-pin Honda connectors. If the optional termination panel assemblies are being used to allow wiring to terminal blocks, provide sufficient mounting space and wiring access for these termination panels. A 1.5 m (5 ft.) cable is provided to connect the termination panel to the drive. See Figure 3.16 for dimensions of the termination panels. The DIN #3 mounting rail is not provided with the termination panels. Use Allen-Bradley type 199-DR1 or equivalent mounting rail. Depending on the system configuration, the termination panels required will vary from one 50 pin and one 20 pin to one 50 pin and as many as four 20 pin units.

Removal of Drive Cover

The front cover of the drive is mounted via two locating pins in the upper corners and two captive retaining screws in the bottom corners.

To remove the cover, loosen the two retaining screws and pull the bottom of the cover outward until the cover is clear of the drive bottom. Next, lift the cover upward until the locating pins are removed from the locating holes on the top of the drive. It may be necessary to remove one or more of the Honda connectors to obtain the necessary clearance at the bottom of the cover.

To replace the cover, hold it with the bottom tilted slightly away from the drive. Engage the cover locating pins into the holes on the top of the drive and carefully swing the bottom toward the drive. Assure that the two guides on the sides of the drive near the bottom of the cover are both inside the cover.

Important: The top edge of the hole for the programming display may hit the top of the display bezel. Do not force the cover backward to its final position or it will bend and possibly damage the I/O Board. Push upward on the bottom of the cover until the edge of the hole clears the top of the bezel. It may be necessary to gently pull downward on the edge of the bezel while pushing upward on the cover to make the cover clear the top of the bezel. When the display bezel is properly located, tighten the two retaining screws in the bottom of the cover.

End of Chapter

Chapter 6

Motor Installation

Chapter Objectives

Chapter 6 provides the information needed to properly install the 1327A AC Motor. Included are environmental conditions that must be met and physical mounting considerations.

Mounting Considerations

The following items must be considered when mounting the 1327A motor.

– The motor can be mounted horizontally or vertically with the shaft down or up.

– Horizontally mounted 1327AD Series motors must always be mounted with the terminal box on top of the motor. If other orientations are required, contact the factory for special motor modifications.

– The motor is fan cooled with air flow from the drive end to the fan end. Both air inlets and outlets must be free of obstructions. Maintain a clearance of at least 150 mm (6 inches) at the fan exhaust area.

– When mounted, the motor must not be exposed to direct splash or spray of cutting fluids or lubricating oils.

– Flange mounted motors include a labyrinth type shaft seal with flinger, which provides excellent protection against oil splash. However, it will not provide protection against oil flooding.

Important: If mounted into a gearbox, assure that the lubricating oil level is about one shaft diameter distance below the bottom of the motor shaft.

Coupling Considerations

The points listed below must be considered when making mechanical connections to the motor.

– Assure that the motor is aligned with the shaft parallel to the driven shaft.

– The motor has been precision balanced with a half height key installed in the keyway. During high speed operation, a small unbalance will cause significant vibration. Take care to accurately dynamically balance any gears, pulleys, or couplings that are mounted to the motor shaft. Best results are obtained by balancing after the device is mounted to the shaft.

– If the motor is belt coupled, the belt tension must not exceed the radial load capabilities of the motor bearings as shown in Table 6.A.

Table 6.A
1327A Radial Load Capabilities

Motor Catalog Number	**Maximum Radial Load**[1]
1327AC-AFM-02	133 kg (292 lb.)
1327AC-AFM-04	165 kg (364 lb.)
1327AC-AFM-06	167 kg (368 lb.)
1327AC-AFL-08	313 kg (688 lb.)
1327AC-AFL-11	335 kg (737 lb.)
1327AB-AFL-15	356 kg (784 lb.)
1327AB-AFL-19	373 kg (820 lb.)
1327AB-AFL-22	384 kg (844 lb.)
1327AD-ABL-04	300 kg (660 lb.)
1327AD-ABL-06	310 kg (682 lb.)
1327AD-ABL-08	360 kg (792 lb.)
1327AD-ACL-08	380 kg (836 lb.)
1327AD-AAK-11	580 kg (1276 lb.)
1327AD-AAK-15	600 kg (1320 lb.)
1327AD-AAK-19	610 kg (1342 lb.)

[1] Load applied at dimension AH/3 or (N-W)/3 from the shaft tip.

Wiring Considerations

Read through and understand the following points before wiring the 1327 motor.

– The terminal box includes two cable entry holes. One hole has a solid cover plate and the other hole has a cover plate to accommodate either IS0-228 “PF” type conduit fittings or ANSI “NPT” type conduit fittings. On request, cover plates to accommodate DIN-40430 “PG” type conduit fittings are available.

– Both motor power and motor feedback leads can be brought through the same conduit. Carefully follow all grounding and shielding procedures outlined in Chapter 8.

– The motor fan must be operating whenever the spindle motor is operating. The motor will quickly overheat if it is operated with the fan de-energized.

Chapter 7

Interface Signal Descriptions

Chapter Objectives

Chapter 7 provides detailed information on the various inputs and outputs available as part of the 8510 AC Drive System. Included are signal level definitions and detailed function descriptions of each I/O point.

I/O Interface

The universal I/O interface of the 8510 provides a wide range of inputs and outputs as listed below. Detailed explanations of the inputs and outputs is provided on the following pages.

Digital Inputs

- Coast to Stop
- Drive Enable
- Drive Reset
- Forward Run Command
- Reverse Run Command
- Low Torque Limit Select
- Accel/Decel Rate Select
- Spindle/Servo Mode Select
- Servo Input Scaling - Low/High
- Orient Command
- Gear Ratio Active
- Motor Winding Select Command - Low Speed/High Speed
- Orient Position or Digital Speed Command - 16 bit binary/BCD

Digital Outputs

- Hard Fault
- Soft Fault
- Drive Ready
- In-Position After Orient
- Zero Speed
- At Set Speed
- Speed Level Indicator
- Load Level
- Current Motor Winding Selected

Analog Inputs – Two inputs with 14 bit A/D resolution can be programmed for the following input functions.

- Spindle Mode Command - Input #l
- Servo Mode Command - Selectable, Input #1 or Input #2
- Torque Mode Command - Input #2

Analog Outputs – Two analog outputs with 12 bit D/A resolution can be programmed to provide any of the following output signals.

- Motor rpm (zero to maximum rpm or – maximum to + maximum rpm)
- Spindle rpm (zero to maximum rpm or – maximum to + maximum rpm)
- % Load
- % Torque
- % Power Output
- Orient Error (full scale is 2 degrees error)

Serial Port – Used for parameter data file upload and download. The port can be configured (jumper selectable) for RS-232 or RS-422 at 9600 baud.

Conventions Used in this Manual

To help differentiate input/output names, programmable parameters and programmable values, the following conventions will be used throughout this chapter and the remainder of this manual.

Input and Output Names	will appear in Initial Capital Letters
Programming Display Text	will appear in *italics*
Menu Names	will appear with *ALL CAPITALS*
Parameter Names	will appear with *Initial Capital Letters*
Programmable Parameter Values	will appear in “quotes”

Signal Level Descriptions

The signal level requirements for the various inputs and outputs of the 8510 are as follows:

Digital Inputs

An open or grounded input will result in an Off condition. Inputs must be pulled high by the external signal to obtain an On condition. An On condition requires an input between 18 and 30V DC at no more than 10 mA. The reference or ground side of the user supplied source voltage should only be connected to the drive through the Digital Ground terminals on the CN9 and CN10 I/O connectors. All inputs are filtered and electrically isolated to withstand voltage impulses in accordance with UL-508. Digital inputs are read at 102.4 ms intervals.

Digital Outputs

The digital outputs use dry contact relays rated 200 mA at 24V DC. The relays provide isolation for the control electronics against voltage impulses in accordance with UL-508. Unless otherwise noted, when the output is On, the relay will be energized and the contact closed.

Analog Inputs

The analog inputs are single ended inputs with the following characteristics:

Maximum Input Voltage Range:	±10V DC
A/D Converters	Two converters selectable via software controlled analog switches. Standard converter for spindle and positioning applications and optional converter for continuous path contouring applications and torque mode operation.
A/D Resolution-Standard Converter	Effective 14 bits over ±10V DC or 1.22 mV = 1 LSB. Within –0.039 < x < +0.039 range, 0.076 mV = 1 LSB Sample Rate Small Input Change: 0.8 ms Large Input Change: ≤ 26.4 ms
A/D Resolution-Optional Converter:	True 14 bits over ±10V DC or 1.22 mV = 1 LSB Sample Rate: 0.8 ms
Noise Filtering:	Baluns, Capacitors, and Clamp Diodes

The drive continuously samples to determine long term zero reference drift of the analog circuitry within the drive and compensates for this drift.

Analog Outputs

The two analog outputs are single ended outputs suitable for driving voltmeter displays or providing input signals to other electronic control devices. The outputs have the following characteristics:

Output Voltage:	±10V DC
D/A Resolution:	12 bits over ±10V DC or 11 bits over 0-10V DC 4.88 mV = 1 LSB
Output Update Interval:	1.6 ms
Output Current:	1 mA typical, short circuit protected
Output Impedance:	440 Ohms
Noise Filtering:	Baluns and Capacitors
Output:	Output capable of driving normal loads such as meters and analog input circuits through normal shielded or unshielded cables.

The outputs can be configured through programming to provide either unipolar or bipolar outputs. The unipolar output represents the absolute value of the variable while the bipolar output represents both magnitude and direction of the variable.

Serial Port

The Serial Port can be jumper configured for RS-422 or RS-232 serial communications with a baud rate of 9,600 baud.

I/O Interface Signal Descriptions

This section describes the various inputs and outputs available at the standard I/O Interface connector, CN9. See Figure 7.3 for connector location.

Digital Inputs

Coast to Stop – CN9-1
The Coast to Stop input is wired in series with the coil of an auxiliary relay that directly controls the operation of the main AC input contactor in the drive. When this input is Off, the auxiliary relay is de-energized causing the main contactor to open and the motor to coast to a stop. Regenerative braking will not occur when this input is Off. When the main contactor opens, the DC bus discharge circuit is activated and the DC bus will be discharged to less than 10 volts within 15 seconds. Internal interlocks require the bus to be discharged below a threshold level (requires about 4 seconds) before drive power-up sequence can be initiated again.

When this input is On, the coil circuit of the auxiliary relay is completed. Then, when the Drive Enable input is applied, the auxiliary relay is energized and the main AC contactor will close. If stated in digital logic terms, this input would be called $\overline{\text{Coast to Stop}}$.

Important: In situations requiring immediate de-energizing of the drive, opening this input will remove power from the motor and the motor will coast to a stop. This input must be a hardwired physical contact that is not controlled by electronics.

ATTENTION: Hazards of severe injury or death exist from unintended machine motion if an electronic malfunction occurs. This input must be Off any time a person is required to physically touch any portion of the machine driven by this drive.

Drive Enable – CN9-2
When this input is turned On (Coast to Stop input must also be On), the drive power-up sequence begins. After 5 to 7 seconds for DC bus precharge (if the DC bus was discharged), the main AC contactor closes and the Drive Ready output is turned On, which completes the power-up sequence. The drive is now ready to run.

If the Drive Enable command is turned Off while the motor is rotating, the drive will regeneratively brake the motor, turn the power transistors off and open the main AC contactor. If the Coast to Stop input remains On, the DC bus will not be discharged even though the AC contactor has been opened. This shortens the time for the power-up sequence to about 1 second after the Drive Enable is applied.

The Drive Enable and Forward or Reverse Run commands can be applied simultaneously (within ±200 ms). In this case the drive will execute the power-up sequence and then begin running at the commanded speed.

The *Enable Torque* programmable parameter will determine whether or not holding torque is available from the motor when the Drive Enable input is On. If the parameter is set to "Without Run," holding torque is available as soon as the Drive Ready output turns On. If the parameter is set to "With Run," either the Forward Run or Reverse Run inputs must be On before holding torque will be available.

The Drive Enable input can not be applied until the drive has completed the initial power-on diagnostics and the Hard Fault output has been turned On to indicate that no control malfunctions were detected. If this input is turned On before the power-on diagnostics are completed, it will be ignored.

Important: The Drive Enable input must not be used by itself to provide a regenerative "emergency" stopping capability since an electronic malfunction could potentially prevent the drive from stopping. To achieve regenerative braking in an "emergency" stop situation, the following circuit that combines the Drive Enable and Coast to Stop input functions is suggested.

A single output from the "emergency" stop circuit of the CNC or control station connects to the Drive Enable input of the drive (see Figure 7.1). This same output is also connected to a user supplied relay with an electro-mechanical or pneumatic controlled time delayed dropout. A contact from the time delayed relay is connected in series with the Coast to Stop input of the drive.

Removing Drive Enable will cause the drive to regenerate to a stop and drop the contactor when zero speed is reached. When the time delay relay opens at the end of the time delay, the contact breaks the coil circuit of the contactor. The drive is then placed in a state in which no silicon circuitry is depended upon for maintaining the power off state.

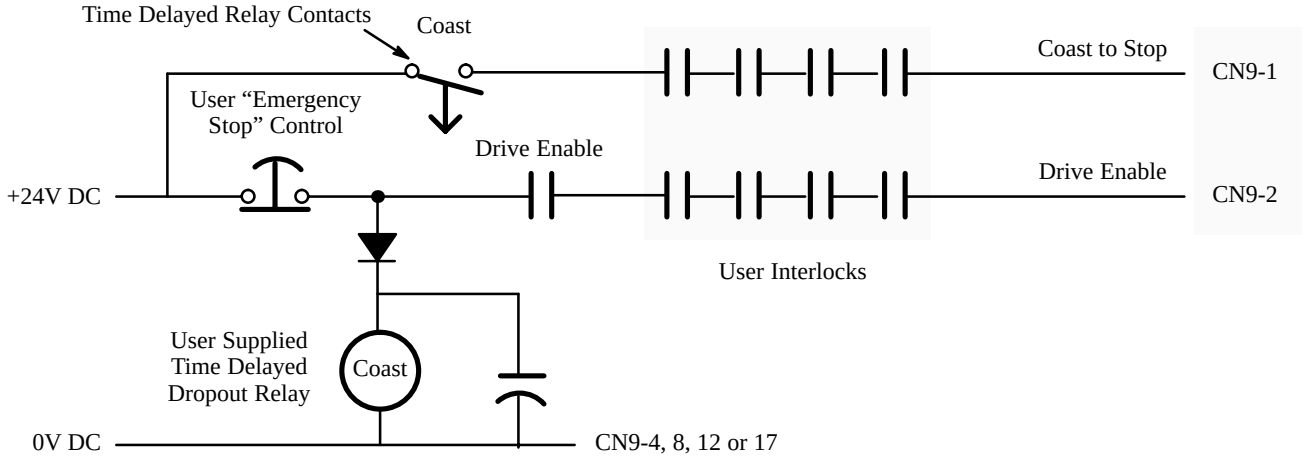
If a drive malfunction occurs, causing it to ignore the disable signal, the drive will only run for the time delay setting of the relay. At the end of the timeout, the motor contactor will be opened by passive circuitry, causing the system to coast to a stop.

Important: The magnitude of the time delay is application dependent and must be carefully chosen. The delay should be sufficient to allow the drive to stop the motor from maximum speed with the maximum expected load inertia. However, excessive time delays could pose a safety hazard in the event of an electronic malfunction.

ATTENTION: If an electronic malfunction occurs that prevents the drive from responding to the removal of the Drive Enable input, the motor will continue to operate under power until the user supplied time delayed dropout relay de-energizes and opens the Coast to Stop input. If this operation poses an unacceptable risk of personal injury or machine damage, immediately remove the Coast to Stop input and use an external braking system to provide rapid stops in an “emergency” situation.

ATTENTION: The user has the ultimate responsibility to determine which stopping method is best suited to the application and will meet applicable standards for operator safety. This responsibility includes machine risk assessments to identify hazards associated with “emergency” conditions and the appropriate system solutions.

Figure 7.1
Suggested Regenerative “Emergency” Stop Interface



Drive Reset – CN9-3
When On, any fault conditions that are present will be reset and the drive will begin the initial power-up sequence. If the fault condition still exists, the drive will immediately return to the fault shutdown condition.

If a fault occurred while the motor was running, it is possible to reset and then restart the drive while the motor is still coasting. The drive will regain control of the motor and either stop it or return it to the commanded operating speed, depending on the input signals applied.

Important: Approximately 2-3 seconds after a fault occurs, the fault message is written to the fault history in EEPROM. If the Drive Reset is turned On while the fault message is being written to EEPROM or while parameter value changes are being written to EEPROM, the reset command will be ignored. After the writing to EEPROM is complete, the Drive Reset input must be replied to reset the drive. To avoid this, do not apply the Drive Reset input until at least 5 seconds after a fault has occurred.

Digital Ground – CN9-4, 8, 12, 17
These terminals serve as grounding points for the digital inputs.

Forward Run and Reverse Run – CN9-5, 6
Turning either the Forward or Reverse Run inputs On will cause the motor to run at the speed commanded by the appropriate analog or digital speed command input.

The relationship between the direction of rotation and the Forward Run and Reverse Run digital commands and the analog velocity input command are shown below. Direction of rotation is determined when viewing the motor output shaft end.

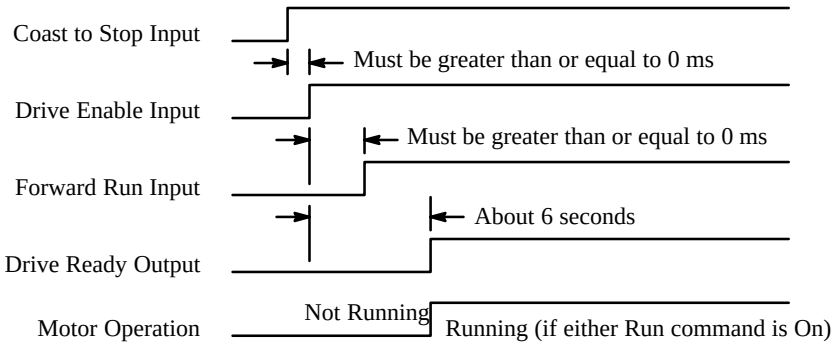
Velocity Command input voltage	**+ Volts**	**– Volts**
Forward Run Command On	Counterclockwise	Clockwise
Reverse Run Command On	Clockwise	Counterclockwise

When a digital speed command or a unipolar 0-10V DC analog speed command is used, these two inputs will reverse the direction of motor rotation.

When this input is turned Off, the motor will be regeneratively braked to zero speed. Whether or not zero speed holding torque will be available will depend on the setting of the programmable parameter *Enable Torque*.

Figure 7.2 shows the relative timing required for the Coast to Stop, Drive Enable and Forward (or Reverse) Run inputs to assure proper drive operation.

Figure 7.2
Timing



Low Torque Limit Select – CN9-7
When this input is On, the maximum allowable motor torque output is restricted to the value programmed with the *Low Torq Lmt* parameter.

When this input is Off, the motor torque is allowed to go to the maximum rating for that specific motor/drive combination.

Accel/Decel Rate Select (Torque Mode Enable) – CN9-9
During normal spindle mode operation, this input is used to select different motor accel/decel ramp rates. When this input is Off, the motor accel/decel rate is determined by the value programmed with the *Acc Rate #1* parameter. When this input is On, the motor accel/decel rate is determined by the value programmed with the *Acc Rate #2* parameter.

In servo mode operation, there is no ramp control supplied to the analog input signal. The drive will immediately respond to any input signal with output torque up to the maximum capability of the motor/drive system (or to the *Low Torq Lmt* level, if selected).

In torque mode operation this input will have a different function. If the *TORQUE MODE – Torque Enable* parameter has been set to “Enable” during the drive setup programming, this input is used to switch the drive between velocity control operation and torque control operation. When this input is Off, the drive runs as a normal velocity controlled drive with the speed command either digital or from Analog Input #1. When this input is On, the drive operates as an open loop torque controlled drive with the torque command from Analog Input #2.

When the *Torque Enable* parameter is set to "Enable," the *Acc Rate #2* parameter is disabled. The *Acc Rate #1* parameter is still active in spindle mode.

Spindle/Servo Mode Select – CN9-10
This input selects the velocity loop configuration and gains for the spindle or servo operating modes. Refer to page 1-3 for a description of the various control modes.

When this input is Off, the spindle mode is active. This mode is designed for basic velocity control without an external control loop. The velocity input must be an analog signal at Analog Input #1 or a 16 bit digital signal on the optional Digital Speed/Orient Position inputs.

When this input is On, the servo mode is active. The servo mode is designed for use in a closed position loop system. This mode should be used during spindle orient operation from the CNC and during C-axis operation on a turning center. The velocity command must be an analog signal with the loop programmed to use either Analog Input #1 or #2 (Analog Input #2 can not be used if *TORQUE MODE – Torque Enable* has been programmed).

Servo Input Scaling (Low/High) – CN9-11
This input is used to switch the scaling of the analog command input while in the servo mode.

When this input is turned Off, the maximum motor speed at maximum analog command is determined by the *LO SPD RANGE* parameter menu. When this input is turned On, the maximum motor speed is determined by the *HI SPD RANGE* parameter menu. Independent loop gain parameter sets can also be programmed for each of these speed ranges.

Orient Command – CN9-13
Turning this input On will activate the integral spindle orient function. The drive velocity control loops will be switched to high speed range servo mode gains and the position loop will be closed in the drive using the spindle position feedback device. Deceleration and stopping will be controlled by the orient function software.

When this input is turned Off, the drive will return to the standard velocity control mode in less than 30 ms and resume operation at the commanded speed.

The programmed value for the *ORIENT TUNE – Hold Position* parameter will determine whether the spindle will be in a free-turning or a servo lock condition after the orient operation is completed. If the parameter is set to "Torque Hold," the drive system will supply holding torque to maintain the orient position as long as the Orient Command is On.

If the Forward and Reverse Run commands are turned Off during orient, the orient operation will be terminated and the motor will be regeneratively braked to a stop.

If the orient operation is terminated by removing either the Forward or Reverse Run commands, the orient cycle will not automatically resume when the Forward or Reverse Run commands are turned On. The orient command must be applied after the Forward/Reverse Run commands.

Gear Ratio Active #1, #2 – CN9-14, 15

Refer to page 1-4 for a description of this function. These two inputs inform the drive of the gear range selected on the machine. Based on these inputs, the drive will select the appropriate group of programmed parameters for optimized performance in each gear range. Up to four gear ranges can be used.

Gear Ratio Active Input	**#1**	**#2**
Gear Range 1 Selected	Off	Off
Gear Range 2 Selected	On	Off
Gear Range 3 Selected	Off	On
Gear Range 4 Selected [1]	On	On

[1] Not available when a dual winding motor is used.

Motor Winding Select (Low/High) – CN9-16

Refer to page 1-6 for a description of this function. When this input is Off, a two winding motor will be operating with the low speed winding.

When the input is On, the high speed winding of a two winding motor will be selected.

If the drive is running and this input is turned On, the drive will initiate the winding change action in less than 30 ms.

If the drive is running and this input is turned Off, the winding change action will be initiated in less than 30 ms, if the motor speed is within the speed range of the low speed winding. If the current speed is faster than the maximum speed on the low speed winding, the winding change will be delayed until the commanded (and actual) motor speed is reduced to a speed that is within the operating range of the low speed winding.

Within 150-200 ms after beginning the winding change operation, the motor will resume supplying torque. Then within 250 ms, the output that indicates which winding is selected will change state. Finally, within about 750 ms, the system will have returned to a stable, fully controlled operation.

Changing windings will simultaneously select the appropriate new set of drive set-up parameters. In most systems, it will be desirable to have the same velocity command scaling for each winding. Having the same scaling will make it possible to command a speed greater than the maximum achievable speed on the low speed winding. If the low speed winding is selected and the commanded speed is greater than the maximum achievable speed with that winding, the drive will clamp the command at the maximum achievable speed.

Digital Outputs

Current Motor Winding Selected (Low/High) – CN9-18, 19
When this output is Off, the low speed motor winding is connected. When this output is turned On, the high speed winding has been connected.

Drive Ready – CN9-20, 21
The Drive Ready output is turned On after the Drive Enable signal has been applied and the drive has successfully completed the power-up sequence (ready for the Forward or Reverse Run commands). If for any reason the drive is unable to respond to the Forward or Reverse Run commands, this output is turned Off.

Hard Fault – CN9-22, 23
The hard fault output will be On if power is applied to the drive, there are no internally detected fault conditions, and the drive is waiting for or executing input commands. If stated in digital terms, this output would be called $\overline{\text{Hard Fault}}$.

This output will be turned Off whenever a drive fault condition occurs that will prevent the drive from properly controlling the motor.

If the motor is rotating when a fault condition is detected, the drive (if it is still capable of controlling the motor) will regenerate the motor to a stop and open the contactor. If the drive is unable to control the motor, the contactor will be opened and the motor will coast to a stop.

After a hard fault has occurred, the fault condition must be corrected, any inputs that command motion must be Off and the Reset input must be applied or the AC power cycled. It is not necessary for the motor to stop rotating before resetting and restarting the drive.

Soft Fault – CN9-24, 25

The Soft Fault output will be On if power is applied to the drive, there are no internally detected fault conditions, and the drive is waiting for or executing input commands. If stated in digital terms, this output would be called $\overline{\text{Soft Fault}}$.

This output will be turned Off as a result of motor overtemperature, drive overtemperature, or improper command sequences that can not be acted upon by the drive. During a soft fault condition, the drive will continue to operate normally. After about 2 minutes for a motor overtemperature and 30 seconds for a drive overtemperature, the fault will be changed to a hard fault and the motor will be regenerated to a stop. If the condition is corrected before it converts to a hard fault, the soft fault is automatically cleared and the output will again be turned On.

Improper command sequences that would cause a soft fault are; application of the Forward Run, Reverse Run, or Orient commands prior to applying the Drive Enable input. Application of the Motor Winding Select Command - Low when the present motor speed exceeds the maximum allowable motor speed on the low speed winding would also cause a soft fault.

Zero Speed Indicator – CN9-26, 27
This output will be turned On when the motor speed drops below 20 rpm. This output will be turned Off at 25 rpm.

At Set Speed Indicator – CN9-28, 29
This output will be turned On when the actual motor speed is within a percentage of the commanded speed. The percentage is determined by the percent of commanded speed value programmed with the *At-Set-Speed* parameter. The actual turn On band is the greater of the programmed commanded speed band or 25 rpm. If either the Forward Run or Reverse Run commands are On, this signal will be output at any operating speed (down to zero) when the conditions are satisfied.

Speed Level Indicator – CN9-30, 31
This output is turned On any time the actual motor speed is below the value programmed for the *Speed Detect* parameter.

Load Level Indicator – CN9-32, 33
This output is turned On any time the commanded torque exceeds a percent of available torque. This is determined by the load value programmed for the *Load Detect* parameter.

In-position – CN9-34, 35
The In-Position output is turned On to indicate that the spindle orient cycle has been completed and the spindle is within the programmed distance of the target position. The distance from the target position is programmed with the *In-Position* parameter.

Analog Inputs

Two analog inputs are available for providing analog speed or torque commands to the drive. Which analog inputs are used and for which input signals is determined by programmable parameters and the drive operating mode selected.

Analog Input #1 – CN9-36, 37, 38
In spindle mode, the drive can be configured to accept either an analog or a digital speed command. If the *SPINDLE MODE – Cmnd Source* parameter is set to “ANALOG,” the input command must be applied to this input.

In servo mode, an analog speed command is required but it can be applied to either analog input. If the *SERVO MODE – Analog In #* programmable parameter is set to "INPUT #1," this input must be used for the servo mode analog speed command. If the CNC or other control system has only a single analog output and the drive must operate in servo mode for functions such as spindle orient or C-axis machining on a turning center, the servo mode speed command should be applied to this input.

If this input is used for both the spindle and servo modes, a given analog input level may result in three different motor speeds. The different speeds are dependent on the operating mode selected and the maximum speed programmed for each operating mode. The *SPINDLE MODE – Max Cmnd Spd, SERVO MODE – LO SPD RANGE – Max Cmnd Spd,* and *SERVO MODE – HI SPD RANGE – Max Cmnd Spd* parameters define the scaling to be used. The Spindle/Servo Mode Select and Servo Input Scaling - Low/High inputs determine which factor will be used.

Analog Input #2 – CN9-39, 40, 41
During servo mode operation, if the *SERVO MODE – Analog In #* programmable parameter is set to "INPUT #2," this input must be used for the servo mode analog speed command. If the CNC or other control system has a separate analog output that is used for servo mode operation (like the 9/Series CNC when configured for C-axis machining on a turning center), the servo mode speed command must be applied to this input.

In servo mode, the maximum motor speed at maximum command will be changed based on the current state of the Servo Input Scaling Low/High digital input. The programmed values of the *LO SPD RANGE* or *HI SPD RANGE* menus will determine the maximum motor speed scaling that is to be used for each input state.

The 8510 drive can also be configured to operate as a torque controlled drive instead of a speed controlled drive. If the *TORQUE MODE – Torque Enable* programmable parameter is set to "ENABLED," the analog torque command must be applied to this input and the *SERVO MODE – Analog In #* programmable parameter must be set to "INPUT #1." The Torque Mode Enable (Accel/Decel Rate Select) input is used to switch between speed controlled operation, either spindle mode or servo mode, using Analog Input # 1 and torque controlled operation using Analog Input # 2.

In torque mode, the maximum analog input signal is always equal to the maximum torque capability of the drive/motor combination.

Analog Outputs

Analog Output #1 – CN9-42, 43, 44
Analog Output #2 – CN9-45, 46, 47
The two analog outputs can be programmed to output one of several different control variables. These variables include:

Motor/Spindle Speed
These outputs can be programmed to display either motor or spindle speed. The actual motor speed is determined from the resolver feedback and can be output directly, or it can be adjusted for the selected gear range and then output as spindle speed.

Full scale calibration is determined by the *SPINDLE MODE – Max Cmnd Spd* parameter. If spindle speed is being output, the full scale calibration is at *Max Cmnd Spd* in the highest speed gear range. The output voltage at full scale output is 8 volts. If speed overshoot occurs because of improper tuning or setup, the output can go to 10 volts or 125% of full scale calibration. By parameter selection, this output can be programmed to be either a unipolar or a bipolar output. In the bipolar mode, this output can be used as an analog tachometer output updated at a 1.6 ms rate.

% Load
This is a unipolar output that indicates the level of commanded torque output as a percent of the torque that can be generated at that specific speed. If the drive operates at maximum torque output from zero speed to base speed and maximum power output from base speed to max speed, the output will be 10V DC throughout the entire range.

Full scale output is the maximum overload rating of the motor and drive combination, i.e. 120% of the intermittent (30 minute) duty rating.

% Torque
This output is identical to Load except that it is a bipolar output. This output can be used as a set-up monitoring point or as a torque command to a slave drive in a master/slave drive combination.

Power Output
This output is a unipolar representation of motor power in kW throughout the entire speed range. Full scale is the maximum overload rating (120% of the intermittent power rating) of the motor/drive combination.

Orient Error
In the orient mode, the position error is shown as the spindle is oriented to the final position. The full scale range of this output is ±2 degrees of the target position.

Resolver Feedback Signals

Connector CN3 is used to connect the resolver and thermal switch that are located in the 1327A series AC spindle motors to the drive. Refer to Figure 7.3 for the connector location. Refer to Chapter 8 for the specific motor connector to CN3 wiring instructions.

Resolver Stator – CN3-8 & 14 and 9 & 15
Sine and cosine excitation of the resolver stator.

Resolver Rotor – CN3-11 & 17
Rotor feedback from the motor resolver.

Thermal Switch – CN3-13 & 20
Thermal switch that is embedded in the motor windings to indicate a motor overtemperature condition.

Cable Shields – CN3-1, 2, 3 & 4
The resolver cable must contain twisted shielded pairs with an additional overall shield and all shields must be terminated to these pins.

Orient Feedback Signals

Connector CN2 provides the connection to the orient feedback sensor when the drive is being used to perform spindle orient. If spindle orient is being done by the CNC, the sensor must be connected to the CNC and not to the drive. Either an optical encoder or the high resolution magnetic sensor can be terminated to this connector. Refer to Figure 7.3 for the connector location. Refer the Chapter 8 for specific wiring instructions for each feedback type.

Optical Encoder Feedback
Use an Allen-Bradley 845T series encoder with a type 33 electrical interface or an equivalent optical encoder with an A, B, and Z channel that uses a push-pull type single ended output and a +12V DC input voltage. Encoder line count should be selected to meet the application requirements. Maximum input frequency is 250 kHz. The encoder must be mounted with a 1:1 mechanical connection to the spindle shaft that is being oriented.

Encoder Channel A Input and Ground – CN2-16 & 10
Channel A output from the orient optical encoder.

Encoder Channel B Input and Ground– CN2-15 & 9
Channel B quadrature output from the orient optical encoder.

Encoder Channel Z Input and Ground – CN2-14 & 8
Channel Z marker pulse output from the orient optical encoder.

Encoder Power Supply and Ground – CN2-6 & 4
Control power, +12V DC, to the optical encoder.

High Resolution Magnetic Sensor
With the 8610SA-PSA sensing head and matching 8510SA-PGxxx feedback gear, orient resolutions of 225,000 to 500,000 parts per revolution can be obtained. The sensing head provides offset sine waves for the analog A, B, and Z channel outputs. Refer to Chapter 1 for a more complete description of this function.

Magnetic Sensor Channel A Input – CN2-19 & 13
Channel A sine output from the high resolution magnetic sensor.

Magnetic Sensor Channel B Input – CN2-18 & 12
Channel B cosine output from the high resolution magnetic sensor.

Magnetic Sensor Channel Z Input – CN2-17 & 11
Channel Z marker pulse output from the high resolution magnetic sensor.

Magnetic Sensor Power Supply and Ground – CN2-5 & 3
Control power, +12V DC, to the magnetic sensing head.

Dual Winding Contactor Signals

Refer to page 1-6 for a complete description of this function. When using a dual winding motor, a pair of contactors are connected between the drive and the motor to perform the winding selection. The contactor coils and auxiliary switches are wired to CNl. Refer to Figure 7.3 for the connector location and Chapter 8 for specific wiring instructions.

Allen-Bradley Bulletin 100 contactors with 24V DC coils are used to perform the winding selection. Refer to the following table for the specific contactor type required for each motor type (2 required).

Table 7.A
Required Contactors

Motor Catalog Number	Contactor Part Number
1327AD-ABL-04	100-A18-NZ243
1327AD-ABL-06	100-A18-NZ243
1327AD-ABL-08	100-A38-NZ243
1327AD-ACL-08	100-A38-NZ243
1327AD-AAK-11	100-A38-NZ243
1327AD-AAK-15	100-A38-NZ243
1327AD-AAK-19	100-A60-NZ243

High Speed Winding Select Command – CN1-2 & 3
Contact output to complete the 24V DC coil circuit and close the contactor that connects the motor winding into a Δ configuration for high speed operation.

Low Speed Winding Select Command – CN1-4 & 5
Contact output to complete the 24V DC coil circuit and close the contactor that connects the motor winding into a Y configuration for low speed operation.

High Speed Winding Selected Feedback – CN1-18 & 11
High speed contactor auxiliary switch input to indicate that the high speed contactor has closed.

Low Speed Winding Selected Feedback – CN1-17 & 10
Low speed contactor auxiliary switch input to indicate that the low speed contactor has closed.

Digital Command Signals

When the drive is supplied with I/O option B or D (Catalog number 8510A-Axx-Bx or 8510A-Axx-Dx), connector CN10 will be present to accept 16 bit digital input signals for spindle speed or orient position commands. Refer to Figure 7.3 for connector location. Refer to Chapter 8 for specific wiring instructions for the connector.

Digital Command Inputs 1-4 – CN10-1, 2, 3 & 4
Inputs used for bits 0 through 3 when binary data is supplied and 1's digit when BCD data is supplied.

Digital Command Inputs 5-8 – CN10-6, 7, 8 & 9
Inputs used for bits 4 through 7 when binary data is supplied and 10's digit when BCD data is supplied.

Digital Command Inputs 9-12 – CN10-11, 12, 13 & 14
Inputs used for bits 8 through 11 when binary data is supplied and 100's digit when BCD data is supplied.

Digital Command Inputs 13-16 – CN10-16, 17, 18 & 19
Inputs used for bits 12 through 15 when binary data is supplied and 1000's digit when BCD data is supplied.

Signal Grounds – CN10-5, 10, 15 & 20
Inputs to use as ground references for the digital command inputs.

Table 7.B
Digital Input Command Weighting

Input Number	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Binary Weight – 2^x	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BCD Weight	8000	4000	2000	1000	8000	4000	2000	1000	800	400	200	100	8	4	2	1

Serial Port

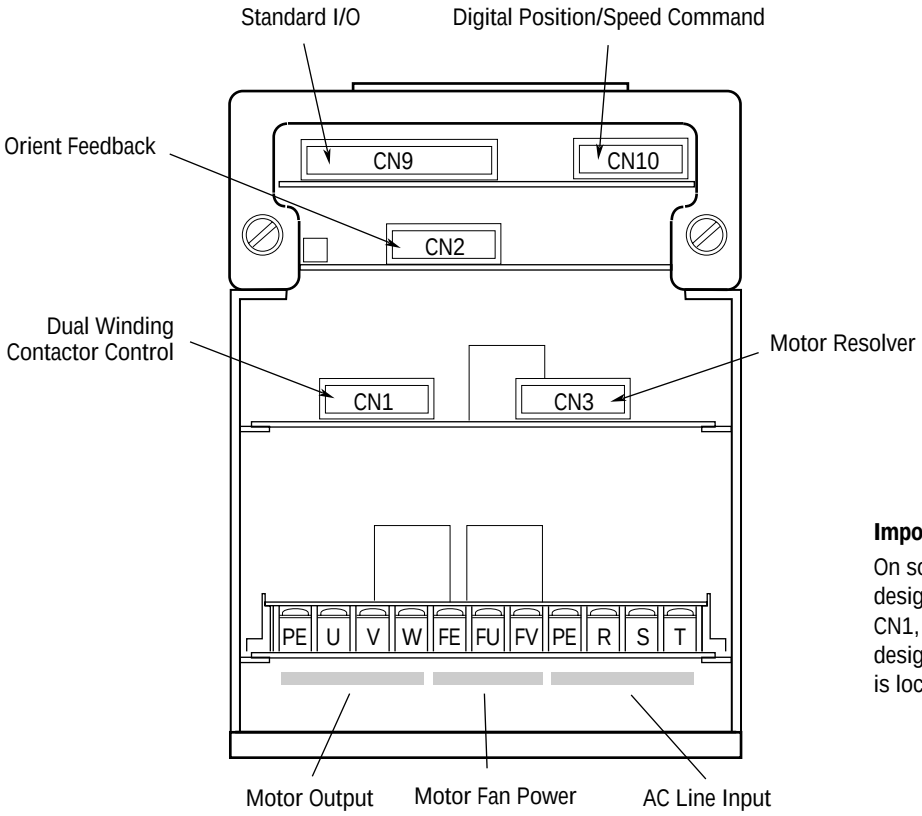
The Serial Port is a 9 pin D-shell connector located on the front of the drive. The Serial Port is used to:

1) read the diagnostic messages and

2) read and download the programmable parameters.

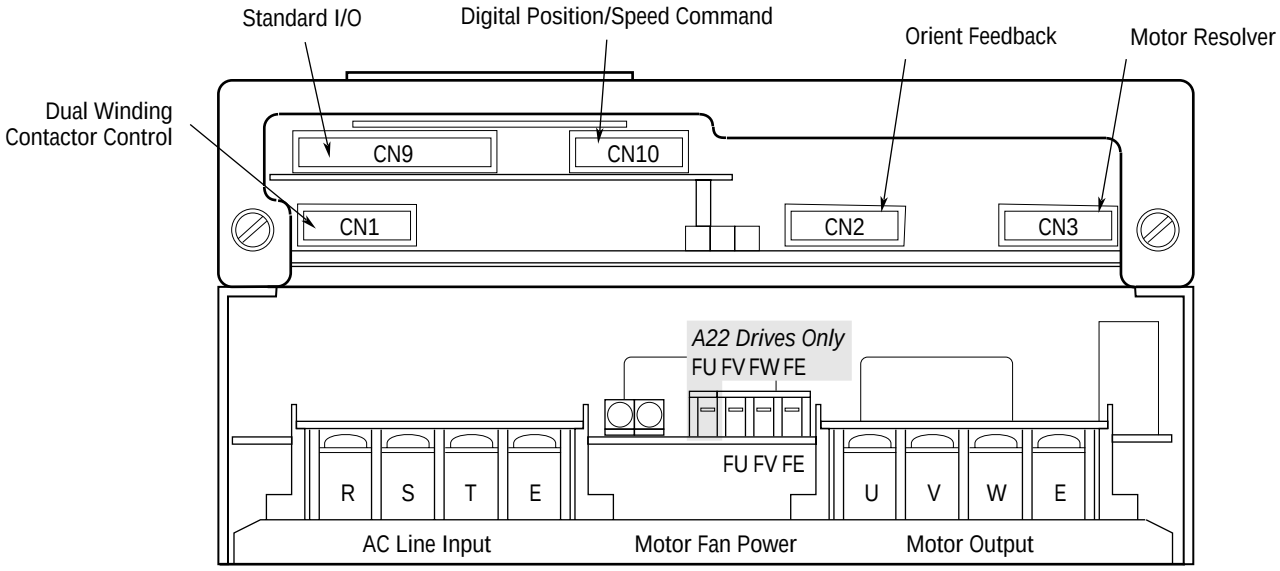
This port does not provide real-time control of the drive.

Figure 7.3
8510 Connector Locations



Bottom View of 8510A-A04, A06 Drive

Important:
On some 8510A-A06-A1 drives, different designators are used for connectors CN1, CN2, and CN3. Although the connector designator may be different, the I/O function is located in the same physical location as shown.



Bottom View of 8510A-A11, A22 Drive

End of Chapter

Chapter 8

Wiring

Chapter Objectives

Chapter 8 provides the information needed to properly wire the 8510 AC Drive System. Included in the chapter are general wiring recommendations and detailed wiring procedures for power and signal wiring.

General Wiring Information

Since most start-up difficulties are the result of incorrect wiring, every precaution must be taken to assure that the wiring is done as instructed. **All items must be read and thoroughly understood before the actual wiring begins.**

ATTENTION: The following information is a general guide for proper installation. The National Electrical Code and any governing regional or local codes will overrule this information. The Allen-Bradley Company **cannot** assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this system or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

The information supplied in this manual on wire sizes, practices, layouts, system configurations and grounding/shielding techniques for the 8510 AC Drive System are presented as guidelines. Due to the diversity of applications and systems, no single method of wiring is completely applicable.

Important: This information represents common system wiring configurations, size and practices that have proven satisfactory in a majority of applications. The National Electrical Code, local electrical codes, special operating temperatures, duty cycles or system configurations will take precedence over the values and methods listed.

Important: For proper interconnection, it is recommended that Allen-Bradley Termination Panels, Cable Assemblies and/or connectors be used.

Wire Sizes

Unless noted, the wire sizes in this manual are recommended minimums and assume type MTW wire (machine tool wire, 75° C, minimum) per NFPA 79. In all cases, the user is responsible for selecting the appropriate wire type to comply with all applicable national and local codes and to satisfy the needs of the particular application and environmental conditions. Since ambient conditions vary widely, on certain applications, a derating factor has to be taken into account. Also, wiring to systems or motors exceeding 15 meters (50 feet) in length (total includes to and from device) may cause excessive voltage drops. Consult the National Electrical Code or appropriate national or local code for factors on ambient conditions, length etc.

Shielding

Reasonable care must be taken when connecting and routing power and signal wiring on a machine or system. Radiated noise from nearby relays (relay coils should have surge suppressors), transformers, other electronic drives, etc. may be induced into the signal lines causing undesired movement of the motor.

All signal wiring must use shielded cables. All power wiring must be installed in a metal conduit or wireway. Power leads are defined here as the transformer primary and secondary leads, motor leads and any 115V AC or above control wiring for relays, fans, thermal protectors etc. Signal wiring is defined as velocity command, feedback, enable lines and low level logic signal lines.

Feedback, command signal and other shields must be insulated from each other and terminated as specified in this chapter. This helps to minimize radiated and induced noise problems and ground loops. Refer to the paragraph entitled *Grounding*.

Open ended shields must be insulated so that they do not accidentally cause ground loops.

All analog signals to and from the drive use twisted, shielded pairs. The typical installation practice is to terminate the shield at the signal source end. While this usually gives good results, there may be systems that require other shield grounding schemes for best results. If noise is a problem with the typical shield grounding methods, try terminating the shields at the load end or at both ends and evaluate the results. There is no single solution that is best for all situations.

Grounding

All equipment and components of a machine or process system shall have their chassis connected to a common earth ground point. This ground system provides a low impedance path that helps minimize shock hazards to personnel and damage to equipment caused by short circuits, transient overvoltages and accidental connection of energized conductors to the equipment chassis.

Grounding requirements, conventions and definitions are contained in the National Electrical Code or appropriate national codes. Local codes will usually dictate what particular rules and regulations are to be followed concerning system safety grounds.

Wiring Clearance and Routing

Although the minimum clearance should be maintained for proper cooling, this space may not always provide proper wiring clearance. The minimum allowable wire bending radius may necessitate that extra space be provided to accommodate power wiring. Consult the National Electrical Code or the appropriate national or local code for the proper wiring method.

Signal Wiring

The 8510 inputs and outputs are all rated for +24V DC. The +24V DC voltage source must be supplied by the user. Each input that is used requires about 10mA of input current and all outputs are physical contact closures.

All signal connections are made through MR series Honda connectors. The mating connectors required for signal interfaces are as follows:

Function	**Number**	**Honda Type**
Standard I/O (Always Required)	CN9	MR-50LF
Motor Resolver Feedback (Always Required)	CN3	MR-20LF
Digital Position/Speed Input (Optional)	CN10	MR-20LF
Spindle Orient Feedback (Optional)	CN2	MR-20LF
Dual Winding Motor Control (Optional)	CN1	MR-20LF

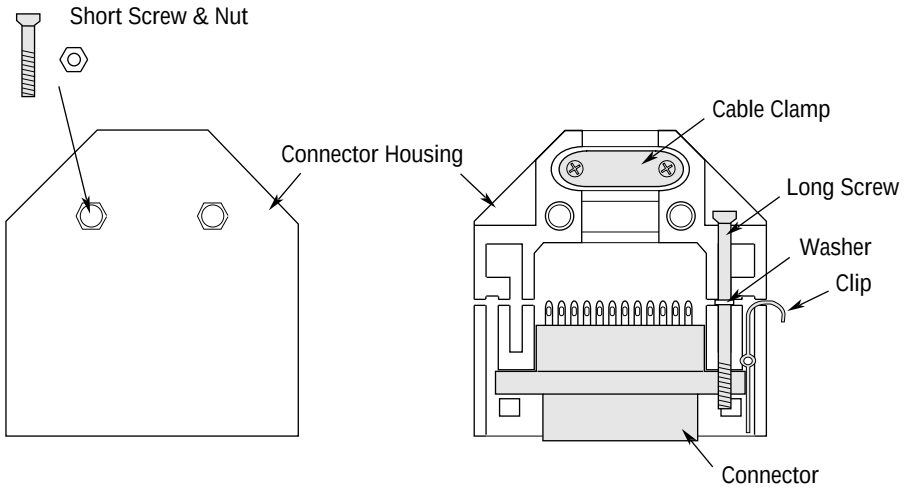
Three termination options are available for each of the connectors.

l) A mating connector kit that requires the user to supply the cable and terminate directly to the Honda connector. This is a solder type connector. A crimp connector, the MRP series, is available from the manufacturer.

2) A termination panel that provides a prefabricated 1.5 m (5 ft.) cable from the drive connector to a DIN rail mounted terminal block interface module. User wiring is to the terminal block.

3) A cable assembly in varying lengths with the Honda connector wired to one end. The other end is loose cable leads for user termination as required.

Figure 8.1
Connector Wiring



Honda Connector Wiring and Assembly
Refer to the following information and the instruction sheet provided with the connector kit for assembly procedure.

1. Disassemble the connector by removing the 2 short screws and nuts (see Figure 8.1). Since the connector contains a number of small pieces, care should be taken during disassembly.
2. Prepare cable and wire ends. Using a rosin core solder, carefully solder wires to connector using the cable information provided in this chapter.
3. Install cable clamp around cable(s). To allow positioning, do not tighten clamp completely.
4. Place connector into housing and slide cable clamp to position shown in Figure 8.1. Tighten cable clamp.
5. Install the 2 long screws and washers through the holes in the connector. Position screws and washers as shown in Figure 8.1.
6. Place clips into housing and secure remaining housing piece over assembly using the 2 short screws and nuts previously removed.

The maximum wire size that the terminals in the Honda connector can accept is 24 AWG (0.28 mm^2). For each connector, the cable type recommended in this chapter, or an equivalent, must be used to assure proper system operation.

If larger wire sizes are preferred, the optional Termination Panels will allow use of up to 16 AWG (1 mm^2) wire. If larger cable sizes are used, the cable configuration and shielding must conform to that specified for the standard cable.

All shields must be terminated in accordance with the following wiring diagrams. If one end of a shield is to be left open, take care to insulate and properly isolate the open end of shield to avoid shorting it to ground.

Motor and Drive Power Wiring

In accordance with NEC, the power wiring size should be based on the 30 minute overload rating of the applicable motor. The user must determine if national or local codes specify other requirements. All power wiring should be terminated to the bolt or screw terminals on the drive and motor using ring type terminal lugs.

ATTENTION: To guard against the hazard of personal injury or damage to equipment, the interconnections to the motor and feedback device must be made as explained in this chapter. Failure to do so could cause loss of motor control and/or severe oscillation of the motor shaft.

The size of the power terminal connections on the drive for incoming AC line power and motor power terminations is shown below.

Table 8.A
Power Terminal Sizes

Drive Catalog Number	Bolt / Screw Size	Maximum Lug Width
8510A-A04-x1	M4	10.8 mm (0.425 in.)
8510A-A06-x1	M4	10.8 mm (0.425 in.)
8510A-A11-x2	M6	17.0 mm (0.668 in.)
8510A-A22-x2	M8	17.0 mm (0.668 in.)

The size of the power terminal connections in the motor terminal box for motor power is shown in Table 8.B.

Table 8.B
Motor Terminal Sizes

Motor Catalog Number	Bolt / Screw Size	Maximum Lug Width
1327AC-AFM-02-F	M5	13 mm
1327AC-AFM-04-x	M5	13 mm
1327AC-AFM-06-x	M5	13 mm
1327AC-AFL-08-x	M6	17 mm
1327AC-AFL-11-x	M6	17 mm
1327AB-AFL-15-x	M8	24 mm
1327AB-AFL-19-x	M8	24 mm
1327AB-AFL-22-x	M8	24 mm
1327AD-ABL-04-x	M8	23 mm
1327AD-ABL-06-x	M8	23 mm
1327AD-ABL-08-E	M8	23 mm
1327AD-ACL-08-F	M8	23 mm
1327AD-AAK-11-x	M8	23 mm
1327AD-AAK-15-x	M10	29 mm
1327AD-AAK-19-x	M10	29 mm

To minimize radiated PWM noise, the individual motor phase wires must be part of a single multi-conductor cable or run very close together. The motor cables should be contained in grounded metal conduit or raceways.

Power Transformers

The allowable AC input voltage range is 200 to 230V AC, ±10% at 60 Hz and 200 to 220V AC, ±10% at 50 Hz. In larger plants with high capacity power systems, it is not uncommon to encounter exceptionally high AC line voltage that will exceed the +10% specification during part of the day. In these cases the nominal secondary voltage of the transformer should be set for 5-10% less than the maximum allowable nominal input voltage of the drive. This will help avoid drive damage caused by the high AC line voltage. Transformers supplied by Allen-Bradley are wound with 220V AC secondaries.

Either autotransformers or isolation transformers can be used. When using isolation transformers, a "Y" secondary with the neutral grounded is recommended.

Power transformer kVA requirements depend on the power rating of the motor being used. Table 8.C defines the transformer requirements.

Table 8.C
Transformer Requirements

Motor Rating *(Cont. / 30 Min. kW)*	**Transformer Rating** *(kVA)*
2.2 / 3.7	6
3.7 / 5.5	9
5.5 / 7.5	12
7.5 / 11	17
11 / 15	22
15 / 18.5	26
18.5 / 22	32
22 / 30	40

Power Grounding

The wire size used for power grounds must be at least as large as the wire gauge of the power conductors or as defined by local codes.

Other Devices and Noise Suppression

Inductive devices (e.g. solenoids, motor starters and relays) must be equipped with suppression devices that will not allow a dv/dt of greater than 200 V/µsec. Devices that produce a strong magnetic field (e.g. chokes, transformers and reactors) must not be mounted closer than 254 mm (10 in.) to the drive. The associated wiring to any of these devices must be physically separated from any low level signal wiring to minimize induced voltages.

Power Wiring

AC Input Power To the 8510 Drive

AC line input terminals are located at the bottom of the drive as shown in Figure 7.3. Input current requirements and wire size are dependent on the motor kW rating and the AC line voltage. The following table defines the drive AC line input current requirements at a nominal 220V AC line voltage and at the low line voltage limit of 180V AC. Wire sizes are selected per NFPA-79 and IEC-204 for wires in a cable or raceway and are based on 75° C wire (70° C for IEC-204).

Table 8.D
AC line Input Current Requirements

Motor Power *(Cont. / 30 Min. kW)*	**30 Minute Current Rating** at 220V AC	at 180V AC	**Wire Size** [1, 2] *(AWG / mm²)*
2.2 / 3.7	15A	18A	12 / 2.5
3.7 / 5.5	22A	27A	10 / 4.0
5.5 / 7.5	30A	37A	8 / 6.0
7.5 / 11	42A	51A	8 / 10.0
11 / 15	55A	67A	6 / 16.0
15 / 18.5	65A	79A	4 / 25.0
18.5 / 22	78A	95A	3 / 25.0
22 / 30	100A	122A	2 / 35.0

[1] AWG wire sizes are based on 220V AC, –10%, with 75° C wire. The mm² wire sizes are based on 70° C wire. For other input voltages, select wire size according to local electrical codes.

[2] If 90° C wire is used, the wire sizes can be reduced about one wire size. Refer to the NEC for proper wire sizing for higher temperature wire.

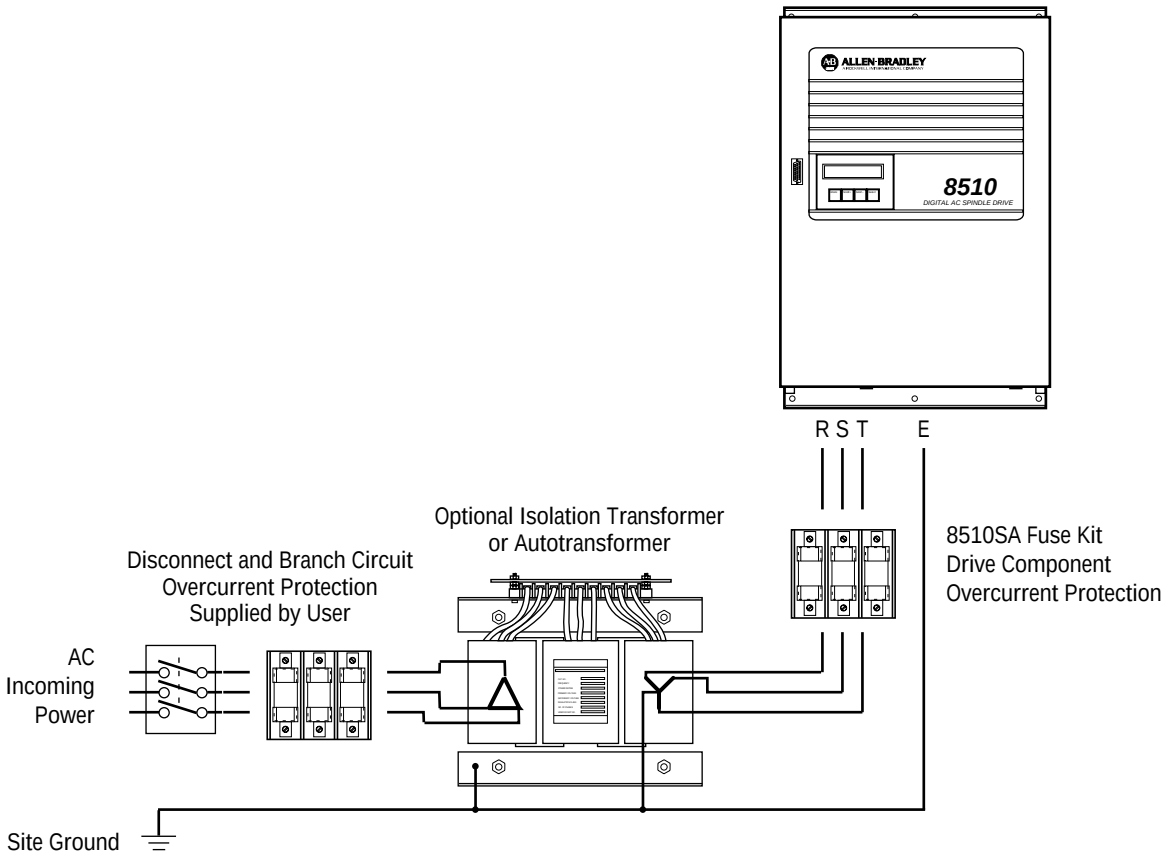
The 8510 does not include incoming AC line overcurrent protection. Either current limiting fuses or a high speed circuit breaker must be installed between the drive and the AC power source. Optional fuse kits that include properly sized high speed, current limiting fuses and the appropriate fuse block are available. The components supplied in the fuse kits are defined in Table 8.E.

Table 8.E
Recommended AC Line Fuses

Fuse Kit Catalog Number	**for use with Drive Model**	**Fuse Type (Qty. 3)** Bussmann	Gould Shawmut	**Fuse Holder** Bussmann	Gould Shawmut
8510SA-FA04	8510A-A04-x1	JKS40	A4J40	J60060-3CR	60608J
8510SA-FA06	8510A-A06-x1	JKS60	A4J60	J60060-3CR	60608J
8510SA-FA11	8510A-A11-x2	JKS100	A4J100	J60100-3CR	61008J
8510SA-FA22	8510A-A22-x2	JKS175	A4J175	J60200-1CR (Qty. 3)	62003J

The recommended AC input power connection is shown in Figure 8.2. If an autotransformer or isolation transformer is used, follow the connection diagram supplied with the transformer to determine proper wiring to the drive.

Figure 8.2
Recommended AC Input Power Connection



Power From 8510 Drive To The 1327A Series Motor

The motor power output terminals are located at the bottom of the drive as shown in Figure 7.3. Motor current requirements and wire size are dependent on the specific motor type. Table 8.F defines the drive output current requirements when used with the various motor catalog numbers.

Wire sizes are selected per NFPA-79 and IEC-204 for wires in a cable or raceway and are based on 75° C wire (70° C for IEC-204).

The motor fan should be wired to the motor fan power terminals on the bottom of the drive (see Figure 7.3 for terminal locations). The terminals in both the drive and motor use M4 screws. The motor fan current ranges from 0.3A in the smallest motor to 1.2A in the largest motor. The power output terminals are fused in the drive with 5A fuses. A #20 AWG/0.50 mm^2 wire is adequate for the motor fan wiring.

Table 8.F
Motor Current Requirements

Motor Catalog Number	**Power Rating** *(Cont. / 30 Minute kW)*	**Current Rating** *(Cont./30 Minute A)*	**Wire Size** [1, 2] *(AWG / mm²)*
1327AC-AFM-02-F		20 / 27	10 / 4.0
1327AC-AFM-04-x	2.2 / 3.7	27 / 33	8 / 6.0
1327AC-AFM-06-x	3.7 / 5.5	36 / 43	8 / 10.0
1327AC-AFL-08-x	5.5 / 7.5	45 / 59	6 / 16.0
1327AC-AFL-11-x	7.5 / 11	73 / 91	3 / 25.0
1327AB-AFL-15-x	11 / 15	97 / 112	2 at 4 / 2 at 16.0 [3]
1327AB-AFL-19-x	15 / 18.5	120 / 135	2 at 3 / 2 at 16.0 [3]
1327AB-AFL-22-x	18.5 / 22	122 / 153	2 at 3 / 2 at 25.0 [3]
1327AD-ABL-04-x	22 / 30	25 / 34	8 / 6.0
1327AD-ABL-06-x	3.7 / 5.5	37 / 45	8 / 10.0
1327AD-ABL-08-E	5.5 / 7.5	50 / 68	6 / 16.0
1327AD-ACL-08-F	7.5 / 11	52 / 68	6 / 16.0
1327AD-AAK-11-x	7.5 / 11	65 / 87	4 / 25.0
1327AD-AAK-15-x	11 / 15	83 / 102	2 at 6 / 2 at 16.0 [3]
1327AD-AAK-19-x	15 / 19	95 / 110	2 at 4 / 2 at 16.0 [3]
	19 / 22		

[1] AWG wire sizes are based on 75° C wire. The mm² wire sizes are based on 70° C wire. Current ratings are based on 30° C ambient.

[2] If 90° C wire is used, the wire sizes can be reduced about one wire size. Refer to the NEC for proper wire sizing for higher temperature wire.

[3] Due to terminal block size limitations on the drive, run two conductors per phase of the size indicated.

See Figure 8.3 for the configuration of a typical terminal box on a standard 1327AB series motor. The power interconnect wiring between the drive and a standard 1327AB series motor is shown in the following diagram.

Figure 8.3
Terminal Box – Standard Motor

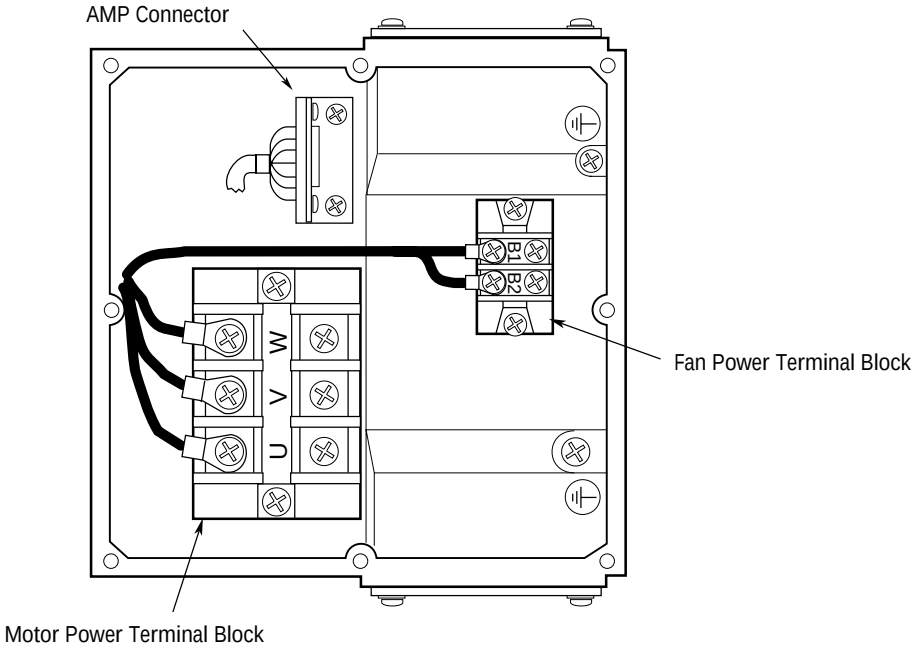
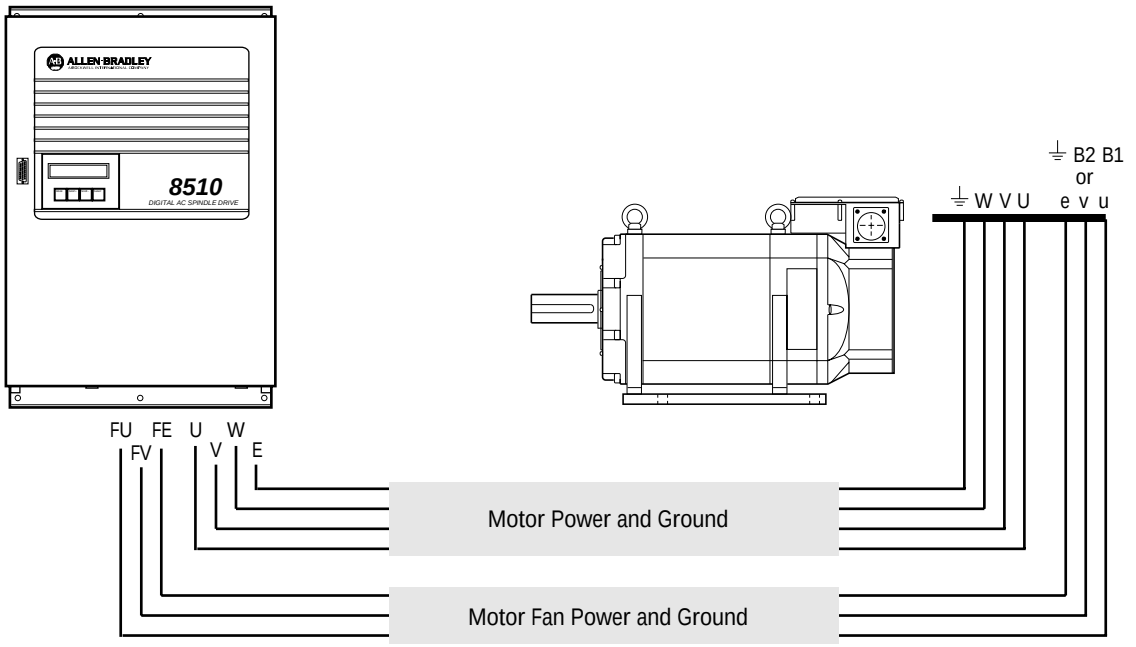


Figure 8.4
Standard Motor Power Connections



If a 1327AD series dual winding motor is being used, two additional power contactors must be mounted and wired to the drive. Refer to Table 7.A for the specific contactors that are required with each motor. See Figure 8.5 for the configuration of a typical terminal box on a dual winding type 1327AD series motor.

The externally mounted contactors used with the 1327AD series motors must be wired according to Figure 8.6.

Figure 8.5
Terminal Box – Dual Winding Motor

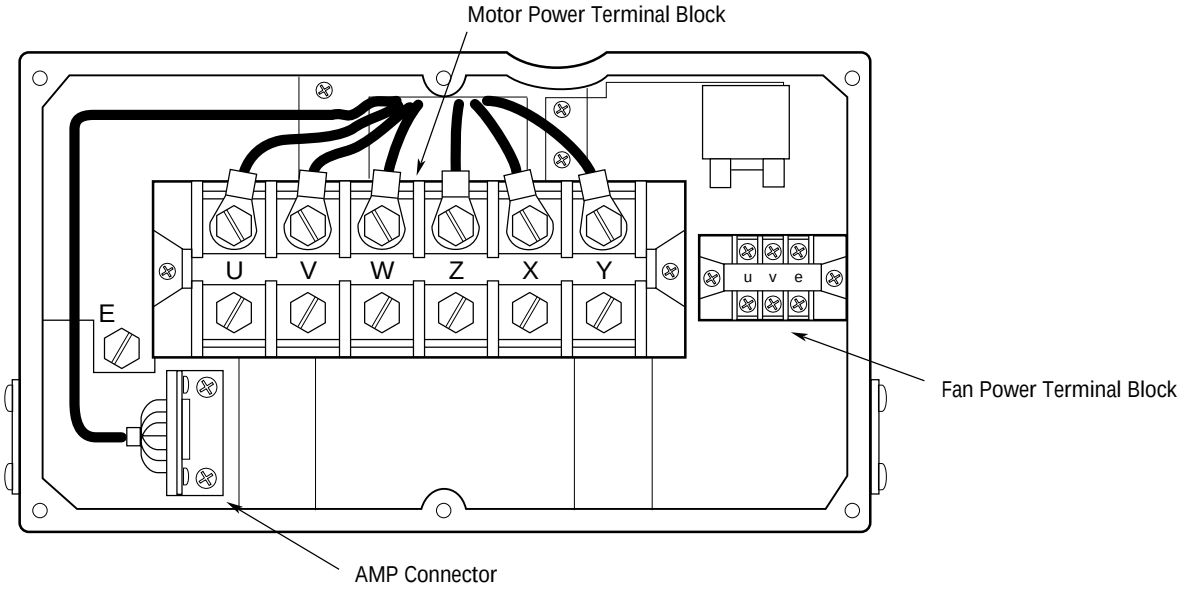
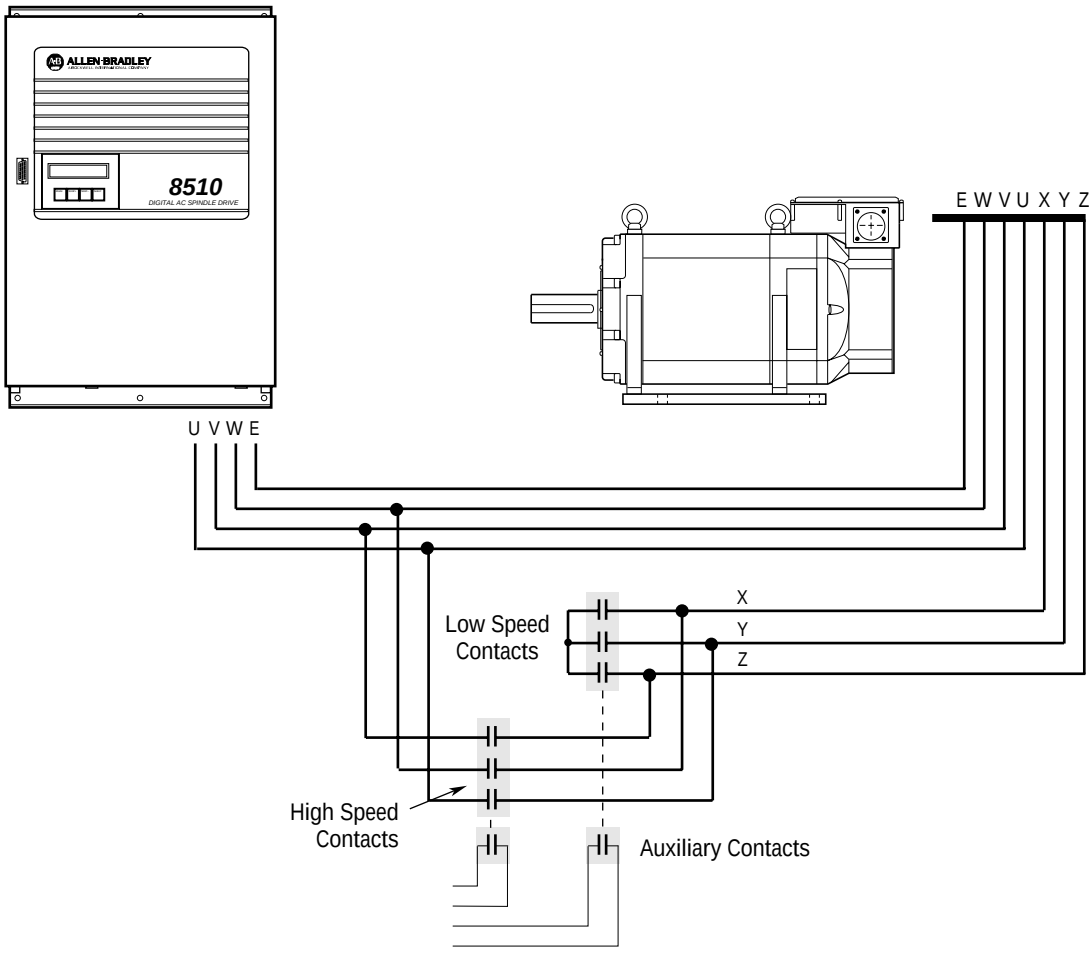


Figure 8.6
Dual Contactor Wiring



Signal Wiring

I/O Interface Wiring

All standard discrete digital control signals and analog inputs and outputs are connected to the drive through the 50 pin CN9 connector. This interface is required for all 8510 systems.

Since both digital and analog signals are passed through the same connector, it is recommended that two separate cables be run into the connector to achieve the proper shielding and grounding. The recommended cables are:

Discrete Digital Signals – Furukawa #OAW(C)SB-18P (18 twisted pairs, #28 AWG)
Analog Signals – Belden # 8164 (4 twisted, shielded pairs, #24 AWG)

As previously described, three termination options are available for this connector: l) a mating connector kit, 2) a termination panel, and 3) an interface cable assembly. Table 8.G shows the I/O function assignment for each of these termination options. Figure 8.7 shows a typical interface to an Allen-Bradley 9/Series CNC for a basic spindle application. Additional I/O connections will be required to access more of the 8510 drive features.

Table 8.G
Standard I/O Interface Wiring Information

Signal Description	Honda Connector Pin Number	Termination Panel Terminal Number	Cable Assem. Wire Color and (Pair #)
Digital Inputs			
Coast to Stop		1	
Drive Enable	1	2	Black (1)
Drive Reset	2	3	Pink (1)
Digital Ground	3	4	Brown (2)
Forward Run	4	5	Pink (2)
Reverse Run	5	6	Red (3)
Low Torque Limit Select	6	7	Pink (3)
Digital Ground	7	8	Orange (4)
Accel/Decel Rate Select	8	9	Pink (4)
Spindle/Servo Mode Select	9	10	Yellow (5)
Servo Input Scaling - Low/High	10	11	Pink (5)
Digital Ground	11	12	Green (6)
Orient Command	12	13	Pink (6)
Gear Ratio Active #1	13	14	Blue (7)
Gear Ratio Active #2	14	15	Pink (7)
Motor Winding Select - High/Low	15	16	Black (8)
Digital Ground	16	17	White (8)
	17		Brown (9)
Digital Outputs			
Current Motor Winding Selected		18	
Current Motor Winding Selected	18	19	Red (10)
Return	19	20	White (10)
Drive Ready	20	21	Orange (11)
Drive Ready Return	21	22	White (11)
Hard Fault	22	23	Yellow (12)
Hard Fault Return	23	24	White (12)
Soft Fault	24	25	Green (13)
Soft Fault Return	25	26	White (13)
Zero Speed Indicator	26	27	Blue (14)
Zero Speed Indicator Return	27	28	White (14)
At Speed Indicator	28	29	Violet (15)
At Speed Indicator Return	29	30	White (15)
Speed Level Indicator	30	31	Gray (16)
Speed Level Indicator Return	31	32	White (16)
Load Level Indicator	32	33	Pink (17)
Load Level Indicator Return	33	34	White (17)
In-Position	34	35	Black (18)
In-Position Return	35		Gray (18)
Analog Inputs			
		36	
Analog Input #1	36	37	Red (1)
Analog Input #1 Return	37	38	Black (1)
Shield [1]	38	39	Drain (1)
Analog Input #2	39	40	White (2)
Analog Input #2 Return	40	41	Black (2)
Shield [1]	41		Drain (2)
Analog Outputs			
		42	
Analog Output #1	42	43	Green (3)
Analog Output #1 Return	43	44	Black (3)
Shield	44	45	Drain (3)
Analog Output #2	45	46	Blue (4)
Analog Output #2 Return	46	47	Black (4)
Shield	47		Braid (4)

[1] Shields should be terminated only at the signal source end.

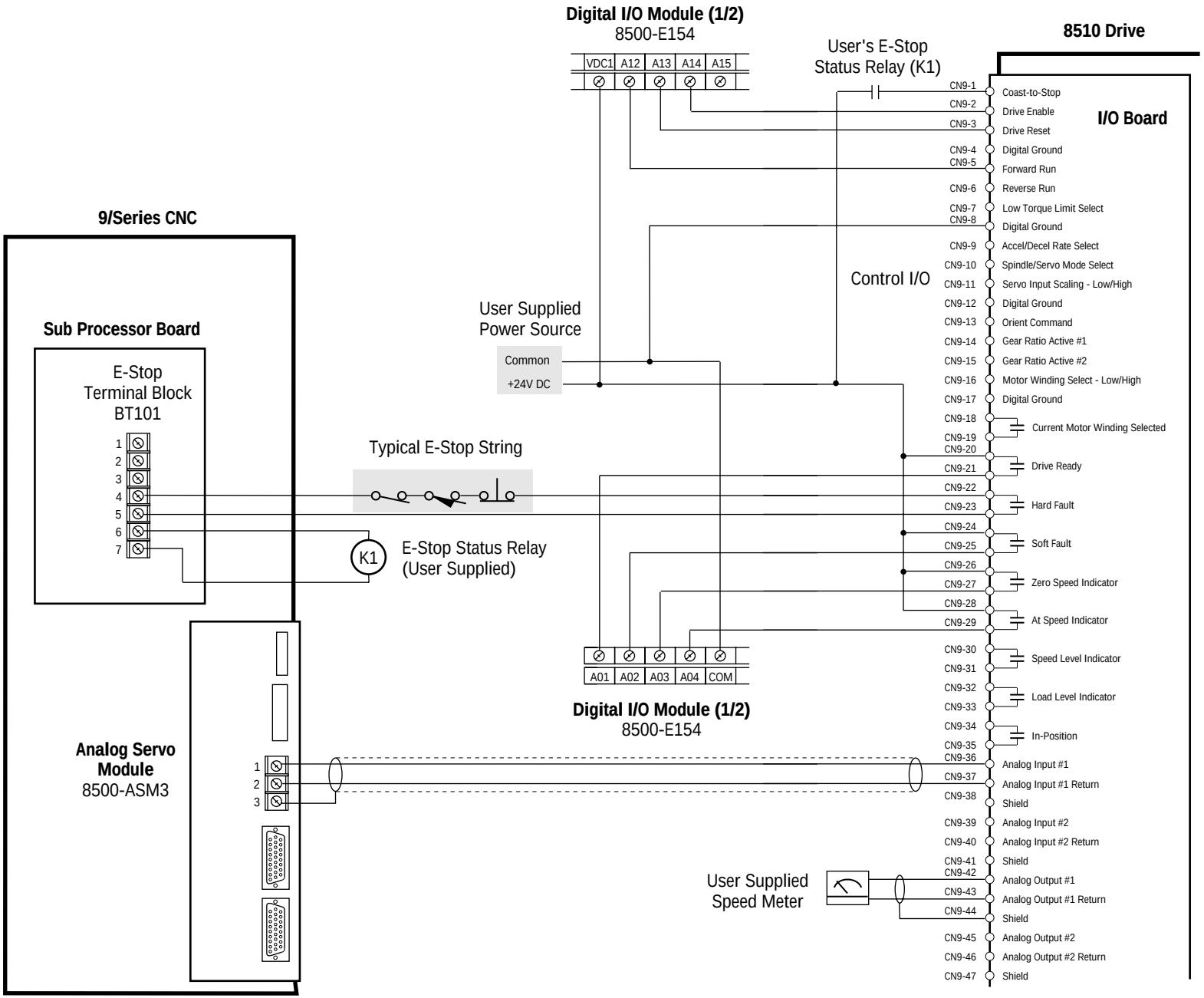


Figure 8.7
Typical 9/Series CNC Interconnect

Resolver Feedback Wiring

The motor resolver feedback signals and the motor thermal switch are connected to the drive through the 20 pin CN3 connector. This interface is required for all 8510 systems. Refer to Figure 7.3 for the location of this connector on the drive.

The feedback cable can be routed through the same conduit used for motor power leads, but it is essential that a properly shielded cable is used. The cable must have four twisted shielded pairs with an overall shield. The recommended cable type is:

Belden # 8164 (4 twisted, shielded pairs, #24 AWG)

The cable is terminated inside the motor terminal box to a connector (see Figure 8.3 or Figure 8.5). On 1327AB Series A and 1327AD Series A motors, an AMP Commercial MATE-N-LOK connector is used. On 1327AB Series B, 1327AC Series A, and 1327AD Series B motors, an AMP Dynamic Series connector is used.

Different sizes of the AMP Commercial MATE-N-LOK connector are used on the 1327AB and 1327AD series motors. The connector component part numbers and the Allen-Bradley connector kit catalog numbers are:

For 1327AB Series A Motors
Connector Housing – AMP # 1-480438-0 (16 pin housing)
Pins (12 required) – AMP # 60617-6 (24-18 AWG, phosphor bronze with gold)
Connector Kit Catalog Number – 8510SA-CABC

For 1327AD Series A Motors
Connector Housing – AMP # 1-480285-0 (10 pin housing)
Pins (9 required) – AMP # 60617-6 (24-18 AWG, phosphor bronze with gold)
Connector Kit Catalog Number – 8510SA-CADC

These connectors use crimp type pins. AMP crimp tool #90123-2 is recommended to properly crimp these pins to the wire. As an alternative, any similar sized hand crimp tool or pliers can be used for the basic mechanical connection. The lead must then be soldered to complete the electrical connection.

With the AMP Dynamic Series connector, the same connector is used on all motors. However, the mating connectors are available for either crimp or solder type wire termination. The component connector part numbers and the Allen-Bradley connector kit catalog numbers are:

Crimp Type For 1327AB Series B, 1327AC Series A, and 1327AD Series B Motors
Connector Housing – AMP # 178289-5 (10 pin housing)
Pins (9 required) – AMP # 1-175217-2 (24-20 AWG, high force, gold plated)
Connector Kit Catalog Number – 8510SA-CMRC

Solder Type For 1327AB Series B, 1327AC Series A, and 1327AD Series B Motors
Connector Housing – AMP # 178289-5 (10 pin housing)
Pins (9 required) – AMP # 1-175218-2 (20-16 AWG, high force, gold plated, with preformed ferrule)
Connector Kit Catalog Number – 8510SA-CMRS

For the crimp type connectors, AMP crimp tool # 90683-1 or # 91459-2 is required to properly crimp the pins to the wire.

A pin extraction tool (AMP # 914677-1) is required to remove a pin from the housing. Both items are available from Allen-Bradley as part of the 8510SA-CTA crimp tool kit.

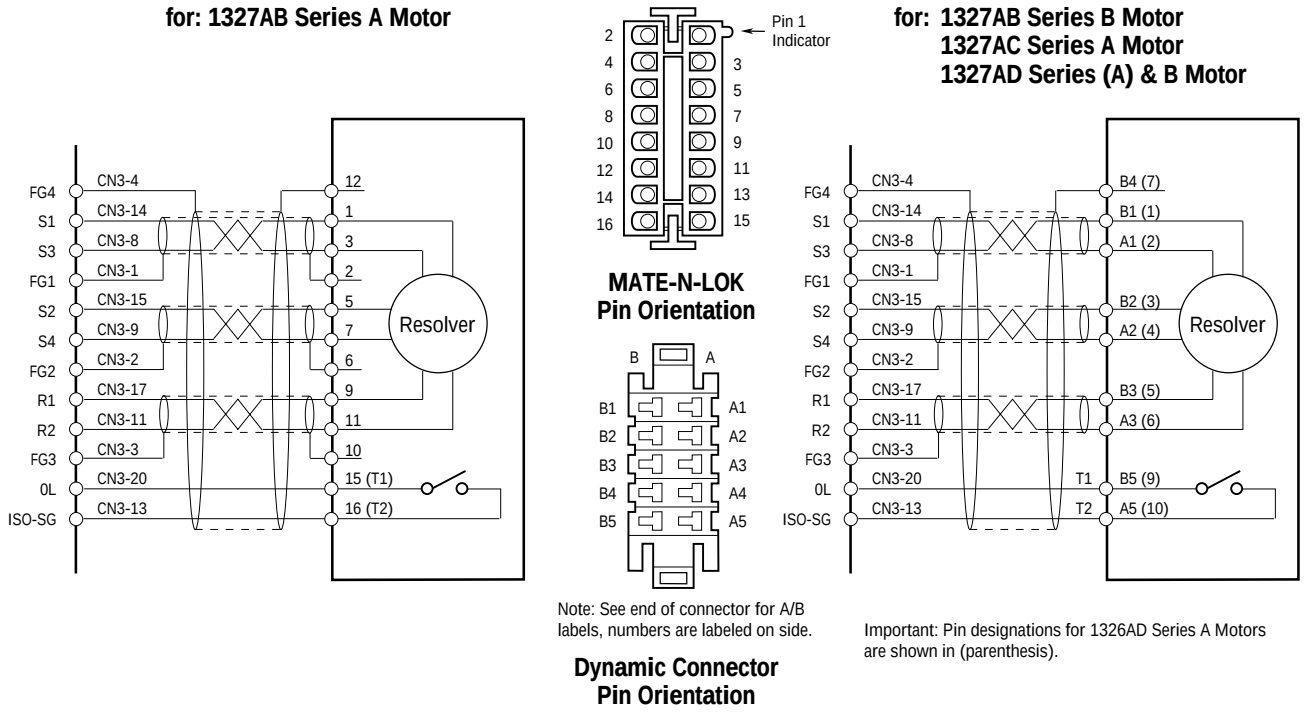
As previously described, three termination options are available for the CN3 connector: l) a mating connector kit, 2) a termination panel, and 3) an interface cable assembly. The following table shows the I/O function assignment for each of these termination options.

Table 8.H
Resolver Connector/Cable information

Signal Description	Honda Connector Pin Number	Termination Panel Terminal Number	Cable Assembly Wire Color and (Pair #)	Connector Pin Number for 1327AB Series A	Connector Pin Number for 1327AD Series A	Connector Pin Number for 1327AB Series B, 1327AC Series A, 1327AD Series B
Stator – S1	2	2	Red (1)	6	Cut	Cut
Stator – S3	14	14	Black (1)	1	1	B1
Pair Shield	8	8	Shield (1)	3	2	A1
Stator – S2	1	1	White (2)	2	Cut	Cut
Stator – S4	15	15	Black (2)	5	3	B2
Pair Shield	9	9	Shield (2)	7	4	A2
Rotor – R1	2	2	Green (3)	6	Cut	Cut
Rotor – R2	17	17	Black (3)	9	5	B3
Pair Shield	11	11	Shield (3)	11	6	A3
Thermal Switch	3	3	Blue (4)	10	Cut	Cut
Thermal Switch	20	20	Black (4)	15	9	B5
Overall Shield	13	13	Braid Shield	16	10	A5
	4	4		12	7	B4

See Figure 8.8 for typical resolver interconnect wiring.

Figure 8.8
Resolver Wiring



Orient Feedback Wiring

In most systems, the spindle orient function can be performed in either the CNC or the spindle drive. If the position control for spindle orient is provided by the drive, the spindle position feedback must be connected to the 8510 through the 20 pin CN2 connector (see Figure 7.3). The 8510 drive can use either a conventional optical encoder or the high resolution magnetic feedback to provide spindle position feedback. The feedback device must be mechanically coupled 1:1 to the spindle shaft being positioned.

If an optical encoder is used, it must provide an A, B, and Z channel output, have a single ended push-pull type output, and use a +12V DC input voltage. The recommended Allen-Bradley encoder is the 845T series with a type 3 electrical option and a type 3 signal option. The 845T encoder provides an MS style connector for the interface.

The high resolution magnetic feedback, from 225,000 to 500,000 counts/turn, consists of a precision gear that must be mounted to the spindle shaft and a sensor head that mounts to the headstock adjacent to the gear. Refer to the instructions provided with the feedback sensor for installation details. The sensor has an integral 2 meter (6 ft.) cable. An interconnection box with terminal strips or connectors must be mounted in a convenient location to complete the wiring to the drive. Assure that continuity of all cable shields is maintained through this box.

Both feedback types are connected to the drive through the CN2 connector, with a unique set of pins for each feedback device. The required interface cable type is the same for either device. The recommended cable type is:

Madison # 08CFJ00004 (4 twisted pairs with shield, #24 AWG)

Three termination options are available for the CN2 connector: l) a mating connector kit, 2) a termination panel, and 3) an interface cable assembly. There are unique versions of the 2nd and 3rd option for optical encoder feedback and high resolution magnetic feedback. The following table shows the function assignment for each of these termination options for the optical encoder interface. Actual connections to the encoder depend on the specific encoder chosen and connector type chosen for the encoder.

Table 8.I
Optical Encoder Cable Information

Signal Description	Honda Connector Pin Number	Termination Panel Terminal Number	Cable Assem. Wire Color and (Pair #)
Channel A Output	16	16	Black (1)
Ground	10	10	White (1)
Channel B Output	15	15	Red (2)
Ground	9	9	Green (2)
Channel Z Output	14	14	Brown (3)
Ground	8	8	Blue (3)
+12V DC Power Source	5	5	Orange (4)
Ground	4	4	Yellow (4)
Cable Shield	1	1	Cable Shield

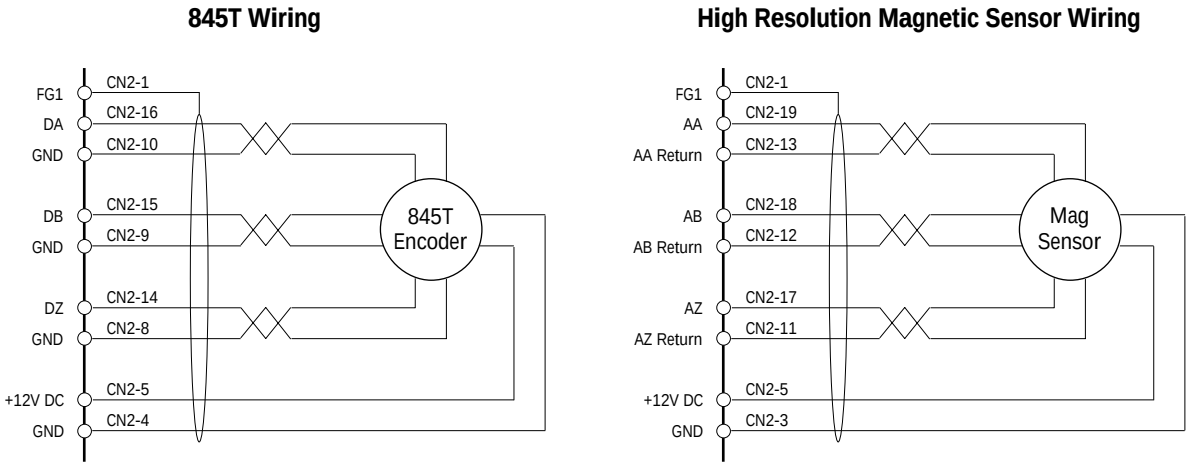
Table 8.J shows the function assignments for the high resolution magnetic feedback and the comparable wire color on the magnetic analog sensor cable.

Table 8.J
High Resolution Magnetic Feedback Cable Information

Signal Description	Honda Connector Pin Number	Termination Panel Terminal Number	Cable Assem. Wire Color and (Pair #)	Magnetic Sensor Wire Color
Channel A Output	19	19	Black (1)	Blue
Ground	13	13	White (1)	Blue/Black
Channel B Output	18	18	Red (2)	Green
Ground	12	12	Green (2)	Green/Black
Channel Z Output	17	17	Brown (3)	Yellow
Ground	11	11	Blue (3)	Yellow/Black
+12V DC Power Source	5	5	Orange (4)	Red
Ground	3	3	Yellow (4)	Black
Cable Shield	1	1	Cable Shield	Shield

Figure 8.9 shows the basic wiring for each of these feedback devices.

Figure 8.9
Orient Feedback Wiring



Dual Winding Motor Contactor Control Wiring

When a dual winding 1327AD series motor is used with the 8510, the user must supply two power contactors that will be used to switch the motor between the Δ and Y winding configurations. In addition, a 24V DC power source must be supplied to operate the contactors. Refer to Table 7.A for the specific contactors that are required for each drive size. The drive will control the operation of these contactors through the 20 pin CN1 connector (see Figure 7.3 for location).

The interface cable for this function requires four twisted pairs. The recommended cable is:

Madison #08CFJ00004 (4 twisted pairs with shield, #24 AWG)

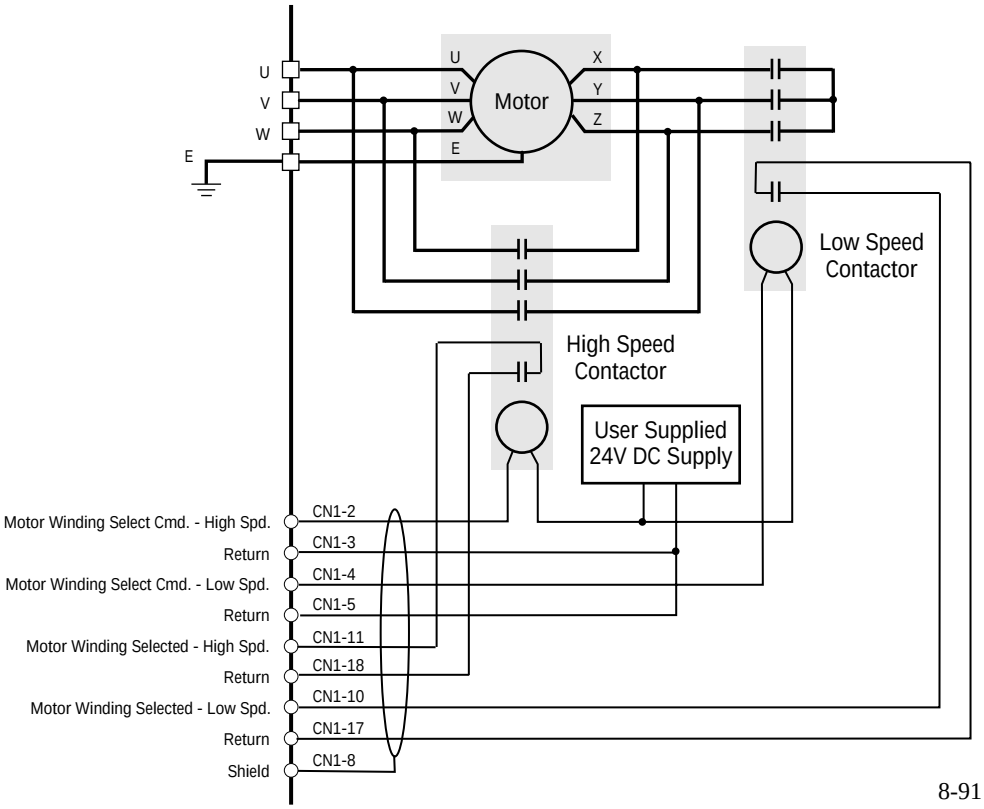
Three termination options are available for the CNl connector: l) a mating connector kit, 2) a termination panel, and 3) an interface cable assembly. The following table shows the I/O function assignment for each of these termination options.

Table 8.K
Dual Winding Contactor Control Cable Information

Signal Description	Honda Connector Pin Number	Termination Panel Terminal Number	Cable Assem. Wire Color and (Pair #)
Motor Winding Select Command – High Speed	2	2	Black (1)
Return for High Speed Select Command	3	3	White (1)
Motor Winding Select Command – Low Speed	4	4	Red (2)
Return for Low Speed Select Command	5	5	Green (2)
Motor Winding Selected Confirm – High Speed	11	11	Brown (3)
Return for High Speed Winding Confirm	18	18	Blue (3)
Motor Winding Selected Confirm – Low Speed	10	10	Orange (4)
Return for Low Speed Winding Confirm	17	17	Yellow (4)
Shield	8	8	Shield

Figure 8.10 shows the signal interconnect wiring for the dual winding motor control contactors.

Figure 8.10
Dual Winding Contactor Wiring



Digital Position/Speed Command Wiring

When the 8510 is ordered with the “-Bx” or “-Dx” I/O option, a 16 bit parallel digital command input can be applied through connector CN10. This command can be used for either a digital speed command or orient position command. Refer to Figure 7.3 for the location of this connector on the drive.

The interface cable for this function requires 10 twisted pairs with an overall shield. The recommended cable is:

Madison #20QFK00001 (10 twisted pairs w/shield, 24 AWG)

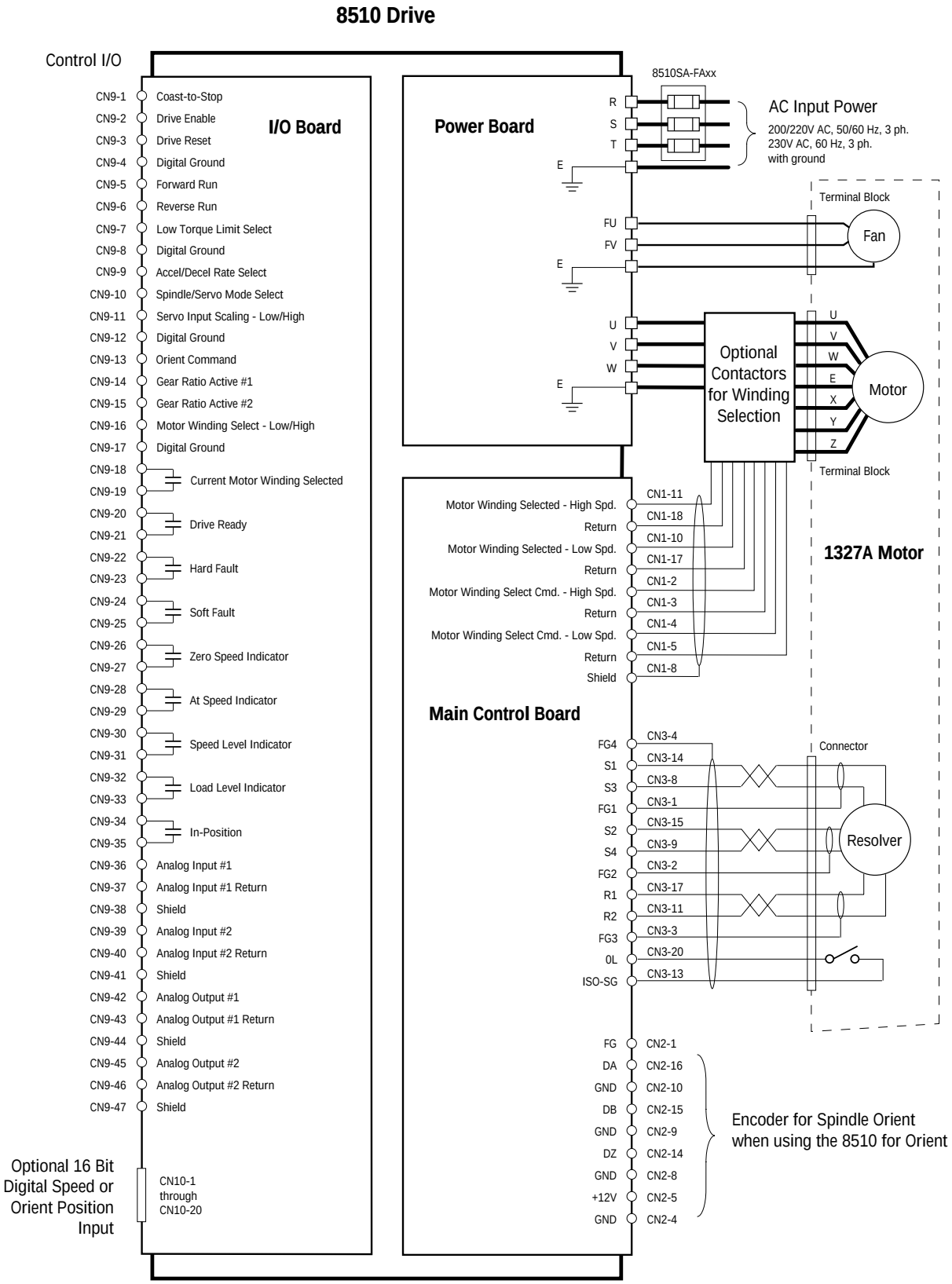
Three termination options are available for the CN10 connector: l) a mating connector kit, 2) a termination panel, and 3) an interface cable assembly. Table 8.L shows the I/O function assignment for each of these termination options.

Table 8.L
Digital Speed/Position Wiring

Signal Description	**Honda Connector Pin Number**	**Termination Panel Terminal Number**	**Cable Assem. Wire Color and (Pair #)**
Input 1 - Bit 0	1	2	Red (1)
Input 2 - Bit 1	2	3	Black (2)
Input 3 - Bit 2	3	4	White (2)
Input 4 - Bit 3	4	5	Black (3)
Signal Common	5	6	Green (3)
Input 5 - Bit 4	6	7	Black (4)
Input 6 - Bit 5	7	8	Blue (4)
Input 7 - Bit 6	8	9	Black (5)
Input 8 - Bit 7	9	10	Yellow (5)
Signal Common	10	11	Black (6)
Input 9 - Bit 8	11	12	Brown (6)
Input 10 - Bit 9	12	13	Black (7)
Input 11 - Bit 10	13	14	Orange (7)
Input 12 - Bit 11	14	15	Red (8)
Signal Common	15	16	White (8)
Input 13 - Bit 12	16	17	Red (9)
Input 14 - Bit 13	17	18	Green (9)
Input 15 - Bit 14	18	19	Red (10)
Input 16 - Bit 15	19	20	Blue (10)/Shield
Signal Common/ Shield	20		

These inputs can be driven by PLC or CNC digital outputs or from thumbwheel or selector switches.

Figure 8.11
8510 System Interconnect



End of Chapter

Chapter 9

Start-Up

Chapter Objectives

The steps needed to start-up the 8510 AC Drive System are provided in this chapter.

Conventions Used in this Manual

To help differentiate input/output names, programmable parameters and programmable values, the following conventions will be used throughout this chapter and the remainder of this manual.

Input and Output Names	will appear in Initial Capital Letters
Programming Display Text	will appear in *italics*
Menu Names	will appear with *ALL CAPITALS*
Parameter Names	will appear with *Initial Capital Letters*
Programmable Parameter Values	will appear in “quotes”

Start-Up Procedure

Since most start-up difficulties are the result of incorrect wiring, every precaution must be taken to assure that the wiring is done as instructed. **All items must be read and thoroughly understood before the actual wiring begins.**

ATTENTION: Power must be applied to the system to perform many of the adjustments specified in the following paragraphs. Some of the voltages present are at incoming line potential. To avoid injury to personnel and/or damage to equipment, only qualified service personnel should perform the following start-up procedure. Thoroughly read and understand the following procedure before beginning. If an event does not occur while performing this start-up, **Do Not Proceed**. **Remove Power** by opening the branch circuit disconnect device and correct the malfunction before continuing.

ATTENTION: High voltage that presents an electrical shock hazard is present on the Main Control Board of the 8510A-A11-x2 and 8510A-A22-x2 drives. The upper right half of the board contains the IGBT gate drive circuits, while the upper left quarter contains the power supply. DC bus voltage (approximately 325V DC) is present in both of these areas. These areas contain the voltage warning symbol (see example) and are outlined with a heavy white line. To avoid injury, only qualified personnel should perform start-up or maintenance procedures on this drive.

ATTENTION: This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltage on the capacitors has been discharged before attempting to service, repair or remove this unit. A relay connects a resistor across the DC bus to discharge the capacitors. Normally the capacitors will discharge within 15 seconds. An LED on the upper right side of the Main Control Board on 8510A-A11-x2 and 8510A-A22-x2 drives will be illuminated when the bus voltage is above 50V DC.

Prior to performing the following procedure, installation and wiring should have been performed as explained in Chapters 5, 6, 7 and 8.

o 1. Verify that the 8510 drive has been correctly wired in accordance with Chapter 8 of this manual.

o 2. Assure that all AC input power is removed from the drive.

o 3. Remove the AC line input fuses (mounted outside of 8510 drive).

o 4. Apply AC power. Use a voltmeter to measure the voltage at the AC line fuse block. The voltage must be as follows:

50 Hz power
Voltage must be between 180 - 242V AC (200 - 220V AC ±10%)

60 Hz power
Voltage must be between 180 - 253V AC (200 - 230V AC ±10%)

Important: AC line voltage greater than the voltages stated will overheat the coil in the main AC contactor and significantly shorten its life.

o 5. Remove the AC power and replace the AC line fuses.

o 6. Apply AC power to the 8510 drive.

o 7. Use the *DIAGNOSTICS – I/O Output* display to verify that a fault was not detected when power was applied. When no faults are present, the $\overline{\text{hard fault}}$ indicator (the letter “E”) should be showing on the display.

o 8. Program all of the drive configuration and tuning parameters according to the information in the *8510 Programming Manual* (publication 8510-5.2). The initial programming of the drive must be performed according to the following procedure.

a) Assure that Drive Enable and Coast to Stop are Off.

b) Use *GEAR RANGES – Select Range* to select gear range "1" for programming. If a dual winding motor (1327AD series) is being used, select gear range "1L."

c) Under *GEAR RANGES – Default Data*, select "YES." This assures that all parameters are initialized to the default values.

d) Under *MOTOR SELECT – Catalog Num*, scroll down the list of motor catalog numbers and select the number that matches the motor being used in this system.

e) Under *PARAMETER SET – ELECT CONFIG – Drive Cat Num*, select the catalog number of the drive being used in this system.

f) Complete the remainder of the configuration and presetting of drive parameters for gear range 1 or 1L.

g) If a multi-speed gearbox is being used (or multiple gear range parameter sets will be used), use *GEAR RANGES – Select Range* to select gear range "2" for programming. If a dual winding motor (1327AD series) is being used, select gear range "1H."

h) Under *GEAR RANGES – Copy Data*, select "RANGE 1" or "RANGE 1L" if the dual winding motor is being used, as the source to copy data from.

i) If the configuration or parameter presetting of this gear range is to be different from the parameters set in step e, adjust the parameters for this gear range.

j) Repeat steps f, g, and h for each gear range data set that will be used in this application. For dual winding motors, both the "L" and "H" data sets must be programmed for each gear range data set.

k) Up to now, all parameter changes have been held in RAM. To permanently store the changes in EEPROM, it is necessary to exit the *DRIVE SETUP* mode. Simultaneously press the Mode and Scroll – keys twice. This will cause the display to change to *DISPLAY TYPE – METER DISPLAY* and all parameter changes will be written to EEPROM. When the data is being written to EEPROM, the "←" symbol will be momentarily shown at character 3 of line 2 on the display.

Once the motor and drive are defined for each gear range data set, the drive is ready to run at a performance level determined by the initial settings. The default parameter values will provide a relatively low level of performance.

ATTENTION: In the following steps the motor will begin to rotate. It is possible that the motor will rotate at an uncontrolled rate or cause incorrect machine movement. Be prepared to remove drive power by opening the branch circuit disconnect device if this occurs. Incorrect movement may be due to a wiring/programming error or system component malfunction and must be corrected before proceeding with this procedure. Damage to machine system components can occur due to uncontrolled machine movements.

It is recommended that the motor be mechanically disconnected from the load if:

A) Improper direction of rotation could cause damage to equipment.

B) Uncontrolled motor rotation due to improper phasing will cause damage to the equipment.

o 9. Apply 24V DC to the Coast to Stop and Drive Enable inputs (Forward Run, Reverse Run and Orient Command must be Off). After about 5-7 seconds, the main contactor will close and the Drive Ready output will turn On. In addition, the letter "G" should appear on the *DIAGNOSTICS – I/O Output* display. If the main contactor does not close and the Hard Fault output is still On, verify that the two wire cable is attached to connector J3 in the lower left corner of the I/O Board. This cable provides the hard wired connection of the Coast to Stop input to the main AC contactor control circuit. If it is not connected, the contactor can not be closed.

o 10. Apply 24V DC to either the Forward Run or Reverse Run inputs. The drive will now run in Spindle Mode at *Acc Rate # 1*. Depending on configuration programming, either an analog speed command on Analog Input # 1 or a digital speed command from the optional digital command inputs will be used.

o 11. If the motor does not turn, runs only at a slow speed, or slowly oscillates forward and reverse, the motor phasing must be reversed. Remove the Run and Drive Enable inputs.

Important: Before changing any parameters in response to observed drive operation, always verify that the gear range indicator number shown in the first position of each line on the display is the same. If they are not, use the *GEAR RANGES – Select Range* parameter to change the number on the second line to match the number on the first line of the display.

Change the setting of the *PARAMETER SET – ELECT CONFIG – Motor Phasing* parameter to reverse the motor phasing without physically changing the wiring to the motor. Reapply the Drive Enable and Run inputs and check for correct operation.

o 12. When a positive analog speed command is applied along with the Forward Run command, the motor should rotate counterclockwise when viewed from the output shaft end. If it does not rotate in this direction, remove the Run and Drive Enable inputs. Use the *PARAMETER SET – ELECT CONFIG – Cmnd Phase #1* parameter to reverse the phasing of the input command. Reapply the Drive Enable and Run inputs and check for correct operation.

o 13. If an analog speed command is being used, the most accurate calibration is achieved by allowing the drive to measure the zero speed command and maximum speed command input voltages.

a) Select the *ANALOG CAL – MEASURE INPUT – Zero Volt In* parameter and apply the actual zero speed input command from the CNC or other control system. Press Select to store the value.

b) Select the *ANALOG CAL – MEASURE INPUT – Max +Volt In* parameter and apply the actual maximum speed input command from the CNC or other control system. Press the Select key to store the value. This completes the analog channel calibration for spindle mode.

o 14. Velocity loop compensation can be tuned while the drive is enabled. The step response of the drive can be tested by applying and removing the speed command or by turning the Forward (or Reverse) Run input On and Off. Basic adjustment can be obtained by observing the motor shaft or spindle as the motor stops in response to a step command. The *Spindl P Gain* and *Spindl I Gain* should be adjusted to give a smooth, quick stop without visible motor reversal. When running, the motor should not make growling or rumbling noises. Excess motor or gear box noise indicates excess torque ripple and excess gain.

The general effect of the P and I gain parameters is:

- Increasing P shortens response time and increases bandwidth.
- Increasing I increases bandwidth and quickens system response to load and command transients. Static velocity error is eliminated.
- Too much P will cause high frequency oscillation.
- Too much I will cause overshoot of commanded speed or low frequency oscillation.

For more accurate setup, an oscilloscope must be used. Following the procedure in the Programming Manual, program Analog Output #1 to output *Motor Speed* and Analog Output #2 to output *% Torque*. Simultaeously press the Mode and Scroll – keys twice to store the parameter changes to EEPROM and cause the display to change to *DISPLAY TYPE – METER DISPLAY.* Then remove and reapply Drive Enable for these settings to take effect. Near the center of the I/O Board (smaller board in lower left corner of drive) are test points for Analog Output #1 (ANAOUT#1 – TP1), Analog Output #2 (ANAOUT#2 – TP2), and Analog Signal Ground (ANA-SG – TP4). On both test points, ±10V DC = maximum output.

ATTENTION: If an oscilloscope is used during start-up or troubleshooting, it must be properly grounded. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. Always connect the oscilloscope chassis to earth ground.

When using an oscilloscope it is recommended that the test probe ground be connected to the test point labeled “GND.”

a) Optimum tuning is obtained by observing the small signal step response. The step should be small enough to assure that the drive output does not become torque limited. In addition, the *Acc Rate* parameter setting should be fast enough so that it does not limit the acceleration rate. To simplify the tuning process, it is best to separate the P Gain and I Gain tuning. First set *Spindl I Gain* equal to zero. Observe test point TP1 during an accel/decel cycle to a low speed. Increase *Spindl P Gain* until the desired response rate is achieved but allow no more than one overshoot of the commanded speed. Then increase the *Spindl I Gain* until the desired level of low frequency and static stiffness is achieved. Proper adjustment of the P Gain and I gain should provide a step response with a relatively sharp corner and minimal overshoot of commanded speed. If the system overshoots with a high frequency ringing, the *Spindl P Gain* is too high. A low frequency ringing indicates excess *Spindl I Gain*.

b) Observe the TP2 test point during an accel/decel cycle. As the actual speed approaches commanded speed, the torque should drop from maximum to a low running torque with only a small overshoot. The overshoot should settle without ringing. Raise the *Spindl P Gain* and lower the *Spindl I Gain* to reduce the ringing. While running at maximum speed the peak to peak torque ripple should be less than 2V DC. Lower both the *Spindl P Gain* and *Spindl I Gain* to reduce the torque ripple.

o 15. If the 8510 must operate in servo mode, apply 24V DC to the Spindle/Servo Mode Select input to activate servo mode. Servo mode can be configured to operate over two different, input selectable, maximum operating speed ranges. Apply 24V DC to the Servo Input Scaling input to select the high operating speed range and then repeat steps 12, 13, and 14.

In servo mode, it is usually desirable to set the *Servo P Gain* and *Servo I Gain* as high as possible to achieve the most responsive servo performance. When approaching the final speed, the torque may overshoot with 1-2 “rings” but then should immediately settle out.

Ideally, if the drive will be operated within a position loop, the final tuning should be performed with the position loop closed by the CNC or other control system. This will allow for the highest overall gains and system stiffness. Independently tuning the velocity loop with step velocity commands leads to a conservative set of tuning parameters.

With an integrator in the velocity loop, a very small command from the position loop will be integrated until it is large enough to cause spindle movement to null the error. If there is a difference between static and dynamic friction, it is possible the spindle will suddenly move too far when it finally moves and a stop/move limit cycle will result. To guard against this, the droop parameter places a maximum limit on the integrator gain to prevent very small inputs from causing motion. The *Droop In Run* parameter is used during very low speed servo operation when the drive is being controlled by an external position loop control. The *Droop In Hold* parameter is used during spindle orient operation. These parameters should be set as low as possible while still giving satisfactory operation on the machine. Effectively, droop assures smooth, quiet operation at rest or very low speeds and tends to minimize small shaft disturbances.

o 16. If two servo mode speed ranges are being used, remove the 24V DC from the Servo Input Scaling input to select the low operating speed range. Repeat step 15.

o 17. If the 8510 drive must perform the spindle orient operation, verify that all of the *ORIENT SETUP – FEEDBACK DEFN* parameters are correctly set for the type of feedback device being used. Verify that the *GEAR RANGES – SET RATIO* parameters accurately define the ratio between the motor and the spindle being oriented. Incorrect settings for either of these parameter groups will cause a drive fault when orient is attempted.

While the drive is running, apply 24V DC to the Orient Command input. The motor should slow to orient speed and then orient to the target position (either preset or entered via the optional digital inputs). If it continues to run at the low orient speed, the feedback phasing must be reversed. Use the *ORIENT SETUP – FEEDBACK DEFN – Encdr Phasing* parameter to reverse the feedback phasing.

The orient function gives an exponential deceleration to the target position. The effective position loop gain is defined by the setting of the *ORIENT TUNE – Orient Speed* and *ORIENT TUNE – Orient Start* parameters.

The effective gain can be increased by either increasing the *Orient Speed* parameter or reducing the *Orient Start* parameter value. To assure that the drive will always orient the spindle without overshoot, setup should be done with the largest expected reflected load inertia. If expected maximum load inertias are not known, always leave sufficient torque margin to assure successful operation with high inertias. *(continued)*

The orient operation always starts by slowing to the orient speed, locating the marker on the feedback encoder, and then starting decel on the following revolution. Shorter orient times can usually be achieved if the *Orient Speed* parameter is set relatively high. With a setting of 300 rpm, final decel to the orient position should begin within 200 ms of reaching the orient speed. Adjust the value of *Orient Start* to give a quick decel without overshoot. With *Orient Speed* set at 300 rpm, a value of 120 degrees for *Orient Start* gives a position loop gain of 15 per second.

For accurate setup, monitor the torque at test point TP2. If the maximum load inertias are well defined, the *Orient Speed* or *Orient Start* parameters can be adjusted so that the torque peaks at +10 volts as the decel starts. If setup is being done without tooling or a workpiece, the maximum torque measured on a machining center should be +7 volts. On a lathe the maximum torque should be only +4 volts to assure successful orient without overshoot.

o 18. If multiple gear range data sets are being used, repeat the above procedure for each data set. If the setups are similar for each gear range, use the *GEAR RANGES – Copy Data* function to copy the initial gear range configuration data to the succeeding gear ranges.

Chapter 10

Display Panel & Fault Diagnostics

Chapter Objectives

This chapter explains the 8510 display panel and how it is used to show different measurements and perform fault diagnostics. Included is an explanation of the display and descriptions of the various parameters that can be displayed.

Menu Format and Conventions

The menu system is based on the 16 character by 2 line display used in the 8510. The menu is arranged in a tree format (see Figure 10.1) to allow easy access to any item. Menu items will be displayed two different ways:

1) UPPER CASE letters (capitals) indicate the item is a menu heading with a group of sub-menus or parameter names below it.

2) Initial Capital letters indicate the item is the name of a parameter.

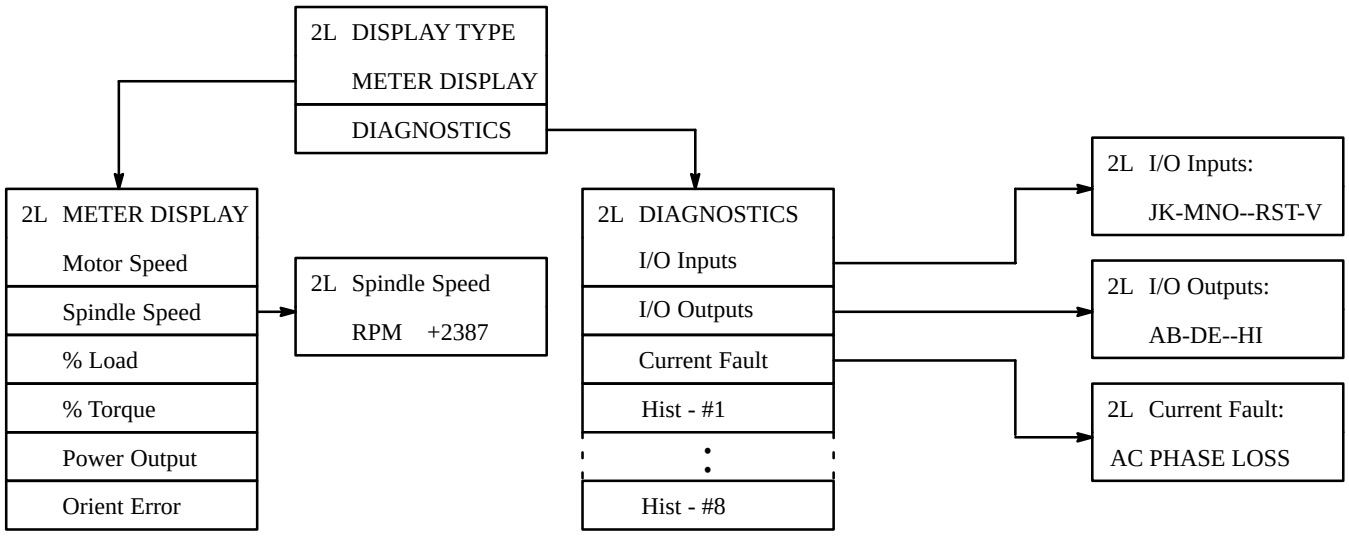
In this manual, any text that shows the exact display format of a menu or parameter name is shown in *italics*.

Any text that shows the exact display format of a parameter data value or selection is enclosed in “quotes.”

When power is first applied to the drive or a reset is performed after a fault, the software version number is indicated on the display during the initial diagnostic checks. Have this software version number available before contacting the factory concerning a malfunctioning drive.

After power is applied, the *DISPLAY TYPE* menu will be shown. This menu allows selection of the *METER DISPLAY* or *DIAGNOSTICS* mode.

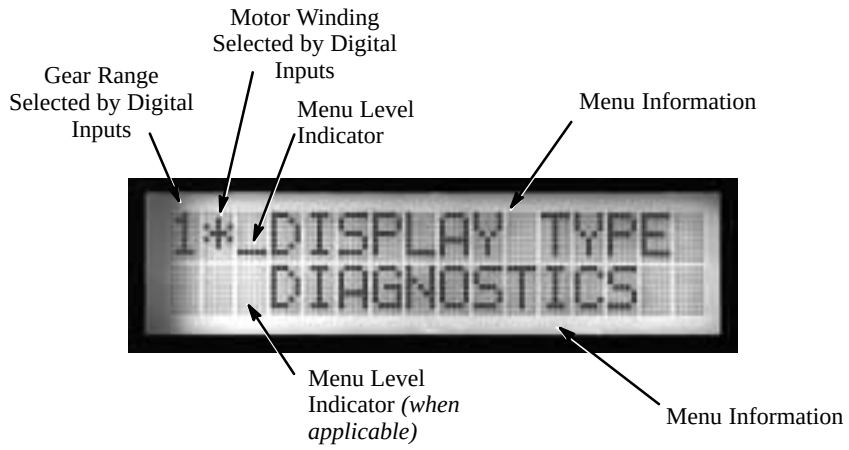
Figure 10.1
“Display Type” Menu Tree



Display Description

The 8510 display which is used for status and diagnostic messages consists of a 16 character, 2 line, LCD (Liquid Crystal) display. The display can be broken into several different sections as shown in Figure 10.2. Refer to the paragraphs that follow for explanations.

Figure 10.2
LCD Display



Line 1, characters 1 & 2 – are used to display the current gear range and motor winding that have been selected by the digital inputs. Character 1 will show the selected gear range (1-4) and if a 2 speed motor is used, character 2 will show the motor winding (H = high speed winding, L = low speed winding). This gear range and motor winding defines the data set that is currently being used for drive operation.

Line 1, character 3 – is a variable length bar (moving from the bottom up) that represents the current depth (level) in the menu system.

Line 1, characters 4-16 – are used to display the name of the current menu level or selected parameter. The menu options or parameter value associated with the item displayed on line 1 will be displayed on line 2.

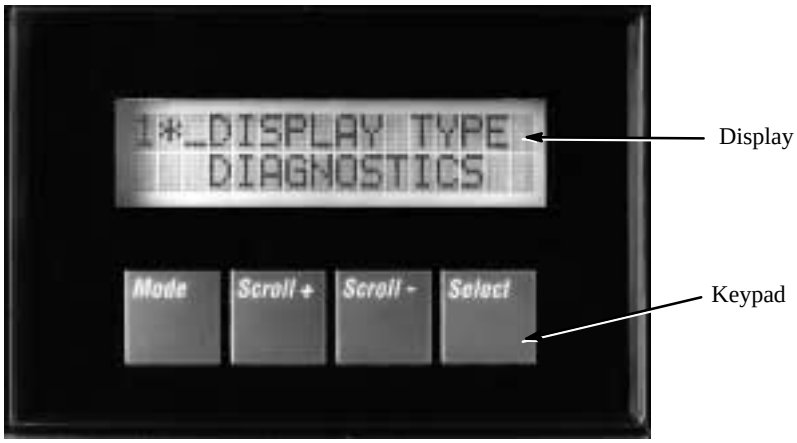
Line 2, character 3 – is a variable length bar (moving from the bottom up) that represents the current depth (level) in the menu system that has been selected. For each level the user moves down the menu tree, another bar is added to the display.

Line 2, characters 4-16 – are used to display the options that are available at the current menu level or the value of the parameter that has been selected.

Display Operation

The 4 button keypad (see Figure 10.3) is used to access the status and diagnostic systems. Key functions are explained below.

Figure 10.3
8510 Keypad and Display



Pressing this key will cause the display to change to the previous menu level within the *DISPLAY TYPE* menu section. If the top item of the menu is shown, the Mode key will have no effect.

Pressing this key once will cause the parameter or sub-menu names shown on line 2 of the display to increment to the next possible choice for the menu listed on line 1. If this key is pressed and held, the display will continuously index through the possible selections until the key is released. When the end of the menu list is reached, it will roll over to the beginning and continue to increment.

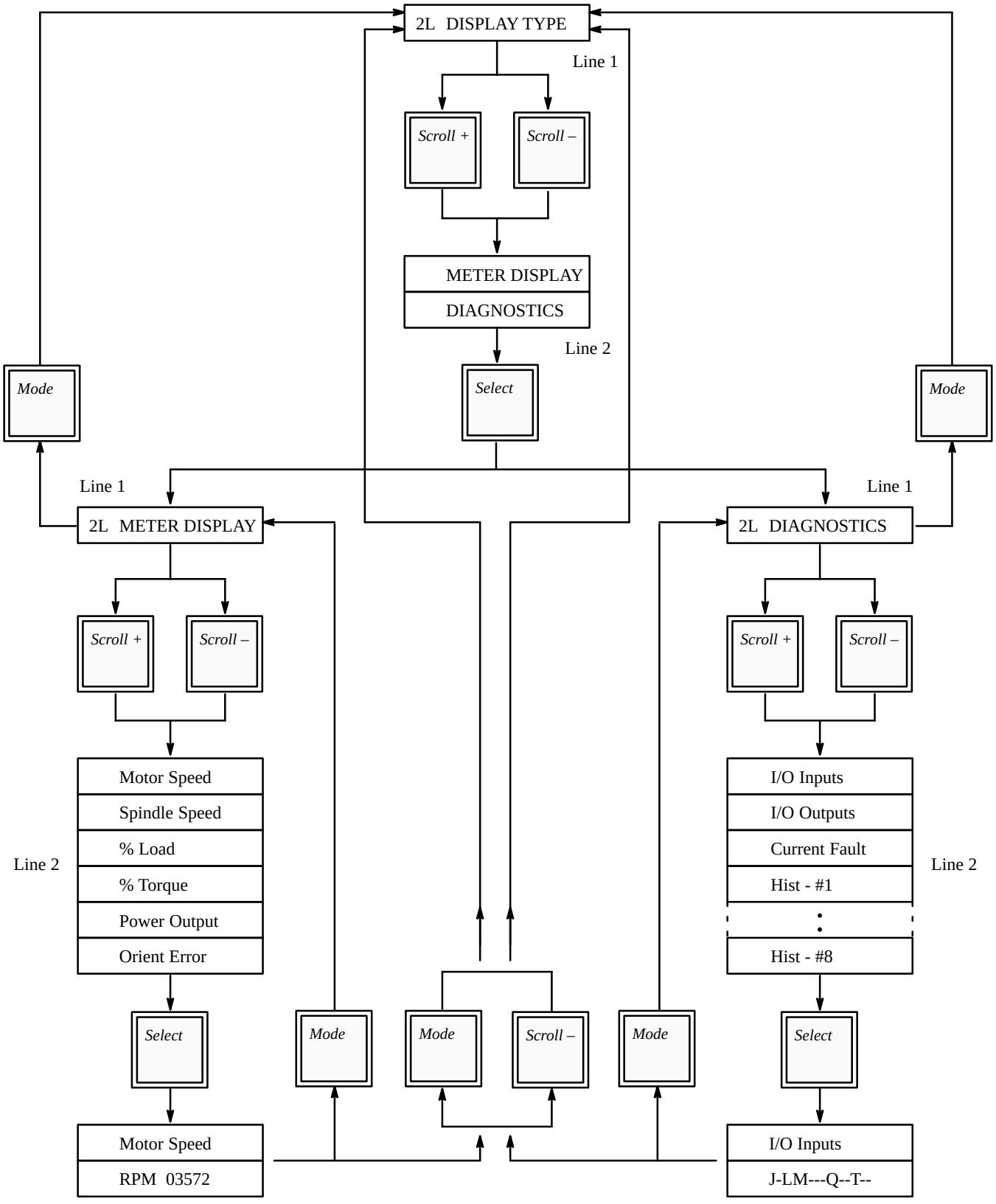
The function of this key is identical to the Scroll+ key except that it causes the display to decrement rather than increment.

Pressing this key will cause the sub-menu or parameter shown on line 2 of the display to become the active menu or parameter. This sub-menu or parameter name will move to line 1 and the new menu choices or parameter value will now be displayed.

Key Combinations
Pressing the Mode and Scroll – keys will cause the display to jump to the first menu in the section.

Figure 10.4 provides a diagram showing the keys needed to select the various items of the *DISPLAY TYPE* menu.

Figure 10.4
Display Type Menu Tree



Display Type Menu

The *DISPLAY TYPE* menu is the top level of the menu tree. This will always be the initial top line display when power is first applied to the drive and after the Reset input has been given.

METER DISPLAY

This is a menu title for all of the parameters that can be displayed in digital meter form on the drive display. The following paragraphs describe the function of each item.

Motor Speed
When selected, the display will show the actual bipolar motor speed as measured from the resolver feedback.

Data Format: RPM 00000

Spindle Speed
Displays the actual spindle speed as calculated from the programmed gear ratio and actual motor speed. The display is bipolar.

Data Format: RPM 00000

% Load
Indicates the percent rated motor load. The displayed data is determined from the torque command with continuous rated motor torque from zero speed to base speed, and continuous rated power output from base speed to maximum speed. This will give the same 100% output reading. The maximum reading shows the peak capability of the drive/motor combination as a percent of the continuous rating and may vary for different drive ratings. This is a unipolar output.

Data Format: %000

% Torque
When selected, the percent rated motor torque is shown. This is identical to the % Load parameter except that it is a bipolar output.

Data Format: %000

Power Output
The motor output power expressed in kilowatts (kW) will be displayed. At zero speed the motor power is zero regardless of the torque output. For a percent load output equal to 100% throughout the speed range, the Power Output will increase linearly from zero at zero speed to rated power at base speed. It will then remain constant from base speed to maximum speed. This is a unipolar output.

Data Format: KW 000.0

Orient Error

When selected, indicates that the display is currently showing the value of the position error when the drive is in spindle orient mode. This is a bipolar output.

Data Format: DEG 00.000

DIAGNOSTICS

The information displayed on the diagnostic display can help to isolate a malfunction in the drive. The following paragraphs describe the diagnostic displays available. Refer to Chapter 11 for further troubleshooting information.

I/O Inputs

This parameter indicates the status of all inputs. For ease in identifying each input, successive letters of the alphabet are used to show when they are On. When an input is Off, a dash (–) will be displayed. Refer to Table 10.A for the input associated with each letter.

Data Format (line 1): I/O Inputs
Data Format (line 2): JKLMNOPQRSTUV

Table 10.A
I/O Inputs

Display Letter	Input Signal Name
J	Coast-to-Stop
K	Drive Reset
L	Drive Enable
M	Forward Run
N	Reverse Run
O	Low Torque Limit Select
P	Accel/Decel Rate Select
Q	Spindle/Servo Mode Select
R	Servo Input Scaling - High/Low
S	Gear Ratio Active Bit #2
T	Gear Ratio Active Bit #1
U	Orient Command
V	High Motor Winding Select Command

I/O Outputs

This parameter indicates the status of all outputs. For ease in identifying each output, successive letters of the alphabet are used to show when they are On. When an output is Off, a dash (–) will be displayed. Refer to Table 10.B for the output associated with each letter.

Data Format (line 1): I/O Outputs
Data Format (line 2): I/O ABCDEFGHI

Table 10.B
I/O Outputs

Display Letter	Output Signal Name
A	Zero Speed
B	At-Speed
C	Speed Level Indicator
D	Load Level Indicator
E	No Hard Fault
F	No Soft Fault
G	Drive Ready
H	In-Position
I	High Motor Winding Selected

Current Fault

Indicates the current fault diagnostic message. The message uses 13 characters on line 2 of the display.

Fault History

Indicates a fault diagnostic message from the fault history queue. The 8 most recent messages are retained with #1 being the newest message. The message can use the last six characters on line 1 and 13 characters on line 2 of the display.

The Scroll+ and Scroll- keys are used to scroll through the message queue.

End of Chapter

Chapter 11

Diagnostics/Troubleshooting

Chapter Objectives

The purpose of this chapter is to assist you in determining the cause of a drive fault or improper drive operation and to define possible corrective actions. Possible corrective actions include:

- Correcting programming or wiring errors
- Replacing blown fuses
- Replacing subassembly modules that have malfunctioned
- Replacing the complete drive

Introduction

The drive performs a number of diagnostic tests at different times during system operation. The different classes of tests include the following:

- Power On Tests - when AC power is applied, all logic level functionality is checked and the data tables are tested to verify data integrity.
- Drive Enable Tests - when the Drive Enable input is applied, the DC bus is energized and the power section is checked for correct operation.
- Normal Operation Tests - various data integrity, control system functionality, and power section tests are performed on a continuous or periodic basis during normal drive operation.

ATTENTION: Power must be applied to the system to perform many of the checks specified in this chapter. Some voltages present are at incoming line potential. To avoid injury to personnel and/or damage to equipment, only qualified service personnel should perform the troubleshooting procedures provided. Thoroughly read and understand any procedure before beginning

The drive provides two discrete digital outputs to indicate fault conditions; Soft Fault and Hard Fault.

The Soft Fault output will be turned Off as a result of motor/drive overtemperature, or improper command sequences that can not be acted upon by the drive. During a soft fault condition, the drive will continue to operate normally. Refer to Chapter 7 for further fault output information.

The Hard Fault output will be turned Off whenever a drive fault condition occurs that will prevent the drive from properly controlling the motor. Refer to Chapter 7 for further fault output information.

In either case, the 8510 display will show a short text message that describes the fault. In addition, the drive can display the last eight faults that have occurred.

Circuit Board Descriptions

The functionality associated with each circuit board in the 8510 AC Spindle Drive is described below. Refer to Figure 11.1 for board locations.

I/O Board
Includes all analog and discrete digital user interface functions along with the integral drive programming system. The EEPROM for user programmed parameter storage is located on this board.

Main Control Board
Used on 8510A-A11-x2 and 8510A-A22-x2 drives only. This board contains all of the basic drive control circuitry including the digital control system for position, velocity and commutation control, motor current loops, IGBT gate drive circuits with fuses, logic power supplies with fuse, resolver feedback interface, spindle position feedback interface, dual winding motor contactor control interface, and fault diagnostics system.

CPU Board
Used on 8510A-A04-x1 and 8510A-A06-x1 drives only. This board contains the digital control system for position, velocity and commutation control, motor current loops, spindle position feedback interface, and fault diagnostics system.

Gate Drive Board
Used on 8510A-A04-x1 and 8510A-A06-x1 drives only. This board contains the IGBT gate drive circuits with fuses, logic power supplies with fuse, resolver feedback interface and dual winding motor contactor control interface.

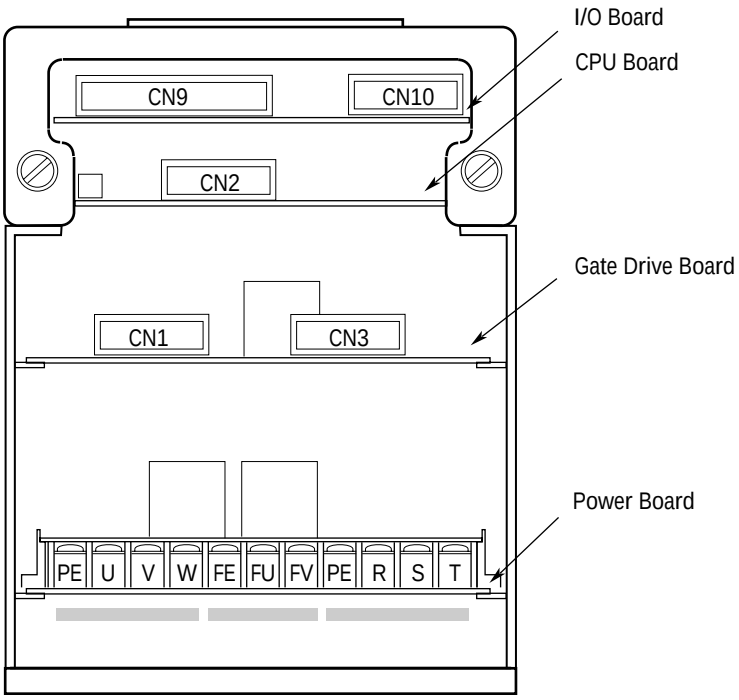
Power Board
Interconnects all items in the power structure to minimize power wiring. The board includes the snubber networks, power filtering, control relays, and AC control fuses.

The following assemblies are mentioned in the sections that follow. Locations are not shown in Figure 11.1, but will be described in text as appropriate.

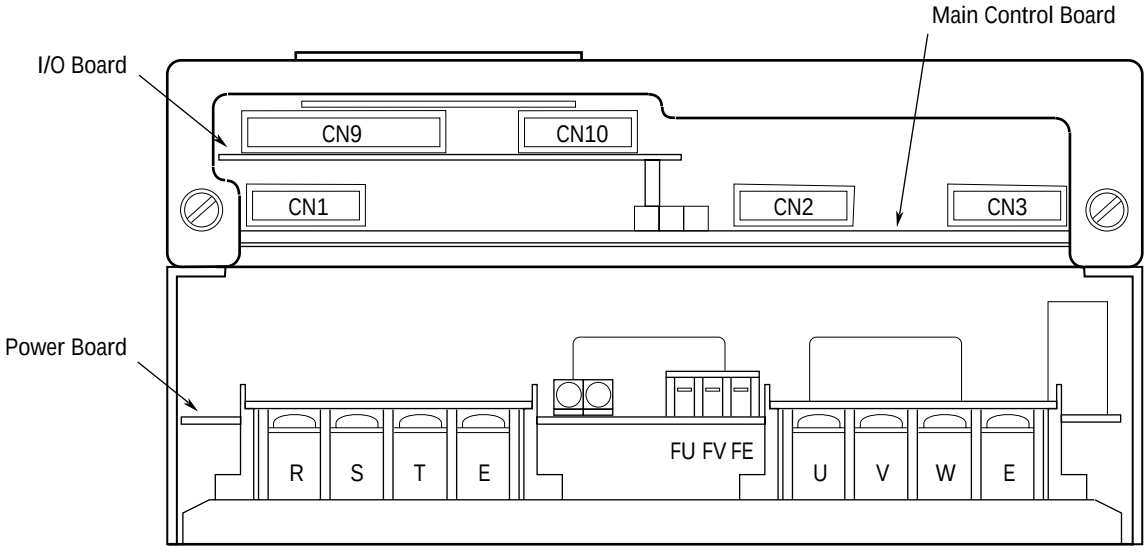
Interconnect Boards
These are three small circuit boards used to interconnect signals from the Power Board to the Main Control or Gate Drive Board.

Power Unit
The Power Unit is the complete drive structure less the I/O and Main Control Board or CPU and Gate Drive Boards.

Figure 11.1
Circuit Board Locations



Bottom View of 8510A-A04, A06 Drive



Bottom View of 8510A-A11, A22 Drive

Power Distribution and Control

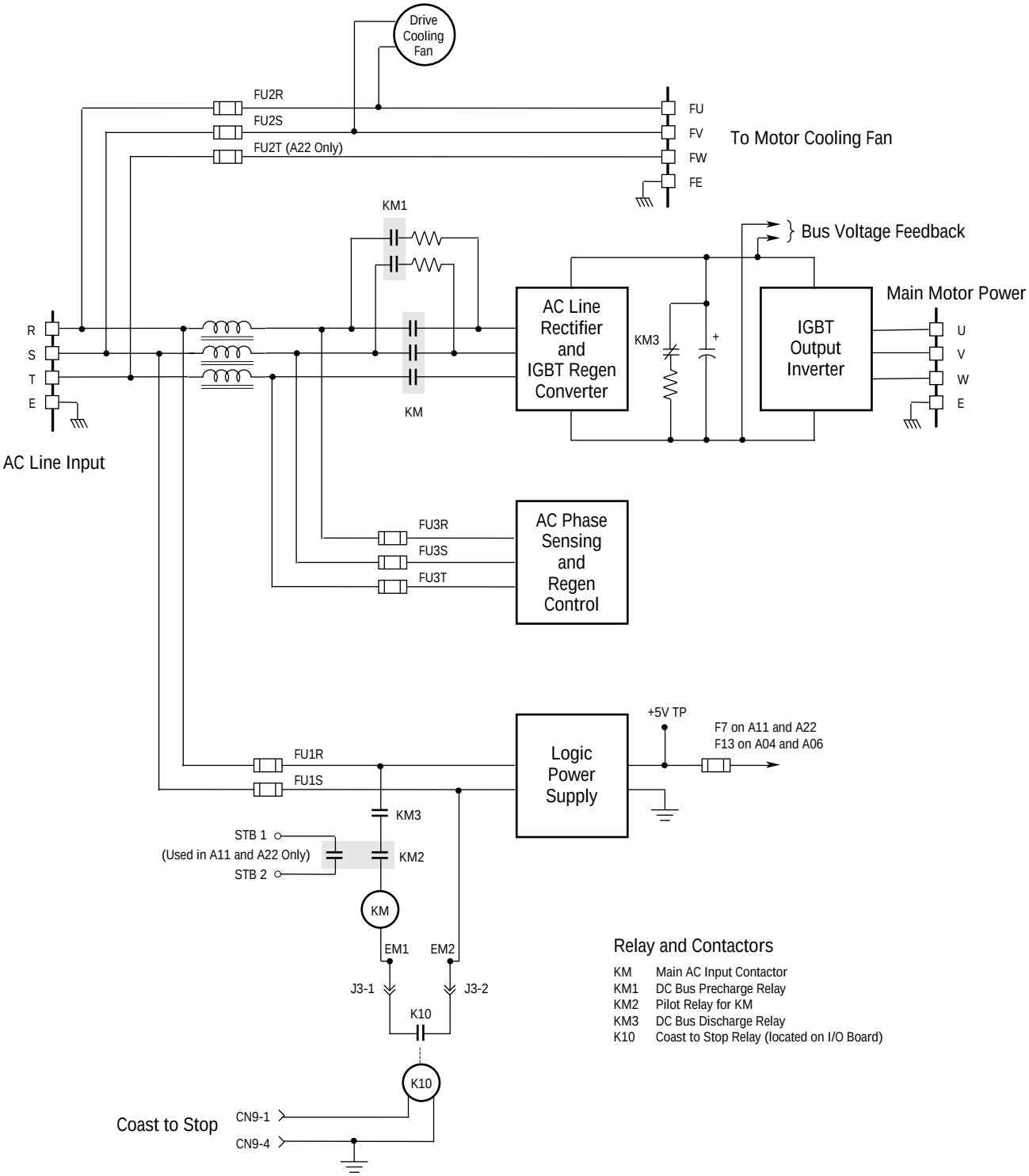
The initial power-up sequence is described below. Refer to Figure 11.2 for the associated power distribution and control circuitry.

1. When AC power is applied to the drive, the cooling fans and all internal control logic is immediately energized through AC control power fuse sets F1, F2, and F3.
2. The external Coast to Stop input must be closed to allow any of the following power-up sequence to be executed. Closing this contact will close the coast to stop control relay (K10) and allow the main contactor (KM) to close.
3. When the Drive Enable input is closed, the DC bus discharge control relay (KM3) is energized. This disconnects the DC bus discharge resistor and allows the main contactor (KM) to be closed.
4. After KM3 energizes, the DC bus precharge control relay (KM1) is energized to allow the DC bus to charge through the precharge resistors.
5. When the DC bus voltage exceeds the under voltage trip level (250V DC), the pilot relay for the main contactor (KM2) will energize, which closes the main AC contactor (KM). The precharge relay (KM1) will also open at this time.
6. After the main contactor is closed, the IGBT output inverter is turned on and the motor is ready to operate.
7. If the Drive Enable or Coast to Stop inputs are opened, the main contactor (KM) will be opened (either after the motor has stopped or immediately, depending on which input is opened). If the Coast to Stop input is opened, the DC bus discharge relay (KM3) will be de-energized which connects the bus discharge resistor across the DC bus. A time delay guards against the relay being energized again until the bus discharge current has decreased to a level that will not damage the relay contacts.

ATTENTION: If an oscilloscope is used during troubleshooting, it must be properly grounded. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. Always connect the oscilloscope chassis to earth ground.

When using an oscilloscope it is recommended that the test probe ground be connected to the test point labeled “GND.”

Figure 11.2
8510 Main Power and Control Interconnect Diagram



Fuse Locations and Types

Fuse location and specific fuse information is provided in the paragraphs that follow.

AC Control Power Fuses

The electrical location of the AC control power fuses is shown in Figure 11.2. Refer to Figures 11.10, 11.13 and 11.14 for fuse locations. Table 11.A provides information on fuse types.

Table 11.A
AC Control Power Fuses – Power Board

Designator	Rating	Vendor Name & Number	A-B P/N
FU1R, FU1S	5A, 250 V	Fuji-FGBO 5A 250V [1]	145863
FU2R, FU2S, FU2T	5A, 250 V	Fuji-FGBO 5A 250V [1]	145863
On A11 & A22 only FU3R, FU3S, FU3T	0.5A, 250 V	Fuji-FGBO 0.5A 250V [1]	151287
On A04 & A06 only FU3R, FU3S, FU3T	0.5A, 250 V	Daito Tsushin - HM05	151465

[1] Any substitute fuse for the Fuji-FGBO type fuses must be a metric style measuring 6.35 mm diameter by 30 mm long.

Gate Drive and +5V DC Fuses

Fuses for each of the IGBT gate drive circuit outputs and for the +5V DC logic power supply are located on the Gate Drive or the Main Control Board, depending on the drive rating. The following tables show the fuse types used. Refer to Figures 11.9 and 11.12 for fuse locations.

Table 11.B
8510A-A04-x1 and 8510A-A06-x1 – Gate Drive Board

Designator	Rating	Vendor Name & Number	A-B P/N
Gate Drive Fuses F1 to F12	0.3A, 250 V	Daito Tsushin-HM03	148133
5V DC Power Supply Fuse F13	5A, 250 V	Daito Tsushin-MP50	148134

Table 11.C
8510A-A11-x2 and 8510A-A22-x2 – Main Control Board

Designator	Rating	Vendor Name & Number	A-B P/N
Gate Drive Fuses F1 to F6, F8 to F13	0.3A, 250V	Daito Tsushin - HM03	148133
5V DC Power Supply Fuse F7	5A, 250V	Daito Tsushin - MP50	148134

If the +5V DC power supply fuse has opened, a white indicator will show in the window on the front of the fuse. The +5V DC test point is before the fuse, so measuring the test point voltage will not verify that the fuse is OK.

The gate drive fuses can not be visually checked to determine if they have malfunctioned. The fuse element is too small to allow a reliable visual check. Use an ohmmeter to test these fuses (with power off & out of circuit).

ATTENTION: Do not apply power to the drive if any of the IGBT gate drive fuses have opened or been removed. **The IGBT power module will be damaged** if power is applied without the module gate leads connected to the control circuitry.

Fault Diagnostics System

As explained in Chapter 10, the integral display and programming system is used to display drive diagnostic messages. When a fault occurs, the display will automatically change (within about 2 seconds) to the *Current Fault* display. If any key is pressed, the display will return to its previous state. Through the *DIAGNOSTICS* menu, the current fault and a fault history showing the eight (8) most recent faults can be accessed. The fault history does not contain date/time information and can not be reset.

The tables found later in this chapter group the fault conditions or the fault display messages by general classification, describe the specific fault, and show probable causes and possible solutions. The general groupings are:

For each fault condition or operating problem, the causes and solutions are listed in order of decreasing probability of occurrence or increasing complexity of required tests.

To aid in locating a specific fault, an alphabetized list of all fault display messages and a Problem Number is provided. This listing can be used to quickly locate an explanation of the fault in the tables that follow.

Display Text Line 1	Display Text Line 2	Problem Number
Current Fault	Abs Overspeed	16
Current Fault	AC Phase Loss	4, 19
Current Fault	Bad Comb M & D	52
Current Fault	Bad PG Count	27
Current Fault	Bad PG Marker	26
Current Fault	Bad PG Output	28
Current Fault	Bus Overvoltg	17
Current Fault	Bus Undervolt	18
Current Fault	Convrtr Short	9
Current Fault	Data Conflict	14
Current Fault	Drive Overtemp	21
Current Fault	Hi Accel Rate	40
Current Fault	Hi Positn Cmd	41

Current Fault	Hi Positn Err	42
Display Text Line 1	**Display Text Line 2**	**Problem Number**
Current Fault	Hi Speed Cmd	43
Current Fault	Inv/Mtr Short	11
Current Fault	I/O Comm Err	30
Current Fault	Main A/D Conv	34
Current Fault	Main Comm Err	32
Current Fault	Main CPU Loss	31
Current Fault	Main CPU Ovfl	38
Current Fault	Main CPU1 Err	35
Current Fault	Main CPU2 Err	36
Current Fault	Main RAM Err	29
Current Fault	Main RAM Init	37
Current Fault	Main Watchdog	33
Current Fault	Max Spd None	53
Current Fault	Motor Overtemp	20
Current Fault	Motor Short	10
Current Fault	Mtr Windg Chg	23
Current Fault	Need Parametr	12
Current Fault	No Precharge	8
Current Fault	Op Dig Set Er	54
Current Fault	Optical Intpt	39
Current Fault	Orient Prm Er	55
Current Fault	Parameter Err	13
Current Fault	Power Supply	5
Current Fault	Resolver Loss	6
Current Fault	Spd Error HI	22
Current Fault	Sp Mtr 1 P Er	56
Current Fault	Sp Mtr 2 P Er	57
!Fault I/O Board	Bad EEPROM	45
!Fault I/O Board	Bad Optional A/D	46
!Fault I/O Board	EEPROM Sumchk	47
!Fault I/O Board	H8 CPU RAM	48
!Fault I/O Board	I/O DURM	49
!Fault I/O Board	LCD Timeout	50
!Fault I/O Board	Misc. Messages	51
Warning I/O Brd	EEPROM No Data	44

The basic approach to hardware maintenance is to replace the I/O Board, Control Board, or complete power section. Component level repair of any board or the power section is not a recommended field repair procedure.

ATTENTION: High voltage that presents an electrical shock hazard is present on the Main Control Board of the 8510A-A11-x2 and 8510A-A22-x2 drives. The upper right half of the board contains the IGBT gate drive circuits, while the upper left quarter contains the power supply. DC bus voltage (approximately 325V DC) is present in both of these areas. These areas contain the voltage warning symbol (see example) and are outlined with a heavy white line. To avoid injury, only qualified personnel should perform start-up or maintenance procedures on this drive.

ATTENTION: This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltage on the capacitors has been discharged before attempting to service, repair or remove this unit. A relay connects a resistor across the DC bus to discharge the capacitors. Normally the capacitors will discharge within 30 seconds. An LED on the upper right side of the Main Control Board on 8510A-A11-x2 and 8510A-A22-x2 drives will be illuminated when the bus voltage is above 50V DC.

Table 11.D
Problems that Occur when AC Power is Applied

No.	Problem	Probable Cause	Possible Solutions
1	Display does not illuminate and drive and motor cooling fans do not start.	Loss of incoming AC power.	Measure AC voltage between terminals R, S, and T on the bottom of the drive to verify that the line to line voltage is 180-253V AC at 60 Hz or 180-242V AC at 50 Hz.
		Loose power connection in Power Unit.	Check and tighten screws that connect the Power Board to the power terminal block. Check for other loose screws or connectors in Power Unit.
2	Drive and motor cooling fans do not start.	Malfunctioning AC control power fuse.	Check fuses FU2R, FU2S, and (on A22 only) FU2T and replace malfunctioning fuse.
		Loose or disconnected fan wiring.	1. Verify that drive cooling fan cables are plugged into Power Board. 2. Verify that motor cooling fan is properly wired to drive and motor terminal blocks.
3	Drive programming/ diagnostics display does not illuminate.	Malfunctioning AC control power fuse or +5V DC power supply fuse.	1. Check fuses FU1R and FU1S and replace malfunctioning fuse. 2. Check 5V DC power supply fuse F7 (or F13 on A04/A06 size unit) and replace malfunctioning fuse.
		Display intensity or contrast is misadjusted.	Intensity and contrast adjustment pots are directly below the display on the I/O Board (below and right on A04/A06 size unit). Turn CCW to increase intensity and contrast.
		Logic power supply has malfunctioned.	Measure voltage at +5V DC test point to verify proper power supply operation. If no +5V DC, remove AC power and then remove cover from board connector CN8 (CN15 on A04/A06 drive). Reapply AC power and using a voltmeter, verify voltage between pins 3 and 4 (pins 1 and 32 on A04/A06 drive) is 255-355V DC. If supply voltage is OK, replace Main Control Board (or Gate Drive Board on A04/A06 drive). If no 255-355V DC, verify Interconnect Boards are properly seated in connectors. Inspect contacts in both connectors to assure that they are making proper contact with the Interconnect Boards. Replace drive Power Unit if 255-355V DC can not be obtained.
		Display has malfunctioned.	Replace I/O Board and display assembly.

Table 11.D *(Continued)*
Problems that Occur when AC Power is Applied

No.	Problem	Probable Cause	Possible Solutions
4	AC Phase Loss displayed - Loss of one phase of incoming AC line detected by drive.	An incoming 3 phase line is open.	Measure all phase to phase voltages. Check all incoming line connections for tightness.
		Malfunctioning AC control power fuse.	Check fuses FU3R, FU3S, and FU3T.
		Malfunctioning drive interconnections or hardware.	1. Check seating of Interconnect Board into board connector CN8 (CN16 on A04/A06 drives). 2. Remove Interconnect Board from CN8 and inspect contacts in both connectors to assure that they are making proper contact with the Interconnect Board. Make certain it is plugged back in correctly, so that “blank side,” if any, is towards outside of drive. 3. Remove Control Boards and check tightness of incoming power connections to Power Board. Check for other loose power interconnects.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board on A04/A06 drive).
		Faulty Power Unit.	If problems were not found with other tests, replace main Power Unit.
5	Power Supply displayed - An internal power supply voltage that is missing or out of tolerance was detected.	Low voltage power supply malfunction.	1. Check +5V test point on Main Control Board. Should be +4.75V to +5.25V. (Note: test point is before the 5.0A fuse in the circuit). 2. Check +15V test point on Main Control Board. Should be +14.25V to +15.75 V. 3. Check –15V test point on Main Control Board. Should be –14.25V to –15.75V. 4. If any voltages are out of tolerance or missing, replace Main Control Board (Gate Drive Board on A04/A06 drive).
6	Resolver Loss displayed - Improper or no signals from motor resolver have been detected.	Incorrect wiring to resolver.	1. Verify that the resolver feedback cable is plugged into connector CN3. 2. Verify that the resolver connector in the motor terminal box is properly inserted. 3. Check each connector to verify that it is wired according to the *8510 User Manual.*
		Resolver waveforms not correct.	1. On Main Control Board (Gate Drive Board on A04/A06 drives), check test points S1 and S2 for excitation sine waves (these will not be smooth, but will have a staircase look). See Figure 11.3 for typical resolver waveforms. If waveforms are not correct, then unplug the resolver cable connector, CN3. If the waveforms are now correct, then the resolver cable is miswired or the resolver is malfunctioning. If the waveforms are still not correct, replace the Main Control Board (or Gate Drive Board). 2. Check test point R1 for a smooth, clean feedback sine wave. See Figure 11.3 for typical waveform. If R1 waveform correct, replace Main Control Board (or Gate Drive Board) 3. If R1 waveform is missing or incorrect, check resolver wiring. If wiring OK, replace motor/resolver.

Table 11.E
Problems that Occur when Drive Enable is Applied (or during operation)

No.	Problem	Probable Cause	Possible Solutions
7	No fault is indicated but the main contactor will not close and the Drive Ready output is not energized.	Improper command sequence has been applied.	Assure that the Coast to Stop input is energized before any other input command is applied. Assure that Drive Enable is energized before either run command or the orient command. Refer to Figure 7.2 for proper sequence.
		Contactor coil circuit not completed via the Coast to Stop input.	Assure that the jumper cable is connected between connector J3 in the lower left corner of the I/O Board and the EM1-EM2 terminal block on the upper left of the power circuit board.
		Loose connections on contactor.	Remove control boards and tighten all connections to main contactor.
		Malfunctioning pilot relay on I/O Board.	Remove power. Remove the jumper cable from connector J3 on the I/O Board. Use a small piece of insulated wire to short between the terminals of the plug on the jumper cable. **Important:** 230V AC is present on this plug when AC power is applied. If the contactor will now close when power is turned On and the Drive Enable is applied, replace I/O Board.
		Malfunctioning pilot relay on Power Board or malfunctioning contactor.	If problems were not found with other tests, replace Power Unit.
8	No Precharge displayed - the DC bus failed to achieve the necessary voltage level during the allowed bus precharge time and the main contactor is blocked from closing.	AC line voltage out of tolerance.	Verify that AC line voltage is between 180-252V AC.
		Malfunctioning drive interconnections.	1. Check seating of Interconnect Board into board connectors CN6 and CN7 (CN14 on A04/A06 drives). 2. Remove Interconnect Board from CN6 and CN7 (CN14) and inspect contacts in both connectors to assure that they are making proper contact with the Interconnect Board. Make certain it is inserted correctly, so that “blank side,” if any, is towards outside of drive. 3. Remove Control Boards and check for any loose hardware on Power Board. In particular, check connections to the terminal block, AC line inductor, and IGBT modules M4, M5, and M6 (or IGBT2 in A04/A06 drive).
		Malfunctioning IGBT module in converter bridge.	Check IGBT modules M4, M5, and M6 (or IGBT2 in A04/A06 drive) according to the “IGBT Test Procedure” presented later in this chapter. Replace Power Unit if IGBT is malfunctioning.
		Malfunctioning bus precharge, KM1, or bus discharge, KM3, relay.	If problems were not found with other tests, replace Power Unit.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drive).

Table 11.E *(Continued)*
Problems that Occur when Drive Enable applied (or during operation)

No.	Problem	Probable Cause	Possible Solutions
9	Convrtr Short displayed - Current sensed by DC link current sensor CT-R was too high. Usually indicates problem with IGBTs in converter bridge.	Momentary power outage while motor is regenerating to a stop.	Remove power to the drive, and restart.
		Malfunctioning drive interconnections.	1. Check seating of Interconnect Boards into board connectors CN7 and CN8 (CN15 and CN16 on A04/A06 drives). 2. Remove interconnect board from CN7 and CN8 and inspect contacts in both connectors to assure that they are making proper contact with the Interconnect Board. Make certain it is inserted correctly, so that “blank side,” if any, is towards outside of drive.
		Possible blown IGBT driver fuse on Main Control Board (Gate Drive Board on A04/A06 Drive).	Remove all twelve 0.3A fuses and check with ohmmeter. Replace any bad fuses. **Important:** Be certain to properly reseat all fuses to avoid possible damage to IGBTs.
		Malfunctioning IGBT module in converter bridge.	Check IGBT modules M4, M5, and M6 (or IGBT2 in A04/A06 drive) according to procedure provided later in this chapter. Replace Power Unit if IGBT is malfunctioning.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drives).
		Malfunctioning Power Unit current sensor or circuit board.	If problems were not found with other tests, replace Power Unit.
10	Motor Short displayed - Current sensed by motor phase current sensors CT-U or CT-V was too high. Usually indicates a problem with the motor or motor wiring.	Improper connection of winding changeover contactors when a dual winding motor is being used.	Check for proper hookup of contactors, motor, contactor coils, and auxiliary contacts.
		Incorrect motor selected in *MOTOR SELECT - Catalog Num* parameter.	Check *Catalog Num* setting to verify that it matches the motor nameplate.
		Shorted or voltage breakdown of motor or motor cabling to ground or another phase.	Disconnect motor at the drive. Use a megger (high voltage ohmmeter) to verify that the insulation resistance to ground for each phase is at least 5 megohm. For dual winding type motors, disconnect the power wires at the motor terminal box and use the megger to measure phase-to-phase insulation resistance. Verify that the insulation resistance between U & V, V & W, and W & U is at least 5 megohms. For single winding motors, use an ohmmeter to measure resistance between phases; depending on motor size, value measured should be from 0.1-1.0 ohms and should be approximately the same between each phase. Phase-to-phase and internal winding shorts may not be detected with this test.
		Improper motor power connections.	Verify that the motor power cable is securely fastened to the drive and motor terminal blocks and that no stray wire strands are shorting out any phases.
		Malfunctioning printed circuit board.	Replace the Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06).
		Malfunctioning Power Unit.	If problems were not found with other tests, replace the Power Unit.

Table 11.E *(Continued)*
Problems that Occur when Drive Enable applied (or during operation)

No.	Problem	Probable Cause	Possible Solutions
11	Inv/Mtr Short displayed - Current sensed by DC link current sensor CT-S was too high. Usually indicates problem with motor or IGBTs in inverter bridge.	See fault condition 10, *Motor Short*.	See fault condition 10, *Motor Short.*
		Malfunctioning drive interconnections.	1. Check seating of Interconnect Boards into board connectors CN7 and CN8 (CN15 and CN16 on A04/A06 drives). 2. Remove Interconnect Board from CN7 and CN8 and inspect contacts in both connectors to assure that they are making proper contact with the Interconnect Board. Make certain it is inserted correctly, so that “blank side,” if any, is towards outside of drive.
		Possible malfunctioning IGBT driver fuse on Main Control Board (Gate Drive Board on A04/A06 Drive).	Remove all twelve 0.3A fuses and check with ohmmeter. Replace any bad fuses. **Important:** Be certain to properly reseat all fuses to avoid possible damage to IGBTs.
		Malfunctioning IGBT module in inverter bridge.	Check IGBT modules M1, M2, and M3 (or IGBT1 in A04/A06 drive) according to procedure later in this chapter. Replace Power Unit if IGBT is malfunctioning.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drives).
		Malfunctioning Power Unit current sensor or circuit board.	If problems were not found with other tests, replace the Power Unit.
12	Need Parameter displayed - A required parameter has not been programmed into the EEPROM before attempting to enable the drive.	Drive programming not completed.	1. Verify that the motor catalog number and drive catalog number are properly programmed. 2. In orient mode, verify proper feedback definition.
13	Parameter Err displayed - Two programmed parameter values conflict with one another.	Parameters are incorrectly programmed.	Re-examine programmable parameters for compatibility; start with the ones most recently changed. Refer to the *8510 Programming Manual* (publication 8510-5.2) as needed.
14	Data Conflict displayed - Programmed parameter values conflict with one another.	Parameters are incorrectly programmed.	Re-examine programmable parameters for compatibility; start with the ones most recently changed. Refer to the *8510 Programming Manual* (publication 8510-5.2) as needed.

Table 11.F
Problems that Occur while the Drive is Operating

No.	Problem	Probable Cause	Possible Solutions
15	Motor runs in a random or uncontrolled manner or with excessive vibration when either the Forward or Reverse Run command is energized.	Resolver phasing is incorrect.	Use the programming parameter *ELECT CONFIG - Motor Phasing* to reverse the relative phasing of the motor to the resolver.
		Motor phase is open.	Check all power wiring to the motor for continuity and tight connections. Use an ohmmeter to verify phase to phase continuity for each motor phase. When 1327AD series dual winding motors are used, check both winding change contactors for proper operation.
		Resolver or resolver wiring is malfunctioning.	Refer to fault condition 6 for solutions.
16	Abs Overspeed displayed - Motor shaft speed exceeding the programmed value of the Overspd Trip parameter was detected.	MOTOR SELECT - Catalog Num and/or ELECT CONFIG - Drive Cat Num programmed as “NONE SELECTED” when the Coast to Stop input is turned On.	Correctly program the MOTOR SELECT - Catalog Num and ELECT CONFIG - Drive Cat Num parameters before applying 24V DC to the Coast to Stop input.
		Overspd Trip parameter set too low relative to commanded speed.	Increase setting of *Overspd Trip* parameter or reduce setting of *Max Cmnd Spd* parameter. The overspeed trip point should be set about 10% higher than the maximum command speed to avoid nuisance trips. Important: If the *Overspd Trip* parameter is inadvertently set to zero, this fault may occur as soon as the power is applied to the drive. With a setting of zero, even a one bit change from the resolver decoding circuit will cause this fault.
		Motor disconnected from load while drive in torque mode.	Never allow the motor to become disconnected from the load or the drive to be disconnected from an external control loop while the drive is operating in torque mode.
		Excess overhauling load.	Reduce the overhauling load to a value that is less than the torque limit setting of the drive.
		Malfunctioning resolver or resolver signals.	Check the resolver signals as defined under fault condition 6.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drives).
17	Bus Overvoltg displayed - DC bus voltage that exceeded maximum allowable limits was detected.	Incorrect motor selected in *MOTOR SELECT - Catalog Num* parameter.	Check *Catalog Num* setting to verify that it matches the motor nameplate.
		Incoming 3 phase voltage is out of tolerance.	Adjust taps on transformer or add step-down transformer to keep AC line voltage below 253V AC, 60 Hz or 242V AC, 50 Hz.
		If overvoltage is detected during regeneration, incoming AC line impedance may be too high.	Increase kVA rating of supply transformer to proper rating for drive size. See Table 8.C.
		Malfunctioning regeneration control circuit.	Replace Main Control Board (Gate Drive Board on A04/A06 drives).

Table 11.F *(Continued)*
Problems that Occur while the Drive is Operating

No.	Problem	Probable Cause	Possible Solutions
18	Bus Undervolt displayed - DC bus voltage less than the minimum allowable level was detected.	Incoming 3 phase voltage is out of tolerance.	Adjust taps on transformer or add step-up transformer to keep AC line voltage above 180V AC, 50/60 Hz.
		Incoming AC line impedance is too high.	Increase kVA rating of supply transformer to proper rating for drive size (especially if fault occurs during accel or when the motor is running under heavy load), see Table 8.C.
		An incoming 3 phase line is open, or has high impedance.	With drive operating in motoring or accel (if possible), check phase to phase line voltages for balanced conditions and verify that voltage is above 180V AC. Check all incoming line connections for tightness.
19	AC Phase Loss displayed - Loss of one phase of incoming AC line detected by drive.	Refer to fault condition 4.	Refer to fault condition 4
		An incoming 3 phase line is open, or has high impedance.	With drive operating in motoring or accel (if possible), check phase to phase line voltages for balanced conditions. Check all incoming line connections for tightness. If a three-phase motor is connected to the AC line, a lost phase may not be detected by a voltage test on a lightly loaded 8510 system.
		Incoming AC line impedance is too high.	Increase kVA rating of supply transformer to proper rating for drive size. (Especially if fault occurs during accel or when the motor is running under heavy load.) See Table 8.C.
		Malfunctioning IGBT module in converter bridge.	Check IGBT modules M4, M5, and M6 (or IGBT2 in A04/A06 drive) according to procedure later in this chapter. Replace Power Unit if IGBT is malfunctioning.
		Malfunctioning printed circuit board.	Replace the Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06).
		Malfunctioning Power Unit.	If problems were not found with other tests, replace the Power Unit.

Table 11.F *(Continued)*
Problems that Occur while the Drive is Operating

No.	Problem	Probable Cause	Possible Solutions
20	Motor Ovrtemp displayed - The drive detected that the thermal switch in the motor has opened.	Motor is overloaded by existing duty cycle.	When the motor cools, the thermal switch will close and the fault will clear. Reduce duty cycle loading or increase size of motor/drive system.
		Motor fan not operating.	1. Measure voltage at fan terminal block in motor terminal box. If voltage not 200 to 230V AC when AC power is applied to the drive, check fuses FU2R, FU2S, and FU2T (on A22 drive only) and wiring to fan. 2. If voltage is present and fan is not operating, check for obstructions. Otherwise replace motor or cooling fan.
		Insufficient air flow through motor cooling passages.	Clean motor fan protective grill and fan. Use pressurized air to clean cooling passages in each corner of the motor frame.
		Incorrect motor selected in *MOTOR SELECT - Catalog Num* parameter.	Check *Catalog Num* setting to verify that it matches the motor nameplate. Incorrect parameter setting or oversized drive can result in excitation currents that exceed motor rating.
		Motor thermal switch or wiring (through resolver cable) has malfunctioned.	1. Measure motor case temperature. Thermal switch should open at 140° ±5°C. Case temperature should be in excess of 110°C at this time. 2. If motor case is below 110°C, use an ohmmeter to check the thermal switch. Approximately zero ohms should be measured between pins 15 & 16 on the resolver connector in 1327AB series motor terminal box. For 1327AD motors, measure pins 9 & 10. If an open circuit or high resistance is measured, replace the motor. 3. If thermal switch is OK, check cable to drive and connectors for proper connection and continuity. Repair or replace as required.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drive).
21	Drive Ovrtemp displayed - The drive detected that the thermal switch on the drive heat sink has opened.	Drive is overloaded by existing duty cycle.	When drive cools, the thermal switch will close and the fault will clear. Reduce duty cycle loading or increase size of motor/drive system.
		Drive cooling fan not operative.	Check fuses FU2R and FU2S. Verify that fan power cable is plugged into the Power Board. The A11 uses connector XB10 in top left corner of Power Board. The A22 uses connector XB9 in the upper right corner and XB10 in the lower right corner of the Power Board. If fuses OK and fans inserted, then cooling fan malfunctioning. Replace Power Unit.
		Insufficient air flow over heat sink or poor heat transfer.	Thoroughly clean the heat sink using pressurized air. Assure that there is sufficient clearance above and below heat sink to allow adequate air flow.
		Incorrect motor selected in *MOTOR SELECT ~ Catalog Num* parameter.	Check *Catalog Num* setting to verify that it matches the motor nameplate. Incorrect parameter setting can cause current oscillation that exceeds drive rating.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drive).

Table 11.F *(Continued)*
Problems that Occur while the Drive is Operating

No.	Problem	Probable Cause	Possible Solutions
22	Spd Error Hi displayed - A motor stall condition or an unexpected motor acceleration or deceleration was detected.	If during startup, the motor runs at a constant low speed or reverses direction frequently, the motor versus resolver phasing is incorrect.	Use the parameter *PARAMETER SET - ELECT CONFIG - Motor Phasing* to reverse the relative phasing of the motor to the resolver.
		Incorrect motor selected in *MOTOR SELECT ~ Catalog Num* parameter.	Check *Catalog Num* setting to verify that it matches the motor nameplate. Incorrect parameter setting can cause torque loss.
		Load requires a torque that exceeds motor torque limit setting.	1. Change duty cycle to reduce required motor torque. 2. Turn Low Torque Limit Select input Off or increase setting of *Low Torq Lmt* parameter to allow sufficient torque to drive the load. Increase rating of motor/drive system if necessary to drive the load.
		Motor phase is open.	Check all power wiring to the motor for continuity and tight connections. Use an ohmmeter to verify phase to phase continuity for each motor phase.
		(When using 1327AD series dual winding motors) Malfunctioning winding change contactor.	Check the contactors to assure they are making proper connections at all times. Replace contactors if necessary.
		Resolver or resolver wiring is malfunctioning.	Refer to fault condition 6 for solutions.
		Malfunctioning Power Unit.	If problems were not found with other tests, replace Power Unit.
		Malfunctioning printed circuit boards.	If problems were not found with other tests, replace Main Control Board (gate drive and CPU Boards on A04/A06 drives).
23	Mtr Windg Chg displayed - The auxiliary contacts on the winding change contactors did not cycle as expected during the winding change operation. Whenever the Motor Winding Select – Low/High input is Off, the auxiliary contact on the Low Speed Contactor should be closed. Whenever the Motor Winding Select – Low/High input is On, the auxiliary contact on the High Speed Contactor should be closed. This fault is monitored only when a 1327AD series dual winding motor has been selected with the *MOTOR SELECT - Catalog Num* parameter.		
		Interconnection problem between the drive and the winding change contactors.	1. Verify that connector CN1 is properly connected to the drive. 2. Verify that the connector CN1 and the contactors are correctly wired. 3. Check the cable for continuity.
		One of the winding change contactors are malfunctioning.	Check the contactors to verify that they operate properly. Verify the operation of the auxiliary contacts.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (Gate Drive Board and possibly CPU Board on A04/A06 drives).

Table 11.G
Problems that Occur during Spindle Orient Operation

No.	Problem	Probable Cause	Possible Solutions
24	Motor runs continuously at the *Orient Speed* parameter setting without faulting and without orienting.	Feedback device is incorrectly phased.	Use the *ORIENT SETUP - FEEDBACK DEFN - Encdr Phasing* parameter to reverse the phasing of the orient feedback device.
		Wrong type of feedback device has been specified.	The *ORIENT SETUP - FEEDBACK DEFN - Encoder Type* parameter must be set to "OPTICAL PULSE" when an optical encoder is used and to "MAGNET ANALOG" when the high resolution magnetic feedback is used. Change this parameter to the correct setting and store it in EEPROM by energizing the Drive Enable input. After the correct setting is stored, AC power must be removed from the drive and then reapplied to reset this parameter value in the drive control software.
		The number of encoder lines has been incorrectly programmed.	Use the *ORIENT SETUP - FEEDBACK DEFN - Encoder Lines* parameter to set the correct encoder line count or number of teeth on the high resolution feedback gear.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (CPU Board on A04/A06 drives).
25	The spindle overshoots the target position and oscillates several times before stopping.	Either the velocity loop or the orient position loop is not tuned correctly.	Adjust *SERVO MODE - HI SPD RANGE* P and I gains to obtain quick stopping without overshoot when the Run command is energized/de-energized.
		The accel/decel ramp rate settings are too slow relative to the orient position loop settings.	The accel/decel ramp rate setting limits the decel rate that can be obtained during orient and a slow decel rate can cause overshoot. Reduce the value of the Acc Rate #1 or Acc Rate #2 parameter setting or select the quicker accel/decel rate setting.
		The orient mode tuning requires a faster decel rate than the drive can provide.	Reduce the value of the *ORIENT TUNE - Orient Speed* parameter setting or increase the value of the *ORIENT TUNE - Orient Start* parameter setting. As explained in the *8510 Programming Manual* (publication 8510-5.2), these parameters control the orient position loop gain and define the required deceleration rate.
26	Bad PG Marker displayed- A correct marker pulse was not detected within one revolution of the feedback device as determined by the programmed number of lines on the feedback device.	The number of encoder lines has been incorrectly programmed.	Use the *ORIENT SETUP - FEEDBACK DEFN - Encoder Lines* parameter to set the correct encoder line count or number of teeth on the high resolution feedback gear.
		Feedback device not correctly connected to the drive.	1. Verify that connector CN2 is connected to the drive. 2. Verify the wiring of the connector at the drive and at the feedback device.
		Malfunctioning feedback device.	1. If an optical encoder is used, verify that the marker pulse is present and of proper amplitude and width relative to the A and B channel outputs. 2. If the high resolution magnetic feedback is used, verify the output signals per Figure 11.4. Adjust the sensor relative to the gear to obtain proper signals or replace the sensor head.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (CPU Board on A04/A06 drives).

Table 11.G *(Continued)*
Problems that Occur during Spindle Orient Operation

No.	Problem	Probable Cause	Possible Solutions
27	Bad PG Count displayed - An incorrect number of spindle position feedback counts was detected between two successive markers pulses as determined by the programmed number of lines on the feedback device.	The number of encoder lines has been incorrectly programmed.	Use the *ORIENT SETUP - FEEDBACK DEFN - Encoder Lines* parameter to set the correct encoder line count or number of teeth on the high resolution feedback gear.
		Feedback device is incorrectly phased.	Use the *ORIENT SETUP - FEEDBACK DEFN - Encdr Phasing* parameter to reverse the phasing of the orient feedback device.
		Feedback device not correctly connected to the drive.	1. Verify that connector CN2 is connected to the drive. 2. Verify the wiring of the connector at the drive and at the feedback device.
		The *ORIENT TUNE - Orient Start* parameter value is much too low relative to the value of *ORIENT TUNE - Orient Speed* parameter.	Either increase the value of *ORIENT TUNE - Orient Start* or decrease the value of *ORIENT TUNE - Orient Speed*.
		Malfunctioning feedback device.	1. If an optical encoder is used, verify that the A, B, and Z channel outputs are present and have proper amplitude/phase relationships and that the signals are relatively free of electrical noise. 2. If the high resolution magnetic feedback is used, follow the procedure shown in Figure 11.4 to verify the output signals. Adjust the mounting of the gear and the position of the sensor relative to the gear to obtain proper signals or replace the sensor head.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (CPU Board on A04/A06 drives).
28	Bad PG Output displayed - The electrical signals from the high resolution magnetic feedback device are abnormal.	Wrong type of feedback device has been specified.	If an optical encoder is being used, the *ORIENT SETUP - FEEDBACK DEFN - Encoder Type* parameter must be set to "OPTICAL PULSE". When this parameter is changed and then stored in EEPROM, AC power must be removed from the drive and then reapplied to reset this parameter value in the drive control software.
		The gear or sensor are not correctly installed.	The gear and sensor must be installed in accordance with the mechanical tolerance specifications in the High Resolution Magnetic Feedback Instructions (8510-5.13). At test point A on the Main Control Board (CPU Board of A04/A06 drive), the amplitude modulation of the signal should be less then 0.1 volts when the gear is properly installed. The magnitude of the signal can be changed by changing the gear to sensor airgap.
		Interconnecting cable or sensor are defective.	1. Verify that proper signals are received from the sensor. See Figure 11.4 for correct waveforms. 2. If not correct, check cables and connectors for continuity and proper connections. 3. If cables and connections are OK, replace sensor.
		Malfunctioning printed circuit board.	If problems were not found with other tests, replace Main Control Board (CPU Board on A04/A06 drives).

Table 11.H
Other Faults that Indicate Control Hardware Malfunction

No.	Problem	Probable Cause	Possible Solutions
29	Main RAM Err displayed- A parity or functional error was detected in RAM on the Main Control Board (CPU Board on A04/A06 drive).	RAM is malfunctioning.	Replace Main Control Board (CPU Board on A04/A06 drive).
30	I/O Comm Err displayed - No communications occurring between microprocessor on Main Control Board (CPU Board on A04/A06 drive) and microprocessor on I/O Board.	Hardware malfunction on either I/O Board or Main Control Board (CPU Board on A04/A06 drive).	1. Verify that EPROMs on both the I/O Board and Main Control Board are inserted correctly. 2. Verify that the I/O Board connectors are fully seated into the Main Control Board (or CPU Board) connectors. 3. If problem remains, replace I/O Board 4. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive).
31	Main CPU Loss displayed - CPU on Main Control Board (CPU Board on A04/A06 drive) unable to complete calculations during allotted time cycle.	Firmware problem or hardware malfunction on Main Control Board (CPU Board on A04/A06 drive).	1. Verify that the EPROM on the Main Control Board is inserted correctly. 2. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive). 3. If problem remains, contact factory.
32	Main Comm Err displayed - No communications occurring between master and slave processors on Main Control Board (CPU Board on A04/A06 drive).	Hardware malfunction.	1. Verify that the EPROM on the Main Control Board is inserted correctly. 2. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive).
33	Main Watchdog displayed - The watchdog timer on the Main Control Board (CPU Board on A04/A06 drive) tripped out.	The microprocessor on Main Control Board ran out of execution time or stopped.	1. Verify that EPROMs on both the I/O Board and the Main Control Board (CPU Board on A04/A06 drive) are inserted correctly. 2. If problem remains, replace Main Control Board. 3. If problem recurs, contact factory.
34	Main A/D Conv displayed - The A/D converter on the main control board (CPU Board on A04/A06 drive) faulted or sensed excessive offset.	Hardware malfunction.	Replace Main Control Board (CPU Board on A04/A06 drive).

Table 11.H *(Continued)*
Other Faults that Indicate Control Hardware Malfunction

No.	Problem	Probable Cause	Possible Solutions
35	Main CPU1 Err displayed - The master cpu on the Main Control Board (CPU Board on A04/A06 drive) malfunctioned.	Hardware malfunction.	1. Verify that EPROM chip on Main Control Board (CPU Board on A04/A06 drive) is inserted correctly. 2. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive).
36	Main CPU2 Err displayed - The slave cpu on the Main Control Board (CPU Board on A04/A06 drive) malfunctioned.	Hardware malfunction.	1. Verify that EPROM chip on Main Control Board (CPU Board on A04/A06 drive) is inserted correctly. 2. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive).
37	Main RAM Init displayed- Functional error detected in RAM on Main Control Board (CPU Board on A04/A06 drive).	Hardware malfunction.	Replace Main Control Board (CPU Board on A04/A06 drive).
38	Main CPU Ovfl displayed - CPU on Main Control Board (CPU Board on A04/A06 drive).ran out of execution time.	Firmware error or hardware malfunction.	1. Verify that both EPROMs on I/O Board and Main Control Board are inserted correctly. 2. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive). If problem recurs, contact Allen-Bradley.
39	Optical Intpt displayed - A system interrupt was sensed through the test system fiber optic transducer.	Bright flash of light triggered the fiber optic input.	1. Assure that the rubber plug is installed in the fiber optic connector on the Main Control Board (CPU Board on A04/A06 drive). The fiber optic connector is located adjacent to connector CN2. 2. If problem remains, replace Main Control Board (CPU Board on A04/A06 drive).
40	Hi Accel Rate displayed	Firmware error.	Reset drive. If fault persists, contact Allen-Bradley.
41	Hi Positn Cmd displayed	Firmware error.	Reset drive. If fault persists, contact Allen-Bradley.
42	Hi Positn Err displayed	Firmware error.	Reset drive. If fault persists, contact Allen-Bradley.
43	Hi Speed Cmd displayed	Firmware error.	Reset drive. If fault persists, contact Allen-Bradley.

I/O Board Faults

When problems occur with the I/O Board, the first line of the display will show either *!Fault I/O Board* or *Warning I/O Brd*. The second line provides more detailed information about the exact nature of the fault.

Table 11.I
Problems Specifically Related to the I/O Board

No.	Problem	Probable Cause	Possible Solutions
44	EEPROM No Data displayed - The I/O Board microprocessor could not find programmed data in the EEPROM.	The drive was not programmed.	Perform the complete drive setup programming procedure as described in the *8510 Programming Manual* (publication 8510-5.2).
		EEPROM not properly installed or malfunctioning.	Verify that the EEPROM is properly installed in the socket. If problem remains, replace I/O Board.
45	Bad EEPROM displayed - The The I/O Board microprocessor can not communicate with the EEPROM.	EEPROM not properly installed or malfunctioning.	Verify that the EEPROM is properly installed in the socket. If problem remains, replace I/O Board.
46	Bad Optional A/D displayed- The I/O Board microprocessor can not communicate with or is receiving bad data from the optional A/D converter on the I/O Board.	This version of the I/O Board does not have the optional 14 bit linear A/D converter installed.	If the drive catalog number does not end in either -Cx or -Dx, the optional A/D converter is not installed. Either program drive to use standard A/D converter or install I/O Board that includes the optional A/D converter.
		Malfunctioning A/D converter or I/O Board.	Replace I/O Board.
47	EEPROM Sumchk displayed - The I/O Board microprocessor has read an incorrect check sum value from the EEPROM which indicates corrupted data in the EEPROM.	Data has become corrupted due to noise or some other means.	Perform the complete drive setup programming procedure as described in the *8510 Programming Manual* (publication 8510-5.2).
		EEPROM is malfunctioning.	Replace the EEPROM or complete I/O Board.
48	H8 CPU RAM displayed - The RAM that is internal to the H8 microprocessor will not pass a read/write test.	The microprocessor on the I/O Board is malfunctioning.	Replace I/O Board.
49	I/O DURM displayed - The dual-port RAM used to communicate to the Main Control Board will not pass a read/write test.	The dual-port RAM on the I/O Board is malfunctioning.	Replace I/O Board.
50	LCD Timeout displayed - Communications between the I/O Board microprocessor and the programming display module did not occur in the allowed time.	The I/O Board is malfunctioning.	Replace I/O Board.
51	Any other !Fault I/O Board fault message displayed - Indication of firmware or hardware malfunction on I/O Board.	Some hardware or firmware on the I/O Board is malfunctioning.	Replace the I/O Board.

Table 11.J
Problems Caused by Programming Errors

No.	Problem	Probable Cause	Possible Solutions
52	Bad Comb M & D displayed - The motor and drive catalog numbers that are selected are not compatible with one another.	For the gear range selected, the MOTOR SELECT - Catalog Num and the ELECT CONFIG - Drive Cat Num parameter values not compatible or are not defined.	Verify that motor and drive catalog numbers have been programmed for the selected gear range. Verify that the selected motor and drive catalog numbers are a compatible set. A 5.5 kW drive can be used with any motor rated 5.5 kW or smaller. An 11 kW drive can be used with any motor rated from 5.5 kW through 11 kW. A 22 kW drive can be used with any motor rated from 11 kW through 22 kW.
53	Max Spd None displayed - The microprocessor can not find a value programmed for the SPINDL PRESET - Overspd Trip parameter.	For the gear range selected, the value for the SPINDL PRESET - Overspd Trip parameter is set to zero.	Verify that the SPINDL PRESET - Overspd Trip parameter is set to a value other than zero.
54	Op Dig Set Er displayed - The drive has been programmed to use the optional 16 bit parallel inputs for two different functions simultaneously.	For the gear range selected, the SPINDLE MODE - Cmnd Source parameter has been set to either “4 DIGIT BCD” or “16 BIT BINARY” and the ORIENT TUNE - Position Data parameter has been set to either “BCD INPUT” or “BINARY INPUT.”	Within a given gear range, the optional 16 bit digital command input can be used as either a spindle speed command or as an orient position command, not both. Verify that only one of these functions are programmed for the BCD or binary command input.
55	Orient Prm Er displayed - One or more of the critical parameters for orient are not properly programmed.	For the gear range selected, one or more of the following parameters has a programmed value of zero: SET RATIOS - Spindle Revs; SET RATIOS - Motor Revs; ORIENT TUNE - Orient Speed; ORIENT TUNE - Orient Start.	Verify that each of the parameters listed under Probable Cause is set to a valid value that must be greater than zero.
56	Sp Mtr 1 P Er displayed - An error was detected in the motor parameter table values.	For the gear range selected, the motor type selected by the MOTOR SELECT - Catalog Num parameter has been set to “NON-STD MTR 1” and this motor has not been defined or is incorrectly defined.	Change the MOTOR SELECT - Catalog Num parameter setting to the correct catalog number for the motor connected to the system. If this does not correct the problem, contact the factory.
57	Sp Mtr 2 P Er displayed - An error was detected in the motor parameter table values.	For the gear range selected, the motor type selected by the MOTOR SELECT - Catalog Num parameter has been set to “NON-STD MTR 2” and this motor has not been defined or is incorrectly defined.	Change the MOTOR SELECT - Catalog Num parameter setting to the correct catalog number for the motor connected to the system. If this does not correct the problem, contact the factory.

Figure 11.3
Resolver Signals

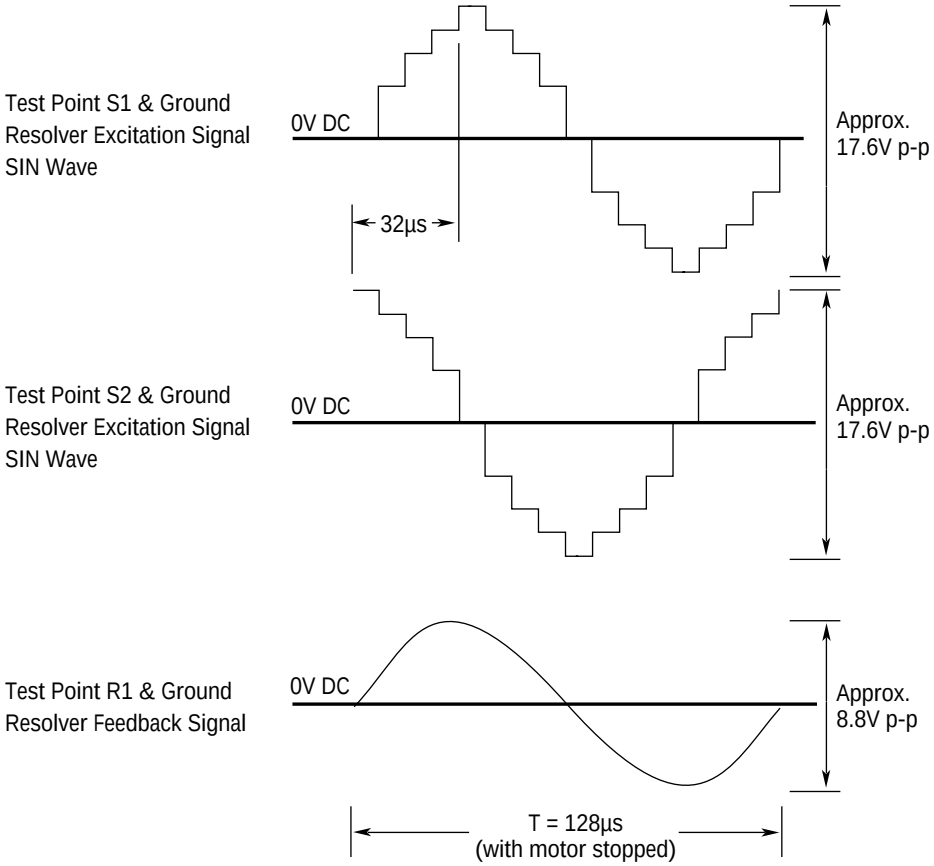
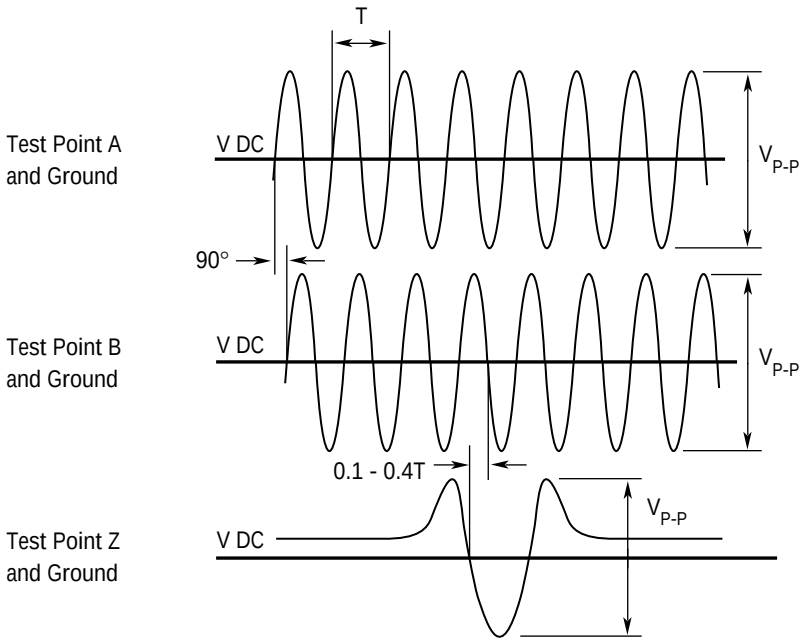


Figure 11.4
High Resolution Magnetic Feedback Signals



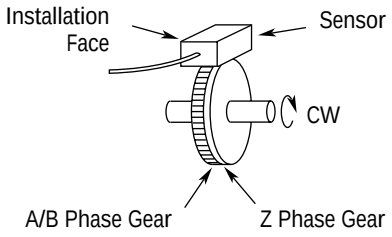
T depends on the number of gear teeth and gear speed.

$$T = \frac{1}{N \times {}^{1}/_{60} \times S}$$

where:
N = Number of Teeth
S = Speed (rpm)

Amplitude of A/B:
V DC = 2.5V
V_{P-P} = 3V

Amplitude of Z:
V DC = 2.5V
V_{P-P} = 3V



Install the gear and sensor as shown. The specifications above should be set at CW rotation when the gear is viewed from the Z phase gear side.

IGBT Test Procedure

The following procedure provides the steps needed to properly test the IGBT modules to determine if replacement is necessary.

1. Remove all power to the drive. Remove the front cover from the drive.
2. Label and remove the three motor wires from the drive terminals U, V and W.
3. Access to the IGBT modules must be gained by removing the following boards:

   On 8510A-A04 and A06 drives remove the CPU, Gate Drive and I/O Boards.

   On 8510A-A11 and A22 drives remove the Main Control (and I/O) Board.
4. The 8510A-A04 and A06 drives have two modules, while the 8510A-A11 and A22 drives have six. For proper testing, each module must be checked four different ways. The procedure for 8510A-A04 and A06 drives is shown in Figure 11.5. The procedure for 8510A-A11 and A22 drives is shown in Figure 11.6.

   On 8510A-A11 and A22 drives the IGBT module will have 4 spade lugs for the gate connection. Use these as a reference point for orientation.

   Measurements must be taken with a Digital Voltmeter (DVM) equipped with a “Diode” setting. The connection polarity for the meter is shown in each figure.

   A reasonable ohm reading would be 1 meg to infinity. A reasonable voltage drop would be 450 - 700mV. If a measurement differs appreciably from these values, the module is bad and the Power Unit must be replaced.
5. When testing/replacement is complete, replace board(s), cover and check for proper operation.

Figure 11.5
IGBT Module Test Procedure for 8510SA-A04 and A06 Drives

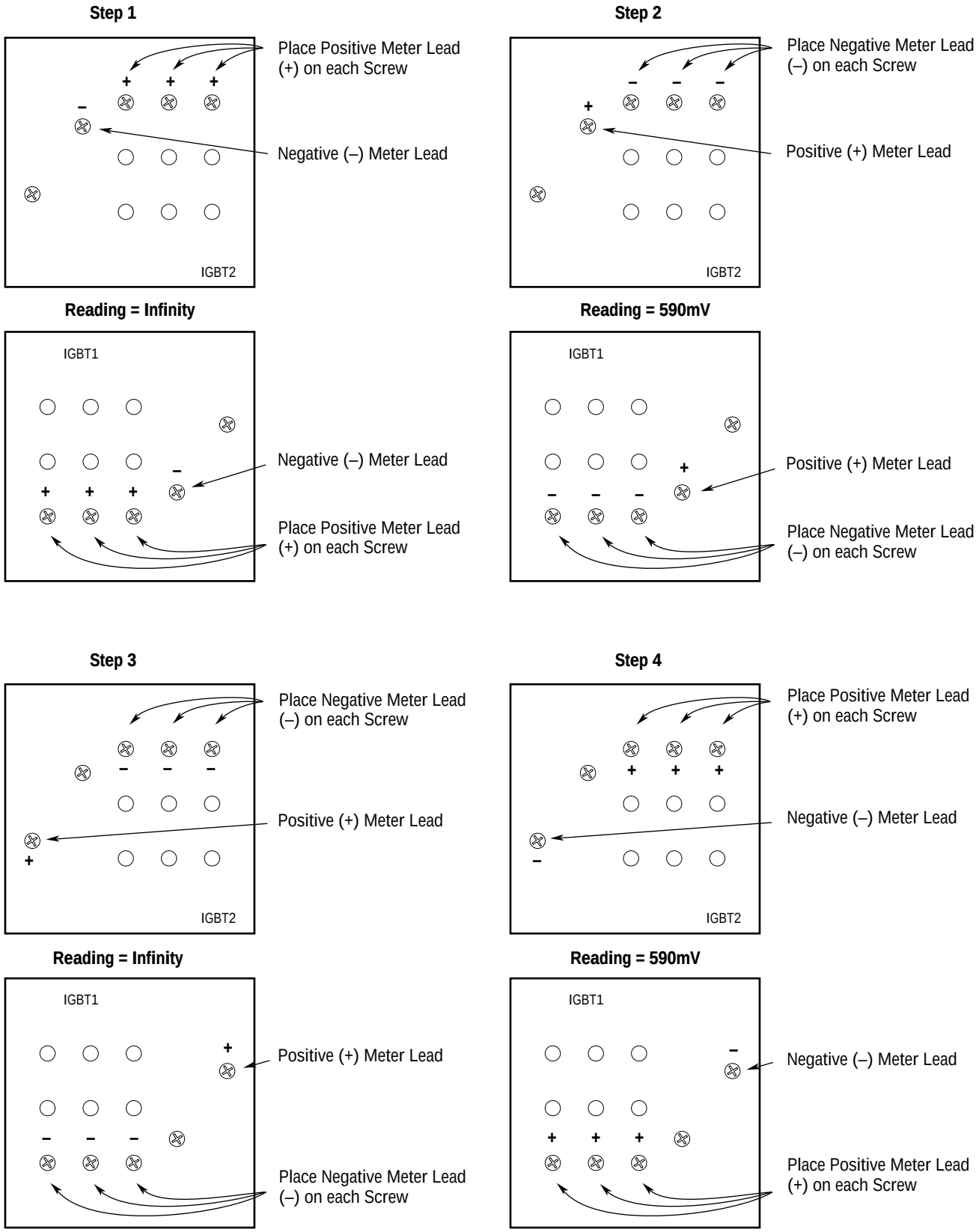


Figure 11.6
IGBT Module Test Procedure for 8510SA-A11 and A22 Drives

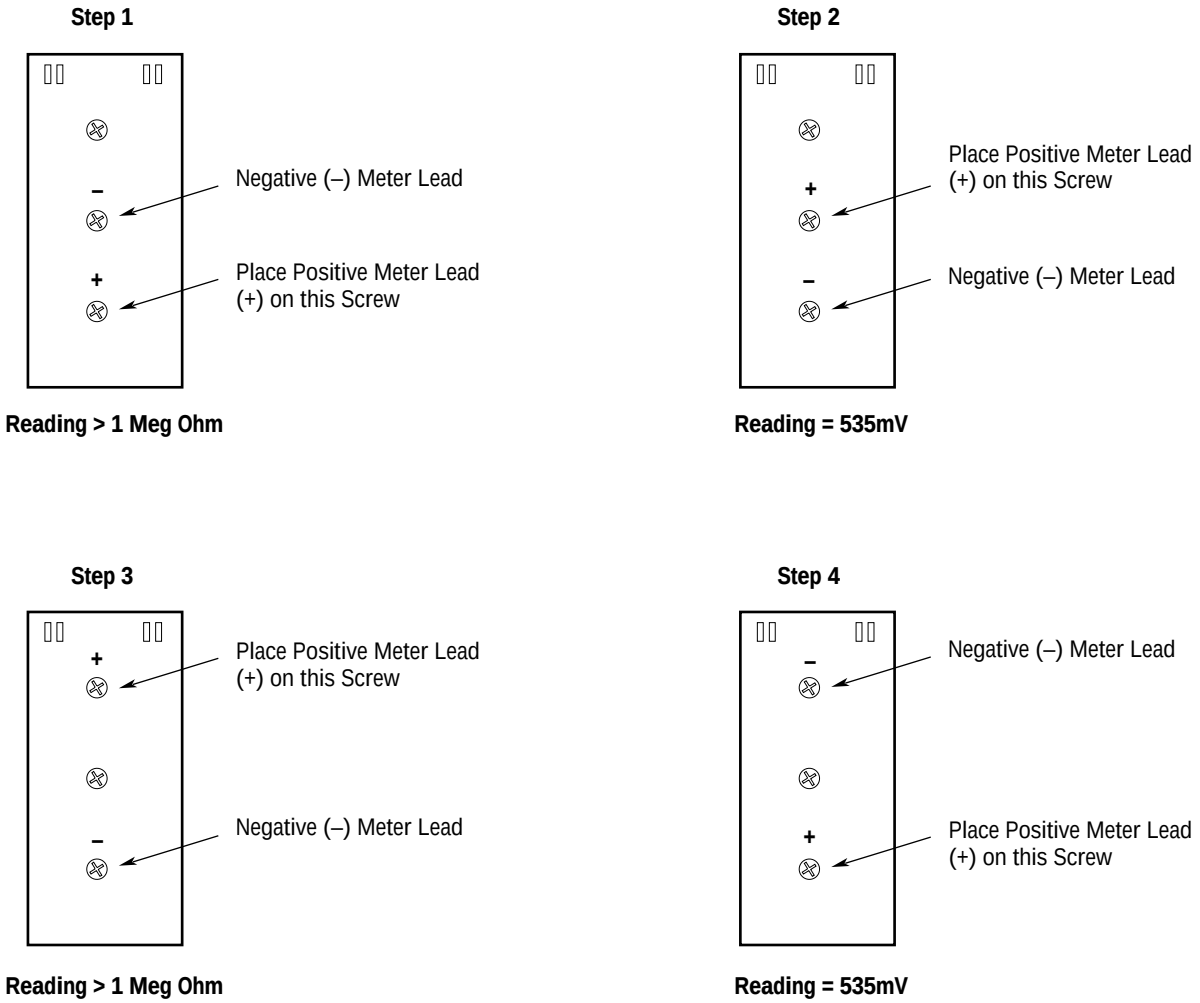


Figure 11.7
I/O Board – 8510A-A04, A06

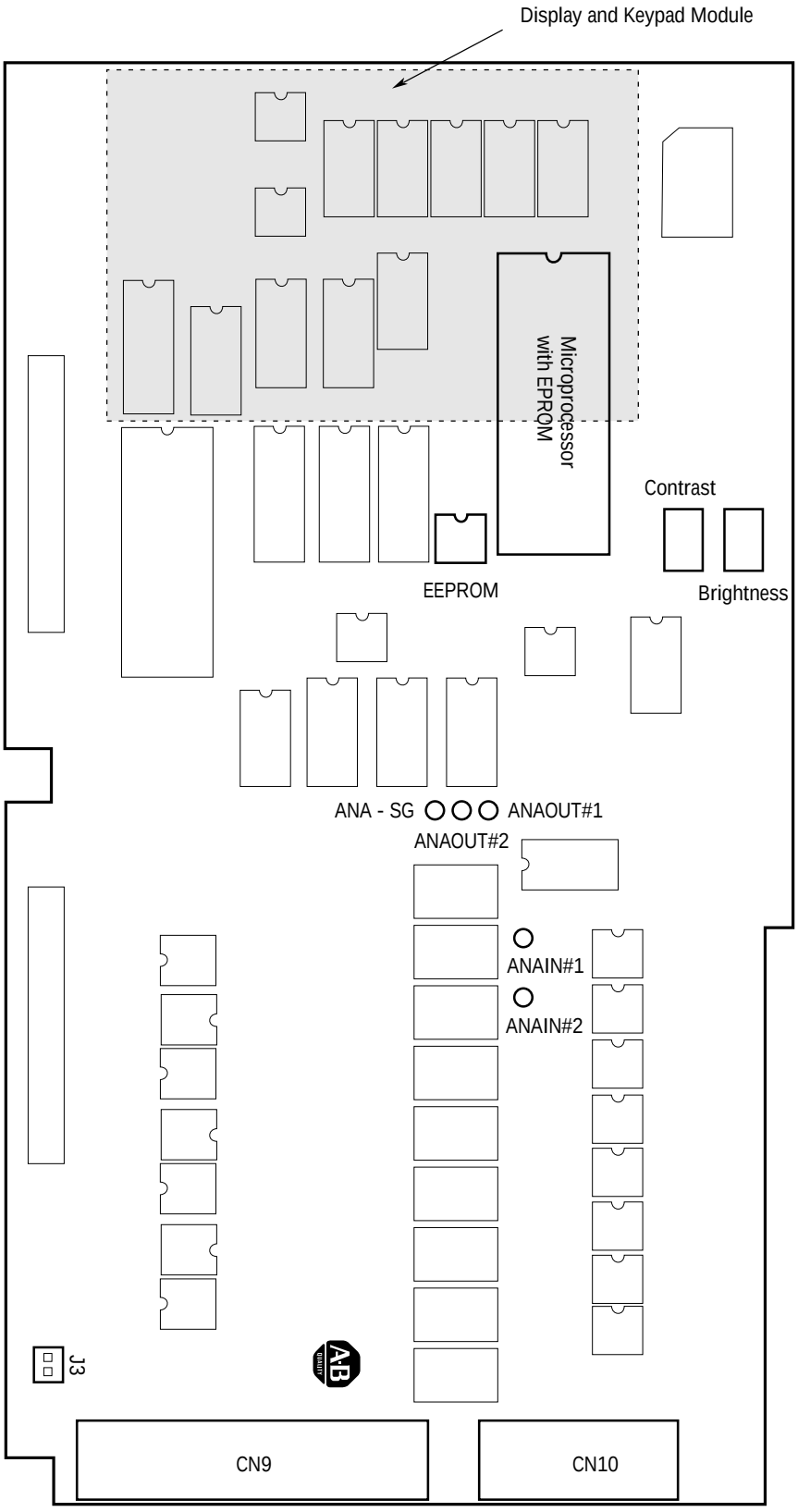


Figure 11.8
CPU Board – 8510A-A04, A06

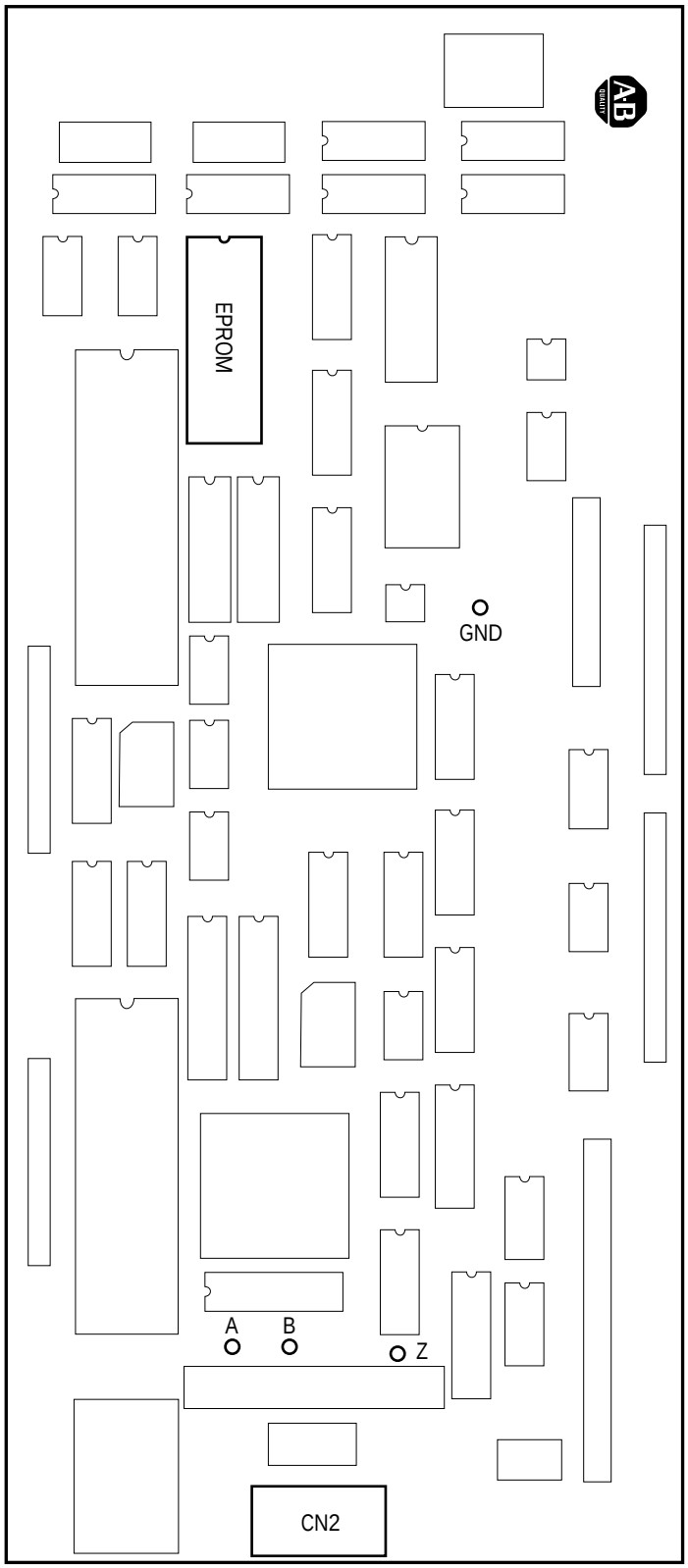


Figure 11.9
Gate Drive Board – 8510A-A04, A06

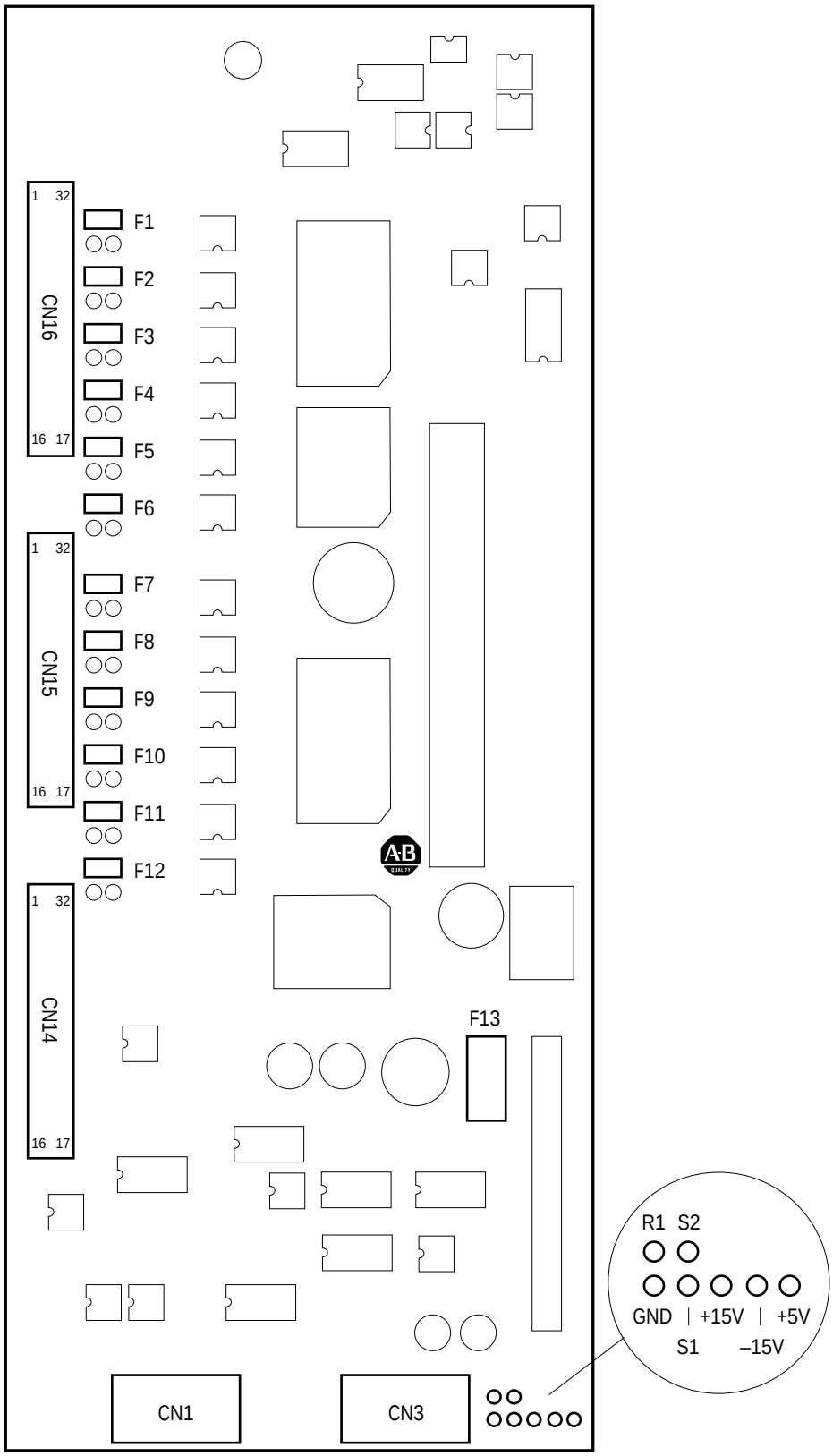


Figure 11.10
Power Board – 8510A-A04, A06

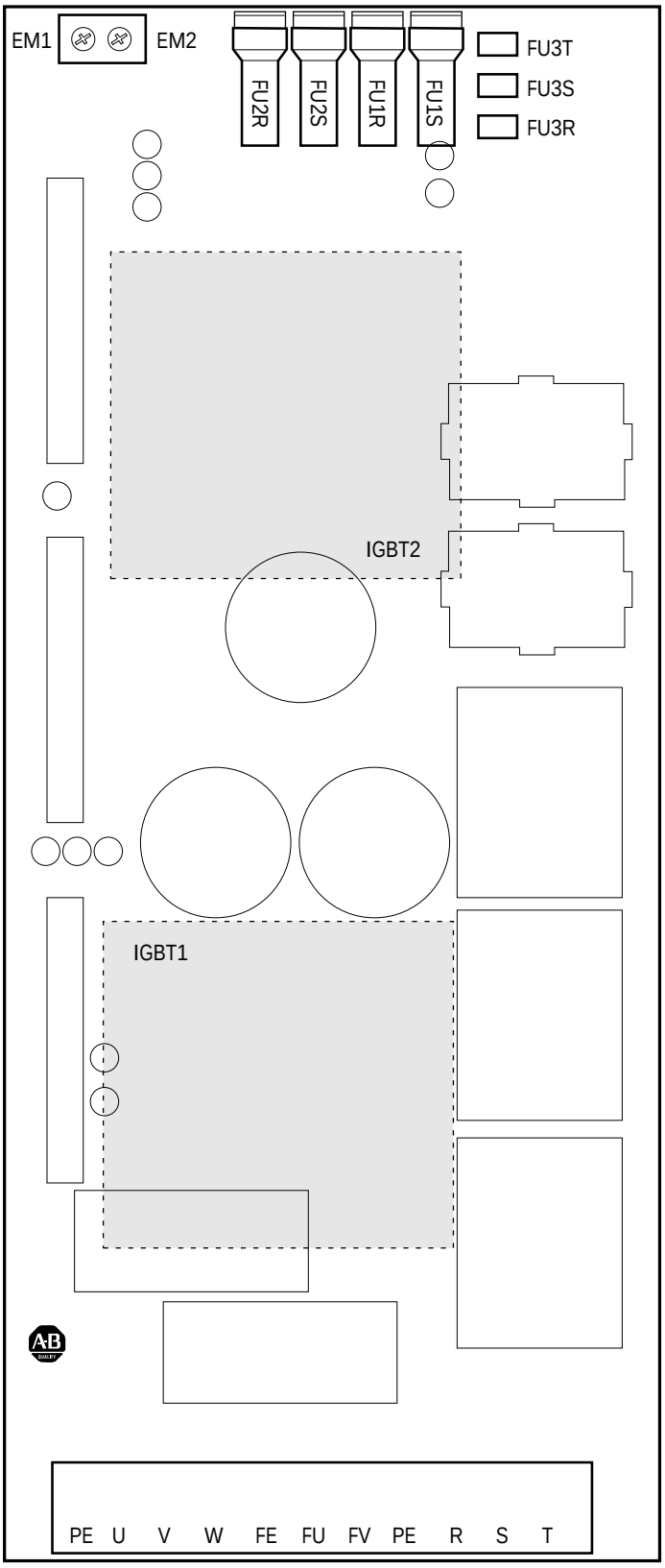


Figure 11.11
I/O Board – 8510A-A11, A22

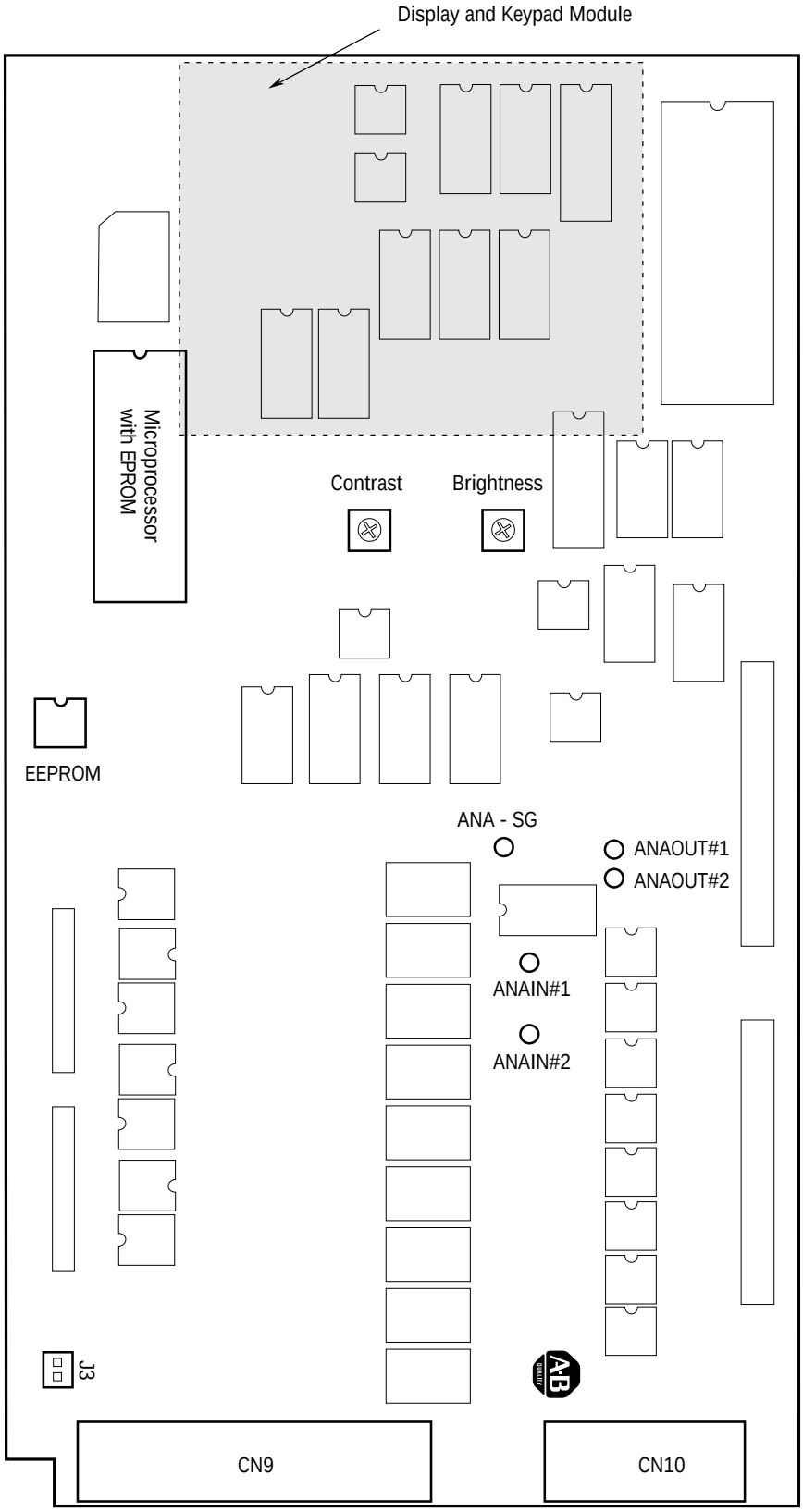


Figure 11.12
Main Control Board – 8510A-A11, A22

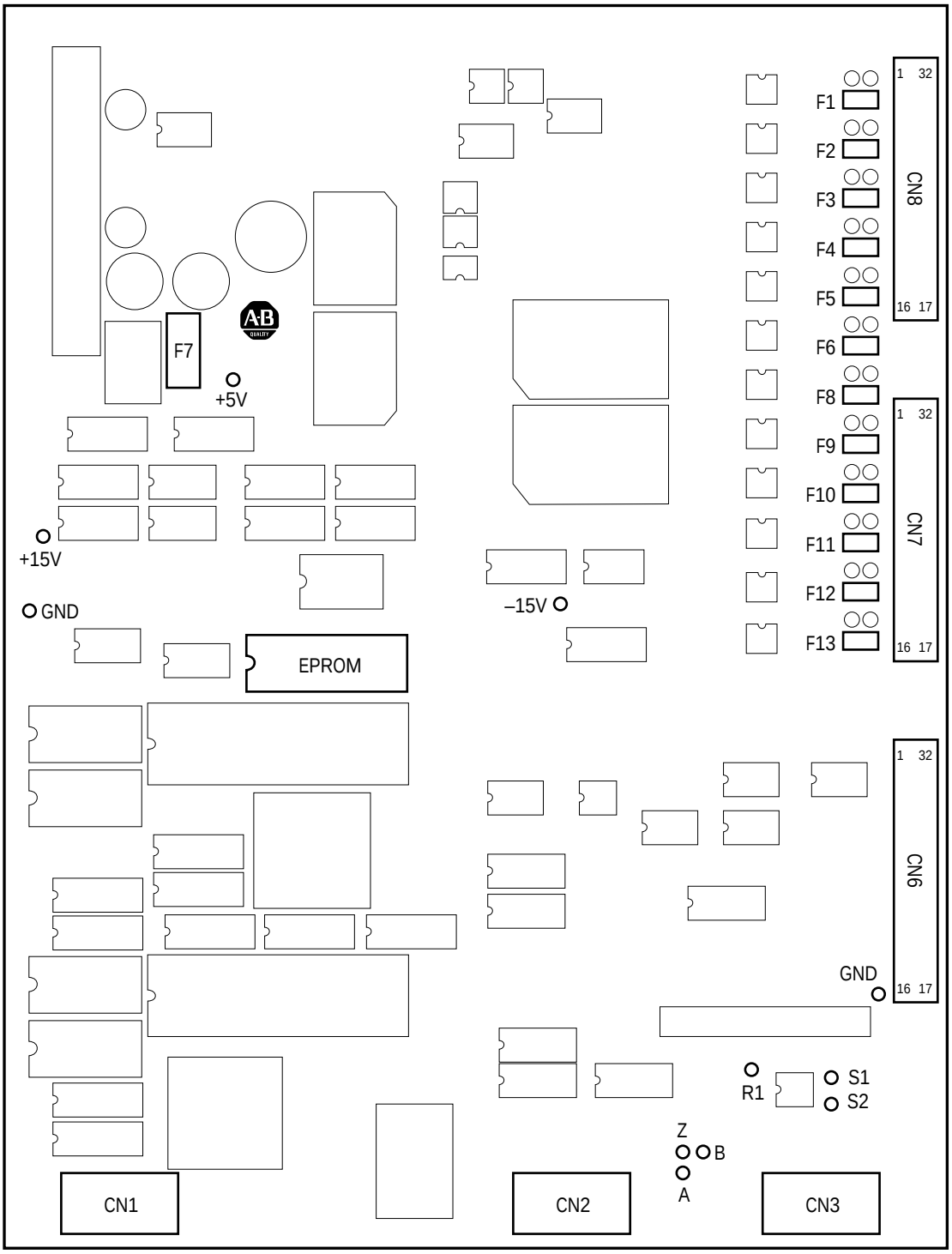


Figure 11.13
Power Board – 8510A-A11

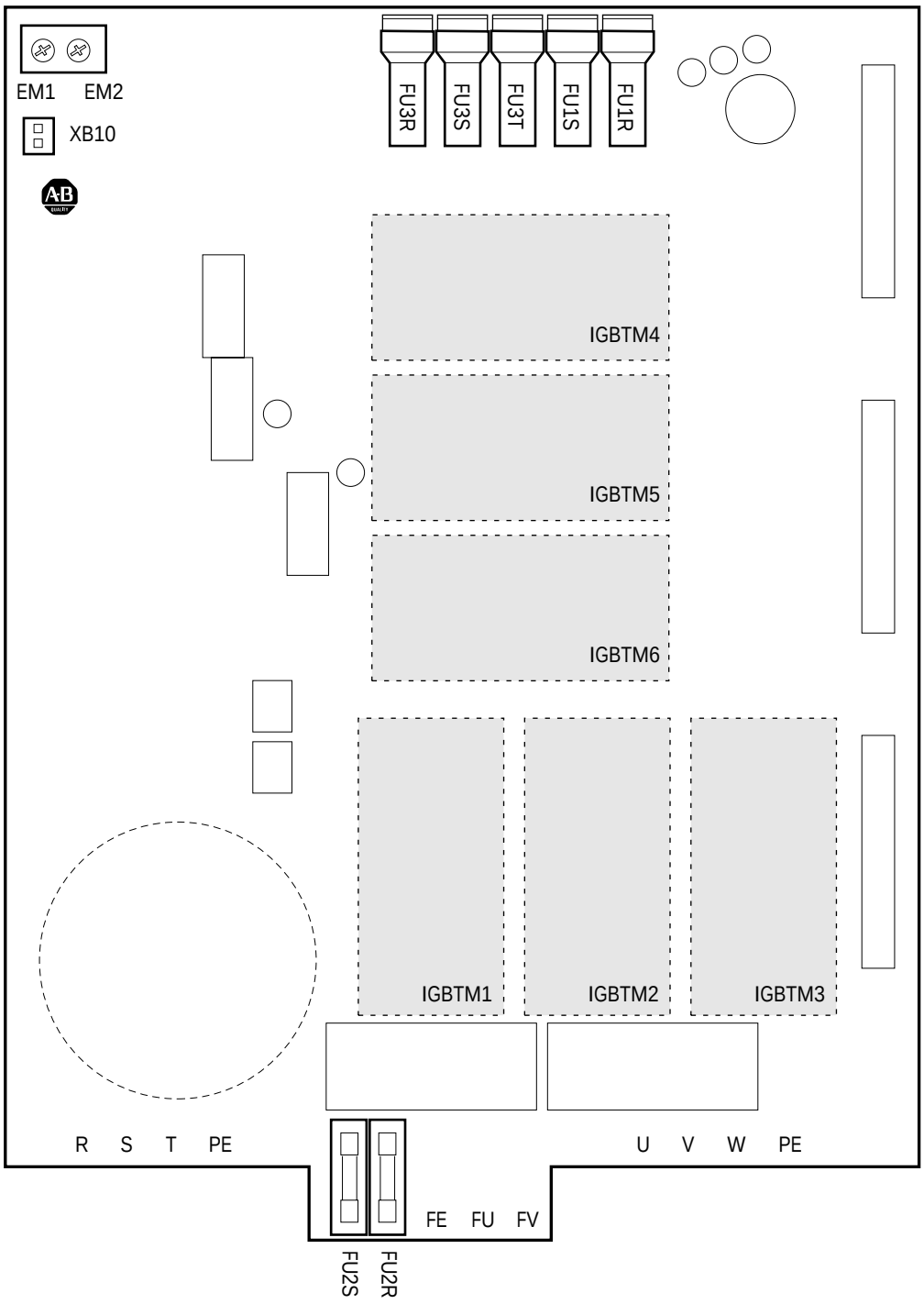
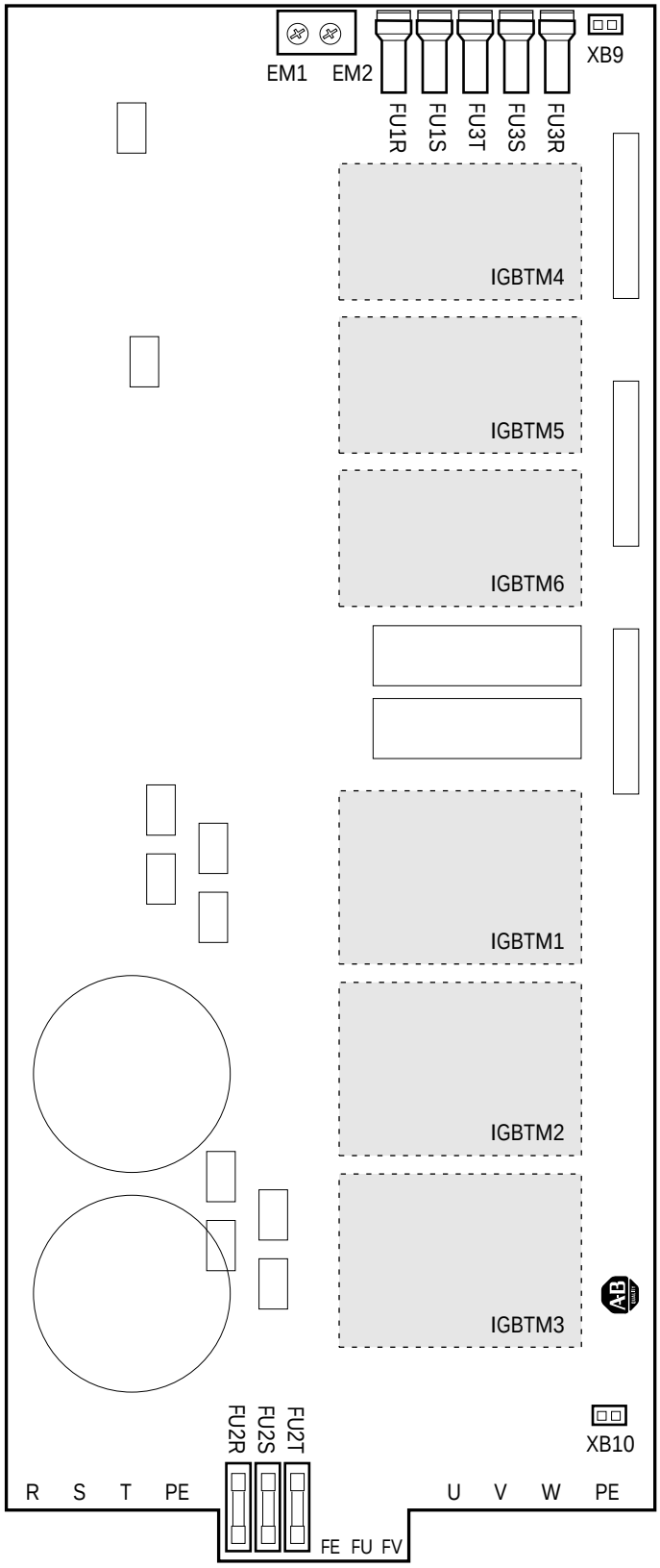


Figure 11.14
Power Board – 8510A-A22



Appendix A

Renewal Parts

Introduction

The following provides a list of the renewal parts available for the 8510 AC Spindle Drive. Information provided is subject to change. Refer to the 8510 Renewal Parts publication (8510-6.0) for current information. For critical process applications, it is recommended that a complete drive be maintained as a spare.

8510A-A06-xx Drive

Part Number	Description
145863	Fuse – FU1R, FU1S
145863	Fuse – FU2R, FU2S
151465	Fuse – FU3R, FU3S, FU3T
148133	Gate Drive Fuses
148134	5V DC Power Supply Fuse
152687	CPU Board
152688	Gate Drive Board
152683	I/O Board Type -A1 *
152684	I/O Board Type -B1 *
152685	I/O Board Type -C1 *
152686	I/O Board Type -D1 *
152905	Keypad/Display Board (included with I/O Board)

8510A-A11-xx Drive

Part Number	Description
145863	Fuse – FU1R, FU1S
145863	Fuse – FU2R, FU2S
151287	Fuse – FU3R, FU3S, FU3T
148133	Gate Drive Fuses
148134	5V DC Power Supply Fuse
152678	Main Control Board
152679	I/O Board Type -A2 *
152680	I/O Board Type -B2 *
152681	I/O Board Type -C2 *
152682	I/O Board Type -D2 *
152905	Keypad/Display Board (included with I/O Board)

***** To avoid being forced to completely reprogram the drive – remove the EEPROM from the malfunctioning I/O Board and install it in the replacement I/O Board.

8510A-A22-xx Drive

Part Number	Description
145863	Fuse – FU1R, FU1S
145863	Fuse – FU2R, FU2S, FU2T
151287	Fuse – FU3R, FU3S, FU3T
148133	Gate Drive Fuses
148134	5V DC Power Supply Fuse
152678	Main Control Board
152679	I/O Board Type -A2 *****
152680	I/O Board Type -B2 *****
152681	I/O Board Type -C2 *****
152682	I/O Board Type -D2 *****
152905	Keypad/Display Board (included with I/O Board)

***** To avoid being forced to completely reprogram the drive – remove the EEPROM from the malfunctioning I/O Board and install it in the replacement I/O Board.

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Publication 8510-5.1 – August, 1993
Supersedes May, 1993

P/N 152824