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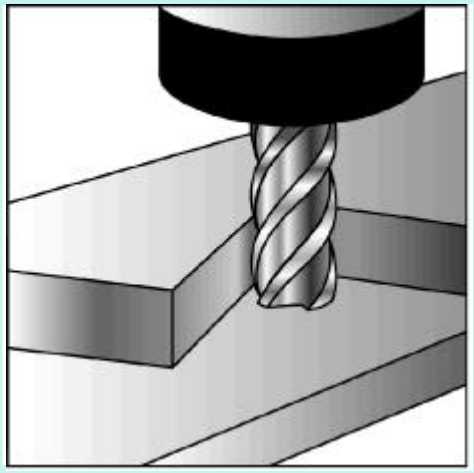
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Allen-Bradley

9/Series CNC Hardware

Integration and Maintenance Manual



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Rockwell Automation
Allen-Bradley

9/Series Hardware
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Important User Information

Because of the variety of uses for this product and because of the differences between solid state products and electromechanical products, those responsible for applying and using this product must satisfy themselves as to the acceptability of each application and use of this product. For more information, refer to publication SGI-1.1 (Safety Guidelines For The Application, Installation and Maintenance of Solid State Control).

The illustrations, charts, and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

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

Attention helps you:

- Identify a hazard
- Avoid the hazard
- recognize the consequences

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

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Summary of Changes

New Information

The following is a list of the larger changes made to this manual since its last printing. Other less significant changes were also made throughout.

- 2 new versions of the MTB panel ; 24 Volt direct I/O and LED lamp version. (chapter 9A)
- New contact information (chapter 14)
- Enhanced servo tuning screens (chapter 15A)
- Enhanced servo diagnostic screens (chapter 15A)
- New Error Messages for the above features (chapter 16)

Revision Bars

We use revision bars to call your attention to new or revised information. A revision bar appears as a thick black line on the outside edge of the page as indicated here.

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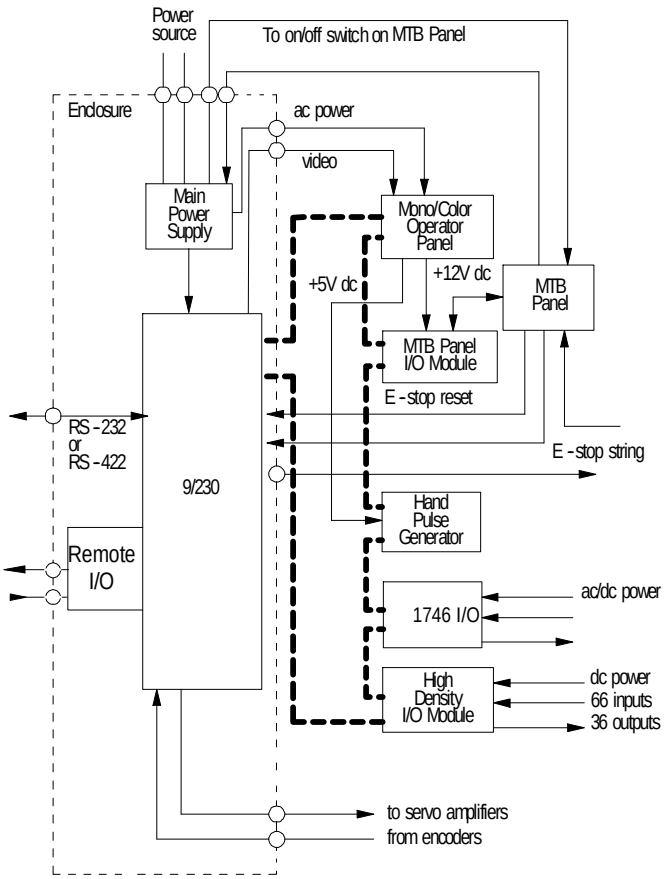
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9/Series Hardware
TAB 1

Using This Manual and System Overview



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Important User Information

Because of the variety of uses for this product and because of the differences between solid state products and electromechanical products, those responsible for applying and using this product must satisfy themselves as to the acceptability of each application and use of this product. For more information, refer to publication SGI-1.1 (Safety Guidelines For The Application, Installation and Maintenance of Solid State Control).

The illustrations, charts, and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

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Throughout this manual we make notes to alert you to possible injury to people or damage to equipment under specific circumstances.



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

Attention helps you:

- Identify a hazard
- Avoid the hazard
- recognize the consequences

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

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Section 1A

Using This Manual

1A.0 Section Overview

This manual provides the information necessary to integrate the Allen-Bradley 9/Series control to a suitable machine tool. It begins with a system overview followed by sections covering mechanical and electrical system design to assist the system installer with component installation. The manual also includes electrical and mechanical specifications for all components of the controls.

This section describes how to use this manual. Major topics include:

Topic:	See page:
Audience	1A-1
Terms and Conventions	1A-2
Attentions and Important Information	1A-3
Related publications	1A-3

1A.1 Audience

This manual presumes that the reader understands machine tools, basic wiring and electronics, and CNC control theory.

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1A.2 Terms and Conventions

To make this manual easier to read and understand, full product names and features are shortened where possible. Here are the shortened terms:

When your see:	It Means:
AMP	Adjustable Machine Parameters
CNC	Computer Numerical Control
CPU	Central Processing Unit (the computing part of the (9/260 and 9/290 control)
CPU Board	the board that holds the processor of the control. It slides into the enclosure to connect to the motherboard (9/260 and 9/290 control)
CRT	Cathode Ray Tube (the control's monitor screen)
The Control	general term that we use to refer to the 9/230, 9/260, 9/290 or 9/440 control.
E-STOP	Emergency Stop
Flash Memory	Non-volatile, programmable memory that resides in Flash SIMMs on the CPU board. This memory backs up the executive program, PAL, and AMP. It retains information even during power failure
HPG	Hand Pulse Generator
I/O	Input/Output
I/O CPU	One of two CPUs in the 9/290. It processes the machine logic interface and I/O control information.
Main CPU	One of two CPUs in the 9/290 and the only CPU in the 9/230 and 9/260. It processes internal CNC functions, including system scans and block decode.
MDI	Manual Data Input
MTB	Machine Tool Builder's control panel
Motherboard	the board that is installed onto the back panel of the enclosure on the 9/260 and 9/290. Most system connections are on this board.
ODS	Offline Development System
PAL	Programmable Application Logic
Processor Board	the board that is installed onto the back panel of the enclosure on the 9/230. Most system connections are made on this board.
RAM	Random Access Memory
RIO	Allen Bradley Remote I/O communications.
SIMM	Single, In-line Memory Module. Flash SIMMs are on the lower half of the CPU module. If you have a 9/290, it has Shadow RAM SIMMs installed on the top half of the module as well as Flash SIMMs.
Softkeys	The row of keys directly below the Operator Panel screen
System Installer	The company or contractor responsible for installing this control on the machine
Workstation	The IBM or compatible personal computer that the ODS software is installed on

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1A.3 Attention and Important Information

We indicate vital information in these ways:



ATTENTION: indicates circumstances or practices that can lead to damage to the control or other equipment.

Information that is especially important is indicated by the following:

Important: indicates information that is necessary for successful application of the control.

1A.4 Related Publications

The following documents are also available:

Pub. No.	Document Name
MCD-5.1	9/Series CNC Offline Development System User's Manual
8520-4.3	9/Series CNC 9/230, 9/260, and 9/290 PAL Reference Manual
8520-5.1.1	9/Series CNC Lathe Operation and Programming Manual
8520-5.1.3	9/Series CNC Mill Operation and Programming Manual
8520-5.1.4	9/Series CNC Grinder Operation and Programming Manual
8520-6.4	9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual
8520-6.5	9/Series CNC Transfer Line Quick Start Guide (Shipped with T-Line-9 only)

END OF SECTION

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Section 1B

System Overview

1B.0 Section Overview

This section provides an overview of the 9/230, 9/260, and 9/290 controls. Typical system configurations and the external appearance of each component of the control are provided in this section. Detailed information on each component is provided in specific sections in this manual.

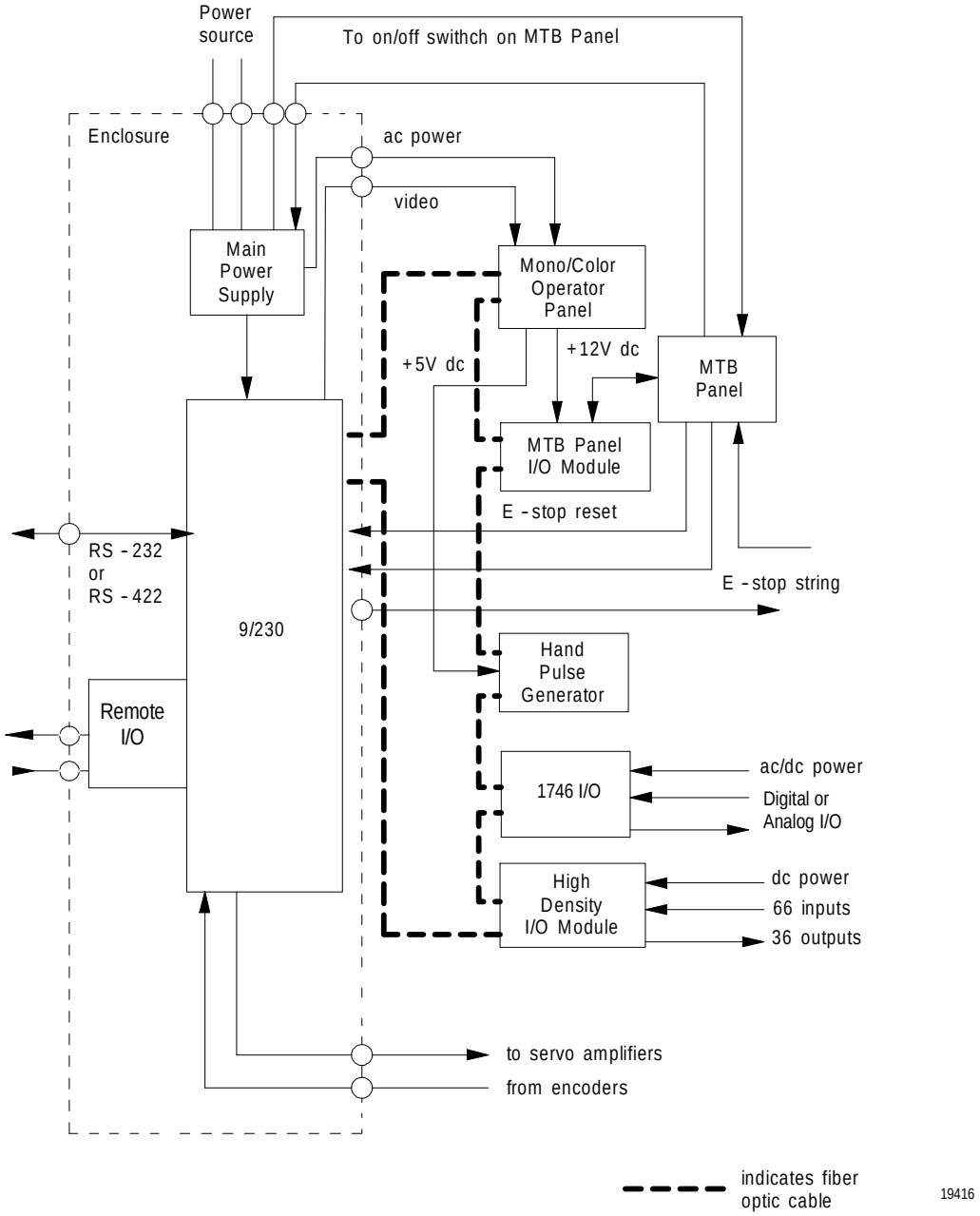
For Information on:	See page:
System Configuration	1B-1
System Configuration for 9/230 System	1B-2
9/230 Component Enclosure	1B-6
9/260 and 9/290 Component Enclosure	1B-7
Operator Interface	1B-8
Drives Interface	1B-11
I/O Interface	1B-12
Communication Interface	1B-15
Offline Development System	1B-15
Adjustable Machine Parameters (AMP)	1B-15
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Fiber Optic I/O Ring	1B-16

1B.1 System Configuration

Figure 1B.2 to Figure 1B.3 show three typical configurations for the 9/230, 9/260, and 9/290 controls. Use these figures for an overview of the inter-component connections you make during integration of the control.

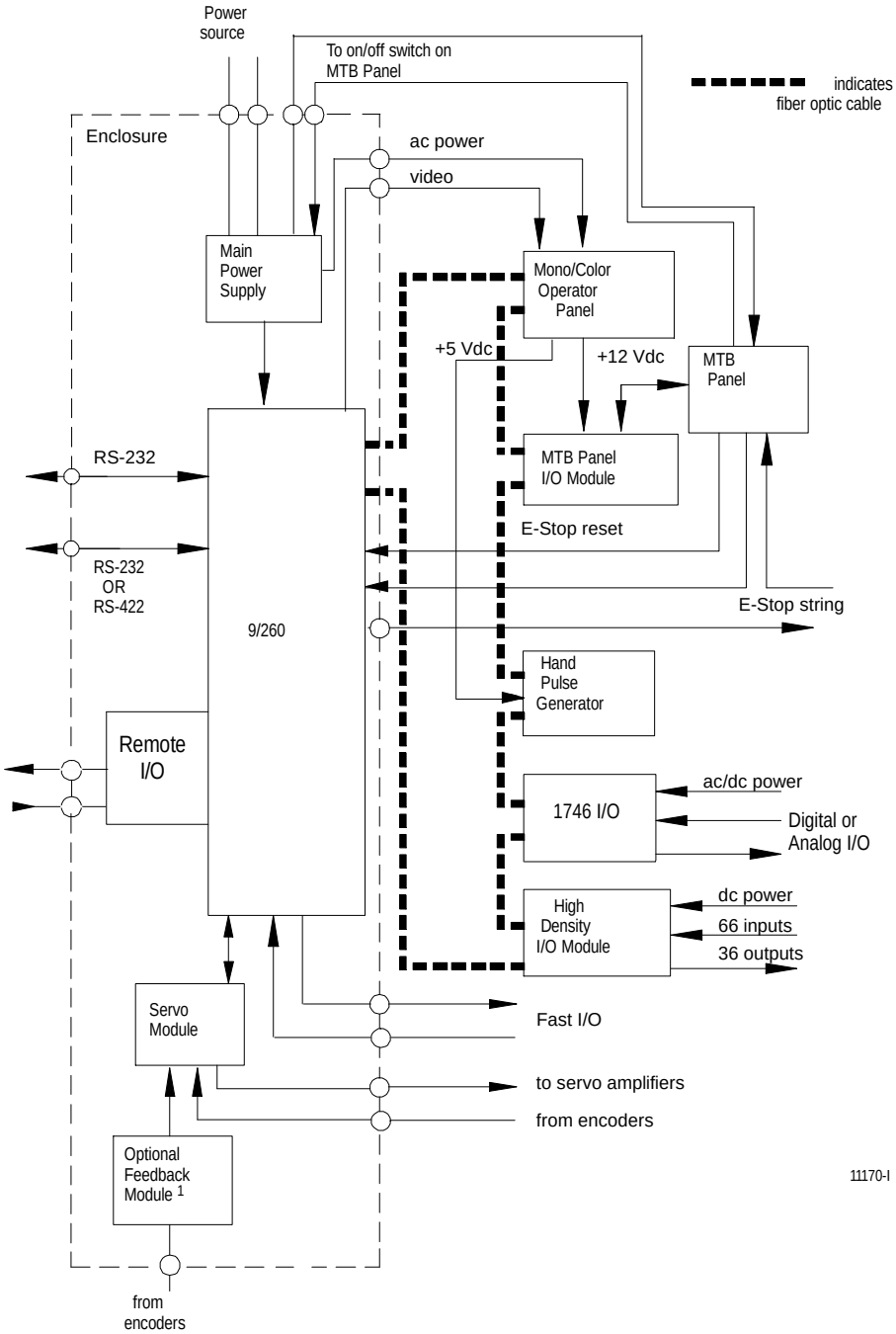
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Figure 1B.1
Typical System Configuration for 9/230



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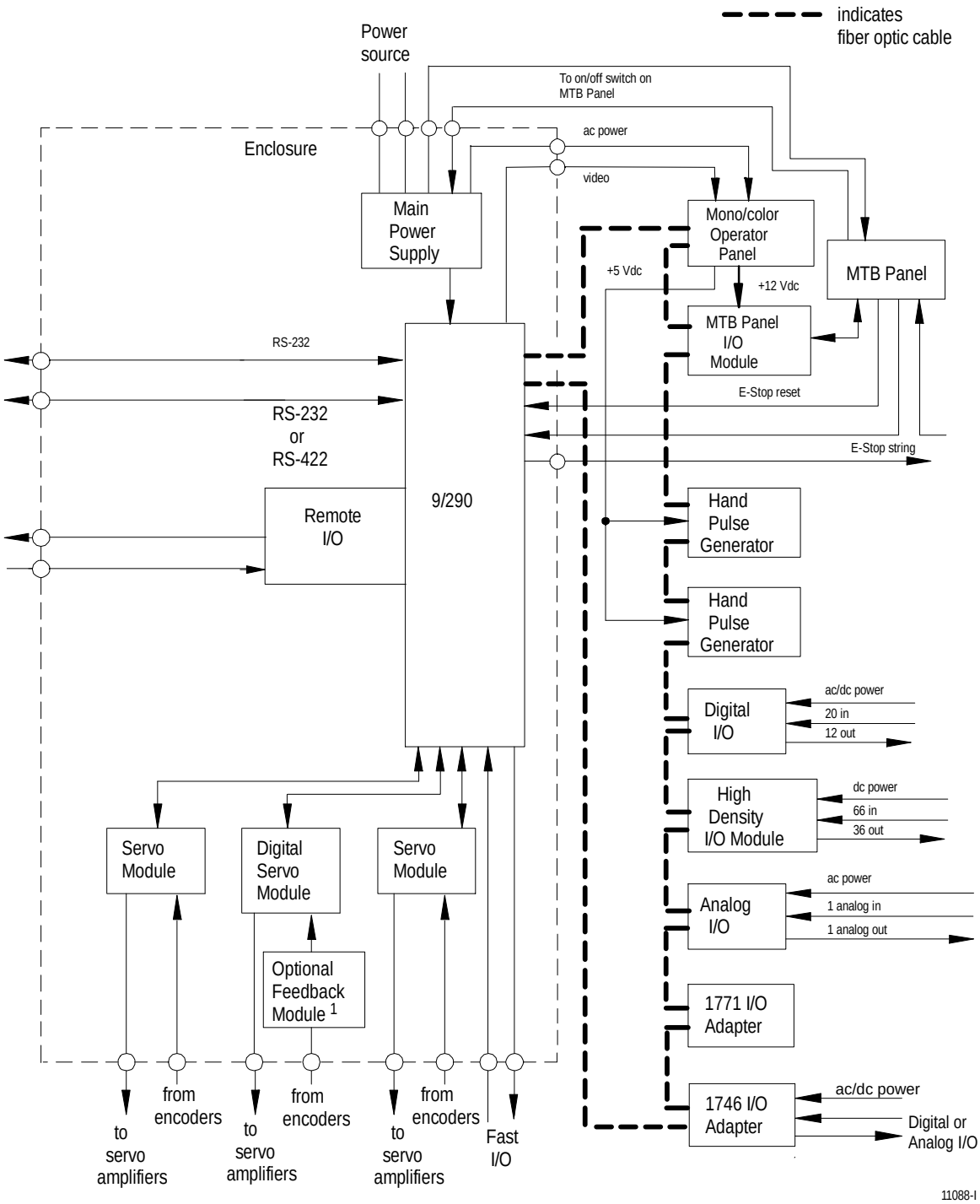
Figure 1B.2
Typical System Configuration for the 9/260



[1] The optional feedback module is compatible only with digital servo modules. It cannot be used with analog modules.

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Figure 1B.3
Typical System Configurationfor the 9/290



[1] The optional feedback module is compatible only with digital servo modules. It cannot be used with analog modules.

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Table 1B.A lists the component options used to configure the control.

Table 1B.A
Component Options

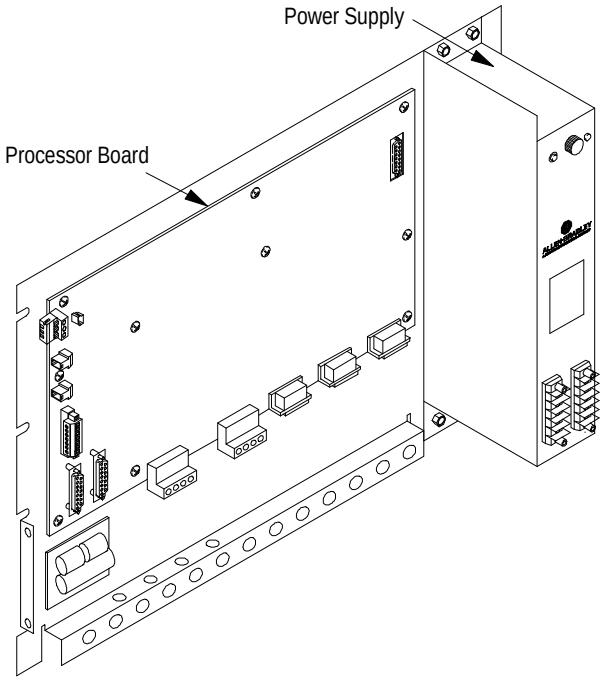
Classification	Module Name	Quantity	Notes
Basic Modules	Processor	1	**9/230 only**
	CPU Module and Motherboard	1	9/260 and 9/290 only
	Main Power Supply	1	
	Digital Servo	maximum 3 servo modules per system;	**not used on the 9/230 and 9/440**
	Analog Servo	(any combination of analog and/or digital servo modules)	**not used on the 9/230 and 9/440**
I/O Ring Input/ Output Modules	Digital I/O	Refer to page 10A-1	20 inputs, 12 outputs
	High Density I/O		66 inputs, 36 outputs
	MTB Panel I/O		44 inputs, 18 outputs
	Analog I/O		1 input, 1 output
	Hand Pulse Generator		Max. 3
	1746 I/O Ring Adapter		A-B 8500-1746I module
	1771 I/O Ring Adapter		A-B 8500-XIOC module
I/O Ring Operator/MTB Panels	Monochrome Operator Panel	Refer to page 9A-1	
	Color Operator Panel		
	Portable Operator Panel		Requires Portable Operator Panel Interface Assembly
	Rotary or Push-Button MTB Panel		44 inputs, 18 outputs
	Monochrome Pendant Option		
	Color Pendant Option		
Expansion Modules	Optional Feedback	3 max.	9/260 and 9/290 Digital only
	Data Highway Communication	Refer to 9/Series Data Highway Plus Communication Module User Manual, publication 8520-5.1.6.	Not used on the 9/230
	MMS/Ethernet Communication	Refer to 9/Series MMS/Ethernet Communication Module User Manual, publication 8520-5.1.5.	Not used on the 9/230

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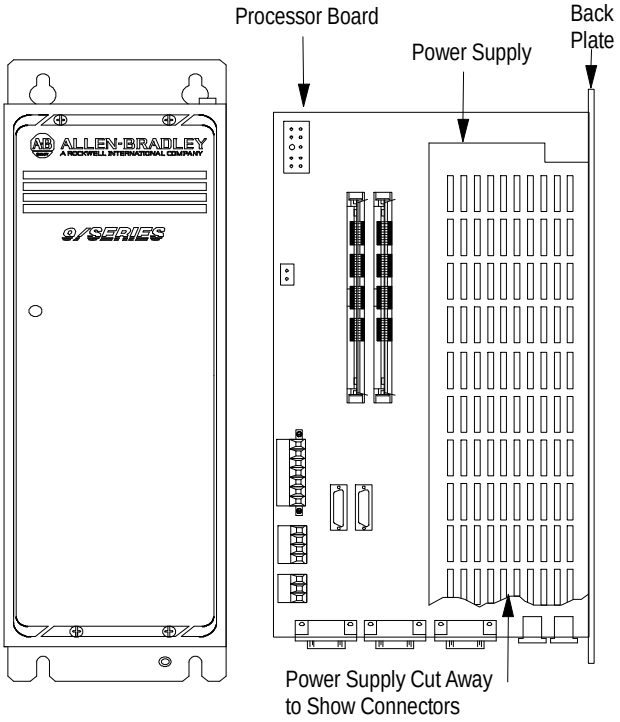
1B.2
9/230 Component Enclosure

The enclosures of the 9/230, shown in Figure 1B.4, supports the system and the power supply. For dimensions refer to page 2B-1. For specific information about the enclosure, refer to page 3A-1.

Figure 1B.4
9/230 Component Enclosures



9/230 Analog



9/230 Digital

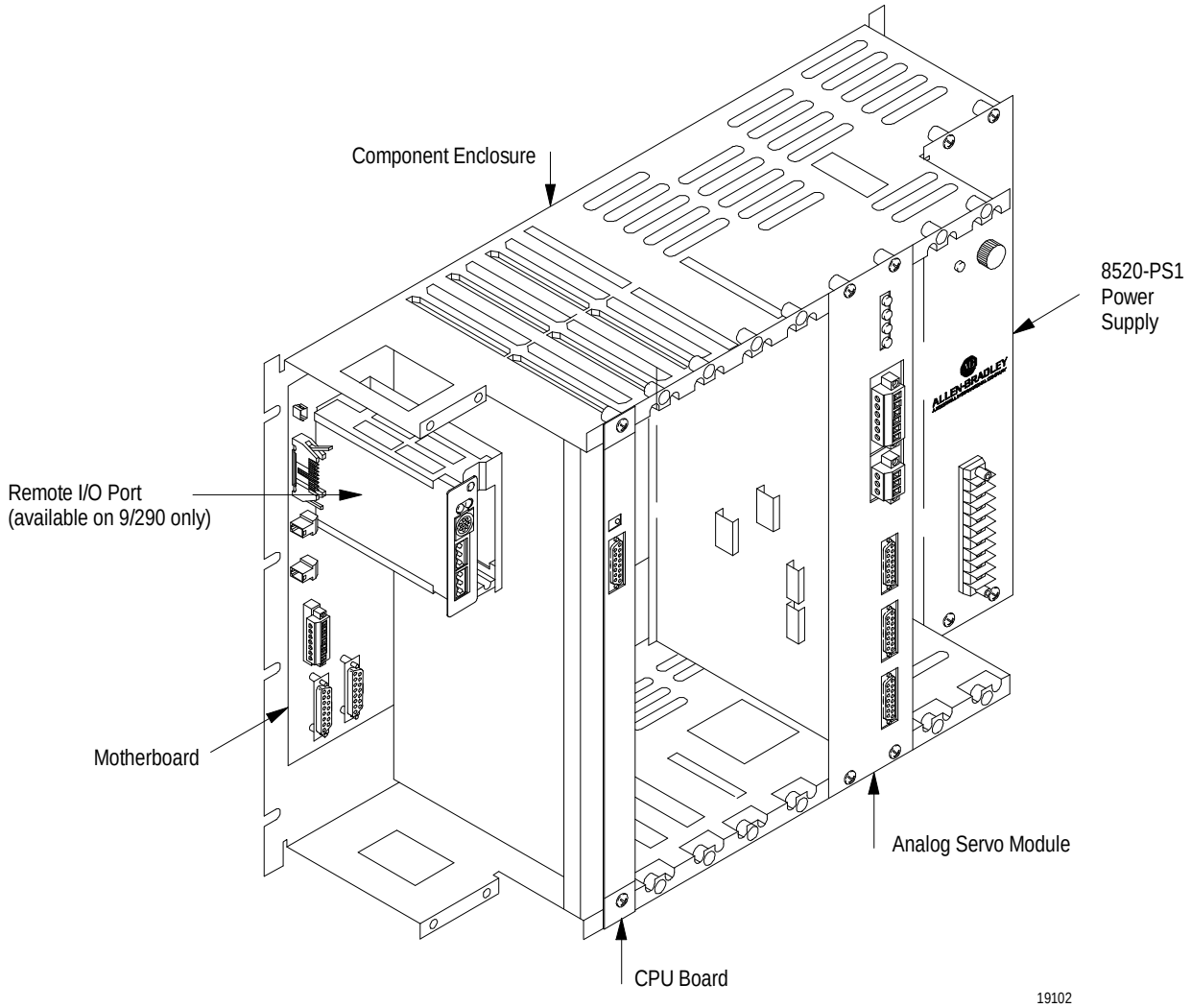
The 9/230 analog control pictured above can also be purchased as a single axis control. Pictured here is the 9/230 three axis control. Refer to page 3A-1 for more details. The single axis version is identical to the three axis version with the exception of the single axis version having only one closed loop axis connector. The single axis version is also always equipped with a remote I/O port which can be purchased as an option on the 3 axis system.

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1B.3
9/260 and 9/290 Component Enclosure

The 9/260 and 9/290 use the same component enclosure. The enclosure, shown in Figure 1B.5, supports the system and CPU boards, the servo modules, and the power supply. For dimensions refer to page 2B-1. For information about the motherboard, CPU board and power supply (PS1), refer to page 4A-1.

Figure 1B.5
9/260-9/290 Component Enclosure



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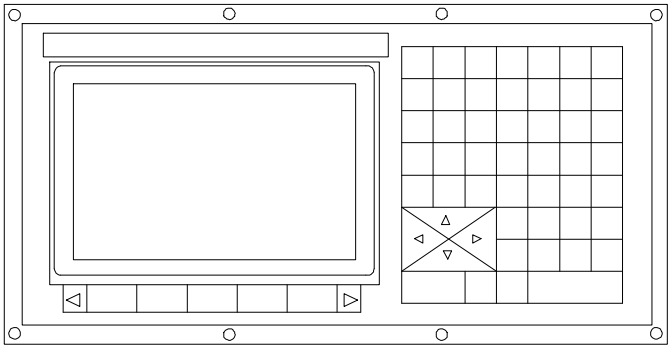
1B.4 Operator Interface

The Operator Interface consists of the Operator Panel, the MTB Panel, and the HPG. These components provide the operator with a direct interface to the control. For dimensions refer to page 2B-1. For specific information on these components refer to page 9A-1.

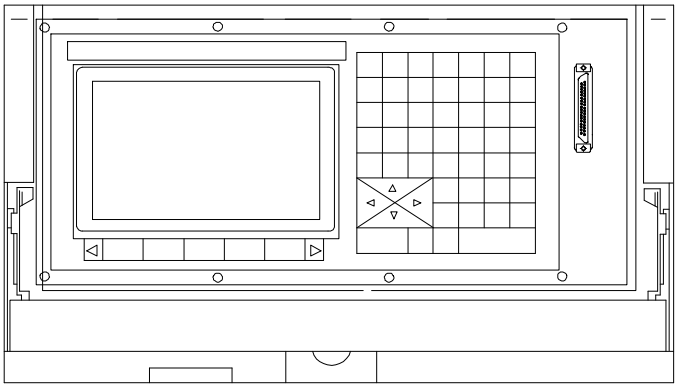
1B.5 Operator Interface Components

The Operator Interface components are shown in Figure 1B.6 through Figure 1B.11. For dimensions refer to page 2B-1. For specific information on these components, refer to page 9A-1.

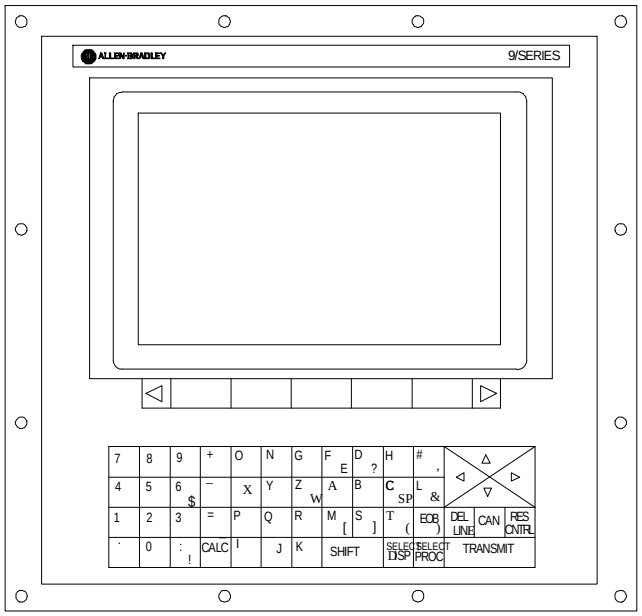
Figure 1B.6
Operator Panels



Monochrome Operator Panel



Portable Operator Panel



Color Operator Panel
(CRT and Flat Panel)

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Figure 1B.7
Portable Operator Panel Interface Assembly

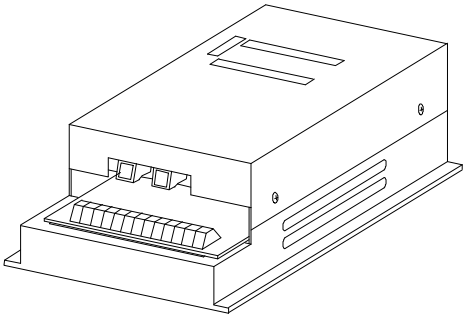
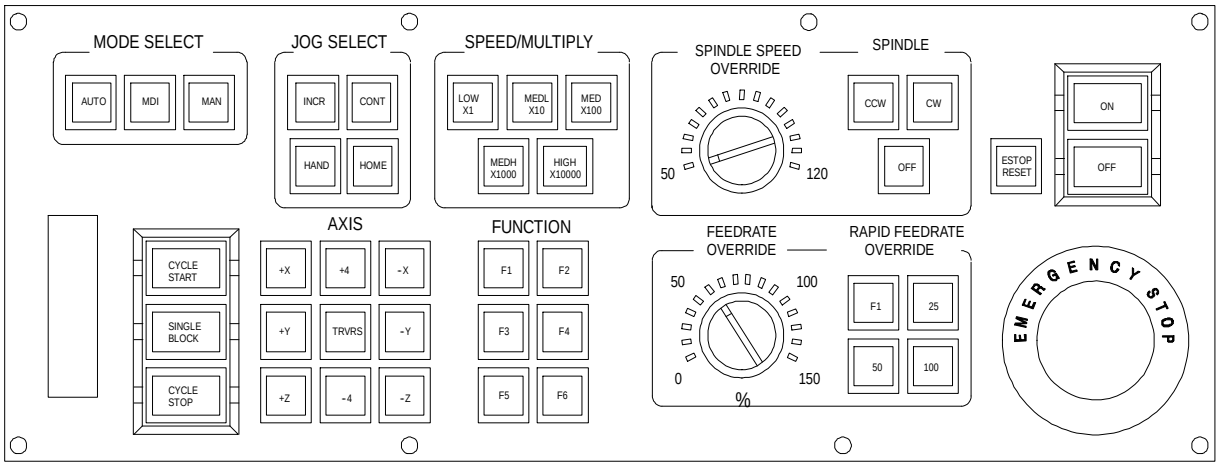
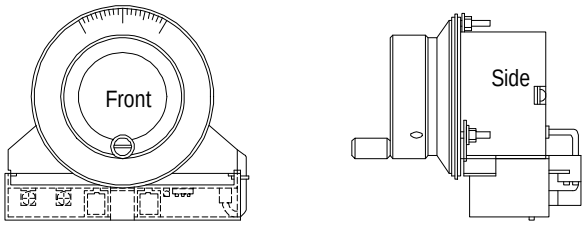


Figure 1B.8
Push-Button MTB Panel



19930

Figure 1B.9
Hand Pulse Generator



11174-I

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Figure 1B.10
Monochrome Pendant Option

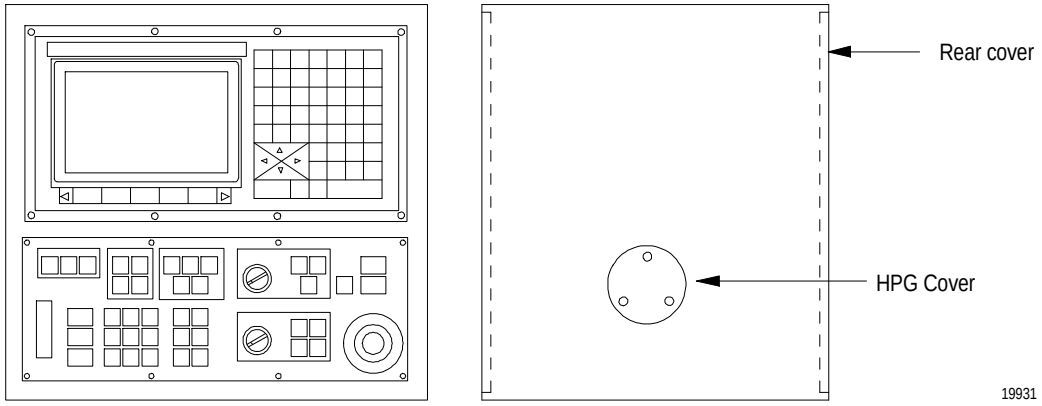
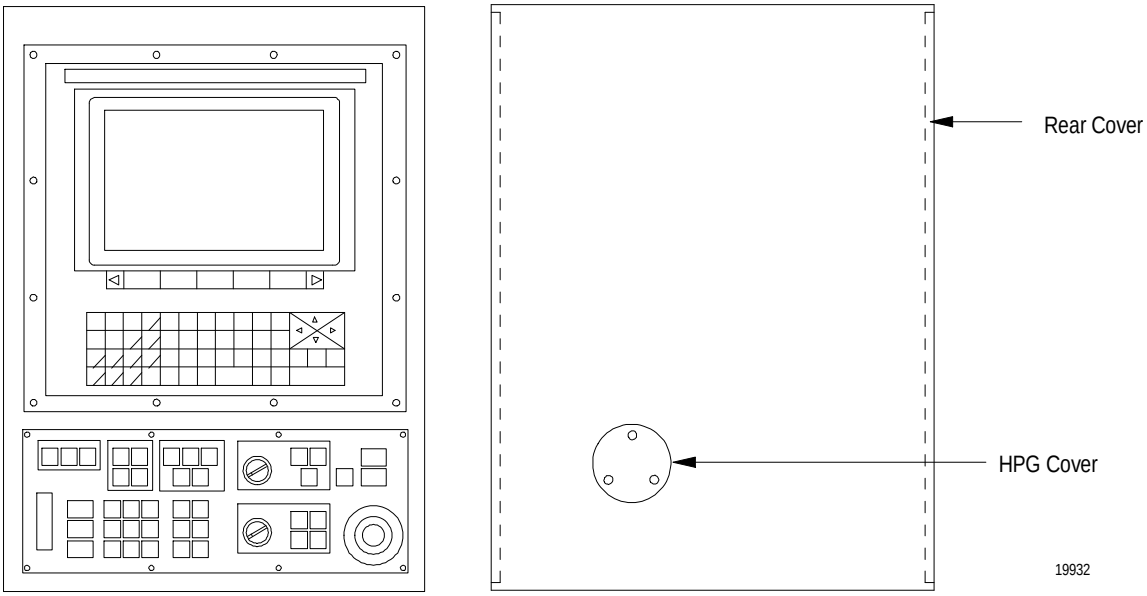


Figure 1B.11
Color Pendant Option

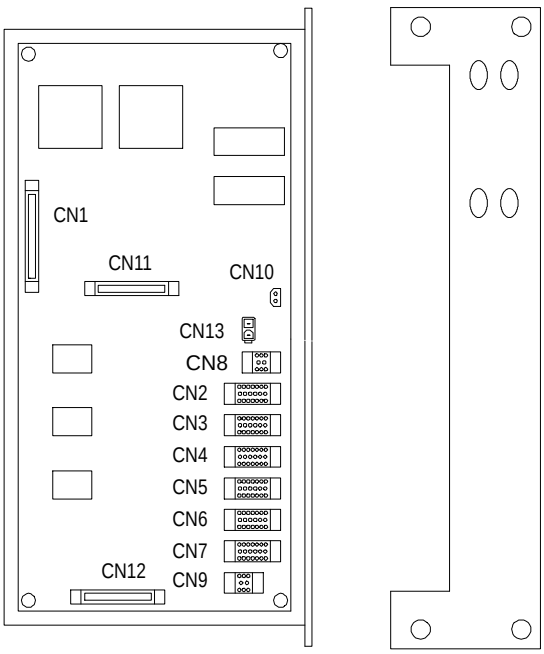


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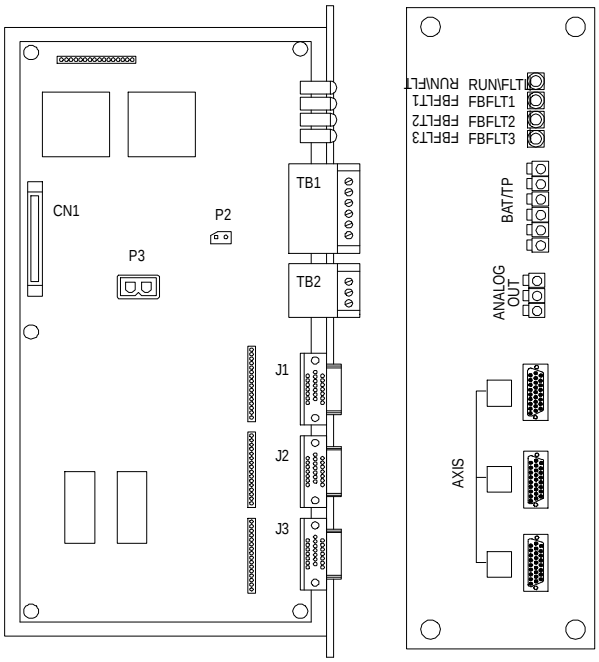
1B.6
Drives Interface

Figure 1B.12 shows the 3-axis Servo Module and Figure 1B.13 shows the 4-axis Servo Module. The 9/230 has a servo module built into it and does not use these modules. For specific information the 3-axis Servo Module, refer to page 4B-1. For specific information on the 4-axis Servo Module, refer to page 4C-1.

Figure 1B.12
3-axis Servo Module



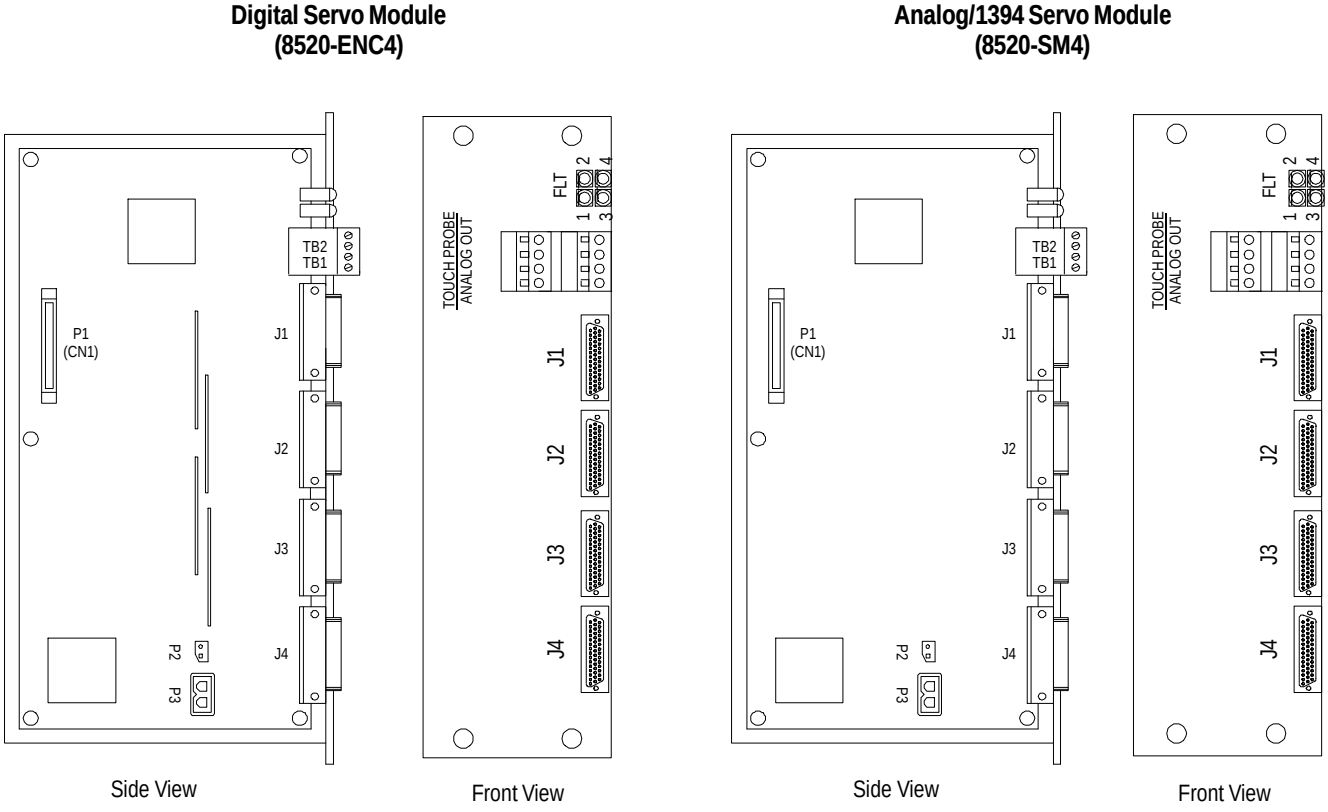
Digital Servo Module



Analog Servo Module

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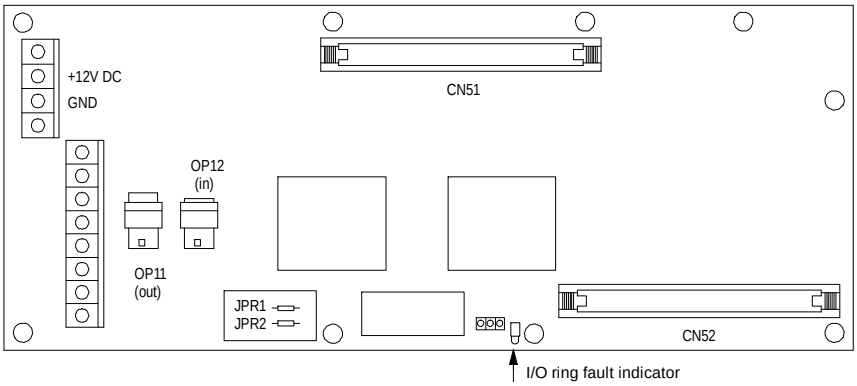
Figure 1B.13
4-axis Servo Module



1B.7 I/O Interface

The I/O Interface modules are shown below. For dimensions refer to page 2B-1. For specific information on these modules refer to page 10A-1.

Figure 1B.14
MTB Panel I/O Module



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Figure 1B.15
Digital and Analog I/O

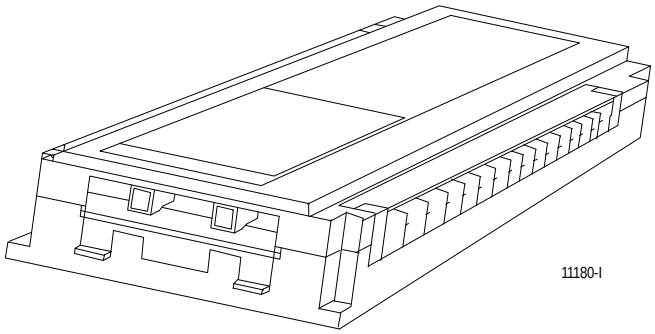
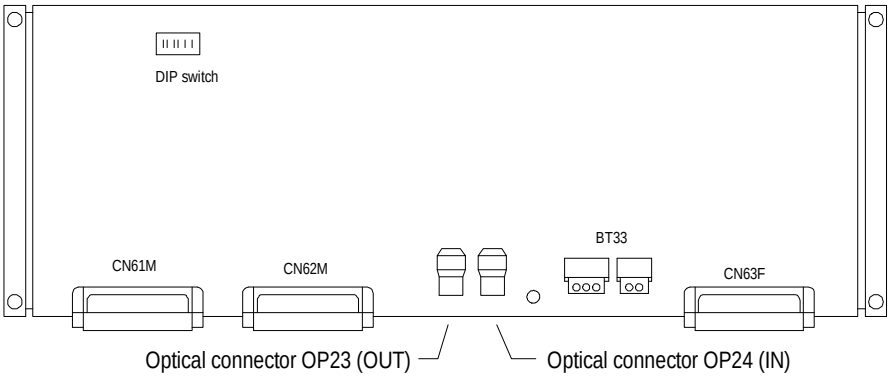
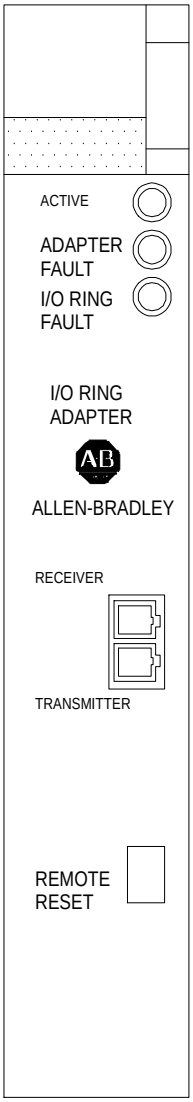


Figure 1B.16
High Density I/O - 8500-HDM1



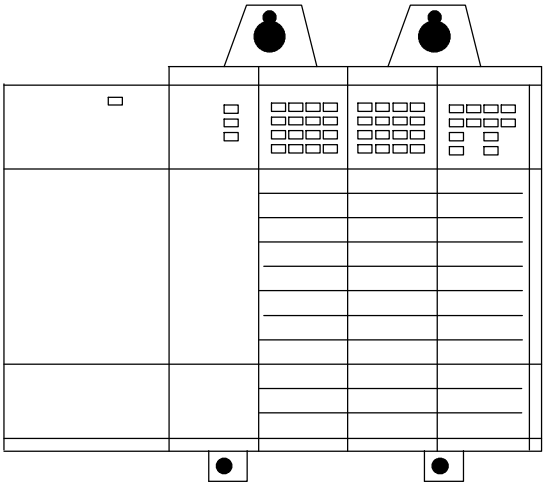
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Figure 1B.17
1771 I/O Ring Adapter - 8500-XIOC



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Figure 1B.18
1746 I/O Ring Adapter - 8500-1746I



1B.8 Communication Interface

Page 8-1 covers the peripherals that can be interfaced to the control. These peripherals are used to input or output data to the control. This data can be in the form of part programs, AMP, PAL and others. The data is input to the control through Port A or Port B, for Series 9/260 and 9/290, or only Port B for 9/230.

1B.9 Offline Development System (ODS)

The Offline Development System (ODS) is a menu driven software package that resides on your personal computer. You can use ODS to:

- create and edit part program files
- download AMP and PAL files to the control
- create, edit and document AMP and PAL files
- upload, copy, restore, rename, or delete files

1B.10 Adjustable Machine Parameters (AMP)

The system installer uses AMP and PAL to integrate the control to the machine. Through AMP, the system installer can:

- define a number of basic parameters such as system resolution, axis types, that affect the overall operation of the control.
- define a number of individual axis parameters such as soft travel limits, position tolerances, feedback constants.

Refer to the 9/Series 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

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1B.11 Programmable Application Logic (PAL)

The system installer uses AMP and PAL to integrate the control to the machine. The system installer uses PAL to form a ladder logic program that is continuously executed by the control to control devices such as tool turrets, limit switches, coolant systems, and lamps.

PAL also controls the I/O process between the control and the machine tool. Through PAL, system variables, which are assigned to each input or output terminal of an I/O device, are monitored. PAL uses these variables to provide system control.

Refer to the 9/Series CNC 9/230, 9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

1B.12 Fiber Optic I/O Ring

9/Series I/O devices are linked together by a fiber optic I/O ring. This I/O ring provides serial communication with the control.

Inputs to the control are first converted to fiber optic signals at the I/O device. These signals are transmitted through the fiber optic I/O ring to the control. There they are converted back to electrical signals that can be monitored and acted on by the PAL program.

Outputs from the control originate from the continuously executing PAL program which is stored in the control's memory. They are converted to fiber optic signals at the control and transmitted through the fiber optic I/O ring to the appropriate I/O device. There they are converted back to electrical signals which cause the desired action.

END OF SECTION

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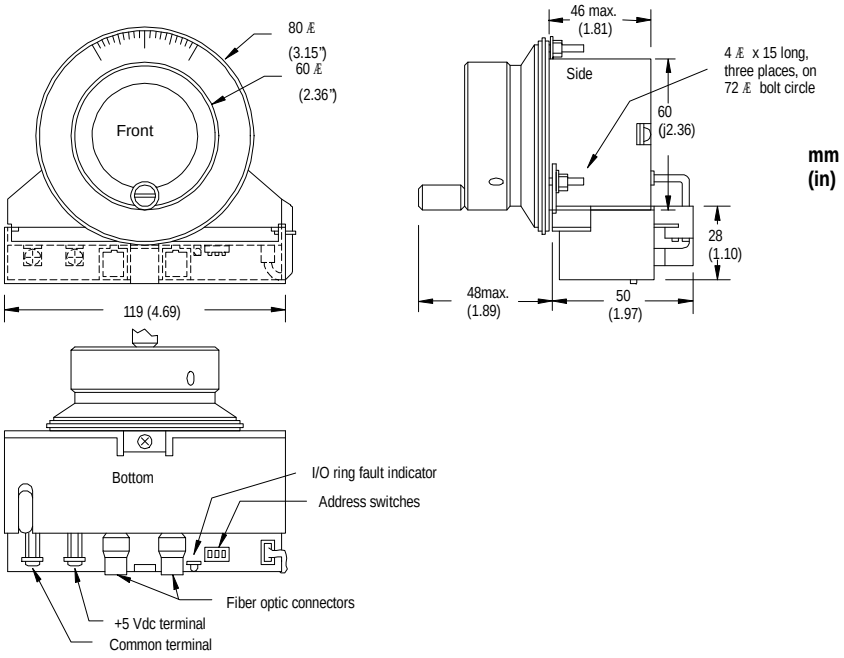
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9/Series Hardware
TAB 2

System Layout and Dimensions



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Section 2A

Planning Your System Layout

2A.0 Section Overview

When planning the system layout of your control, take into consideration the restrictions and specifications covered in this section.

Mechanical system design specifications necessary for cabinet design and construction are listed in the following sections:

Table 2A.A
To Plan your System Layout

For Information on:	See Page
Determining Cable Lengths	2A-1
Meeting Environmental Conditions	2A-1
Designing the Cabinet for Its Environment	2A-3
Reducing Noise	2A-8
Installing the Components	2A-8

2A.1 Determining Cable Lengths

When you install the components, refer to page 7A-1 for electrical cable lengths, and page 7B-1 for fiber optic cable lengths.



ATTENTION: The system installer should consult local and state regulations for additional installation requirements.

2A.2 Meeting Environmental Conditions

You must install the components inside a cabinet that satisfies the environmental conditions listed in Table 2A.A. All components must meet these conditions for you to successfully operate the control.

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Table 2A.A
Environmental Conditions

Condition	Range or Limit
Operating temperature	CPU Board and Servo Amplifiers: 0 ℃ to 55 ℃ (32 ℉ to 131 ℉) except 9/440 0 ℃ to 50 ℃ (32 ℉ to 122 ℉) 9/440 only
	Operator Panels (standard and removable): 0 ℃ to 55 ℃ (32 ℉ to 131 ℉) 0 ℃ to 45 ℃ (32 ℉ to 113 ℉) external ambient Operator Panels (flat): 0 ℃ to 50 ℃ (32 ℉ to 122 ℉) 0 ℃ to 40 ℃ (32 ℉ to 104 ℉) external ambient Operator Panels (pendant): 0 ℃ to 55 ℃ (32 ℉ to 131 ℉) 0 ℃ to 40 ℃ (32 ℉ to 104 ℉) external ambient
	8500 Digital Servo Motors: 0 ℃ to 40 ℃ (32 ℉ to 104 ℉)
Storage or Transport Temperature	CPU Board, Servo Motors, and Servo Amplifiers -30 ℃ to 70 ℃ (-40 ℉ to 158 ℉)
	Operator Panel: -30 ℃ to 65 ℃ (-40 ℉ to 131 ℉)
Maximum Temperature Change Rate	1.1 ℃/min. (1.80 ℉/min.)
Altitude	Above temperature based on operation at 1000m (3500 ft)
Atmosphere	Components placed in a protected enclosure with filtered air. Avoid placing components in areas where there is high concentration of dust, cutting oil, or organic solvents.
Relative Humidity	CPU Board and Operator Panel 5-95% (no condensation)
	8500 Digital Servo Motors 20-80% (no condensation)
Vibrations (operating)	Max. 1.0 G (operator panel) Max. 2.5 G (all 9/Series controls except 9/440) Max. 1.0 G (9/440 CNC) Max. 2.5 G (E-150 Series I/O)



ATTENTION: Environmental conditions exceeding those shown above may cause component failure and/or unpredictable control operation.

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2A.3 Designing the Cabinet for your System's Environment

When designing the cabinet, consider the environment in which the control operate. The degree of cabinet sealing and whether or not external air must be filtered before entering the cabinet will depend on the expected environmental conditions.

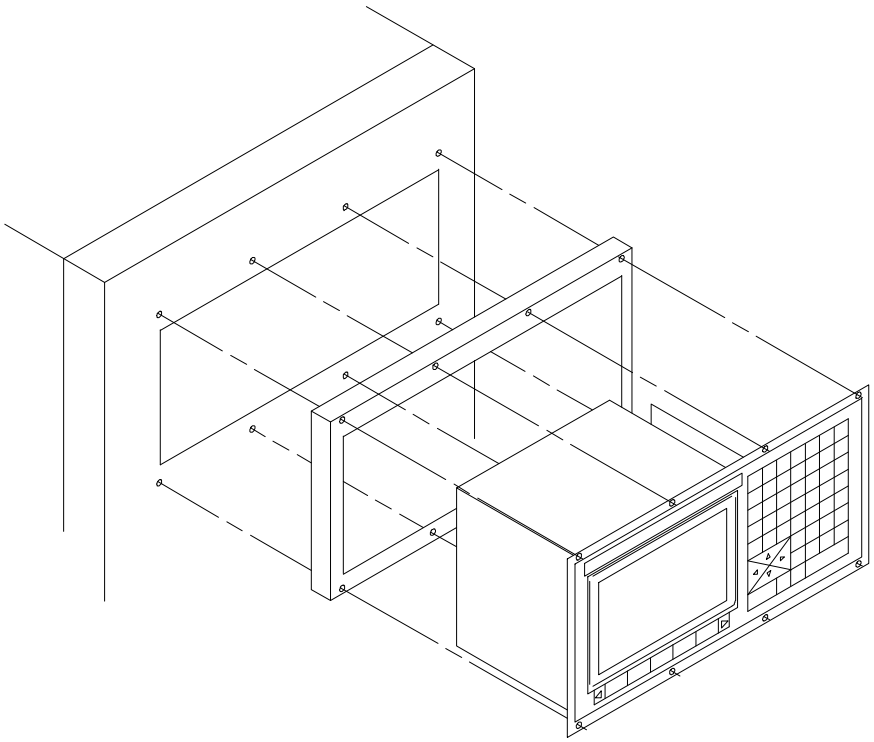
Industrial environments frequently require the cabinet be airtight. If it is not airtight, outside air may bring contaminants into the cabinet. Dust will accumulate in high voltage areas on the operator panel. Coolant mist adhering to this dust may cause an insulation failure.

ATTENTION: If the environmental conditions require an airtight cabinet, the cooling system cannot bring outside air into the cabinet. In this case, an air conditioner or heat exchanger may be required.

To make the cabinet airtight, place gaskets between the component mounting faces, service ports, doors, covers, and the cabinet.

Figure 2A.1 is an installation example that shows gasket placement between the operator panel and the cabinet.

Figure 2A.1
Gasket Placement Example



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2A.4 Maintaining Cabinet Temperature

The components of the control, like all electronic devices, dissipate power in the form of heat. The components and all modules in the control cabinet must be continuously cooled to prevent overheating.



ATTENTION: If the internal temperature of the control cabinet exceeds 55 ℃ (131 ℉), irreparable damage may result to the control and its components within the enclosure and injury to personnel.

Since solid state electronic equipment is more reliable at lower operating temperatures, we recommend that the internal control cabinet temperature be kept as cool as possible, without going below 0 ℃ (32 ℉).

Using Fans

Install fans inside the cabinet to keep the modules cool by circulating air inside the enclosure as shown in Figure 2A.2. Do not blow the air directly on the modules as this may cause accumulation of foreign matter on or inside the module.

As fan driven air circulates inside the control enclosure, it absorbs some of the heat dissipated by the control components. If this air circulation does not guarantee sufficient thermal exchange through the cabinet walls, then the air must be cooled before it comes in contact with the components again.

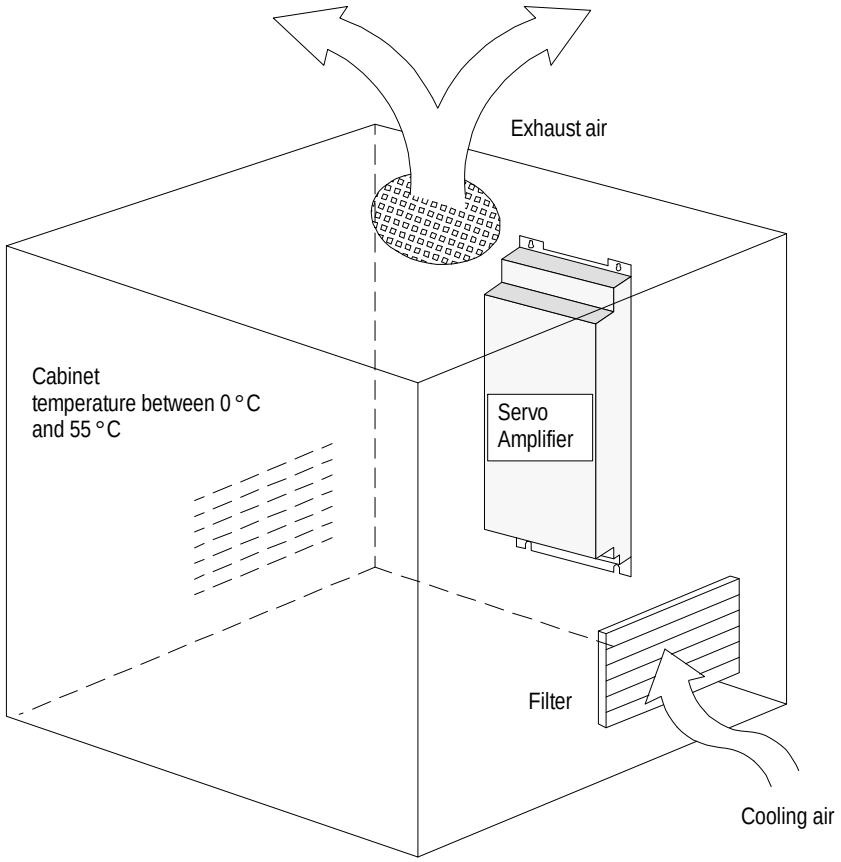
Using Air Conditioners or Heat Exchangers

The approximate change in internal air temperature due to a heat exchanger or air conditioner is a function of dissipated power, vertical surface area, and air conditioner or heat exchanger rating. In calculating the change in internal air temperature, be sure to use only the exposed vertical surface areas of the enclosure; do not include the top or bottom of the enclosure in the calculation.

Important: To help assure adequate internal air flow, do not mount any obstructions within 0.6 meters of the intake and exhaust ports of fans, heat exchangers or air conditioners.

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Figure 2A.2
Filtered Air Flow In A Fan Cooled Cabinet



Regardless of air conditioner or heat exchanger rating, be sure its blowers and all other fans provide sufficient internal air flow.

Calculating the Temperature within the Cabinet

If you have a cabinet that contains an Operator Panel, allow for an increase in ambient temperature of up to +5 ℃ (10 ℉). If you have a cabinet that contains modules other than the Operator Panel, allow for an increase of up to +10 ℃ (20 ℉).

Temperature information needed when designing a cabinet is listed with the specifications for each module.

Design the cabinet so that temperature rise inside the cabinet, caused by heat generation of the modules and other units mounted inside, will not exceed allowable maximums.

Table 2A.B shows the heat generation wattages of each component or module.

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Table 2A.B
Component and Module Heat Generation Wattages

Component or Module	Heat Generation Wattage (W)
9/230 and Main Power Supply	130
9/260 or 9/290 **and** Main Power Supply	225
9/440 CNC/1394 Drive 5kw System Module (@100%)	80
9/440 CNC/1394 Drive 10kw System Module (@100%)	98
9/440 Axis Modules/1394 Drive (each module @100%)	AM03 AM04 AM07 AM75 48 63 93 346*
9/440 CNC Power On/Off Control Module	5
Portable Operator Panel Interface Assembly	72
Monochrome Operator Panel	125
Color TFT Operator Panel (flat panel)	55
Color CRT Operator Panel	175
MTB Panel	15
HPG	1.2
3-axis Digital Servo Module	13.5
3-axis Analog Servo Module	14
4-axis Digital Servo Module (8520-ENC4)	15
4-axis Analog/1394 Servo Module (8520-SM4)	14
1746I Ring Adaptor (module only)	0.9
1771-HTE Termination Panel	0
MTB Panel I/O Module	5
Remote I/O Module (8520-RIOM)	4.2
* 18 Watts in cabinet, 328 Watts out through cabinet heat sink	

The temperature rise inside a metallic cabinet incorporating only an internal convection cooling fan can be roughly calculated with the following formula:

$$T = W/6S$$

- T = Temperature rise in cabinet (℃)
- W = Heat generation (Watts) by units and modules
- S = Heat radiation surface area (sq. meter) of cabinet

(total cabinet surface area minus any area in contact with the floor or building wall)

The above equation assumes a closed cabinet with heat dissipated only through cabinet radiation.

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Example of Calculating Cabinet Temperature

A design example of a cabinet is given below assuming a component-type frame incorporating the following:

Main Power Supply (PS1)	225 watts @ 50^0 C
Main Power Supply (PS2A)	130 watts @ 50^0 C
CPU Board	33.5 watts
3-axis Digital Servo module	13.5 watts

The total heat generation (W) for this example would be 47W.

1. Determine a minimum T value for the equation in the previous section:

a. Estimate the maximum air temperature at the location where the cabinet will be installed.

b. Subtract this estimate from the maximum internal cabinet temperature for your application (if you use 55 ℃, there is no margin for error). The difference is the allowable temperature rise in the cabinet (T).

For example, assume a maximum air temperature of 35 ℃ and a desired maximum internal cabinet temperature of 45 ℃, The value of T would be 45 - 35 = 10

2. Using the W and T values just derived, calculate the minimum heat radiation surface area, S.

```
T = W/6S
S = W/6T
  = 47/(6 x 10)
  = 0.783 sq. meter (8.4 sq. feet)
```

This result indicates that a cabinet with a minimum of 0.783 m^2 (8.4 ft^2) of heat radiation surface is required.

Important: Any cabinet surface in contact with the floor or building wall is not considered a heat radiation surface in this calculation.

If the resulting cabinet size is prohibitively large, or if the T value calculated was 10 or more, then the use of a heat exchanger or air conditioner must be considered. Such designs require more detailed analysis, beyond that considered within scope of this manual.

Important: The temperature rise value used in this calculation is a constant. Actual temperature rise will vary depending on the amount of air flow inside the cabinet.

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2A.5 Reducing Noise

For information on noise prevention measures refer to page 7C-1. We mention them here because these factors should be taken into consideration during the beginning stages of cabinet design. These noise prevention measures are covered in that section:

- Signal Grounding
- Mechanical Shielding
- Shielded Cables and Twisted-pair Cables
- Separation of Cable Routes
- Noise Suppressors

2A.6 Installing the Components

Install the components in the cabinet with at least 100 mm (4 inches) of clearance between the cabinet side wall and each component to allow air flow inside the cabinet. Install the components in the cabinet with 50 mm (2 inches) of clearance between them.

The system installer should also consider any local regulations regarding component placement within a cabinet.

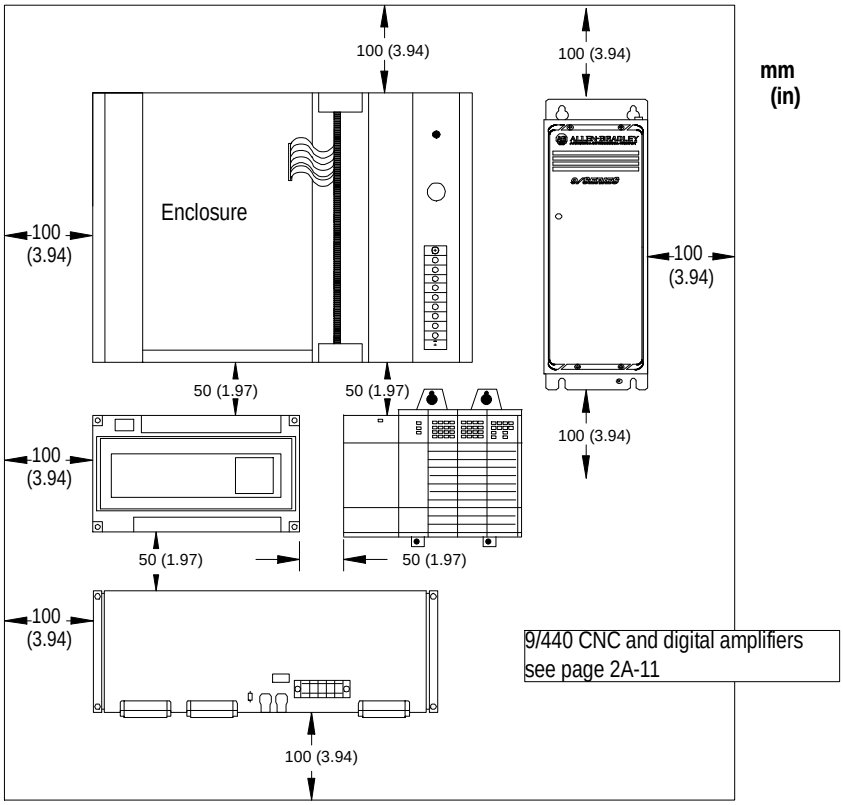


ATTENTION: Do not install modules above heat generating devices (transformers, resistors, etc.)

Figure 2A.3 shows the minimum component spacing.

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Figure 2A.3
Minimum Component Spacing to Allow Air Flow in the Cabinet



Follow the minimum component spacing requirements when designing the electrical system layout. You can reduce noise by placing the modules at least 50 mm apart. If this is not possible, install an electrically conductive metallic shield plate between the units. Place all devices at least 100 mm from the cabinet walls. For additional information on electrical system design requirements refer to 4D-1.

ATTENTION: Do not install the control close to equipment, such as an arc welder, power transformer, or large motor, that generates high level noise.

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Installing Servo Modules

Digital and analog servo modules include processors that make them very sensitive to electrical noise. These modules must be placed more than 100 mm (4 in) away from devices and cables to which any AC voltages or DC voltages greater than 50 Vdc are applied.

Installing Operator Panels

You must place the Operator Panel more than 300 mm (12 inches) away from devices (transformers, main AC, electromagnetic contactors, etc.) that generate magnetic fields to protect the CRT display from any possible adverse effects.

However, a strong magnetic field generated by multiple devices can have an adverse effect on the CRT display even if the operator panel is placed more than 300 mm away from these devices. If this occurs, shield the operator panel from the devices using an electromagnetic and electrostatic shield plate.

Installing Servo Amplifiers

If you are installing analog servo amplifiers, refer to documentation that came with your amplifiers for specific installation instructions.

If you are using digital servo amplifiers, place them vertically so that cooling air can flow upward and remove heat efficiently. Figure 2A.4 and Figure 2A.5 show the digital servo amplifier installation and spacing restrictions.

If you are installing digital or analog servo amplifiers in the same cabinet as the control chassis (excluding the 9/440), then separate the amplifiers and the control chassis with a grounded, metallic plate to shield the control from electrical noise. You can use a cabinet with a center divider, where the power transformers and servo amplifiers are installed on one side, and the control, operator panel, and I/O modules installed on the other side.

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Figure 2A.4
1394 and 9/440 CNC Servo Amplifier Spacing Restrictions

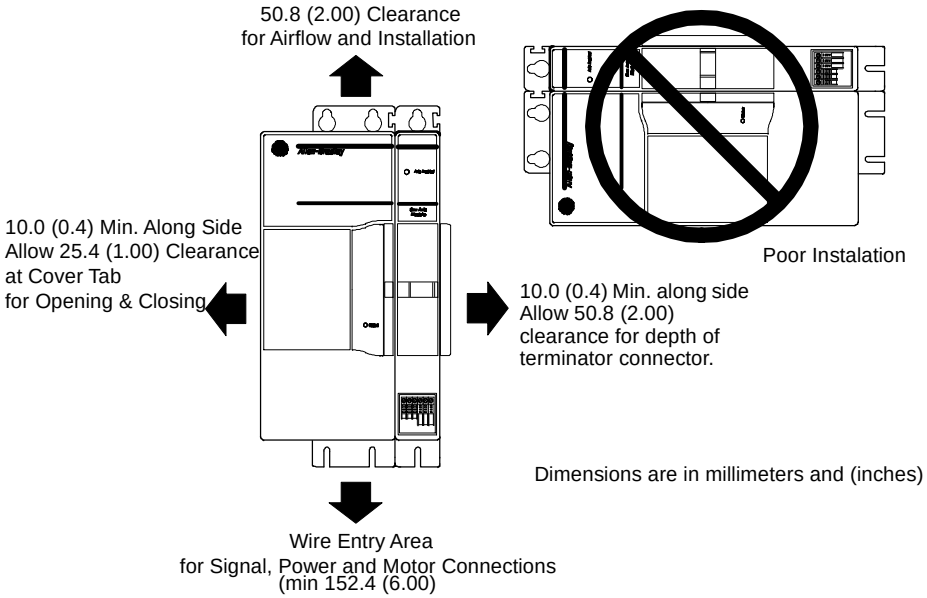
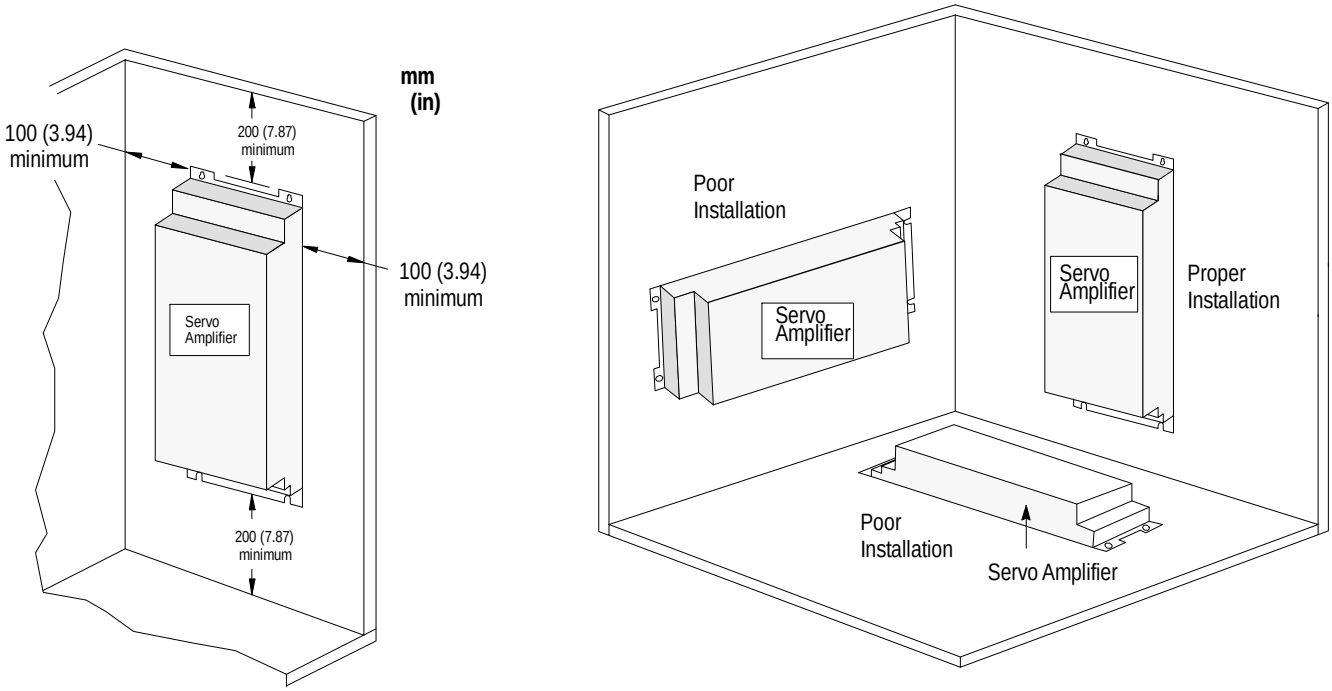


Figure 2A.5
8520 Digital Servo Amplifier Spacing Restrictions



END OF SECTION

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Section 2B

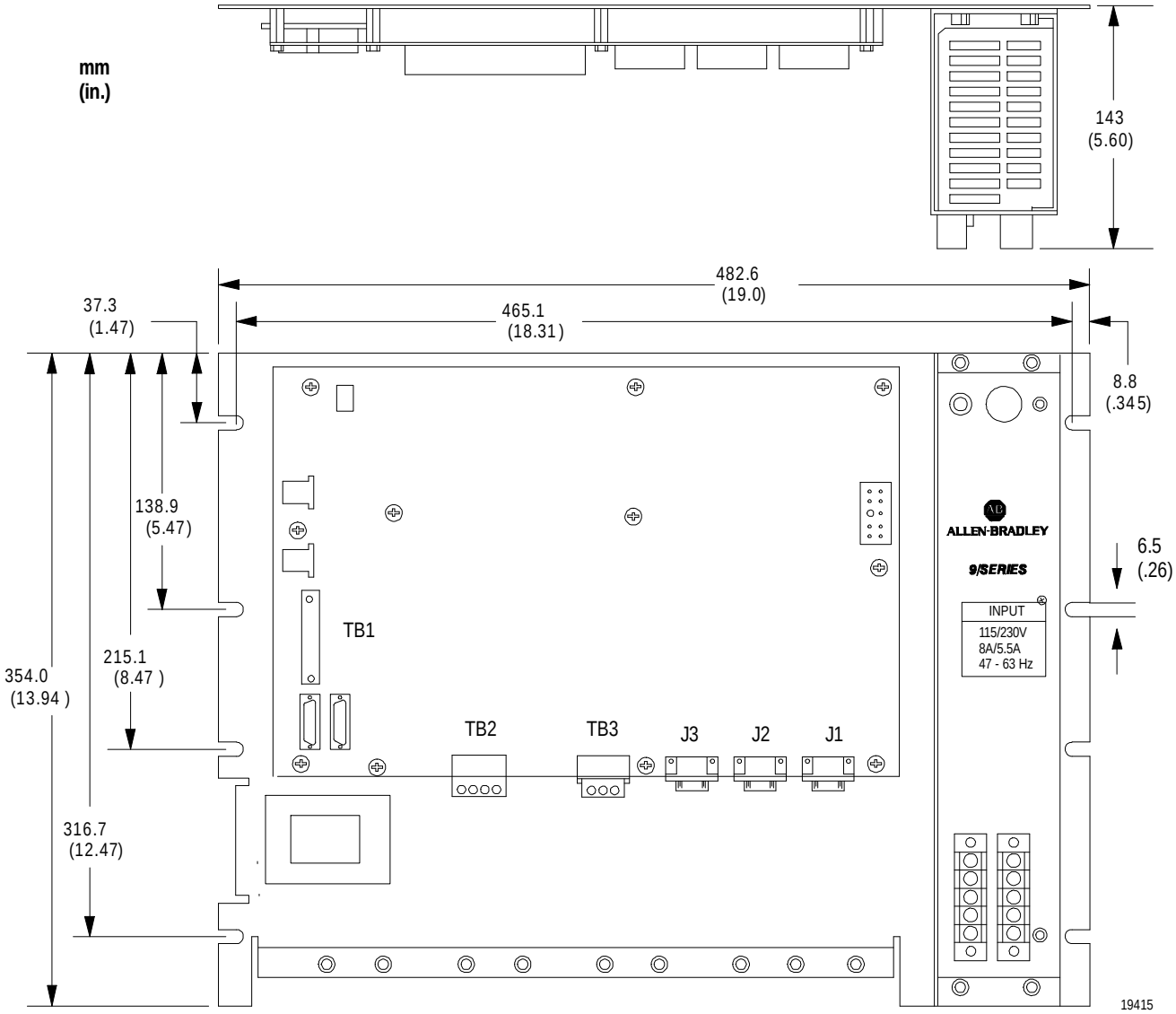
Mounting Dimensions

2B.0 Processor Dimensions

9/230 Component Enclosure

This section covers the dimensions and weight of the component for the 9/230. The dimensions outside of the brackets are given in millimeters and inside the brackets in inches. For additional information on this component refer to page 3A-1.

Figure 2B.1
9/230 Analog Component Enclosure Dimensions

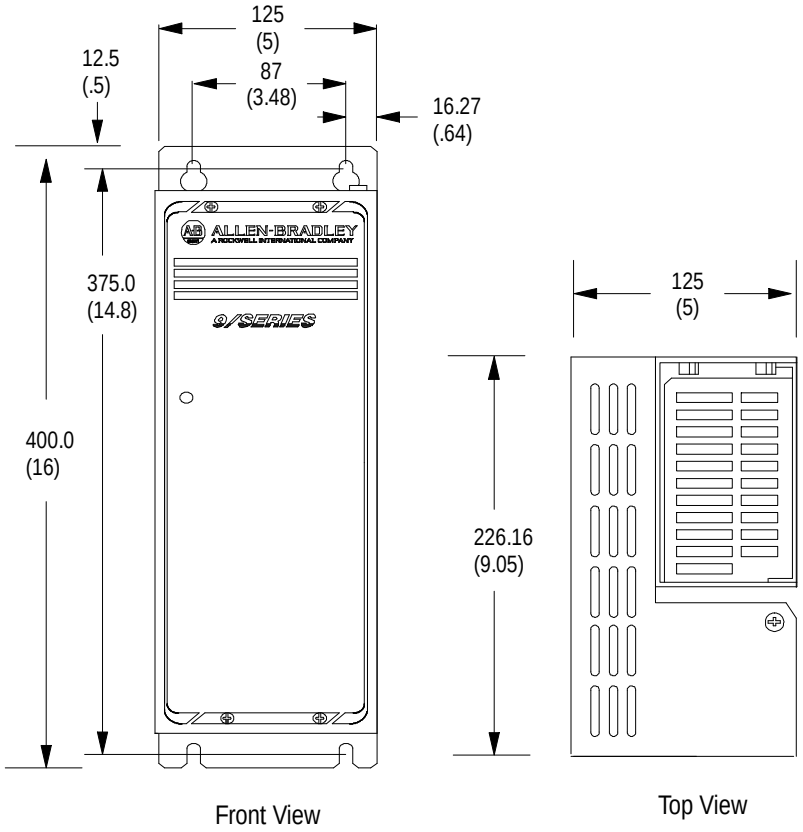


The 9/230 enclosure weighs 6.2 kg (13.7 lb).

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Figure 2B.2
9/230 Digital Component Enclosure Dimensions

mm
(in.)



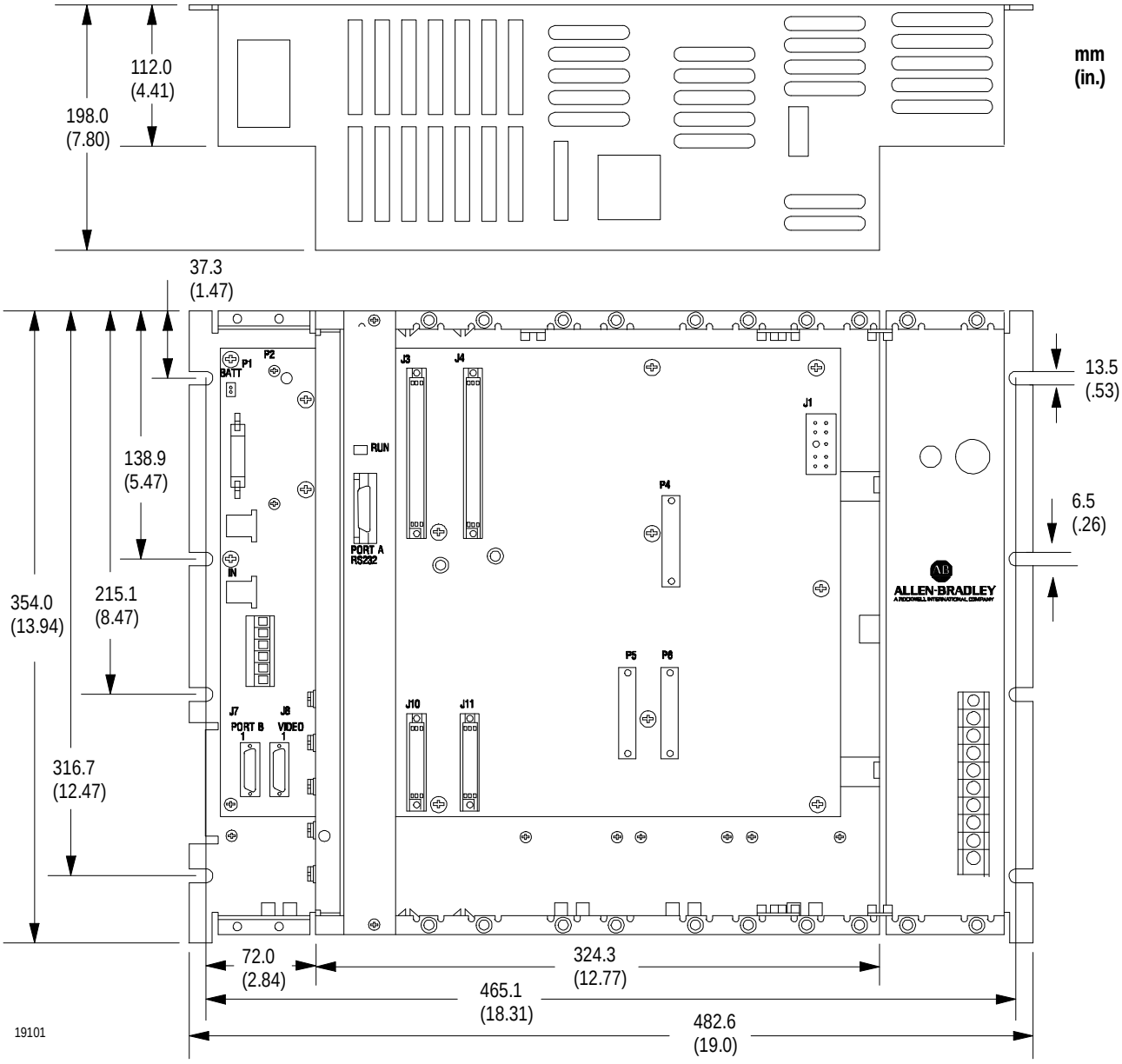
The 9/230 enclosure weighs 6.75 kg (15 lb).

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9/260 and 9/290 Component Enclosures

This section covers the dimensions and weight of the component for the 9/260 and the 9/290. The dimensions outside of the brackets are given in millimeters and inside the brackets in inches. For additional information on this component refer to page 4A-1.

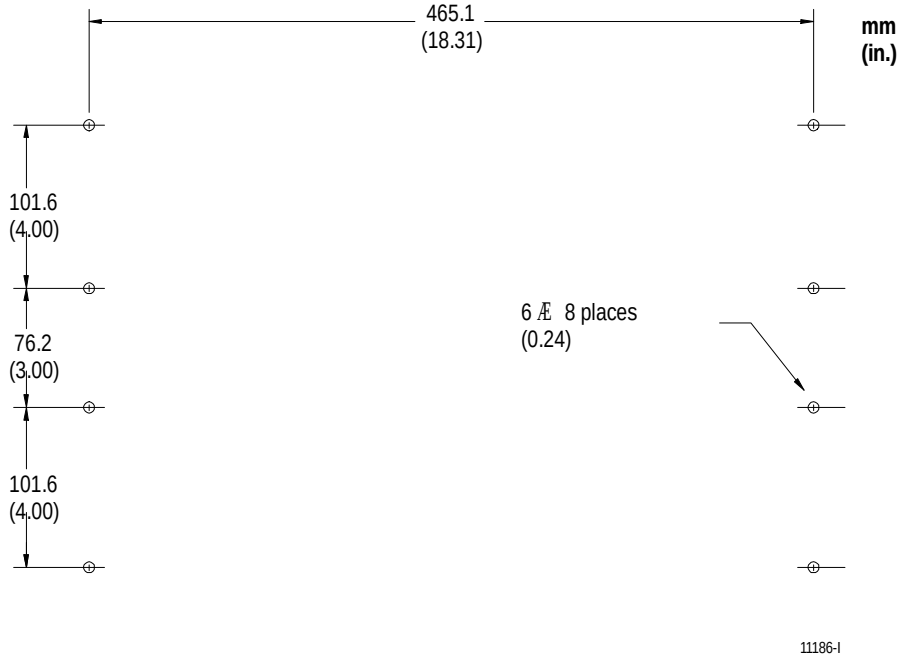
Figure 2B.3
9/260 and 9/290 Component Enclosure Dimensions



The 9/260 and 9/290 component enclosure weighs 9.25 kg (20.41 lb).

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Figure 2B.4
Blank Cut-Out Dimensions for the 9/260 or 9/290 Component Enclosure



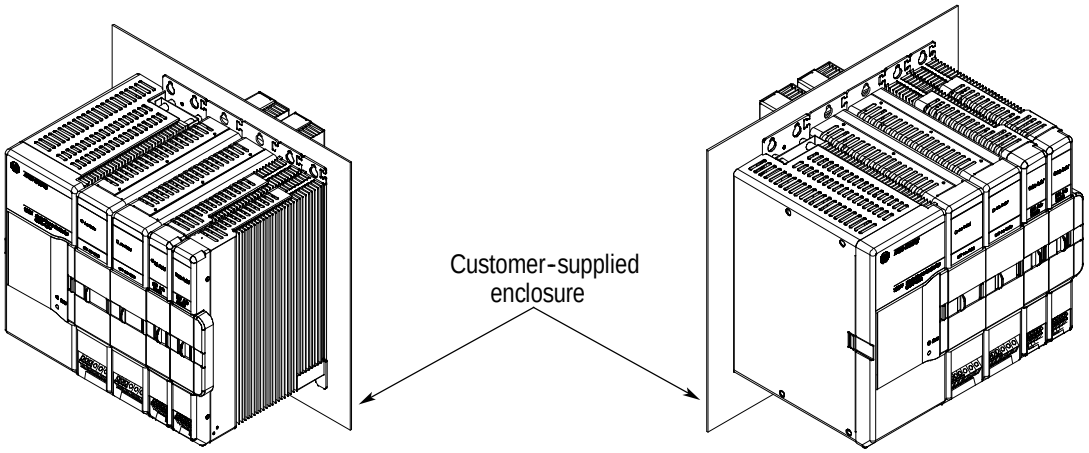
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9/440 CNC and 1394 Drive

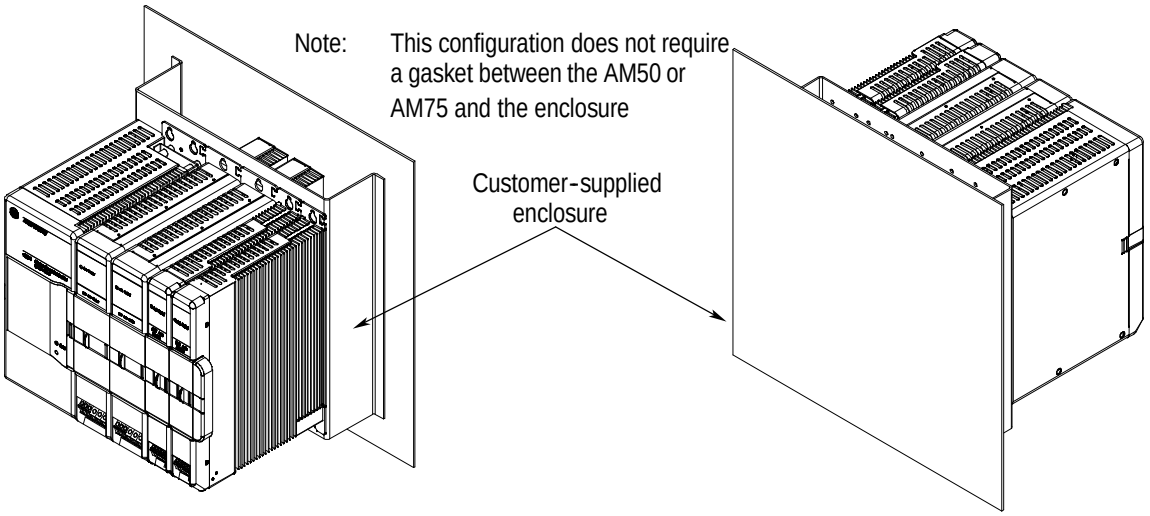
This section covers the dimensions and weight of the component for the 9/440. The dimensions outside of the brackets are given in millimeters and inside the brackets in inches. For additional information on this component refer to page 5A-1 or page 11A-1.

Figure 2B.5
Mounting Options for 9/440 or 1394 Drive

Through Enclosure Wall

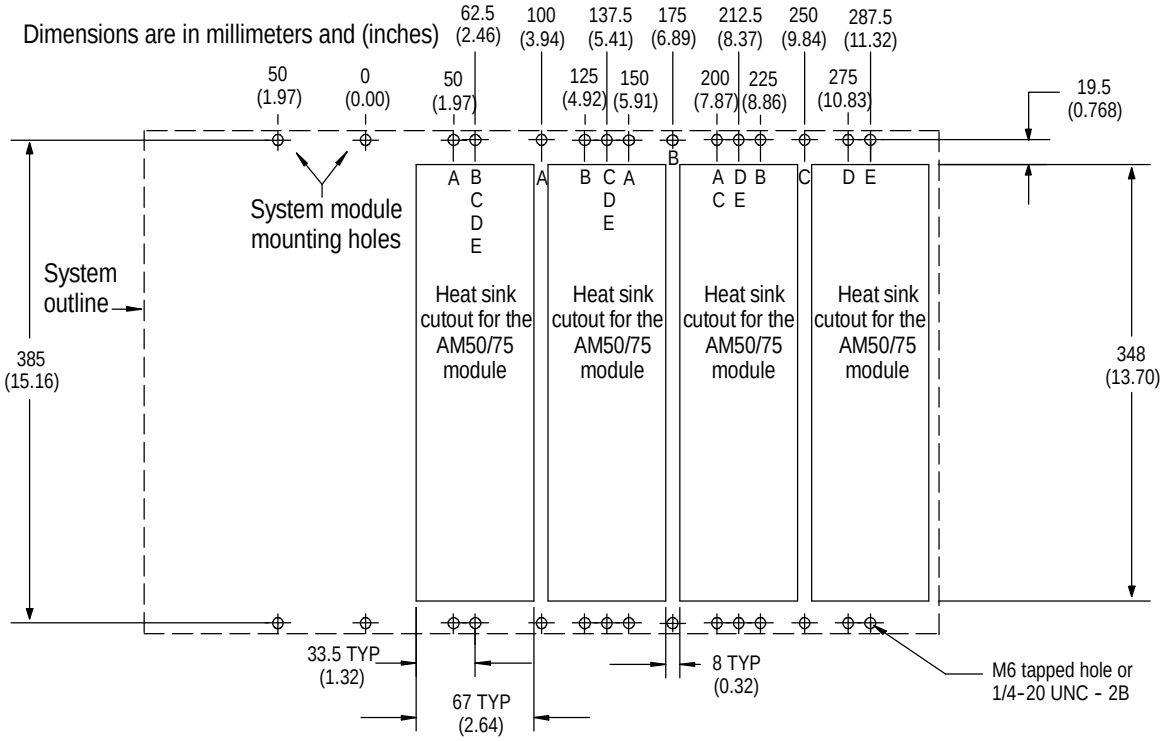


Inside Enclosure Using U Bracket



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Figure 2B.6
9/440 CNC and 1394 Drive Mounting Template

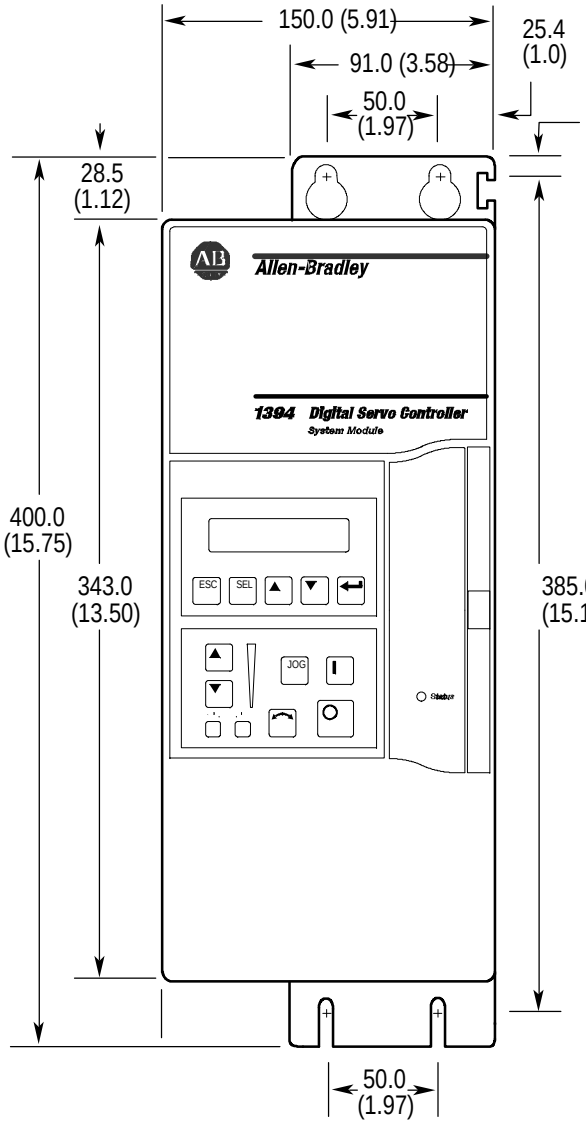


Mounting Options	Number of Axes	Type of Axis	Cutout Needed?
A[1]	1	1394-AM50 or AM75 Axis, 75 mm (2.95 in.) wide	yes
	up to 3	1394-AM03, AM04 or AM07 Axis, 50 mm (1.97 in.) wide	no
B[1]	2	1394-AM50 or AM75 Axis, 75 mm (2.95 in.) wide	yes
	up to 2	1394-AM03, AM04 or AM07 Axis, 50 mm (1.97 in.) wide	no
C[1]	3	1394-AM50 or AM75 Axis, 75 mm (2.95 in.) wide	yes
	up to 1	1394-AM03, AM04 or AM07 Axis, 50 mm (1.97 in.) wide	no
D	4	1394-AM50 or AM75 Axis, 75 mm (2.95 in.) wide	yes

[1] When mounting axis module combinations, the AM50 and AM75 must be mounted closest to the system module and ahead of any 1394-AM03, AM04, and AM07 axis modules.

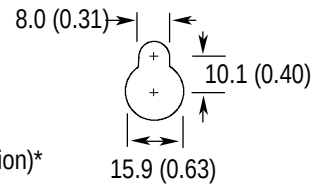
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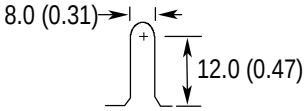
Figure 2B.7
9/440 CNC and 1394 Drive System Module Dimensions



Dimensions are in millimeters and (inches)
Depth = 279.4 (11.0)

Mounting Hole Detail



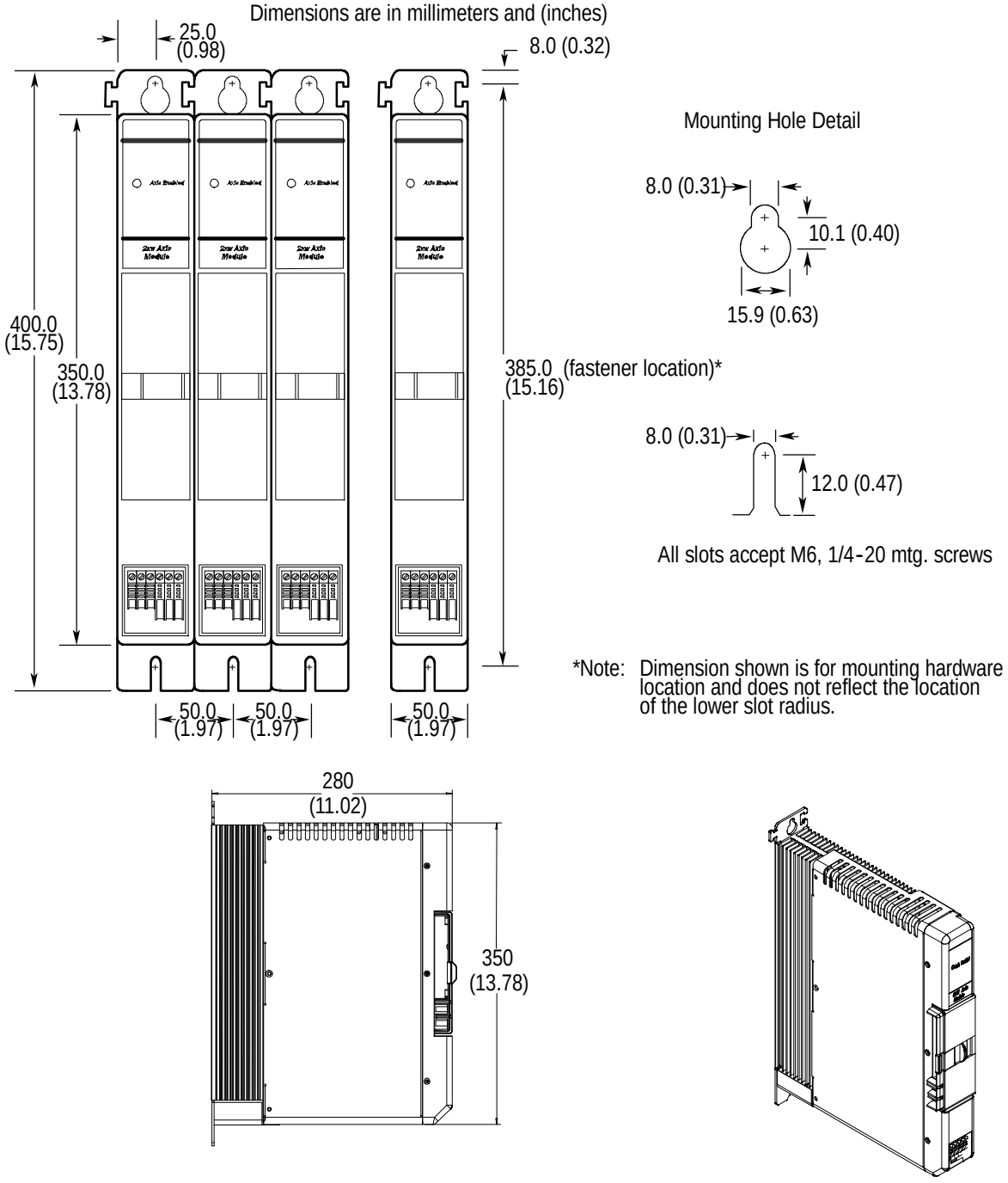


All Slots Accept M6, 1/4–20 Mtg. Screws

*Note Dimension shown is for mounting hardware location and does not reflect the location of the lower slot radius.

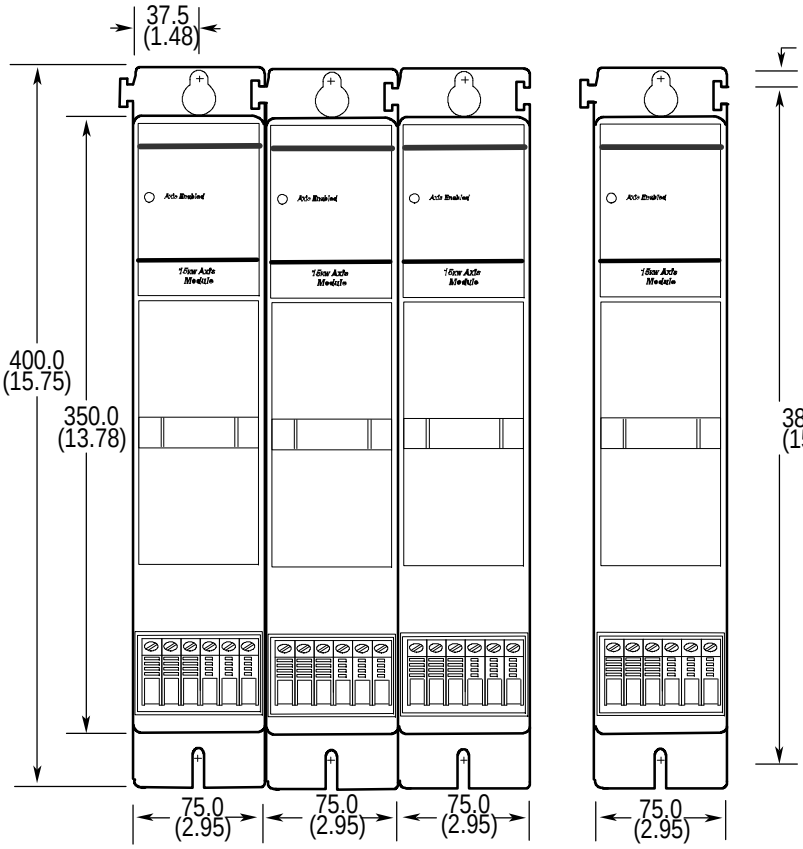
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Figure 2B.8
9/440 CNC and 1394 Drive Dimensions for AM03, AM04, and AM07 Axis Modules
Dimensions are in millimeters and (inches)



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Figure 2B.9
9/440 CNC and 1394 Drive Dimensions for AM50 and AM75 Axis Modules

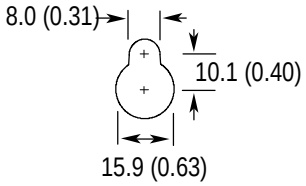


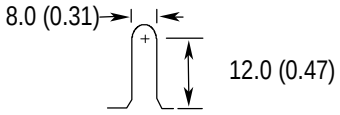
8.0 (0.32)

385.0 (fastener location)*
(15.16)

Dimensions are in millimeters and (inches)

Mounting Hole Detail

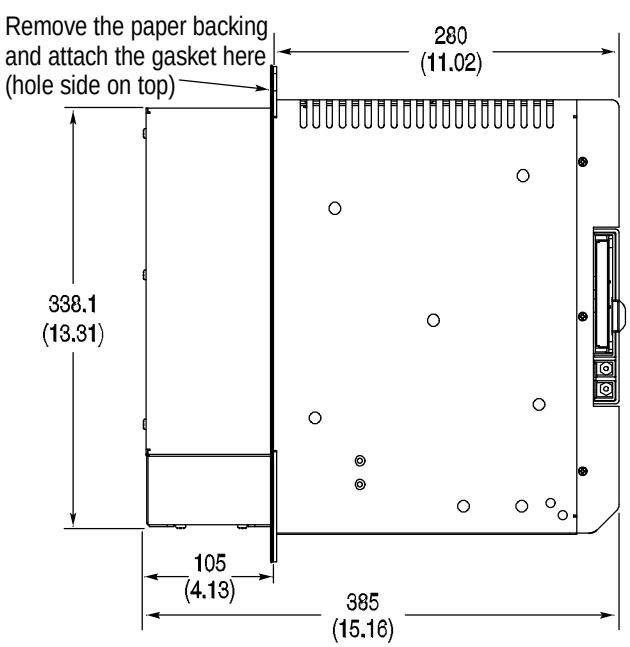


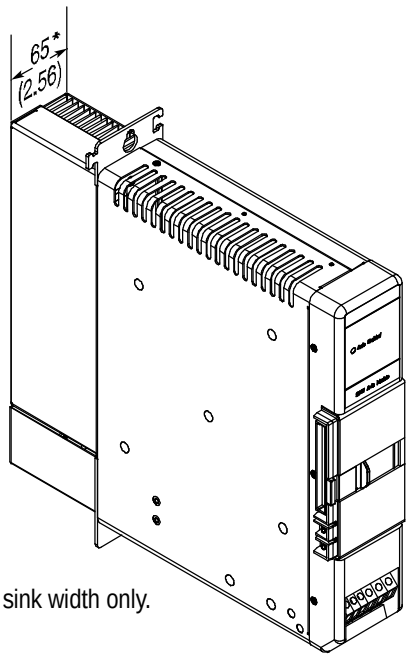


All slots accept M6, 1/4-20 mtg. screws

When using the gasket provided with the axis module, torque the M6 to 7.9 N-m and the 1/4-20 to 75 in-lbs.

*Note: Dimension shown is for mounting hardware location and does not reflect the location of the lower slot radius.

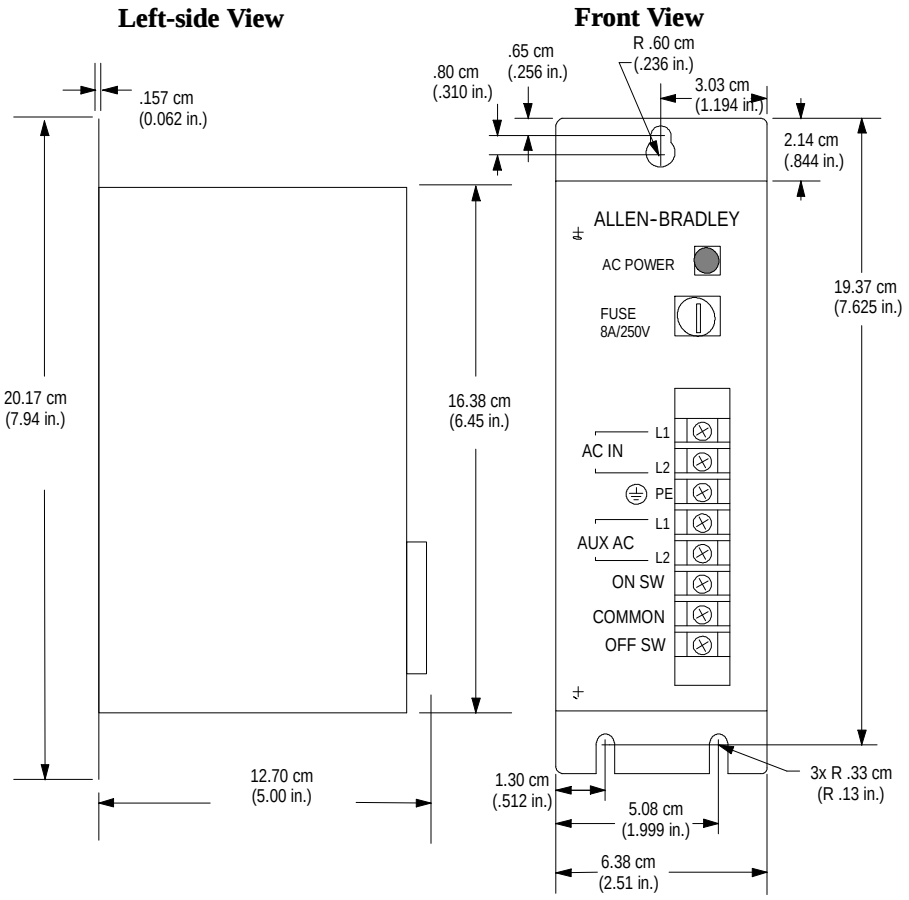




*Note: Heat sink width only.

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Figure 2B.10
9/440 CNC Power Control Module Dimensions



2B.1 Common System Component Dimensions

Detailed information on the common system component is provided in the following sections.

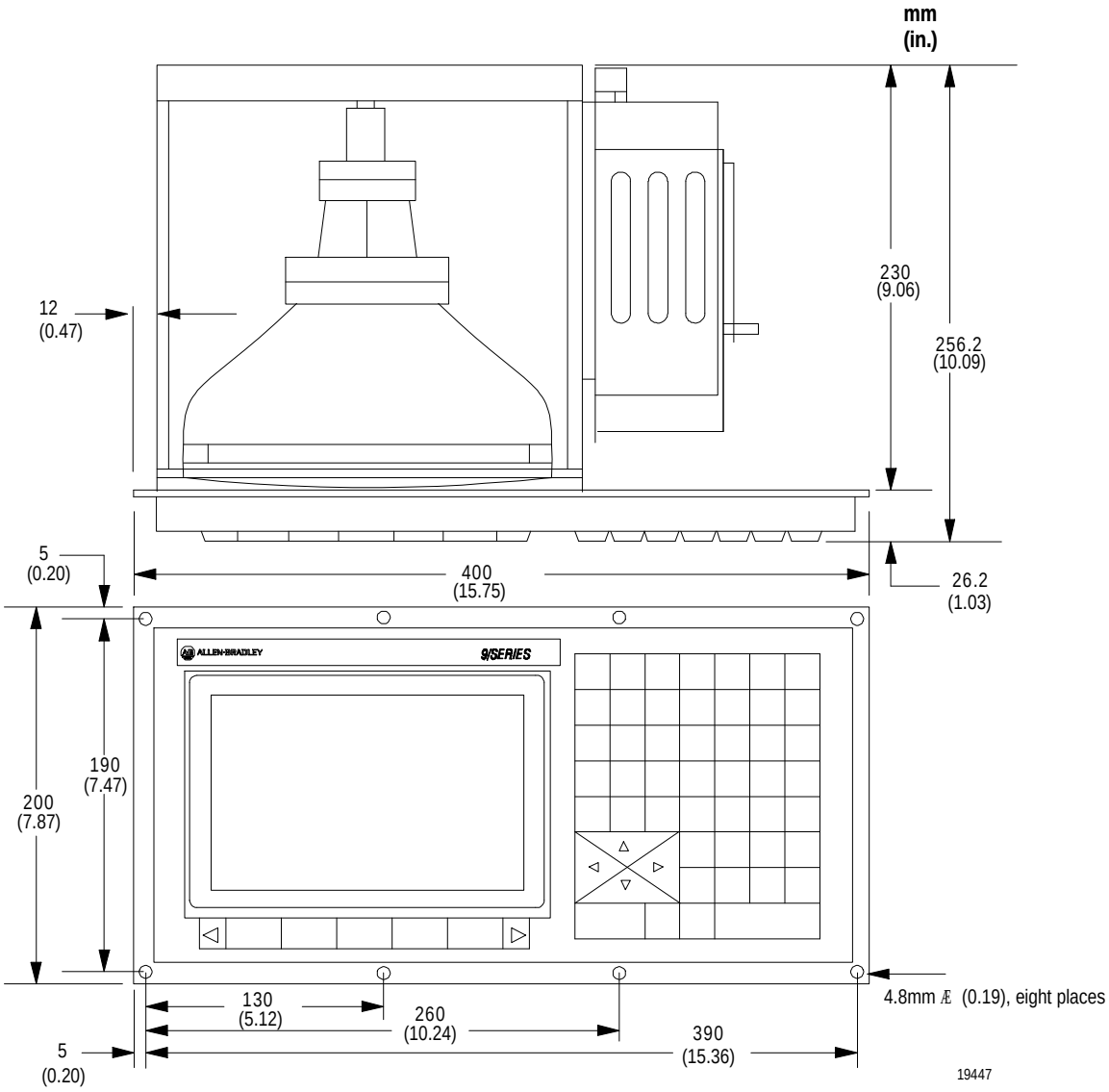
Form Information On:	See Page
Operator Panel (monochrome and color)	2B-11
MTB Panel	2B-14
Pendant Option	2B-15
Hand Pulse Generator	2B-17
Servo Modules	2B-18
Encoder Termination Panel	2B-18
Servo Drives	2B-19
MTB Panel I/O Module	2B-20
Digital I/O Module	2B-20
High Density I/O Module	2B-21

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Operator Panel

For detailed information on operator panels refer to page 9A-1.

Figure 2B.11
Monochrome Operator Panel Dimensions



The monochrome operator panel weighs 6.5 kg (19.8 lb).

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Figure 2B.12
Blank Cut-Out Dimensions for the Monochrome Operator Panel

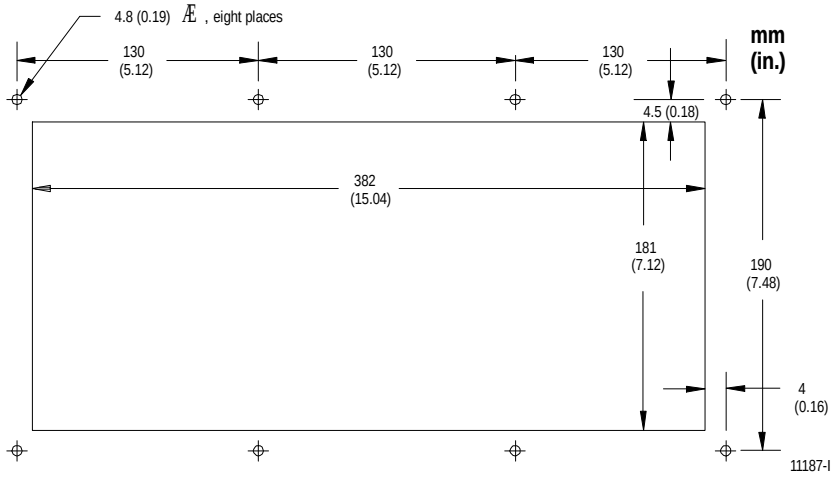
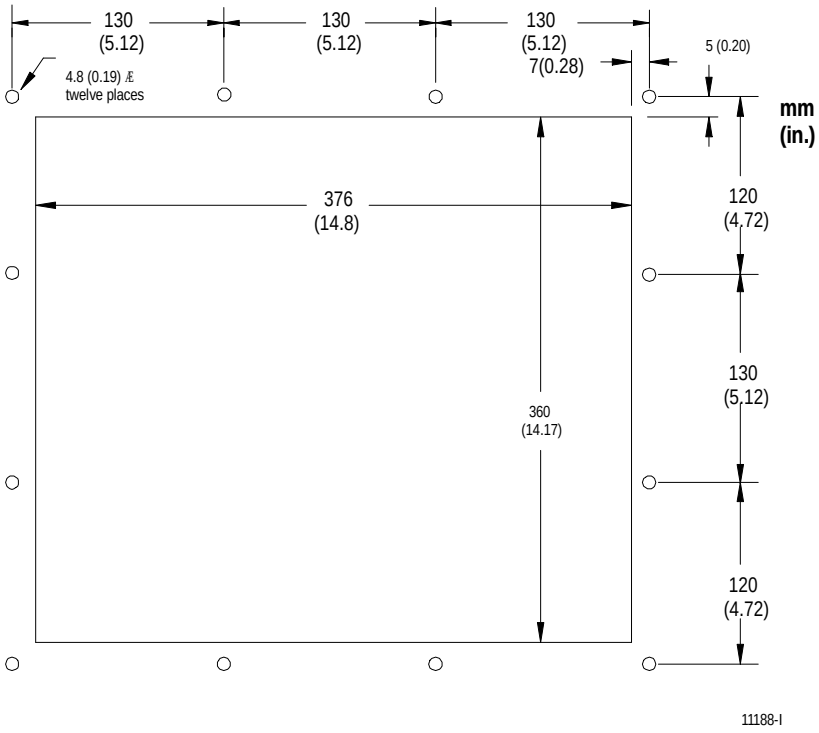
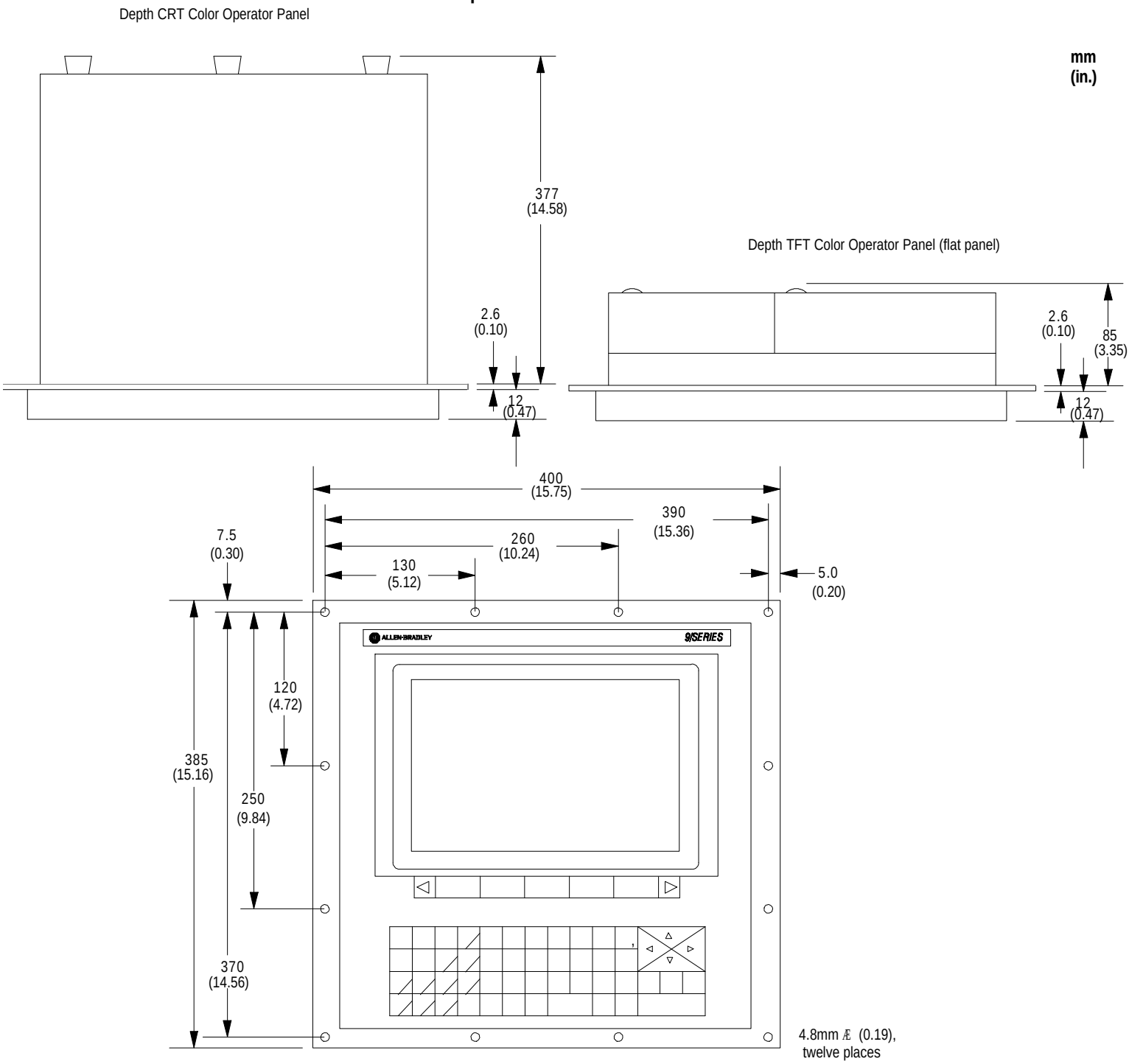


Figure 2B.13
Blank Cut-Out Dimensions for the Color Operator Panels
(both CRT and TFT flat panel)



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Figure 2B.14
Color Operator Panel Dimensions



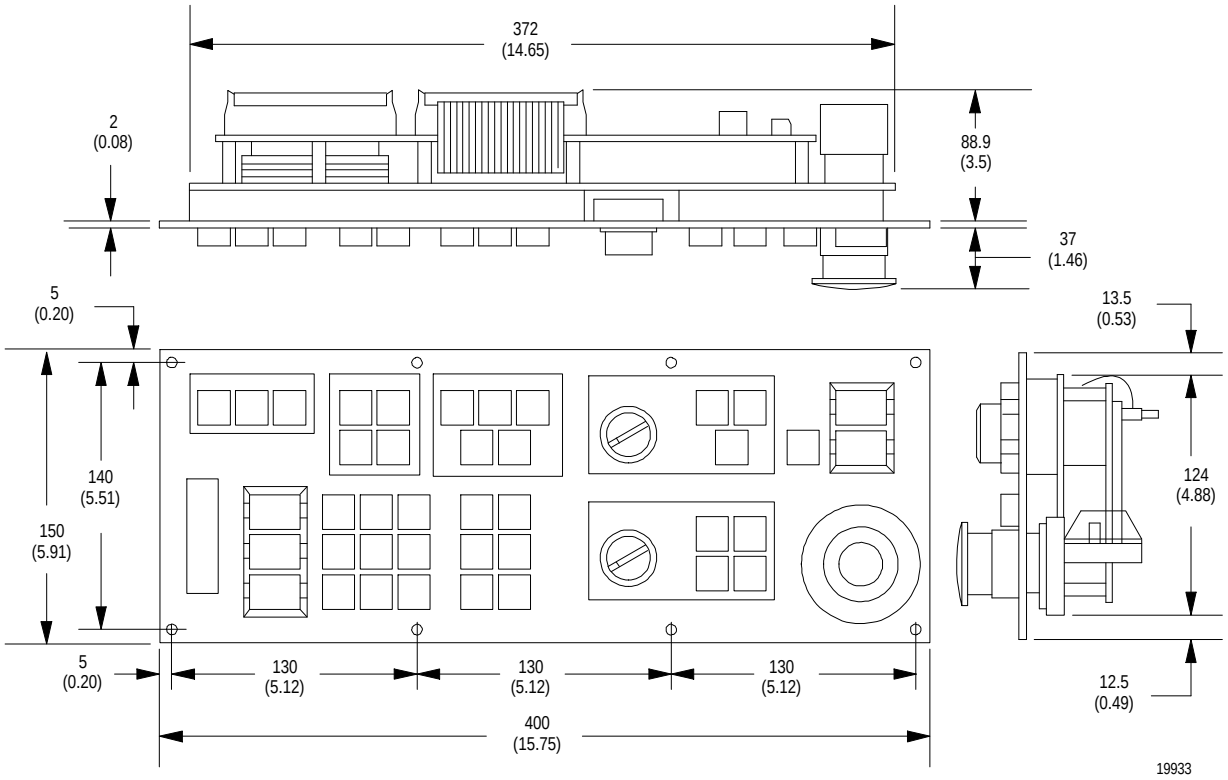
The color CRT operator panel weighs 20.0 kg (44.0 lb).
The color TFT operator panel (flat panel) weighs 6.1 kg (13.5 lb).

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MTB Panel

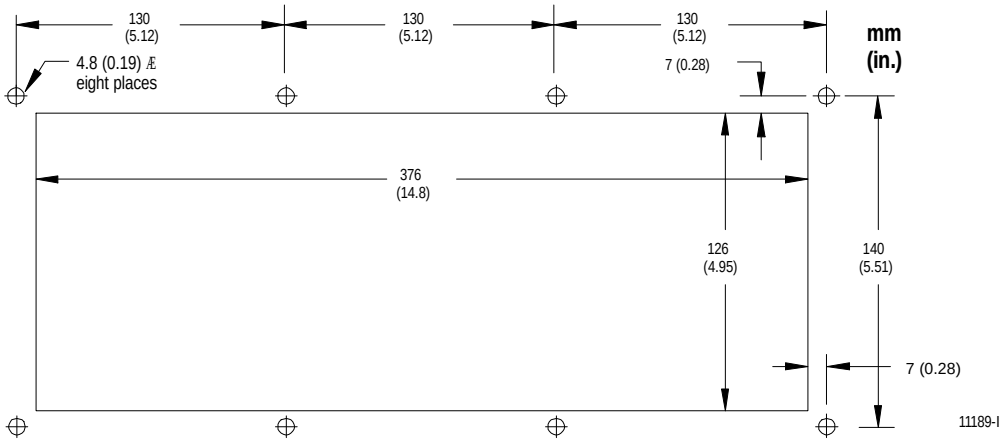
For detailed information on this component refer to page 9A-1.

Figure 2B.15
MTB Panel Dimensions



The MTB panel weighs 2.09 kg (4.62 lb).

Figure 2B.16
Blank Cut-Out Dimensions for the MTB Panel

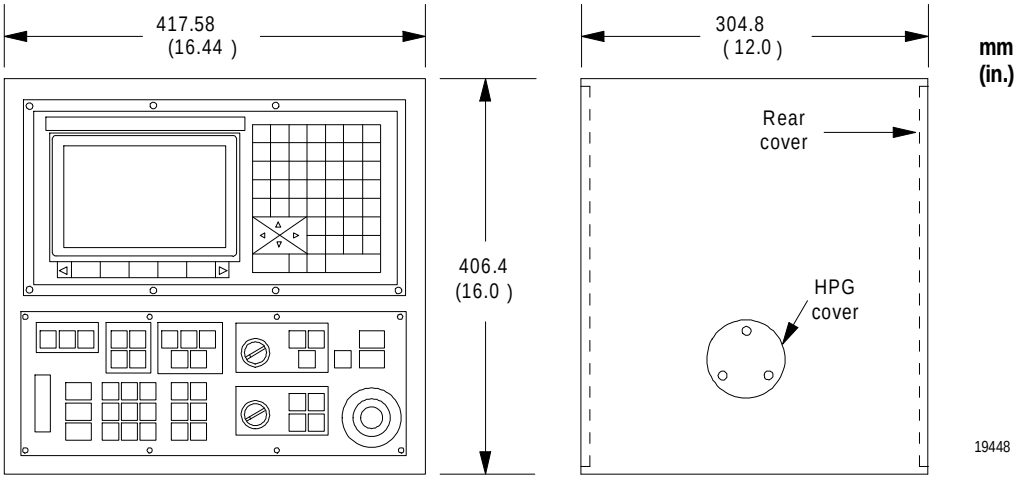


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Pendant Option

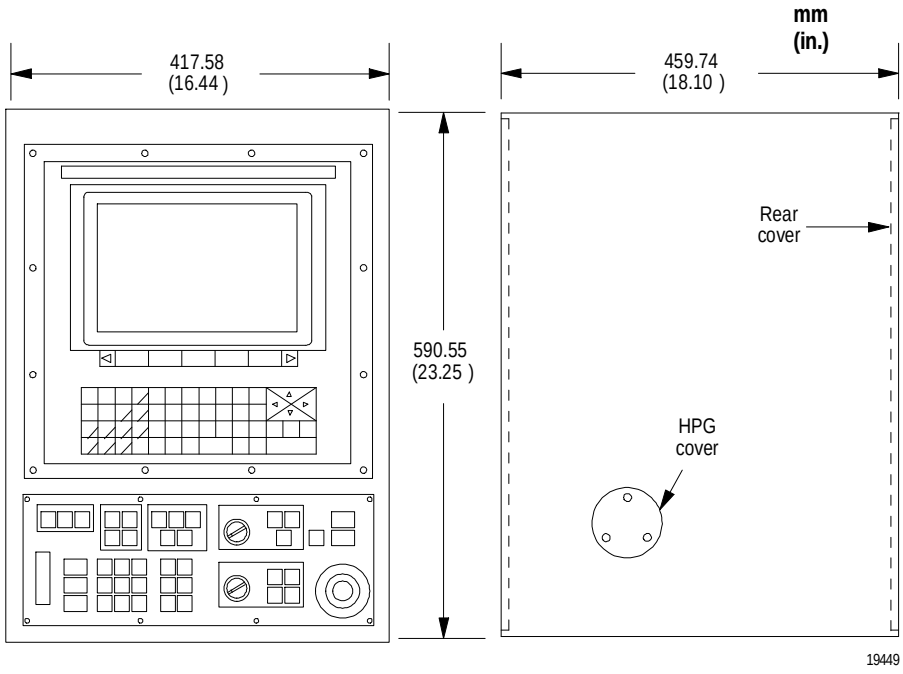
Figure 2B.17 and Figure 2B.18 show the dimensions for the pendant option that contains the monochrome or color operator panel and the MTB panel. For detailed information on the pendant components refer to page 9A-1.

Figure 2B.17
Monochrome Pendant Dimensions



The monochrome pendant weighs 21.3 kg (46.1 lb).

Figure 2B.18
Color Pendant Dimensions



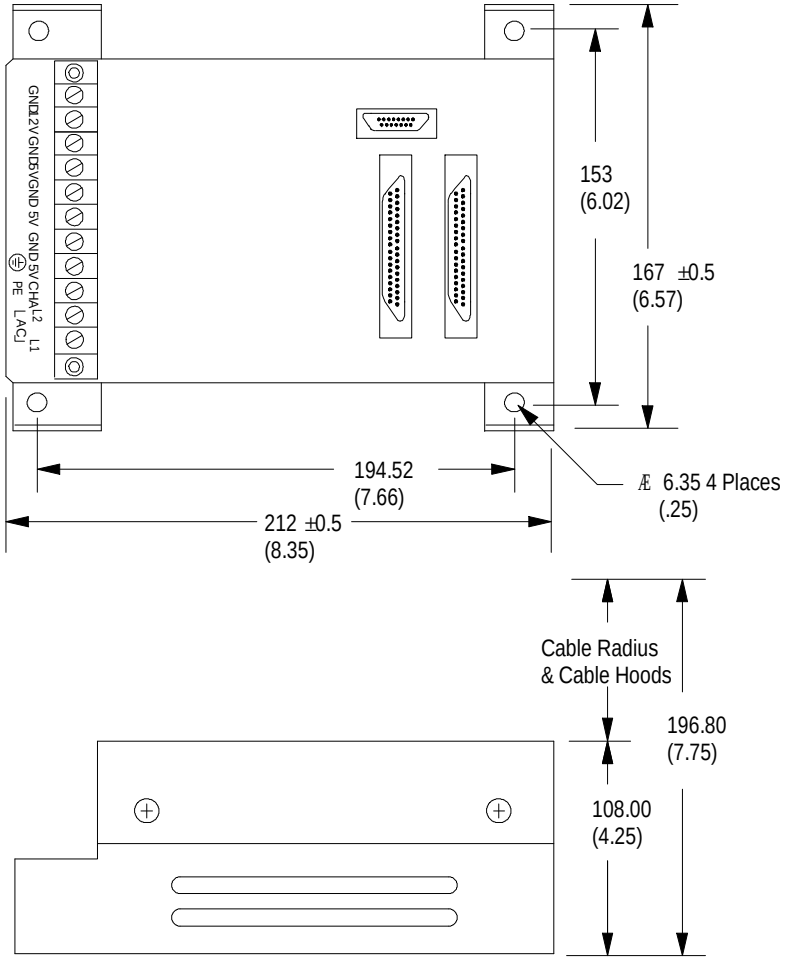
The color pendant weighs 41.1 kg (90.5 lb).

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Removable Operator Panel Interface Assembly

The removable operator panel interface assembly is used in conjunction with the 9/Series removable operator panel. For detailed information on this component refer to page 9A-1.

Figure 2B.19
Removable Operator Panel Interface Assembly

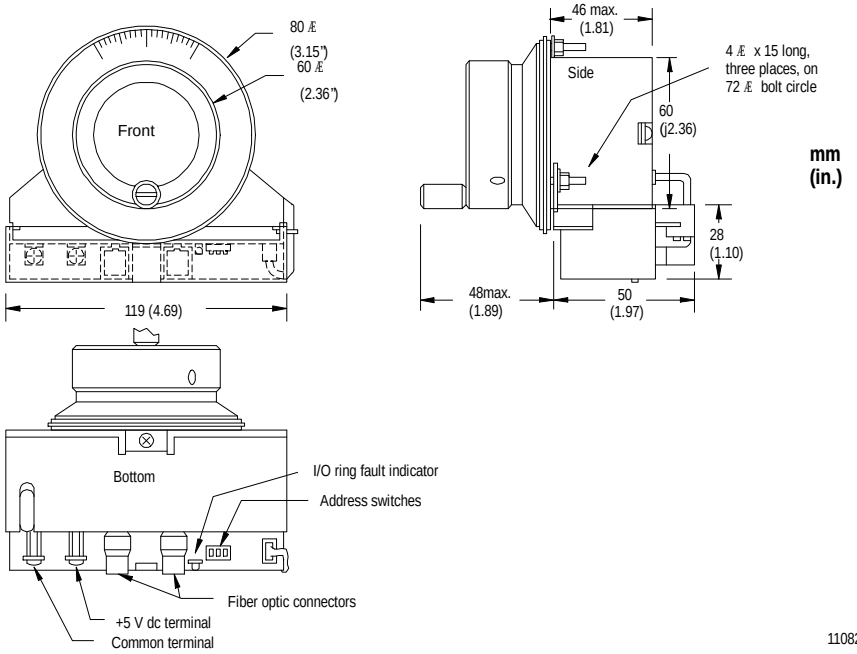


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Hand Pulse Generator

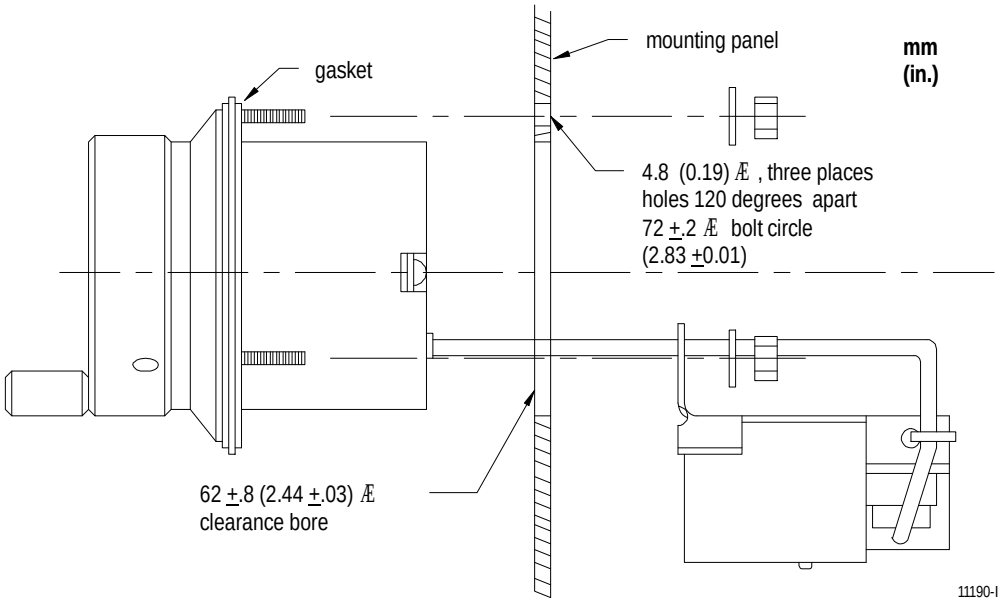
For detailed information on this component refer to page 9A-1.

Figure 2B.20
Hand Pulse Generator Dimensions



The hand pulse generator weighs .58 kg (1.28 lb).

Figure 2B.21
Hand Pulse Generator Dimensions



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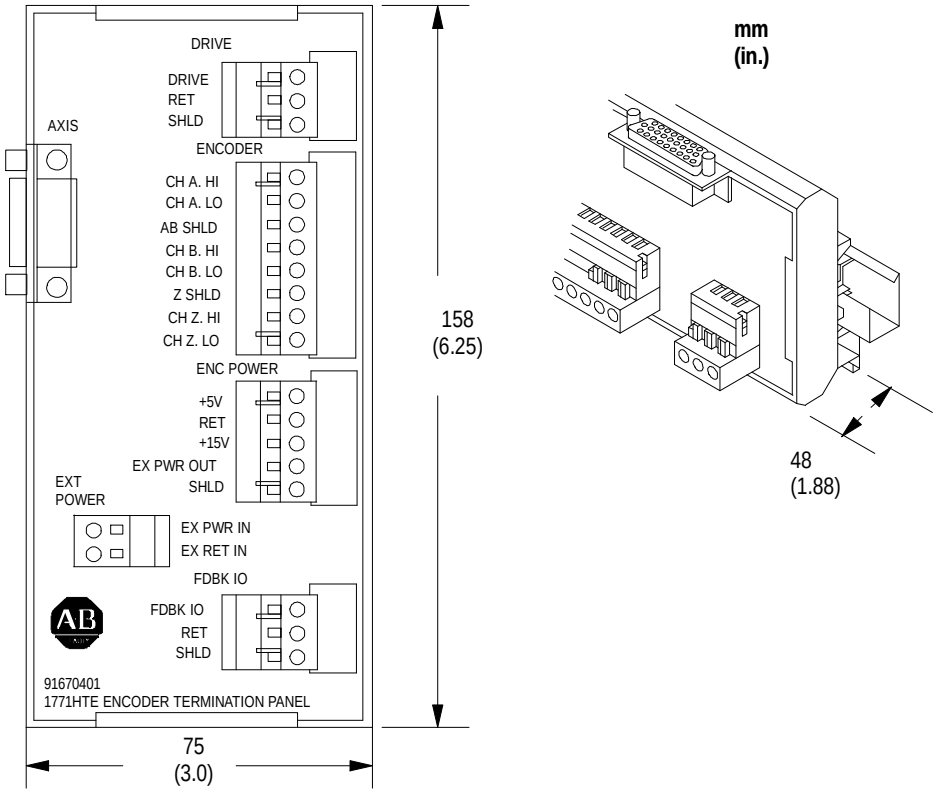
Servo Modules

Mount the 3-axis or 4-axis servo module by gently sliding them into the guides that run along the bottom of the 9/260 or 9/290 component enclosure. Figure 2B.3 and Figure 2B.4 show the dimensions for installing the component enclosure. To connect the 3-axis servo module, refer to page 4B-1. To connect the 4-axis servo module, refer to page 4C-1.

Encoder Termination Panel

The 1771-HTE encoder termination panel simplifies the integration of an analog amplifier system. The termination panels are shipped with all the connectors and associated circuitry installed. Mount the termination panels to a DIN type #46277-1 rail, as shown in the figure below. You can attach the rail either vertically or horizontally to the enclosure wall.

Figure 2B.22
1771-HTE Encoder Termination Panel Dimensions



The encoder termination panel weighs .17 kg (.37 lb)

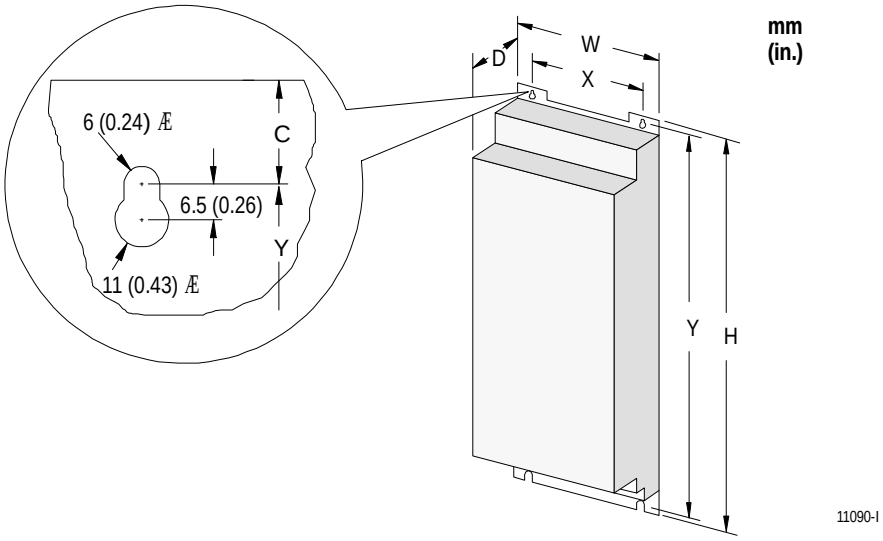
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Servo Amplifiers

The 9/230, 9/260 and 9/290 are compatible with a variety of analog servo amplifiers. For the dimensions of your analog servo amplifier, refer to its documentation. For detailed information on compatible analog servo amplifiers refer to page 12-1.

Figure 2B.23 shows the mounting dimensions for the 8520 digital servo amplifier. For detailed information on the 8520 digital servo amplifier refer to page 13A-1. For detailed information on the 1394 digital servo amplifiers refer to page 11A-1.

Figure 2B.23
8520 Digital Servo Amplifier Dimensions



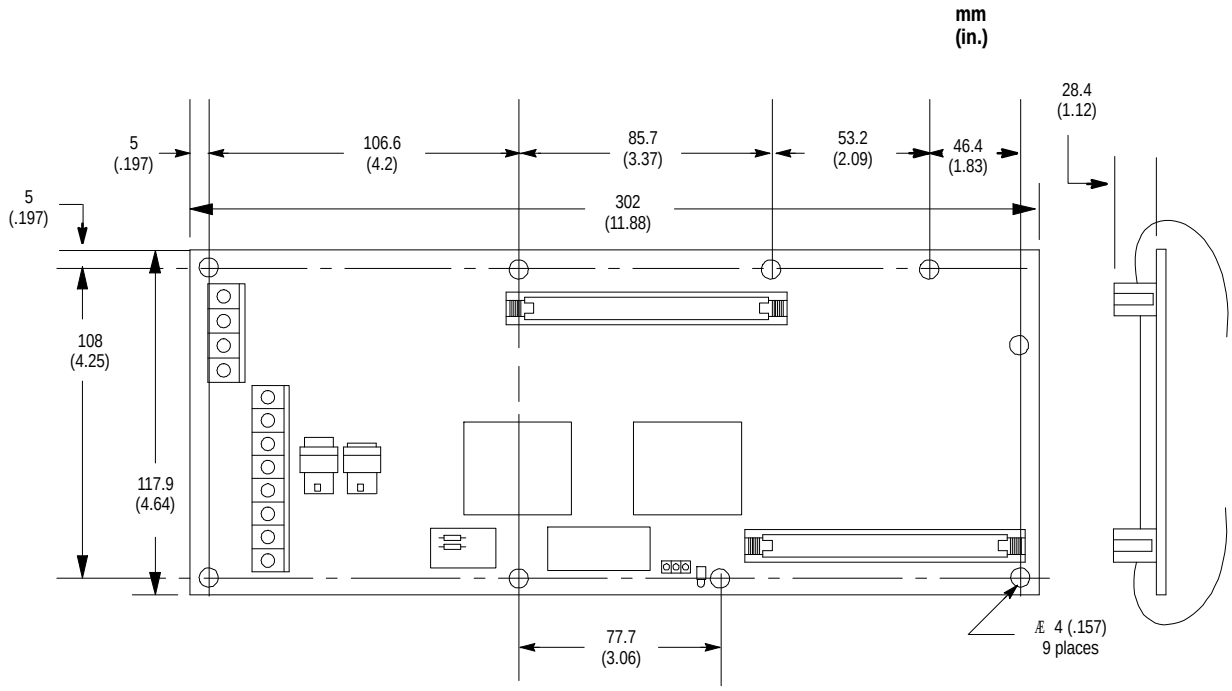
8520 Amplifier	W mm (in.)	H mm (in.)	D mm (in.)	X mm (in.)	Y mm (in.)	C mm (in.)
1AX-D	158 (6.22)	450 (17.72)	205 (8.07)	100 (3.94)	430 (16.93)	6.5 (0.26)
2AX-D	158 (6.22)	450 (17.72)	205 (8.07)	100 (3.94)	430 (16.93)	6.5 (0.26)
3AX-D	241 (9.49)	450 (17.72)	205 (8.07)	200 (7.87)	430 (16.93)	10 (0.39)

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MTB Panel I/O Module

For detailed information on this component refer to page 10A-8.

Figure 2B.24
MTB Panel I/O Module Dimensions



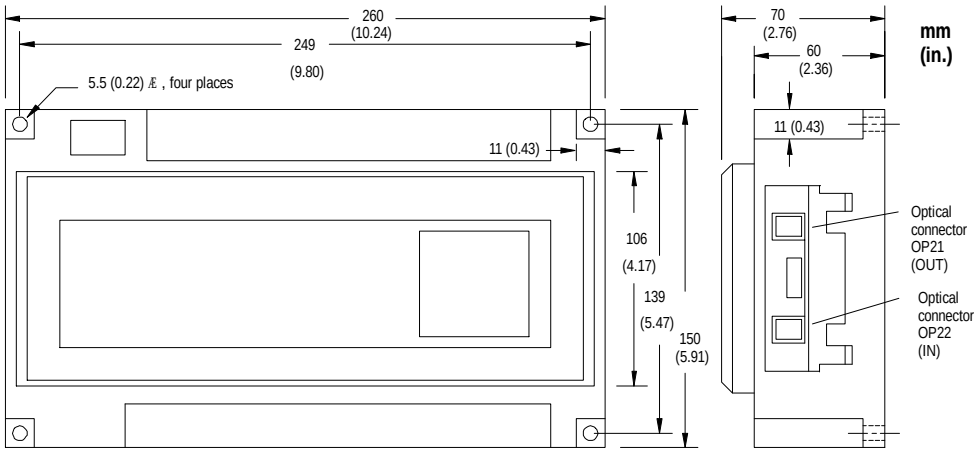
Digital I/O Module

For detailed information on this component refer to page 10A-18.

Important: The digital I/O module uses the cabinet's back panel as a heat sink for dissipating excess heat during operation. It is important that the unit be mounted on a smooth, metal, back panel to provide good thermal conductivity.

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Figure 2B.25
Digital I/O Dimensions



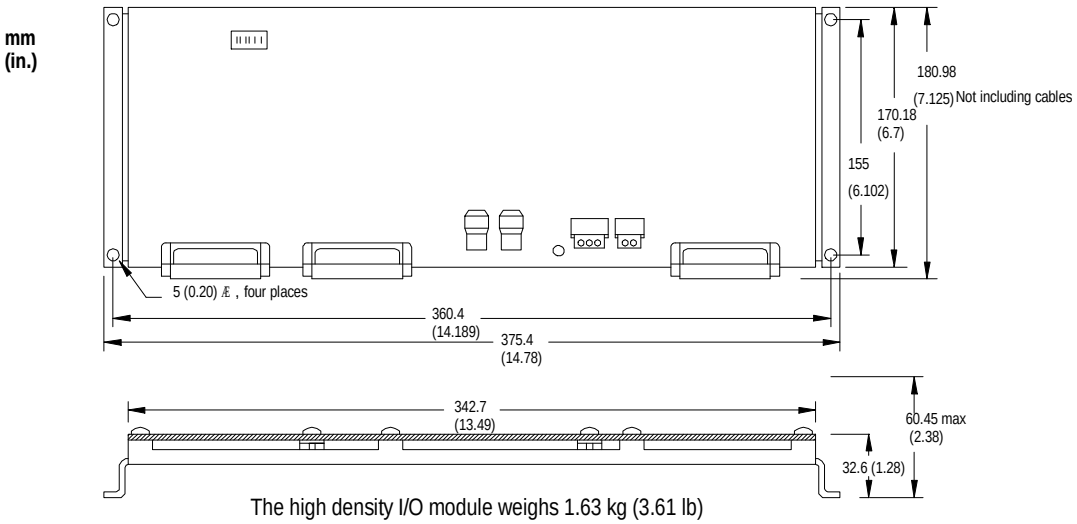
The digital I/O module weighs 1.77 kg (3.9 lb)

11083-I

High Density I/O Module

For more information on connection and configuration of high density I/O modules refer to page 10A-33.

Figure 2B.26
High Density I/O Module Dimensions for 8500-HDM1



The high density I/O module weighs 1.63 kg (3.61 lb)

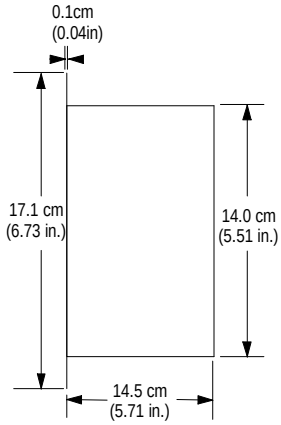
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1746 I/O

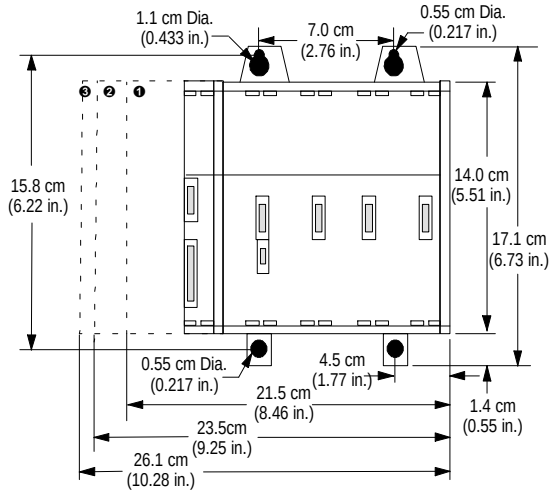
Three standard 1746 I/O assemblies with a variety of commonly used I/O modules already installed are available for the 9/Series CNC. These assemblies come with the I/O cards you need, and a 1746I module to interface to the 9/Series I/O ring. For more details on 1746 I/O refer to page 10A-49. If you did not purchase one of these preconfigured assemblies refer to page 10B-1 for details. The three standard 1746 I/O configurations all use the 4–card 1746 chassis. The dimensions for the 4–slot chassis (1746-A4) are shown below.

1746-A4 I/O Mounting Dimensions

Left-side View



Front View



❶ Dimensions for power supply catalog number 1746–P1

❷ Dimensions for power supply catalog number 1746–P2 & 1746–P3

❸ Dimensions for power supply catalog number 1746–P4

END OF SECTION

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Publication 8520-6.2.2 – August 1998

PN176437

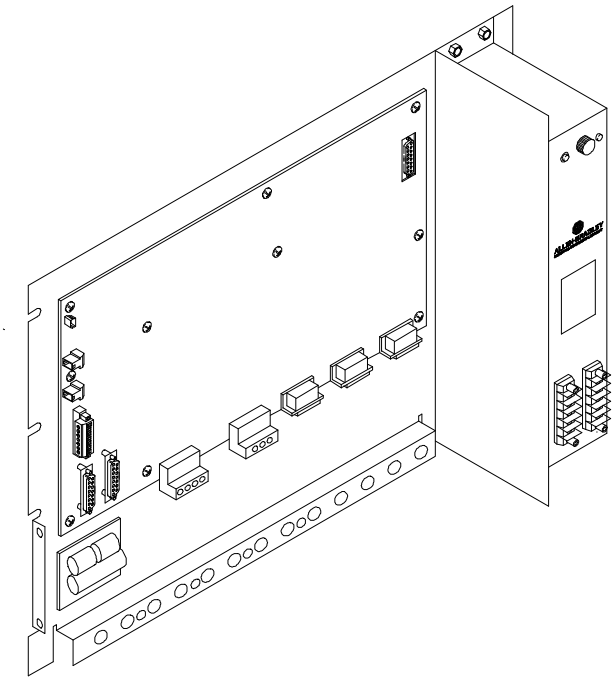
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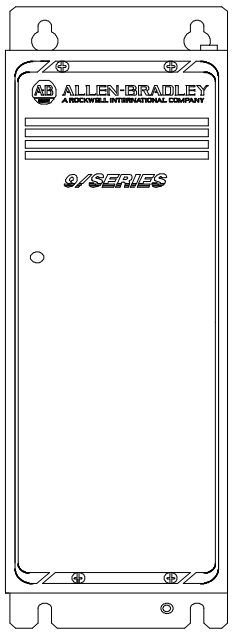
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9/Series Hardware
TAB 3

9/230 CNC Systems



9/230 Analog



9/230 Digital

8520-6.2.3 – February 1997 PN–176025

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Section 3A

Primary 9/230 Components

3A.0 Section Overview

This section discusses:

- 9/230 1 axis and 3 axis processor boards
- main power supply (PS2A)
- 9/230 mounting

This section covers standard 9/230 CNCs as well as 9/230 CNCs purchased as part of the T-Line-9 transfer line control. A portion of this section is devoted to each of the following:

For Details on the Processor Board and Power Supply	See Page:
Processor Board	3A-2
Connections on the Processor Board	3A-3
Reading LEDs	3A-5
Battery Backup	3A-6
Main Power Supply (PS2A)	3A-7
For Details on the Analog Servo Interface	**See Page:**
Servo Axis Connectors on the Analog Processor Module	3A-8
Connecting Axes to the Analog Servo Interface	3A-9
Analog Servo Operation and Specifications	3A-12
Analog Servo Connectors and Pin Assignments	3A-13
Analog Servo Amplifiers	3A-16
Analog Servo Motors	3A-16
For Details on the 9/230 Digital Servo Interface	**See Page:**
Servo Axis Connectors on the 9/230 Digital Processor Module	3A-24
Connecting Axes to the Digital Servo Interface	3A-24
Digital Servo Operation and Specifications	3A-26
Digital Servo Connectors and Pin Assignments	3A-27
Digital Servo Amplifiers	3A-30
Digital Servo Motors	3A-31
For Details on Testing and Connecting Feedback Devices	**See Page:**
Using Test Points	3A-32
Encoder Termination Panel	3A-17
Feedback Devices	3A-18
Wiring an Incremental Feedback Device	3A-21
Wiring a Touch Probe to the Processor Module	3A-33

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3A.1
The Processor Board

The processor board is attached to the mounting plate. Refer to Figure 3A.1 and Figure 3A.2 for the processor board identification.

Figure 3A.1
Front View of the 9/230 Analog Processor

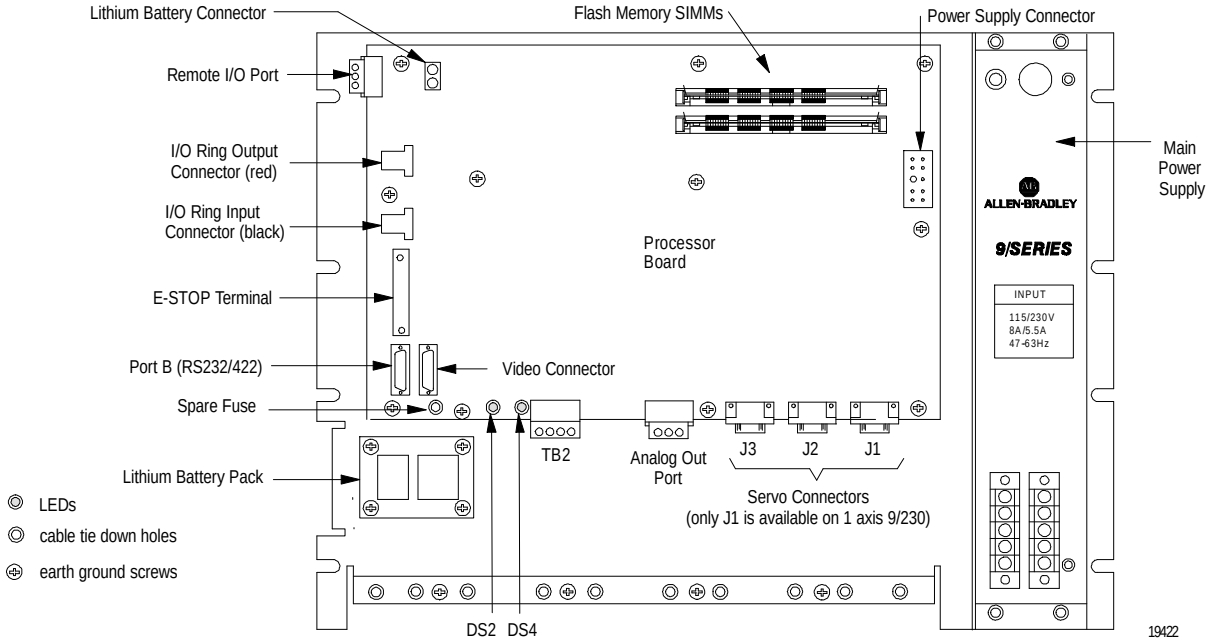
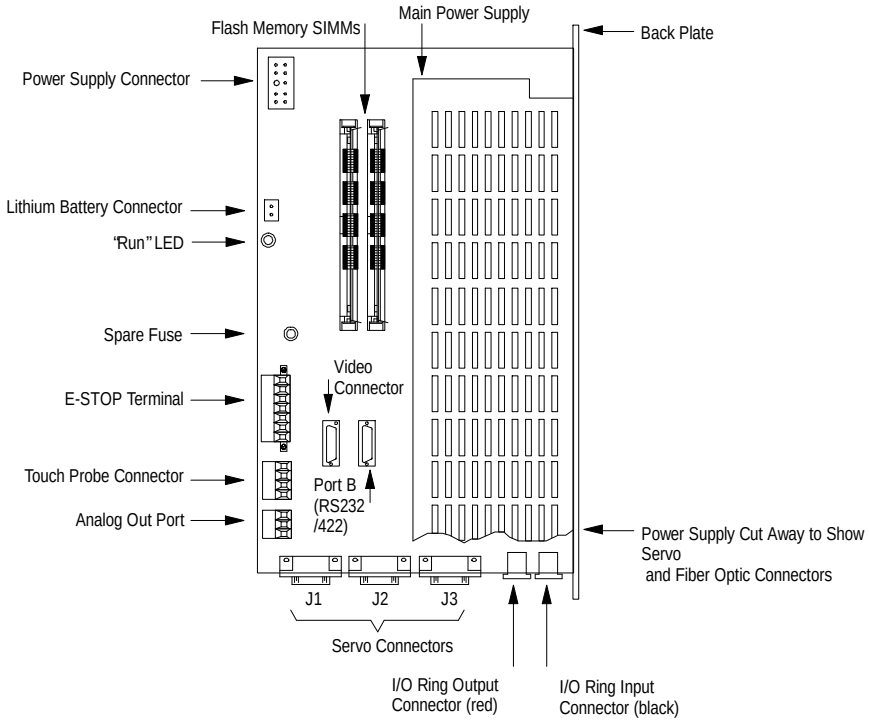


Figure 3A.2
Side View of the 9/230 Digital with Power Supply Cut Away



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3A.1.1 Connections on the Processor Board

Table 3A.A lists the connections on the 9/230 processor board and where to locate the cable diagrams within this manual. Refer to page 7A-1 for detailed cable drawings.

Table 3A.A
Locating Wiring Diagrams for the 9/230 Processors

Attach this connector:	To:	Use this Cable
Lithium Battery (P1)	Lithium Battery Pack	C13,
I/O Ring Output (Red)	First Device on I/O Ring	C10
I/O Ring Input (Black)	Last Device on I/O Ring	C10
E-Stop (TB1)	E-stop String	C05, C06
Port B (J7)	Peripheral Devices	C07
Video (J8)	Operator Interface (Color or Monochrome)	C09
TP (TB2)	Touch Probe	C46
Analog Out (TB3)	Spindle	C42
Analog Servo Connector (J1, J2, or J3)	Termination Panel	C36
Digital Servo Connector (J1, J2, or J3)	Servo System	C18, C20
Power Supply (P12)	Power Supply	C04

Port B

Serial port B is used to transmit data to and from peripheral devices. It can be wired for RS-232 communications or RS-422 communications. Softkey selections on the controls operator panel now selection at the specific device protocol to be used.

The MTB panel may have the optional serial interface connector mounted on it. This connector provides an external interface port for RS-232 or RS-422 interface from a peripheral to the control. It connects to port B with cable C07. Refer to the "Cable List" section on page 7A-1 for additional information on cable C07. For more information on the signals of each pin, refer to page 8-1.

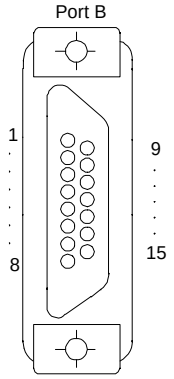


Figure 3A.3
Port B-J7 (has pin sockets) and Pin Assignments

Pin	Assignment	Pin	Assignment
1	Chassis GND	9	Send Data B
2	Send Data A	10	Receive Data B
3	Receive Data A	11	Request to Send B
4	Request to Send A	12	Clear to Send B
5	Clear to Send A	13	Data Set RDY B
6	Data Set RDY A	14	Data Term RDY B
7	Signal GND	15	Not Used
8	Data Term RDY A		

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Video Monitor Connector

The video monitor connector is used to interface the video monitor with the control. Figure 3A.4 shows this connector and lists the pin assignments of this connector.

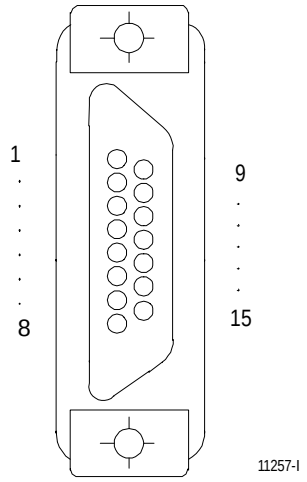


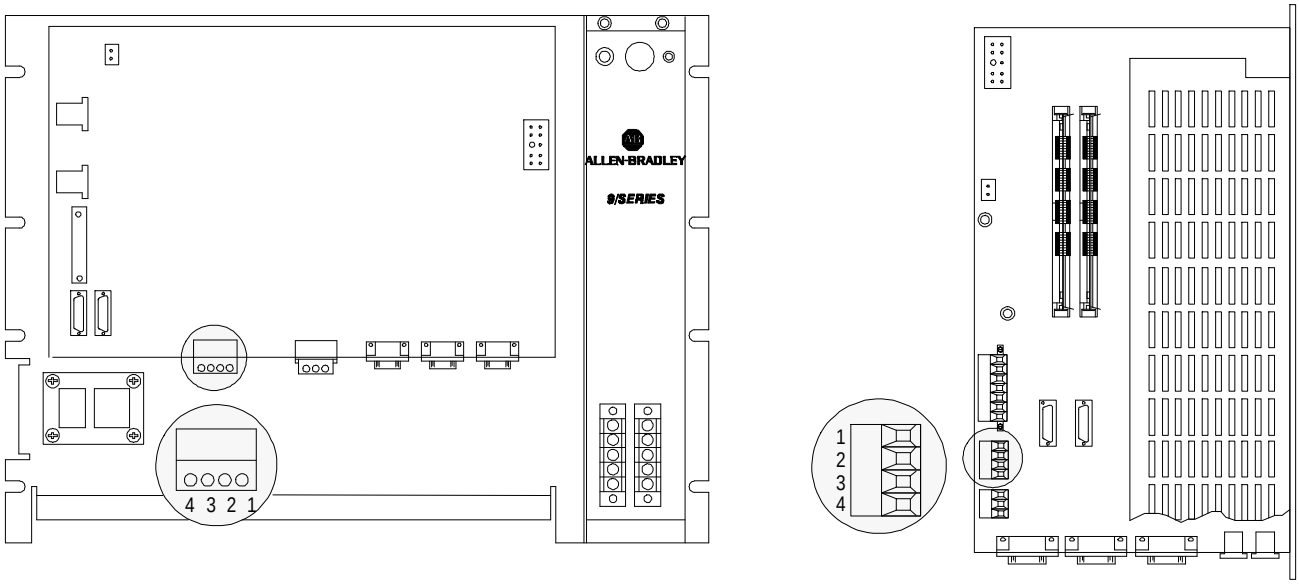
Figure 3A.4
Video Monitor Connector J8 and (has pin sockets) Pin Assignments

Pin No.	Signal Name	Pin No.	Signal Name
1	GND (SHIELD)	9	RED (L)
2	RED (H)	10	GREEN (L)
3	GREEN (H)	11	BLUE (L)
4	BLUE (H)	12	NC
5	NC	13	CLOCK (L)
6	CLOCK (H)	14	H-SYNC (L)
7	H-SYNC (H)	15	V-SYNC (L)
8	V-SYNC (H)		

Touch Probe Connector (TB2)

The control module receives touch probe feedback through the connector labeled TP (TB2). Figure 3A.5 shows the location of the TP connector. Table 3A.B lists the terminal assignments of this connector.

Figure 3A.5
Touch Probe, 4 Plug-type Terminal Block Connections.



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Table 3A.B
Connector TB2, TP, Terminal Assignments

Terminal No.	Signal	Description	Signal Destination
1	+5V	Probe Power	Touch Probe
2	PRB_FIRE	Probe Fired Signal [1]	Servo Module
3	TP_GRD	Touch Probe Common	Touch Probe
4	Shield	Probe Shield	connect at module only

[1] The True level (voltage transition the probe fires) is either "HIGH" or "LOW" as defined by the AMP parameter PROBE TRANSITION. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

Important: The touch probe connector supports only +5V probing device applications.

3A.1.2 Reading LEDs

The 9/230 can have two LEDs (DS4 is present only if you have purchased the 9/230 remote I/O option). Figure 3A.1 shows the location of these LEDs on the main board. Use them to determine the following:

Table 3A.C
LED Sequence at Power Up for the 9/230

LED	Status	Description
DS2 WDOG OK	ON	System is running.
	OFF	Watchdog timeout has occurred, or system did not power-up properly
DS4 NA COMM ACTIVE	ON	Active Link to PLC. This is the normal state when the RIO channel is on and active.
	FLASHING	The remote I/O channel is on and active but the PLC is currently in program mode.
	OFF	Remote I/O channel is offline. The port is not being used, not configured, or not attached to a remote I/O scanner device.

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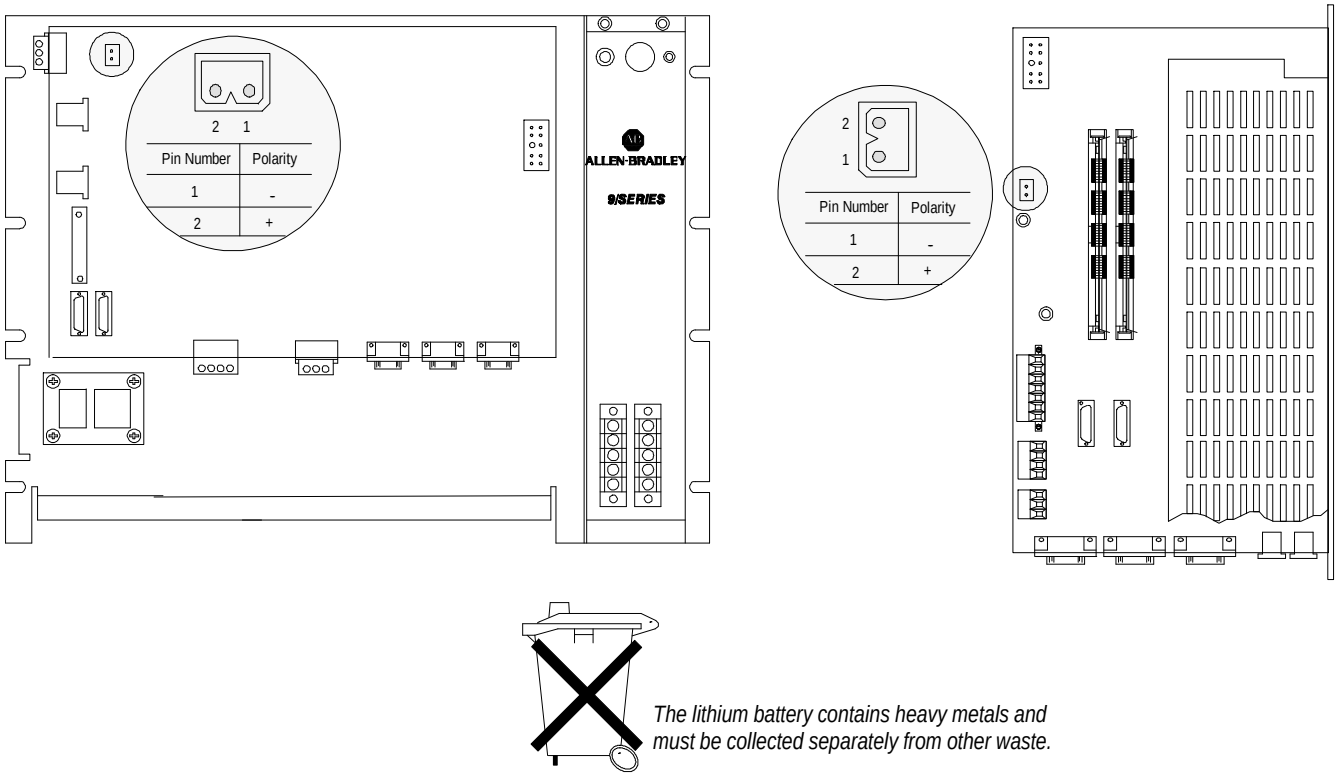
3A.1.3 Battery Backup

The memory for data such as part programs, tool offset/compensation data, and work coordinate offset data is stored on the processor board. In the case of a power failure, there is a super capacitor on the processor board that backs up this data for up to 5 days (at 40°C) on systems without extended program storage. This super capacitor recharges within 1 hour of power turn on if completely discharged. If you want to extend this backup time, install the lithium battery pack (8520-LIBAT) that supports the data for:

9/230 Control and Description:	Time (at 40°C Discharge):
standard	3 years
with extended program storage	1 year

The lithium battery pack also supports 8520 absolute encoder power. This battery pack is connected to the lithium battery connector (P1) on the processor board as shown in Figure 3A.6. Batteries and battery cable are included with the battery replacement kit.

Figure 3A.6
Lithium Battery



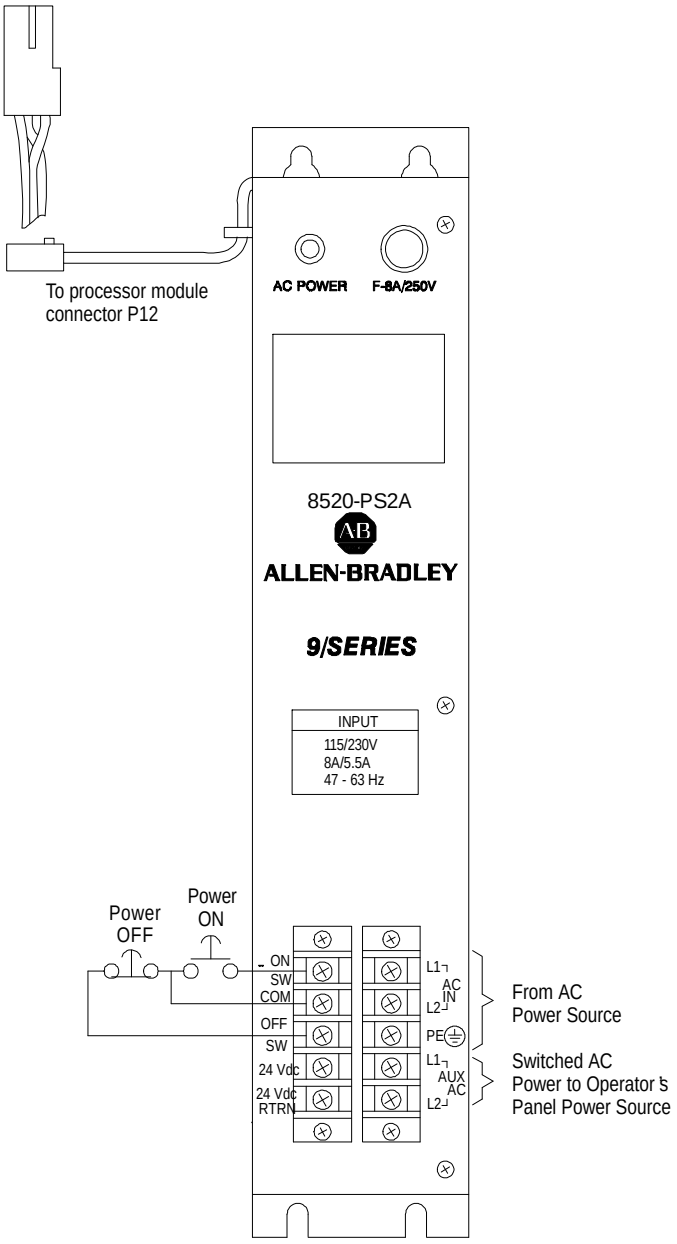
The lithium battery contains heavy metals and must be collected separately from other waste.

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3A.1.4 Main Power Supply (PS2A)

You receive the main power supply with your control. The main power supply powers the system processor board, customer 24V devices, encoders and the operator panel power supply. Figure 3A.7 shows the main power supply.

Figure 3A.7
8520-PS2A Main Power Supply



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Output Specifications

The 8520-PS2A main power supply output specifications are shown in Table 3A.D. For input specifications and fuse specifications refer to page 13A-22. The power supply shuts down if the 2A limit on the customer 24V supply is exceeded. This causes the control to shut off. You must provide protection for this circuit if you do not want this auto-shut down feature to activate.

Table 3A.D
8520-PS2A Main Power Supply Output Specifications

Item	Specifications	Remark
Rated Outputs	+5.30V dc (10A) @ 50 °C (8A) @ 60 °C) +15V dc (.75A) @ 50 °C (.2A) @ 60 °C -15V dc (-.75A) @ 50 °C (.2A) @ 60 °C +24V dc (2.0A) @ 50 °C (2.0A) @ 60 °C	Total of 130 Watts @ 50 °C, 96.4 Watts @ 60 °C with convection cooling, or 130 Watts @ 60 °C with minimum of 25 CFM
Line Monitor	--	Detects Loss of AC Power
Hold Up Time	6 msec	@ 130 Watts

3A.2 Servo Axis Connectors on the 9/230 Analog

The 9/230 analog control can be purchased as either a three axis controller or as a single axis controller. Both the single and three axis configurations have an additional open loop analog spindle output terminal.

A separate analog servo amplifier amplifies the signal from the 9/230 processor to deliver the power necessary to drive the servo motors. Refer to appendix D for analog drive options.

Position and velocity data are read from a feedback device that is mounted on the slide, ballscrew, or servo motor. This feedback device generates differential signals that are then fed to the processor. If the spindle motor incorporates an encoder (closed loop) it will supply spindle position feedback to the processor module. If you require a closed loop spindle you must connect the spindle drive to the last available axis connector (no closed loop spindle port is available on the single axis 9/230).

Most analog servo drive amplifiers require some form of velocity feedback from the servo motor. This feedback is usually generated by a tachometer or resolver attached to the motor shaft. Refer to your servo drive amplifier literature for details.

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3A.2.1 Connecting Axes to Analog Servo Interface

Axes are connected to the D-shell connectors marked J1, J2, and J3 (single axis 9/230 processors only have a J1 connector). Axes must be connected consecutively with no empty connections between axes. For example, an axis may not be connected to connector J3 unless both J1 and J2 are used.

If a spindle with feedback is configured the spindle must be connected to the first available D-Shell connector after the last connector used by a linear or rotary axis. If you have a closed loop axis on a single axis 9/230 control you can not connect a spindle with position feedback.

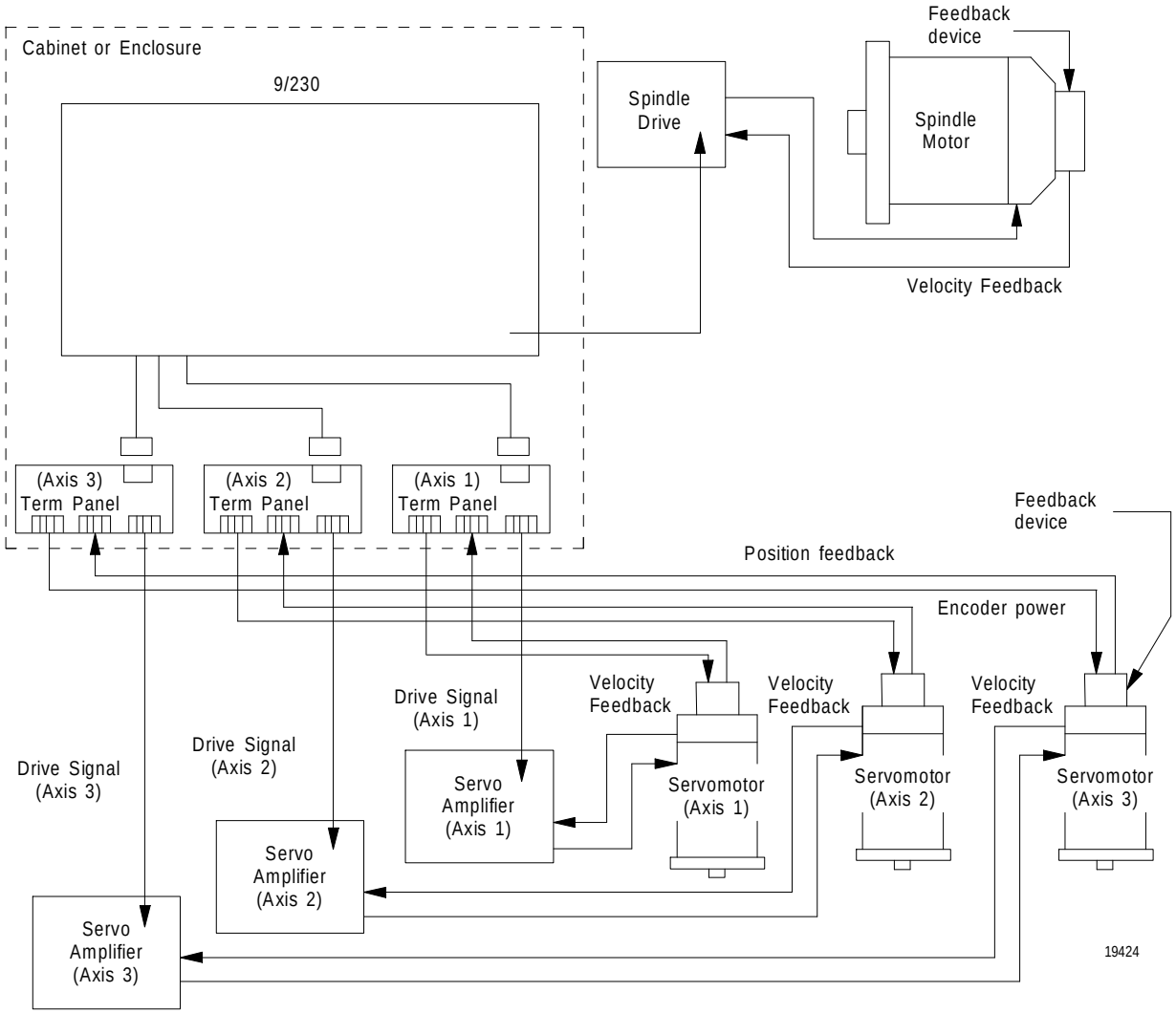


ATTENTION: Do not insert the plug-type ANALOG OUT terminal block (TB3) into an encoder termination panel DRIVE terminal block or vice versa. Although these plugs will fit together, pin assignments are different. Switching these connections without rewiring the plug-type terminal block may cause damage to equipment.

Figure 3A.8 and Figure 3A.9 show typical analog servo drive configurations for a mill and a lathe. For specific details on configuring axes, axis positioning loops, and axis port selection, refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4.

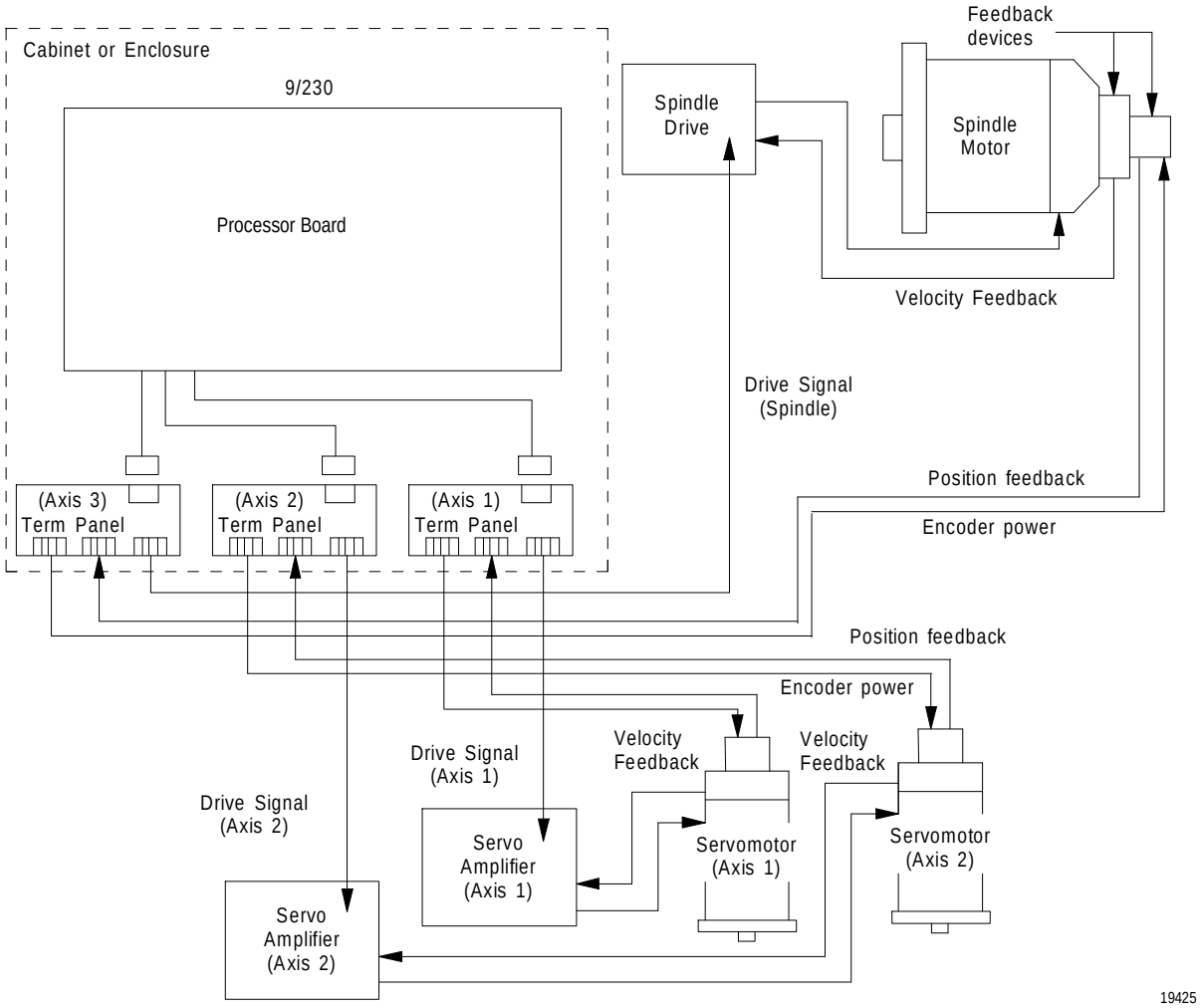
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Figure 3A.8
Typical Analog Servo Drive Configuration for a Mill



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Figure 3A.9
Typical Analog Servo Drive Configuration for a Lathe



For additional information on each of the major components refer to the section that covers that component.

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3A.2.2 Analog Servo Operation and Specifications

The Analog Servo control is a function at the 9/230 Analog processor board. The control calculates positioning and velocity data and processes the data to generate the necessary analog drive signals. These signals are sent to the analog servo amplifiers, which power the servo motors of the machine. The 9/230 Analog may control up to three closed loop axes and one open loop axis (typically used for a spindle).

The control receives position data from the axis feedback devices. It combines this position feedback data with the interpolated commands from the control to generate the command signals that are outputs to the servo amplifiers.

The function of the control on the processor module is designed to make the servomotors run with optimum performance. The maximum feedrates are limited by the mechanical abilities of the machine. System gain and the maximum allowable following error also limit the feedrates. These limits are entered as AMP parameters. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

Table 3A.E lists the analog servo output specifications. This table is provided as an aid to determine the compatibility of different analog servo amplifiers. This section contains a list of compatible analog servos. Input specifications are discussed in sections covering the individual input devices. Refer to Table 3A.I for encoder feedback input specifications.

Table 3A.E
Analog Servo Interface Output Specifications

Item	Specification	Remark
Output Voltage Range	±10V	
Output Offset Voltage	500mV Max.	
Resolution	1.22mV	(13 bits) [1]
Sampling Frequency	500 Hz	
Output Current	5mA Max.	
Load Range	2K ohms to infinity	
Conversion Time	8.25ms	
Differential Non-Linearity	±1 LSB Max.	[2]
Gain Error	±1 LSB Max.	
Load Capacitance	0.01mF Max.	

[1] This resolution is obtained through software. It is equal to a 13-bit numeric value with an additional sign bit (14 bits total).
[2] Monotonic over the entire temperature range. LSB means least significant bit.

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3A.2.3 Analog Servo Connectors and Pin Assignments

Table 3A.F lists the connectors that are used to integrate the analog servo connections with other modules of the control. If you have purchased the single axis 9/230 control, only one servo connector (J1), an open loop spindle connector (TB3), and the touch probe connector (TB2) is available.

Table 3A.F
Typical Processor Module Connection

Connector On	Connected To		Cable	Remark
	Module	Connector	Number	
J3 (D shell)[1]	Term. Panel	AXIS	C35	AXIS
J2 (D shell)[1]	Term. Panel	AXIS	C35	AXIS
J1 (D shell)	Term. Panel	AXIS	C35	AXIS
T.P. (TB2)	Touch Probe	--	C46	--
ANALOG OUT (TB3)	Spindle Drive		C42	Spindle
Remote I/O (P2)	PLC Scanner		C17	Page 8-19 has details on RIO (purchased as an option)

[1] - Not available on single axis 9/230 controls

J1, J2, and J3 D-Shell AXIS Connectors

The 9/230 sends drive signals to the servo amplifier through connectors labeled J1, J2, and J3. Figure 3A.10 shows an end view of connector J1, J2, and J3 and lists the pin assignments of these connectors.

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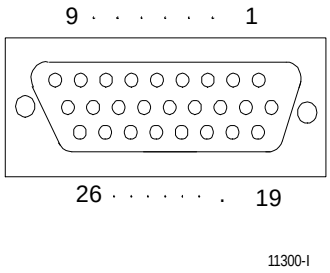


Figure 3A.10
Connectors J1, J2, and J3 - 26 Pin Female, D-Shell Connector

Pin No.	Signal	Description	Signal Destination
1	Not Used		
2	Not Used		
3	CHA_HI	Feedback device Channel A	Servo Module
4	CHB_HI	Feedback device Channel B	Servo Module
5	CHZ_HI	Feedback device Channel Z	Servo Module
6	+5V_ENC	+5V Encoder Power Supply	Feedback Device
7	+5V_ENC	+5V Encoder Power Supply	Feedback Device
8	SEN	Switched +5V Encoder Power Supply (not used)	Feedback Device
9	DRIVE	±10V analog drive command	Servo Amplifier
10	Not Used		
11	Not Used		
12	CHA_LO	Feedback device Channel A	Servo Module
13	CHB_LO	Feedback device Channel B	Servo Module
14	CHZ_LO	Feedback device Channel Z	Servo Module
15	Not Used		
16	GND	Encoder Power Return	Feedback Device
17	SEN. RET	Encoder Power Return	Feedback Device
18	DRIVE.RET	±10V analog drive command return	Servo Amplifier
19	Not Used		
20	Not Used		
21	SHLD_CHA	Shield for phase A	connect at module only
22	SHLD_CHB	Shield for phase B	connect at module only
23	SHLD_CHZ	Shield for phase Z	connect at module only
24	SHLD_+5V	Shield for +5V	connect at module only
25	SHLD_SEN	Shield for switched +5V	connect at module only
26	SHLD_DRV	Shield for drive command	connect at module only

ANALOG OUT Auxiliary Output Connector

An auxiliary analog output is provided through the connector labeled ANALOG OUT (TB3). This connector is typically used to command an analog spindle drive system with no position feedback. TB3 is not capable of receiving encoder feedback information. Figure 3A.11 shows the location of ANALOG OUT connector. Table 3A.G lists terminal assignments of this connector.

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Important: TB3 (labeled ANALOG OUT) should only be used for drive applications that do not require a feedback device. If a feedback is required, the output signal to the drive and its corresponding encoder feedback should be wired through one of the axis connectors J3, J2, or J1. A drive application with feedback would typically not use the connector TB3.

Figure 3A.11
Analog Out Connector, 3 Plug-type Terminal Block Connections

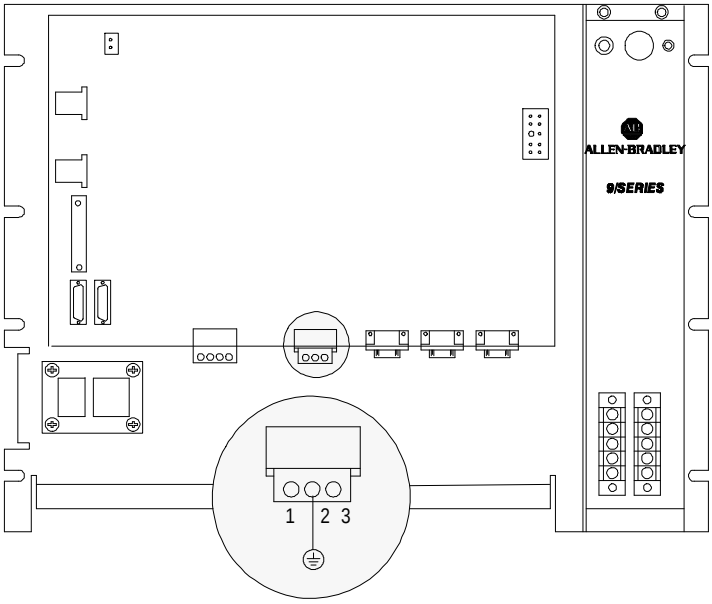


Table 3A.G
Analog Out Connector Terminal Assignments

Terminal No.	Signal	Description	Signal Destination
1	Analog Out +	±10V Analog with no feedback	(typically spindle drive)
2	Analog Out -	Signal Return and chassis ground	(typically spindle drive)
3	Shield		connect at control only

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3A.3 Analog Servo Amplifiers

The 9/Series CNC supports Allen-Bradley Series 1386, 1387, 1388, 1389, 1391, and 1392 analog servo drive systems. If you are using a 1387 drive, it must be equipped with 115V ac and the dynamic-braking option. Refer to appendix D for details on wiring one of these AB drives to your control.

Table 3A.H lists references to help you select a suitable drive system.

Table 3A.H
Compatible A-B Drives

A-B Drive	Publication No.	Title
1386	1386-5.0	DC PWM Servo Drive (Multi-Axis)
1387	1387-5.0	DC Spindle Drive (Analog) Product Data
1388	1388-5.1	DC PWM Servo Drive (Single Axis) Product Data Series B
1389	1389-5.1	AC Servo Amplifier (Multi-Axis) Product Data
1391	1391-5.0	AC Servo Amplifier (Single Axis) Product Data
1392	1392-5.1	High Performance AC Drive (460V and 230V) Product Data

The processor module provides a $\pm$ 10V analog velocity command output for up to four drive amplifiers. This analog voltage is generated from a 12-bit value plus an additional sign bit (13 bits total) and interfaces to drive amplifiers with a 2K-20K ohm range.

3A.4 Analog Servo Motors

Servo Motors are used to drive the axes of the machine because of their ability to respond accurately to small positioning commands. Typically they have two feedback devices mounted on them, one that provides position data to the processor module, and one that provides velocity data to the servo amplifier.

Any servo motor that meets the needs of your machine tool and is compatible with the servo amplifier that you will be using, can be used with the control.

Allen-Bradley has a wide selection of servo motors that can be used with the Allen-Bradley servo amplifiers. These motors can also be used with other servo amplifiers that are compatible with the servo interface. For more information on Allen-Bradley servomotors, contact your Allen-Bradley sales representative.

Motor installation and maintenance will depend on the type of motor used and the hardware to which it is mounted. For more specific information, refer to the documentation prepared by your drive and motor manufacturers.

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3A.5
Encoder Termination Panel

The encoder termination panels are options with the analog system that provide an easy and convenient means for you to connect and troubleshoot your servo system. We strongly recommend the use of termination panels as part of the system.

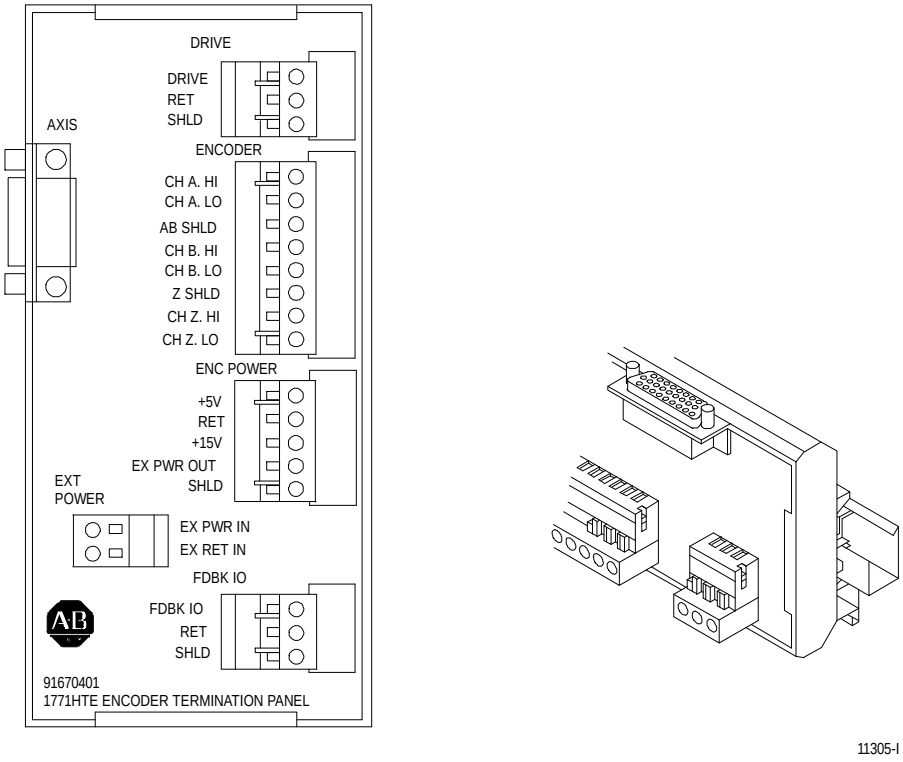
Termination panels feature:

- D-shell connectors for cables from the motion controller (A-B cable number 8520-TPC)
- Plug-type connectors for wiring to user devices
- DIN Rail Mountable

All user connections with the exception of the ANALOG OUT (TB3) and TP (TB2) connections are routed through the termination panels. User side voltages of +5V dc and +15V dc for encoder power (chosen by wiring to the appropriate connector pin) are available on-board. External power supplies for the encoders may also be routed through the termination panel (refer to the feedback section).

Figure 3A.12 shows an encoder termination panel.

Figure 3A.12
Encoder Termination Panel



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3A.6 9/230 Compatible Feedback Devices

This section discusses encoder feedback devices that are compatible for both analog and digital servo systems. Feedback devices on all the CNCs must return a 5V compatible output signal to the control.

For **analog systems** this feedback device can be used to provide:

- velocity feedback (used only if your system does not provide tachometer velocity feedback to the drive) In this case, the analog servo amplifier must be configured to run in "torque mode" with no tachometer. Tachless servo configurations work best if an encoder type feedback device is used and mechanically coupled directly to the servomotor shaft.
- position feedback (can be the same device as used to close the velocity loop if the velocity loop is closed by the CNC, or an additional feedback device, as discussed in this section, can be used for the position loop)
- spindle feedback

For **digital systems** this feedback device can be used to provide:

- position feedback (digital systems require the motor mounted feedback device, provided on our standard digital servo motors, be used for velocity loop feedback. This motor mounted feedback device can also be used to close the position loop or an additional feedback device, as discussed in this section, can be used for the position loop.) You can not replace or bypass the motor mounted feedback device. The motor mounted feedback device must be used for velocity feedback and to attain proper motor commutation on digital servo systems.
- spindle feedback

Only the 8520 digital drive system supports absolute feedback.

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The 9/230 supports:

Feedback Device	Additional hardware
Allen-Bradley 845H series differential encoders	--
Sony Magnascale model GF-45E	Board-type detector model MD10-FR
Heidenhain Model 704	External interpolation and digitizing model EXE602 D/5-F
Futaba Pulscale model FM45NY	PCB interface Module model CZ0180 with cable PCB020EA

Other feedback devices can be compatible if they comply with the specifications listed in Table 3A.I. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

This manual is written under the assumption that your system is using the Allen-Bradley 845H series differential encoder. If you are using some other feedback device such as a linear scale, an application note is available through Allen-Bradley CNC Commercial Engineering Department at area code (216) 646-3963.

The following table lists feedback specifications for a differential encoder however, this information can be interpreted to select an appropriate linear scale.

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Table 3A.I
Encoder Specifications

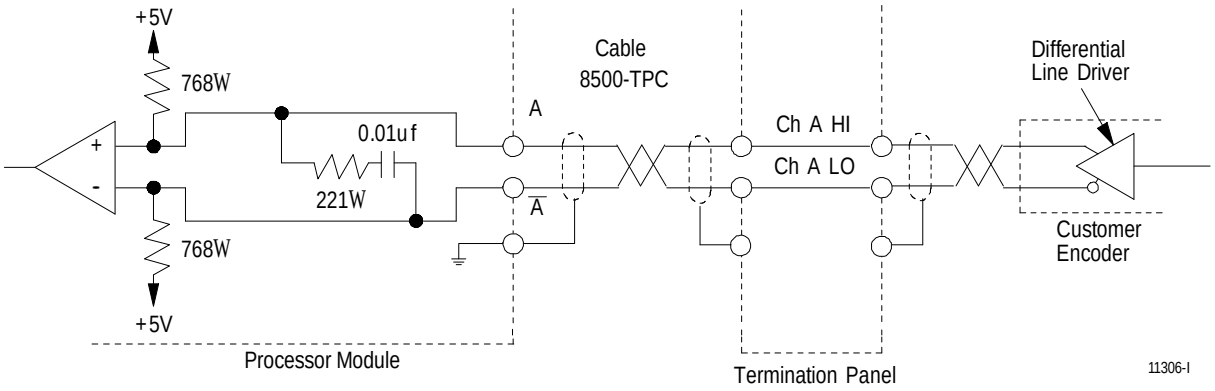
Item	Specification
Maximum Encoder Channel Frequency (ECF)	Use the following equation to determine the maximum channel frequency $\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90\text{-Eq}}\right) \text{ x } 1.15}$ Where: Clock - is the Control's Feedback Clock Frequency: 5×10^6 - for 9/230, 9/440, and three axis servo cards. 2.3×10^7 - for 9/260 or 9/290 systems using a four axis servo card E_Q = Quadrature Error in Degrees 1.15 = Our minimum recommended safety factor As long as the actual feedback channel frequency does not exceed the maximum channel frequency calculated above, the servo module should process the feedback data without a quadrature fault.
Maximum Axis Speed	Use the following equation to determine the maximum axis speed. Note that this equation does not take into consideration any mechanical deficiencies in the encoder or motor. It is only concerned with the 9/Series capability of receiving feedback. Refer to the manufactures specs for encoder and motor hardware RPM limitations. $\frac{(\text{ECF x } 60)}{(E)\ (N)\ (P)} = \text{Maximum Axis Speed}$ Where: Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute) ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec. E = the number of encoder lines between markers for your encoder N = the ratio of encoder turns to ballscrew turns P = the ballscrew pitch (turns per inch or turns per millimeter. For rotary axes, substitute the appropriate gear ration for N and P in the equation above to solve for a max RPM in revolutions per minute. If the maximum axis speed resulting from this equation is less than you would like, you may need to sacrifice some axis resolution by selecting an encoder with fewer lines between markers.
Input Signal	Encoder feedback must be differential format with 5V compatible output signals, single-ended open-collector outputs are not supported, i.e., channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent.
Current Drawn from Encoder by Servo Module	7mA maximum; 44mA peak
Marker Channel	Narrow marker (gated) or Wide marker (ungated) type markers are supported
Encoder Cable Length	Refer to 9/Series Integration and Maintenance Manual for details on cabling

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3A.6.1 Wiring an Incremental Feedback Device

Figure 3A.13 shows an incremental feedback device equivalent circuit for feedback channel A.

Figure 3A.13
Incremental Feedback Device Equivalent Circuit



Wiring Position Feedback

Feedback devices used with the control must be configurable such that the marker Z is true at the same time that channels A & B are true. If you are using an Allen-Bradley 845H encoder this requirement will already be met if you wire them as shown in the cable diagrams on page 7A-1.

If you are using an encoder type feedback device other than the Allen-Bradley 845H encoder, then use the following wiring procedure:

1. Obtain the encoder output timing diagram from the vendor's data sheets. A typical one is provided in Figure 3A.14 as an example.

2. On the timing diagram, look at the marker Z and its complement, marker $\overline{Z}$. Whichever one is low for most of the encoder revolution and pulses high should be wired to "CH Z.HI" of the encoder termination panel. Wire the remaining marker to "CH Z.LO" of the encoder termination panel.

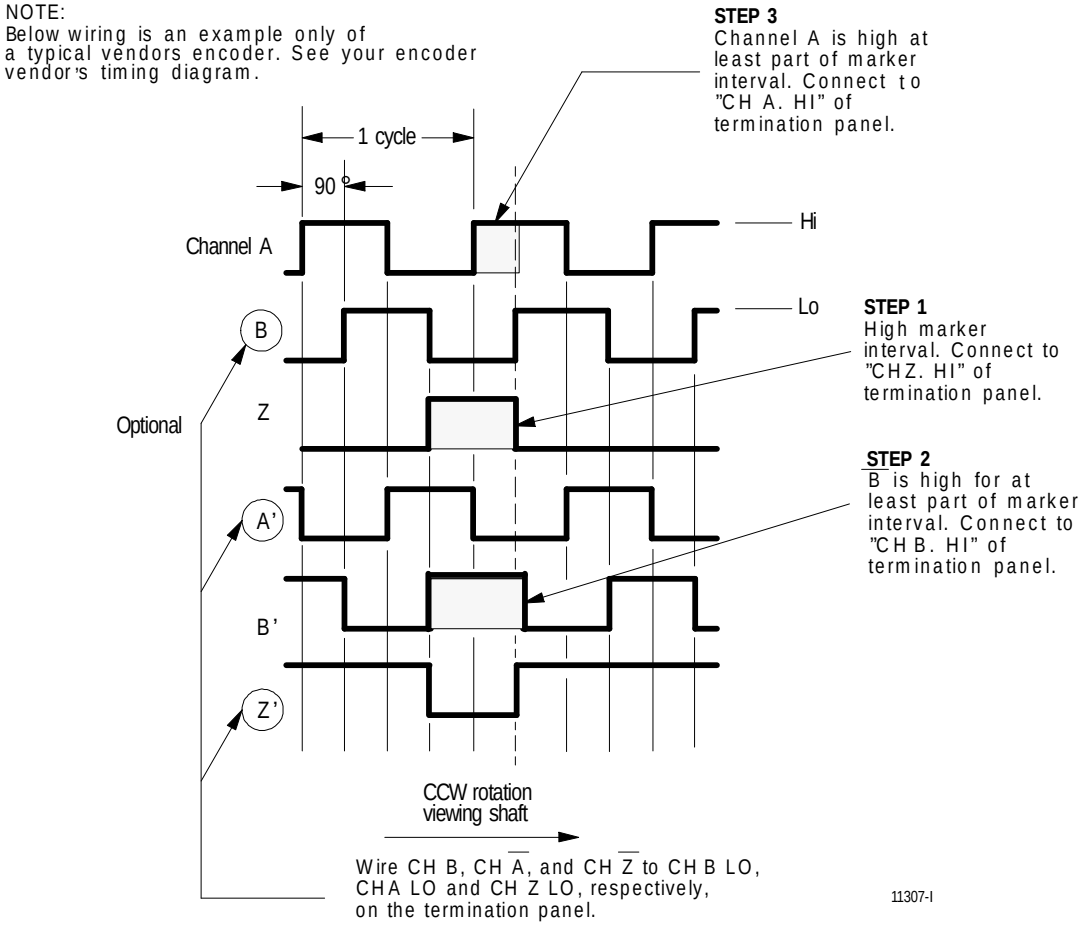
3. Look at channel B and its complement, channel $\overline{B}$. Whichever one is high for at least part of the marker interval should be wired to "CH B.HI" of the encoder termination panel. It is possible that both channels meet this requirement depending on the encoder manufacturer, in which case, use either one. Wire the remaining channel to "CH B.LO" of the encoder termination panel.

4. Look at channel A and its complement channel $\overline{A}$ and repeat as in step 3 using "CH A.HI" and "CH A.LO" of the encoder termination panel.

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If the previous procedure is not performed correctly, inconsistent homing of the axis may occur. If your encoder phasing cannot provide an interval at which the marker and both channels are simultaneously true, the encoder should be considered incompatible with the control.

Figure 3A.14
Example of a Typical Vendor Encoder Timing Diagram



Important: Since positive and negative axis directions can be assigned without regard to encoder rotation directions, it is possible for the feedback direction to be "backwards". This is easily corrected before attempting to command axis motion through the AMP parameter Sign of Position Feedback**.** Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

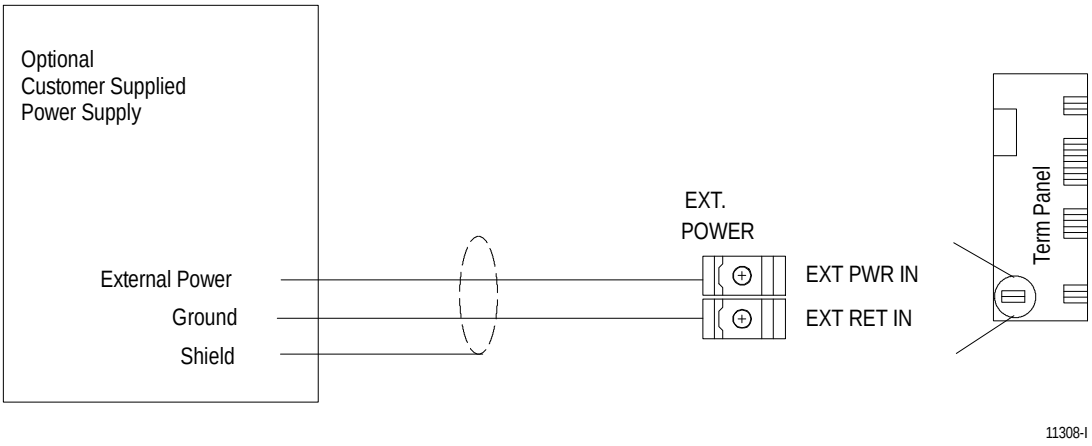
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Wiring Power for your Feedback Device (Analog Systems Only)

The control supports feedback devices with 5v compatible output signals. The voltage that these feedback devices require may vary. The processor module is equipped to supply 5V dc power to feedback devices. These voltages may be accessed directly from the encoder termination panel

If your feedback device requires an external power supply, it may be easily incorporated through the EXT. POWER connector on the termination panel. Power is then output through the ENC POWER connector terminal labeled EX PWR OUT. The following figure shows the termination panel connection for EXT. POWER. Refer to page 7A-1 for details on wiring to ENC POWER.

Figure 3A.15
Wiring Optional Customer Supplied Power Supply for Feedback Devices



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3A.7 Servo Axis Connectors on the 9/230 Digital CNC

There are two different digital 9/230 systems. One is used to support the 8520-xx series of digital amplifiers (its catalog number is 8520-DSP). The other supports 1394-xx series of digital servo amplifiers (its catalog number is 8520-CSP). Both 9/230 digital systems support a maximum of three axes, each having a servo motor and feedback device, and an open loop spindle motor.

The servo amplifier amplifies the signal from the 9/230 processor in order to deliver the power necessary to drive the servo motors.

Position and velocity data are read from a feedback device that is mounted on the servo motor. If the spindle motor incorporates an encoder it must supply spindle position feedback to the processor module.

3A.7.1 Connecting Axes to Digital Servo Interface

Axes are connected to the D-shell connectors that are at the bottom edge of the processor board. Axes must be connected consecutively with no empty connections between axes. If a spindle with feedback is configured the spindle must be connected to the first available D-Shell connector after the last connector used by a linear or rotary axis.

Figure 3A.16 and Figure 3A.17 show typical digital servo drive configurations for a 8520 system and a 1394 system respectively. For specific details on configuring axes, axis positioning loops, and axis port selection, refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4.

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Figure 3A.16
Typical 8520 Digital Servo Drive Configuration

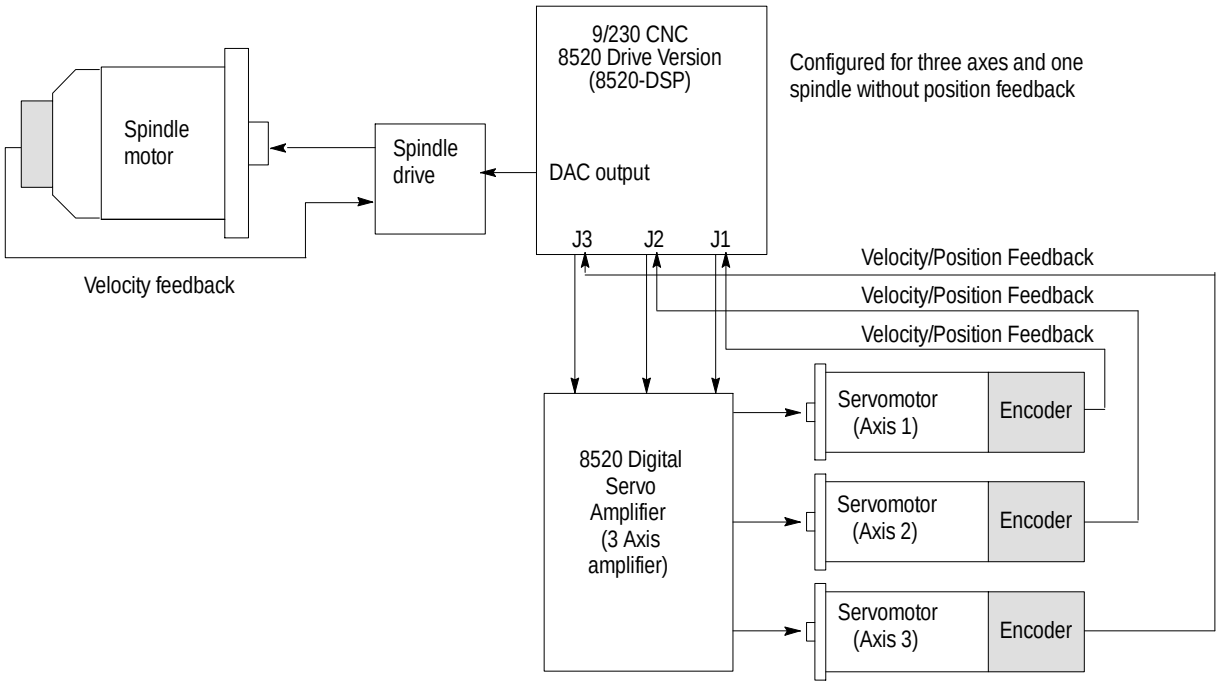
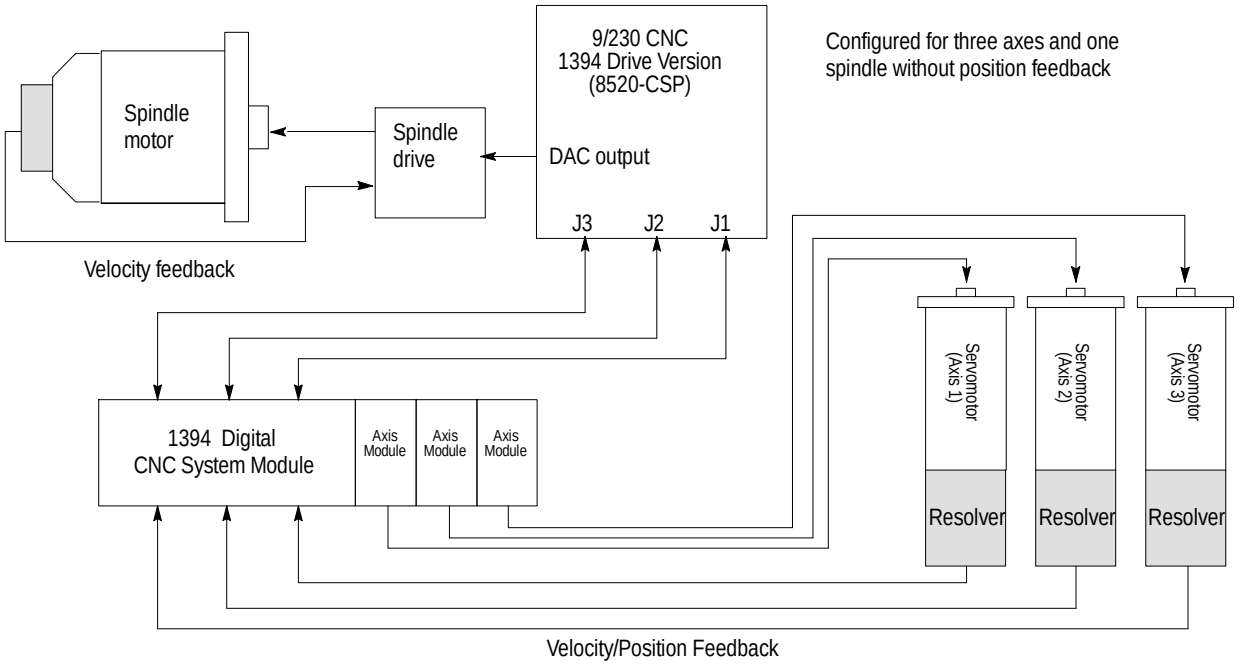


Figure 3A.17
Typical 1394 Digital Servo Drive Configuration



For additional information on each of the major components refer to the section that covers that component.

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3A.7.2 Digital Servo Operation and Specifications

The Digital Servo control is a function at the 9/230 Digital processor board. The control calculates positioning and velocity data and processes the data to generate the necessary digital drive signals. These signals are sent to the digital amplifiers which power the servo motors of the machine. The 9/230 Digital may control up to three closed loop axes and one open loop axis (typically used for a spindle).

The control receives position data from the axis feedback devices. On a 1394, system position data is converted to an A quad B signal in the 1394 drives system module. The control combines this position feedback data with the interpolated commands from the control to generate the command signals that are outputs to the servo amplifiers.

The 9/230 control is designed to make the servomotors run with optimum performance. The maximum feedrates are limited by the mechanical abilities of the machine. System gain and the maximum allowable following error also limit the feedrates. These limits are entered as AMP parameters. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

Table 3A.J lists the digital servo output specifications. Refer to Table 3A.I for 8520 encoder feedback input specifications or appendix H for 1394 systems. Be aware that encoders or resolvers are mounted directly to the digital motor shaft before they are shipped and should not be removed. Use only if you intend to use a second feedback device for an axis.

Table 3A.J
Digital Servo Interface Output Specifications

Item		Specification	Remark
PWM Output (8520 digital only)	PWM Frequency	Approx. 2.0 KHz	
	PWM Signal Type	RS-422-A	
Comutated Output (1394 digital only)	Comutated Signal IA and IB	Approx. 1000 Hz	(±12 bits)
DAC Output	Output Voltage Range	±10V	
	Resolution	2.44mV	(±12 bits)
	Sampling Frequency	1000 Hz	
	Output Current	5mA Max.	
	Load Capacitance	0.01mF Max.	

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3A.7.3 9/230 Digital Connectors and Pin Assignments

The 9/230 CNC sends drive signals to the servo amplifier and receives feedback through these connectors. Figure 3A.18 and Figure 3A.19 show an end view of a digital servo connector and lists its pin assignments for the 8520 and 1394 digital 9/230 CNC's respectively.

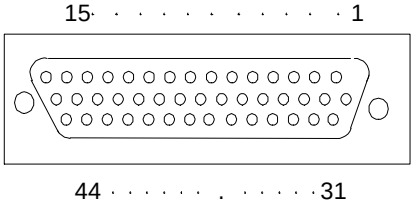


Figure 3A.18
Pinout for the Servo Connectors on the 9/230 8520 Digital

Pin	Signal	Description	Connect	Pin	Signal	Description	Connect
1	Shield	Chassis Ground	Not Used	23	EXT_BAT	Battery +/- for absolute encoder	Feedback Device
2	CHU_HI	Channel U Sense_HI	Feedback Device	24	+5V_ENC	+5V Encoder Power Supply	
3	CHV_HI	Channel V Sense_HI		25			
4	CHW_HI	Channel W Sense_HI		26			
5	/PWM_A_LO	Current Cmd for Phase A_LO	Servo Amplifier	27			
6	/PWM_B_LO	Current Cmd for Phase B_LO		28	GND	Encoder Return	Feedback Device
7	/PWM_C_LO	Current Cmd for Phase C_LO		29			
8	STATUS	Amplifier Status_HI		30	Shield	Chassis Ground	Not Used
9	CHZ_LO	Feedback device Channel Z	Feedback Device	31			
10	CHB_HI	Feedback device Channel B		32	CHU_LO	Channel U Sense_LO	Feedback Device
11	CHA_HI	Feedback device Channel A		33	CHV_LO	Channel V Sense_LO	
12	$I_{FDBK\ Phase\ B}$ (Ib)	Current sensing from feedback Phase _B		34	CHW_LO	Channel W Sense_LO	
13	ENABLE	Motor Amplifier Enable_HI	Servo Amplifier	35	PWM_A_HI	Current Cmd for Phase A_HI	Servo Amplifier
14	$I_{FDBK\ Phase\ A}$ (Ia)	Current sensing from feedback Phase _A	Feedback Device	36	PWM_B_HI	Current Cmd for Phase B_HI	
15	GND	Encoder Return		37	PWM_C_HI	Current Cmd for Phase C_HI	
16				38	/STATUS	Amplifier Status_LO	
17	+15V_ENC	+15V Encoder Power Supply		39	CHZ_HI	Feedback device Channel Z	Feedback Device
18				40	CHB_LO	Feedback device Channel B	
19	GND	Encoder Return		41	CHA_LO	Feedback device Channel A	
20	+5V_ENC	+5V Encoder Power Supply		42	$/I_{FDBK\ Phase\ B}$ (/Ib)	Current sensing from feedback Phase _B	
21				43	/ENABLE	Motor Amplifier Enable_LO	Servo Amplifier
22				44	$/I_{FDBK\ Phase\ A}$ (/Ia)	Current sensing from feedback Phase _A	Feedback Device

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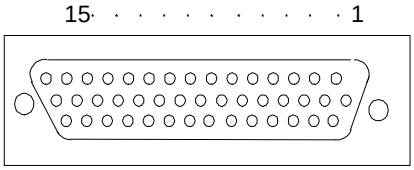


Figure 3A.19
Pinout for the Servo Connectors on the 9/230 1394 Digital

Pin	Signal	Description	Signal Destination
1	Shield	Chassis Ground	N/A
2	CHU_HI	Channel U Sense_HI	Servo Module
3	CHV_HI	Channel V Sense_HI	
4	CHW_HI	Channel W Sense_HI	
5	V_A	Command Voltage	CNC Interface Board
6			
7			
8	STATUS	Amplifier Status_HI	CNC Interface Board
9	CHZ_LO	Feedback device Channel Z	Servo Module
10	CHB_HI	Feedback device Channel B	
11	CHA_HI	Feedback device Channel A	
12			
13	ENABLE	Motor Amplifier Enable_HI	CNC Interface Board
14			
15	GND	Signal Common	CNC Interface Board
16	GND	Ground 24V input return	
17			
18			
19	GND	Signal Common	CNC Interface Board
20	+5V_ENC	+5V Encoder Power Supply	Feedback Device
21			
22			
23			
24	+5V_ENC	+5V Encoder Power Supply	Feedback Device
25			
26			
27			
28	GND	Encoder Return	CNC Interface Board
29	GND	Signal Common	CNC Interface Board
30	Shield	Chassis Ground	n/a
31	GND	Motor Amplifier Enable_LO	CNC Interface Board
32	CHU_LO	Channel U Sense_LO	Servo Module
33	CHV_LO	Channel V Sense_LO	
34	CHW_LO	Channel W Sense_LO	
35	V_B	Command Voltage	CNC Interface Board
36			
37			
38	/STATUS	Amplifier Status_LO	CNC Interface Board
39	CHZ_HI	Feedback device Channel Z	Servo Module
40	CHB_LO	Feedback device Channel B	
41	CHA_LO	Feedback device Channel A	
42			
43	Return	Drive Return	Servo Module
44			

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ANALOG OUT Auxiliary Output Connector

An auxiliary analog output is provided through the connector labeled ANALOG OUT. This connector is typically used to command a spindle drive system with no position feedback. This connector is not capable of receiving encoder feedback information. Figure 3A.20 shows the location of ANALOG OUT connector. Table 3A.K lists terminal assignments of this connector.

Important: For spindle applications, you need to wire the drive to the analog out connector, and the feedback to a servo connector (J1, J2, or J3).

Figure 3A.20
Analog Out Connector, 3 Plug-type Terminal Block Connections

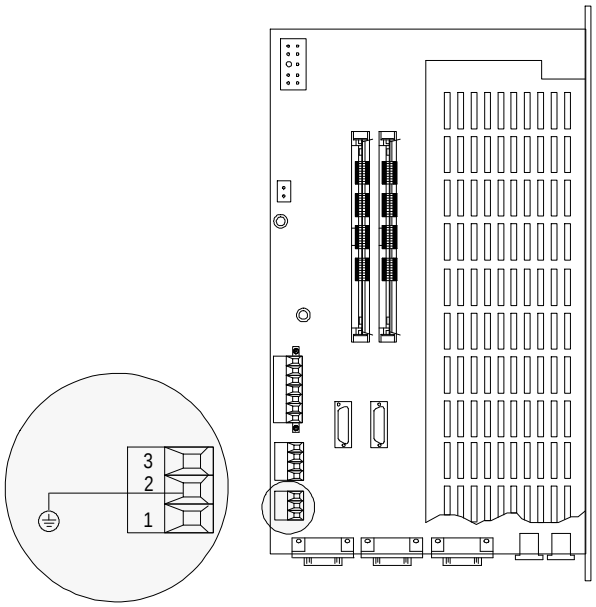


Table 3A.K
Analog Out Connector Terminal Assignments

Terminal No.	Signal	Description	Signal Destination
1	Analog Out +	±10V Analog with no feedback	(typically spindle drive)
2	Analog Out -	Signal Return and chassis ground	(typically spindle drive)
3	Shield		connect at control only

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3A.7.4 Digital Servo Amplifiers

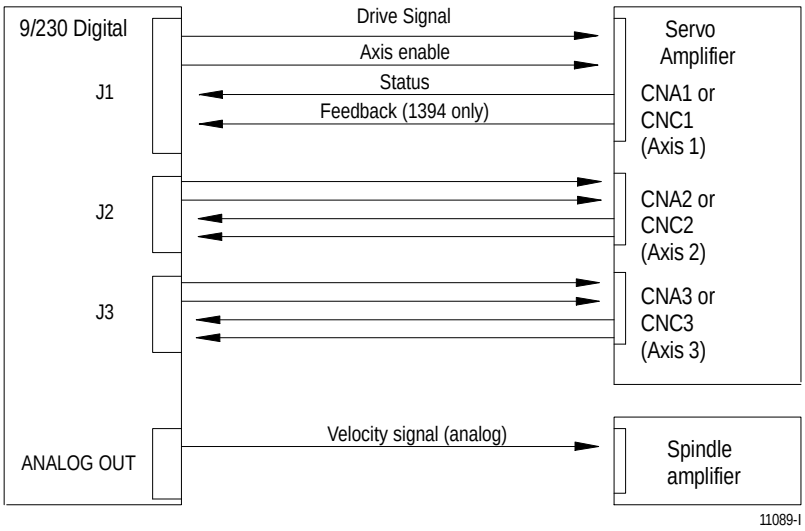
Two versions of the 9/230 digital are available which interface to the 8520 digital amplifier or the 1394 digital amplifier. Do not attempt to interface an 8520 digital 9/230 to a 1394 drive or a 1394 digital 9/230 to an 8520 digital drive. These two systems are mutually exclusive.

Both the 1394 and 8520 digital servo amplifiers receive an "Axis enable" signal and returns a "Drive OK" signal from/to the 9/230 digital CNC provided certain system and motor tests are successful.

Important: The digital servo amplifier should be separated or isolated from the processor module because of the electrical noise it generates. Refer to page 7A-1 for unit mounting spacing and other noise prevention techniques that will have to be followed when installing 8520 digital amplifiers. Refer to your 1394 Amplifier documentation for details on installing 1394 drive systems.

Figure 3A.21 shows the interface between the digital servo interface and the servo amplifier.

Figure 3A.21
Digital Servo Amplifier Interface



Important: The configuration of the digital servo module output ports with the digital servo amplifier connectors will vary depending on the AMP configuration of the system. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

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3A.7.5 Digital Servo Motors

The digital servo motors are used to drive the axes of the digital servo drive system. The digital servo motors have a feedback device mounted on them that provides position and velocity data to the servo module. This motor mounted feedback device must never be removed from the digital motor. Even a slight change in the feedback devices orientation relative to the motor shaft will cause improper motor commutation. This motor mounted feedback device provides the control with velocity and motor commutation information. It is also typically used for position feedback.

A second feedback device can be mounted directly on the axis (such as a linear slide) to provide greater precision for positioning feedback. On these systems with multiple feedback devices, the motor mounted feedback must still be used for motor commutation and velocity feedback.

The digital servo motors that the 8520 9/230 Digital CNC supports are listed in the appendix titled Digital Motor Dimensions. This appendix lists all compatible 8520 series motors in two sections. The first section lists motors that include holding brakes, and the second section list motors without holding brakes.

The 1394 9/230 Digital CNC supports 1326 digital servo motors. For more information on this Allen-Bradley family of motors, refer to the 1326AB Torque Plus Series Servomotors Product Data, publication 1326A-2.9.

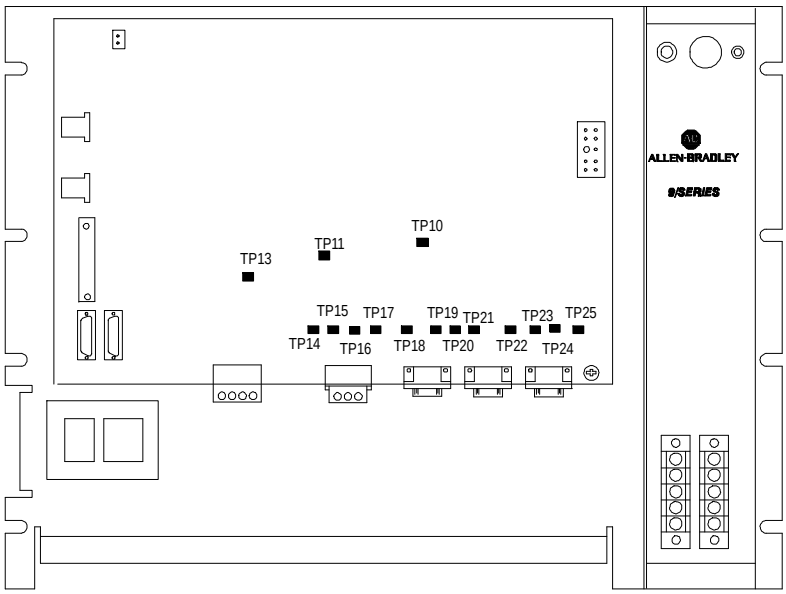
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3A.8 Using Test Points

Test points are small metallic pins on the processor module circuit board. Hardware troubleshooting and testing for proper wiring can begin by testing for proper voltage or signals at these pins. Test points are labeled with the letters TP followed by a number. Use Figure 3A.22 to find the location and function of each test point on the 9/230 Analog CNC. Use Figure 3A.23 to find the location and function of each test point on the 9/230 Digital CNC.

Figure 3A.22
Test Points on the 9/230 Analog

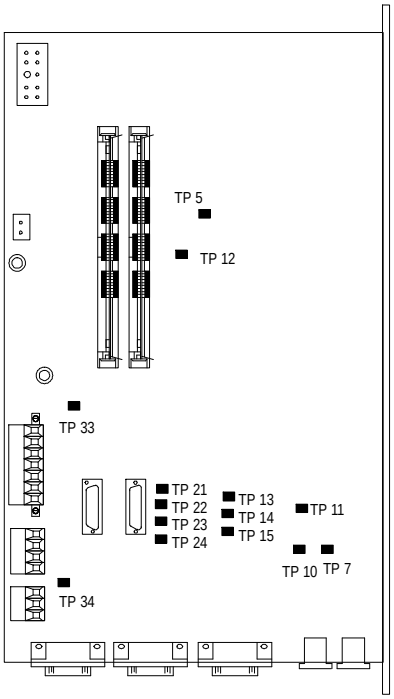
Test Point	Analog DAC reference
TP11	Analog Ground
Test Point	**Encoder Feedback Reference Voltage**
TP10	Digital Ground
Test Point	**Encoder Feedback Signals**
TP25	A Channel connector J1
TP24	B Channel connector J1
TP23	Z Channel connector J1
TP22	Analog out J1
TP21	A Channel connector J2
TP20	B Channel connector J2
TP19	Z Channel connector J2
TP18	Analog out J2
TP17	A Channel connector J3
TP16	B Channel connector J3
TP15	Z Channel connector J3
TP14	Analog out J3
TP13	Analog Out TB3



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Figure 3A.23
Test Points on the 9/230 Digital

Test Point	Analog Out Signal (Spindle)
TP34	DAC Spindle Output
TP33	Analog Output
Test Point	**Encoder Feedback Signals**
TP22	A Channel connector J1
TP23	B Channel connector J1
TP24	Z Channel connector J1
TP11	A Channel connector J2
TP10	B Channel connector J2
TP21	Z Channel connector J2
TP15	A Channel connector J3
TP14	B Channel connector J3
TP13	Z Channel connector J3
Test Point	**Other Signals**
TP5	Digital Ground
TP12	Reset Pin (Connect to Analog GND to Reset)



3A.9 Wiring a Touch Probe to the Processor Module

Connect a touch probe to the connector labeled TP on the processor module (TB2). Connector terminal identification is provided in Figure 3A.24. Touch probe cable information can be found on page 7A-1 of this manual.

The time delay between the processor module receiving the touch probe trigger and latching the current axis position is negligible. However, you should be aware of any external delays that may introduce position "staleness" in the probing operation, especially at high probing speeds.

It is a good idea to establish an offset for the distance between the actual location, as sensed by the probe at a very low speed, and the location sensed by the probe at the intended probing speed. The offset can then be added or subtracted to any future values obtained through probing. This helps make sure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is removed from the measurement (assuming the external delay is repeatable).

The motion controller touch probe interface is intended for use with units that offer 5V dc compatible solid state relay outputs. Other configurations can be supported as long as the user operates within the published electrical specifications.

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The touch probe circuitry resident on the processor module only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, position data is captured , and additional occurrences of the trigger signal have no effect until the probe is reenabled under program control.

Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

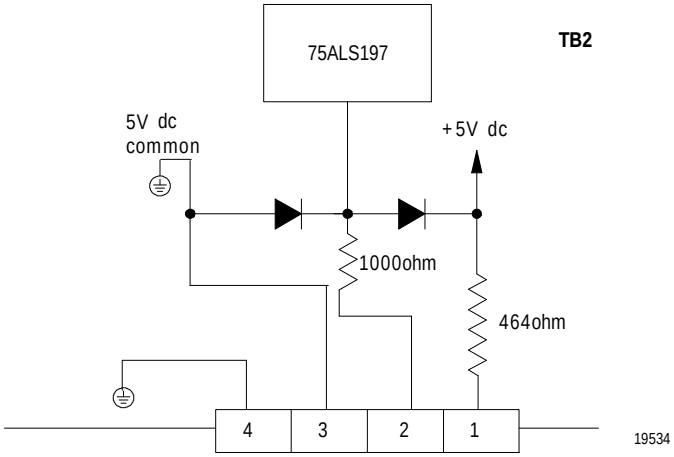


ATTENTION: It is preferred, from a safety standpoint, that the touch probe relay be closed at rest and open when the touch probe stylus deflects. Then, if a wire breaks or shorts to ground, it will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort towards the fail-safe operation of the touch probe. Not all vendor's touch probe control units conform to this safety consideration.

Figure 3A.24 shows the internal processor module circuitry that interfaces to the touch probe connector. It is shown here to assist you in determining whether your touch probe hardware is compatible.

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Figure 3A.24
Internal Circuitry Supporting the Touch Probe



The following table indicates probing threshold voltages. Maximum Input Threshold (critical if the control has been configured to fire on the falling edge of the probe signal) indicates the voltage that the probe signal must fall below to be considered as “fired”. Minimum Input Threshold (critical if the control has been configured to fire on the rising edge of the probe signal) indicates the voltage that the probe signal must rise above to be considered as fired

Probe Thresholds	Voltage at Threshold
Minimum Input Threshold (probe circuit)	2.875 (min)
Maximum Input Threshold (probe circuit)	2.125V dc (max)

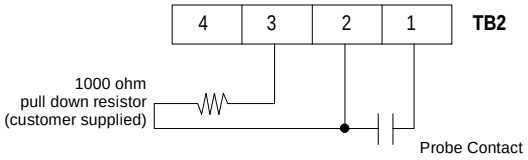
To avoid misfires use the threshold values from the above table to determine the necessary signal voltage for steady state operation (probe not fired). For probes configured to fire on the falling edge the steady state voltage must remain above 2.875 volts. For probes configured to fire on the rising edge the steady state voltage must remain below 2.125 volts.

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Wiring a Probe for Rising Edge Configurations

Typical wiring of a simple contactor type touch probe configured to fire on the rising edge of the probe signal, requires the addition of a 1000 ohm pull down resistor. Figure 3A.25 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

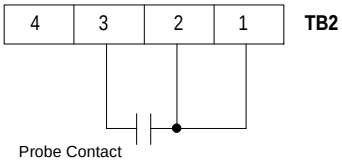
Figure 3A.25
Typical Wiring of a Touch Probe Configured for Rising Edge Trigger



Wiring a Probe for Falling Edge Configuration

Figure 3A.26 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

Figure 3A.26
Typical Wiring of a Touch Probe Configured for Falling Edge Trigger



3A.10 Adaptive Depth Probing

Use the Adaptive Depth probe feature to enable an adaptive depth probe that monitors tool depth relative to the actual part surface. This feature allows:

- a more flexible part mounting system (small changes to part size or part mounting do not require reprogramming of the machine or station)
- greater accuracy with a less accurate machine drive system (tool position is relative to the part surface rather than the machine home)
- a retroactive change in axis positioning resolution (feedback for axis positioning switches between the normal axis encoder and the adaptive depth probe once the probe is triggered).

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Important: Since the adaptive depth probing feature requires one feedback port to pass probe position data to the control and one feedback port for normal axis positioning feedback, the adaptive depth feature is not compatible with the single axis 9/230 processor which only has one feedback port.

The adaptive depth probe is wired like any A quad B rotary encoder. It is connected to one of the controls feedback ports. Refer to page 7A-1 for details on cabling requirements for a feedback device. Table 3A.I lists specifications for an encoder. These same specifications apply to your adaptive depth probe.

If you are using the adaptive depth probe to close the position loop (selected in AMP) the maximum axis speed calculations from Table 3A.I also apply. Refer to your AMP reference manual for details on other configuration required to operate using an adaptive depth probe.

In AMP the adaptive depth probe is assigned an axis name. Using the axis monitor page for that axis (see page 15A-35) you can view the current following error on the adaptive depth probe and the adaptive depth probe position relative to zero. The probe is zeroed automatically at power up or through PAL.

END OF SECTION

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Section **3B**

Power Distribution

3B.0 Section Overview

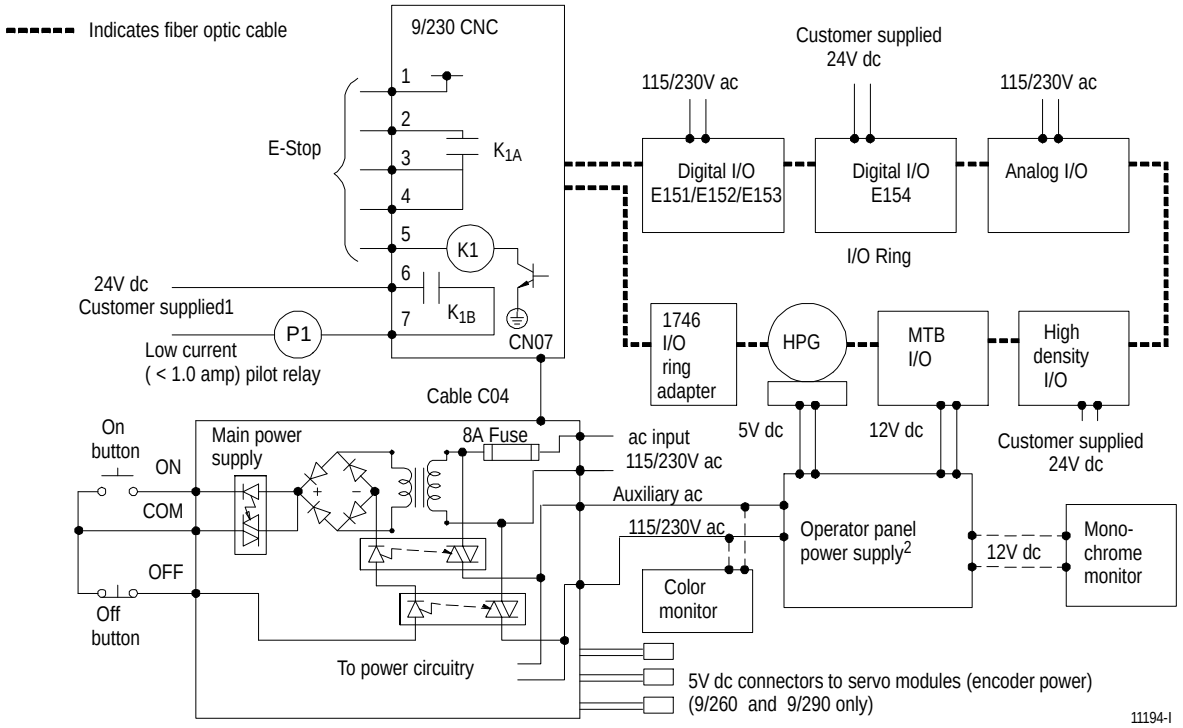
Once you have planned your system layout, you can begin connecting power and components to your system. In this section we discuss:

- how ac power is distributed through the system
- connecting the main power supply and operator interface power supply
- main and operator panel power supply input power specifications
- protective grounding

The external ac power connections to the control and operator panel are covered in this section. For information on external ac power source connections to servo amplifiers, servo motors, and I/O modules, refer to the sections that cover these components. For details on external ac power source connections to an analog servo amplifier or analog servo motor, refer to the documentation provided by the manufacturer.

Figure 3B.1 shows the power distribution from the supply to the control and its components.

Figure 3B.1
Power Distribution from the Supply to the Control and its Components



[1] May not be necessary on PS2 24V is part of the power supply.
[2] May be mounted on operator panel or portable operator panel interface assembly.

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3B.1 Connecting the PS2 Main Power Supply

This section discusses the connections of the main power supply and the operator panel power supply.

Connecting the Main Power Supply to AC Power Source



ATTENTION: To guard against electrical shock hazards, never make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

Important: In addition to supplying power to the operator panel power supply, the main power supply also supplies power to the motherboard and the CPU board. As shown in Figure 3B.2, the power cables for these modules originate from the side of the main power supply.

Refer to Figure 3B.2 while performing these steps:

1. Locate AC-IN, L1, L2, and PE on terminal block BT04.

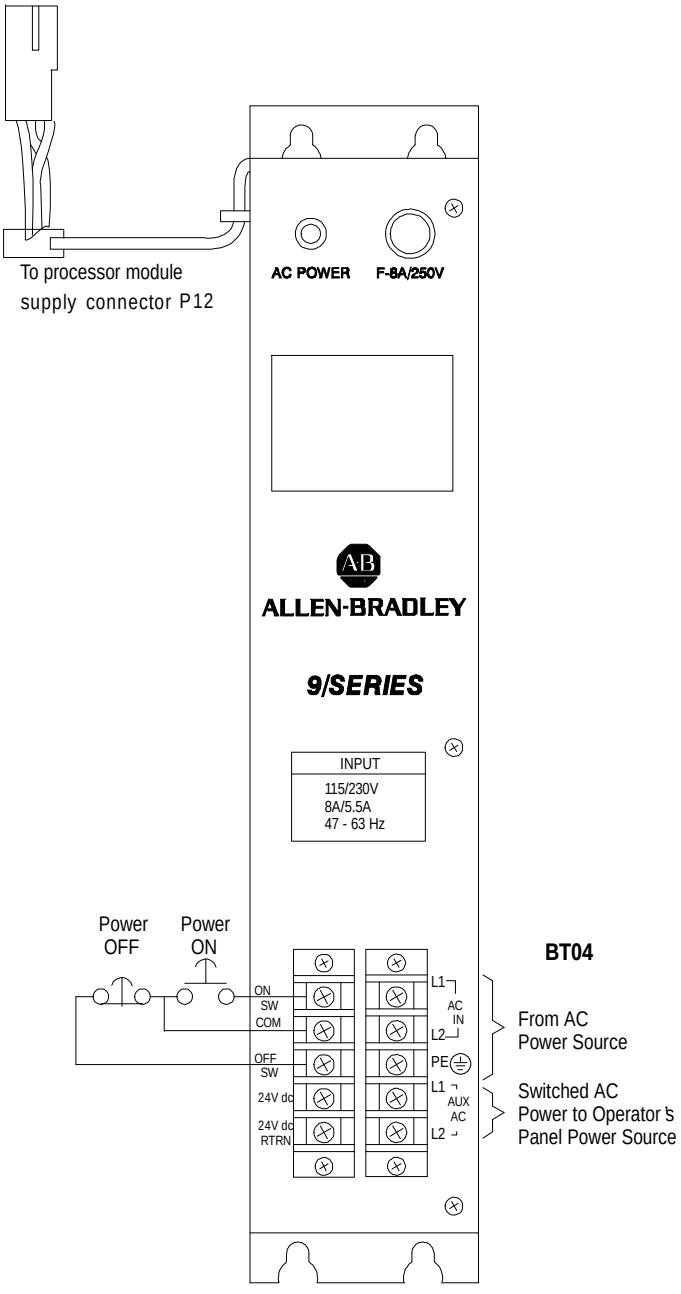
2. Connect the ac power source cable (C02) from the external ac power source to AC-IN, L1, L2, and PE on BT04.

3. Connect the chassis ground terminal to the cabinet's grounding bus bar.

Important: The chassis ground terminal connects to the control chassis and designated cable shields. Power supply common is AC coupled to chassis ground. It is the users responsibility to determine if a direct connection to cabinet ground bus is required.

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Figure 3B.2
Main Power Supply Connection for the 9/230



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3B.2 Main and Operator Panel Power Supply Input Power Specifications

The input power specifications of the main power supply, the operator panel power supply, and the portable operator panel interface module power supply are shown in Table 4D.A and Table 4D.B. For output power specifications of the main power supply for the 9/260 and 9/290, refer to page 4A-10. For output power specifications of the operator panel power supply, refer to page 9A-7.

Table 3B.A
Main Input Power Specifications

Item		Specifications	Remark
Input	Rated Input	115V/230V ac -- 50/60Hz	
	Input Range	90-265V ac -- 47-63Hz	
	Power Consumption 8520-PS1 8520-PS2A	225 Watts @ 50 °C 130 Watts @ 50 °C	168 Watts @ 60 °C or 225 Watts with min. 25 CFM 96.4 Watts @ 60 °C or 130 Watts with 25 CFM
	Fuse	8A/250V	Protects power supply module and sub-power supply and the color CRT
	Connection	Terminal Block	

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Connecting the Main Power Supply to the Monochrome Operator Panel Power Supply

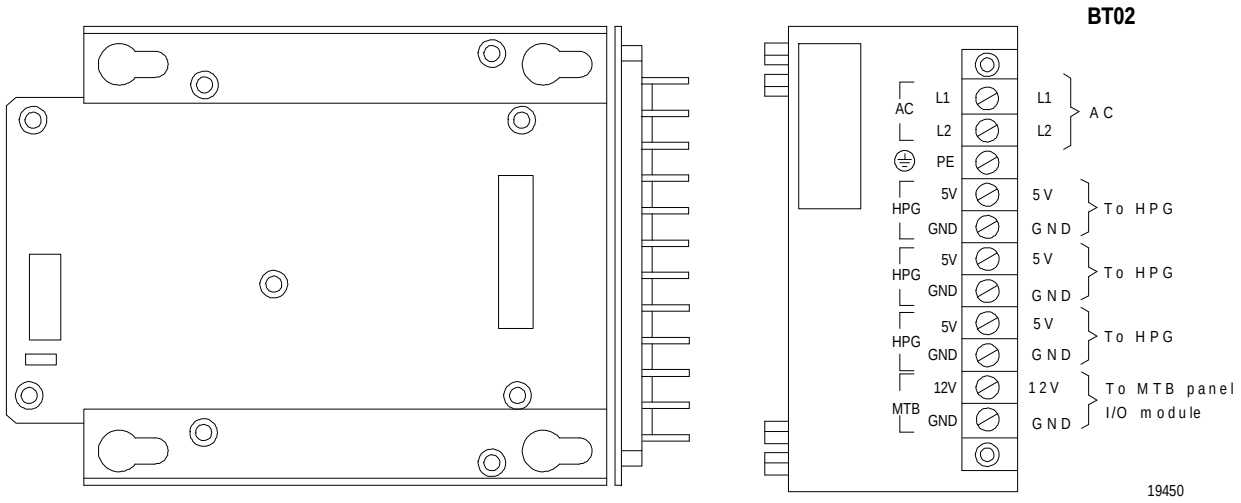
You connect the operator panel power supply directly to the main power supply. Refer to Figure 3B.2 and Figure 3B.3 when performing these steps:

1. Use the ac power supply cable (C03) to connect terminals AUX-AC L1 and L2 of terminal block BT04 on the main power supply to terminals L1 and L2 of terminal block BT02 on the operator panel power supply.

2. Connect the chassis ground terminal on the operator panel power supply to the cabinet's grounding bus bar.

Important: The chassis ground terminal connects to the operator panel chassis and designated cable shields. Power supply common is AC coupled to chassis ground. It is the user's responsibility to determine if a direct connection to cabinet ground bus is required.

Figure 3B.3
Power Supply Connector on Monochrome Operator Panel



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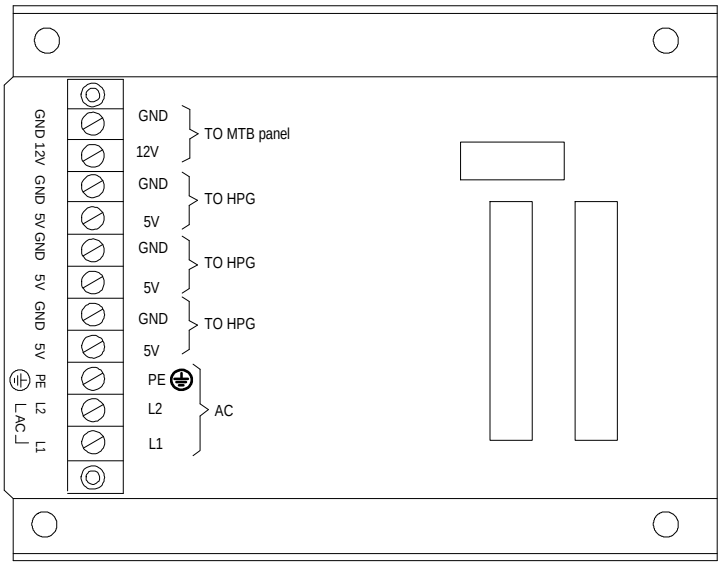
Connecting the Main Power Supply to the Portable Operator Panel Interface Assembly Power Supply

You connect the Portable Operator Panel Interface Assembly power supply directly to the main power supply. Refer to Figure 3B.2 and Figure 3B.4 when performing these steps:

1. Use the ac power supply cable (C03) to connect terminals AUX-AC L1 and L2 of terminal block BT04 on the main power supply to terminals L1 and L2 of terminal block BT02 on the power supply for the portable operator panel interface module.

2. Connect the chassis ground terminal on the portable operator panel interface assembly power supply to the cabinet's grounding bus bar.

Figure 3B.4
Power Supply Connector on Portable Operator Panel Interface Assembly

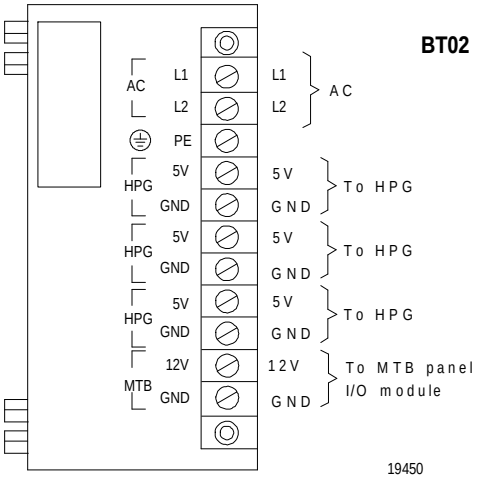


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Connecting Main Power Supply to the Color Operator Panel

You connect the operator panel power supply directly to the main power supply. The operator panel power supply receives power from the color CRT power supply through an internal jumper from the AC (H and L) terminals.

Figure 3B.5
Color Operator Panel Power Supply Connection



Connect terminals AUX-AC H and L of terminal block BT04 on the main power supply to the color CRT power supply terminals AC H and AC L, which are located on the rear of the color operator panel, using the power supply cable C03.

Important: The chassis ground terminal connects to the operator panel chassis and designated cable shields. Power supply common is AC coupled to chassis ground. It is the user's responsibility to determine if a direct connection to cabinet ground bus is required.

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Connecting the Power Supply to the MTB Panel ON/OFF Switch

Terminal block BT04 terminals ON-SW, COM, and the OFF-SW are connected to terminal block BT-20 terminals ON, COM, and OFF on the MTB panel using the ON/OFF signal cable C01. Figure 3B.6 shows terminal block BT-20 on the MTB panel.

Figure 3B.6
MTB Panel ON/OFF Switch Connection

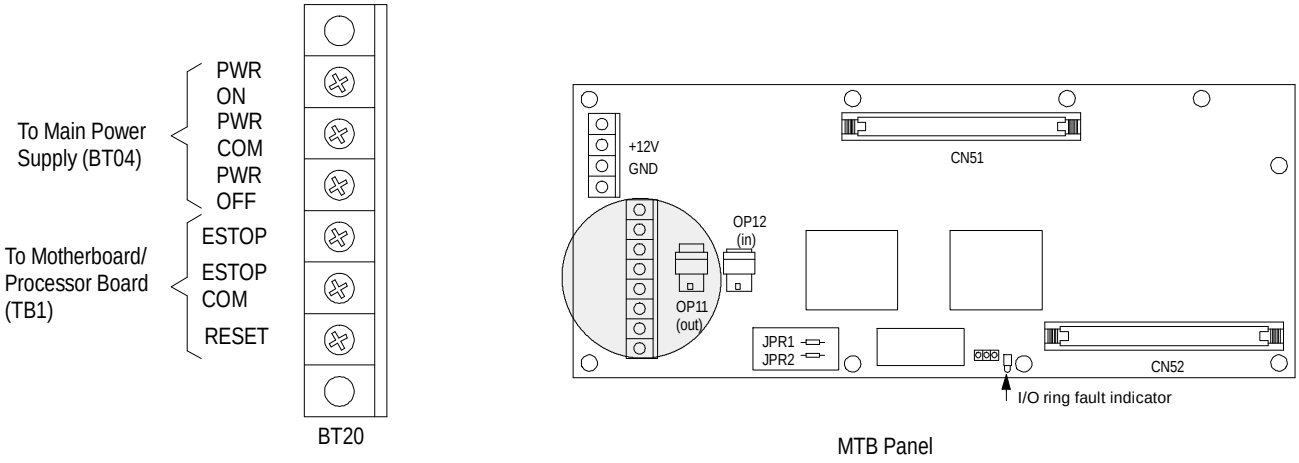


Table 3B.B
Operator Panel or Portable Operator Panel Interface Assembly Power Supply Input Power Specifications

Item		Specifications
Input	Rated Input	115/230V ac --- 50/60Hz
	Input Range	90-265V ac --- 47-63Hz
	Power Consumption	55 Watts
	Fuse	2A/250V
	Connection	Terminal Block

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3B.3 Protective Grounding

All components and modules must be correctly grounded to protect against electrical shock hazards. Proper grounding also helps to reduce the effect of electrical noise by isolating induced noise voltages to individual ground wires and shunting them to ground.

There are two types of grounds used in electrical system design, chassis and earth. Chassis ground is defined as the internal ground of a cabinet. Earth ground is defined as the central ground for all electrical equipment and ac power within any factory.

For the chassis ground use a conductor such as the control cabinet or the cabinet's grounding bus bar. To provide good conductivity when the cabinet is used as the conductor, remove rust and any coating from the area of the cabinet that will be a contact point for the ground cables. Each component installed in the cabinet will have a separate grounding cable connected to the conductor.

Each electrical cabinet requires two separate connections from the cabinet to the earth ground:

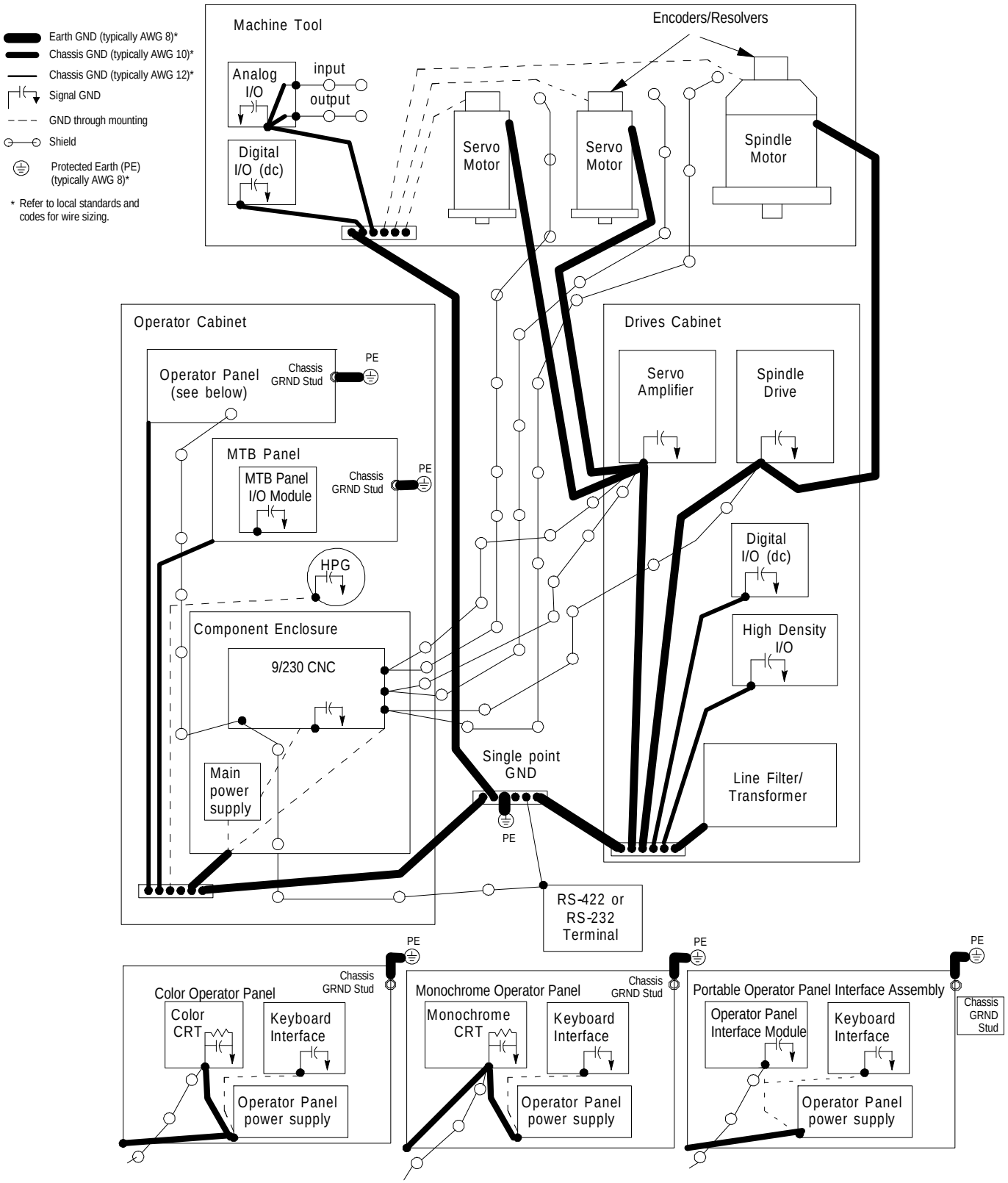
- from the chassis ground – each component installed in a cabinet is connected to the cabinet's chassis ground. The cabinet chassis ground is connected to the earth ground by a single grounding cable.
- from the cabinet – each cabinet is connected separately to the earth ground.



ATTENTION: To guard against damage to the machine, do not interconnect chassis ground wires between the components. This would place ground wires in series and cause their noise voltages to be additive. The resulting increased noise energy can interfere with proper control and machine functions.

A general system grounding diagram, which shows both chassis ground and earth ground, is shown in Figure 5A.21.

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END OF SECTION

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Publication 8520-6.2.3 – February 1997

PN176025

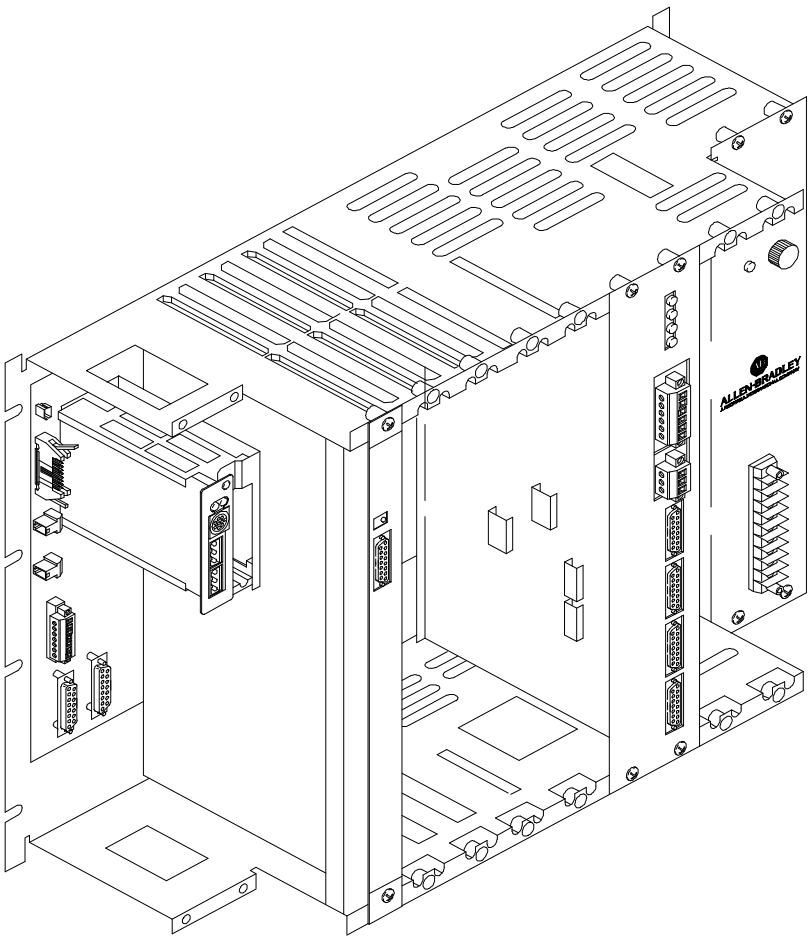
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9/Series Hardware
TAB 4

9/260 and 9/290 CNC Systems



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Section 4A

Primary 9/260 and 9/290 Components

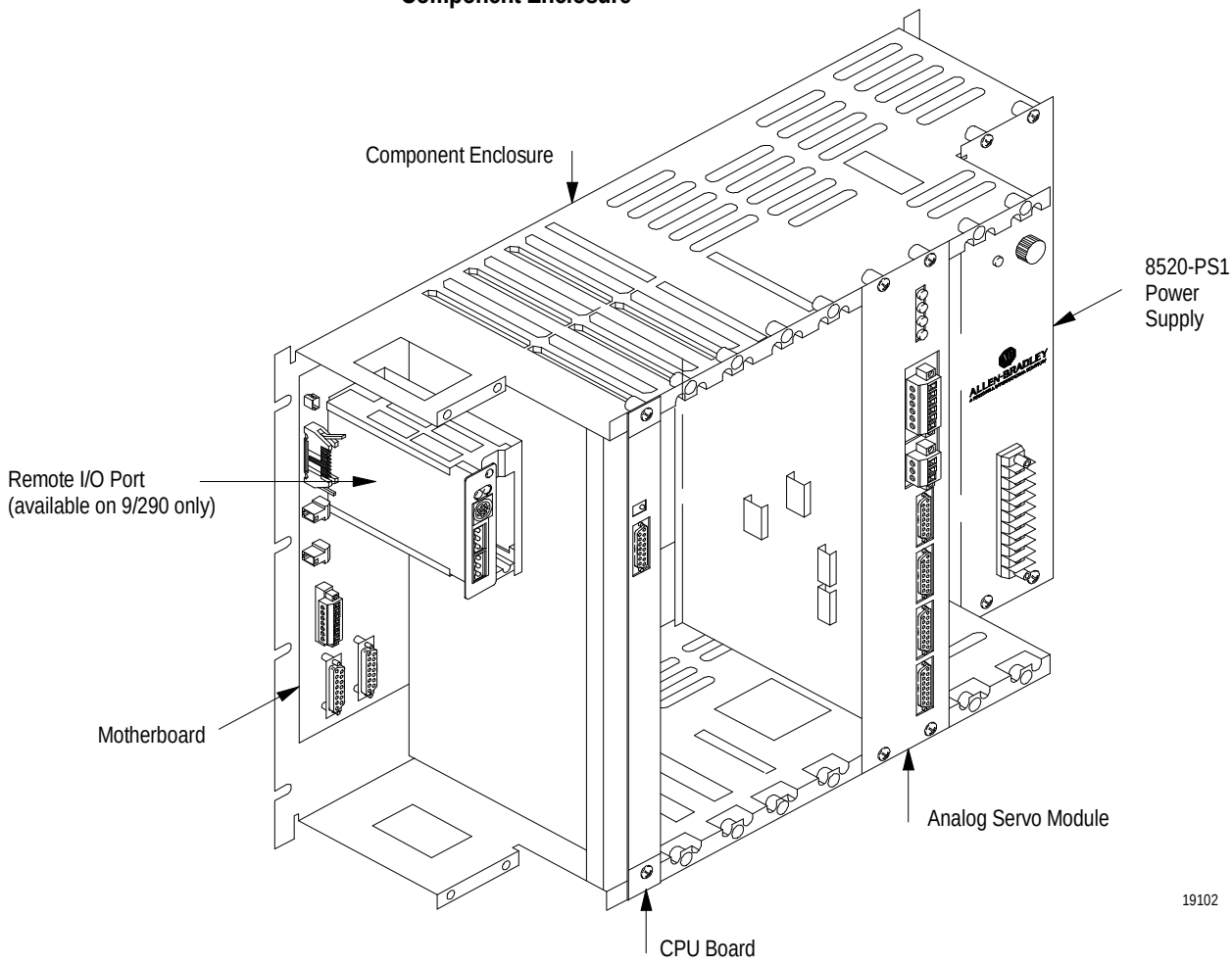
4A.0 Section Overview

This section discusses the primary components of the 9/260 and 9/290 enclosure:

- Motherboard (9/260 and 9/290)
- CPU Board (9/260 and 9/290)
- Main Power Supply (PS1)

These modules are installed into the component enclosure. The component enclosure also supports the digital or analog servo module(s), the remote I/O port (9/290) and main power supply on the 9/260 and 9/290. The 9/260 and 9/290 component enclosure is shown in Figure 4A.1.

Figure 4A.1
Component Enclosure

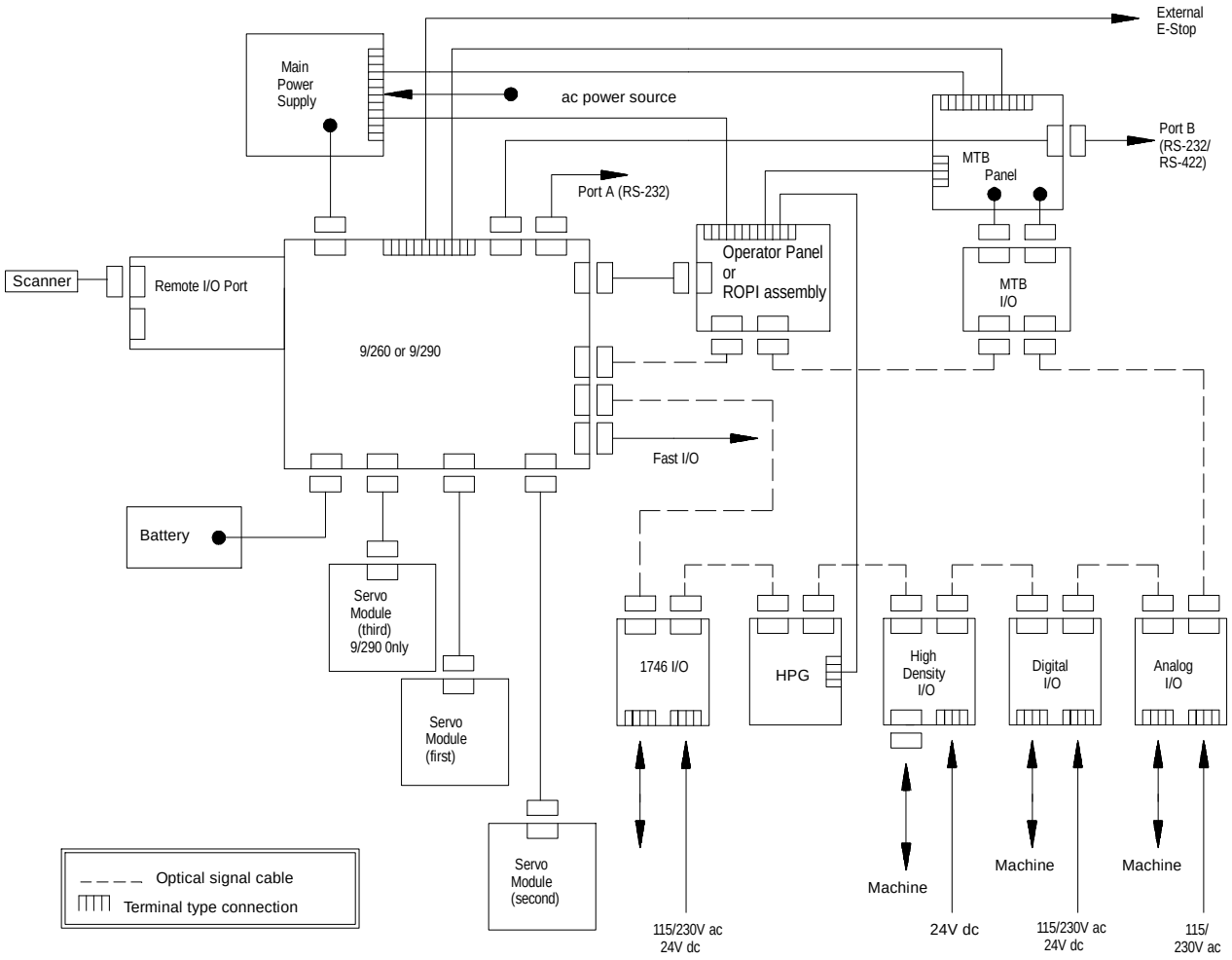


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The motherboard is attached to the back wall of the enclosure. The CPU board slides into the enclosure and connects to the motherboard. Figure 4A.3 shows motherboard is featured.

The servo module(s) slide into the right-most module guides on the enclosure. The right-most component in the rack is the power supply.

Figure 4A.2
9/260 & 9/290 CNC's System Overview

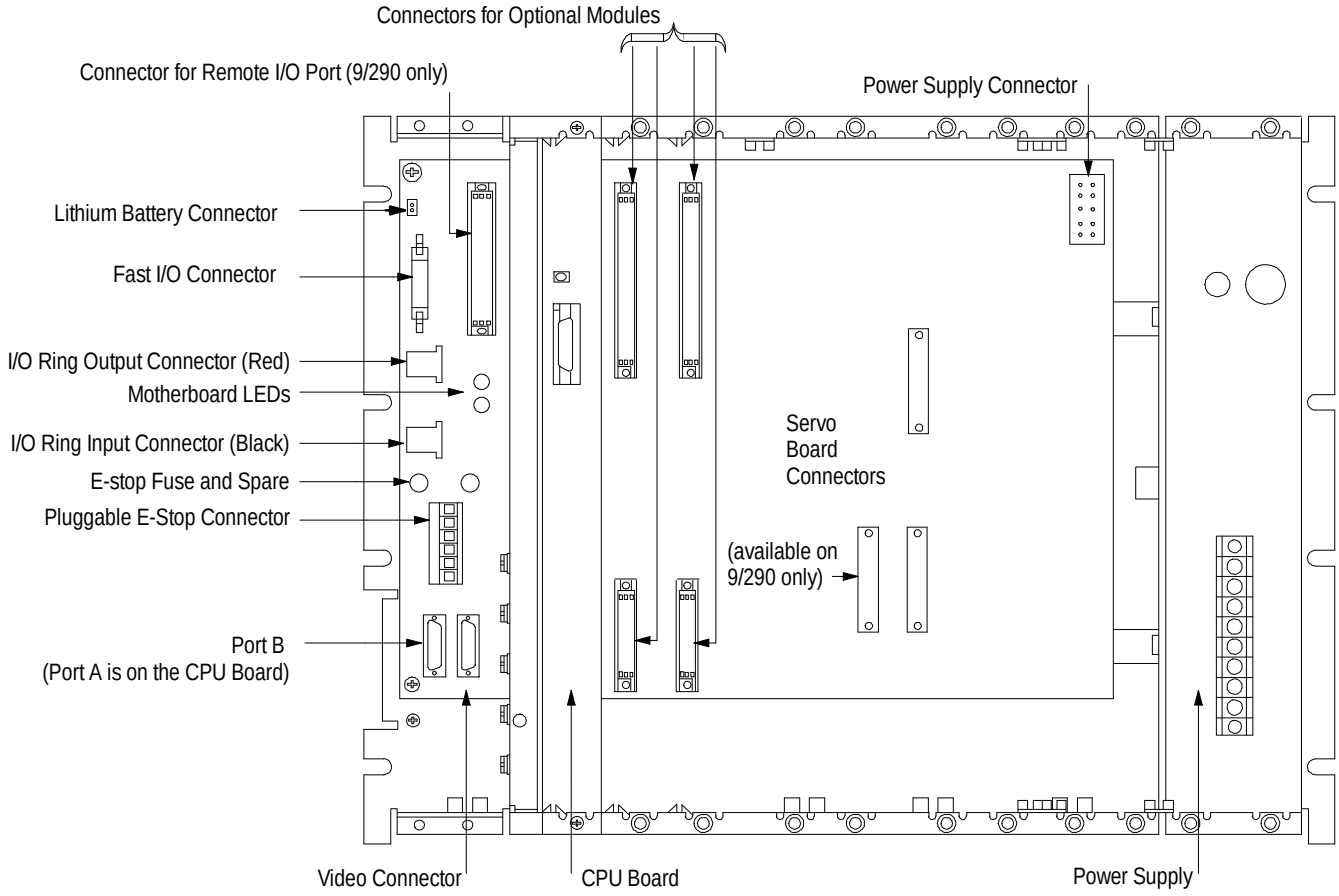


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4A.1 The Motherboard

On the 9/260 and the 9/290 the motherboard works with the CPU board to process all software functions of the control. Figure 4A.3 shows the CPU board connected to the motherboard within the enclosure.

Figure 4A.3
Front View of the Motherboard within the Enclosure



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4A.2 Connections on the Motherboard

Table 4A.A lists the connections on the 9/260 and 9/290 motherboard and where to locate the cable diagrams within this manual. Refer to page 7A-1 for cable details.

Table 4A.A
Locating Motherboard Wiring Diagrams for the 9/260 and 9/290

Attach this connector:	To:	Use this Cable
Lithium Battery (P1)	Lithium Battery Pack	C13, C24
Fast I/O (P3)	Fast Inputs	C11
I/O Ring Output (Red)	First Device on I/O Ring	C10
I/O Ring Input (Black)	Last Device on I/O Ring	C10
E-Stop (TB1)	E-stop String	C05, C06
Port B (J7)	Peripheral Devices	C07
Video (J8)	Operator Interface (Color or Monochrome)	C09
Remote I/O (P2))	PLC Scanner	C17
CPU Board (J2, J9)	Motherboard	No cable necessary
Servo Connector (P4)	Servo Module #1	C12
Servo Connector (P6)	Servo Module #2	C12
Servo Connector (P5)	Servo Module #3	C12
Power Supply (J1)	Power Supply	C04

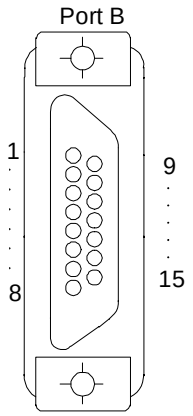
Port B

Use serial port B transmits data to and from peripheral devices. It is configured for RS-232 communications. You can configure, it for use as a RS-422 port by using the softkeys on the operator panel.

The MTB panel may have the optional serial interface connector mounted on it. This connector provides an external interface port for RS-232 or RS-422 interface from a peripheral to the control. It communicates with ports A or B with cable C07. Refer to the “Cable List” section on page 7A-1 for additional information on cable C07. For more information on the signals of each pin, refer to page 8-1.

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Figure 4A.4
Port B-J7 (has pin sockets) and Pin Assignments

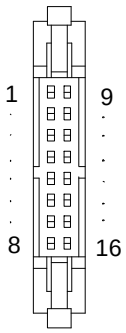


Pin	Assignment	Pin	Assignment
1	Chassis GND	9	Send Data B
2	Send Data A	10	Receive Data B
3	Receive Data A	11	Request to Send B
4	Request to Send A	12	Clear to Send B
5	Clear to Send A	13	Data Set RDY B
6	Data Set RDY A	14	Data Term RDY B
7	Signal GND	15	Not Used
8	Data Term RDY a		

Fast I/O Connector (P3)

The fast I/O connector provides an interface port for fast input and output to and from the control. Use the Fast I/O feature for direct inputs and outputs to PAL, affecting features such as block skip and probing. Use cable C11 to interface this connector with external I/O devices. For information on using a termination panel to wire your fast I/O, refer to page 10A-63, I/O Interface. Refer to the Cable List section on page 7A-26 for additional information on cable C11. Figure 4A.5 shows this connector and lists the pin assignments.

Figure 4A.5
Fast I/O Connector-P3 (has pins) and Pin Assignments



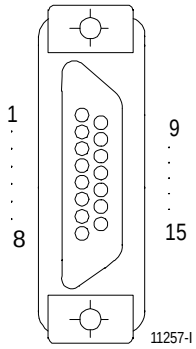
Pin No.	Signal Name	Pin No.	Signal Name
1	FAST_I1	9	FAST_O1
2	COM	10	COM
3	FAST_I2	11	FAST_O2
4	COM	12	COM
5	FAST_I3	13	FAST_O3
6	COM	14	COM
7	FAST_I4	15	FAST_O4
8	COM	16	COM

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Video Monitor Connector

The video monitor connector is used to interface the video monitor with the control. Figure 4A.6 shows this connector and lists the pin assignments.

Figure 4A.6
Video Monitor Connector-J8 (has pin sockets) and Pin Assignments



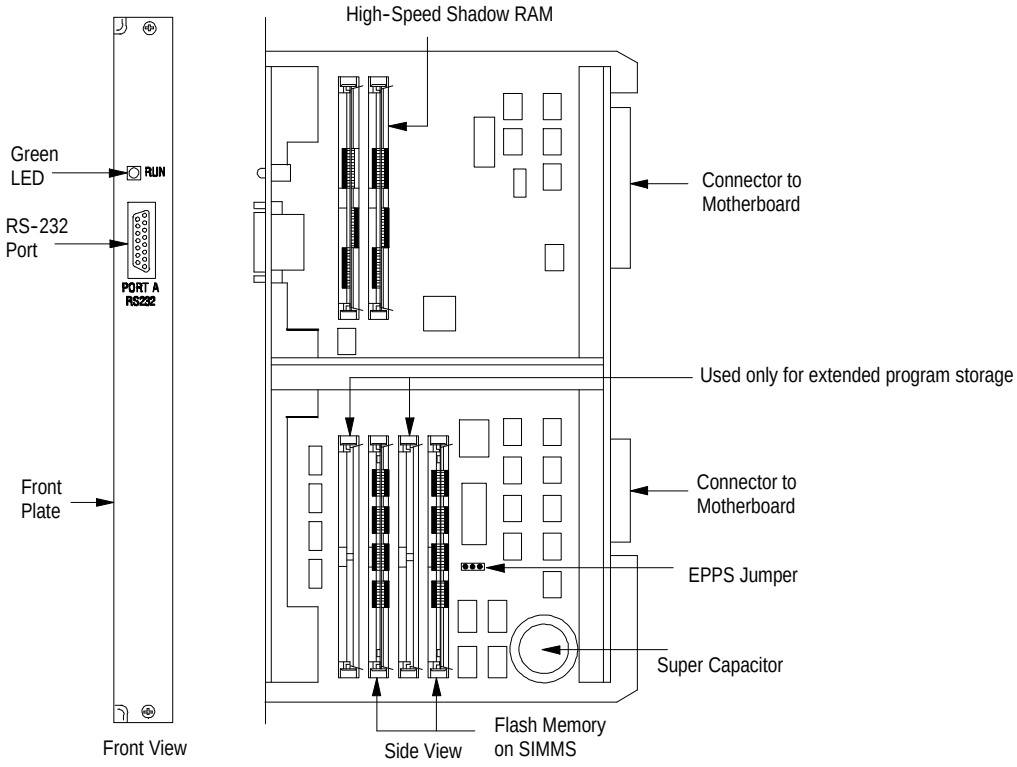
Pin No.	Signal Name	Pin No.	Signal Name
1	GND (SHIELD)	9	RED (L2)
2	RED (L1)	10	GREEN (L2)
3	GREEN (L1)	11	BLUE (L2)
4	BLUE (L1)	12	NC
5	NC	13	CLOCK (2L)
6	CLOCK (L1)	14	H-SYNC (L2)
7	H-SYNC (L1)	15	V-SYNC (L2)
8	V-SYNC (L1)		

4A.3 CPU Board for 9/260 and 9/290

The CPU board works with the motherboard to process all software functions of the 9/260 and 9/290 control. You can remove the CPU board from the enclosure by gently sliding it out. When you replace the board be sure to line the board with the guide tracks on the top and bottom panels of the enclosure. Figure 4A.7 shows the CPU board layout.

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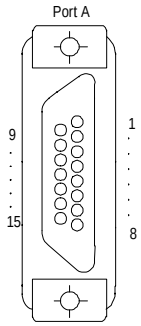
Figure 4A.7
CPU Board



RS-232 Port (Port A)

Serial port A is used to transmit data to and from peripheral devices. It is configured for RS-232 communications only. Figure 4A.8 shows this connector and lists the pin assignments of Port A. For more information on the signals of each pin, refer to page 8-1.

Figure 4A.8
Port A (has pin sockets) and Pin Assignments



Pin	Assignment
1	Chassis GND
2	Send Data
3	Receive Data
4	Request to Send
5	Clear to send
6	No connection
7	Signal GND
8-15	Not Used

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4A.4 Reading LEDs

The green and red LEDs on the motherboard and the CPU board for 9/260 and 9/290 indicate the overall status of your system during power and operation. Use Table 4A.B to read these LEDs when you power up the system.

Table 4A.B
LED Sequence at Power Up for the 9/260 and 9/290

Motherboard LEDs		CPU Board LED	
Red	**Green**	**Green**	**Status**
OFF	OFF	OFF	CNC off- No power
ON	OFF	OFF	Power is on. Control begins diagnostics. If control does not quickly change states, this indicates an error during diagnostics. If cycling power does not clear the error, then contact A-B System Support Services.
ON	ON	OFF	CNC is on and running diagnostics. If control does not quickly change states, this indicates an error during diagnostics. If cycling power does not clear the error, then contact A-B System Support Services.
OFF	ON	OFF	Diagnostics completed. Check CRT for error messages. If control does not quickly change states this indicates an error. If cycling power does not clear the error, then contact A-B System Support Services.
OFF	ON	ON	System is running.

System Error LED Pattern

If this LED pattern appears while the control is running, contact Allen-Bradley Support Services:

Motherboard LEDs		CPU Board LED (for 9/260 and 9/290)	
Red	**Green**	**Green**	**Status**
OFF	ON	OFF	Watchdog timeout has occurred.

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4A.5 Battery Backup for the 9/260 and 9/290

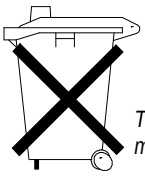
The memory for data such as part programs, tool offset/compensation data, interference zones, and work coordinate offset data is stored in on the CPU board. In the case of a power failure, there is a super capacitor on the CPU board that backs up this data for up to 5 days (at 40 °C) on systems without extended program storage. This super capacitor recharges within 1 hour of power turn on if completely discharged. If you want to extend this backup time, or if you have extended program storage (2 Megabytes) you install a lithium battery pack (8520-LIBAT) that supports the data for:

9/260 and 9/290 Control and Description:	Time (at 40 °C Discharge)
standard	3 years
with extended program storage	1 years

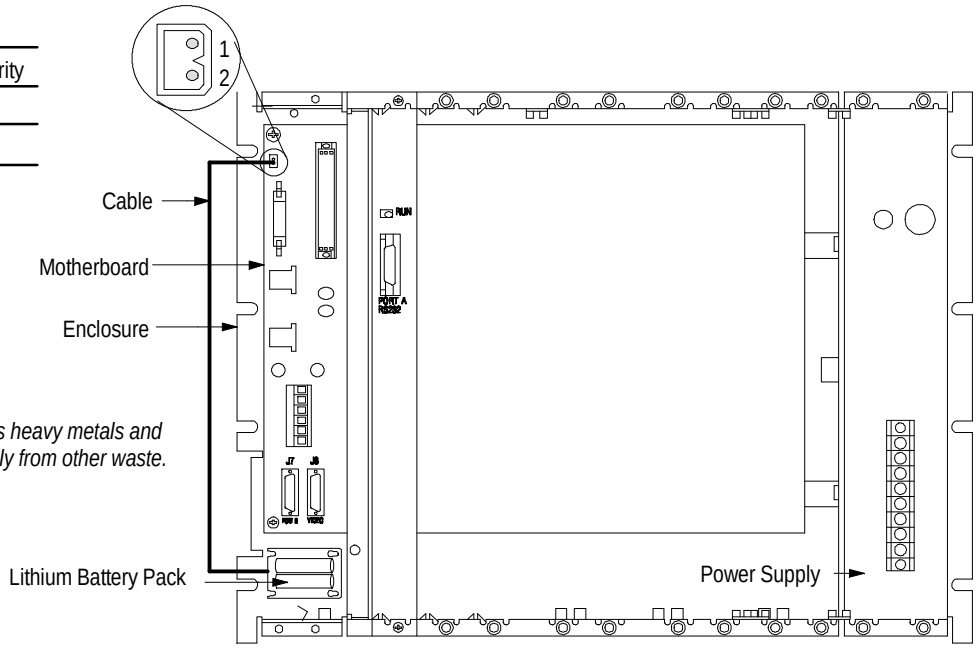
This battery pack is connected to the lithium battery connector (P1) on the motherboard as shown in Figure 4A.9. Batteries and the battery cable are included with the battery replacement kit.

Figure 4A.9
Lithium Battery Connector (P1)

Pin Number	Polarity
1	-
2	+



The lithium battery contains heavy metals and must be collected separately from other waste.

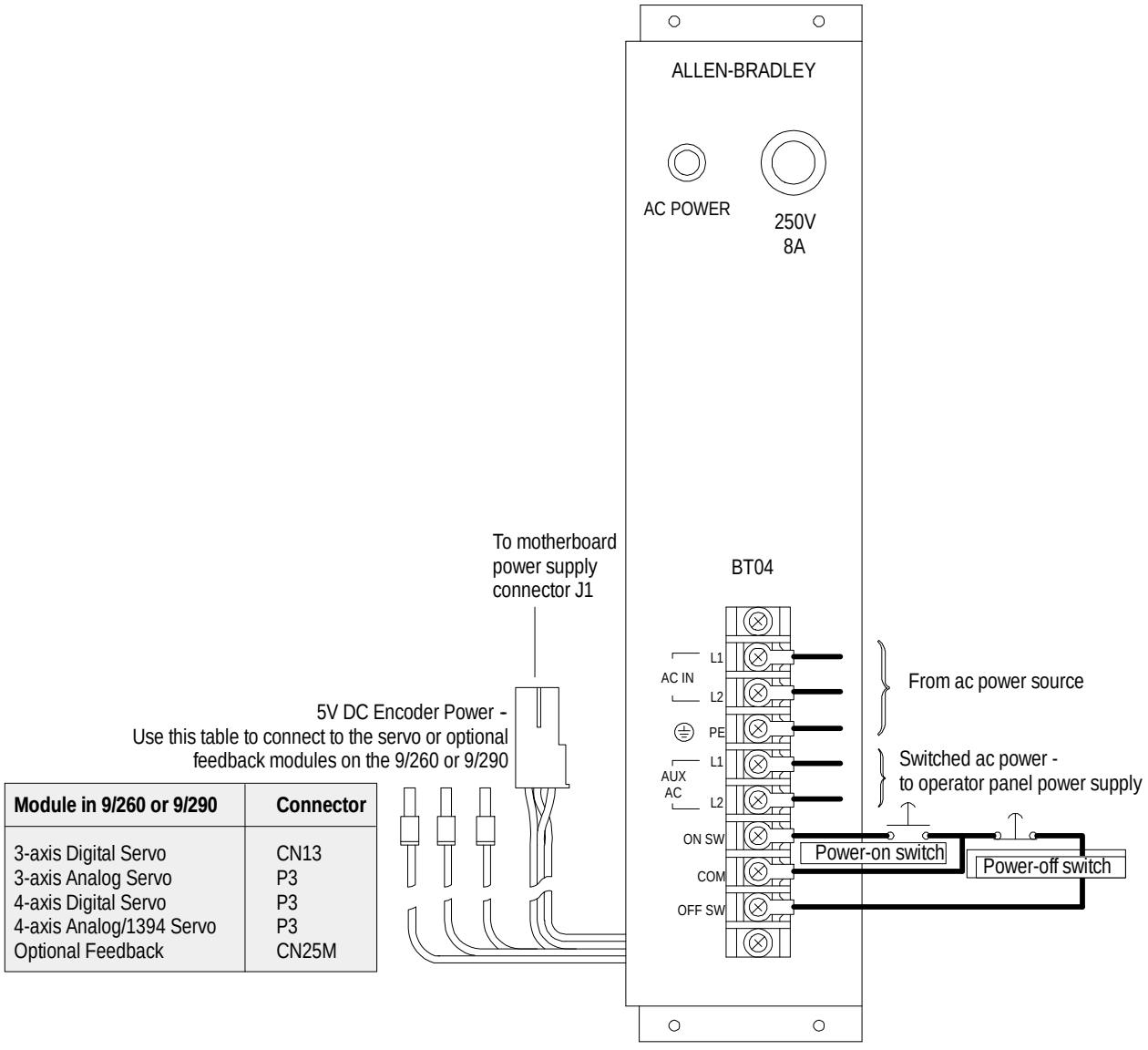


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4A.6
Main Power Supply

You receive the main power supply with your control. The main power supply powers the motherboard, the CPU board, the servo module(s), and the operator panel power supply. Figure 4A.10 shows the main power supply.

Figure 4A.10
Main Power Supply



Module in 9/260 or 9/290	Connector
3-axis Digital Servo	CN13
3-axis Analog Servo	P3
4-axis Digital Servo	P3
4-axis Analog/1394 Servo	P3
Optional Feedback	CN25M

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Output Specifications

The main power supply output specifications are shown in Table 4A.C. For input specifications and fuse specifications refer to page 4D-5.

Table 4A.C
Main Power Supply Output Specifications

Item	Specifications	Remark
Rated Outputs	+5.1V dc (25A) @ 50 °C (18A) @ 60 °C) +15V dc (4A) @ 50 °C (3A) @ 60 °C -15V dc (2A) @ 50 °C (1A) @ 60 °C +5.35V dc (4A) @ 50 °C (3A) @ 60 °C	Total of 225 Watts @ 50 °C, 168 Watts @ 60 °C with convection cooling, or 225 Watts @ 60 °C with minimum of 25 CFM
Line Monitor	--	Detects Loss of AC Power
Hold Up Time	6 msec	@ 225 Watts

END OF SECTION

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Section 4B

Connecting the 3-axis Servo Module

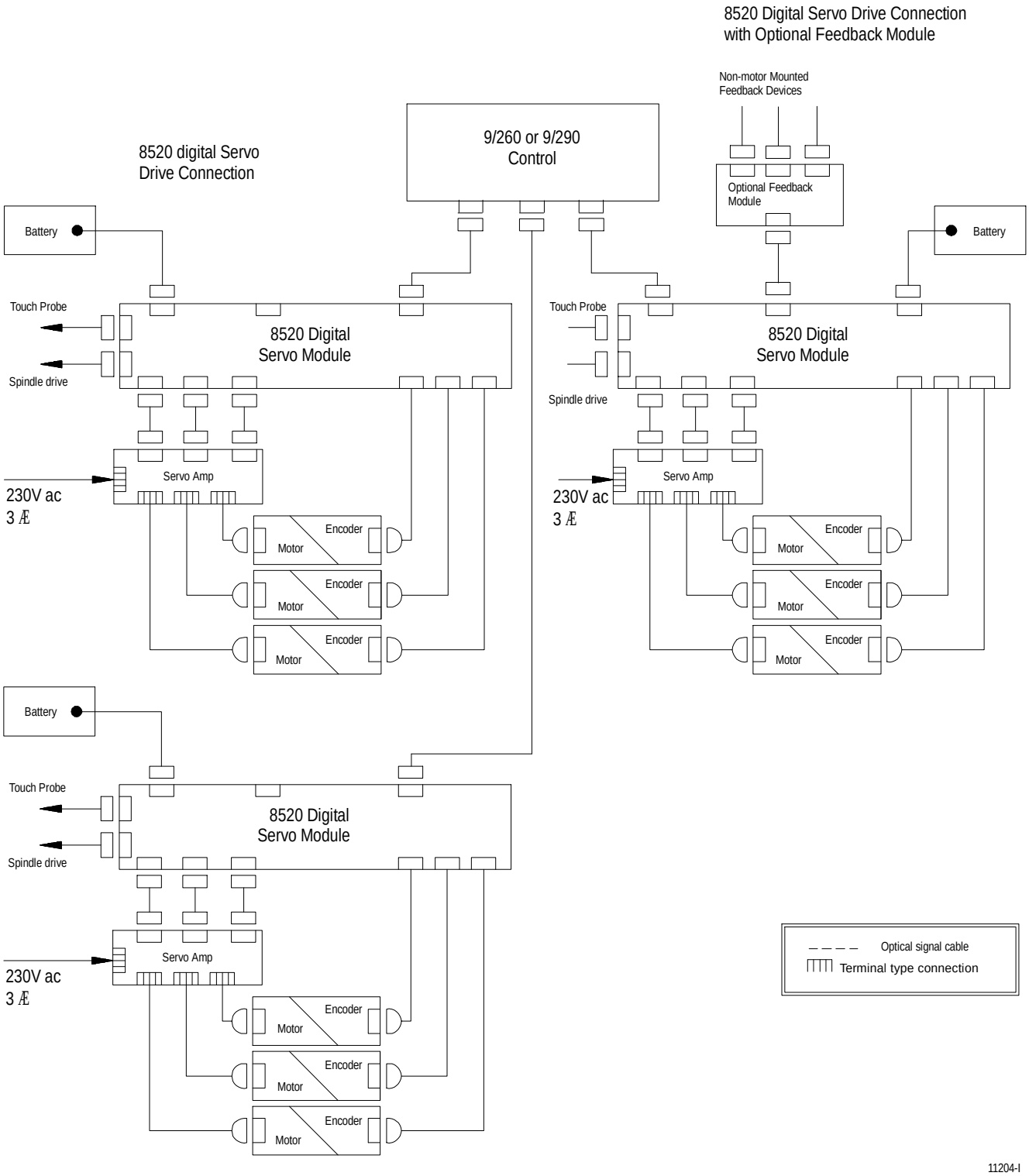
4B.0 Section Overview

This section covers the integration of the 8520 digital and analog servo module and its components. A section of this section is devoted to each of the following drive components:

For Information:	See Page:
8520 Digital Servo Module	4B-6
Optional Feedback Module	4B-16
Wiring a Touch Probe	4B-25
Analog Servo Module	4B-29
Analog Servo Module Connectors and Pin Assignments	4B-33
Analog Servo Module Specifications	4B-37
Connecting Axes to Analog Servo Module	4B-38
Analog Servo Module LED Indicators	4B-38
Analog Servo Module Test Points	4B-39
Encoder Termination Panel	4B-41
Feedback Devices	4B-42
Wiring a Touch Probe to the Analog Servo Module	4B-48

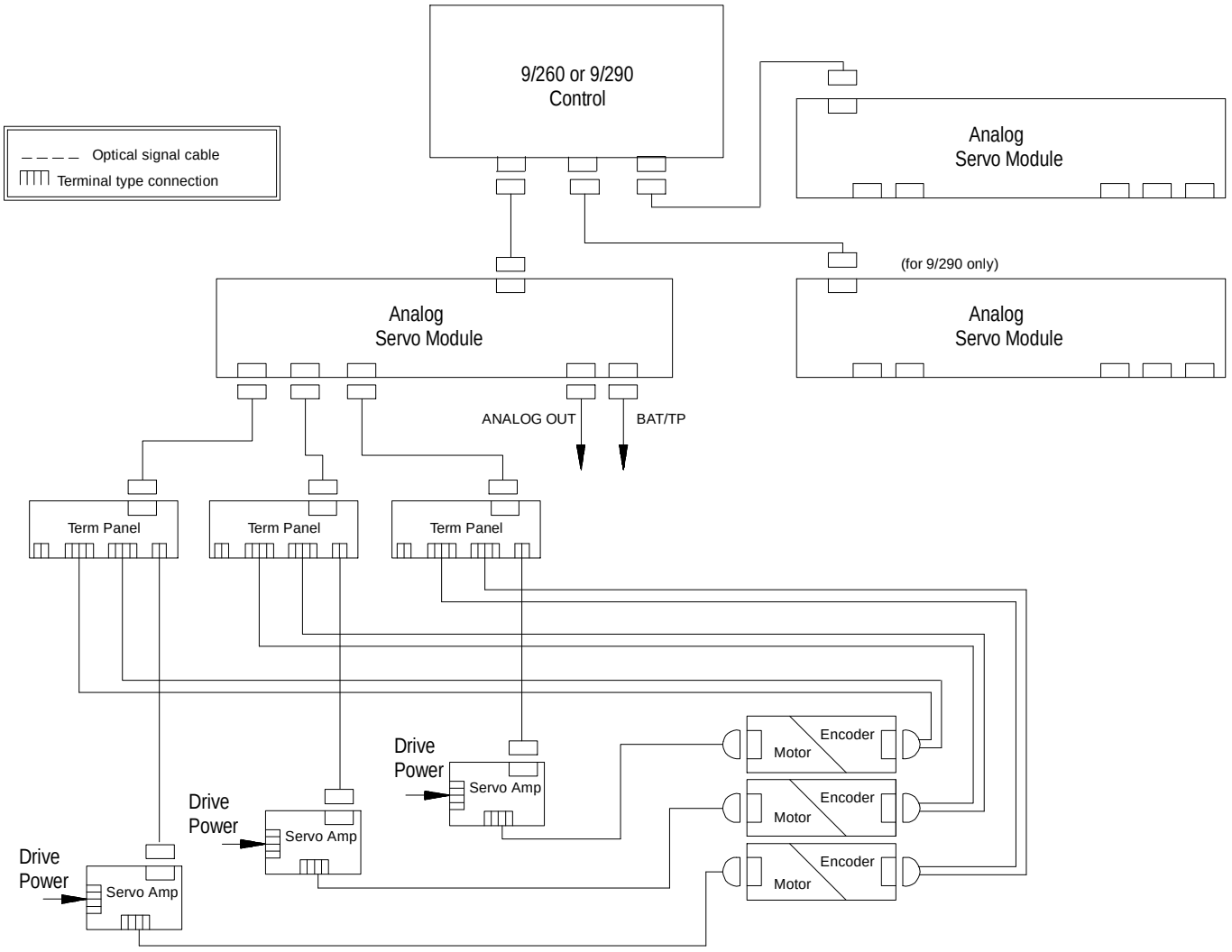
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Figure 4B.1
9/260 and 9/290 Connections from the 3-Axis Servo Module to 8520 Digital Drives



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Figure 4B.2
9/260 and 9/290 Connections from the 3-axis Servo Module to Analog Drives



11205-I

4B.1
How the 8520 Digital Servo Card Works

There are two typical 8520 digital servo drive configurations for the control. The typical mill configuration has 3-axes, each having a servo motor and feed back device, and a analog open loop spindle motor. The typical lathe configuration has 2-axes, each having a servo motor and feedback device, and a analog open loop spindle motor with position feedback.

The 8520 digital Servo module functions as a high-speed servo processor. It is installed in the component enclosure.

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The 8520 digital Servo Amplifier translates low-level PWM signals from the 8520 digital servo module to the power levels necessary to drive the servo motors.

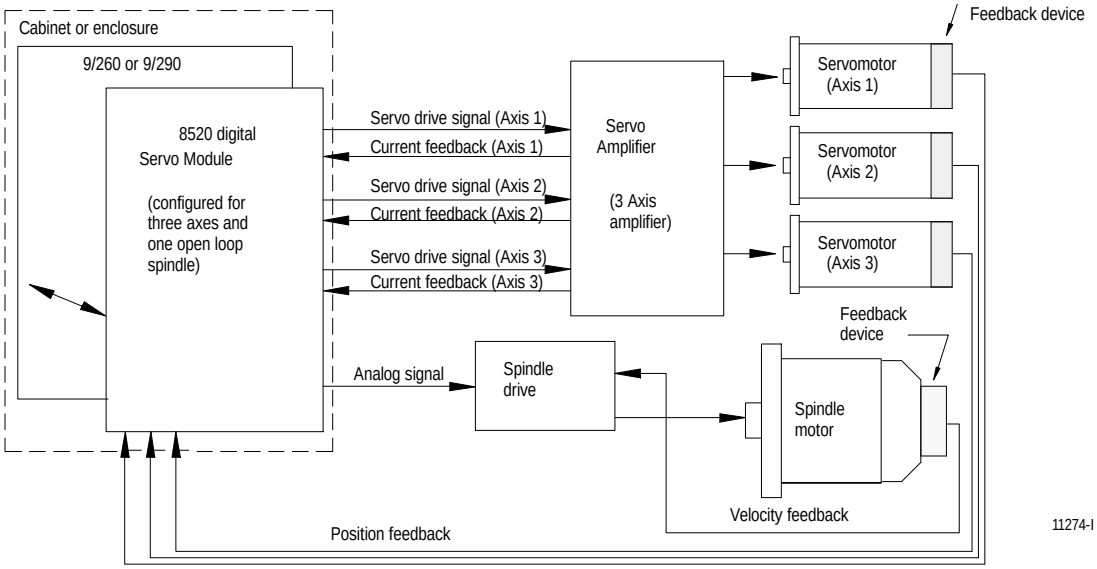
Current feedback data is read from the current sensors in the 8520 digital servo amplifier and returned to the 8520 digital servo module. This data is processed by the servo module to maintain velocity and position control, according to module, AMP, and part program constraints.

Important: In order to use the solid tapping feature that is available on the 9/260 and 9/290 CNC, you must use the Allen-Bradley 8510 AC spindle drive system.

Position and velocity data are read from a feedback device that is mounted on the servo motor. This feedback device generates differential signals that are then fed to the 8520 digital servo module. If the spindle motor uses an encoder, it will supply spindle position feedback to the 8520 digital servo module.

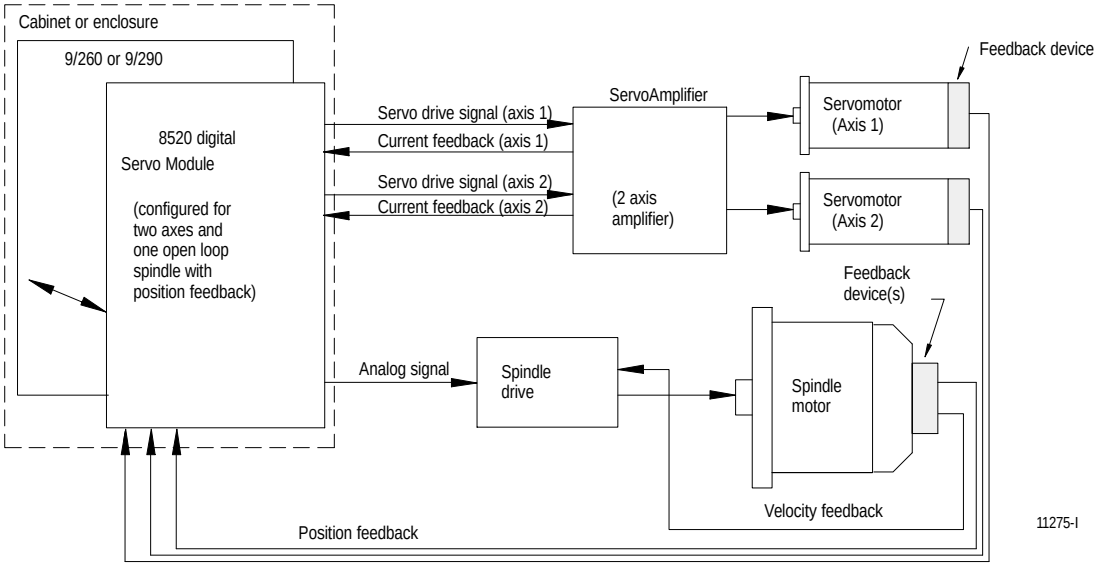
Figure 4C.1 and Figure 4C.2 show typical 8520 digital servo drive configurations for a mill and a lathe. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for specific details on configuring axes, axis positioning loops, and axis port selection.

Figure 4B.3
Typical 8520 Digital Servo Drive Configuration for a Mill



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Figure 4B.4
Typical 8520 digital Servo Drive Configuration for a Lathe



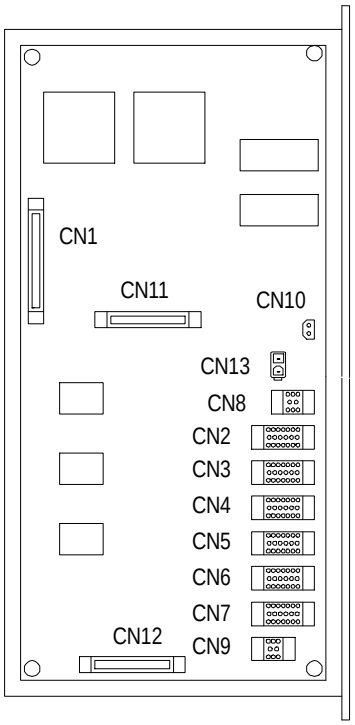
For additional information on each of the major components, refer to the section that covers that component.

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4B.2
8520 Digital Servo Module (8520-ENC3)

The 8520 Digital Servo Module is mounted in the component enclosure. It functions as a high-speed servo processor. The control sends positioning and velocity data to the servo module where it is processed to generate the necessary pulse width modulated (PWM) command signals. These signals are sent to the digital servo amplifier, which power the servo motors of the control. The digital servo module also provides an analog velocity command signal for a servo (typically the spindle) that is not using a digital servo amplifier.

Figure 4B.5
Servo Module



The digital servo module receives two forms of feedback:

- position data from the feedback devices on the axes
- current feedback from the servo amplifier

It combines this position and current feedback data with the interpolated commands from the control to generate the PWM command signals that it outputs to the servo amplifiers.

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The functions of the digital servo module are designed to make the axes run with optimum performance. Generally, the maximum feedrates are limited by the mechanical abilities of the machine. System gain and the maximum allowable following error will also limit the feedrates. These limits are entered as AMP parameters. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

4B.2.1 Servo Module Connectors and Pin Assignments

Table 4C.A lists the connectors that are used to integrate the digital servo module with other modules of the control.

Table 4B.A
Digital Servo Module Connectors

Connector on Servo Module	Connected to:		Cable Number	Remark
	Component	Connector		
CN1	Motherboard	P4, P5 or P6	C12	
CN2	Servo Amplifier	CNA1	C19	Axis 1
CN3	Servo Amplifier	CNA2	C19	Axis 2
CN4	Servo Amplifier	CNA3	C19	Axis 3
CN5	Feedback Device		C17	1
CN6	Feedback Device		C17	1
CN7	Feedback Device		C17	1
CN8	Spindle		C21	
CN9	Touch Probe		C22	
CN10	Battery Pack		C23	
CN11	Optional Feedback Module			
CN12	Optional Feedback Module			
CN13	+5V Encoder Power Cable from Main Power Supply			

Important: When 1 servo module is used, it must be connected to P4 of the motherboard. When 2 servo modules are used, the first servo module must be connected to P4 and the second to connector P6. 9/290 only, when three modules are used, connect the first to P4, the second to P6 and the third to P5.

1 If a spindle incorporates an encoder to supply position feedback to the servo module, the spindle encoder must be interfaced with the last open connector of these 3 connectors. Refer to the 9/260-9/290 AMP Reference Manual, publication 8520-6.4, for more information.

CN1 Servo Module Interface Connector

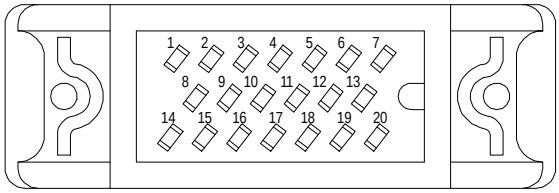
The servo module is interfaced with the motherboard through connector CN1. The control transmits and receives various signals to and from the servo module through this connector.

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CN2, CN3, and CN4 Servo Drive Signal Connectors

The digital servo module sends servo drive signals and receives current feedback from the servo amplifier through connectors CN2, CN3, and CN4. Figure 4C.7 shows an end view of connectors CN2, CN3, and CN4 and lists the pin assignments of the these connectors.

Figure 4B.6
End View of Connectors and Pin Assignments of CN2, CN3, CN4, 20 pin male, Honda MR-20RMD2



11277-I

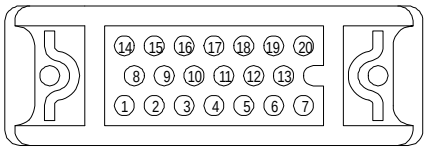
Pin No.	Signal	Description	True Level	Signal Destination
1	ENABLE	Motor Amplifier Enable	HIGH	Servo Amplifier
2	/ENABLE	"ON" State -- Enable (Active)	LOW	Servo Amplifier
3	Shield	Chassis ground for shielded cable		
4	Shield	Chassis ground for shielded cable		
5	Shield	Chassis ground for shielded cable		
6	STATUS	Amplifier status flag	HIGH	Servo Module
7	/STATUS	"ON" state - normal operation	LOW	Servo Module
8	PWM_A	Current command for Phase_A	HIGH	Servo Amplifier
9	/PWM_A	Diff. signal	LOW	Servo Amplifier
10	PWM_B	Current command for Phase_B	HIGH	Servo Amplifier
11	/PWM_B	Diff. signal	LOW	Servo Amplifier
12	PWM_C	Current command for Phase_C	HIGH	Servo Amplifier
13	/PWM_C	Diff. signal	LOW	Servo Amplifier
14	Ia	Current sensing value for Phase_A	HIGH	Servo Module
15	/Ia	Diff. Signal	LOW	Servo Module
16	Shield	Chassis ground for shielded cable		
17	Shield	Chassis ground for shielded cable		
18	Shield	Chassis ground for shielded cable		
19	Ib	Current sensing value for Phase_B	HIGH	Servo Module
20	/Ib	Diff. Signal	LOW	Servo Module

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CN5, CN6, and CN7 for Absolute and Incremental Encoder Connectors

The digital servo module receives feedback from the feedback devices (absolute or incremental encoders) of the servo motors or spindle through connectors CN5, CN6, and CN7. Figure 4B.7 shows an end view of connectors CN5, CN6, and CN7 and lists the pin assignments of this connector when it is used with absolute encoders.

Figure 4B.7
Absolute Encoder Connections and Pin Assignments of Connectors CN5, CN6, CN7, 20 pin female, Honda MR-20RFD2



11278-I

Pin. No	Signal	Description	True Level	Signal Destination
1	GND	Encoder Power Return		Feedback Device
2	GND	Encoder Power Return		Feedback Device
3	ENC_5V	Switched +5V Encoder Power Supply		Feedback Device
4	ENC_5V	+5V Encoder Power		Feedback Device
5	ENC_15V	+15V Encoder Power		Feedback Device
6	ENC_15V	+15V Encoder Power		Feedback Device
7	BAT_+	Battery Power Supply		Feedback Device
8-11	N.C.			
12	Reset	Used for Reset Operation Only		Feedback Device
13	N.C.			
14	PZ	Phase_Z, 1 pulse per rev	High	Servo Module
15	/PZ	Diff. Signal	Low	Servo Module
16	PA	Phase_A, 2-phase pulse	High	Servo Module
17	/PA	Diff. Signal	Low	Servo Module
18	PB	Phase_B, 2-phase pulse	High	Servo Module
19	/PB	Diff. Signal	Low	Servo Module
20	Shield	Chassis Ground		Servo Module



ATTENTION: Reversing the polarity of the absolute encoder battery power supply can destroy some elements of the absolute encoder.

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Table 4B.B lists the pin assignments of this connector when it used with incremental encoders.

Table 4B.B
CN5, CN6, and CN7 Incremental Encoder Pin Assignments

Pin No.	Signal	Description	True Level	Signal Destination
1	GND	Encoder Power Return		Feedback Device
2	GND	Encoder Power Return		Feedback Device
3	ENC_5V	Switched +5V Encoder Power Supply		Feedback Device
4	ENC_5V	+5V Encoder Power		Feedback Device
5	ENC_15V	Spindle Encoder +15V Power Supply		Feedback Device
6	ENC_15V	+15V Encoder Power		Feedback Device
7	N.C.			
8	PU	Pole Sensor output Phase_U, 0 °	High	Servo Module
9	/PU	Diff. Signal	Low	Servo Module
10	PV	Pole Sensor output Phase_V, 120 °	High	Servo Module
11	/PV	Diff. Signal	Low	Servo Module
12	PW	Pole Sensor output Phase_W, 240 °	High	Servo Module
13	/PW	Diff. Signal	Low	Servo Module
14	PZ	Phase_Z, 1 pulse per rev.	High	Servo Module
15	/PZ	Diff. Signal	Low	Servo Module
16	PA	Phase_A, 2-phase pulse	High	Servo Module
17	/PA	Diff. Signal	Low	Servo Module
18	PB	Phase_B, 2-phase pulse	High	Servo Module
19	/PB	Diff. Signal	Low	Servo Module
20	Shield	Chassis Ground		Feedback Device

The encoder marker signal is sent to the control on the Phase_Z pins (#14 and #15).

Important: If a spindle incorporates an encoder to supply position feedback to the digital servo module, the spindle encoder must be interfaced with the last open connector of these 3 connectors. Refer to the AMP reference manual for additional information on digital servo board configuration.

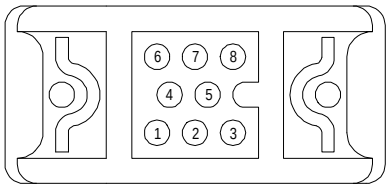
Pins 8 through 13 of connectors CN5, CN6, and CN7 are used for motor phasing only. When using connectors CN5, CN6, or CN7 for spindle feedback, pins 7 through 13 are not connected (N.C.).

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CN8 DAC Output Connector

The digital servo module sends analog signals to the spindle motor drive through connector CN8. Figure 4B.8 shows an end view of connector CN8 and lists the pin assignments.

Figure 4B.8
Connector CN8, 8 pin female, Honda MR-8RFD2 and the Pin Assignments



11279-I

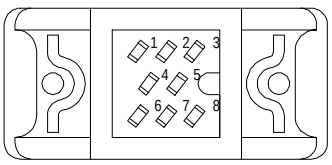
Pin No	Signal	Description	True Level	Signal Destination
1-3	N.C.			
4	SPDL_O	±10V Analog (Spindle AMP Drive Signal)		Spindle Drive
5	SPDL_G	Analog Signal Return		Spindle Drive
6-8	Shield			

Important: Note that the DAC output connector (CN8) can also be used to output selected servo information using a feature called DAC monitor. This feature is controlled by Patch AMP. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

CN9 Touch Probe Connector

The digital servo module receives touch probe feedback through connector CN9. Figure 4B.9 shows an end view of connector CN9 and lists the pin assignments.

Figure 4B.9
Connector CN9, 8 pin male, Honda MR-8RMD2 and Pin assignments



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Pin No.	Signal	Description	True Level	Signal Destination
1	+5V dc	Probe Power		Touch Probe
2	TP_IN	Touch signal input	[1] LOW (HIGH)	Servo Module
3	TP_G	Touch signal ground		Touch Probe
4-5	N.C.			
6-8	Shield			

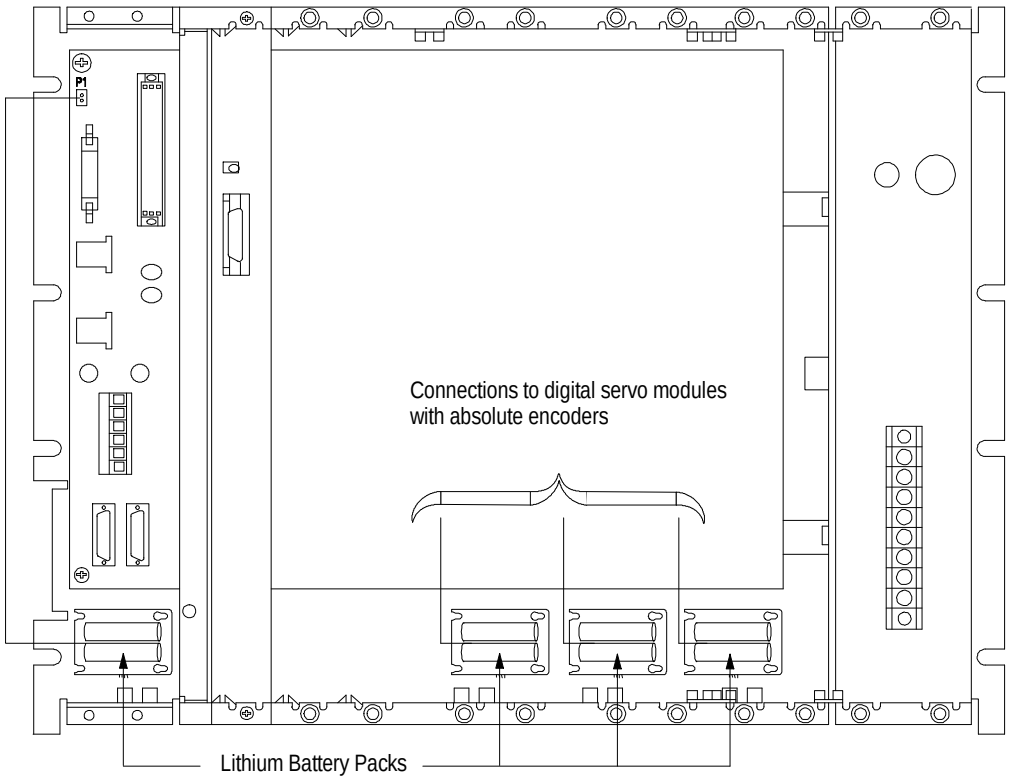
[1] The True level is either "HIGH" or "LOW" as defined by AMP parameter PROBE TRANSITION. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

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CN10 Absolute Encoder Battery Connector

The digital servo module receives battery power from the battery pack through connector CN10. This battery power supplies battery backup to the absolute encoder position register. You can connect up to four lithium battery backs to one enclosure: one to support the SuperCap memory backup and three others to support a maximum of three digital servo modules. Figure 4B.10 shows the lithium battery packs installed in the component enclosure. Figure 4B.11 shows the connector on the module and lists the pin assignments.

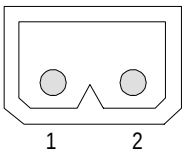
Figure 4B.10
Lithium Battery Packs Installed in the Component Enclosure



ATTENTION: Reversing the polarity of the absolute encoder battery power supply can destroy some elements of the absolute encoder.

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Figure 4B.11
Connector CN10 Pin Assignments



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Pin No.	Signal	Description	Signal Destination
1	BAT_+	Battery Voltage Supply	Absolute Encoder
2	BAT_-	Battery Ground	Absolute Encoder

CN11 Optional Feedback Module Interface Connector

The servo module is interfaced with the optional feedback module through connectors CN11 and CN12. Control signals from the servo module and position feedback information from the non-motor mounted feedback devices pass through this connector. Connector CN11 connects directly to connector CN21M on the optional feedback module. A cable is not required for this connection.

CN12 Optional Feedback Module Interface Connector

The servo module is interfaced with the optional feedback module through connectors CN11 and CN12. Encoder feedback signals from the digital servo module pass through this connector. Connector CN12 connects directly to connector CN22M on the optional feedback module. A cable is not required for this connection.

CN13 5V dc Encoder Power Connector

The digital servo module receives +5 V dc power directly from the main power supply through connector CN13. This +5V dc power is used only for powering the encoders. If the 5V dc encoder power is not used (i.e. you are not using AB standard motors, you are using 15V dc encoders, or some other power source is used), this connection is not needed.

Figure 4B.12 shows an end view of connector CN13 and lists the pin assignments of this connector. For details on this connection refer to the section in page 4D-4 that discusses connections to the Main Power Supply.

Important: This connector must be used to provide power for the encoders if using the standard digital servo motors.

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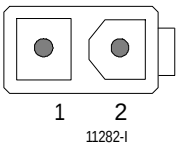


Figure 4B.12
Connector CN13 Pin Assignments

Pin No.	Signal	Description	Signal Destination
1	+5V dc	+5V dc Encoder Power Supply	Absolute or Incremental Encoder
2	N.C.	_____	_____

4B.2.2 Digital Servo Module Specifications

Table 4B.C lists the digital servo module input specifications.

Table 4B.C
Digital Servo Module Input Specifications

Item	Specification	Remark
Input Power Range for Encoders	+5V (+10%, -1%) +15V (±7%)	From Main Power Supply
Maximum Input Frequency of Encoder Feedback	546KHz	_____
Desired Voltage Range of Encoder Battery Backup	3.5V to 4.5V	_____

Table 4B.D lists the digital servo module output specifications.

Table 4B.D
Digital Servo Module Output Specifications

Item		Specification	Remark
PWM Output	PWM Frequency	Approx. 2.5 KHz	
	PWM Signal Type	RS-422-A	
DAC Output	Output Voltage Range	±10V	
	Resolution	2.44mV	(±12 bits)
	Sampling Frequency	500 Hz	
	Output Current	5mA Max.	
	Load Capacitance	0.01mF Max.	

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4B.2.3 Servo Module Battery Replacement

Important: Battery backup is required for absolute encoders only. Incremental encoders do not require battery backup.

The servo module provides battery backup for the absolute encoder position register. This register retains position data during power loss. The battery backup power originates from the batteries plugged into the servo board at connector CN10.

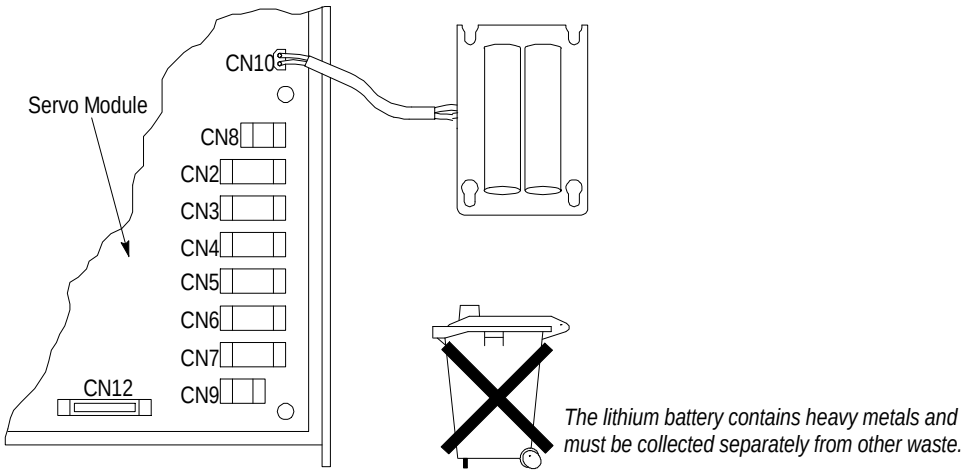
Even if battery backup fails, or the encoder cable is temporarily disconnected, the encoder will still maintain position data for up to 24 hours. This also allows for battery replacement without loss of data.

The battery backup is tested at power up, and at four hour intervals while system power is on. If battery voltage drops to 2.8V during the battery test, the control automatically displays the warning message "REPLACE ABSOLUTE FEEDBACK BATTERY" on the operator panel.

Important: Once the "REPLACE ABSOLUTE FEEDBACK BATTERY" message is displayed, it is essential that the batteries be replaced to avoid loss of absolute position data.

To replace the servo module battery, turn all system power **OFF** and disconnect the old batteries from CN10 on the servo module. Battery replacement instructions are included with the battery replacement kit. Before installing new batteries, use a voltage meter to make sure that new battery voltage is higher than 3.5V dc.

Figure 4B.13
Digital Servo Module Battery Connector CN10



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4B.3
Optional Feedback Module

The optional feedback module provides extra feedback ports for the digital servo module. Use these ports to provide axis position feedback to the digital servo module from a non-motor mounted second feedback device. When using an optional feedback module, the incremental or absolute encoder mounted on the digital servo motor provides current and velocity loop feedback while a non-motor mounted feedback device provides axis position feedback.

Figure 4B.14
Optional Feedback Module

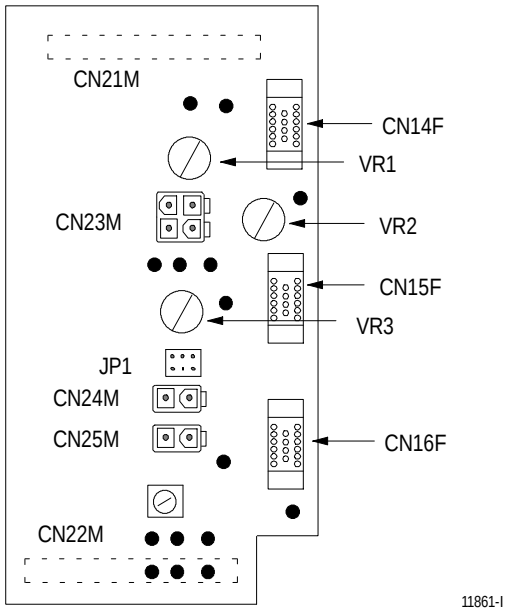
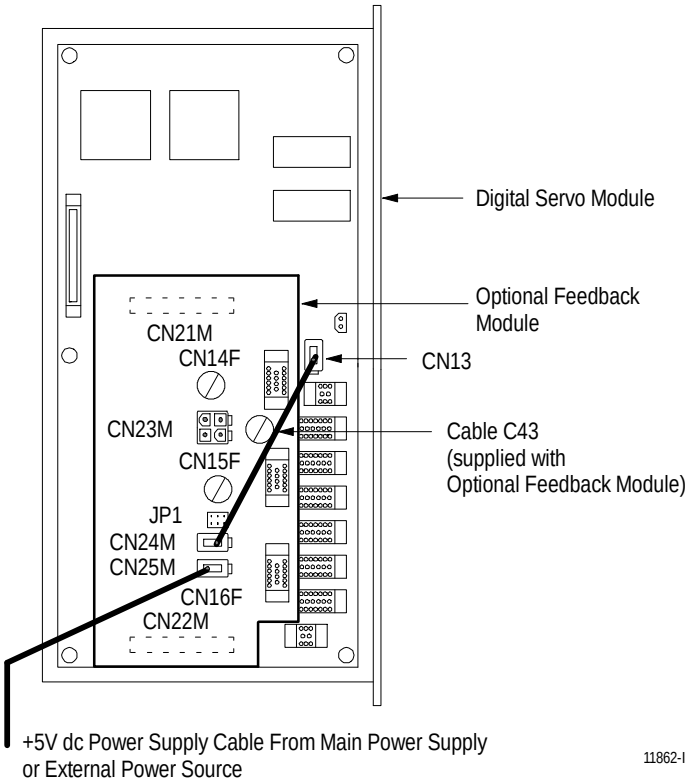


Figure 4B.15 shows the optional feedback module mounted to and interfaced with the digital servo module through connectors CN21M and CN22M. Typically the optional feedback module receives +5V dc power from the main power supply through connector CN25M. This +5V dc power is then transferred from connector CN24M on the optional feedback module to connector CN13 on the digital servo module using the cable supplied with the optional feedback module.

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Figure 4B.15
Optional Feedback Module Interfaced with Digital Servo Module



4B.3.1 Optional Feedback Module Power Requirements

Table 4B.E lists the power requirements of the optional feedback module and the non-motor mounted feedback devices.

Table 4B.E
Optional Feedback Module Power Requirements

Item		Optional Feedback Module	Feedback Devices
Voltage	+5V dc	5.1V dc ±3.2%	5.347V dc ±3.1%
	+15V dc	15V dc ±4.34%	15V dc ±4.34%
Current	+5V dc	340mA max.	0.25A max./device
	+15V dc	6mA max.	0.2A max./device
Power Consumption		1.9W max.	

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4B.3.2 Optional Feedback Module Connectors and Pin Assignments

Table 4B.F lists the connectors used to connect the optional feedback module to the servo module, non-motor mounted feedback devices, and power sources.

Table 4B.F
Optional Feedback Module Connectors

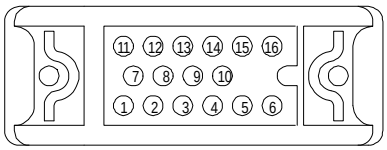
Connector on Optional Feedback Module	Connected to:		Cable Number
	Module	Connector	
CN14F	Non-motor Mounted Feedback Device		C44
CN15F	Non-motor Mounted Feedback Device		C44
CN16F	Non-motor Mounted Feedback Device		C44
CN21M	Digital Servo Module	CN11	
CN22M	Digital Servo Module	CN12	
CN23M	+15V dc External Power Source		
CN24M	Digital Servo Module	CN13	C43
CN25M	+5V dc Power Source		

CN14F, CN15F, and CN16F Optional Feedback Device Connectors

The optional feedback module is interfaced with non-motor mounted feedback devices through connectors CN14F, CN15F, and CN16F. These connectors provide +5V dc or +15V dc power to the non-motor mounted feedback devices and receive axis position feedback. Figure 4B.16 shows an end view of connectors CN14F, CN15F, and CN16F and lists the pin assignments of these connectors.

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Figure 4B.16
Connectors and Pin Assignments for the CN14F, CN15F, CN16F, 16 pin female, Honda MR-16MRFD2



11863-I

Pin No.	Signal	Description	True Level	Signal Destination
1	PB	Phase B, phase pulse	HIGH	Optional Feedback Module
2	$\overline{PB}$	Diff. Signal	LOW	Optional Feedback Module
3	ENC_15V	+15V dc power for feedback device		Feedback Device
4	ENC_15V	+15V dc power for feedback device		Feedback Device
5	Shield	Chassis ground for shielded cable		Feedback Device
6	Shield	Chassis ground for shielded cable		Feedback Device
7	PZ	Phase C, phase pulse	HIGH	Optional Feedback Module
8	$\overline{PZ}$	Diff. Signal	LOW	Optional Feedback Module
9	PA	Phase A, phase pulse	HIGH	Optional Feedback Module
10	$\overline{PA}$	Diff. Signal	LOW	Optional Feedback Module
11	GND	Feedback device power return		Optional Feedback Module
12	GND	Feedback device power return		Optional Feedback Module
13	GND	Feedback device power return		Optional Feedback Module
14	ENC_5V	+5V dc power for feedback device		Feedback Device
15	ENC_5V	+5V dc power for feedback device		Feedback Device
16	ENC_5V	+5V dc power for feedback device		Feedback Device

CN21M Optional Feedback Module Interface Connector

The optional feedback module is interfaced with the the servo module through connectors CN21M and CN22M. Control signals from the servo module and position feedback information from the non-motor mounted feedback devices pass through this connector. Connector CN21M connects directly to connector CN11 on the servo module. A cable is not required for this connection.

CN22M Optional Feedback Module Interface Connector

The optional feedback module is interfaced with the the servo module through connectors CN21M and CN22M. Encoder feedback signals from the digital servo module pass through this connector. Connector CN22M connects directly to connector CN12 on the servo module. A cable is not required for this connection.

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CN23M External +15V dc Power Supply Connector

Use connector CN23M on the optional feedback module to connect an external +15V dc power supply to the optional feedback module. Typically the optional feedback module receives +15V dc power from the main power supply through connector CN21M. This +15V dc power supply powers the non-motor mounted feedback devices of the optional feedback module.

When the sum of the power requirements of the non-motor mounted feedback devices exceed the internal +15V dc output of the main power supply, use an external power source to supply the +15V dc power. Figure 4B.17 shows an end view of connector CN23M and lists the pin assignments.

Important: Jumper JP1 shown in Figure 4B.20 must be jumpered for external +15V dc power if an external +15V dc power supply is used.

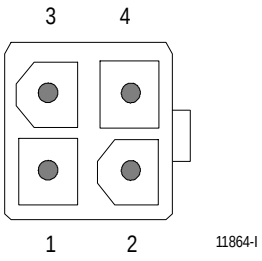


Figure 4B.17
Connector and Pin Assignments for the CN23M, 4 pin male, Molex 5566-4A

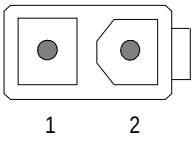
Pin No.	Signal	Description	Signal Destination
1	EXT_15V	External +15V dc for feedback devices	Feedback Device
2	EXT_15V	External +15V dc for feedback devices	Feedback Device
3	GND	Ground	System Common
4	GND	Ground	System Common

CN24M Servo Module +5V dc Power Supply Connector

Use connector CN24M on the optional feedback module to provide +5V dc power to the digital servo module. Typically the optional feedback module receives +5V dc power from the main power supply through connector CN25M. This +5V dc power is transferred from connector CN24M on the optional feedback module to connector CN13 on the digital servo module using cable C43 that is supplied with the optional feedback module. Figure 4B.18 shows an end view of connector CN24M and lists the pin assignments of this connector.

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Figure 4B.18
Connector and Pin Assignments of the CN24M, 2 pin male, Molex 5566-2A



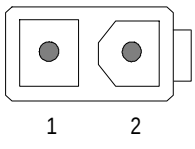
Pin No.	Signal	Description	Signal Destination
1	ENC_5V	+5V dc power for digital servo module	Digital Servo Module
2	GND	Ground	System Common

CN25M +5V dc Power Supply Connector

Use connector CN25M on the optional feedback module to connect a +5V dc power supply to the optional feedback module. Typically the optional feedback module receives +5V dc power from the main power supply through connector CN25M. This +5V dc power supply powers the encoders of the digital servo module and the non-motor mounted feedback devices of the optional feedback module.

When the sum of the power requirements of the servo module and the optional feedback module exceed the +5V dc output of the main power supply, use an external power source to supply the +5V dc power. Figure 4B.19 shows an end view of connector CN25M and lists the pin assignments.

Figure 4B.19
Connector and Pin Assignments for the CN25M, 2 pin male, Molex 5566-2A



Pin No.	Signal	Description	Signal Destination
1	ENC_5V	+5V dc for optional feedback device	Optional Feedback Device
2	GND	Ground	System Common

4B.3.3 Optional Feedback Module Jumper (JP1)

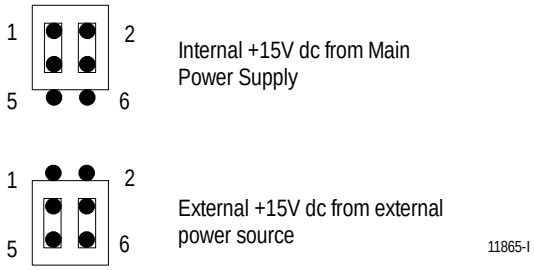
Use jumper JP1 on the optional feedback module to select whether the +15V dc power supply for the non-motor mounted feedback devices is :

- supplied from the main power supply
- supplied from an external power source
- removed from the feedback connectors

Non-motor mounted feedback devices receive +15V dc power through pins 3 and 4 of connectors CN14F, CN15F, and CN16F on the optional feedback module. Figure 4B.20 shows the jumper selections of jumper JP1.

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Figure 4B.20
Optional Feedback Module Jumper JP1 Jumper Selections

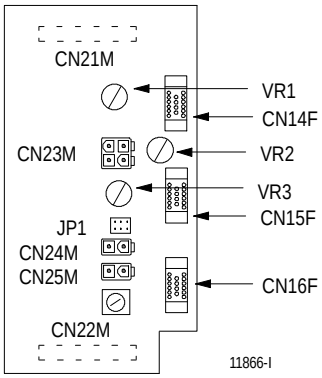


All other jumper selections remove the +15V dc power from the pins of connectors CN14F, CN15F, and CN16F on the optional feedback module.

4B.3.4 Optional Feedback Module Variable Resistors (Pots)

There are three variable resistors (pots) located on the optional feedback module. Use these pots to adjust the +5V dc output to the non-motor mounted feedback devices. Figure 4B.21 shows the optional feedback module pots,corresponding connectors and lists the pots and their corresponding connectors and pin numbers on the optional feedback module.

Figure 4B.21
Optional Feedback Module Pots and Corresponding Connectors



Optional feedback Module	
Pot	**Corresponding Connector and Pins**
VR1	CN14F, Pins 14, 15, and 16
VR2	CN15F, Pins 14, 15, and 16
VR3	CN16F, Pins 14, 15, and 16

Adjust the pots so that the +5V dc voltage of pins 14, 15, and 16 at the feedback device end of the feedback cable is within the operating voltage range of the non-motor mounted feedback device. The pot adjustment depends on the:

- length of the cable running from the optional feedback module to the non-motor mounted feedback devices
- +5V dc operating voltage range of the non-motor mounted feedback devices

If adjusting the pots does not adjust the +5V dc output so that it falls within the operating voltage range of the non-motor mounted feedback device, an external +5V dc power supply is required or the feedback device cable must be shortened.

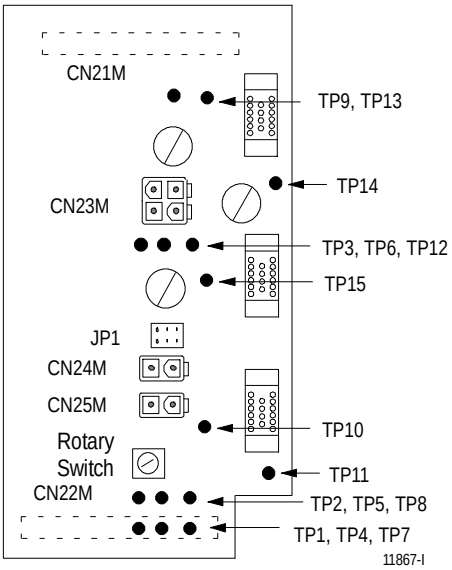
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4B.3.5 Optional Feedback Module Test Points

Test points are small metallic pins on the optional feedback module. Hardware troubleshooting and testing for proper wiring can begin by testing for proper voltage or signals at these pins.

Test points are labeled with the letters TP followed by a number. Figure 4B.22 shows the location of each test point and lists the test data of each test point.

Figure 4B.22
Optional Feedback Module Test Point Locations and Test Point Values



Test Point	Optional Feedback Module Voltage
TP9	+5V dc Power for Feedback Devices
TP14	+5V dc Power for Feedback Devices
TP15	+5V dc Power for Feedback Devices
TP11	+15V dc Power for Feedback Devices
TP10	GND
TP13	GND

Test Point	Servo Module Encoder Feedback Signals
TP5	A Channel
TP2	B Channel
TP8	Z Channel
TP4	U Channel
TP7	V Channel
TP1	W Channel

Test Point	Optional Feedback Device Feedback Signals
TP12	A Channel
TP6	B Channel
TP3	Z Channel

The test points of the optional feedback module can monitor the feedback signals from one feedback port on the servo module and/or one feedback port on the optional feedback module at one time. A rotary switch on the optional feedback module allows the selection of which ports the test points are monitoring. Table 4B.G lists the rotary switch positions and the corresponding ports the test points monitor at each switch position.

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Table 4B.G
Optional Feedback Module Rotary Switch Positions

Rotary Switch Position	Corresponding Ports
0	No Feedback Signals
1	Port CN5 on the servo module
2	Port CN6 on the servo module
3	Port CN7 on the servo module
4	Port CN14F on the optional feedback module
5	Ports CN5 on the servo module and CN14F on the optional feedback module
6	Ports CN6 on the servo module and CN14F on the optional feedback module
7	Ports CN7 on the servo module and CN14F on the optional feedback module
8	Port CN15F on the optional feedback module
9	Ports CN5 on the servo module and CN15F on the optional feedback module
A	Ports CN6 on the servo module and CN15F on the optional feedback module
B	Ports CN7 on the servo module and CN15F on the optional feedback module
C	Port CN16F on the optional feedback module
D	Ports CN5 on the servo module and CN16F on the optional feedback module
E	Ports CN6 on the servo module and CN16F on the optional feedback module
F	Ports CN7 on the servo module and CN16F on the optional feedback module

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4B.4 Wiring a Touch Probe to the Digital Servo Module

A touch probe can be interfaced with the digital servo module through connector CN9. Refer to Figure 4B.5 for the location of connector CN9 on the digital servo module. Touch probe cable information can be found on page 7A-38.

The time delay between the servo module receiving the touch probe trigger and latching the current axis position is considered negligible. However, you should take into account any external delays that can introduce position "staleness" in the probing operation, especially at high probing speeds.

It is a good idea to establish an offset for the distance between the actual location, as sensed by the touch probe at a very low speed, and the location sensed by the touch probe at the intended probing speed. The offset can then be added or subtracted to any future values obtained through probing. This helps insure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is removed from the measurement (assuming the external delay is repeatable).

The motion controller touch probe interface is intended for use with units that offer 5V dc compatible solid state relay outputs (see Figure 4B.23). Other configurations can be supported as long as the user operates within the published electrical specifications.

The touch probe circuitry resident on the servo module only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is programmable through the AMP parameter Probe Transition Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, position data is captured by the module, and additional occurrences of the trigger signal have no effect until the probe is reenabled under program control.

Refer to the 9/Series CNC 9/230, 9/260 and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

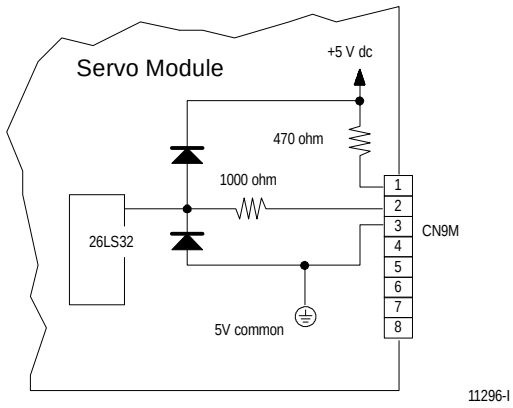


ATTENTION: It is preferred, from a safety standpoint, that the touch probe relay be closed at rest and open when the touch probe stylus deflects. Then, if a wire breaks or shorts to ground, it will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort to insure fail-safe operation of the touch probe. Not all vendors of touch probe control units conform to this safety consideration.

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Figure 4B.23 shows the internal servo module circuitry that interfaces to the touch probe connector. It is shown here to assist you in determining whether your touch probe hardware is compatible.

Figure 4B.23
Internal Circuitry Supporting the Touch Probe



The following table indicates probing threshold voltages. Maximum Input Threshold (critical if the control has been configured to fire on the falling edge of the probe signal) indicates the voltage that the probe signal must fall below to be considered as “fired”. Minimum Input Threshold (critical if the control has been configured to fire on the rising edge of the probe signal) indicates the voltage that the probe signal must rise above to be considered as fired.

Probe Thresholds	Voltage at Threshold
Minimum Input Threshold (probe circuit)	3.06V dc (min)
Maximum Input Threshold (probe circuit)	2.18V dc (max)

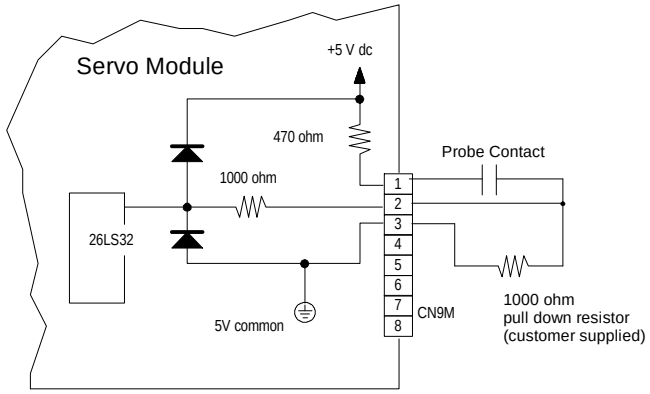
To guard against misfires use the threshold values from the above table to determine the necessary signal voltage for steady state operation (probe not fired). For probes configured to fire on the falling edge the steady state voltage must remain above 3.06 volts. For probes configured to fire on the rising edge the steady state voltage must remain below 2.18 volts.

Wiring a Probe for Rising Edge Configurations

Typical wiring of a simple contactor type touch probe configured to fire on the rising edge of the probe signal, requires the addition of a 1000 ohm pull down resistor. Figure 4B.24 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

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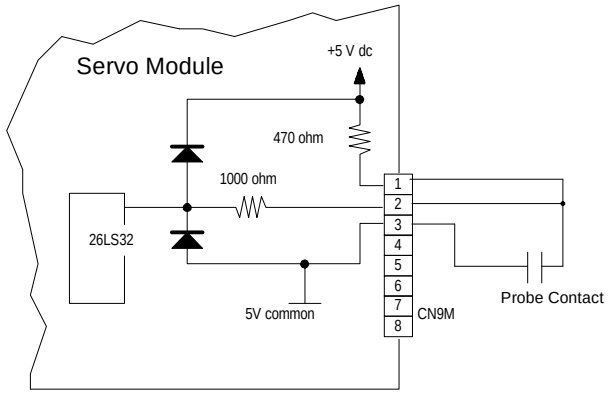
Figure 4B.24
Typical Wiring of a Touch Probe Configured for Rising Edge Trigger



Wiring a Probe for Falling Edge Configuration

Figure 4B.25 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

Figure 4B.25
Typical Wiring of a Touch Probe Configured for Falling Edge Trigger



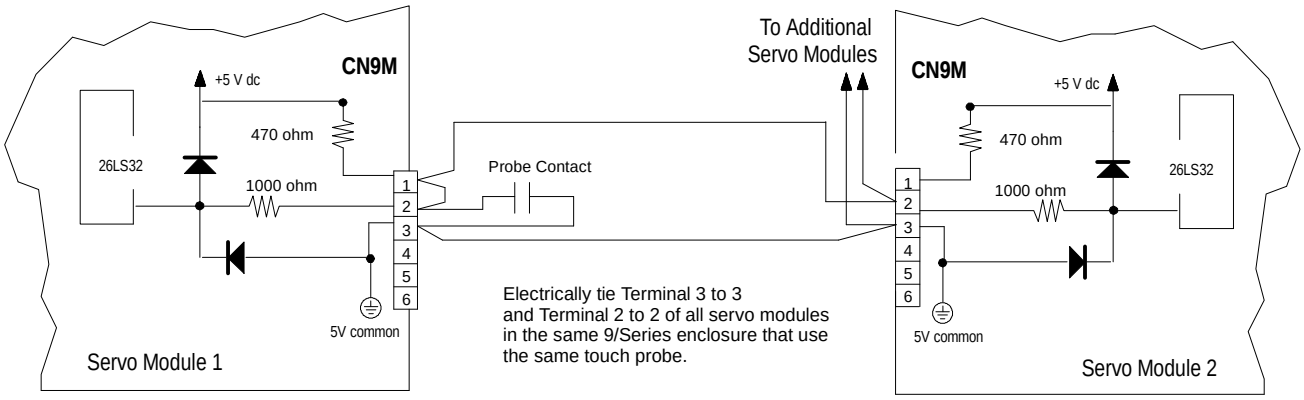
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Wiring a Probe to Multiple Servo Modules

Systems with more than one servo module should have their touch probe connections tied together in parallel. This allows the position to be latched on all servo modules at the same time with the same input. Only one power connection needs to be made (with pull up or down resistor). The other probe connections should be made in parallel on all servo cards.

Figure 4B.26 shows a typical wiring diagram for multiple servo cards.

Figure 4B.26
Multiple Servo Card Touch Probe Wiring (Falling Edge Trigger)



4B.5
Adaptive Depth Probing

The adaptive depth probe feature is not available on the three axis digital servo card.

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4B.6 How the Analog Servo Module Works

There are two typical analog servo drive configurations for the control. The typical mill configuration has three axes, each having a servo motor and feedback device, and an open loop spindle motor. The typical lathe configuration has two axes, each having a servo motor and feedback device, and an open loop spindle motor with position feedback.

The analog servo module functions as a high speed servo processor. It is installed in the component enclosure.

The analog servo amplifier amplifies the signal from the analog servo module in order to deliver the power necessary to drive the servo motors.

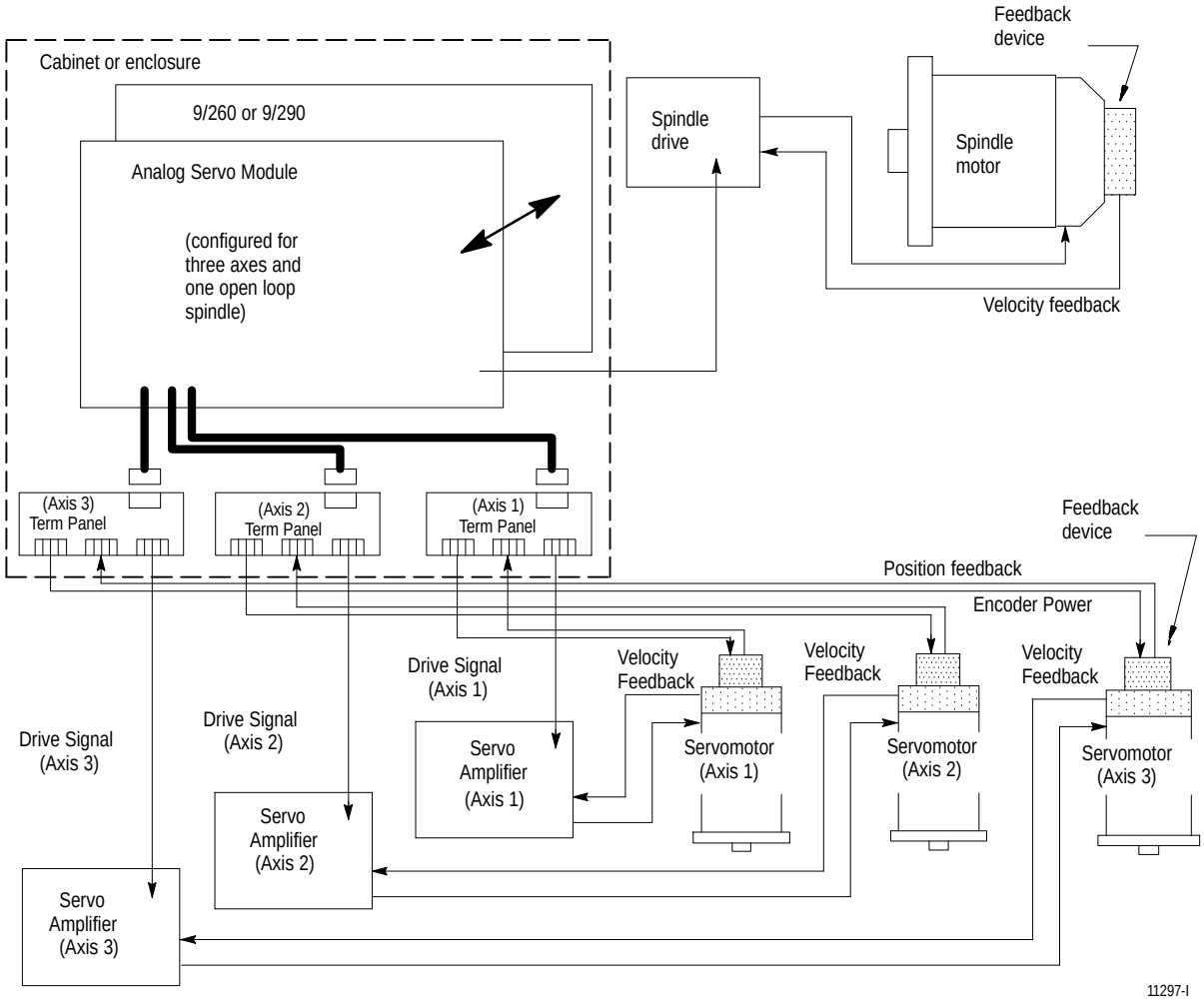
Position and velocity data are read from a feedback device that is mounted on the slide, ballscrew, or servo motor. This feedback device generates differential signals that are then fed to the analog servo module. If the spindle motor incorporates an encoder it will supply spindle position feedback to the analog servo module.

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Most analog servo drive amplifiers require some form of velocity feedback from the servo motor. This feedback is usually generated by a tachometer or resolver attached to the motor shaft. Refer to your servo drive amplifier literature for details.

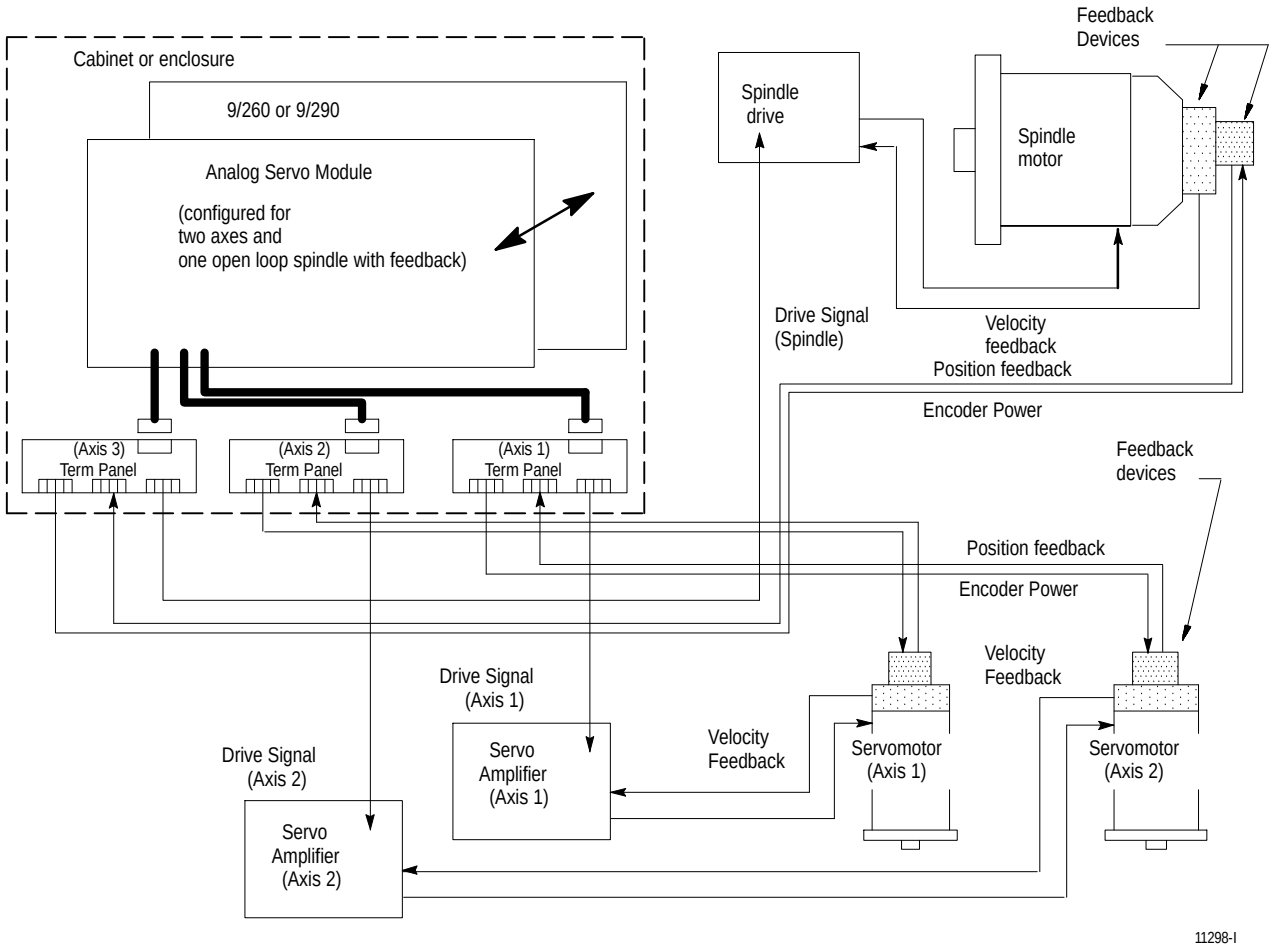
Figure 4B.27 and Figure 4B.28 show typical analog servo drive configurations for a mill and a lathe. For specific details on configuring axes, axis positioning loops, and axis port selection, refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4.

Figure 4B.27
Typical Analog Servo Drive Configuration for a Mill



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Figure 4B.28
Typical Analog Servo Drive Configuration for a Lathe



For additional information on each of the major components refer to the section that covers that component.

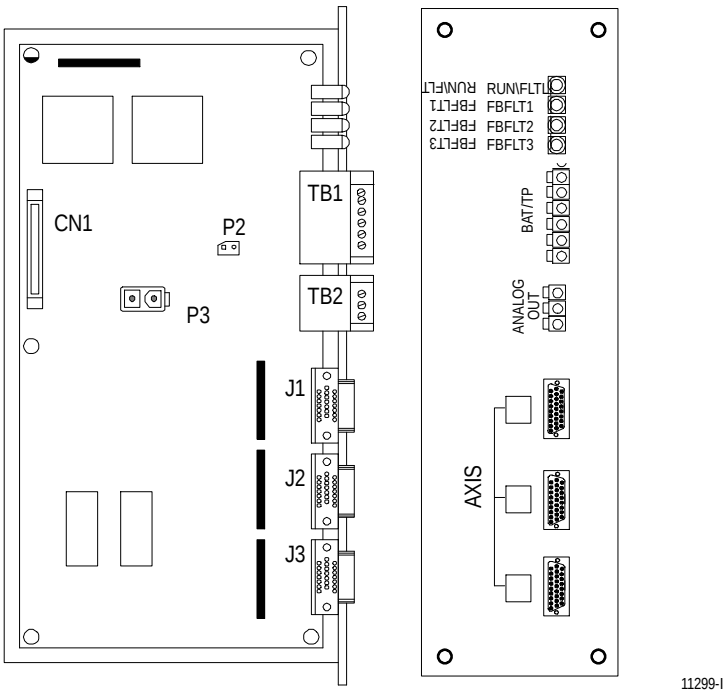
Important: In order to use the solid tapping feature that is available on the 9/260 and 9/290 CNC, you must use the the Allen-Bradley 8510 AC spindle drive system.

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4B.6.1 Analog Servo Module

The Analog Servo Module is mounted in the component enclosure. It functions as a high-speed servo processor. The control sends positioning and velocity data to the servo module, which processes the data to generate the necessary analog drive signals. These signals are sent to the analog servo amplifiers, which power the servo motors of the control. Each analog servo module may control up to three closed loop axes and one open loop axis (typically used for a spindle).

Figure 4B.29
Analog Servo Module



The servo module receives position data from the axis feedback devices. It combines this position feedback data with the interpolated commands from the control to generate the command signals that it outputs to the servo amplifiers.

The functions of the analog servo module are designed to make the servomotors run with optimum performance. The maximum feedrates are be limited by the mechanical abilities of the machine. System gain and the maximum allowable following error also limit the feedrates. These limits are entered as AMP parameters. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

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4B.6.2 Analog Servo Module Connectors and Pin Assignments

Table 4B.H lists the connectors that are used to integrate the analog servo module with other modules of the control.

Table 4B.H
Typical Analog Servo Module Connection

Connector On Servo Module	Connected To		Cable Number	Remark
	Module	Connector		
CN1	Motherboard	P4, P5, or P6	C12	
J1 (D shell)	Term. Panel	AXIS	C35	AXIS
J2 (D shell)	Term. Panel	AXIS	C35	AXIS
J3 (D shell)	Term. Panel	AXIS	C35	AXIS
BAT/T.P. (TB1)	Touch Probe	--	C41	
ANALOG OUT (TB2)	--	--	C42	1
(P2)	Not Used	N/A	N/A	
(P3)	Main Power Supply (Encoder Power)	Wire and plug from main power supply		

Important: When 1 servo module is used, it must be connected to P4 of the motherboard. When 2 servo modules are used, the first servo module must be connected to P4 and the second to connector P6. When three modules are used (9/290 only), connect the first to P4, connect the second to P6, and connect the third to P5.

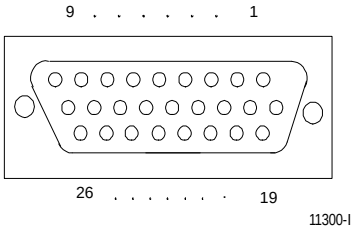
1 Analog drives attached to TB2 that incorporate an encoder to supply position feedback to the servo module must be interfaced with one of the regular AXIS "D shell" connections (J1, J2, or J3). The ANALOG OUT (TB2) has no feedback capabilities.

J1, J2, and J3 D-Shell AXIS Connectors

The analog servo module sends drive signals to the servo amplifier through connectors labeled J1, J2, and J3. Figure 4B.30 shows an end view of connector J1, J2, and J3 and lists the pin assignments of these connectors.

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Figure 4B.30
Connectors J1, J2, and J3 - 26 Pin Female, D-Shell Connector and Pin Assignments



Pin No.	Signal	Description	Signal Destination
1	Not Used		
2	Not Used		
3	CHA_HI	Feedback device Channel A	Servo Module
4	CHB_HI	Feedback device Channel B	Servo Module
5	CHZ_HI	Feedback device Channel Z	Servo Module
6	+5V_ENC	+5V Encoder Power Supply	Feedback Device
7	+5V_ENC	+5V Encoder Power Supply	Feedback Device
8	SEN	Switched +5V Encoder Power Supply (not used)	Feedback Device
9	DRIVE	±10V analog drive command	Servo Amplifier
10	Not Used		
11	Not Used		
12	CHA_LO	Feedback device Channel A	Servo Module
13	CHB_LO	Feedback device Channel B	Servo Module
14	CHZ_LO	Feedback device Channel Z	Servo Module
15	+15V_ENC	+15V Encoder Power Supply	Feedback Device
16	GND	Encoder Power Return	Feedback Device
17	SEN. RET	Encoder Power Return	Feedback Device
18	DRIVE.RET	±10V analog drive command return	Servo Amplifier
19	Not Used		
20	Not Used		
21	SHLD_CHA	Shield for phase A	connect at module only
22	SHLD_CHB	Shield for phase B	connect at module only
23	SHLD_CHZ	Shield for phase Z	connect at module only
24	SHLD_+5V	Shield for +5V	connect at module only
25	SHLD_SEN	Shield for switched +5V	connect at module only
26	SHLD_DRV	Shield for drive command	connect at module only

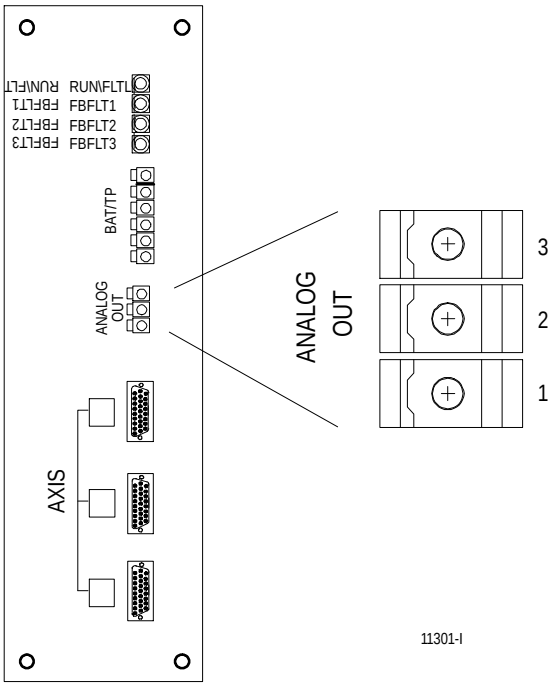
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ANALOG OUT (TB2) Auxiliary Output Connector.

An auxiliary analog output is provided through the connector labeled ANALOG OUT (TB2). This connector is typically used to command an analog spindle drive system with no position feedback. TB2 is not capable of receiving encoder feedback information. Figure 4B.31 shows the location of ANALOG OUT connector and lists terminal assignments of this connector.

Important: Note that TB2 should only be used for drive applications that do not require a feedback device. If a feedback is required, the output signal to the drive and its corresponding encoder feedback should be wired through one of the axis connectors J1, J2, or J3. A drive application with feedback would typically not use the connector labeled ANALOG OUT (TB2). However, if necessary, TB2 may be used with encoder feedback configured in AMP to be returned to one of the axis connectors J1, J2, or J3.

Figure 4B.31
Terminal Block ANALOG OUT, 3 Plug-type Terminal Block Connections.



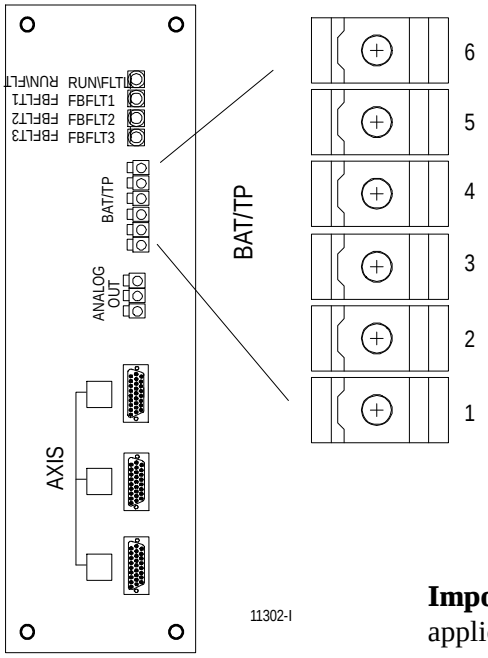
Terminal No.	Signal	Description	Signal Destination
1	Analog Out +	±10V Analog with no feedback	(typically spindle drive)
2	Analog Out -	Signal Return	(typically spindle drive)
3	Shield	shield	connect at module only

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BAT/TP (TB1) Touch Probe Connector.

The analog servo module receives touch probe feedback through the connector labeled BAT/TP (TB1). Figure 4B.32 shows the location of the BAT/TP connector and lists the terminal assignments.

Figure 4B.32
Connector BAT/TP, 6 Plug-type Terminal Block Connections.



Terminal No.	Signal	Description	Signal Destination
1	Not Used		
2	Not Used		
3	+5V	Probe Power	Touch Probe
4	PRB_FIRE	Probe Fired Signal [1]	Servo Module
5	PE	Touch Probe Common	Touch Probe
6	Shield	Probe Shield	connect at module only

[1] The True level (voltage transition the probe fires) is either "HIGH" or "LOW" as defined by the AMP parameter PROBE TRANSITION. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

Important: The touch probe connector supports only +5V probing device applications.

P3 5V dc Encoder Power Connector

The analog servo module receives +5V dc power directly from the main power supply through connector P3. This +5V dc power is used only for powering the encoder. If the EXT Power connection on the encoder termination panel is used or if the 15V dc encoder power is used the connection to P3 is not needed. Figure 4B.33 shows an end view of connector P3 and lists the pin assignments. For details on this connection refer to the section on the main power supply connections on page 4D-4.

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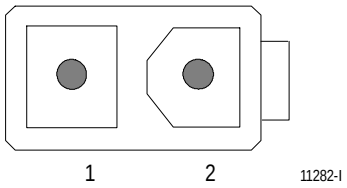


Figure 4B.33
Connector P3, 2 pin male, Molex 5566-02A

Pin No.	Signal	Description	Signal Destination
1	Not Used		
2	+ 5V dc	Encoder Power	Main Power Supply

4B.6.3 Analog Servo Module Specifications

Table 4B.I lists the analog servo module output specifications. This table is provided as an aid to determining the compatibility of different analog servo amplifiers and spindle drives. Table 12.A contains a list of compatible analog servos. Input specifications are discussed in sections covering the individual input devices. Refer to Table 4C.E for encoder feedback input specifications.

Table 4B.I
Analog Servo Module Analog Output Specifications

Item	Specification	Remark
Output Voltage Range	±10V	
Analog Output Driver	Single Ended	Drive return connected to common.
Output Offset Voltage	500mV Max.	
Resolution	1.22mV	(13 bits) [1]
Sampling Frequency	500 Hz	
Output Current	5mA Max.	
Load Range	2K ohms to infinity	
Conversion Time	8.25ms	
Differential Non-Linearity	±1 LSB Max.	[2]
Gain Error	±1 LSB Max.	
Load Capacitance	0.01mF Max.	

[1] This resolution is obtained through software. It is equal to a 13-bit numeric value with an additional sign bit (14 bits total).
[2] Monotonic over the entire temperature range. LSB means least significant bit.

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4B.6.4 Connecting Axes to Analog Servo Module

Axes are connected to the D-shell connectors marked J1, J2, and J3. Axes must be connected consecutively with no empty connections between axes. For example, an axis may not be connected to the connector J3 unless both J1 and J2 are used. If two servo modules are used, all three axes on the first servo module must be connected before an axis may be configured on the second servo module.

If a spindle with feedback is configured the spindle must be connected to the first available D-Shell connector after the last connector used by a linear or rotary axis.



ATTENTION: Do not insert the plug-type ANALOG OUT terminal block (TB2) into an encoder termination panel DRIVE terminal block or vice versa. Although these plugs will fit together, pin assignments are different. Switching these connections without rewiring the plug-type terminal block may cause damage to equipment.

For example to configure a four axis system with a spindle with feedback two servo modules are necessary. The first three axes must be connected to the three D shell connectors on the first servo board. The fourth axis must connect to the second servo board connector labeled J1. The spindle with feedback must then be connected to the D shell labeled J2 on the second servo board. For this specific application the spindle may not be attached to the first servo board or J3 of the second servo board.

4B.6.5 Analog Servo Module LED Indicators

The analog servo module is equipped with a set of four LEDs located on the front of the servo module. Table 4B.J lists the meaning of these LEDs.

Table 4B.J
Analog Servo Module LED Indicators

LED	Color	Description
RUN/FLT	Green	Indicates the servo processor OK when lit. Watch dog has failed or power fault has occurred when LED is not lit.
FBFLT 1	Red	Indicates the servo module is not receiving feedback, or is receiving interrupted or irregular feedback from the feedback device on J1 when lit.
FBFLT 2	Red	Indicates the servo module is not receiving feedback, or is receiving interrupted or irregular feedback from the feedback device on J2 when lit.
FBFLT3	Red	Indicates the servo module is not receiving feedback, or is receiving interrupted or irregular feedback from the feedback device on J3 when lit.

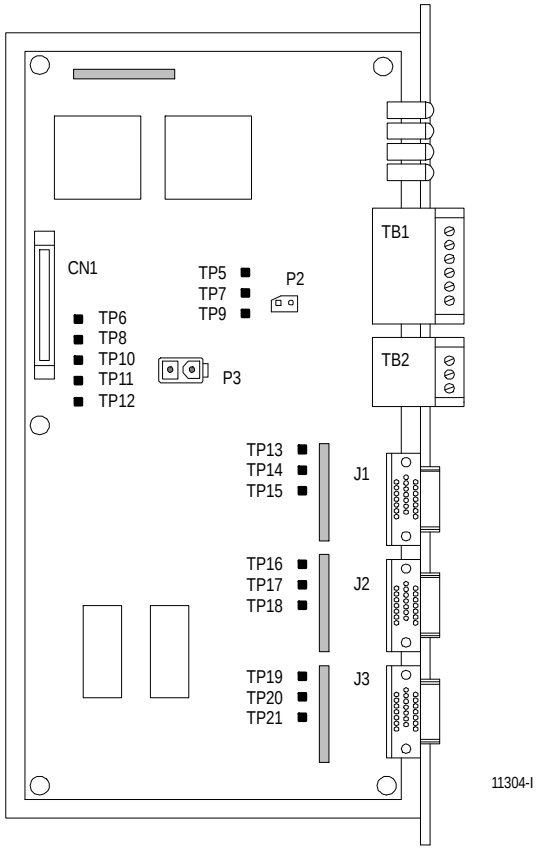
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4B.6.6 Analog Servo Module Test Points

Test points are small metallic pins on the analog servo module circuit board. Hardware troubleshooting and testing for proper wiring can begin by testing for proper voltage or signals at these pins.

Test points are labeled with the letters TP followed by a number. Figure 4B.34 shows the location of each test point. Table 4B.K lists the test data of each test point.

Figure 4B.34
Analog Servo Module Test Point Locations



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Table 4B.K
Analog Servo Module Test Point Values

Test Point	Analog DAC reference Voltages
TP5	+10V dc Reference
TP7	Analog Ground
TP9	-10V dc Reference

Test Point	Module Power Reference Voltages
TP6	+5 V dc
TP8	Digital Ground
TP10	+15V dc
TP11	Analog Ground
TP12	-15V dc

Test Point	Encoder Feedback Signals
TP13	Z Channel connector J1
TP14	B Channel connector J1
TP15	A Channel connector J1
TP16	Z Channel connector J2
TP17	B Channel connector J2
TP18	A Channel connector J2
TP19	Z Channel connector J3
TP20	B Channel connector J3
TP21	A Channel connector J3

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4B.7
Encoder Termination Panel

The encoder termination panels are options with the analog system that provide an easy and convenient means for you to connect and troubleshoot your servo system. We strongly recommend the use of termination panels when installing an analog system.

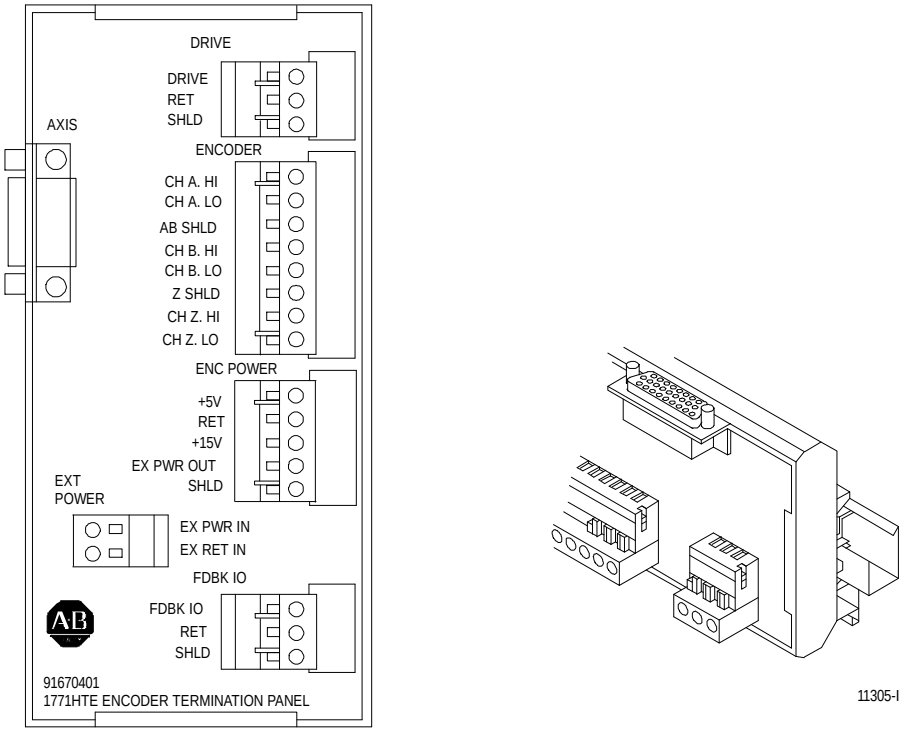
Termination panels feature:

- D-shell connectors for cables from the motion controller (A-B cable number 8520-TPC)
- Plug-type connectors for wiring to user devices
- DIN Rail Mountable

All user connections with the exception of the ANALOG OUT (TB2) and BAT/TP (TB1) connections are routed through the termination panels. User side voltages of +5V dc and +15V dc for encoder power (chosen by wiring to the appropriate connector pin) are available on-board. External power supplies for the encoders may also be routed through the termination panel (refer to the feedback section).

Figure 4B.35 shows an encoder termination panel.

Figure 4B.35
Encoder Termination Panel



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4B.8 Compatible Feedback Devices

This section discusses encoder feedback devices that are compatible for both analog and digital servo systems. The servo module supplies these devices with either +5V or +15V power. Feedback devices on all the CNCs must return a 5V compatible output signal to the control (1326 motor mounted resolvers have their signals converted by the system module to be compliant with this requirement).

For **analog systems** this feedback device can be used to provide:

- velocity feedback (used only if your system does not provide tachometer velocity feedback to the drive) In this case, the analog servo amplifier must be configured to run in "torque mode" with no tachometer. Tachless servo configurations work best if an encoder type feedback device is used and mechanically coupled directly to the servomotor shaft.
- position feedback (can be the same device as used to close the velocity loop if the velocity loop is closed by the CNC, or an additional feedback device, as discussed in this section, can be used for the position loop)
- spindle feedback

For **digital systems** this feedback device can be used to provide:

- position feedback (digital systems require the motor mounted feedback device, provided on our standard digital servo motors, be used for velocity loop feedback. This motor mounted feedback device can also be used to close the position loop or an additional feedback device, as discussed in this section, can be used for the position loop.) You can not replace or bypass the motor mounted feedback device. The motor mounted feedback device must be used for velocity feedback and to attain proper motor commutation on digital servo systems.
- spindle feedback

Only the 8520 digital drive system supports absolute feedback.

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The 3 axis 9/260 and 9/290 servo cards support:

Feedback Device	Additional hardware
Allen-Bradley 845H series differential encoders	--
Sony Magnascale model GF-45E	Board-type detector model MD10-FR
Heidenhain Model 704	External interpolation and digitizing model EXE602 D/5-F
Futaba Pulscale model FM45NY	PCB interface Module model CZ0180 with cable PCB020EA

Other feedback devices can be compatible if they comply with the specifications listed in Table 4B.L. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

This manual is written under the assumption that your system is using the Allen-Bradley 845H series differential encoder. If you are using some other feedback device such as a linear scale, an application note is available through Allen-Bradley CNC Commercial Engineering Department at area code (216) 646-3963.

The following table lists feedback specifications for a differential encoder however, this information can be interpreted to select an appropriate linear scale.

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Table 4B.L
Encoder Specifications

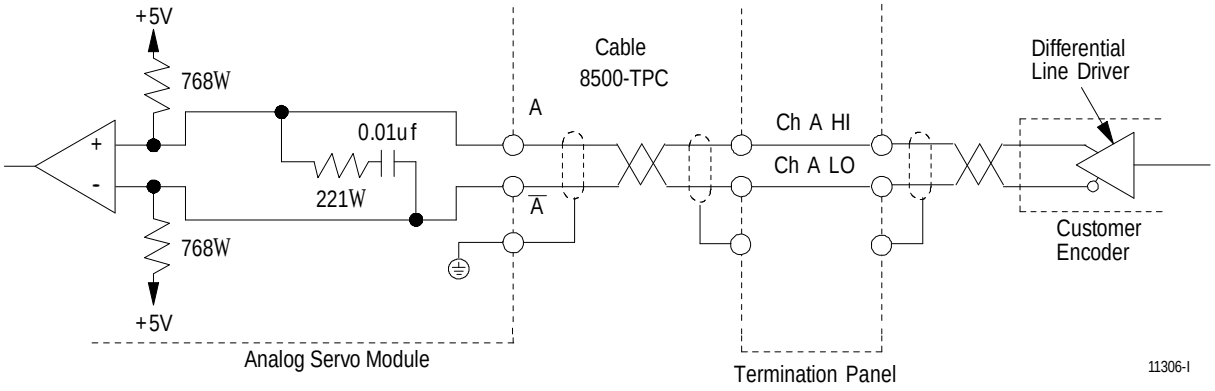
Item	Specification
Maximum Encoder Channel Frequency (ECF)	Use the following equation to determine the maximum channel frequency $\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90\text{-Eq}}\right)} \times 1.15$ Where: Clock - is the Control's Feedback Clock Frequency: 5×10^6 - for 9/230, 9/440, and three axis servo cards. 2.3×10^7 - for 9/260 or 9/290 systems using a four axis servo card E_Q = Quadrature Error in Degrees 1.15 = Our minimum recommended safety factor As long as the actual feedback channel frequency does not exceed the maximum channel frequency calculated above, the servo module should process the feedback data without a quadrature fault.
Maximum Axis Speed	Use the following equation to determine the maximum axis speed. Note that this equation does not take into consideration any mechanical deficiencies in the encoder or motor. It is only concerned with the 9/Series capability of receiving feedback. Refer to the manufactures specs for encoder and motor hardware RPM limitations. $\frac{(ECF \times 60)}{(E)(N)(P)} = \text{Maximum Axis Speed}$ Where: Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute) ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec. E = the number of encoder lines between markers for your encoder N = the ratio of encoder turns to ballscrew turns P = the ballscrew pitch (turns per inch or turns per millimeter. For rotary axes, substitute the appropriate gear ration for N and P in the equation above to solve for a max RPM in revolutions per minute. If the maximum axis speed resulting from this equation is less than you would like, you may need to sacrifice some axis resolution by selecting an encoder with fewer lines between markers.
Input Signal	Encoder feedback must be differential format with 5V compatible output signals, single-ended open-collector outputs are not supported, i.e., channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent.
Current Drawn from Encoder by Servo Module	7mA maximum; 44mA peak
Marker Channel	Narrow marker (gated) or Wide marker (ungated) type markers are supported
Encoder Cable Length	Refer to 9/Series Integration and Maintenance Manual for details on cabling

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4B.8.1 Wiring an Incremental Feedback Device

Figure 4B.36 shows an incremental feedback device equivalent circuit for feedback channel A.

Figure 4B.36
Incremental Feedback Device Equivalent Circuit



Wiring Position Feedback

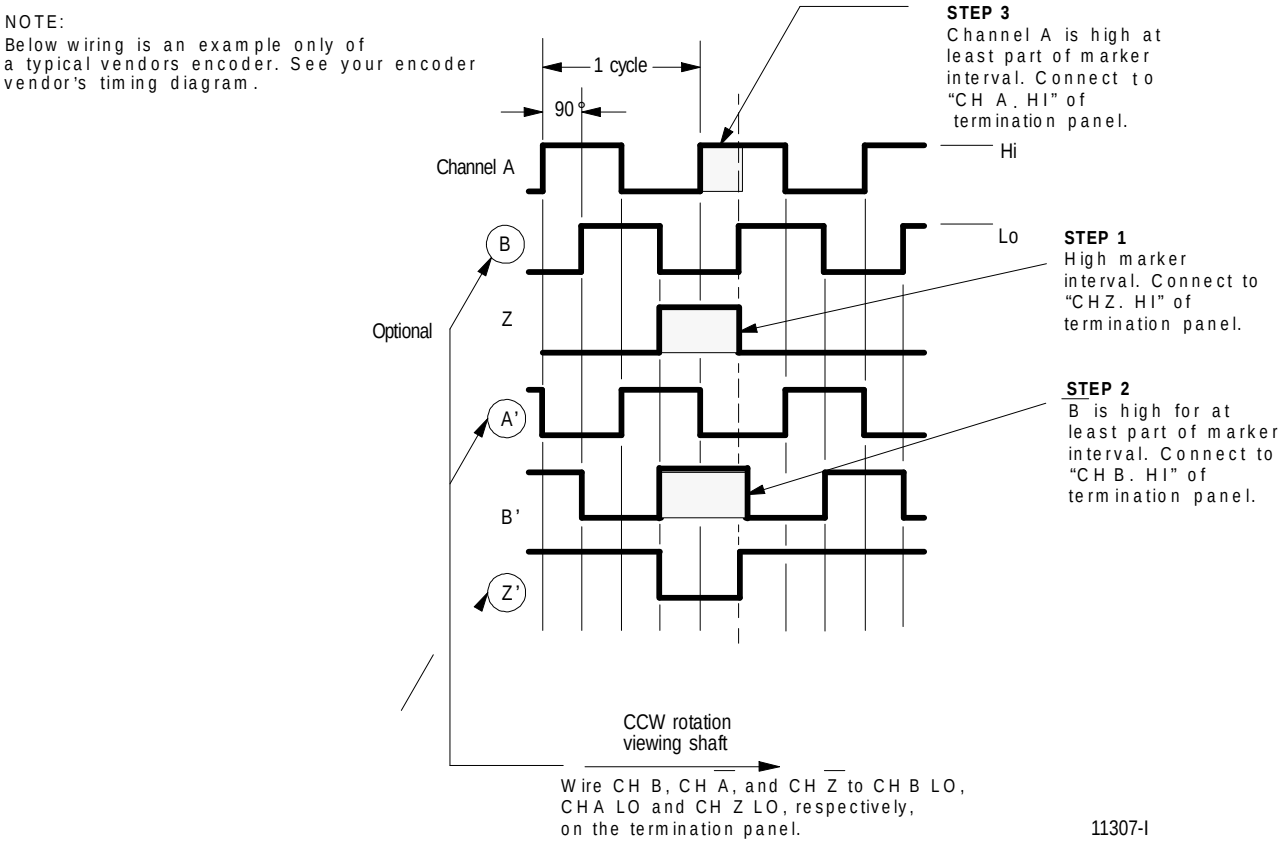
Feedback devices used with the control must be configurable such that the marker Z is true at the same time that channels A & B are true. If you are using an Allen-Bradley 845H encoder this requirement will already be met if you wire them as shown in the cable diagrams on page 7A-53.

If you are using an encoder type feedback device other than the Allen-Bradley 845H encoder, then use the following wiring procedure:

1. Obtain the encoder output timing diagram from the vendor's data sheets. A typical one is provided in Figure 4B.37 as an example.

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Figure 4B.37
Example of a Typical Vendor Encoder Timing Diagram



2. On the timing diagram, look at the marker Z and its complement, marker Z'. Whichever one is low for most of the encoder revolution and pulses high should be wired to "CH Z.HI" of the encoder termination panel. Wire the remaining marker to "CH Z.LO" of the encoder termination panel.

3. Look at channel B and its complement, channel B'. Whichever one is high for at least part of the marker interval should be wired to "CH B.HI" of the encoder termination panel. It is possible that both channels meet this requirement depending on the encoder manufacturer, in which case, use either one. Wire the remaining channel to "CH B.LO" of the encoder termination panel.

4. Look at channel A and its complement channel A' and repeat as in step 3 using "CH A.HI" and "CH A.LO" of the encoder termination panel .



ATTENTION: You can find a marker even if your encoder is not phased properly. An improperly phased encoder will still home successfully.

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If the previous procedure is not performed correctly, inconsistent homing of the axis may occur. If your encoder phasing cannot provide an interval at which the marker and both channels are simultaneously true, the encoder should be considered incompatible with the control.

Important: Since positive and negative axis directions can be assigned without regard to encoder rotation directions, it is possible for the feedback direction to be "backwards". This is easily corrected before attempting to command axis motion through the AMP parameter Sign of Position Feedback**.** Refer to the 9/Series CNC 9/230,9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

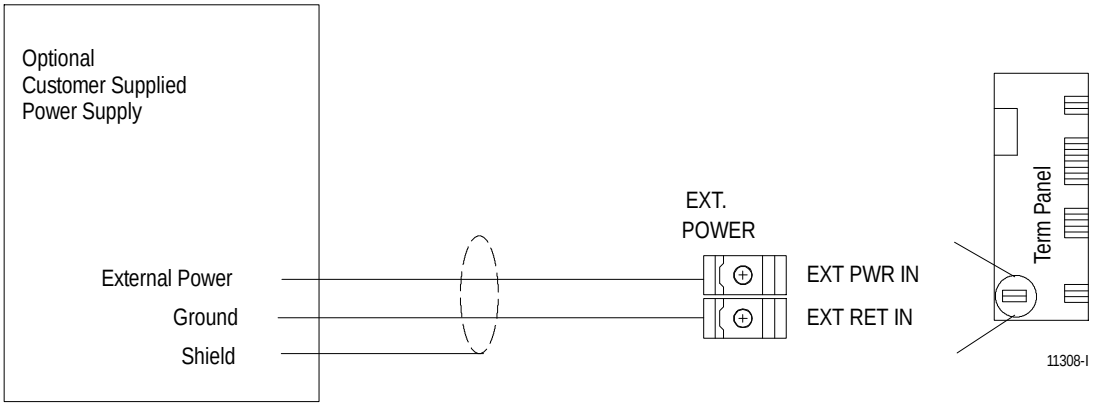
Wiring Power for your Feedback Device (Analog Systems Only)

The control supports feedback devices with 5v compatible output signals. The voltage that these feedback devices require may vary. The analog servo module is equipped to supply 5V dc or 15V dc power to feedback devices. These voltages may be accessed directly from the encoder termination panel . For more information refer to page 7A-8.

Important: Be aware that if the 5V dc encoder power is to be used the connector P3 on the servo module must be directly connected to the power supply. Refer to page 4D-4 for details on this power supply connection.

If your feedback device requires an external power supply, you can incorporate it through the EXT. POWER connector on the termination panel. Power outputs through the ENC POWER connector terminal labeled EX PWR OUT. The next figure shows the termination panel connection for EXT. POWER.

Figure 4B.38
Wiring Optional Customer Supplied Power Supply for Feedback Devices



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4B.9 Wiring a Touch Probe to the Analog Servo Module

Connect a touch probe to the connector labeled BAT/TP on the servo module (TB1). Connector terminal identification is provided in Figure 4B.39. Touch probe cable information can be found on page 7A-38.

The time delay between the servo module receiving the touch probe trigger and latching the current axis position is negligible. However, you should be aware of any external delays that may introduce position "staleness" in the probing operation, especially at high probing speeds.

It is a good idea to establish an offset for the distance between the actual location, as sensed by the probe at a very low speed, and the location sensed by the probe at the intended probing speed. The offset can then be added or subtracted to any future values obtained through probing. This helps make sure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is removed from the measurement (assuming the external delay is repeatable).

The motion controller touch probe interface is intended for use with units that offer 5V dc compatible solid state relay outputs (see figure 9.12). Other configurations can be supported as long as the user operates within the published electrical specifications.

The touch probe circuitry resident on the servo module only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, position data is captured by the module, and additional occurrences of the trigger signal have no effect until the probe is reenabled under program control.

Refer to the 9/Series CNC 9/230,9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

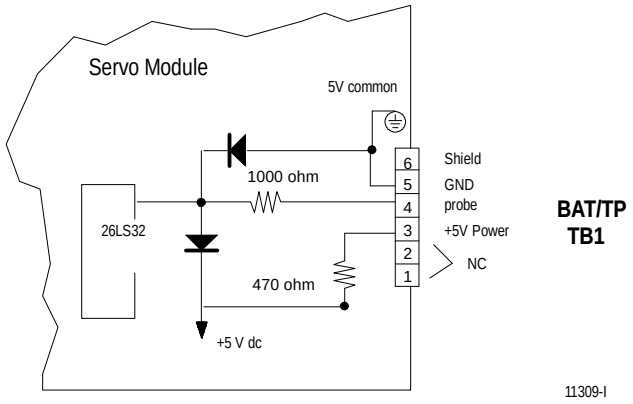


ATTENTION: It is preferred, from a safety standpoint, that the touch probe relay be closed at rest and open when the touch probe stylus deflects. Then, if a wire breaks or shorts to ground, it will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort towards the fail-safe operation of the touch probe. Not all vendor's touch probe control units conform to this safety consideration.

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Figure 4B.39 shows the internal servo module circuitry that interfaces to the touch probe connector. It is shown here to assist you in determining whether your touch probe hardware is compatible.

Figure 4B.39
Internal Circuitry Supporting the Touch Probe



The following table indicates probing threshold voltages. Maximum Input Threshold (critical if the control has been configured to fire on the falling edge of the probe signal) indicates the voltage that the probe signal must fall below to be considered as “fired”. Minimum Input Threshold (critical if the control has been configured to fire on the rising edge of the probe signal) indicates the voltage that the probe signal must rise above to be considered as fired

Probe Thresholds	Voltage at Threshold
Minimum Input Threshold (probe circuit)	3.06 (min)
Maximum Input Threshold (probe circuit)	2.18V dc (max)

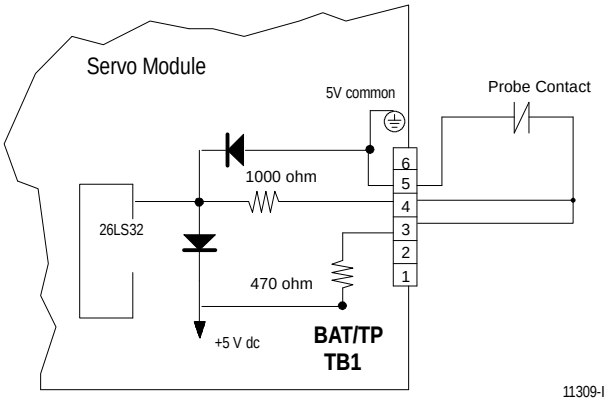
To avoid misfires use the threshold values from the above table to determine the necessary signal voltage for steady state operation (probe not fired). For probes configured to fire on the falling edge the steady state voltage must remain above 3.06 volts. For probes configured to fire on the rising edge the steady state voltage must remain below 2.18 volts.

Wiring a Probe for Rising Edge Configurations

Typical wiring of a simple contactor type touch probe configured to fire on the rising edge of the probe signal, requires the addition of a 1000 ohm pull down resistor. Figure 4B.40 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probe’s signal.

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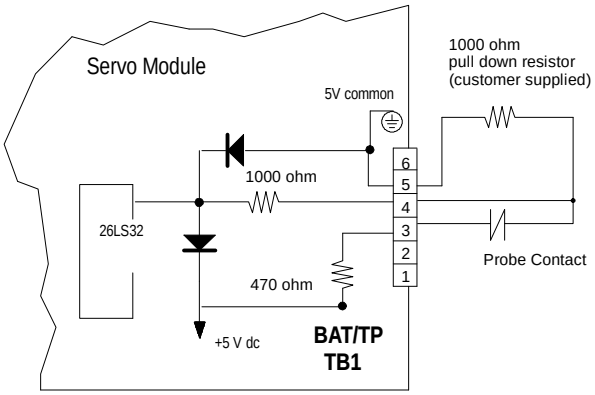
Figure 4B.40
Typical Wiring of a Touch Probe Configured for Rising Edge Trigger



Wiring a Probe for Falling Edge Configuration

Figure 4B.41 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

Figure 4B.41
Typical Wiring of a Touch Probe Configured for Falling Edge Trigger



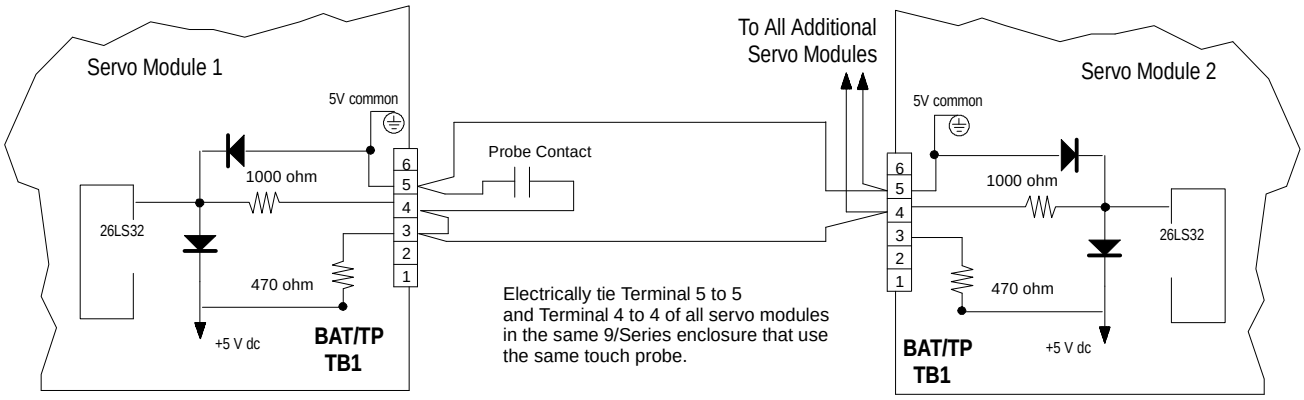
Wiring a Probe to Multiple Servo Cards

Systems with more than one servo module should have their touch probe connections tied together in parallel. This allows the position to be latched on all servo modules at the same time with the same input. Only one power connection needs to be made (with pull up or down resistor). The other probe connections should be made in parallel on all servo cards.

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Figure 4C.22 shows a typical wiring diagram for multiple servo cards.

Figure 4B.42
Multiple Servo Card Touch Probe Wiring (Falling Edge Trigger)



4B.10
Adaptive Depth Probing

Use the Adaptive Depth probe feature to enable an adaptive depth probe that monitors tool depth relative to the actual part surface. This feature allows:

- a more flexible part mounting system (small changes to part size or part mounting do not require reprogramming of the machine or station)
- greater accuracy with a less accurate machine drive system (tool position is relative to the part surface rather than the machine home)
- a retroactive change in axis positioning resolution (feedback for axis positioning switches between the normal axis encoder and the adaptive depth probe once the probe is triggered).

Important: Since the adaptive depth probing feature requires one feedback port to pass probe position data to the control and another feedback port for normal axis positioning feedback, the adaptive depth feature is not compatible with the single axis 9/230 processor which only has one feedback port.

The adaptive depth probe is wired like any A quad B rotary encoder. It is connected to one of the controls feedback ports. Table 4C.E lists specifications for an encoder. These same specifications apply to your adaptive depth probe.

If you are using the adaptive depth probe to close the position loop (selected in AMP) the maximum axis speed calculations from Table 4C.E also applies. Refer to your AMP reference manual for details on other configuration required to operate using an adaptive depth probe.

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In AMP the adaptive depth probe is assigned an axis name. Using the axis monitor page for that axis (see page 15A-35) you can view the current following error on the adaptive depth probe and the adaptive depth probe position relative to zero. The probe is zeroed automatically at power up or through PAL.

END OF SECTION

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Section 4C

Connecting the 4-axis Servo Module

4C.0 Section Overview

This section covers the integration of the 4-axis analog/1394 and digital servo module components. A section is devoted to each of the following drive components:

For Information:	See Page:
How the Digital Servo Card Works	4C-1
Digital Servo Module (8520-ENC4)	4C-4
How the Analog/1394 Servo Card Works	4C-5
Analog/1394 Servo Module (8520-ENC4)	4C-8
Connecting Axes to the Servo Module	4C-9
Servo Module Connectors and Pin Assignments	4C-9
8520-ENC4 Servo Module Specifications	4C-15
8520-SM4 Servo Module Specifications	4C-16
Servo Module Battery Replacement	4C-17
Servo Module LED Indicators	4C-19
Servo Module Test Points	4C-19
Encoder Termination Panel	4C-20
Feedback Devices	4C-21
Wiring a Touch Probe to the Servo Module	4C-27

4C.1 How the Digital Servo Card Works

There are two typical digital servo drive configurations for the control. The typical mill configuration has 3-axes, each having a servo motor and feed back device, and a 1-axis analog open loop spindle motor. The typical lathe configuration has 2-axes, each having a servo motor and feedback device, and a 1-axis analog open loop spindle motor with position feedback.

The servo module functions as a high speed servo processor. It is installed in the component enclosure. The digital servo amplifier translates low-level PWM signals from the servo module to the power levels necessary to drive the servo motors.

Current feedback data is read from the current sensors in the digital servo amplifier and returned to the servo module. This data is processed by the servo module to maintain velocity and position control, according to module, AMP, and part program constraints.

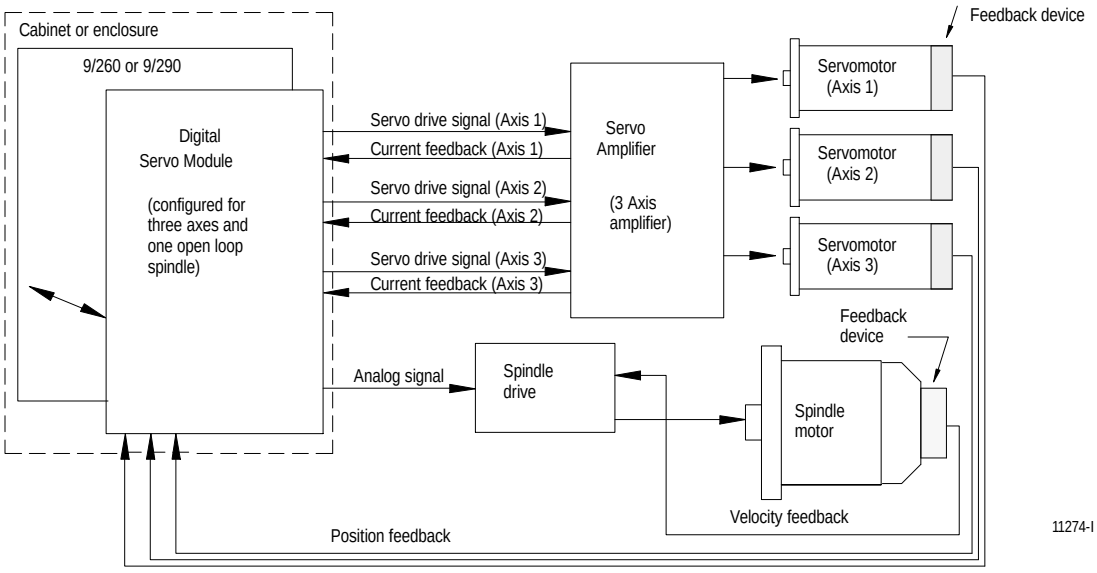
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Important: In order to use the solid tapping feature that is available on the 9/260 and 9/290 CNC, you must use the Allen-Bradley 8510 AC spindle drive system.

Position and velocity data are read from a feedback device that is mounted on the servo motor. This feedback device generates differential signals that are then fed to the servo module. If the spindle motor uses an encoder, it will supply spindle position feedback to the digital servo module.

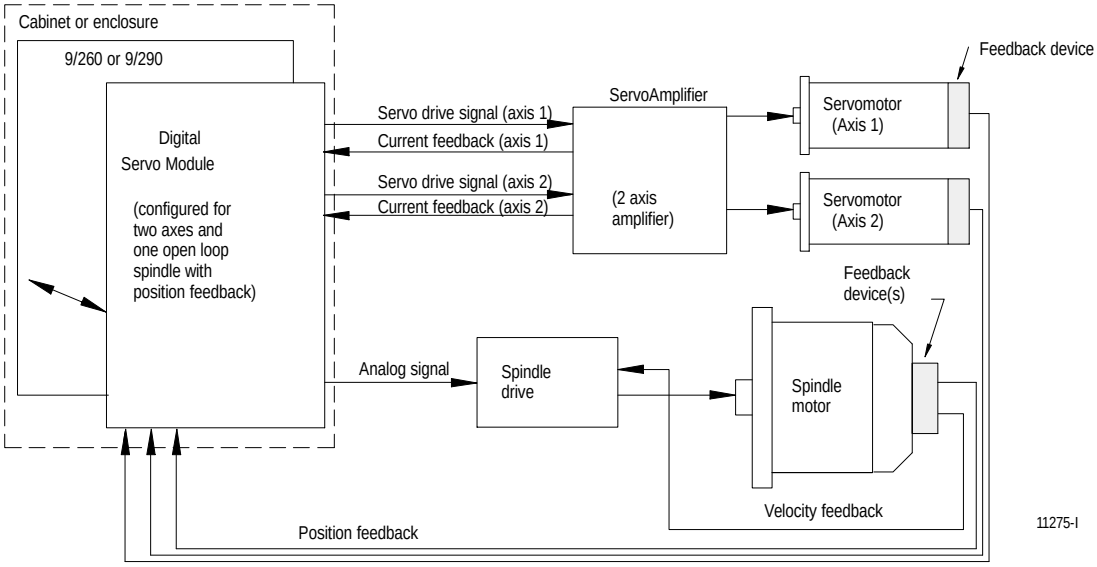
Figure 4C.1 and Figure 4C.2 show typical servo drive configurations for a mill and a lathe. Refer to your AMP reference manual for specific details on configuring axes, axis positioning loops, and axis port selection.

Figure 4C.1
Typical Digital Servo Drive Configuration for a Mill



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Figure 4C.2
Typical Digital Servo Drive Configuration for a Lathe



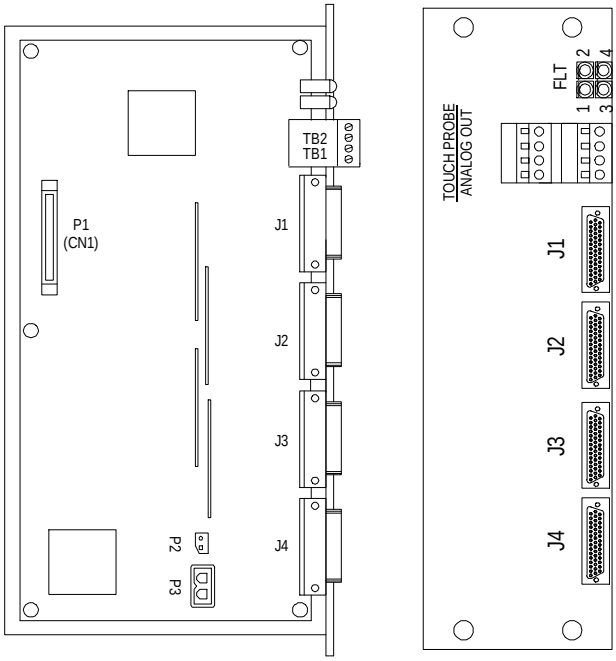
For additional information on each of the major components refer to the section that covers that component.

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4C.2 Digital Servo Module (8520-ENC4)

The servo module is mounted in the component enclosure. It functions as a high-speed servo processor. The control sends positioning and velocity data to the servo module where it is processed to generate the necessary pulse width modulated (PWM) command signals. These signals are sent to the digital servo amplifier, which power the servo motors of the control. The servo module also provides an analog velocity command signal for a servo (typically the spindle) that is not using a digital servo amplifier.

Figure 4C.3
8520-ENC4 Servo Module



The servo module receives two forms of feedback:

- position data from the feedback devices on the axes
- current feedback from the servo amplifier

It combines this position and current feedback data with the interpolated commands from the control to generate the PWM command signals that it outputs to the servo amplifiers.

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The functions of the servo module are designed to make the axes run with optimum performance. Generally, the maximum feedrates are limited by the mechanical abilities of the machine. System gain and the maximum allowable following error will also limit the feedrates. These limits are entered as AMP parameters. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

4C.3 How the Analog/1394 Servo Module Works

There are two typical analog servo drive configurations for the control. The typical mill configuration has three axes, each having a servo motor and feedback device, and an open loop spindle motor. The typical lathe configuration has two axes, each having a servo motor and feedback device, and an open loop spindle motor with position feedback.

This servo module functions as a high speed servo processor. It is installed in the component enclosure. The servo amplifier amplifies the signal from the servo module in order to deliver the power necessary to drive the servo motors.

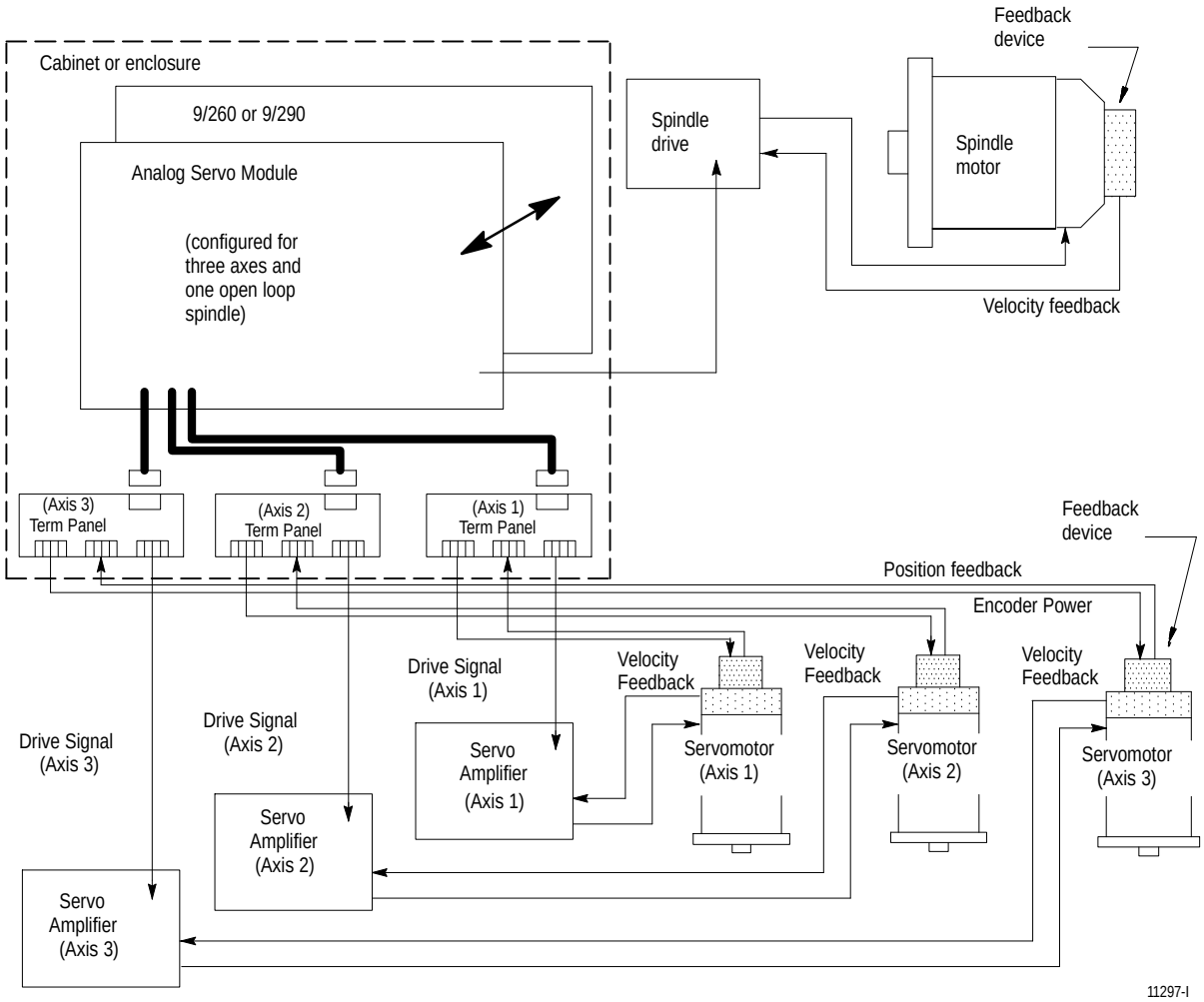
Position and velocity data are read from a feedback device that is mounted on the slide, ballscrew, or servo motor. This feedback device generates differential signals that are then fed to the servo module. If the spindle motor incorporates an encoder it will supply spindle position feedback to the servo module.

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Most analog servo drive amplifiers require some form of velocity feedback from the servo motor. This feedback is usually generated by a tachometer or resolver attached to the motor shaft. Refer to your servo drive amplifier literature for details.

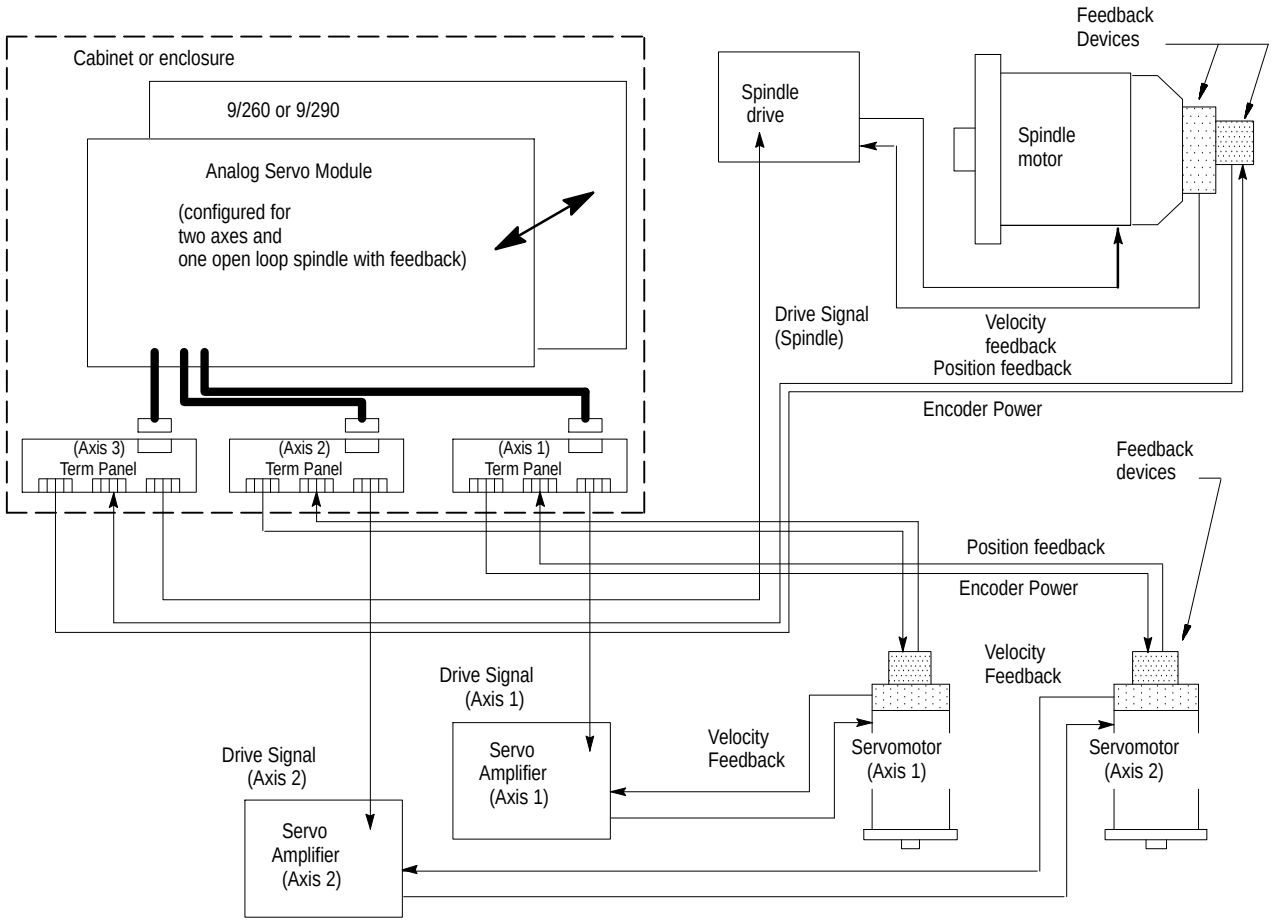
Figure 4C.4 and Figure 4C.5 show typical analog servo drive configurations for a mill and a lathe. For specific details on configuring axes, axis positioning loops, and axis port selection, refer to your AMP reference manual.

Figure 4C.4
Typical Analog Servo Drive Configuration for a Mill



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Figure 4C.5
Typical Analog Servo Drive Configuration for a Lathe



For additional information on each of the major components refer to the section that covers that component.

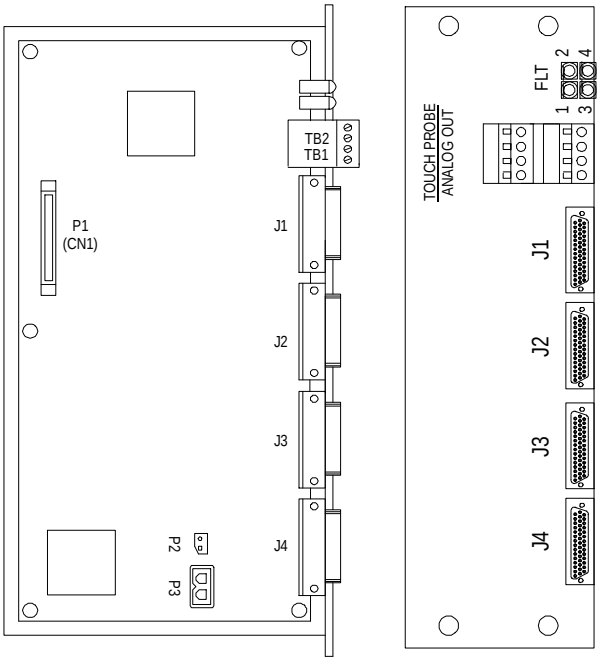
Important: In order to use the solid tapping feature that is available on the 9/260 and 9/290 CNC, you must use the the Allen-Bradley 8510 AC spindle drive system.

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4C.4 Analog/1394 Servo Module (8520-SM4)

The Analog/1394 Servo Module is mounted in the component enclosure. It functions as a high-speed servo processor. The control sends positioning and velocity data to the servo module, which processes the data to generate the necessary analog drive signals. These signals are sent to the analog servo amplifiers, which power the servo motors of the control. Each analog servo module may control up to four closed loop axes and one open loop axis (typically used for a spindle).

Figure 4C.6
Analog Servo Module



The servo module receives position data from the axis feedback devices. It combines this position feedback data with the interpolated commands from the control to generate the command signals that it outputs to the servo amplifiers.

The functions of the analog servo module are designed to make the servomotors run with optimum performance. The maximum feedrates are be limited by the mechanical abilities of the machine. System gain and the maximum allowable following error also limit the feedrates. These limits are entered as AMP parameters. Refer to your AMP reference manual for more information.

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4C.5 Connecting Axes to the Servo Module

Axes are connected to the D-shell connectors marked J1, J2, J3 and J4. Axes can be connected in any order on the servo module. However, if a spindle with feedback is configured the spindle must be connected to the first available D-Shell connector after the last connector used by a linear or rotary axis.

ATTENTION: With analog systems, do not insert the plug-type ANALOG OUT terminal block (TB2) into an encoder termination panel DRIVE terminal block or vice versa. Although these plugs will fit together, pin assignments are different. Switching these connections without rewiring the plug-type terminal block may cause damage to equipment.

4C.5.1 Servo Module Connectors and Pin Assignments

Table 4C.A lists the connectors that are used to integrate the digital servo module with other modules of the control.

Table 4C.A
Servo Module Connectors

This Servo Module Connector	Connects to:	8520 Drive		1394 Drive		Analog Drive	
		Connector	Cable No.	Connector	Cable No.	Connector	Cable No.
P1	Motherboard	P4, P5 or P6	C12	P4, P5 or P6	C12	P4, P5 or P6	C12
J1	Servo Amplifier	CNA1	C14/15	CNC1	C47	see drive's documentation	C36-C39
J2	Servo Amplifier	CNA2	C14/15	CNC2	C47	see drive's documentation	C36-C39
J3	Servo Amplifier	CNA3	C14/15	CNC3	C47	see drive's documentation	C36-C39
J4	Servo Amplifier	CNA4	C14/15	CNC4	C47	see drive's documentation	C36-C39
TB1	Spindle		C42		C42		C42
TB2	Touch Probe		C46		C46		C46
P2	Battery Pack		C24		C24		C24
P3	+5V Encoder Power Cable from Main Power Supply						

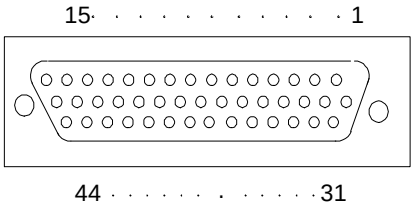
Important: When 1 servo module is used, it must be connected to P4 of the motherboard. When 2 servo modules are used, the first servo module must be connected to P4 and the second to connector P6. When three modules are used, connect the first to P4, the second to P6 and the third to P5.

[1] If a spindle incorporates an encoder to supply position feedback to the servo module, the spindle encoder must be interfaced with the last open connector of these 3 connectors. Refer to the 9/260-9/290 AMP Reference Manual, publication 8520-6.4, for more information.

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Servo Module Interface Connector - P1

The servo module is interfaced with the motherboard through connector P1. The control transmits and receives various signals to and from the servo module through this connector.



Servo Connectors - J1, J2, J3, and J4

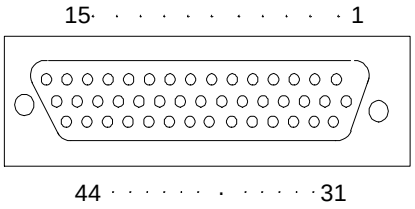
The servo module sends drive signals to the servo amplifier through the connectors labeled J1, J2, J3, and J4. Figure 4C.7, Figure 4C.8, and Figure 4C.9 show an end views of one of these connectors and lists the pin assignments for the different versions of 4-axis modules.

Figure 4C.7
Pinout for the Servo Connectors on 8520-ENC4

Pin	Signal	Description	Connect	Pin	Signal	Description	Connect
1	Shield	Chassis Ground	Not Used	23	EXT_BAT	Battery +/- for absolute encoder	Feedback Device
2	CHU_HI	Channel U Sense_HI	Feedback Device	24	+5V_ENC	+5V Encoder Power Supply	
3	CHV_HI	Channel V Sense_HI		25			
4	CHW_HI	Channel W Sense_HI		26			
5	/PWM_A_LO	Current Cmd for Phase A_LO	Servo Amplifier	27			
6	/PWM_B_LO	Current Cmd for Phase B_LO		28	GND	Encoder Return	Feedback Device
7	/PWM_C_LO	Current Cmd for Phase C_LO		29			
8	STATUS	Amplifier Status_HI		30	Shield	Chassis Ground	Not Used
9	CHZ_LO	Feedback device Channel Z	Feedback Device	31			
10	CHB_HI	Feedback device Channel B		32	CHU_LO	Channel U Sense_LO	Feedback Device
11	CHA_HI	Feedback device Channel A		33	CHV_LO	Channel V Sense_LO	
12	$I_{FDBK\ Phase\ B}$ (Ib)	Current sensing from feedback Phase _B		34	CHW_LO	Channel W Sense_LO	
13	ENABLE	Motor Amplifier Enable_HI	Servo Amplifier	35	PWM_A_HI	Current Cmd for Phase A_HI	Servo Amplifier
14	$I_{FDBK\ Phase\ A}$ (Ia)	Current sensing from feedback Phase _A	Feedback Device	36	PWM_B_HI	Current Cmd for Phase B_HI	
15	GND	Encoder Return		37	PWM_C_HI	Current Cmd for Phase C_HI	
16				38	/STATUS	Amplifier Status_LO	
17	+15V_ENC	+15V Encoder Power Supply		39	CHZ_HI	Feedback device Channel Z	Feedback Device
18				40	CHB_LO	Feedback device Channel B	
19	GND	Encoder Return		41	CHA_LO	Feedback device Channel A	
20	+5V_ENC	+5V Encoder Power Supply		42	$/I_{FDBK\ Phase\ B}$ (/Ib)	Current sensing from feedback Phase _B	
21				43	/ENABLE	Motor Amplifier Enable_LO	Servo Amplifier
22				44	$/I_{FDBK\ Phase\ A}$ (/Ia)	Current sensing from feedback Phase _A	Feedback Device

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Figure 4C.8
Pinout for the Servo Connectors on 8520-SM4 for 1394 Systems



Pin	Signal	Description	Signal Destination
1	Shield	Chassis Ground	N/A
2	CHU_HI	Channel U Sense_HI	Servo Module
3	CHV_HI	Channel V Sense_HI	
4	CHW_HI	Channel W Sense_HI	
5	V_A	Command Voltage	CNC Interface Board
6			
7			
8	STATUS	Amplifier Status_HI	CNC Interface Board
9	CHZ_LO	Feedback device Channel Z	Servo Module
10	CHB_HI	Feedback device Channel B	
11	CHA_HI	Feedback device Channel A	
12			
13	ENABLE	Motor Amplifier Enable_HI	CNC Interface Board
14			
15	GND	Signal Common	CNC Interface Board
16	GND	Ground 24V input return	
17			
18			
19	GND	Signal Common	CNC Interface Board
20	+5V_ENC	+5V Encoder Power for optional feedback systems only (P3 must be connected)	Optional Feedback Device
21			
22			
23			
24	+5V_ENC	+5V Encoder Power for optional feedback systems only (P3 must be connected)	Optional Feedback Device
25			
26			
27			
28	GND	Encoder Return	CNC Interface Board
29	GND	Signal Common	CNC Interface Board
30	Shield	Chassis Ground	n/a
31	GND	Motor Amplifier Enable_LO	CNC Interface Board
32	CHU_LO	Channel U Sense_LO	Servo Module
33	CHV_LO	Channel V Sense_LO	
34	CHW_LO	Channel W Sense_LO	
35	V_B	Command Voltage	CNC Interface Board
36			
37			
38	/STATUS	Amplifier Status_LO	CNC Interface Board
39	CHZ_HI	Feedback device Channel Z	Servo Module
40	CHB_LO	Feedback device Channel B	
41	CHA_LO	Feedback device Channel A	
42			
43	Return	Drive Return	Servo Module
44			

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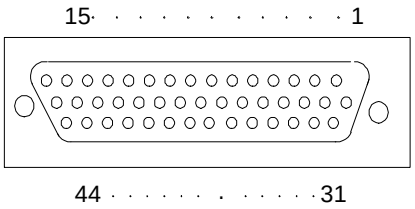


Figure 4C.9
Pinout for the Servo Connectors on 8520-SM4 for Analog Systems

Pin	Signal	Description	Signal Destination
1	Shield	Chassis Ground	N/A
2			
3			
4			
5	V_A	Command Voltage	Servo Amplifier
6			
7			
8	STATUS	Amplifier Status_HI	Servo Amplifier
9	CHZ_LO	Feedback device Channel Z	Servo Module or Termination Panel
10	CHB_HI	Feedback device Channel B	
11	CHA_HI	Feedback device Channel A	
12			
13			
14			
15	GND	Encoder Return	Feedback Device
16	GND	Encoder Return	
17	+15V	+15V Encoder Power Supply	
18			
19	GND	Encoder Return	Feedback Device
20	+5V_ENC	+5V Encoder Power Supply	Feedback Device
21			
22			
23			
24	+5V_ENC	+5V Encoder Power Supply	Feedback Device
25			
26			
27			
28	GND	Encoder Return	Feedback Device
29			
30	Shield	N/A	N/A
31			
32			
33			
34			
35			
36			
37			
38	/STATUS	Amplifier Status Flag_LO	Servo Amplifier
39	CHZ_HI	Feedback device Channel Z	Servo Module
40	CHB_LO	Feedback device Channel B	
41	CHA_LO	Feedback device Channel A	
42			
43	Return	Drive Return	Servo Module
44			

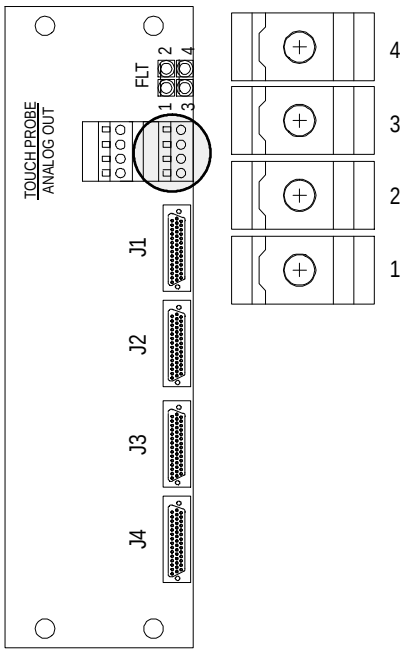
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ANALOG OUT (TB2) Auxiliary Output Connector.

An auxiliary analog output is provided through the connector labeled ANALOG OUT (TB2). This connector is typically used to command an analog spindle drive system with no position feedback. TB2 is not capable of receiving encoder feedback information. Figure 4C.10 shows the location of ANALOG OUT connector and lists terminal assignments of this connector.

Important: Note that TB2 should only be used for drive applications that do not require a feedback device. If a feedback is required, the output signal to the drive and its corresponding encoder feedback should be wired through one of the servo connectors. A drive application with feedback would typically not use the connector labeled ANALOG OUT (TB2). However, if necessary, TB2 may be used with encoder feedback configured in AMP to be returned to one of the servo connectors.

Figure 4C.10
Terminal Block ANALOG OUT, 4 Plug-type Terminal Block Connections.



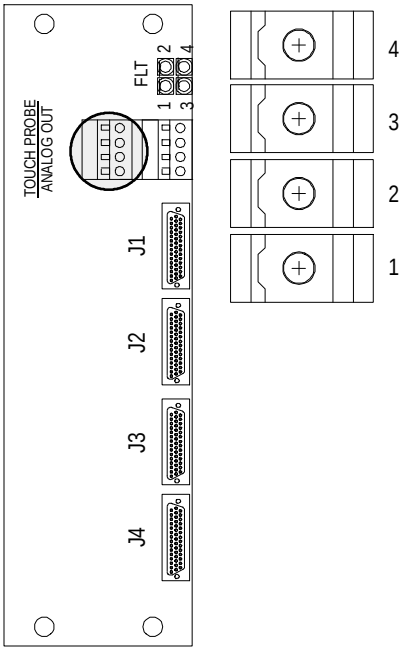
Terminal No.	Signal	Description	Signal Destination
1	not connected		
2	Analog Out +	+10V Analog with no feedback	(typically spindle drive)
3	Analog Out -	Signal Return	(typically spindle drive)
4	Shield	shield	connect at module only

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Touch Probe Connector - TB1

The servo module receives touch probe feedback through the connector labeled TB1. Figure 4C.11 shows the location of this connector and lists its terminal assignments.

Figure 4C.11
TB1 Connector , 4 Plug-type Terminal Block Connections.



Terminal No.	Signal	Description	Signal Destination
1	+5V	Probe Power	Touch Probe
2	PRB_FIRE	Probe Fired Signal [1]	Servo Module
3	PE	Touch Probe Common	Touch Probe
4	Shield	Probe Shield	connect at module only

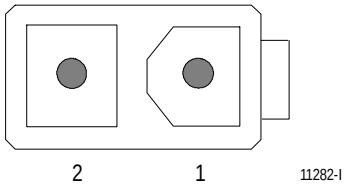
[1] The True level (voltage transition the probe fires) is either "HIGH" or "LOW" as defined by the AMP parameter PROBE TRANSITION. Refer to your AMP reference manual for more information.

Important: The touch probe connector supports only +5V probing device applications.

5V DC Encoder Power Connector - P3

The servo module receives +5V dc power directly from the main power supply through connector P3. This +5V dc power is used only for powering the encoder. If the EXT Power connection on the encoder termination panel is used or if the 15V DC encoder power is used the connection to P3 is not needed. Figure 4C.12 shows an end view of connector P3 and lists the pin assignments. For details on this connection refer to the section on the main power supply connections on page 4D-4.

Figure 4C.12
Connector P3, 2 pin male, Molex 5566-02A



Pin No.	Signal	Description	Signal Destination
1	Not Used		
2	+ 5V dc	Encoder Power	Main Power Supply

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4C.5.2 8520-ENC4 Servo Module Specifications

Table 4C.B lists the servo module input specifications.

Table 4C.B
Servo Module Input Specifications

Item	Specification	Remark
Input Power Range for Encoders	+5V (+10%, -1%) +15V (±7%)	From Main Power Supply
Maximum Input Frequency of Encoder Feedback	2MHz	Maximum Cable Length Specified
Desired Voltage Range of Encoder Battery Backup	3.5V to 4.5V	_____

Table 4C.C lists the servo module output specifications.

Table 4C.C
Servo Module Output Specifications

Item		Specification	Remark
PWM Output (8520 digital only)	PWM Frequency	Approx. 2.0 KHz	
	PWM Signal Type	RS-422-A	
Comutated Output (1394 digital only)	Comutated Signal IA and IB	Approx. 1000 Hz	(±12 bits)
DAC Output	Output Voltage Range	±10V	
	Resolution	2.44mV	(±12 bits)
	Sampling Frequency	1000 Hz	
	Output Current	5mA Max.	
	Load Capacitance	0.01mF Max.	

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4C.5.3 8520-SM4 Servo Module Specifications

Table 4C.D lists the servo module output specifications. This table is provided as an aid to determining the compatibility of different servo amplifiers and spindle drives. Table 12.A contains a list of compatible analog servos. Input specifications are discussed in sections covering the individual input devices. Refer to Table 4C.E for encoder feedback input specifications.

Table 4C.D
8520-SM4 Servo Module Analog Output Specifications

Item	Specification	Remark
Output Voltage Range	±10V	
Analog Output Driver	Single Ended	Drive return connected to common.
Output Offset Voltage	500mV Max.	
Resolution	1.22mV	13 bits plus one sign bit (14 total)
Sampling Frequency	500 Hz	
Output Current	5mA Max.	
Load Range	>2K ohms	
Conversion Time	5ms	
Differential Non-Linearity	±1 LSB Max.	Monotonic over the entire temperature range. LSB means least significant bit.
Gain Error	±1 LSB Max.	
Load Capacitance	0.01mF Max.	

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4C.5.4 Digital Servo Module Battery Replacement

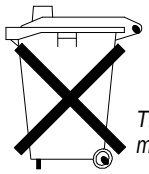
The Digital Servo Module, 8520-ENC4, provides battery backup for the absolute encoder position register. This register retains position data during power loss. The battery backup power originates from the batteries plugged into the servo board at connector P2.

Important: Battery backup is required for absolute encoders only. Incremental encoders do not require battery backup.

Even if battery backup fails, or the encoder cable is temporarily disconnected, the encoder will still maintain position data for up to 24 hours. This also allows for battery replacement without loss of data.

The battery backup is tested at power up, and at four hour intervals while system power is on. If battery voltage drops to 2.8V during the battery test, the control automatically displays the warning message "REPLACE ABSOLUTE FEEDBACK BATTERY" on the operator panel.

Important: Once the "REPLACE ABSOLUTE FEEDBACK BATTERY" message is displayed, it is essential that the batteries be replaced to avoid loss of absolute position data.

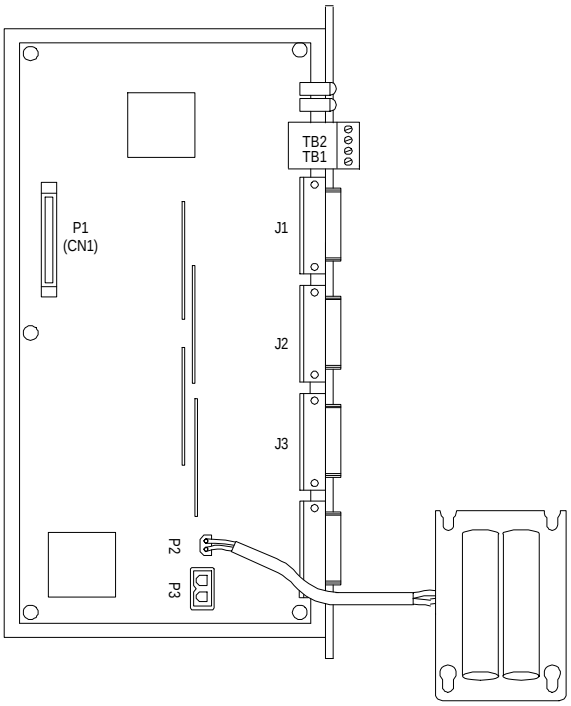


The lithium battery contains heavy metals and must be collected separately from other waste.

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To replace the servo module battery, turn all system power **OFF** and disconnect the old batteries from connector P2 on the servo module. Battery replacement instructions are included with the battery replacement kit. Before installing new batteries, use a voltage meter to make sure that new battery voltage is higher than 3.5V dc.

Figure 4C.13
Servo Module Battery Connector P2



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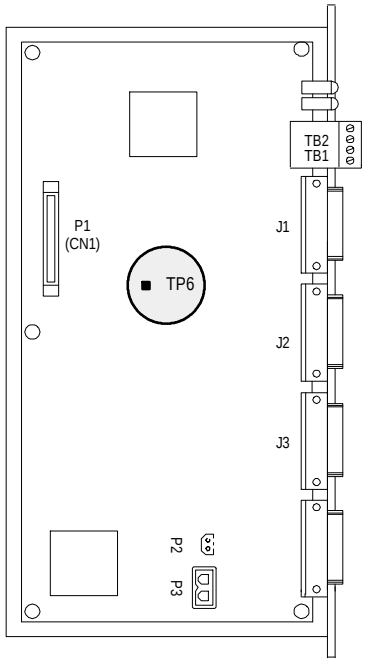
4C.5.5 Servo Module LED Indicators

The servo module is equipped with a set of four LEDs located on the front of the servo module. All four LEDs turn on, then off, at power up. All the LEDs remain off during normal operation. If a servo fault occurs, the light for the corresponding axis flashes. The servo fault may occur if the module is not receiving feedback, or is receiving interrupted or irregular feedback through the J1, J2, J3 or J4 connector.

4C.5.6 Servo Module Test Points

A test point is a small metallic pin on the servo module's circuit board. There is one test point available in the servo module that you can use to ground an oscilloscope during testing or troubleshooting. You can locate this test point, TP6, with Figure 4C.14.

Figure 4C.14
Servo Module Test Point Location



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4C.6
Encoder Termination Panel

The encoder termination panels are options with the analog system that provide an easy and convenient means for you to connect and troubleshoot your servo system. We strongly recommend the use of termination panels when installing an analog system.

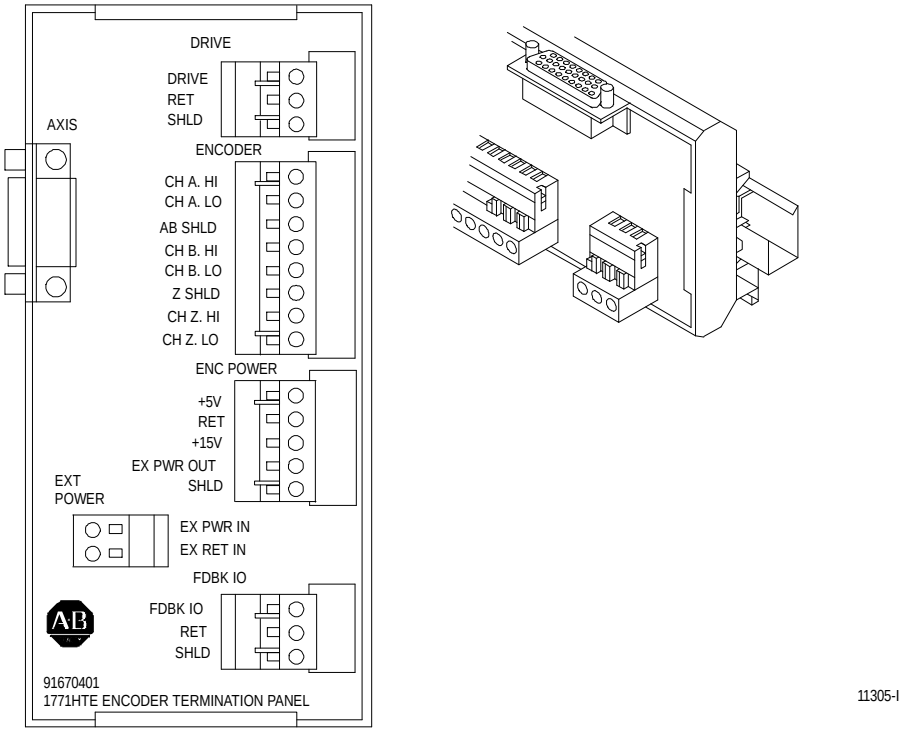
Termination panels feature:

- D-shell connectors for cables from the servo module (A-B cable number 8520-TPC)
- Plug-type connectors for wiring to user devices
- DIN Rail Mounting

All user connections with the exception of the analog out and touch probe connections are routed through the termination panels. User side voltages of +5V dc and +15V dc for encoder power (chosen by wiring to the appropriate connector pin) are available on-board. External power supplies for the encoders may also be routed through the termination panel (refer to the feedback section).

Figure 4C.15 shows an encoder termination panel.

Figure 4C.15
Encoder Termination Panel



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4C.7 Compatible Feedback Devices

This section discusses encoder feedback devices that are compatible for both analog and digital servo systems. The servo module supplies these devices with either +5V or +15V power. Feedback devices on all the CNCs must return a 5V compatible output signal to the control (1326 motor mounted resolvers have their signals converted by the system module to be compliant with this requirement).

For **analog systems** this feedback device can be used to provide:

- velocity feedback (used only if your system does not provide tachometer velocity feedback to the drive) In this case, the analog servo amplifier must be configured to run in "torque mode" with no tachometer. Tachless servo configurations work best if an encoder type feedback device is used and mechanically coupled directly to the servomotor shaft.
- position feedback (can be the same device as used to close the velocity loop if the velocity loop is closed by the CNC, or an additional feedback device, as discussed in this section, can be used for the position loop)
- spindle feedback

For **digital systems** this feedback device can be used to provide:

- position feedback (digital systems require the motor mounted feedback device, provided on our standard digital servo motors, be used for velocity loop feedback. This motor mounted feedback device can also be used to close the position loop or an additional feedback device, as discussed in this section, can be used for the position loop.) You can not replace or bypass the motor mounted feedback device. The motor mounted feedback device must be used for velocity feedback and to attain proper motor commutation on digital servo systems.
- spindle feedback

Only the 8520 digital drive system supports absolute feedback.

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The 4 axis 9/260 and 9/290 servo cards support:

Feedback Device	Additional hardware
Allen-Bradley 845H series differential encoders	--
Sony Magnascale model GF-45E	Board-type detector model MD10-FR
Heidenhain Model 704	External interpolation and digitizing model EXE602 D/5-F
Futaba Pulscale model FM45NY	PCB interface Module model CZ0180 with cable PCB020EA

Other feedback devices can be compatible if they comply with the specifications listed in Table 4B.L. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

This manual is written under the assumption that your system is using the Allen-Bradley 845H series differential encoder. If you are using some other feedback device such as a linear scale, an application note is available through Allen-Bradley CNC Commercial Engineering Department. Contact your local Allen–Bradley sales representative.

The following table lists feedback specifications for a differential encoder however, this information can be interpreted to select an appropriate linear scale.

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Table 4C.E
Encoder Specifications

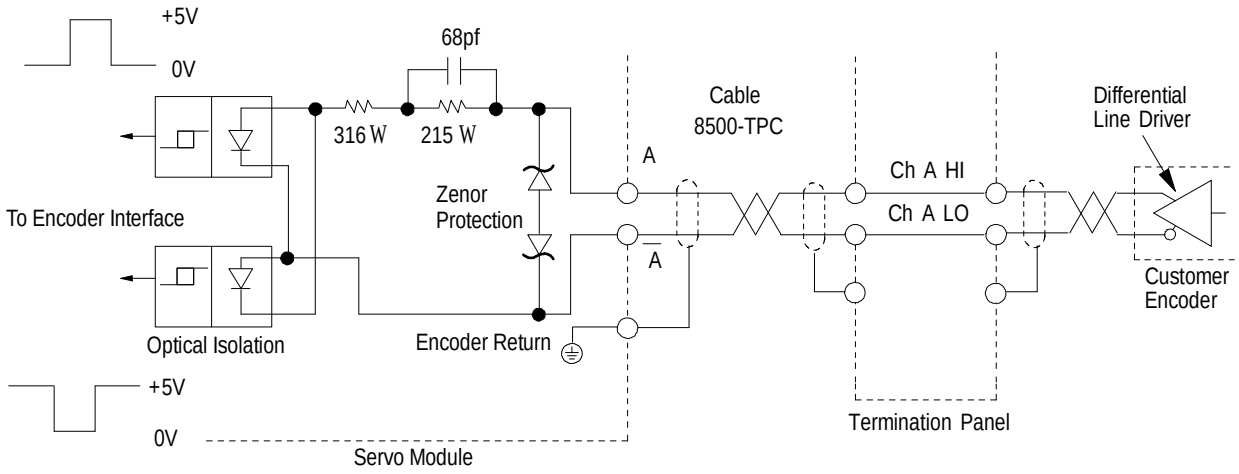
Item	Specification
Maximum Encoder Channel Frequency (ECF)	Use the following equation to determine the maximum channel frequency $\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90\text{-Eq}}\right) \text{ x } 1.15}$ Where: Clock - is the Control's Feedback Clock Frequency: 5×10^6 - for 9/230, 9/440, and three axis servo cards. 2.3×10^7 - for 9/260 or 9/290 systems using a four axis servo card E_Q = Quadrature Error in Degrees 1.15 = Our minimum recommended safety factor As long as the actual feedback channel frequency does not exceed the maximum channel frequency calculated above, the servo module should process the feedback data without a quadrature fault.
Maximum Axis Speed	Use the following equation to determine the maximum axis speed. Note that this equation does not take into consideration any mechanical deficiencies in the encoder or motor. It is only concerned with the 9/Series capability of receiving feedback. Refer to the manufactures specs for encoder and motor hardware RPM limitations. $\frac{(\text{ECF} \times 60)}{(4E)(N)(P)} = \text{Maximum Axis Speed}$ Where: Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute) ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec. E = the number of encoder lines between markers for your encoder N = the ratio of encoder turns to ballscrew turns P = the ballscrew pitch (turns per inch or turns per millimeter. For rotary axes, substitute the appropriate gear ration for N and P in the equation above to solve for a max RPM in revolutions per minute. If the maximum axis speed resulting from this equation is less than you would like, you may need to sacrifice some axis resolution by selecting an encoder with fewer lines between markers.
Input Signal	Encoder feedback must be differential format with 5V compatible output signals, single-ended open-collector outputs are not supported, i.e., channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent.
Current Drawn from Encoder by Servo Module	7mA maximum; 44mA peak
Marker Channel	Narrow marker (gated) or Wide marker (ungated) type markers are supported
Encoder Cable Length	Refer to 9/Series Integration and Maintenance Manual for details on cabling

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4C.7.1 Wiring an Incremental Feedback Device

Figure 4C.16 shows an incremental feedback device equivalent circuit for feedback channel A.

Figure 4C.16
Incremental Feedback Device Equivalent Circuit



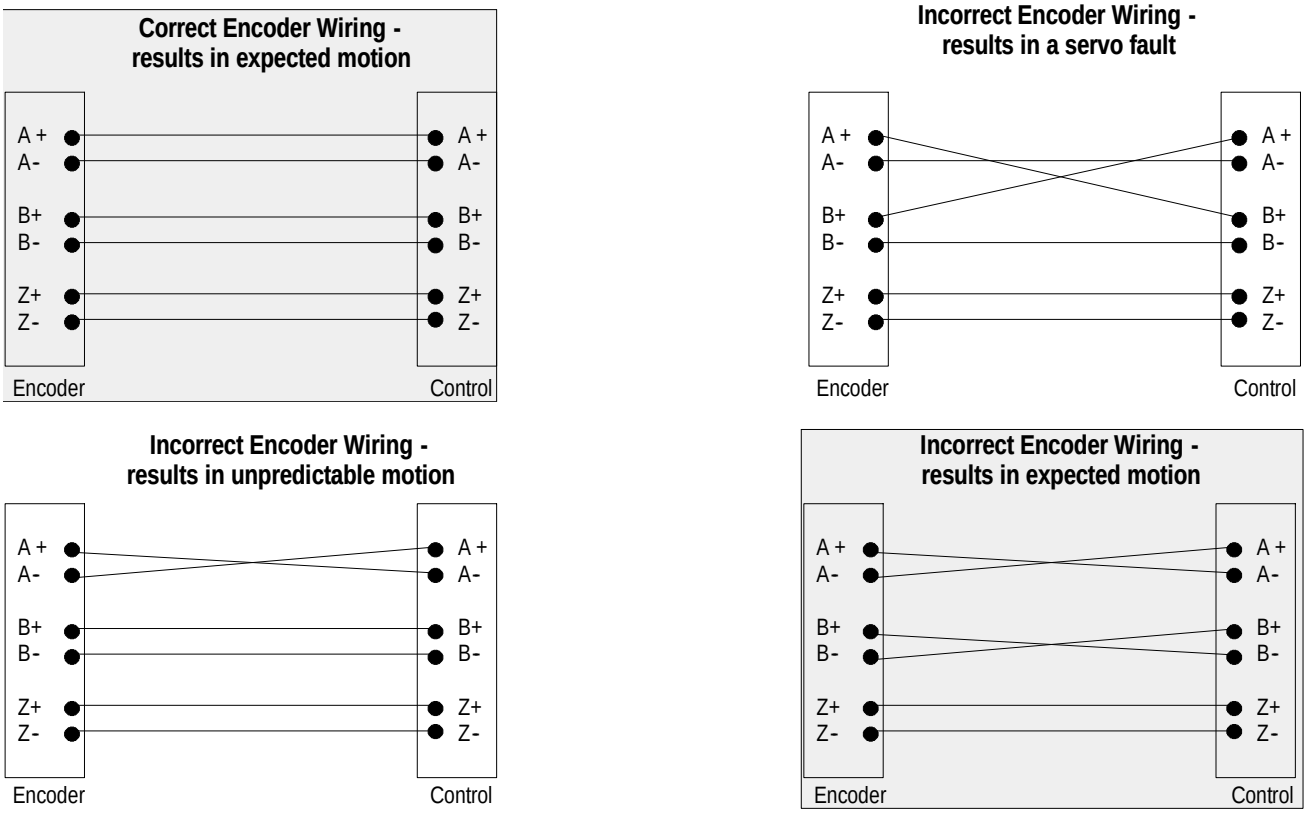
Wiring Position Feedback

Feedback devices used with the control must be configurable such that the marker Z is true at the same time that channels A & B are true. If you are using an Allen-Bradley 845H encoder this requirement will already be met if you wire them as shown in the cable diagrams on page 7A-28.

If you are using an encoder type feedback device other than the Allen-Bradley 845H encoder, then use the following examples to determine the correct wiring:

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Figure 4C.17
Examples of a Correct and Incorrect Encoder Wiring



Important: Since positive and negative axis directions can be assigned without regard to encoder rotation directions, it is possible for the feedback direction to be "backwards". This is easily corrected before attempting to command axis motion through the AMP parameter Sign of Position Feedback**.** Refer to your AMP reference manual for more information.

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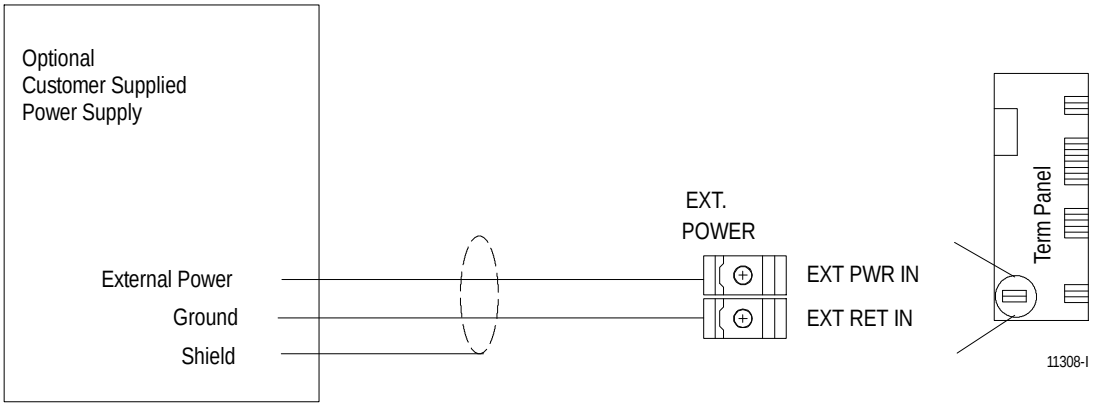
Wiring Power for your Feedback Device (Analog Systems Only)

The control supports feedback devices with 5V compatible output signals. The voltage that these feedback devices require may vary. The servo module is equipped to supply 5V DC or 15V DC power to feedback devices. These voltages may be accessed directly from the encoder termination panel. However, for the 1394 this power connection is only necessary if you are using optional feedback devices. The 1394 drive supplies feedback power to the 1326 motor resolvers.

Important: Be aware that if the 5V DC encoder power is to be used the connector P3 on the servo module must be directly connected to the power supply. Refer to page 4D-4 for details on this power supply connection.

If your feedback device requires an external power supply, you can incorporate it through the EXT. POWER connector on the termination panel. Power outputs through the ENC POWER connector terminal labeled EX PWR OUT. The next figure shows the termination panel connection for EXT. POWER.

Figure 4C.18
Wiring Optional Customer Supplied Power Supply for Feedback Devices



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4C.8 Wiring a Touch Probe to the Servo Module

Connect a touch probe to the connector labeled BAT/TP on the servo module (TB1). Connector terminal identification is provided in Figure 4C.18. Touch probe cable information can be found on page 7A-38.

The time delay between the servo module receiving the touch probe trigger and latching the current axis position is negligible. However, you should be aware of any external delays that may introduce position "staleness" in the probing operation, especially at high probing speeds.

It is a good idea to establish an offset for the distance between the actual location, as sensed by the probe at a very low speed, and the location sensed by the probe at the intended probing speed. The offset can then be added or subtracted to any future values obtained through probing. This helps make sure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is removed from the measurement (assuming the external delay is repeatable).

The motion controller touch probe interface is intended for use with units that offer 5V dc compatible solid state relay outputs (see Figure 4C.19). Other configurations can be supported as long as the user operates within the published electrical specifications.

The touch probe circuitry resident on the servo module only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, position data is captured by the module, and additional occurrences of the trigger signal have no effect until the probe is reenabled under program control.

Refer to the 9/Series CNC 9/230,9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

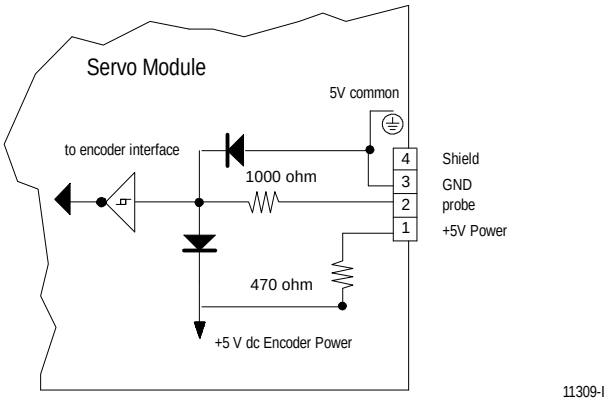


ATTENTION: It is preferred, from a safety standpoint, that the touch probe relay be closed at rest and open when the touch probe stylus deflects. Then, if a wire breaks or shorts to ground, it will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort towards the fail-safe operation of the touch probe. Not all vendor's touch probe control units conform to this safety consideration.

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Figure 4C.19 shows the internal servo module circuitry that interfaces to the touch probe connector. It is shown here to assist you in determining whether your touch probe hardware is compatible.

Figure 4C.19
Internal Circuitry Supporting the Touch Probe



The following table indicates probing threshold voltages. Maximum Input Threshold (critical if the control has been configured to fire on the falling edge of the probe signal) indicates the voltage that the probe signal must fall below to be considered as “fired”. Minimum Input Threshold (critical if the control has been configured to fire on the rising edge of the probe signal) indicates the voltage that the probe signal must rise above to be considered as fired

Probe Thresholds	Voltage at Threshold
Minimum Input Threshold (probe circuit)	3.06 (min)
Maximum Input Threshold (probe circuit)	2.18V dc (max)

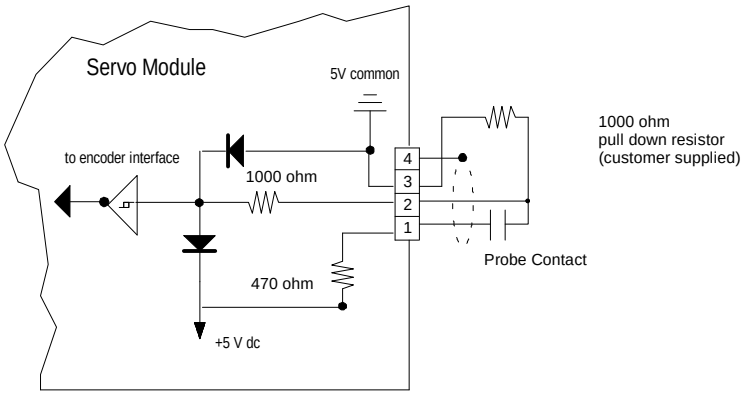
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To avoid misfires use the threshold values from the above table to determine the necessary signal voltage for steady state operation (probe not fired). For probes configured to fire on the falling edge the steady state voltage must remain above 3.06 volts. For probes configured to fire on the rising edge the steady state voltage must remain below 2.18 volts.

Wiring a Probe for Rising Edge Configurations

Typical wiring of a simple contactor type touch probe configured to fire on the rising edge of the probe signal, requires the addition of a 1000 ohm pull down resistor. Figure 4C.20 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

Figure 4C.20
Typical Wiring of a Touch Probe Configured for Rising Edge Trigger

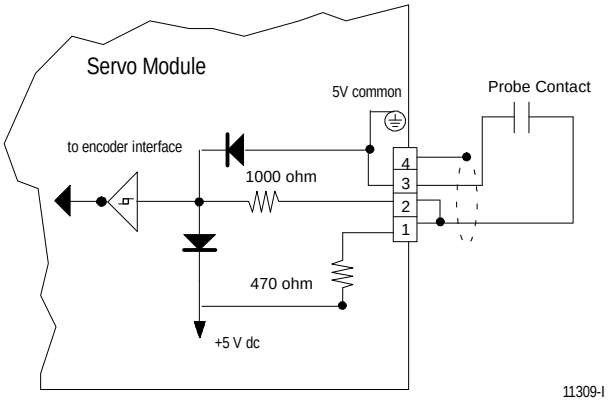


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Wiring a Probe for Falling Edge Configuration

Figure 4C.21 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

Figure 4C.21
Typical Wiring of a Touch Probe Configured for Falling Edge Trigger

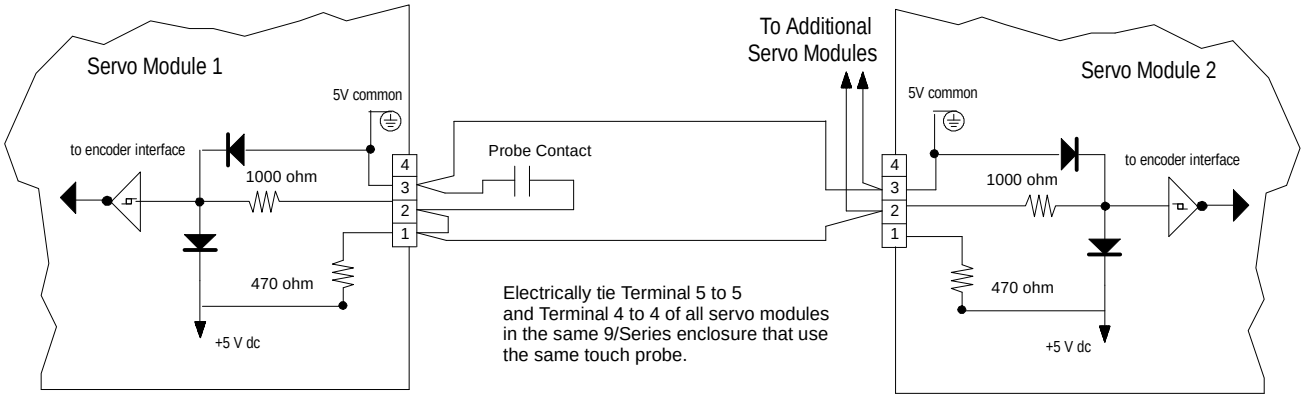


Wiring a Probe to Multiple Servo Cards

Systems with more than one servo module should have their touch probe connections tied together in parallel. This allows the position to be latched on all servo modules at the same time with the same input. Only one power connection needs to be made (with pull up or down resistor). The other probe connections should be made in parallel on all servo cards.

Figure 4C.22 shows a typical wiring diagram for multiple servo cards.

Figure 4C.22
Multiple Servo Card Touch Probe Wiring (Falling Edge Trigger)



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4C.9 Adaptive Depth Probing

Use the Adaptive Depth probe feature to enable an adaptive depth probe that monitors tool depth relative to the actual part surface. This feature allows:

- a more flexible part mounting system (small changes to part size or part mounting do not require reprogramming of the machine or station)
- greater accuracy with a less accurate machine drive system (tool position is relative to the part surface rather than the machine home)
- a retroactive change in axis positioning resolution (feedback for axis positioning switches between the normal axis encoder and the adaptive depth probe once the probe is triggered).

The adaptive depth probe is wired like any A quad B rotary encoder. It is connected to one of the controls feedback ports. Refer to page 7A-1 for details on cabling requirements for a feedback device. 4C-23 lists specifications for an encoder. These same specifications apply to your adaptive depth probe.

If you are using the adaptive depth probe to close the position loop (selected in AMP) the maximum axis speed calculations from 4C-23 also applies. Refer to your AMP reference manual for details on other configuration required to operate using an adaptive depth probe.

In AMP the adaptive depth probe is assigned an axis name. Using the axis monitor page for that axis (see page 15A-35) you can view the current following error on the adaptive depth probe and the adaptive depth probe position relative to zero. The probe is zeroed automatically at power up or through PAL.

END OF SECTION

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Section 4D

Power Distribution

4D.0 Section Overview

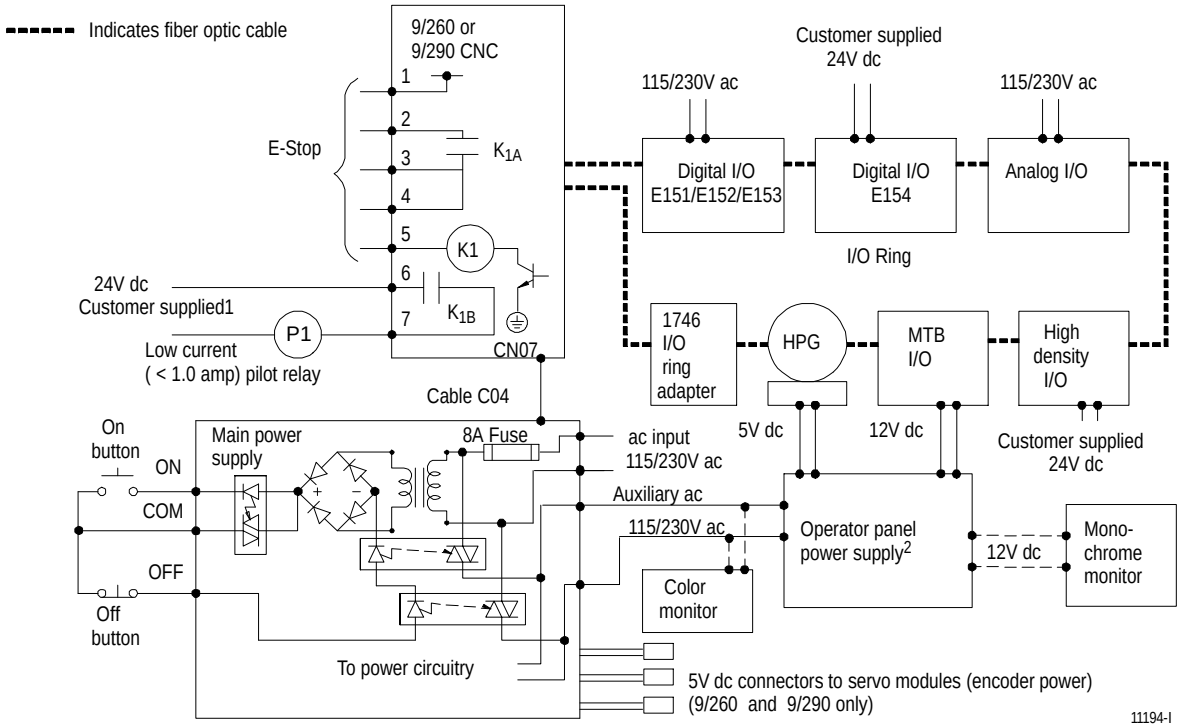
Once you have planned your system layout, you can begin connecting power and components to your system. In this section we discuss:

- how ac power is distributed through the system
- connecting the main power supply and operator interface power supply
- main and operator panel power supply input power specifications
- protective grounding

The external ac power connections to the control and operator panel are covered in this section. For information on external ac power source connections to servo amplifiers, servo motors, and I/O modules, refer to the sections that cover these components. For details on external ac power source connections to an analog servo amplifier or analog servo motor, refer to the documentation provided by the manufacturer.

Figure 4D.1 shows the power distribution from the supply to the control and its components.

Figure 4D.1
Power Distribution from the Supply to the Control and its Components



[1] May not be necessary on PS2 24V is part of the power supply.
[2] May be mounted on operator panel or portable operator panel interface assembly.

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4D.1 Connecting the Main Power Supply

This section discusses the connections of the main power supply and the operator panel power supply.

Connecting the Main Power Supply to AC Power Source



ATTENTION: To guard against electrical shock hazards, never make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

Important: In addition to supplying power to the operator panel power supply, the main power supply also supplies power to the motherboard, the CPU board, and the servo module(s) (9/260 and 9/290 only). As shown in Figure 4D.2, the power cables for these modules originate from the side of the main power supply (for 9/260 and 9/290).

Refer to Figure 4D.2 while performing these steps:

1. Locate AC-IN, L1, L2, and PE on terminal block BT04.

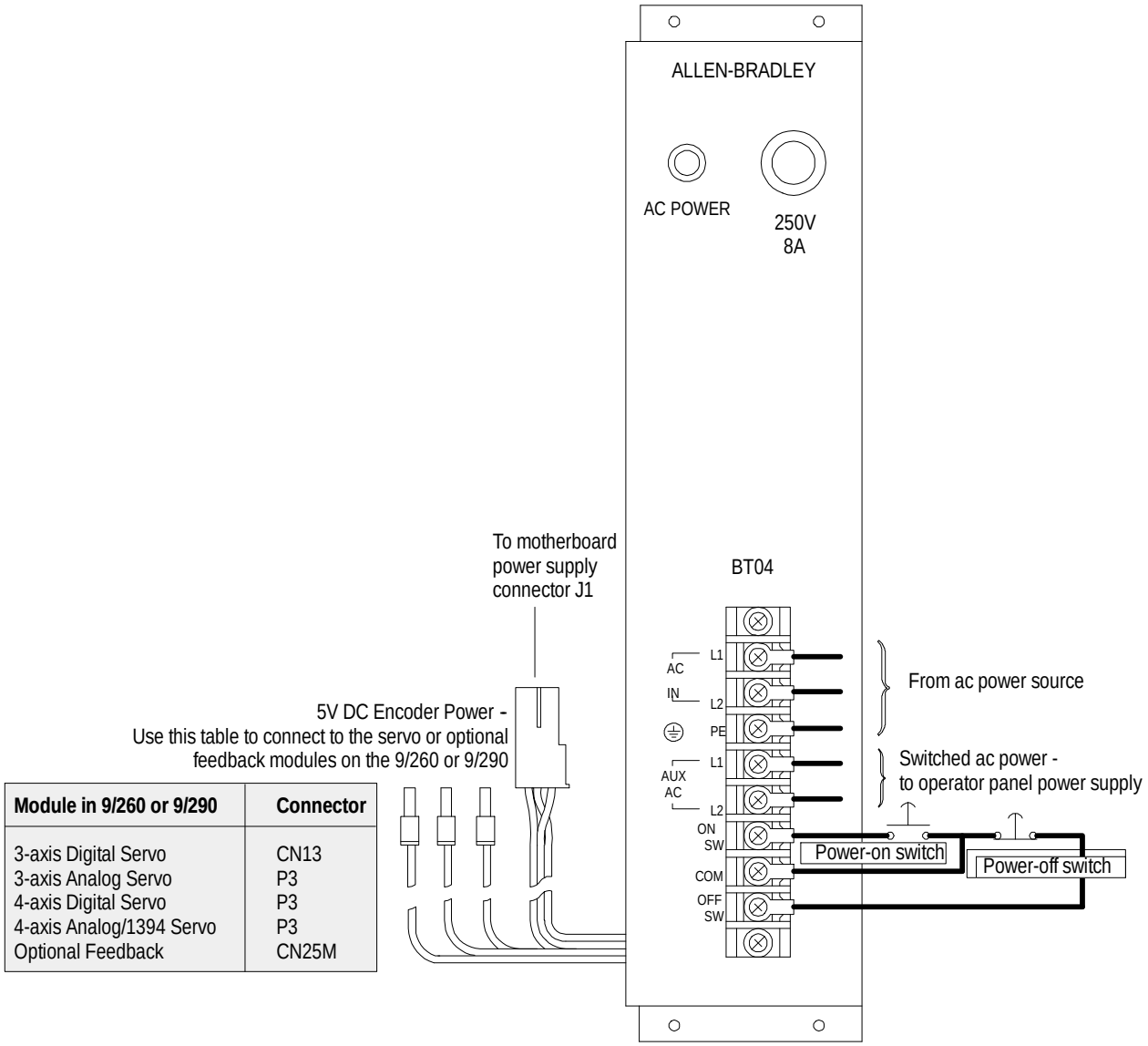
2. Connect the ac power source cable (C02) from the external ac power source to AC-IN, L1, L2, and PE on BT04.

3. Connect the chassis ground terminal to the cabinet's grounding bus bar.

Important: The chassis ground terminal connects to the control chassis and designated cable shields. Power supply common is AC coupled to chassis ground. It is the users responsibility to determine if a direct connection to cabinet ground bus is required.

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Figure 4D.2
Main Power Supply Connection (for the 9/260 and the 9/290)



Module in 9/260 or 9/290	Connector
3-axis Digital Servo	CN13
3-axis Analog Servo	P3
4-axis Digital Servo	P3
4-axis Analog/1394 Servo	P3
Optional Feedback	CN25M

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Connecting the Main Power Supply to the Servo Module for +5V dc Encoders on 9/260 and 9/290 Systems

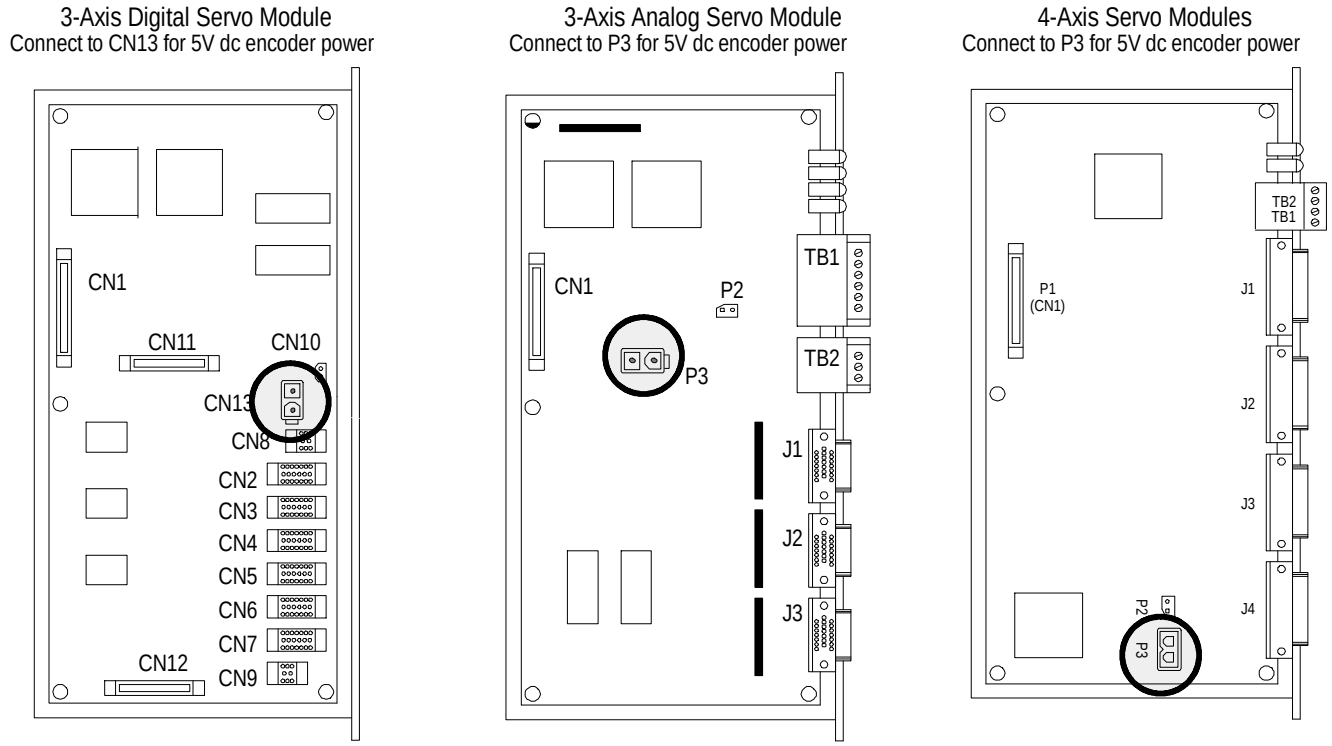
The servo modules gets power directly from the motherboard. However, 5V dc encoder power, which runs through the servo module, must come directly from the main power supply.

Important: Some applications may not require the use of the servo module's 5V dc encoder power (i.e., servo modules 15V dc encoder power or an external power supply is used). For these applications, this connection is not necessary.

The main power supply provides 3 wires (with connectors) for 5V dc encoder power supply. These wires are shown in Figure 4D.2.

Connect any of the 5V dc encoder power wires to connector on your servo module that is shown here:

Figure 4D.3
5V dc Encoder Power Connections to Servo Module



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4D.2 Main and Operator Panel Power Supply Input Power Specifications

The input power specifications of the main power supply, the operator panel power supply, and the portable operator panel interface module power supply are shown in Table 4D.A and Table 4D.B. For output power specifications of the main power supply (PS1) for 9/260 and 9/290, refer to page 4A-10. For output power specifications of the operator panel power supply, refer to page 9A-7.

Table 4D.A
Main Input Power Specifications

Item		Specifications	Remark
Input	Rated Input	115V/230V ac -- 50/60Hz	
	Input Range	90-265V ac --- 47-63Hz	
	Power Consumption 8520-PS1 8520-PS2A	225 Watts @ 50 °C 130 Watts @ 50 °C	168 Watts @ 60 °C or 225 Watts with min. 25 CFM 96.4 Watts @ 60 °C or 130 Watts with 25 CFM
	Fuse	8A/250V	Protects power supply module and sub-power supply and the color CRT
	Connection	Terminal Block	

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Connecting the Main Power Supply to the Monochrome Operator Panel Power Supply

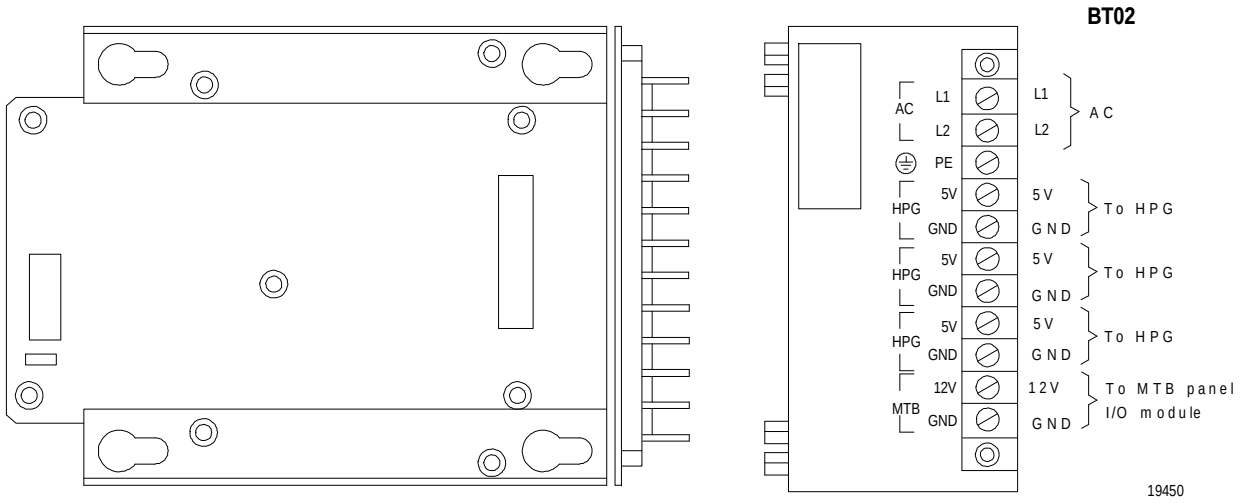
You connect the operator panel power supply directly to the main power supply. Refer to Figure 4D.2 and Figure 4D.4 when performing these steps:

1. Use the ac power supply cable (C03) to connect terminals AUX-AC L1 and L2 of terminal block BT04 on the main power supply to terminals L1 and L2 of terminal block BT02 on the operator panel power supply.

2. Connect the chassis ground terminal on the operator panel power supply to the cabinet's grounding bus bar.

Important: The chassis ground terminal connects to the operator panel chassis and designated cable shields. Power supply common is AC coupled to chassis ground. It is the users responsibility to determine if a direct connection to cabinet ground bus is required.

Figure 4D.4
Power Supply Connector on Monochrome Operator Panel



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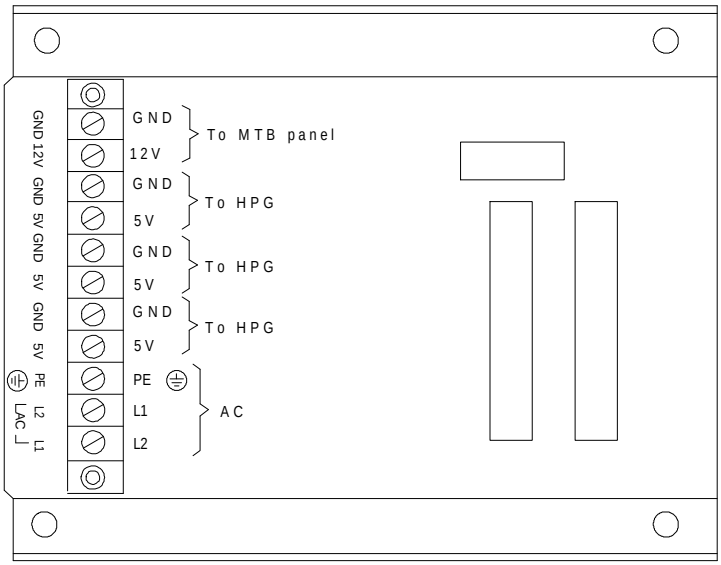
Connecting the Main Power Supply to the Portable Operator Panel Interface Assembly Power Supply

You connect the Portable Operator Panel Interface Assembly power supply directly to the main power supply. Refer to Figure 4D.2 and Figure 4D.5 when performing these steps:

1. Use the ac power supply cable (C03) to connect terminals AUX-AC L1 and L2 of terminal block BT04 on the main power supply to terminals L1 and L2 of terminal block BT02 on the power supply for the portable operator panel interface module.

2. Connect the chassis ground terminal on the portable operator panel interface assembly power supply to the cabinet's grounding bus bar.

Figure 4D.5
Power Supply Connector on Portable Operator Panel Interface Assembly

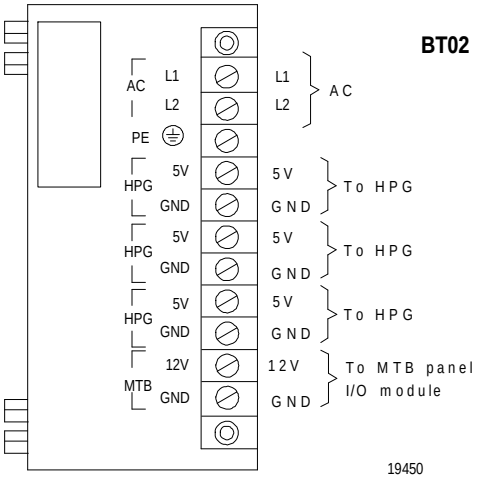


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Connecting Main Power Supply to the Color Operator Panel

You connect the operator panel power supply directly to the main power supply. The operator panel power supply receives power from the color CRT power supply through an internal jumper from the AC (L1 and L2) terminals.

Figure 4D.6
Color Operator Panel Power Supply Connection



Connect terminals AUX-AC L1 and L2 of terminal block BT04 on the main power supply to the color CRT power supply terminals AC L1 and AC L2, which are located on the rear of the color operator panel, using the power supply cable C03.

Important: The chassis ground terminal connects to the operator panel chassis and designated cable shields. Power supply common is AC coupled to chassis ground. It is the users responsibility to determine if a direct connection to cabinet ground bus is required.

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Connecting the Power Supply to the MTB Panel ON/Off Switch

Terminal block BT04 terminals ON-SW, COM and the OFF-SW are connected to terminal block BT-20 terminals ON, COM and OFF on the MTB panel using the ON/OFF signal cable C01. Figure 4D.7 shows terminal block BT-20 on the MTB panel.

Figure 4D.7
MTB Panel ON/OFF Switch Connection

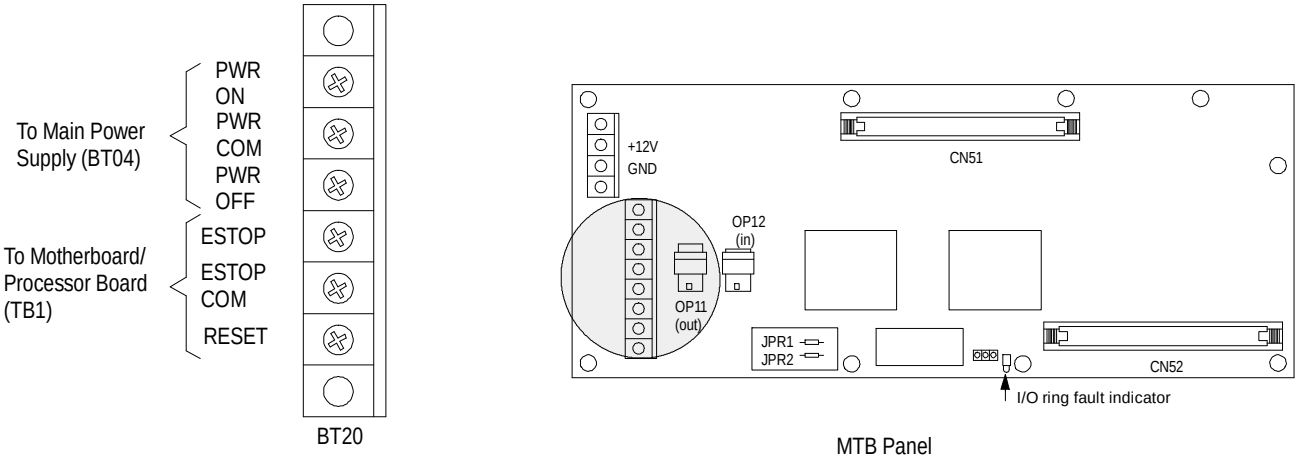


Table 4D.B
Operator Panel or Portable Operator Panel Interface Assembly Power Supply Input Power Specifications

Item		Specifications	Remark
Input	Rated Input	115/230V ac --- 50/60Hz	
	Input Range	90-265V ac --- 47-63Hz	
	Power Consumption	55 Watts	
	Fuse	2A/250V	
	Connection	Terminal Block	

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4D.3 Protective Grounding

All components and modules must be correctly grounded to protect against electrical shock hazards. Proper grounding also helps to reduce the effect of electrical noise by isolating induced noise voltages to individual ground wires and shunting them to ground.

There are two types of grounds used in electrical system design, chassis and earth. Chassis ground is defined as the internal ground of a cabinet. Earth ground is defined as the central ground for all electrical equipment and ac power within any factory.

For the chassis ground use a conductor such as the control cabinet or the cabinet's grounding bus bar. To provide good conductivity when the cabinet is used as the conductor, remove rust and any coating from the area of the cabinet that will be a contact point for the ground cables. Each component installed in the cabinet will have a separate grounding cable connected to the conductor.

Each electrical cabinet requires two separate connections from the cabinet to the earth ground:

- from the chassis ground – each component installed in a cabinet is connected to the cabinet's chassis ground. The cabinet chassis ground is connected to the earth ground by a single grounding cable.
- from the cabinet – each cabinet is connected separately to the earth ground.

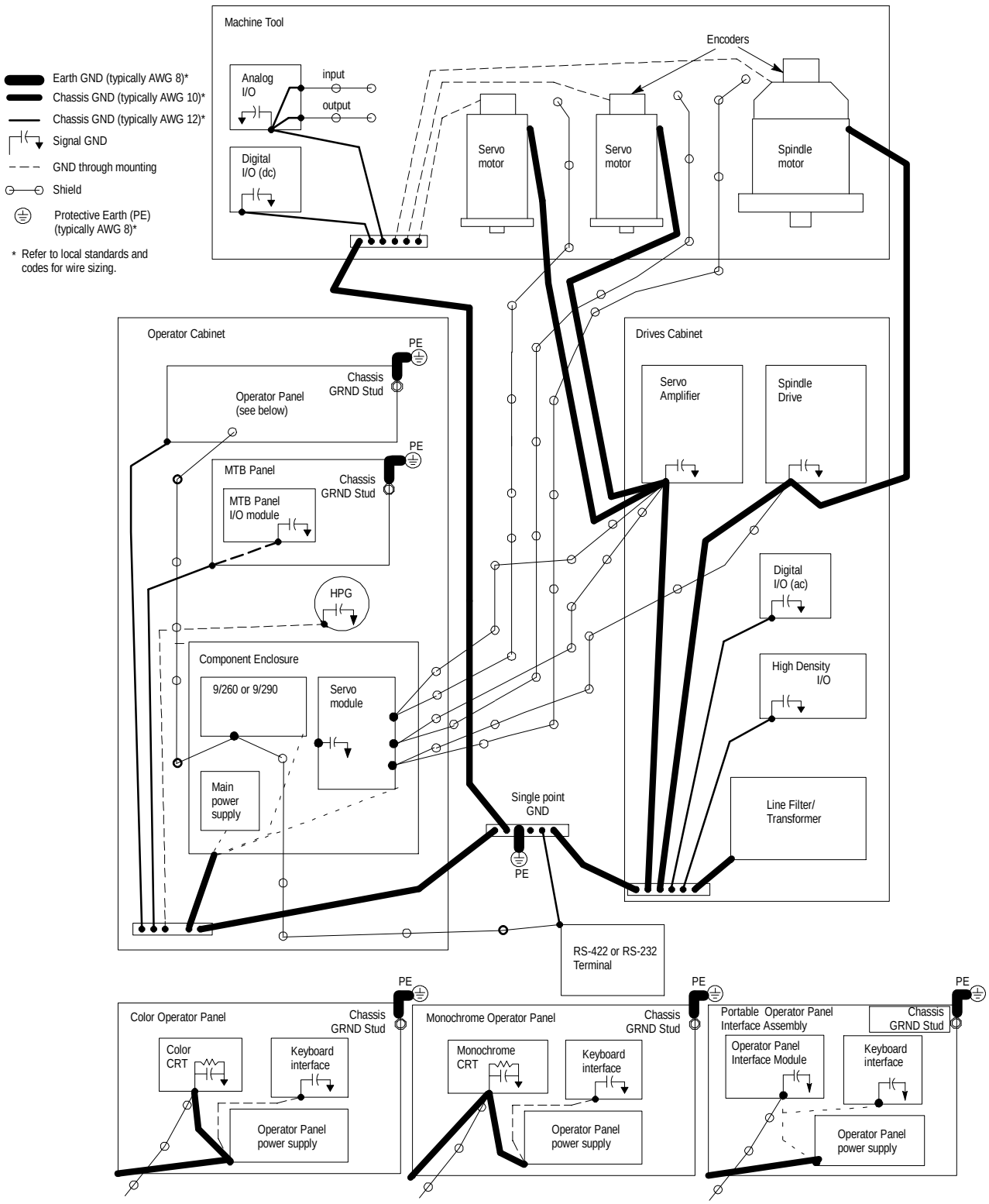


ATTENTION: To guard against damage to the machine, do not interconnect chassis ground wires between the components. This would place ground wires in series and cause their noise voltages to be additive. The resulting increased noise energy can interfere with proper control and machine functions.

A general system grounding diagram, which shows both chassis ground and earth ground, is shown in Figure 5A.21.

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Figure 4D.8
System Grounding Diagram for 9/260 and 9/290 control



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Allen-Bradley Headquarters, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414 382-2000 Fax: (1) 414 382-4444

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9/Series Hardware
TAB 5

9/440 CNC Systems



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Section **5A**

The 9/440 Resolver-based CNC/Drive System

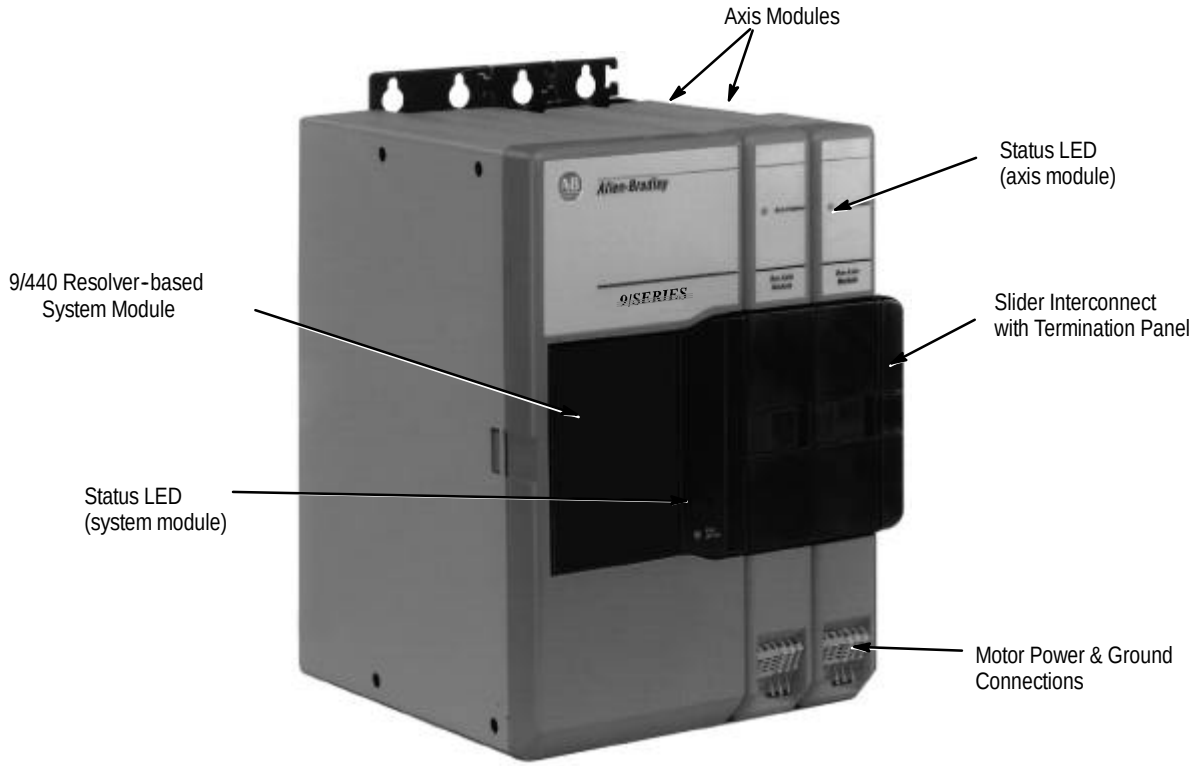
5A.0 Section Overview

The 9/440 Resolver–based CNC/Drive system is a unique machining solution that incorporates a CNC with a digital drive as a single cohesive unit. This system improves machine performance as well as decreasing cost, system integration time and cabling. The 9/440 Resolver–based CNC/Drive supports up to four closed loop axes and two closed loop analog systems (typically spindles).

This system is designed to interface to Allen-Bradley 1326 digital servo motors.

5A.1 Hardware Overview

The following figure shows some of the key features of the 9/440 Resolver–based CNC/Drive:



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- System Module – This is the largest module in the 9/440 Resolver–based CNC/Drive system (leftmost module). It contains the following circuit boards:

  9/440 Resolver–based CNC Assembly Section

  - Processor Board – This board provides the CNC logic as well as connections to the 9/Series Fiber optic I/O ring, serial ports A and B, E–Stop connection, and video connection.

  - Feedback Board – The 1326 motors' resolver is wired to this board which also provides power for resolver excitation. Additional encoder feedback ports are also available for spindle feedback, optional feedback, or analog axis feedback.

  Power Assembly

  - Power Supply – This supplies power to the system module as well as the axis modules. Attach incoming AC three-phase power and 24 V logic power to this supply.

  Interconnecting Power and 9/440 Resolver–based CNC Assembly Section

  - Wiring Board – spindle outputs, touch probe connections, and RIO connection are located on this board which also interfaces the 9/440 Resolver–based CNC assembly with the power portion of the 9/440.

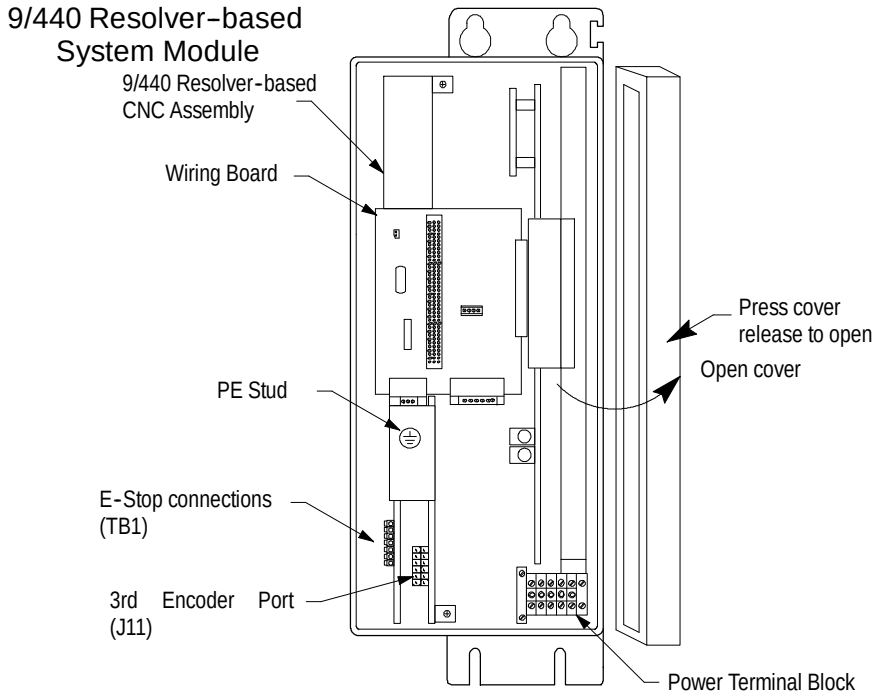
There are three versions of the 9/440 resolver–based system module available. This manual assumes you are using the 4–axis 9/440 resolver–based version. The number of axes supported and the feedback available for these systems is as follows:

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1 Axis 9/440 (8520-1Sx)	3 Axis 9/440 (8520-3Sx)	4 Axis 9/440 (8520-4Sx)
1 Axis Module (max)	3 Axis Modules (max)	4 Axis Modules (max)
1 Resolver Feedback Port	3 Resolver Feedback Ports❶	4 Resolver Feedback Ports❷
2 Analog Output	2 Analog Outputs	2 Analog Outputs
No Encoder Feedback Ports	1 Encoder Feedback Port❶	3 Encoder Feedback Ports❷

❶ A total of three feedback devices can be connected. If three resolvers are used, then the encoder port (J11) is not available. If the encoder feedback port (J11) is used, then the third resolver feedback (J3) is disabled.

❷ A total of six feedback devices can be connected. If four resolvers are used, then the last encoder port (J11) is not available. If all three encoder feedback ports are used, the third resolver feedback (J3) is disabled.



This chapter only covers the 9/440 Resolver-based CNC assembly and the interconnecting wiring board. The 9/440 Resolver-based CNC assembly consists of a CNC processor board and a CNC feedback board both connected into a mounting bracket. For details on the drive/power portion of the 9/440 resolver-based system module, refer to your 1394 Digital AC Multi-Axis Motion Control System Users Manual (publication 1394-5.0).

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- Axis Module - Connect up to four axis modules to the 9/440 Resolver–based CNC/Drive system (depending on your system module selection). Axis modules convert the DC power supplied by the system module to a variable AC voltage (460V AC input provides 460 AC out, derated 380V AC input provides 380V AC out). This voltage will have controlled phase, amplitude and frequency for regulating the speed, torque and direction of the 1326 AC Servomotors. The axis modules are available in a wide range of power ratings with continuous peak capabilities of 200% of continuous rating for short durations.

  Make motor connections for power, ground, brake, and thermal sensor to each axis module. Each motor is wired to its own axis module.

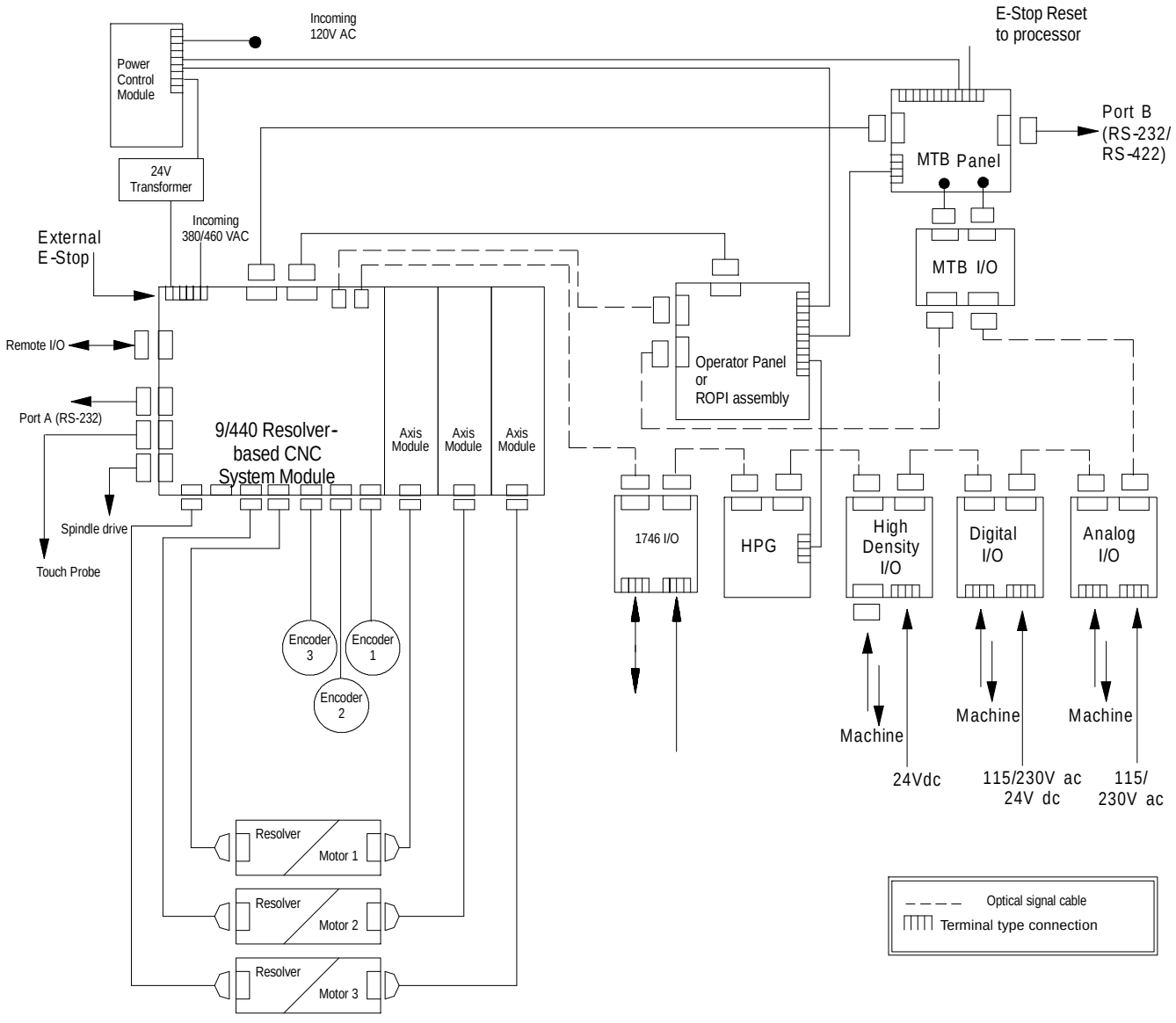


- 1326 motors are described in the 1326 Servomotor Product Data (publication 1326A-2.9). The 1326 series of motors operate at either 460V AC or 380V AC. Connection of these motors is made directly to the Axis Module.

  Each 1326 motor is equipped with a resolver required for motor commutation. This resolver can also be used for positioning feedback, or an external A quad B encoder can be used for positioning. Resolvers are connected to the feedback board found in the system module.

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Figure 5A.1
9/440 Resolver-based System Overview

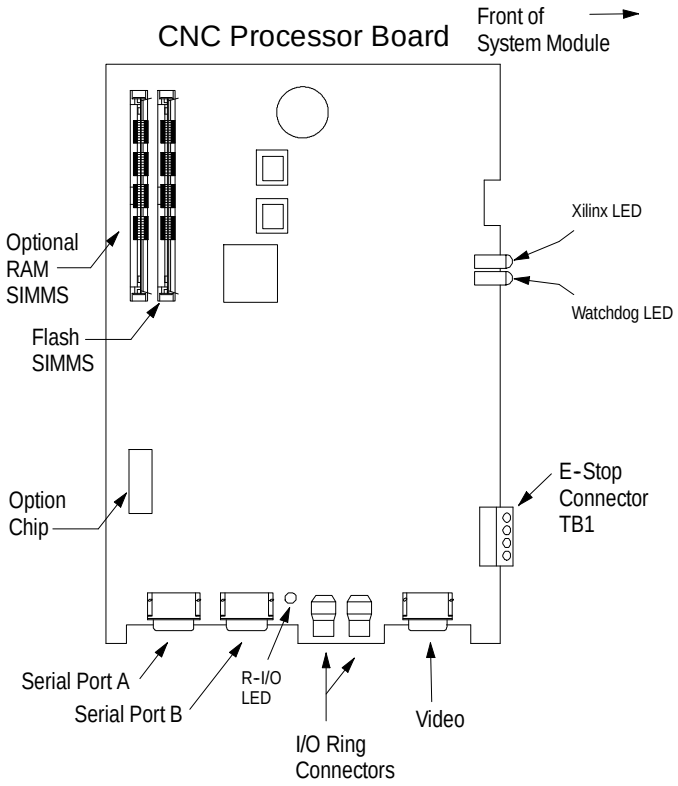


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5A.2
CNC Processor Board

The CNC processor board contains the main CPU. It provides connection for the 9/Series:

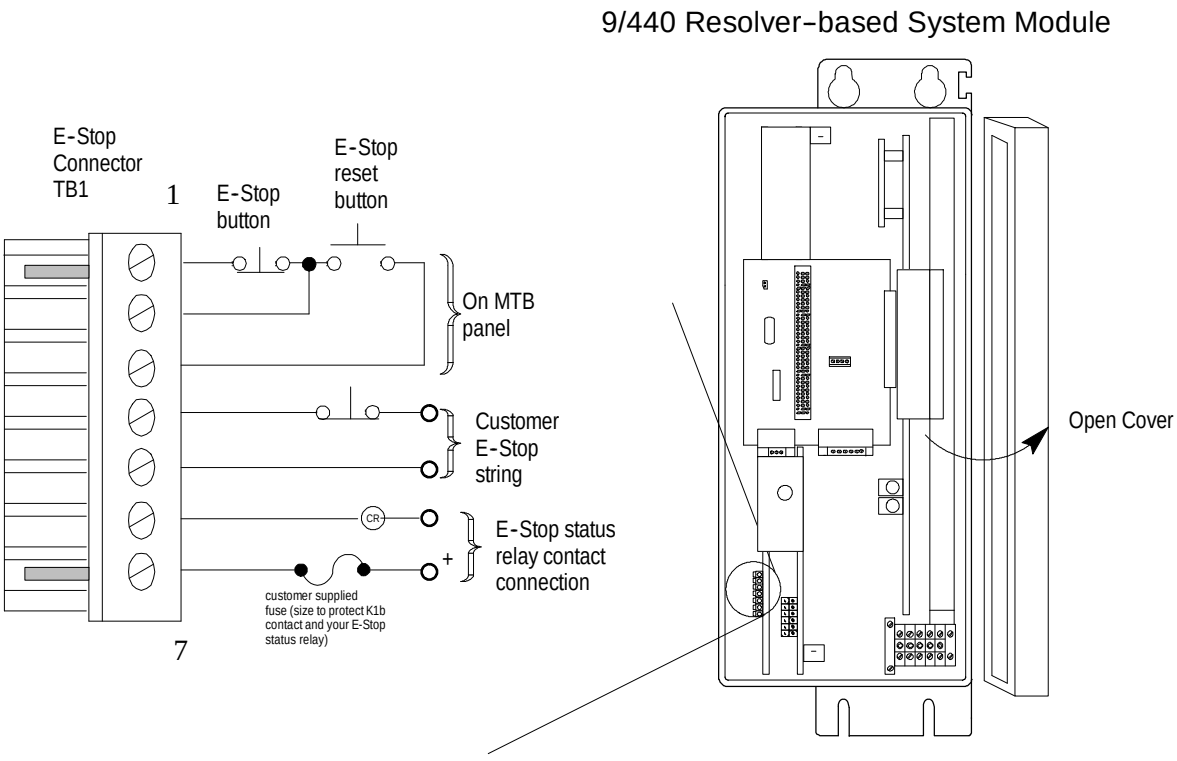
- fiber optic I/O ring
- E–Stop string
- connection to peripheral devices (two serial ports A and B)
- video connection



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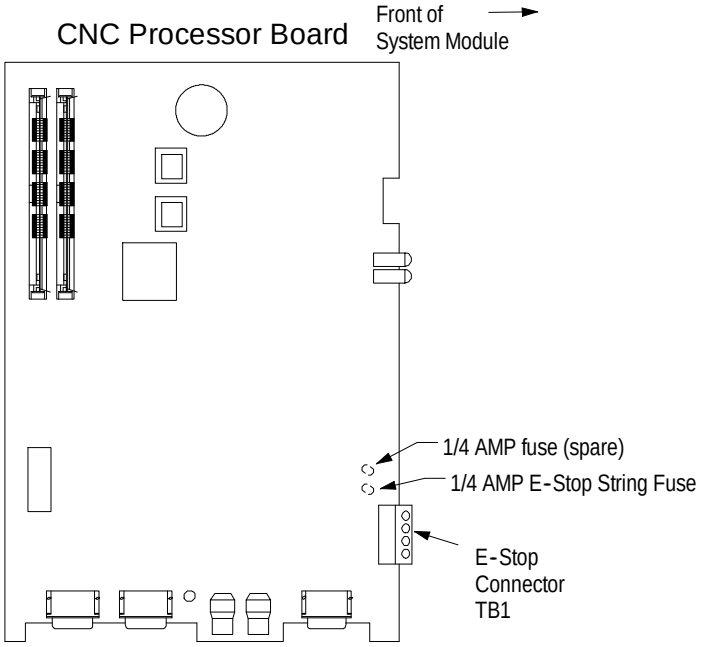
E-Stop Plug

Connection of the E–Stop string is shown in the following figure. More details on E–Stop connections to the 9/Series are given on page 6-1.



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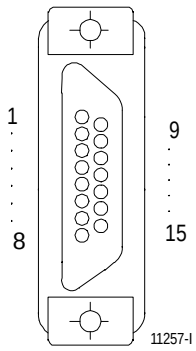
The E-Stop string is a 12V dc string protected by a .25 AMP 115 V fuse located on the 9/440 Resolver-based CNC processor board. You must remove the CNC assembly from the system module to replace this fuse (see page 15B-58 for details).



Video Monitor Connector

The video monitor connector is used to interface the video monitor with the control. Figure 5A.1 shows this connector and lists the pin assignments.

Figure 5A.1
Video Monitor Connector-J8 (has pin sockets) and Pin Assignments



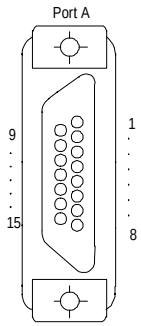
Pin No.	Signal Name	Pin No.	Signal Name
1	GND (SHIELD)	9	RED (L)
2	RED (H)	10	GREEN (L)
3	GREEN (H)	11	BLUE (L)
4	BLUE (H)	12	NC
5	NC	13	CLOCK (L)
6	CLOCK (H)	14	H-SYNC (L)
7	H-SYNC (H)	15	V-SYNC (L)
8	V-SYNC (H)		

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RS-232 Port (Port A)

Serial port A is used to transmit data to and from peripheral devices. It is configured for RS-232 communications only. Figure 5A.2 shows this connector and lists the pin assignments of Port A. For more information on the signals of each pin, refer to page 8-2.

Figure 5A.2
Port A-J6 (has pin sockets) and Pin Assignments



Pin	Assignment
1	Chassis GND
2	Send Data
3	Receive Data
4	Request to Send
5	Clear to send
6	No connection
7	Signal GND
8-15	Not Used

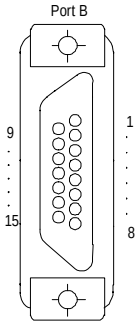
Port B

Serial port B transmits data to and from peripheral devices. Port B can be configured for either RS-232 or RS-422 communications using the softkeys on the operator panel (see your 9/Series Operation and Programming manual). Figure 5A.3 shows this connector and lists the pin assignments of Port B.

The MTB panel may have the optional serial interface connector mounted on it. This connector provides an external interface port for RS-232 or RS-422 interface from a peripheral to the control. It communicates with ports A or B with cable C07. Refer to the page 7A-22 for additional information on cable C07. For more information on the signals of each pin, refer to page 8-7.

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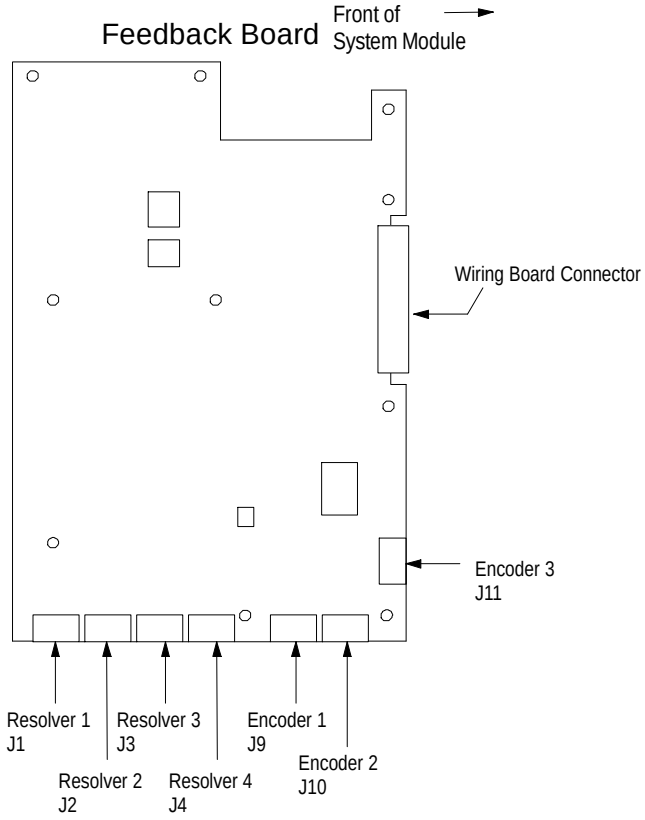
Figure 5A.3
Port B-J7 (has pin sockets) and Pin Assignments



Pin	Assignment	Pin	Assignment
1	Chassis GND	9	Send Data B
2	Send Data A	10	Receive Data B
3	Receive Data A	11	Request to Send B
4	Request to Send A	12	Clear to Send B
5	Clear to Send A	13	Data Set RDY B
6	Data Set RDY A	14	Data Term RDY B
7	Signal GND	15	Not Used
8	Data Term RDY A		

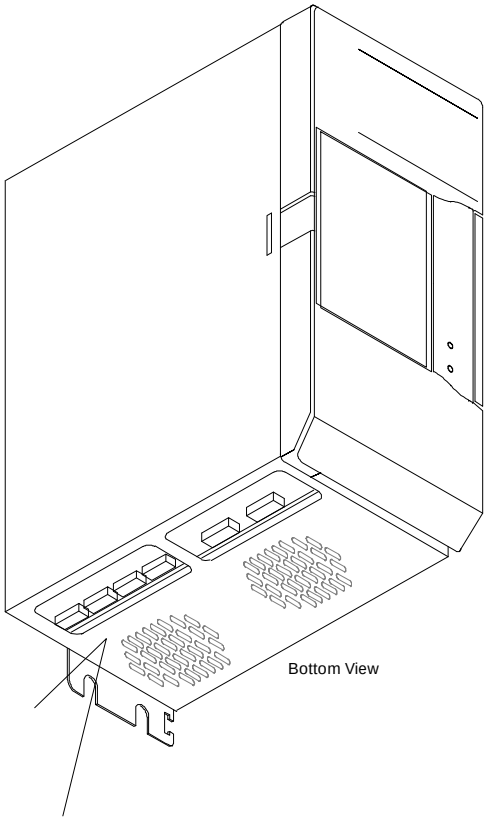
5A.3 Connecting Feedback

The feedback board is used to receive feedback from the resolvers on the 1326 motors and from external encoders. The full 9/440 resolver–based control can support up to six feedback devices (any combination that does not exceed a maximum of four resolvers or a maximum of three encoders). For example 3 resolvers and 3 encoders or 4 resolvers and 2 encoders.

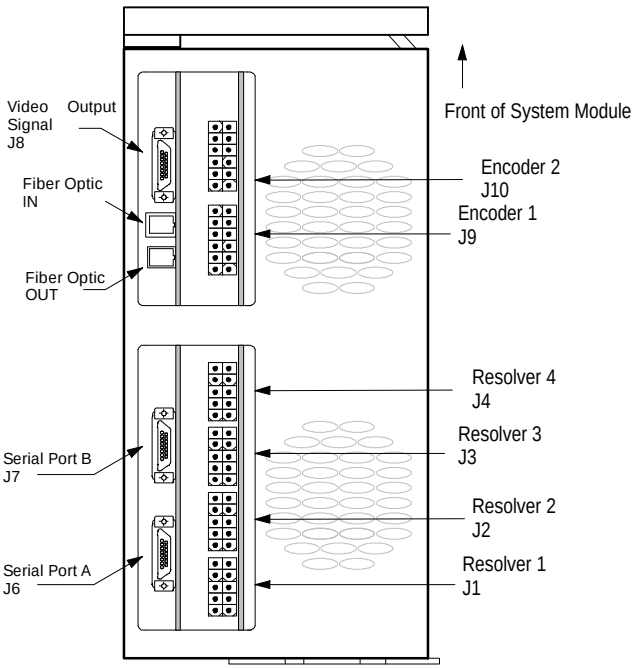


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Important: Each feedback port must be configured in AMP to identify which motor the feedback is from as well as the type, direction, and resolution of the feedback. Refer to your 9/Series AMP Reference manual for details.



System Module
Bottom View



Note: Encoder 3 input connector (J11) is accessible only through the front cover.

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Maximum Axis Speeds

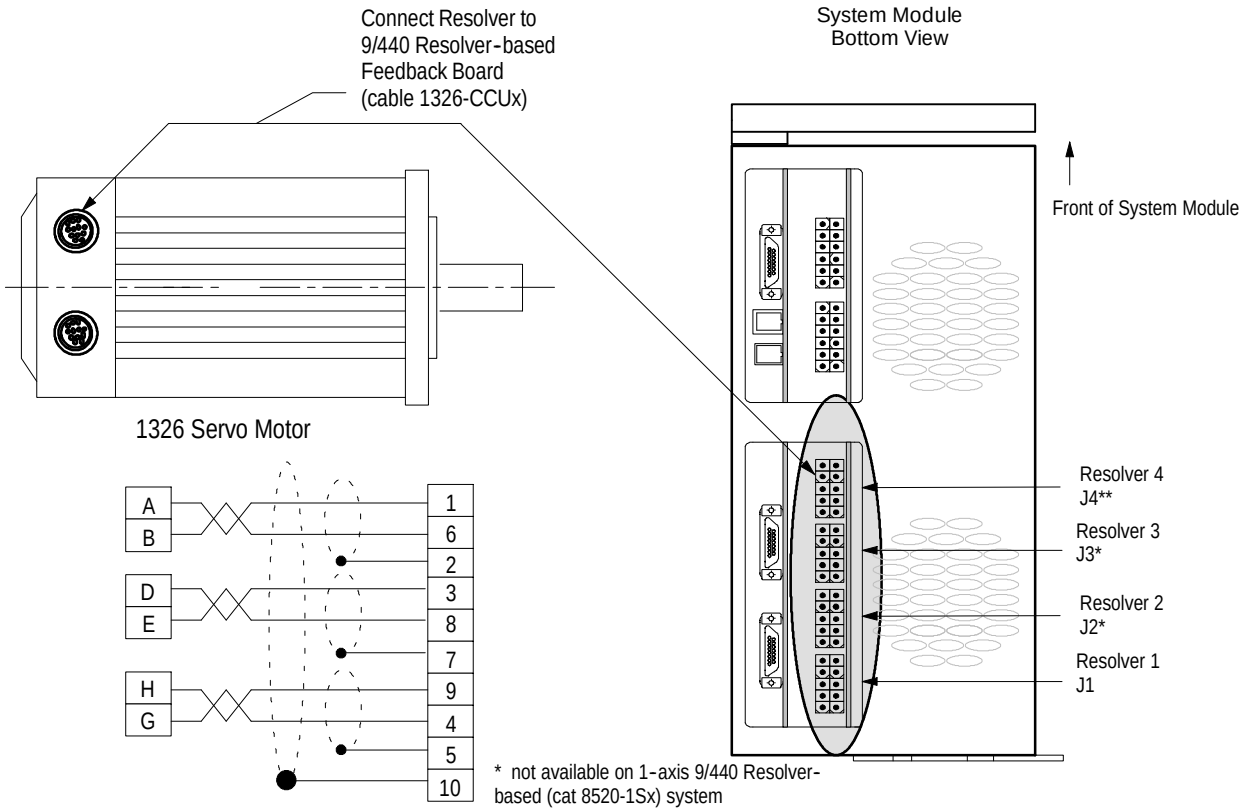
Axis feedback resolution (for 1326 motor resolvers) is selected in AMP to be either 8192 counts/rev or 32768 counts/rev. The maximum motor RPM when set for 8192 counts/rev is 6000 RPM. The maximum motor RPM when set for 32768 counts/rev is 3000 RPM. Actual final axis speed is based on gearing and lead screw pitch. Exceeding this motor speed can result in feedback overflow on the 9/440 resolver–based feedback board and a feedback or maximum speed error will be generated. The encoder ports do not have this same restriction.

5A.3.1 Connecting Resolver Feedback

The 1326 motors are equipped with resolvers used to generate velocity feedback and provide motor commutation. These resolvers can also be used as positioning devices for the axis. Resolver feedback is converted into A quad B encoder type feedback on the 9/440 resolver–based feedback board before being transferred to the 9/440 resolver–based processor. Resolution of the resolvers is selectable through ODS as either 32768 counts or 8192 counts per revolution.

Resolver feedback is wired directly from the motor mounted resolver to the 9/440 resolver–based feedback board found in the system module. This cable can be purchased directly from Allen-Bradley (cat. no. 1326-CCUx).

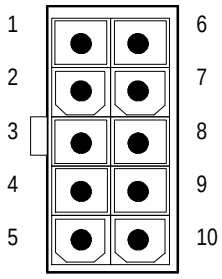
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Important: If you are using the 1-axis 9/440 (cat. no. 8520-1Sx) resolver ports J2, J3, and J4 are not available. If you are using the 3 axis 9/440 (cat. no. 8520-3Sx) resolver port J4 is not available.

If you are using encoder port (J11) for encoder feedback, refer to page 5A-14 for details.

Figure 5A.4
Pin Configuration for the Resolver Connectors on the 9/440 Resolver-based CNC/Drive



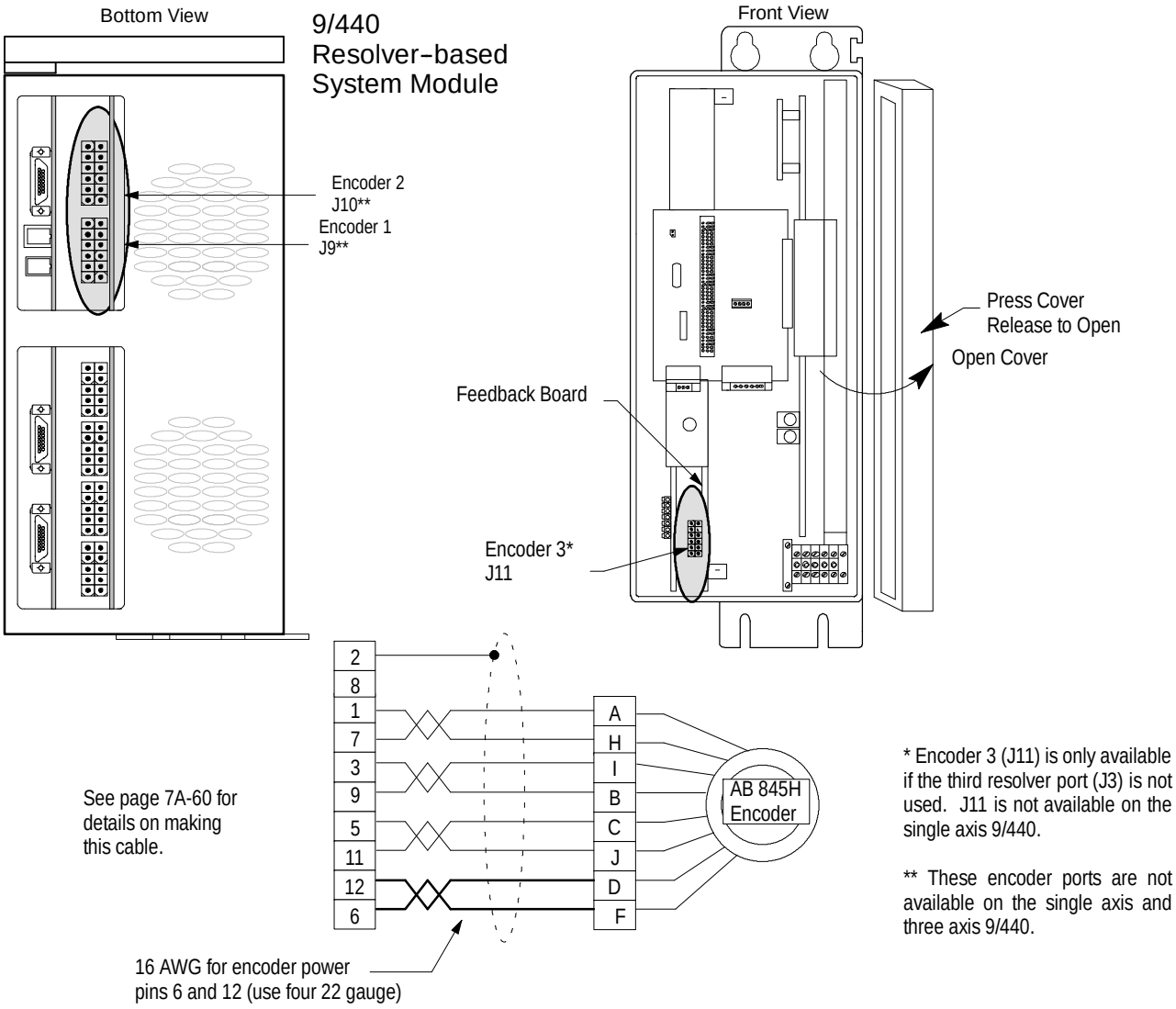
Pin	Signal	Description	Signal Destination
1	R1	Resolver Excitation +	Resolver
2	Shield	Shield Excitation (R1/R2)	
3	S1	Feedback Sin +	Feedback Board
4	S2	Feedback Cos +	Feedback Board
5	Shield	Shield Cos. (C1/C2)	
6	R2	Resolver Excitation -	Resolver
7	Shield	Shield Sin (S1/S2)	
8	C1	Feedback Sin -	Feedback Board
9	C2	Feedback Cos -	Feedback Board
10	Shield	Overall Shield	

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5A.3.2 Encoder Feedback (Optional Feedback)

The encoder ports are intended for systems that use either spindles with position feedback, to provide positioning feedback if you are using optional feedback for one of the 1326 servo motors, or to provide feedback for an analog servo you are controlling from one of the analog output ports. Up to three encoder ports are available.

Important: If you use encoder 3 (connector J11 accessed through the front of the system module), resolver 3 (connector J3) is disabled. You can not use both J3 and J11 at the same time.



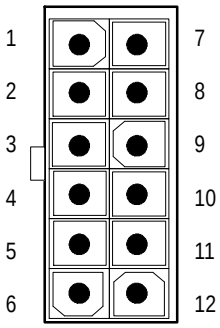
* Encoder 3 (J11) is only available if the third resolver port (J3) is not used. J11 is not available on the single axis 9/440.

** These encoder ports are not available on the single axis and three axis 9/440.

Important: If you are using the 1-axis 9/440 resolver-based (cat. no. 8520-1Sx) system, no encoder ports are available. If you are using the 3-axis 9/440 resolver-based (cat. no. 8520-3Sx) system, only one encoder port (J11) is available. Note, if you use J11, you can not use your third resolver port.

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Figure 5A.5
Pin Configuration for the Encoder Connectors on the 9/440 Resolver-based CNC/Drive



Pin	Signal	Description
1	CHA_HI	Feedback device Channel A
2	Shield	Chassis Ground
3	CHB_HI	Feedback device Channel B (connect to B_LO on 845H)
4	N/C	no connection
5	CHZ_HI	Feedback device Channel Z
6	GND	Encoder Return
7	CHA_LO	Feedback device Channel A
8	Shield	Chassis Ground
9	CHB_LO	Feedback device Channel B (connect to B_HI on 845H)
10	N/C	no connection
11	CHZ_LO	Feedback device Channel Z
12	+5V_ENC	+5V Encoder Power Supply

Compatible Optional Feedback Devices and Spindle Feedback

This section discusses optional feedback devices that are compatible with the 9/440. The 9/440 resolver–based control supplies these devices with +5V power. Feedback devices must return a 5V compatible output signal to the control.

This feedback device can be used to provide:

- auxiliary position feedback – Digital systems require the motor mounted feedback device, provided on our standard digital servo motors, be used for velocity loop feedback. This motor mounted feedback device can also be used to close the position loop or an additional auxiliary feedback device, as discussed in this section, can be used for the position loop. You can not replace or bypass the motor mounted feedback device. The motor mounted feedback device must be used for velocity feedback and to attain proper motor commutation on digital servo systems.

- spindle feedback – Provide position feedback for your spindle using these encoder ports.

- analog servo feedback – If you are using one of the two analog ports to control an axis these encoder ports can be used for its position feedback.

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The 9/440 resolver-based control supports:

Feedback Device	Additional hardware
Allen-Bradley 845H series differential encoders	--
Sony Magnascale model GF-45E	Board-type detector model MD10-FR
Heidenhain Model 704	External interpolation and digitizing model EXE602 D/5-F
Futaba Pulscale model FM45NY	PCB interface Module model CZ0180 with cable PCB020EA

Other feedback devices can be compatible if they comply with the specifications listed in Table 5A.C. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

This manual is written under the assumption that your system is using the Allen-Bradley 845H series differential encoder. If you are using some other feedback device such as a linear scale, an application note is available through the Allen-Bradley CNC Commercial Engineering Department bulletin board at (440) 646-3963. For more information about linear scales, refer to the Home Parameters chapter in your AMP reference manual.

The following table lists feedback specifications for a differential encoder however, this information can be interpreted to select an appropriate linear scale.

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Table 5A.C
Encoder Specifications

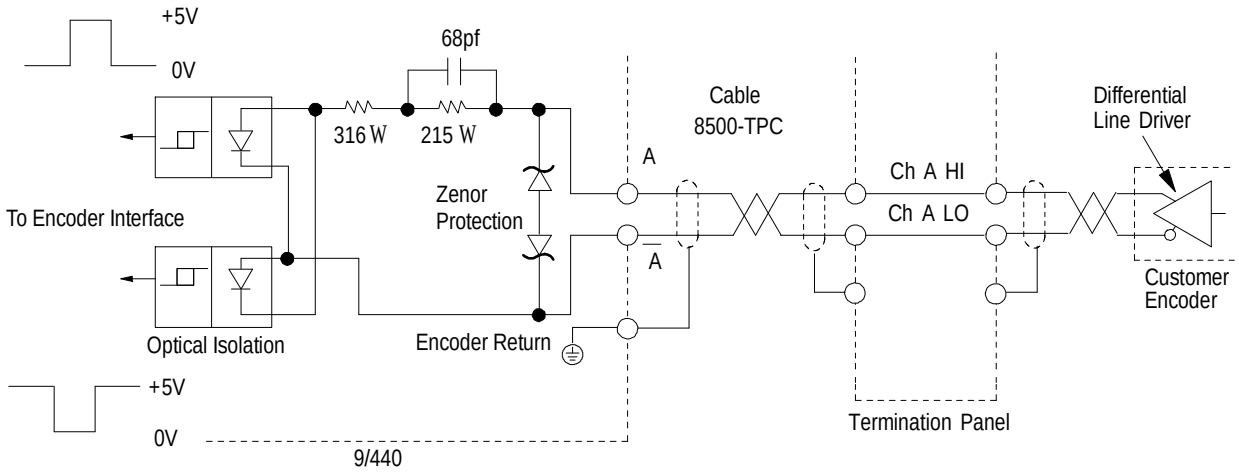
Item	Specification
Maximum Encoder Channel Frequency (ECF)	Use the following equation to determine the maximum channel frequency $\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90\text{-Eq}}\right)} \times 1.15$ Where: Clock - is the Control's Feedback Clock Frequency: 5×10^6 - for 9/230, 9/440, and three axis servo cards. 2.3×10^7 - for 9/260 or 9/290 systems using a four axis servo card E_Q = Quadrature Error in Degrees 1.15 = Our minimum recommended safety factor As long as the actual feedback channel frequency does not exceed the maximum channel frequency calculated above, the servo module should process the feedback data without a quadrature fault.
Maximum Axis Speed	Use the following equation to determine the maximum axis speed. Note that this equation does not take into consideration any mechanical deficiencies in the encoder or motor. It is only concerned with the 9/Series capability of receiving feedback. Refer to the manufactures specs for encoder and motor hardware RPM limitations. $\frac{(ECF \times 60)}{(E)(N)(P)} = \text{Maximum Axis Speed}$ Where: Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute) ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec. E = the number of encoder lines between markers for your encoder N = the ratio of encoder turns to ballscrew turns P = the ballscrew pitch (turns per inch or turns per millimeter. For rotary axes, substitute the appropriate gear ration for N and P in the equation above to solve for a max RPM in revolutions per minute. If the maximum axis speed resulting from this equation is less than you would like, you may need to sacrifice some axis resolution by selecting an encoder with fewer lines between markers.
Input Signal	Encoder feedback must be differential format with 5V compatible output signals, single-ended open-collector outputs are not supported, i.e., channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent.
Current Drawn from Encoder by Servo Module	7mA maximum; 44mA peak
Marker Channel	Narrow marker (gated) or Wide marker (ungated) type markers are supported
Encoder Cable Length	Refer to 9/Series Integration and Maintenance Manual for details on cabling

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Wiring an Incremental Feedback Device

Figure 5A.6 shows an incremental feedback device equivalent circuit for feedback channel A.

Figure 5A.6
Incremental Feedback Device Equivalent Circuit



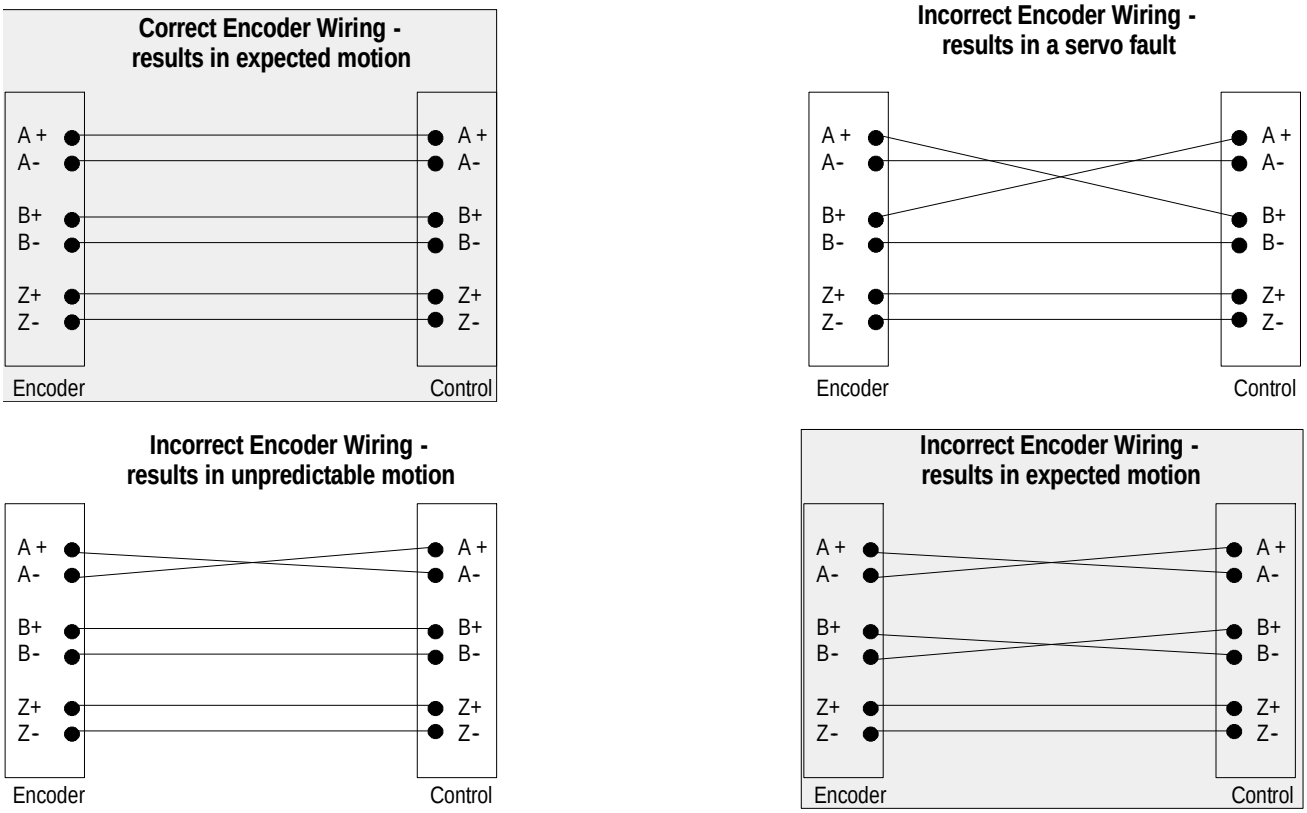
Wiring Position Feedback

Feedback devices used with the control must be configurable such that the marker Z is true at the same time that channels A & B are true. If you are using an Allen-Bradley 845H encoder this requirement will already be met if you wire them as shown in the cable diagrams on page 7A-28.

If you are using an encoder type feedback device other than the Allen-Bradley 845H encoder, then use the following examples to determine the correct wiring:

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Figure 5A.7
Examples of Correct and Incorrect Encoder Wiring



Important: Since positive and negative axis directions can be assigned without regard to encoder rotation directions, it is possible for the feedback direction to be "backwards". This is easily corrected before attempting to command axis motion through the AMP parameter Sign of Position Feedback**.** Refer to your AMP reference manual for more information.

5A.4 9/440 Resolver-based CNC Wiring Board

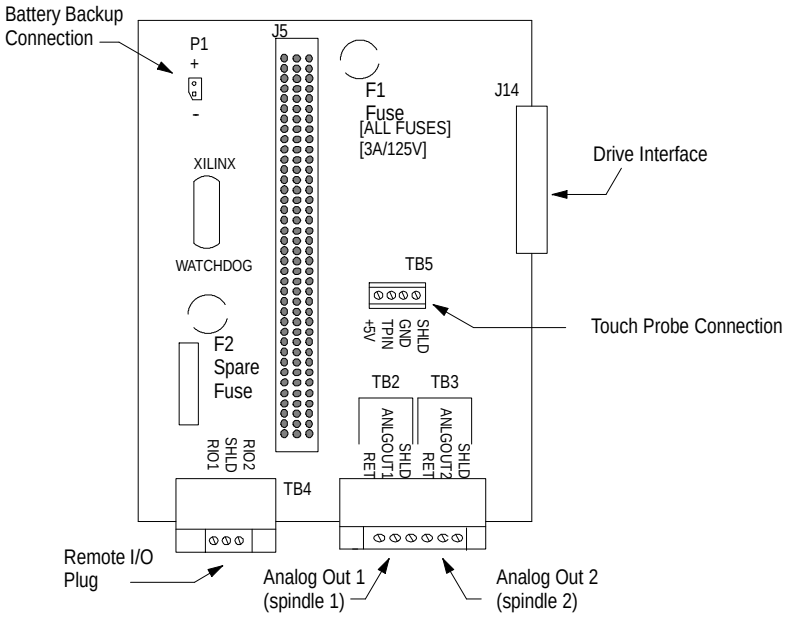
The CNC wiring board provides an easy location to wire additional hardware. It provides connection for:

- analog outputs (typically for spindles)
- touch probe
- remote I/O
- interface between the CNC assembly and power assembly

The main fuse for the 9/440 Resolver–based CNC assembly is also located on this board.

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Wiring Board



5A.4.1 Wiring a Touch Probe to the 9/440

The 9/440 resolver-based system module touch probe connection is made to connector TB5 on the wiring board. Table 5A.A shows the location of this connector and lists its terminal assignments.

Wiring Board

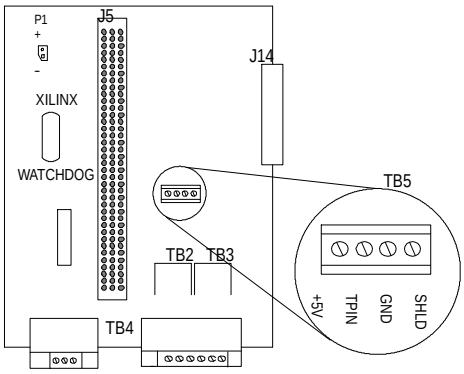


Table 5A.A
TB5 Connector , 4 Plug-type Terminal Block Connections

Terminal	Description	Signal Destination
+5V	Probe Power	Touch Probe
TP IN	Probe Fired Signal [1]	Servo Position Latch
GND	Touch Probe Common	Touch Probe
SHLD	Probe Shield	connect at module only

[1] The True level (voltage transition the probe fires) is either "HIGH" or "LOW" as defined by the AMP parameter PROBE TRANSITION. Refer to your AMP reference manual for more information.

Important: The touch probe connector supports only +5V probing device applications.

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The time delay between the 9/440 resolver–based control receiving the touch probe trigger and latching the current axis position is negligible. However, you should be aware of any external delays that may introduce position "staleness" in the probing operation, especially at high probing speeds.

It is a good idea to establish an offset for the distance between the actual location, as sensed by the probe at a very low speed, and the location sensed by the probe at the intended probing speed. The offset can then be added or subtracted to any future values obtained through probing. This helps make sure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is removed from the measurement (assuming the external delay is repeatable).

The touch probe interface is intended for use with units that offer 5V dc compatible solid state relay outputs (see Figure 5A.8). Other configurations can be supported as long as the user operates within the published electrical specifications.

The touch probe circuitry resident on the 9/440 resolver–based control only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, position data is captured by the module, and additional occurrences of the trigger signal have no effect until the probe is re-enabled under program control.

Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

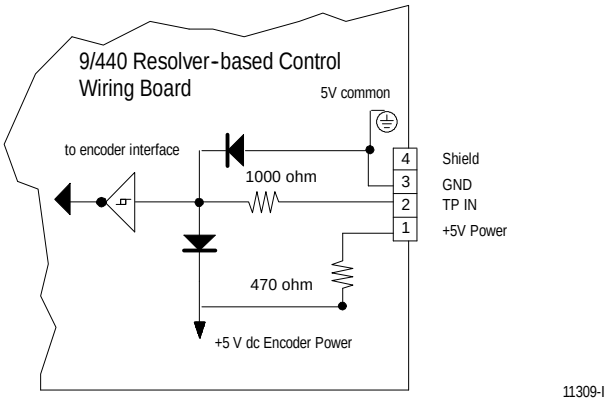


ATTENTION: It is preferred, from a safety standpoint, that the touch probe relay be closed at rest and open when the touch probe stylus deflects. Then, if a wire breaks or shorts to ground, it will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort towards the fail-safe operation of the touch probe. Not all vendor's touch probe control units conform to this safety consideration.

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Figure 5A.8 shows the internal servo module circuitry that interfaces to the touch probe connector. It is shown here to assist you in determining whether your touch probe hardware is compatible.

Figure 5A.8
Internal Circuitry Supporting the Touch Probe



The following table indicates probing threshold voltages. Maximum Input Threshold (critical if the control has been configured to fire on the falling edge of the probe signal) indicates the voltage that the probe signal must fall below to be considered as “fired”. Minimum Input Threshold (critical if the control has been configured to fire on the rising edge of the probe signal) indicates the voltage that the probe signal must rise above to be considered as fired

Probe Thresholds	Voltage at Threshold
Minimum Input Threshold (probe circuit)	3.06 (min)
Maximum Input Threshold (probe circuit)	2.18V dc (max)

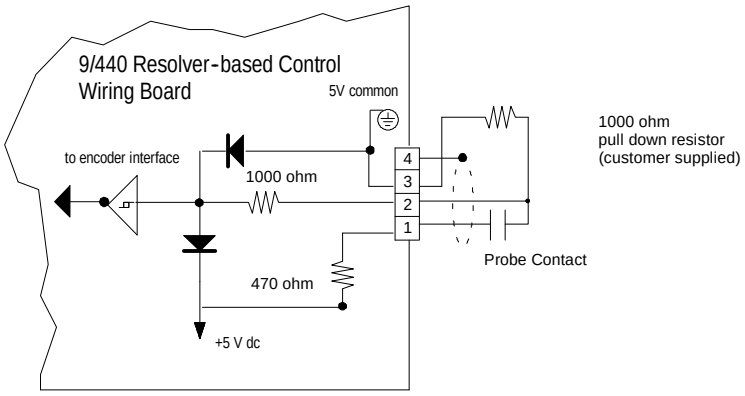
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To avoid misfires use the threshold values from the above table to determine the necessary signal voltage for steady state operation (probe not fired). For probes configured to fire on the falling edge the steady state voltage must remain above 3.06 volts. For probes configured to fire on the rising edge the steady state voltage must remain below 2.18 volts.

Wiring a Probe for Rising Edge Configurations

Typical wiring of a simple contactor type touch probe configured to fire on the rising edge of the probe signal, requires the addition of a 1000 ohm pull down resistor. Figure 5A.9 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

Figure 5A.9
Typical Wiring of a Touch Probe Configured for Rising Edge Trigger

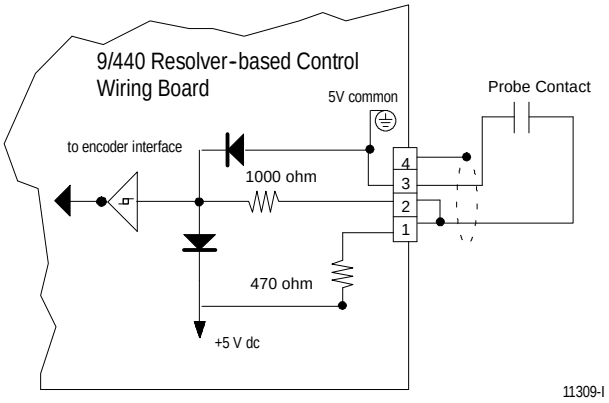


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Wiring a Probe for Falling Edge Configuration

Figure 5A.10 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

Figure 5A.10
Typical Wiring of a Touch Probe Configured for Falling Edge Trigger



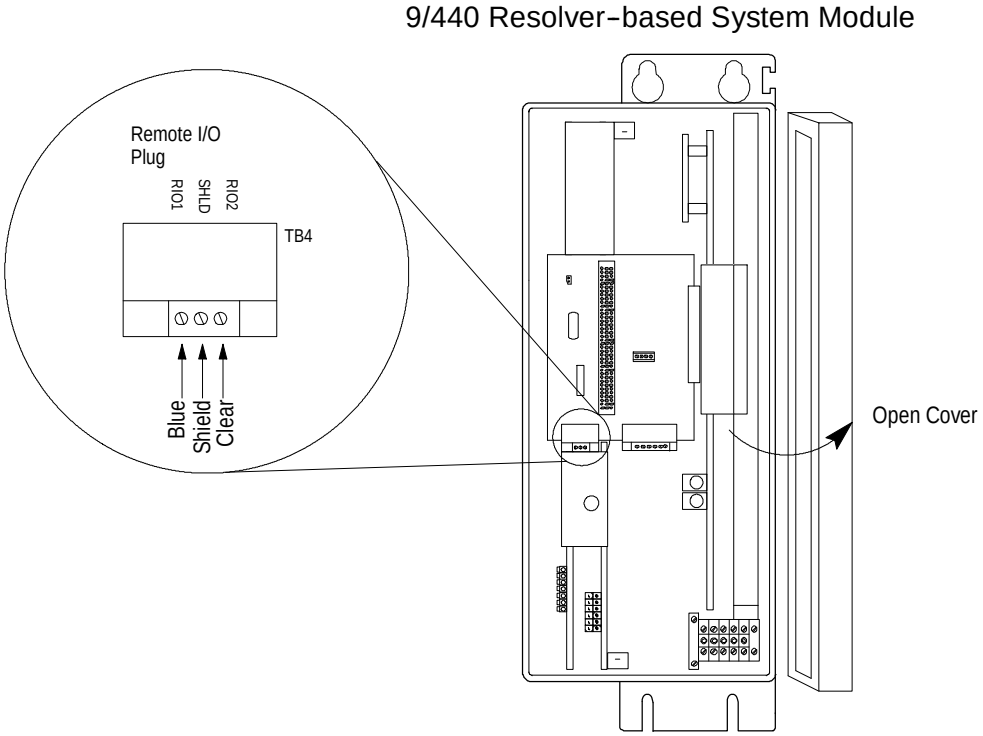
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5A.4.2 9/440 Resolver-based Control Remote I/O Connection

The remote I/O circuitry and connector are integral parts of the wiring board in the 9/440 resolver-based system module. Figure 5A.11 shows the remote I/O connector mounted on the 9/440 resolver-based control wiring board.

Wire connections for the remote I/O communications are made through the TB4 NODE ADAPT connector. Connect the wires for remote I/O as shown in the following figure. Refer to your 1771 I/O documentation for details on making remote I/O connections.

Figure 5A.11
Remote I/O Connector in System Module

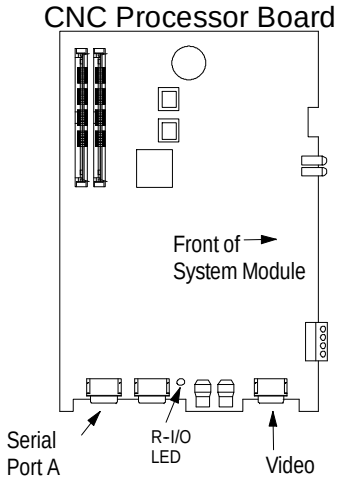


9/440 Resolver-based Control Remote I/O LED

Assuming you have:

- made all necessary remote I/O communication connections on your 1771 I/O network
- configured your remote I/O port for the remote I/O network in AMP
- written PAL to set $RMON true during the first PAL foreground execution, and to handle input and output words ($RMI1 – $RMI8 inputs to PAL and $RMO1 – $RMO8 outputs from PAL.)

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You are ready to start receiving and transmitting remote I/O information. An LED is provided on the 9/440 resolver–based CNC processor board and is visible from the bottom of the system module. As remote I/O responds to commands, you should see this LED pattern:

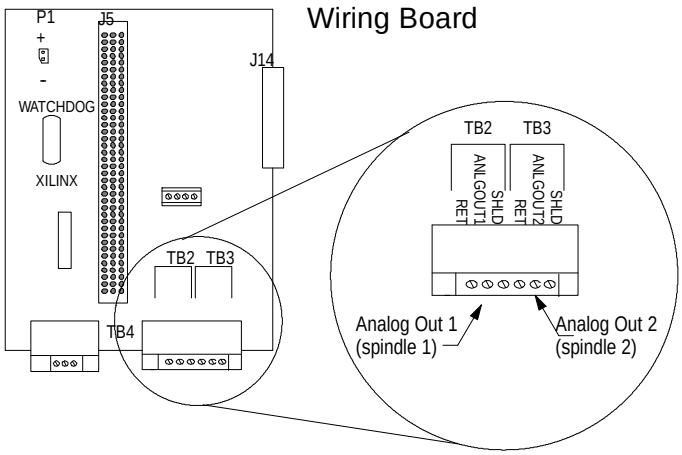
LED	Status	Description
Green R-I/O LED	ON	Active Link to PLC. This is the normal state when the RIO link is active.
	FLASHING	The remote I/O link is active but the PLC is currently in program mode.
	OFF	Remote I/O link is offline. The port is not being used, not configured in AMP correctly, not turned on with $RMON, or not attached to a 1771 device.

5A.4.3 9/440 Resolver-based Analog Out (TB2 and TB3)

Two auxiliary analog outputs are provided through the connectors labeled TB2 and TB3 of the 9/440 resolver–based wiring board. These connectors are typically used to command external analog spindle drive systems but can also be configured in AMP to control additional analog servo systems. Figure 5A.12 shows the location of ANALOG OUT connector and lists terminal assignments of this connector.

Important: If positioning feedback is required for the spindle or analog servo system, its corresponding encoder feedback should be wired through one of the encoder feedback connectors and indicated as such in AMP.

Figure 5A.12
Terminal Block TB2 and TB3, Plug-type Terminal Block Connections.



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Connector	Description	Signal Destination
Analog Out	±10V Analog with no feedback	(typically spindle drive)
RET	Signal Return	(typically spindle drive)
SHLD	shield	connect at wiring board only

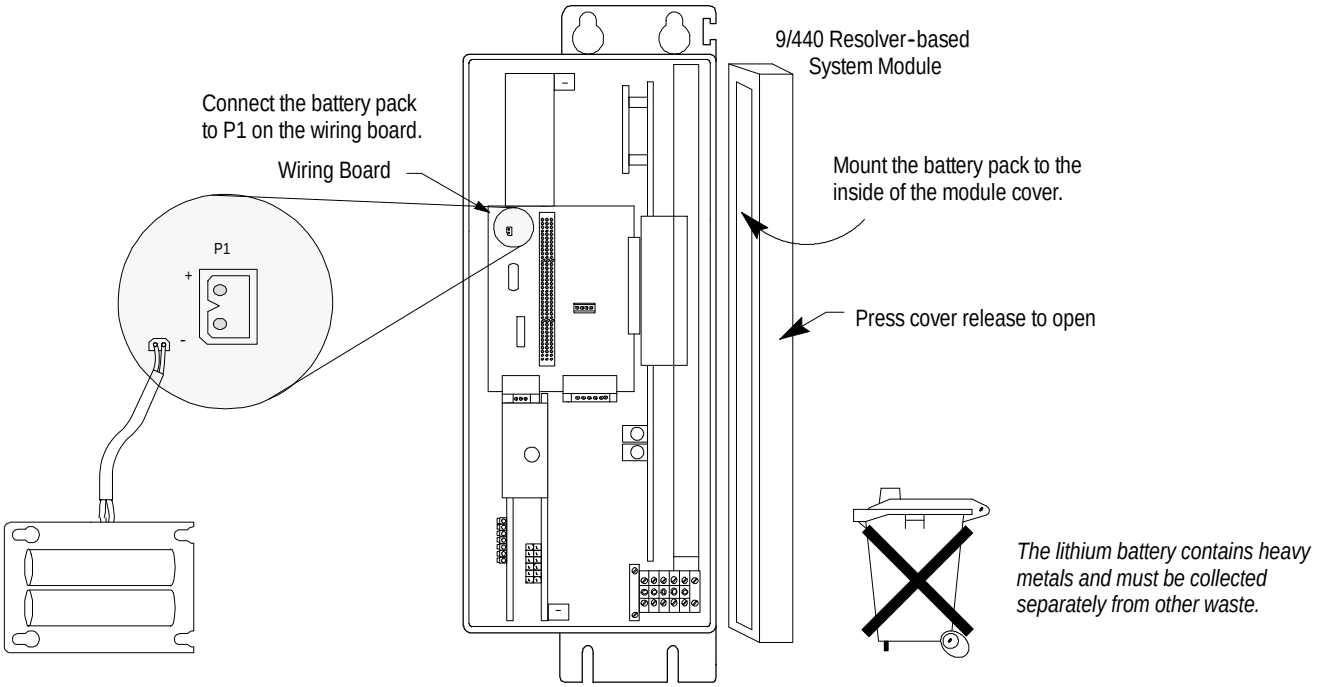
5A.4.4 Battery Backup

The memory for part programs, tool offset/compensation data, work coordinate offset data, etc... is stored on the processor board. In the case of a power failure, there is a super capacitor on the processor board that backs up this data for up to 5 days (at 40 °C) on systems without extended program storage. This super capacitor re-charges within 1 hour of power turn on if completely discharged. If you want to extend this backup time install the lithium battery pack that supports the data for:

9/440 Resolver-based Memory Option:	**Time (at 40 °C Discharge):**
standard	3 years
with extended program storage	1 year

This battery pack is connected to the lithium battery connector (P1) on the wiring board as shown in Figure 5A.13. Batteries and the battery cable are included with the battery replacement kit.

Figure 5A.13
Lithium Battery



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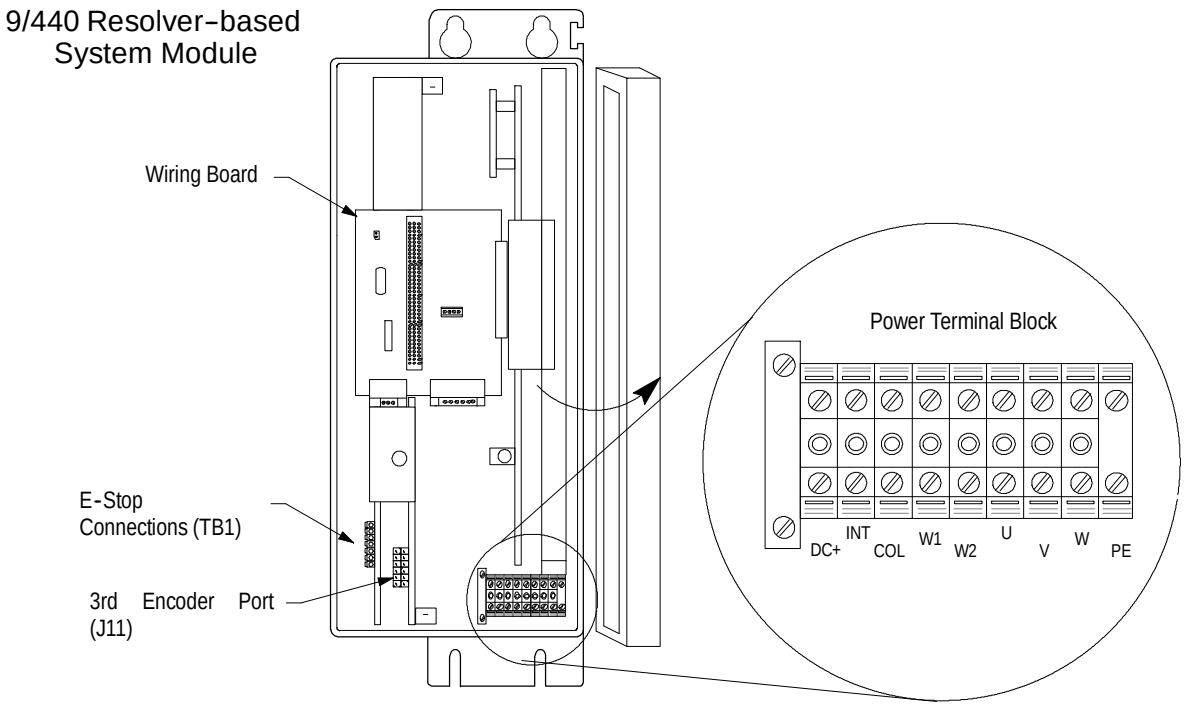
5A.5 Power Terminal Block Connection

All external power connections to the 9/440 Resolver–based CNC/Drive are wired through the system modules power strip, located behind the front cover in the lower right corner. Input power is wired to this strip in two different voltages:

- 24 V Logic Power – this is 24 volt AC or 24 volt DC. The logic power is used to operate the processors in the system module, axis module logic boards, and power the resolvers/encoders.
- Drive Power – this is 324-528 V AC, three phase, 50/60 Hz. The drive power is used to supply the drive portion of the 9/440 resolver–based control the voltages necessary to power the axis modules and the servo motors.

To this Power Strip Connector	Connect:
W1	+24 V Logic Power
W2	24 V Logic Power common
U, V, W	380/460V AC, three phase power (not phase sensitive)
PE	System Ground Bar
DC+, INT, COL	Shunt resistor connection. When the jumper exists between INT and COL the internal 200 W shunt is used. When using the optionally purchased 1000 W shunt the jumper is removed and the new shunt is installed between DC+ and COL.
All connectors on the power strip support a maximum of AWG 12 gauge solid wire.	

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5A.5.1 On/Off Control and 24V Logic Power

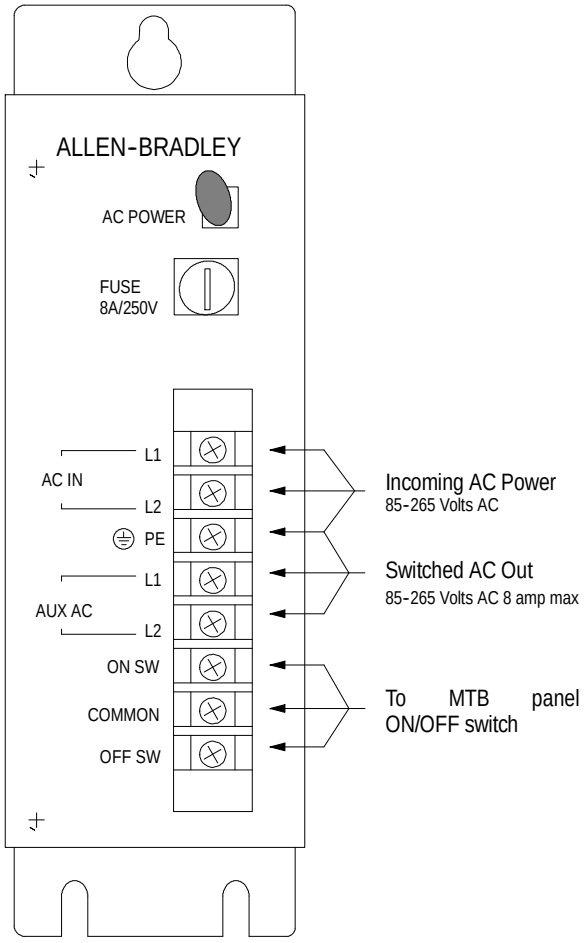
24 Volt logic power is supplied to the 9/440 resolver–based control to run the processor board and axis module logic boards. The 24 volts are provided from a customer supplied transformer. Specifications for this supply are:

Transformer Input Voltage	9/440 Resolver-based Input Voltage Range (Transformer Output)	Number of Axis Modules			
		1	2	3	4
125/240 V AC (85-265 V AC @50/60 Hz)	24V ac (19 - 28V ac, single phase @50/60 Hz) or 24V dc (18.75 - 31.25V)	3.5 A	4.4 A	5.2 A	6.0 A

On/Off connections are made through the Allen-Bradley On/Off Control assembly (8520-OFC). This assembly allows connection to the standard MTB panel on/off switch and should be used to supply power to your 24 V transformer.

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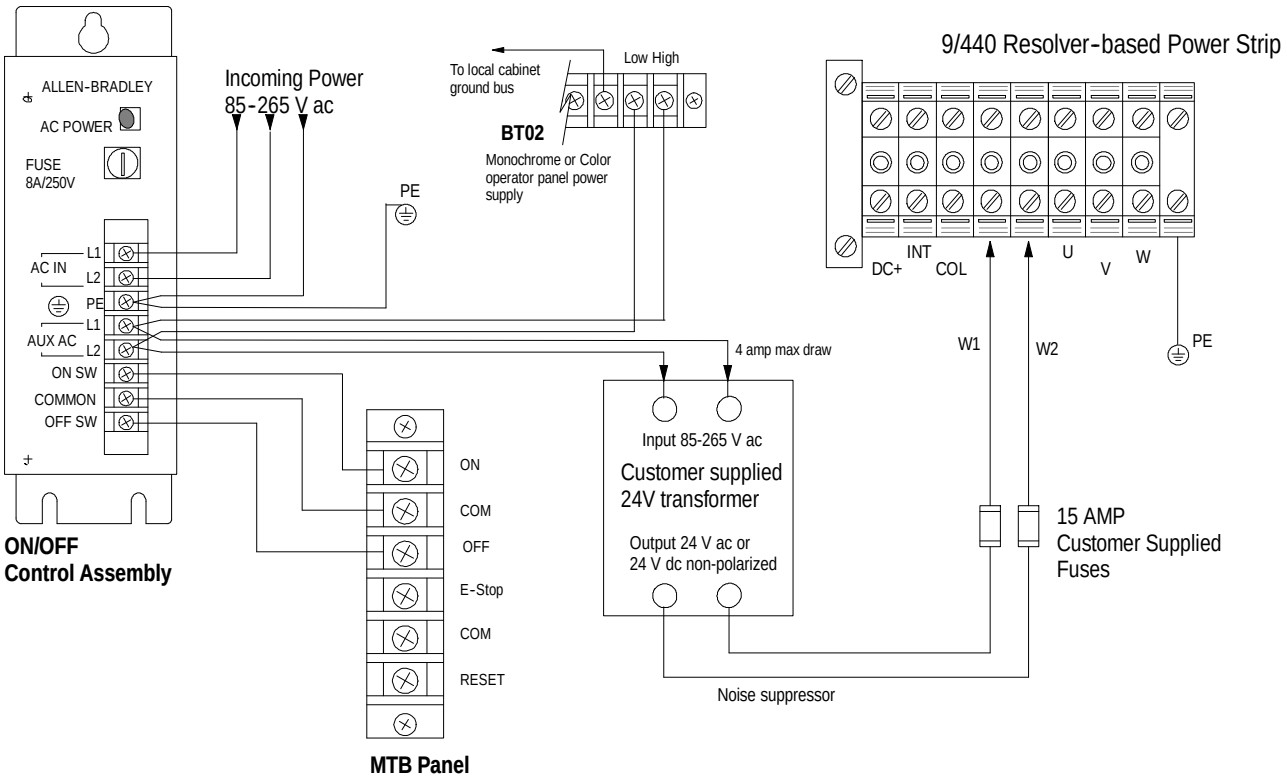
Figure 5A.14
On/Off Control Assembly



Logic power should be wired so that if the 24 V is not available to the system module, it will open the drive contactors and disable 3 phase drive power (see Figure 5A.18).

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Figure 5A.15
Connecting On/Off Power Control Assembly and 24V Transformer

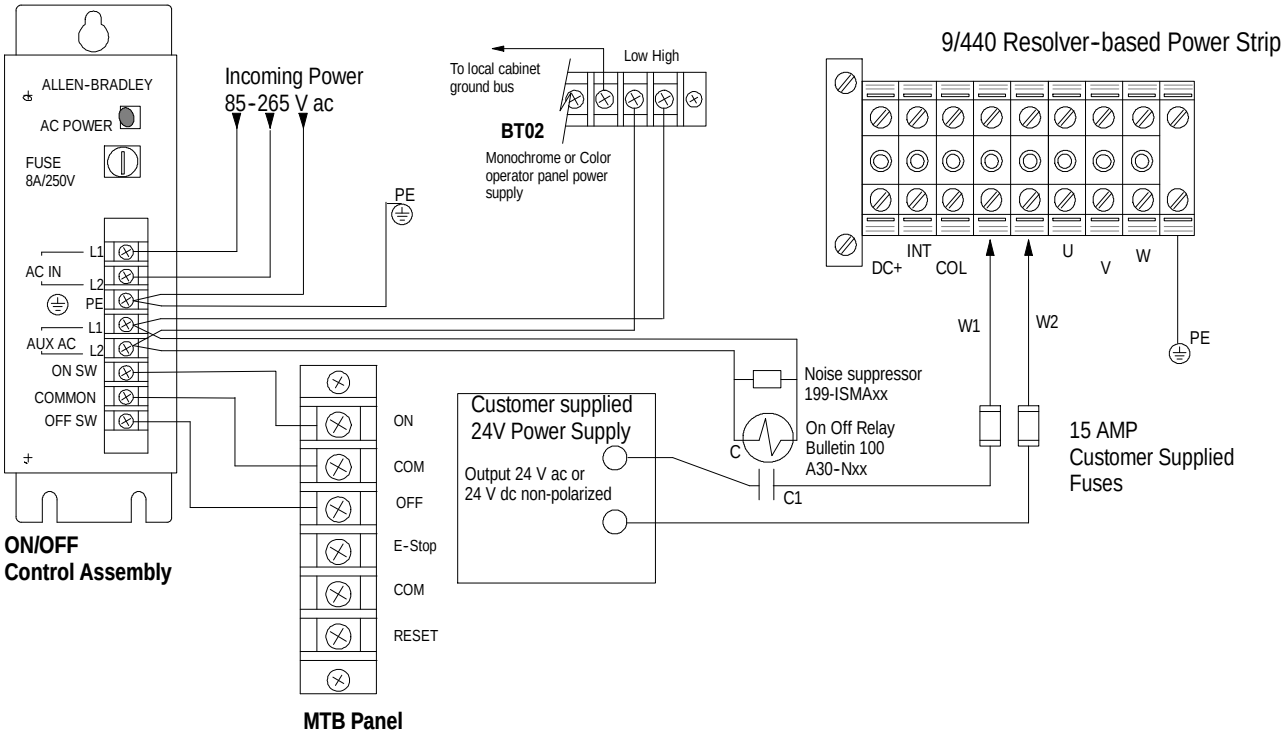


ATTENTION: You must make sure logic power (24V) is applied to the system module and the system module is out of E–Stop before you allow 3 phase power to be enabled.

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If 24 V power is required for other devices in your machine system, you can use a 24 V power supply in place of the 24 V transformer as shown in Figure 5A.16.

Figure 5A.16
Connecting On/Off Power Control Assembly and 24V Power Supply



5A.5.2
Drive Power 3 Phase

Three-phase power to the 9/440 resolver-based control must be 324-528 V AC, 50/60 Hz. The drive power is used to supply the drive portion of the 9/440 resolver-based control the voltages necessary to power the axis modules and the servo motors.

All power connectors on the 9/440 Resolver-based power strip accept AWG 12 gauge solid wire. Refer to local codes for required wire type and gauge.

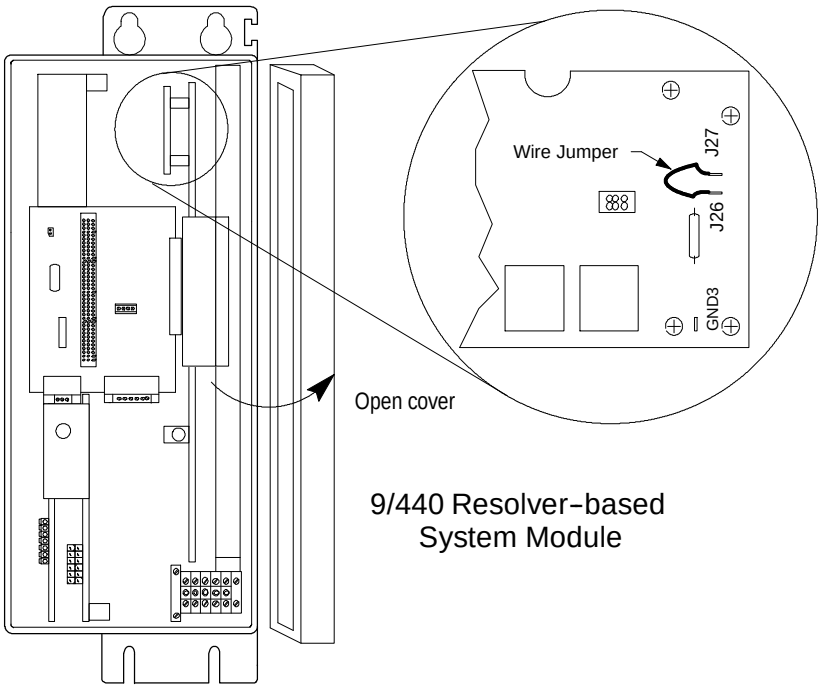
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Grounded vs Ungrounded Three Phase

The 9/440 Resolver–based CNC/Drive comes from the factory set for three phase grounded systems. If your facility uses an ungrounded three phase 360/480 volt system, you must move a jumper in the 9/440 Resolver–based system module. This jumper will connect an internal resistor that helps keep high voltage static, that can be typical of ungrounded three phase systems, from building up in the system module.

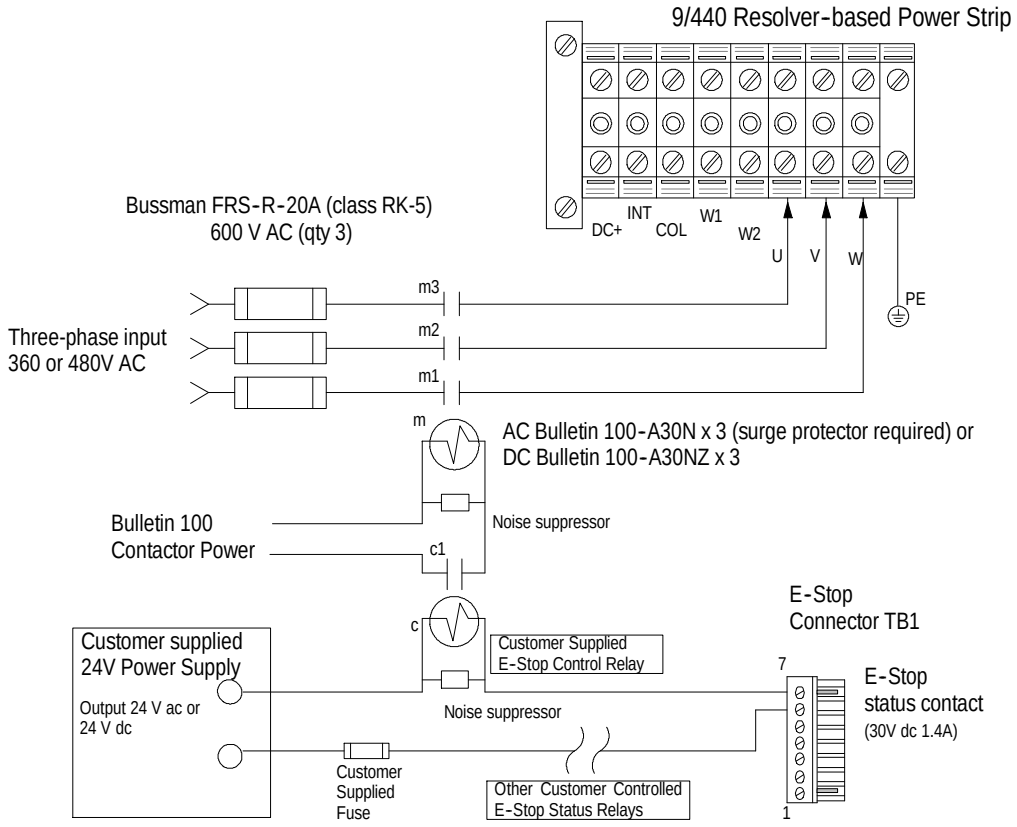
Jumper Setting	Three Phase Power
J27 to J26 (factory setting)	Grounded system
J27 to GND3	Ungrounded systems

Figure 5A.17
Three-phase Jumper



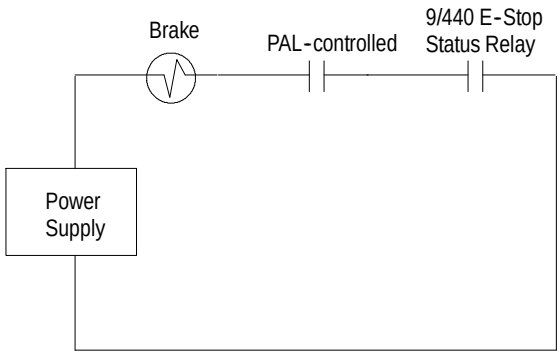
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Figure 5A.18
Recommended Connection of 3-phase Drive Power



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ATTENTION: The E-Stop status relay (or your customer-supplied E-Stop control relay) should not be the only method through which axis brakes are directly released (see the illustration below). Brakes should be released by a combination of the PAL logic when it determines that the 9/440 system is in full control of the servo motors and the control's E-Stop status contact and an external hardware E-Stop contact. Refer to the description of the PAL flags $AXME and $STME for details about testing drive status.

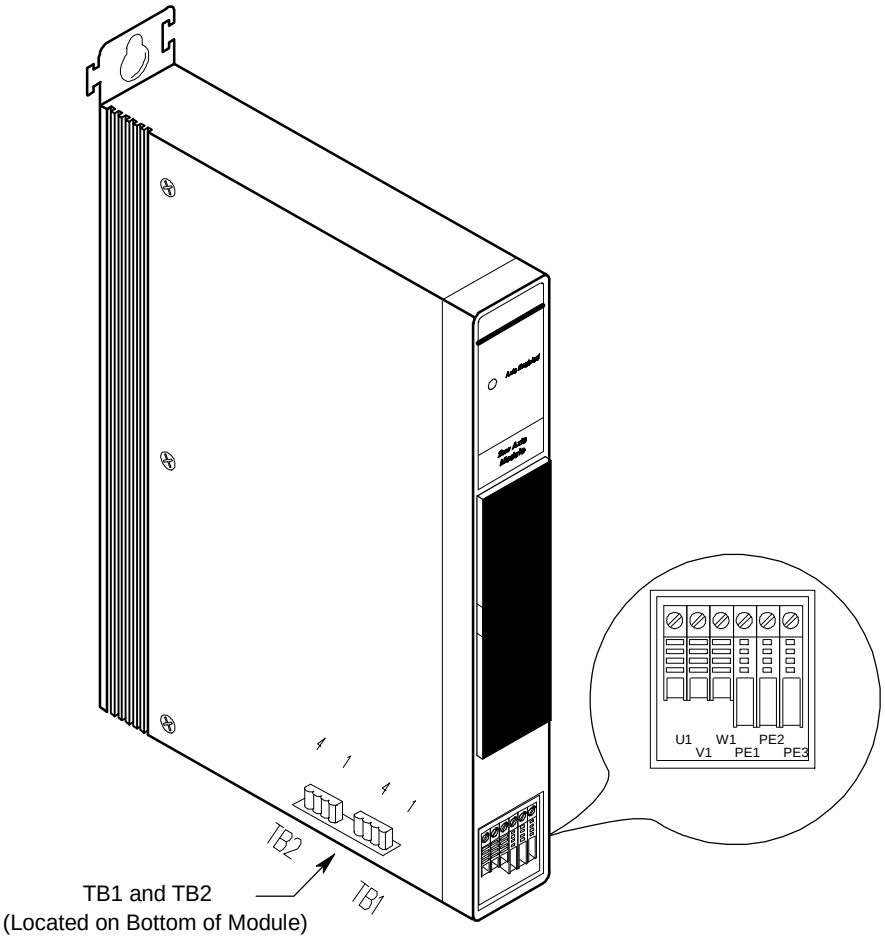


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5A.6
Connecting Axis Modules

The Axis Module provides terminating points for the motor power, thermal sensor and brake. Axis module wiring is identical for all module ratings. Refer to Figure 5A.19 and the paragraphs that follow for detailed information.

Figure 5A.19
Axis Module Connections



Motor Wiring

Allen-Bradley 1326-CPB1xxx cables must be used for connection to the motor. The motor wiring size is determined by the continuous and overload current requirements (RMS Duty Cycle), NEC and local codes. In general, motors operated with the 1394 should not require wire sizes larger than those accepted by the motor terminal blocks. In addition, the motor leads must be twisted throughout their entire length to minimize radiated electrical noise. The maximum motor wire sizes that the 1394 Axis Module terminal block will accept are dependent upon axis module selection (see your 1394 users manual).

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See page 5A-12 for details on resolver cables (1326-CCUxxx).

1326 servo motors have integral thermal protection. This contact must be connected in the E–Stop string for motor overload protection.

Connections are performed through the front panel terminal block as shown in Figure 5A.19. Refer to the information below and the Interconnect Drawings on page 5A-41 for further information.

Table 5A.B
Motor Power Terminations

Terminal	Description	Wire/Pin Number
U1	Motor Power A	1
V1	Motor Power B	2
W1	Motor Power C	3
PE1	Axis Ground	Ground Bar
PE2	Motor Ground	8
PE3	Overall Shield	7

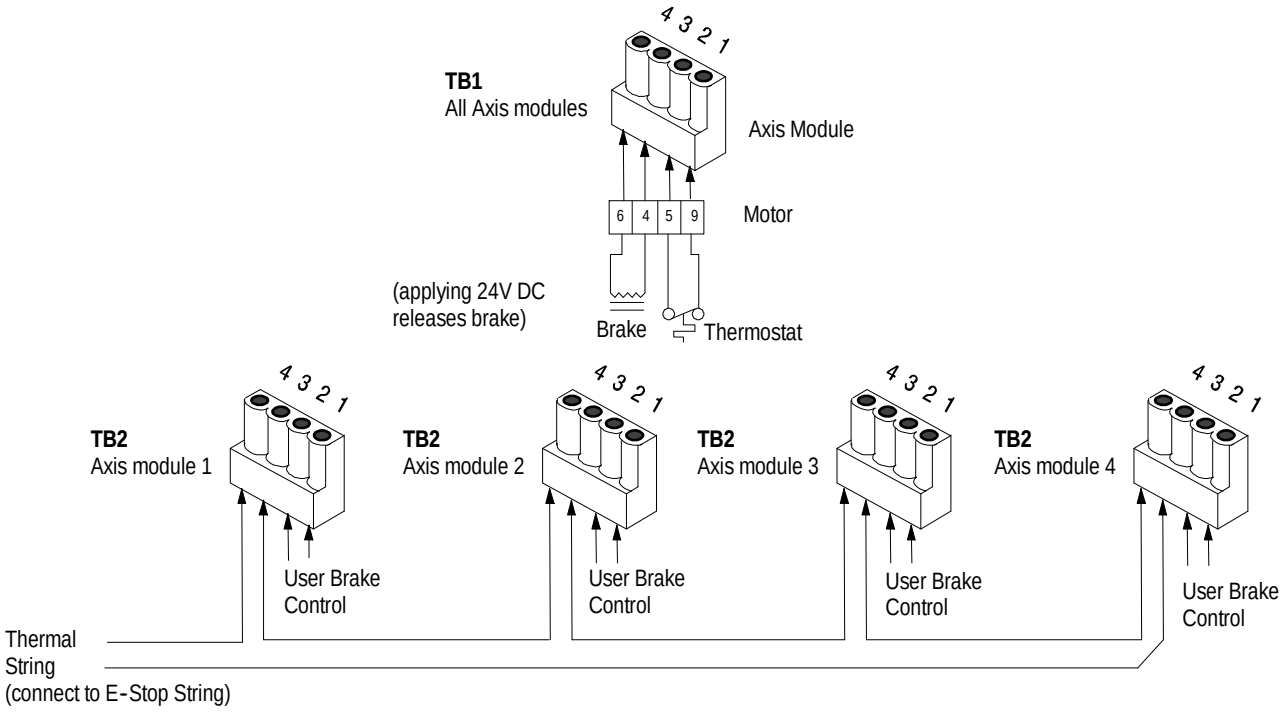
Thermal and Brake Leads

The motor thermal sensor and brake leads (if used) are connected to the Axis Module at TB1 & TB2. See Figure 5A.19 for location and Table 5A.C for terminations.

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Table 5A.C
Thermal Sensor and Brake Terminations

Terminal	Description	Wire/Pin Number
TB1-1, 2	Thermal Sensor Input from Motor Cable	string axis modules
TB1-3, 4	Brake 24V DC Input from Motor Cable	user brake
TB2-1, 2	Brake 24V DC To Brake Control	5, 9
TB2-3, 4	Thermal Sensor Output to Fault System	4, 6



ATTENTION: Brake control should not be directly released by the E-Stop status relay (or your customer supplied E-Stop control relay). Brakes should only be released by the PAL logic when it has determined that the 9/440 resolver-based control is in full control of the servo motors and the control is out of E-Stop. See the description of the PAL flag $PFLT.15 for detail on how to test drive status.

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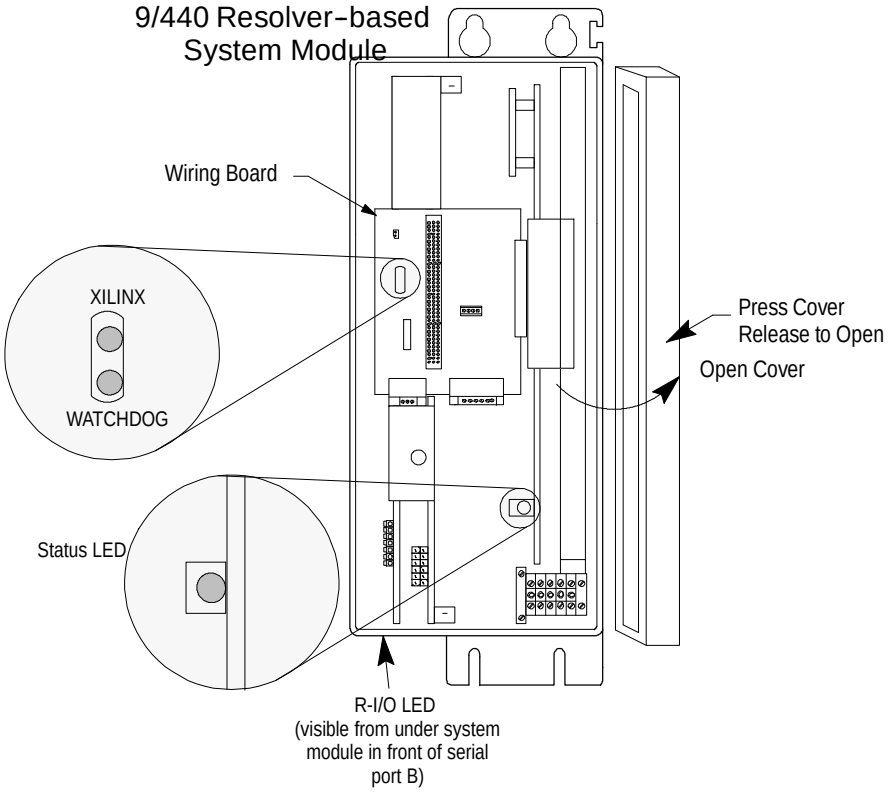
5A.7
9/440 Resolver-based LEDs

9/440 Resolver–based CNC/Drive has 4 LEDs on the system module and one LED on each axis module in the system. The LEDs operate as follows.

System Module LEDs

The system module has 4 LEDs. They are:

LED	Indicates
XILINX	Under normal operation this LED is on. If it turns off while the system module is under power it indicates a XILINX hardware fault. Contact your local Allen-Bradley Service.
WATCHDOG	Under normal operation this LED is on. If it turns off while the system module is under power it indicates the watchdog has timed out and a processor failure has occurred. Contact your local Allen-Bradley Service.
R-I/O	Only available on systems with remote I/O. This LED illuminates when the remote I/O link is communicating. See page 5A-26.
STATUS	This is identical to the Watchdog LED but is visible through the system modules front cover.



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Check your 9/Series CRT for any drive faults that may have occurred and are displayed as an error.

Axis Module LEDs

The Axis module has a Status LED visible thru the front cover. It is:

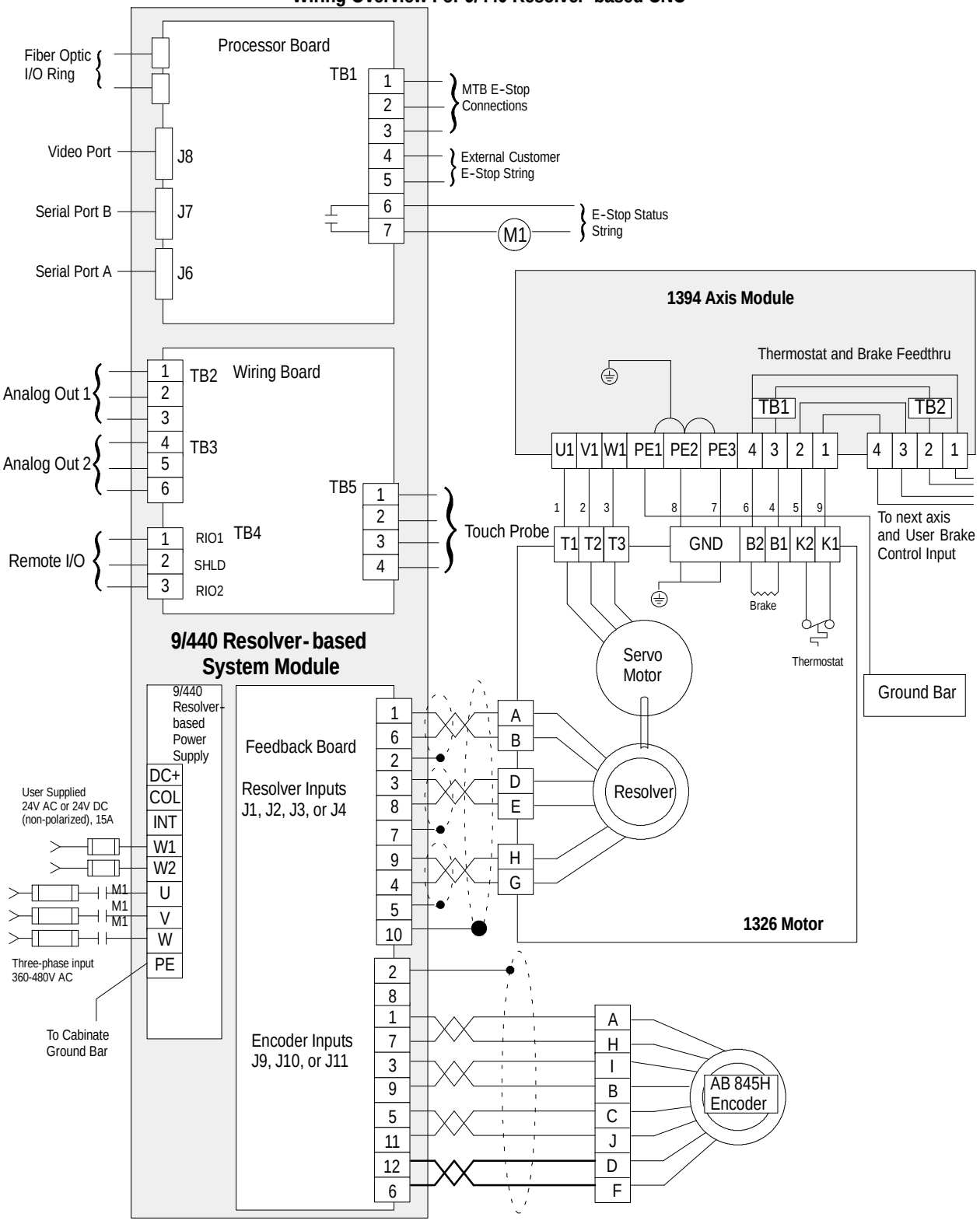
LED	Indicates	
STATUS	Steady Green	bus up, axis enabled
	Flashing Green	bus up, axis not enabled
	Flashing Red/Green	ready, bus not up
	Flashing Red	fault present
	Steady Red	hardware malfunction
For more details on how to diagnose and troubleshoot your axis module refer to the 1394 Digital AC Multi-Axis Motion Control System Users Manual (publication 1394-5.0)		

5A.8 General Wiring Overview

The following figure shows a typical interconnect diagram for a 9/440 Resolver–based CNC to 1326 motors. Note this figure illustrates only one servo motor with optional feedback encoder. The 9/440 Resolver–based CNC can support up to four servo's and two spindle drives.

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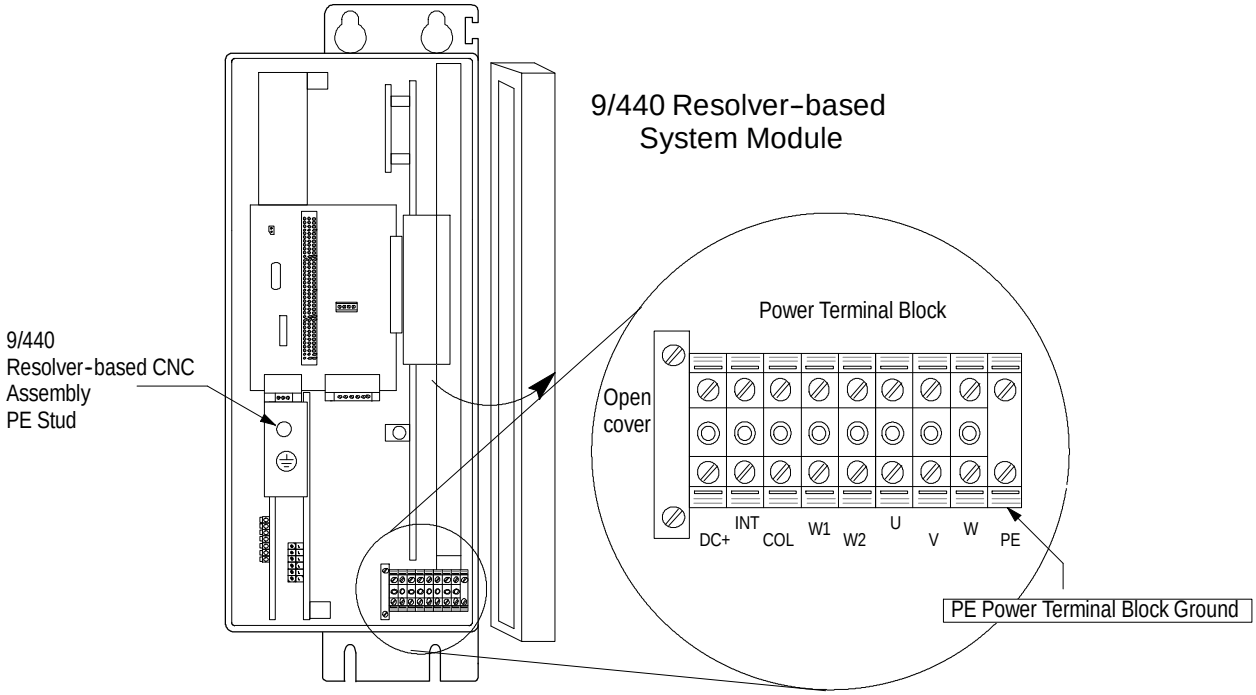
Figure 5A.20
Wiring Overview For 9/440 Resolver-based CNC



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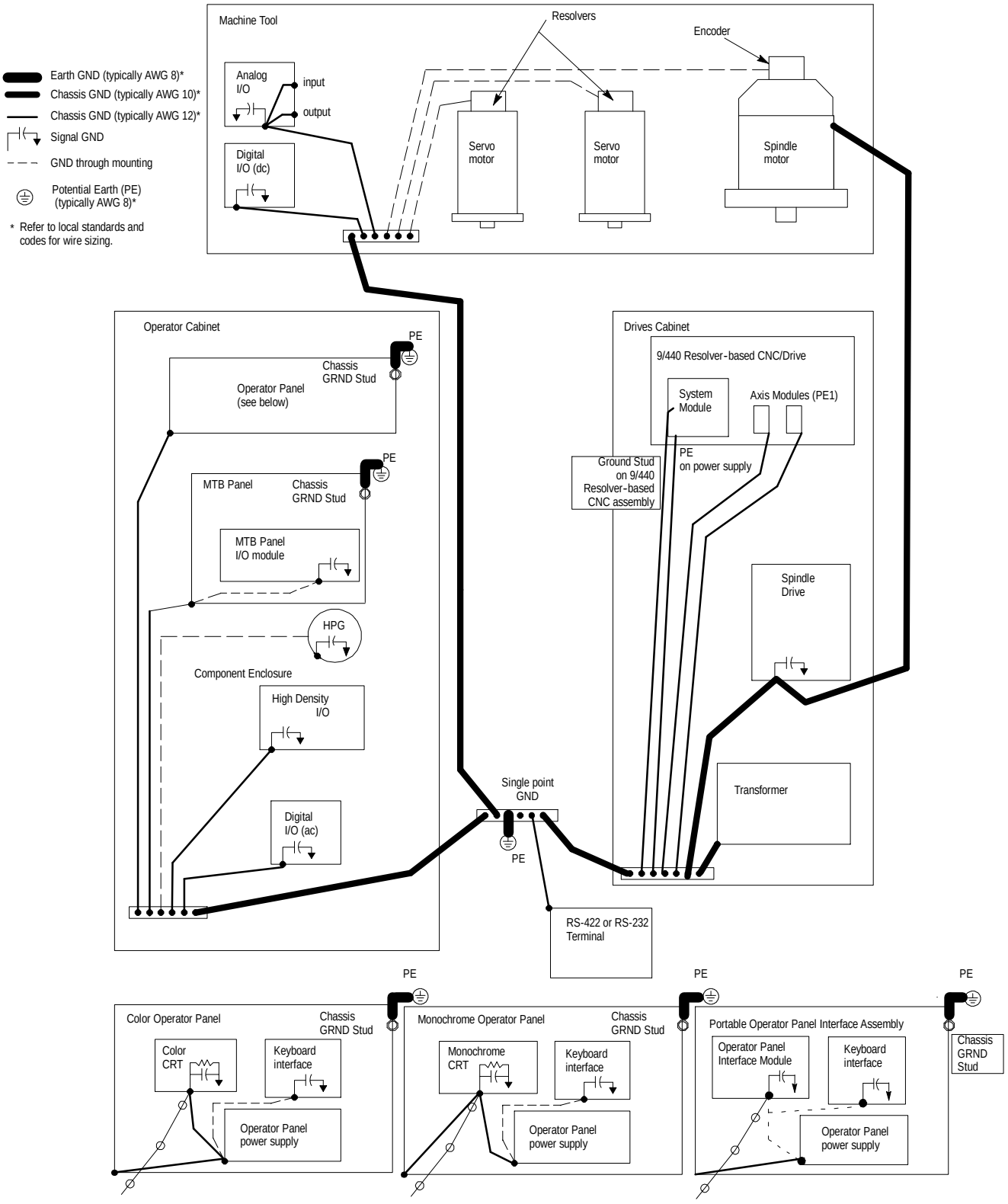
System Grounding

Figure 5A.21 illustrates the recommended 9/440 Resolver–based grounding scheme. All grounds terminate on a single point. Note there are two separate ground wires going to the system module. One ground connects to PE of the system module power terminal block, the other connects to the ground stud found just beneath the wiring board on the mounting bracket for the 9/440 Resolver–based CNC assembly.



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Figure 5A.21
System Grounding Diagram for 9/440 Resolver-based control



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Section **5B**

The 9/440HR CNC/Drive System

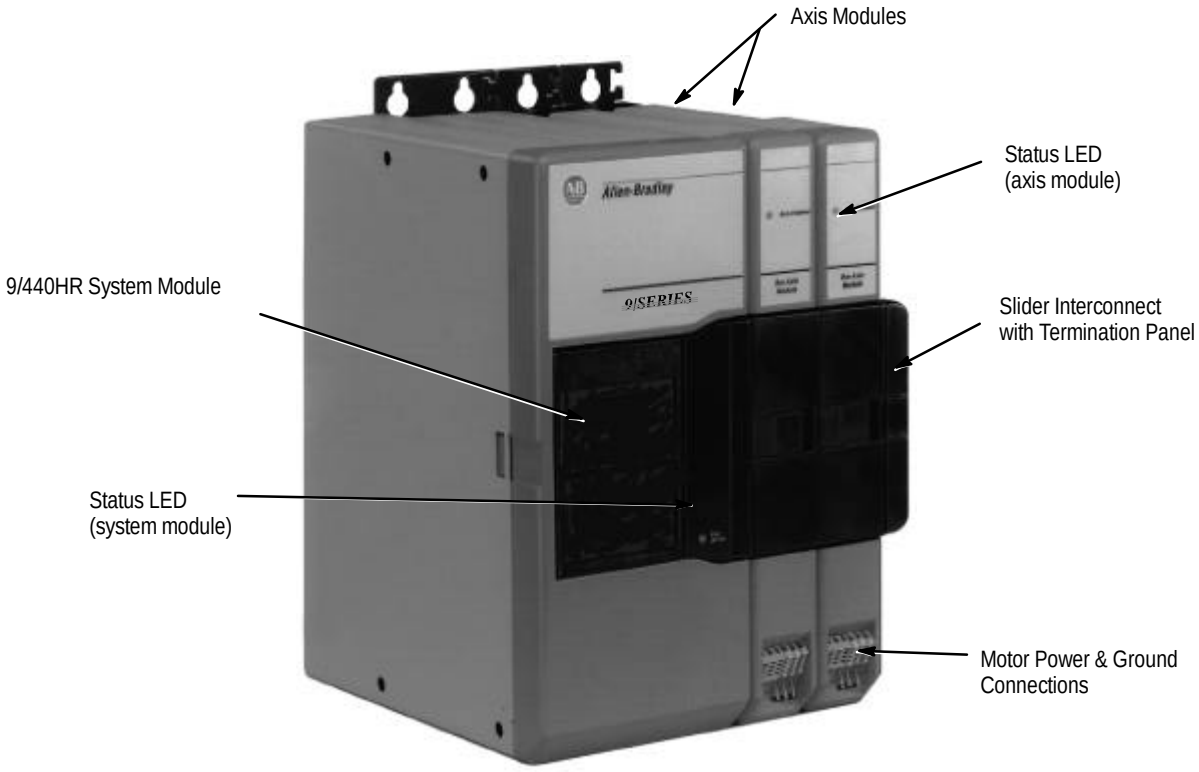
5B.0 Section Overview

The 9/440HR CNC/Drive system offers you a unique, high–resolution machining solution that incorporates a CNC with a digital drive as a single cohesive unit. This system improves machine performance, system integration time, and cabling. The 9/440HR CNC/Drive system supports up to four closed–loop axes and two closed–loop analog axes (typically spindles).

This 9/440HR system is designed to interface to Allen-Bradley 1326AB digital servo motors with high–resolution feedback. These 1326AB servo motors are equipped with either incremental (2 million counts/rev) or absolute (1 million counts/rev) high–resolution feedback devices.

5B.1 Hardware Overview

The following figure shows some of the key features of the 9/440HR CNC/Drive:



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- System Module – This is the largest module in the 9/440HR CNC/Drive system (left most module). It contains the following circuit boards:

  9/440HR CNC Assembly Section

  - Processor Board – This board provides the CNC logic as well as connections to the 9/Series fiber optic I/O ring, serial ports A and B, E-Stop connection, and video connection.

  - Feedback Board – Each 1326AB motor's high–resolution feedback device (up to 4 available) is wired to this board, which also provides encoder power. Additional encoder feedback ports are available for spindle feedback, optional feedback, or analog axis feedback.

  Power Assembly

  - Power Supply – This supplies power to the system module as well as the axis modules. Attach incoming AC three-phase power and 24 V logic power to this supply.

  Interconnecting Power and 9/440HR CNC Assembly Section

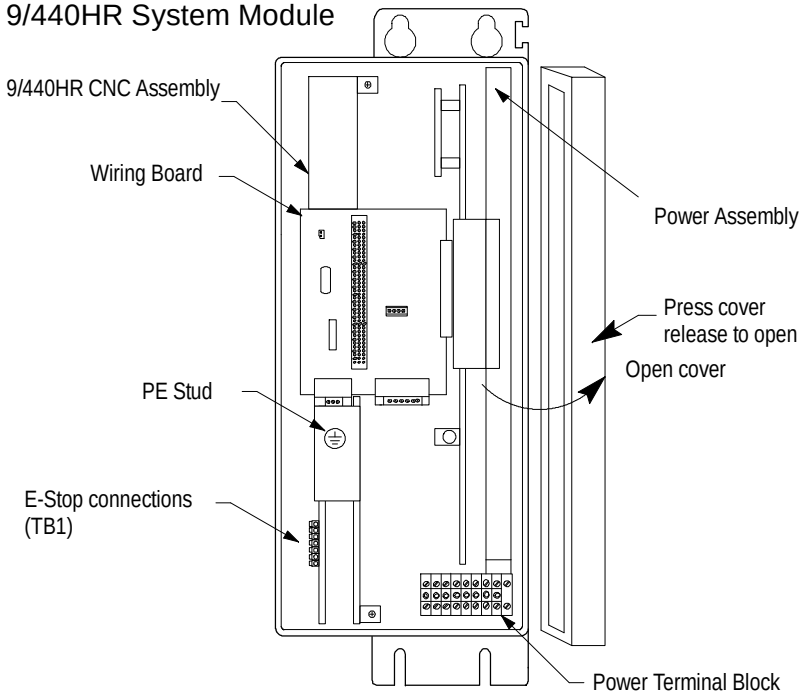
  - Wiring Board – spindle outputs, touch probe connections, and the RIO connection are located on this board, which also interfaces the 9/440HR CNC assembly with the power portion of the 9/440.

The number and type of available feedback ports supported on your 9/440HR system are defined by options installed at the factory. Some ports may not be enabled. To determine what ports are operational on your system, refer to the system configuration label located on the outer left side of your system module. The following table shows catalog numbers and the feedback ports enabled by them.

	8520-A1	**8520-A2**	**8520-A3**	**8520-A4**	**8520-2Q**	**8520-4Q**
Stegmann HIPERFACE (absolute or incremental)	J1	J2	J3	J4	–	–
A quad B (with single or distance-coded marker)	–	–	–	–	J9, J10	J11, J12

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9/440HR System Module



This chapter only covers the 9/440HR CNC assembly and the interconnecting wiring board. The 9/440HR CNC assembly consists of a CNC processor board and a high–resolution CNC feedback board both connected into a mounting bracket. Refer to the section entitled Connecting Feedback for details on the high–resolution CNC feedback board and refer to the section entitled 9/440HR CNC Wiring Board for details on the interconnecting wiring board. For details on the drive/power portion of the 9/440HR system module, refer to your 1394 Digital AC Multi-Axis Motion Control System Users Manual (publication 1394-5.0) and the section entitled Power Terminal Block Connection.

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- Axis Module - Connect up to four axis modules to the 9/440HR CNC/Drive system (depending on your system module selection). Axis modules convert the DC power supplied by the system module to a variable AC voltage (460V AC input provides 460 AC out, derated 380V AC input provides 380V AC out). This voltage will have controlled phase, amplitude, and frequency for regulating the speed, torque, and direction of the 1326AB AC Servomotors. The axis modules are available in a wide range of power ratings with continuous peak capabilities of 200% of continuous rating for short durations.

  Make motor connections for power, ground, brake, and thermal sensor to each axis module. Each 1326AB servomotor is wired to its own axis module.

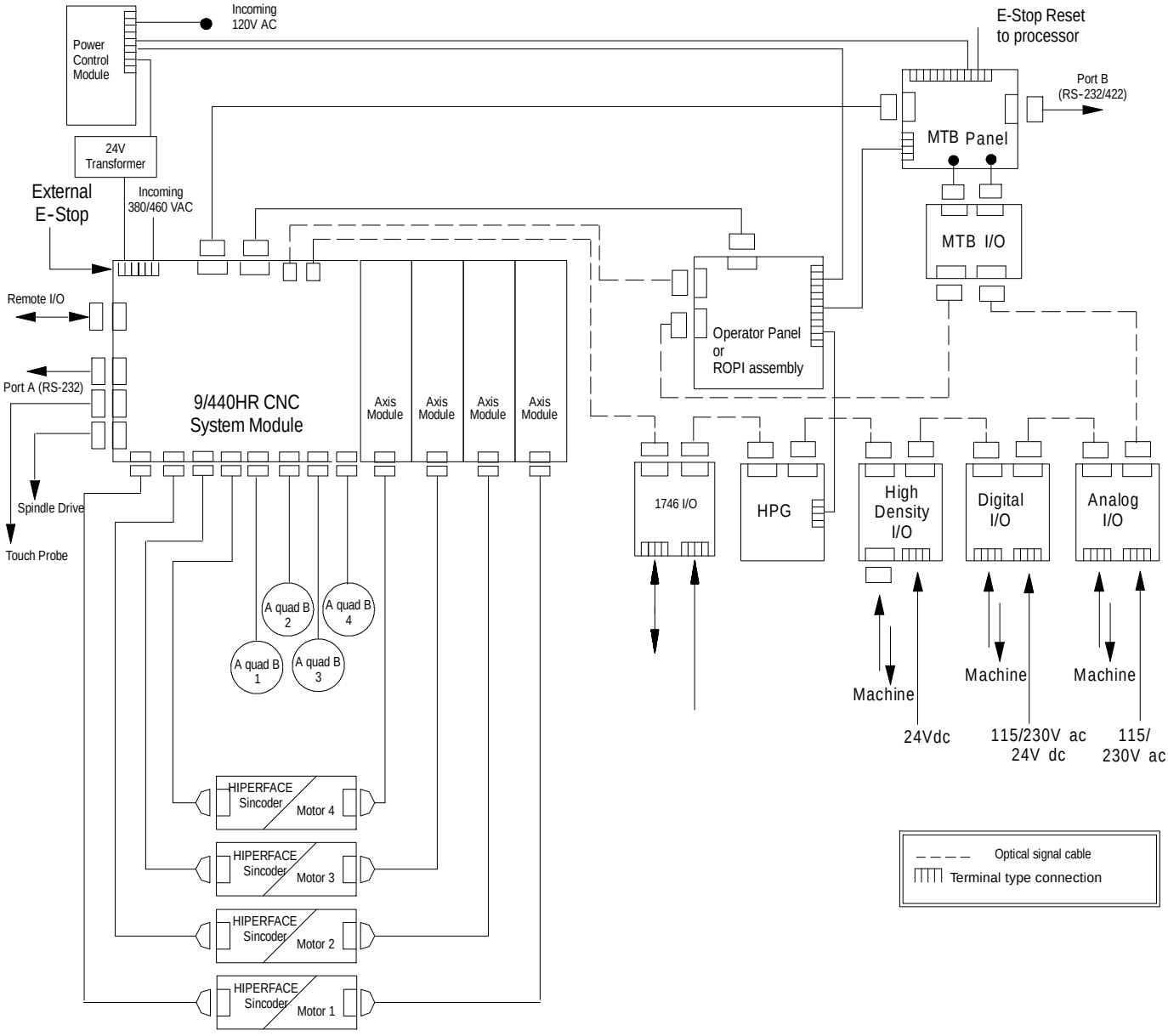


- 1326AB motors are described in the 1326AB Servomotor Product Data (publication 1326A-2.9). The 1326AB series of motors operate at either 460V AC or 380V AC. Connection of these motors is made directly to the Axis Module.

  Each 1326AB motor can be equipped with incremental or absolute high–resolution feedback devices that use the HIPERFACEÒ electrical interface. An external A quad B feedback device can also be used for positioning feedback. These high–resolution feedback devices are connected to the feedback board found in the system module.

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Figure 5B.1
9/440HR System Overview

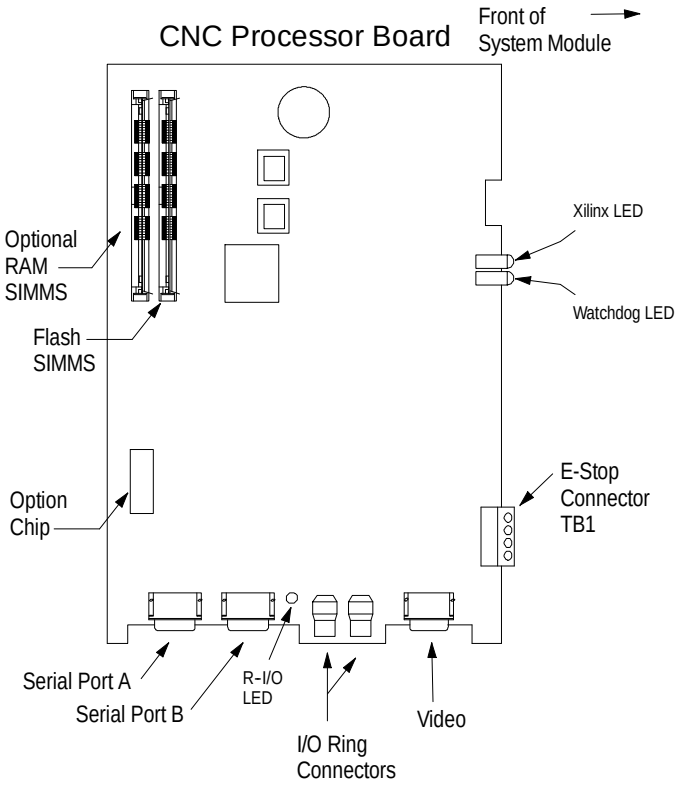


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5B.2
CNC Processor Board

The CNC processor board contains the main CPU. It provides connection for the 9/Series:

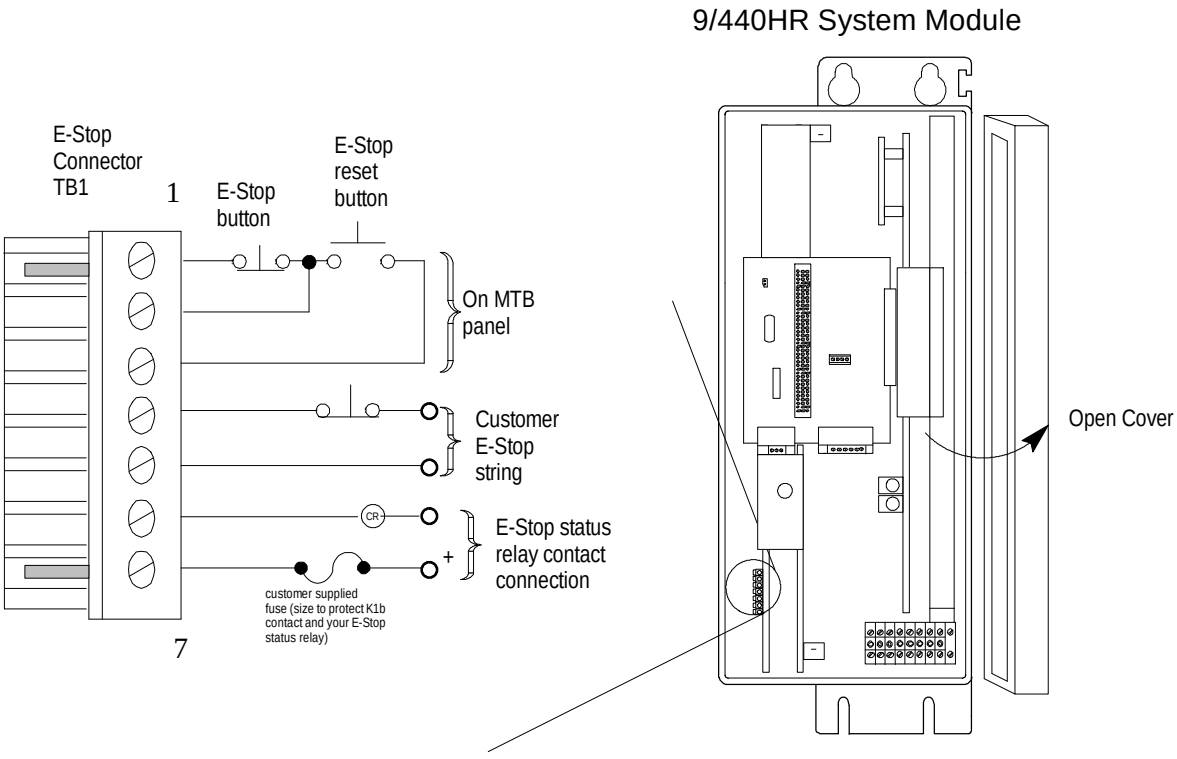
- fiber optic I/O ring
- E-Stop string
- connection to peripheral devices (two serial ports: A and B)
- video connection



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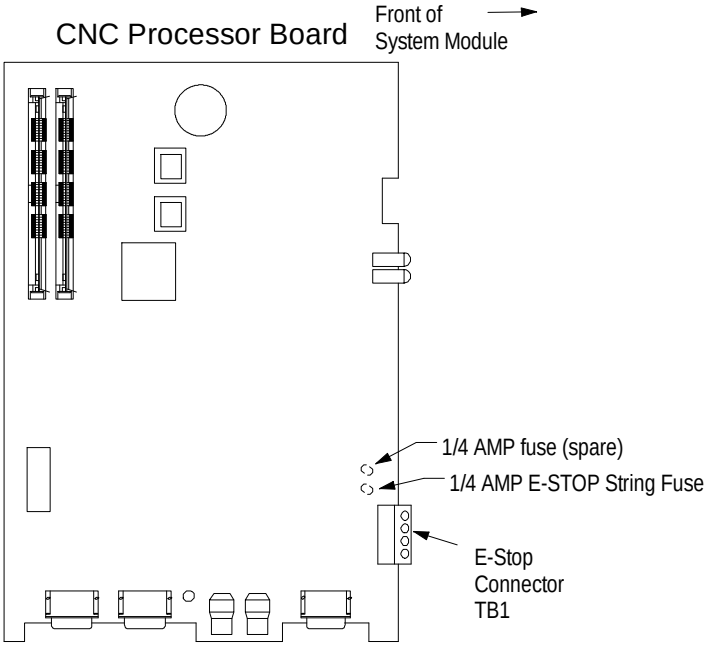
E-Stop Plug

Connection of the E-Stop string is shown in the following figure. More details on E-Stop connections to the 9/Series are given on page 6-1.



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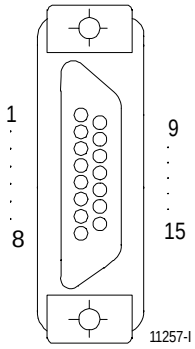
The E-Stop string is a 12V dc string protected by a .25 AMP 115 V fuse located on the 9/440HR CNC processor board. You must remove the CNC assembly from the system module to replace this fuse (see page 15B-58 for details).



Video Monitor Connector

The video monitor connector is used to interface the video monitor with the control. Figure 5B.2 shows this connector and lists the pin assignments.

Figure 5B.2
Video Monitor Connector-J8 (has pin sockets) and Pin Assignments



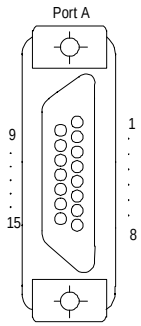
Pin No.	Signal Name	Pin No.	Signal Name
1	GND (SHIELD)	9	RED (L)
2	RED (H)	10	GREEN (L)
3	GREEN (H)	11	BLUE (L)
4	BLUE (H)	12	NC
5	NC	13	CLOCK (L)
6	CLOCK (H)	14	H-SYNC (L)
7	H-SYNC (H)	15	V-SYNC (L)
8	V-SYNC (H)		

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RS-232 Port (Port A)

Serial port A is used to transmit data to and from peripheral devices. It is configured for RS-232 communications only. Figure 5B.3 shows this connector and lists the pin assignments of Port A. For more information on the signals of each pin, refer to page 8-2.

Figure 5B.3
Port A-J6 (has pin sockets) and Pin Assignments



Pin	Assignment
1	Chassis GND
2	Send Data
3	Receive Data
4	Request to Send
5	Clear to send
6	No connection
7	Signal GND
8-15	Not Used

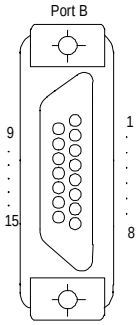
Port B

Serial port B transmits data to and from peripheral devices. Port B can be configured for either RS-232 or RS-422 communications using the softkeys on the operator panel (see your 9/Series Operation and Programming manual). Figure 5B.4 shows this connector and lists the pin assignments of Port B.

The MTB panel may have the optional serial interface connector mounted on it. This connector provides an external interface port for RS-232 or RS-422 interface from a peripheral to the control. It communicates with ports A or B with cable C07. Refer to the page 7A-22 for additional information on cable C07. For more information on the signals of each pin, refer to page 8-7.

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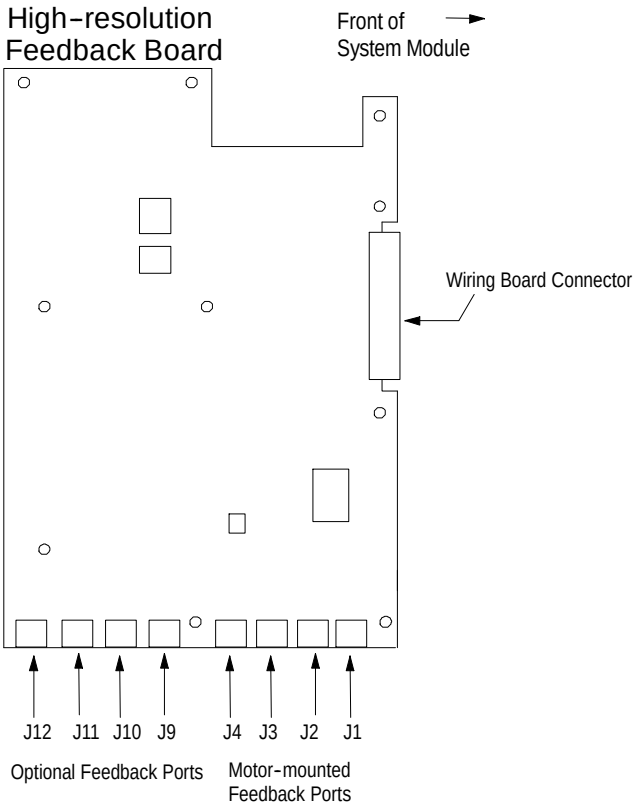
Figure 5B.4
Port B-J7 (has pin sockets) and Pin Assignments



Pin	Assignment	Pin	Assignment
1	Chassis GND	9	Send Data B
2	Send Data A	10	Receive Data B
3	Receive Data A	11	Request to Send B
4	Request to Send A	12	Clear to Send B
5	Clear to Send A	13	Data Set RDY B
6	Data Set RDY A	14	Data Term RDY B
7	Signal GND	15	Not Used
8	Data Term RDY A		

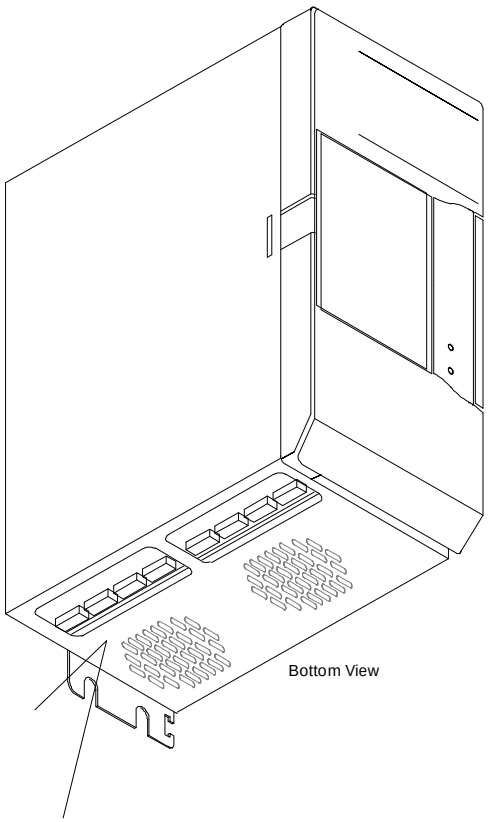
5B.3 Connecting Feedback

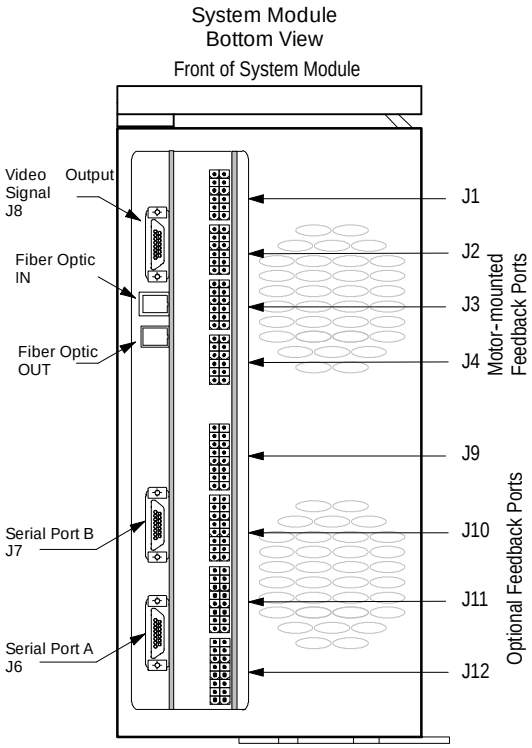
The high–resolution feedback board is used to receive feedback from the devices on the 1326AB motors and from the external high–resolution feedback devices. The full 9/440HR system can support up to eight feedback devices.



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Important: Each feedback port must be configured in AMP to identify which axis the feedback is from as well as the type, direction, and resolution of the feedback. Refer to your 9/Series AMP Reference Manual for details.





Note: The number and type of available feedback ports supported on your 9/440HR system are defined by the options that you purchased through the factory. To determine which options are enabled on your system, refer to the table on page 5B-2.

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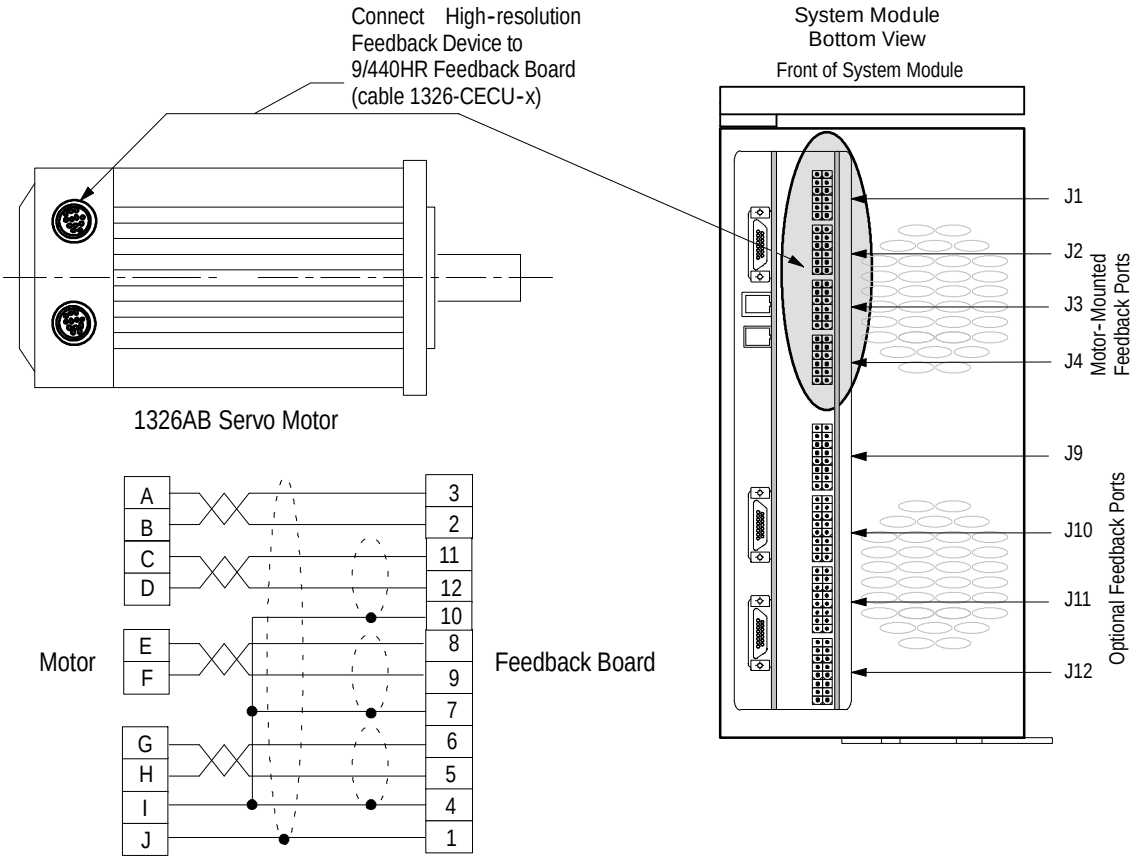
Maximum Axis Speeds

Axis feedback resolution (for 1326AB motors with high–resolution feedback devices) for single (SinCoder) and multiturn (SinCos) absolute high–resolution feedback devices is selected in AMP. The axis feedback resolution is 2,097,152 counts/rev or 1,048,576 counts/rev, respectively. The maximum motor RPM for both devices is based on the maximum speed on the 1326AB motor plate found on the side of your motor's housing. Actual final axis speed is based on gearing and lead screw pitch.

5B.3.1 Connecting the 1326AB Motor- mounted Feedback Device

The 1326AB motors are equipped with devices used to generate velocity feedback and provide motor commutation. These devices can also be used as positioning devices for the axis. Resolution of the high–resolution feedback devices depends on the motor type (SinCos or SinCoder feedback) your system requires.

The high–resolution feedback device's feedback is wired directly from the motor–mounted high–resolution feedback device to the 9/440HR Feedback board found in the system module. This cable can be purchased directly from Allen-Bradley (cat. no. 1326-CECU–x).

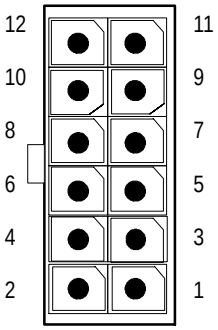


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Important: Not all system modules have each of the eight feedback ports enabled. The number and type of available feedback ports supported on your 9/440HR system are defined by the options you purchased through the factory. To determine which of the eight feedback ports are enabled on your system, refer to page 5B-2.

Important: The 9/440HR feedback device is capable of achieving a maximum of 2,097,152 cnts/mm (53,267,660.8 cnts/in.). Exceeding this number of feedback counts forces your system into E–Stop, causing an error message to display.

Figure 5B.5
Connecting the 1326 HIPERFACE Motor-mounted Devices on the 9/440HR CNC/Drive



View of connector on the end of the feedback cable

Pin	Signal	Description	Wire Color
1	Overall Shield	PE	Green/Yellow
2	Supply GND	Encoder Supply Ground	White
3	Supply Power	Encoder Supply Power [1]	Black
4	Wire Pair Shield	PE	Clear
5	RS485_LO	Serial Data Low	Green
6	RS485_HI	Serial Data High	Black
7	Wire Pair Shield	PE	Clear
8	CHB_LO	Feedback Device Channel B Low	Black
9	CHB_HI	Feedback Device Channel B High	Blue
10	Wire Pair Shield	PE	Clear
11	CHA_LO	Feedback Device Channel A Low	Black
12	CHA_HI	Feedback Device Channel A High	Red

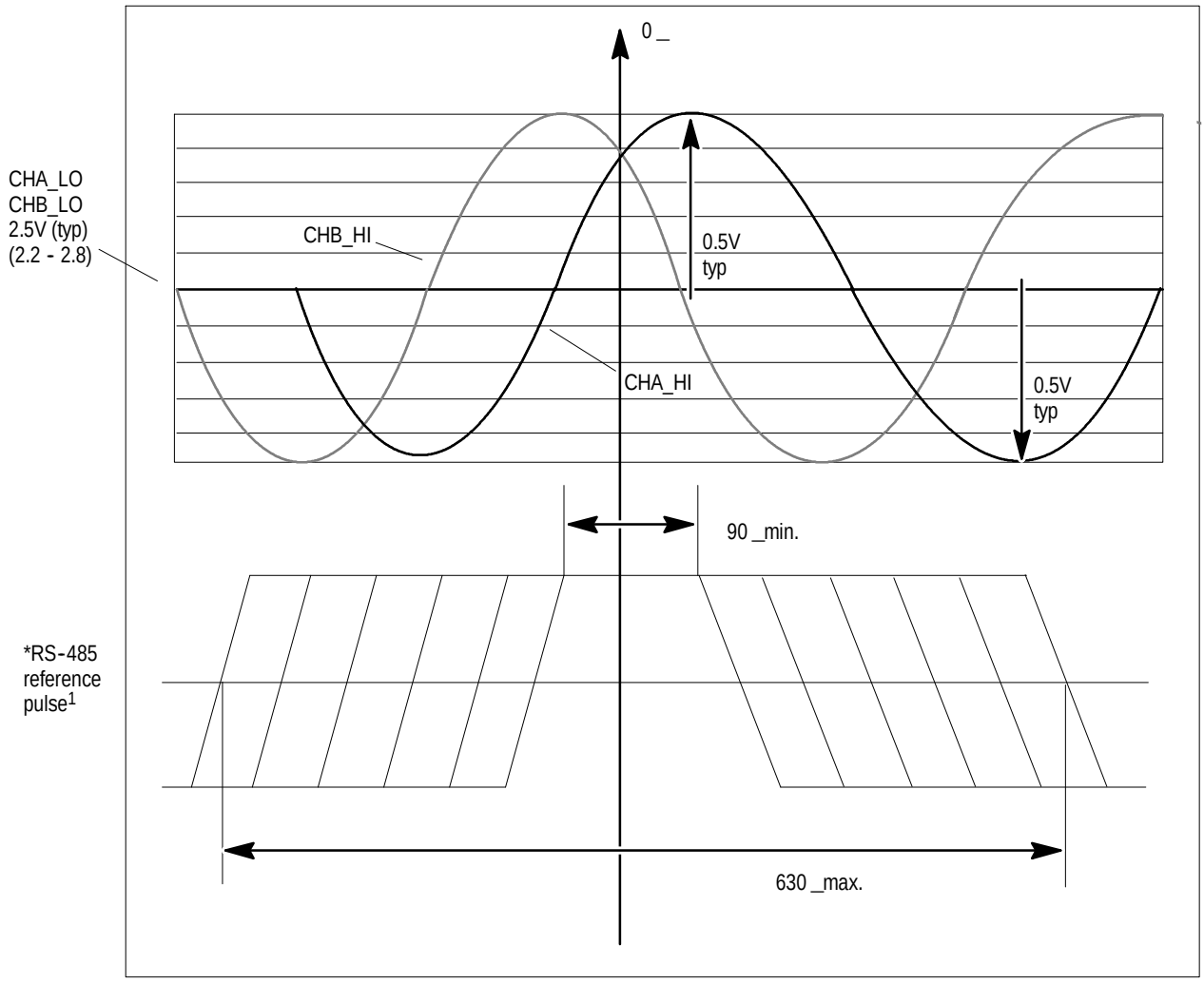
[1] HIPERFACE devices (J1–J4) use 9.7V. A quad B devices (J9–J12) use 5Vdc.

ATTENTION: You cannot mount an auxiliary feedback device to the rear of a 1326AB motor. By removing the back cover of the motor, you will void the motor warranty and possibly permanently disable it.

ATTENTION: Only auxiliary feedback devices are replaceable. HIPERFACE devices are permanently mounted by the factory and should not be removed. By removing it, you will void the warranty and possibly permanently disable it.

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Figure 5B.6
Signal Specification of HIPERFACE Devices



[1]The reference pulse signal is output once per revolution on the RS485 interface, after power up initialization.

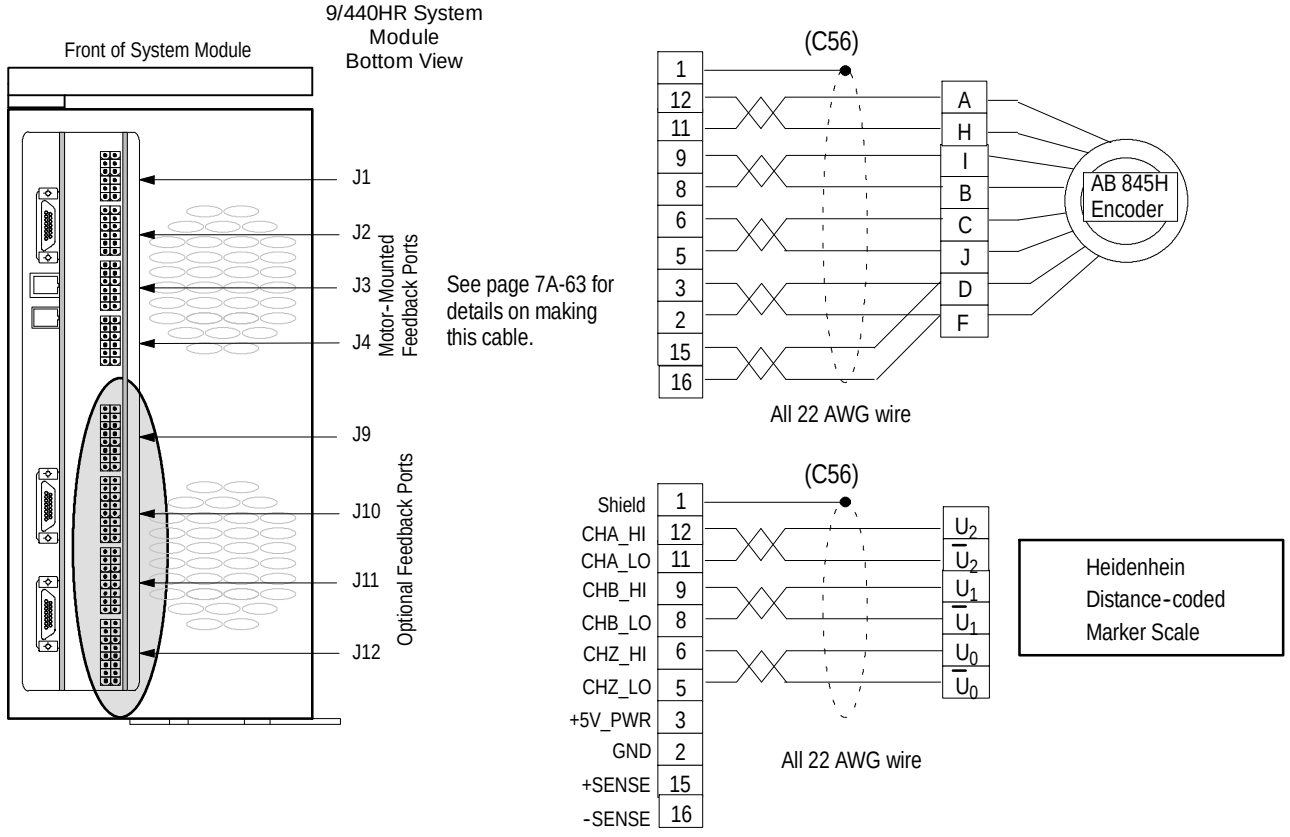
During the power up initialization, the RS485 channel is used to determine:

- rotational position for incremental HIPERFACE devices
- absolute position and rotational position for absolute HIPERFACE devices

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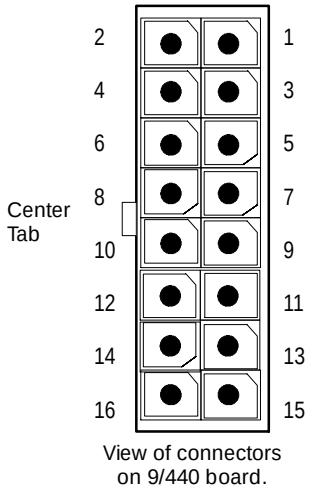
5B.3.2 Connecting A Quad B Optional Feedback Ports

High-resolution feedback device ports J9 through J12 are intended for systems that use either spindles with position feedback, to provide positioning feedback if you are using optional feedback for one of the 1326AB servo motors, or to provide feedback for an analog servo you are controlling from one of the analog output ports. Up to four optional A quad B ports are available.



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Figure 5B.7
Pin Configuration for the Encoder Connectors on the 9/440HR CNC/Drive



View of connectors on 9/440 board.

Pin	Signal	Description
1	Shield	PE
2	GND	Encoder Supply Ground
3	+5V PWR	+5V Encoder Power Supply
4	Shield	No connection
5	CHZ_LO	Feedback device Channel Z
6	CHZ_HI	Feedback device Channel Z
7	Shield	No connection
8	CHB_LO	Feedback device Channel B
9	CHB_HI	Feedback device Channel B
10	Shield	No connection
11	CHA_LO	Feedback device Channel A
12	CHA_HI	Feedback device Channel A
13	N/C	No connection
14	N/C	No connection
15	+SENSE	Encoder Sense Power
16	-SENSE	Encoder Sense Ground

Important: For proper operation, you must connect pins 15 and 16 to the supply loading device.

Compatible Optional Feedback Devices and Spindle Feedback

This section discusses optional feedback devices that are compatible with the 9/440. The 9/440HR supplies these devices with +5V power. Feedback devices must return a 5V-compatible output signal to the control.

This feedback device can be used to provide:

- auxiliary position feedback - Digital systems require the motor-mounted feedback device, provided on our standard digital servo motors, be used for velocity-loop feedback. This motor-mounted feedback device can also be used to close the position loop or an additional auxiliary feedback device, as discussed in this section, can be used for the position loop. You can not replace or bypass the motor-mounted feedback device. The motor-mounted feedback device must be used for velocity feedback and to attain proper motor commutation on digital servo systems.

- spindle feedback - Provide position feedback for your spindle using these high-resolution feedback device ports.

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- analog servo feedback – If you are using one of the two analog ports to control an axis these high–resolution feedback device ports can be used for its position feedback.

The 9/440HR supports:

Feedback Device	Additional hardware
Allen-Bradley 845H Series Differential Encoders	--
Sony Magnascale Model GF-45E	Board-type detector model MD10-FR
Heidenhain Model 704	External interpolation and digitizing model EXE602 D/5-F
Futaba Pulscale Model FM45NY	PCB interface Module model CZ0180 with cable PCB020EA
Heidenhain Distance-coded Marker	LS176[1]

[1]Refer to your vendor's catalog for a complete listing of additional hardware you may need to support distance-coded markers.

Other feedback devices can be compatible if they comply with the specifications listed in Table 5B.A. Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

The following table lists feedback specifications for a differential encoder however, this information can be interpreted to select an appropriate linear scale.

Table 5B.A
Encoder Specifications

Item	Specification
Maximum Encoder Channel Frequency (ECF)	Use the following equation to determine the maximum channel frequency $\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90\text{-Eq}}\right)} \times 1.15$ Where: Clock - is the Control's Feedback Clock Frequency: 5×10^6 - for 9/230, 9/440, and three-axis servo cards. 2.3×10^7 - for 9/260 or 9/290 systems using a four-axis servo card E_Q = Quadrature Error in Degrees 1.15 = Our minimum recommended safety factor As long as the actual feedback channel frequency does not exceed the maximum channel frequency calculated above, the servo module should process the feedback data without a quadrature fault.

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Maximum Axis Speed	Use the following equation to determine the maximum axis speed. Note that this equation does not take into consideration any mechanical deficiencies in the encoder or motor. It is only concerned with the 9/Series capability of receiving feedback. Refer to the manufactures specs for encoder and motor hardware RPM limitations. $\frac{(ECF \times 60)}{(E)(N)(P)} = \text{Maximum Axis Speed}$ Where: Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute) ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec. E = the number of encoder lines between markers for your encoder E = 1024 sin/cos cycles per revolution for HR Single-turn Absolute (SinCoder) E = 512 sin/cos cycles per revolution for HR Multiturn Absolute (SinCos) N = the ratio of encoder turns to ballscrew turns P = the ballscrew pitch (turns per inch or turns per millimeter. For rotary axes, substitute the appropriate gear ration for N and P in the equation above to solve for a max RPM in revolutions per minute. If the maximum axis speed resulting from this equation is less than you would like, you may need to sacrifice some axis resolution by selecting an encoder with fewer lines between markers.
Input Signal	Encoder feedback must be differential format with 5V-compatible (9.7V for HIPERFACE feedback devices) output signals, single-ended open-collector outputs are not supported, i.e., channels A, B, and Z must have source and sink current capability, 8830 line driver outputs or equivalent.
Current Drawn from Encoder by Servo Module	20 mA maximum; 50 mA peak/differential output[1]
Marker Channel	Narrow (gated), Wide (ungated), and Distance-coded type markers are supported.
Encoder Cable Length	Refer to chapter 7 for details on cabling.

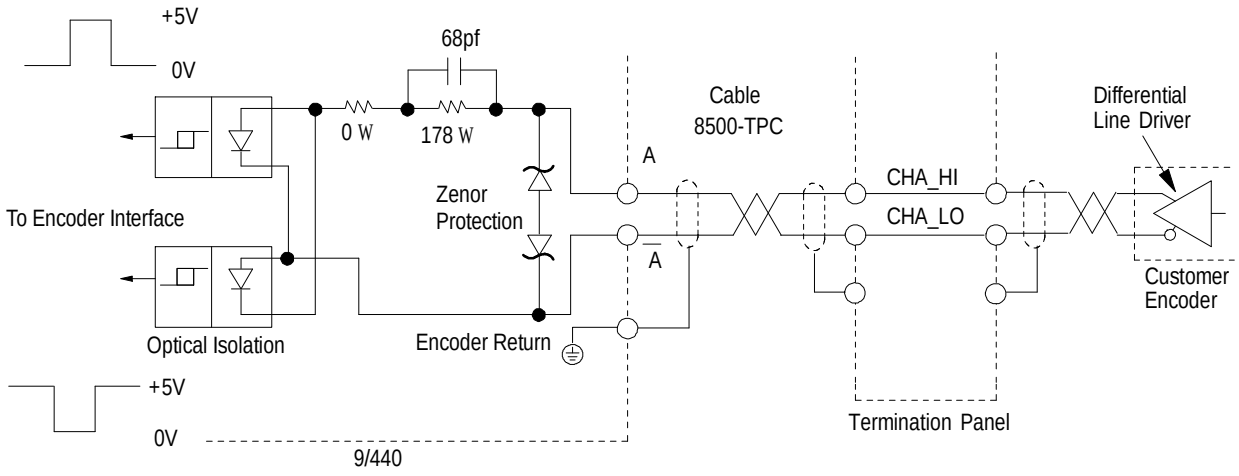
[1]Applies to A quad B feedback ports (J9 - J12) only. Current drawn is rated for each channel (A and B) output.

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Wiring an Incremental Feedback Device

Figure 5B.8 shows an incremental feedback device equivalent circuit for feedback channel A.

Figure 5B.8
Incremental Feedback Device Equivalent Circuit for
A Quad B High-resolution Feedback Devics (J9 - J12)



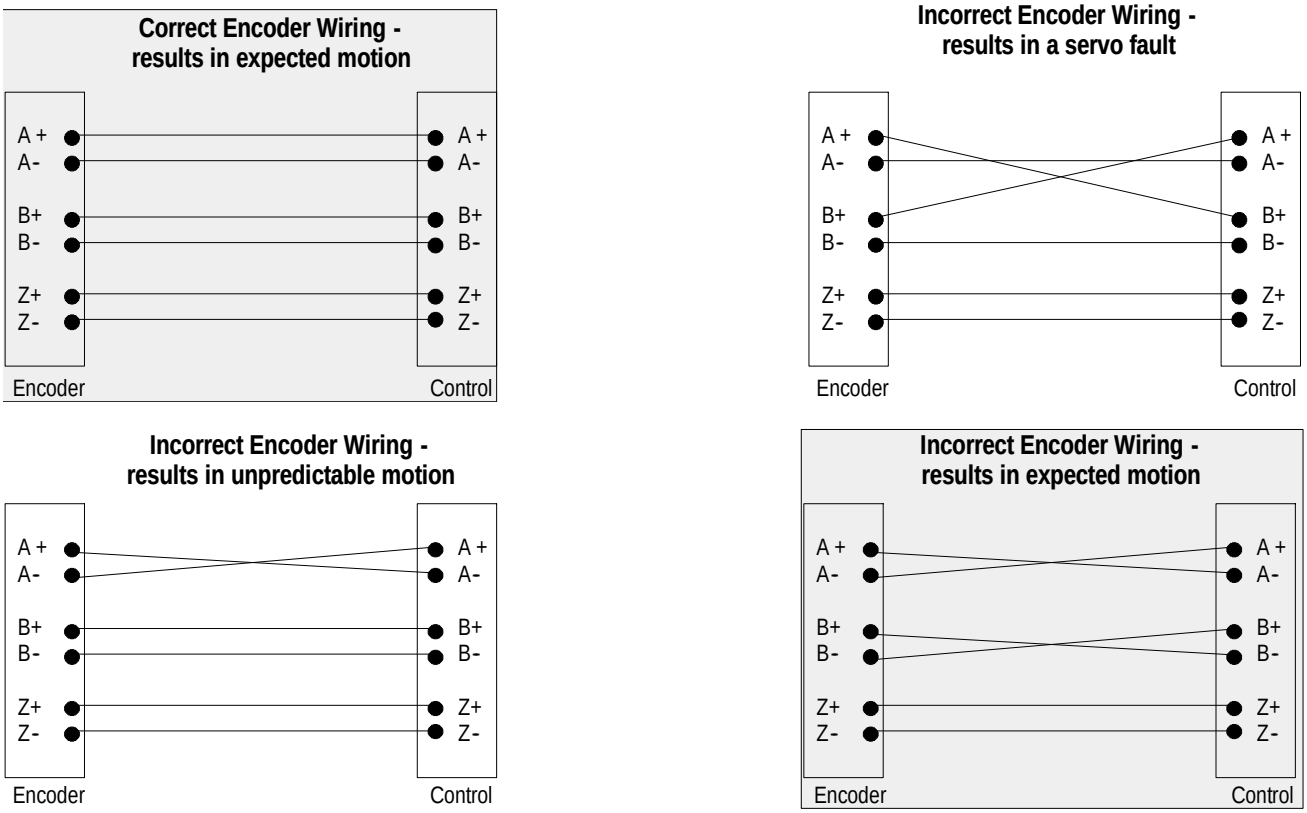
Wiring Position Feedback

Feedback devices used with the control must be configurable such that the marker Z is true at the same time that channels A and B are true. If you are using an Allen-Bradley 845H encoder this requirement will already be met if you wire them as shown in the cable diagrams on page 7A-63.

If you are using an encoder type feedback device other than the Allen-Bradley 845H encoder, then use the following examples to determine the correct wiring:

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Figure 5B.9
Examples of Correct and Incorrect Encoder Wiring



Important: Since positive and negative axis directions can be assigned without regard to encoder rotation directions, it is possible for the feedback direction to be "backwards". This is easily corrected before attempting to command axis motion through the AMP parameter Sign of Position Feedback**.** Refer to your AMP reference manual for more information.

5B.4
9/440HR CNC Wiring Board

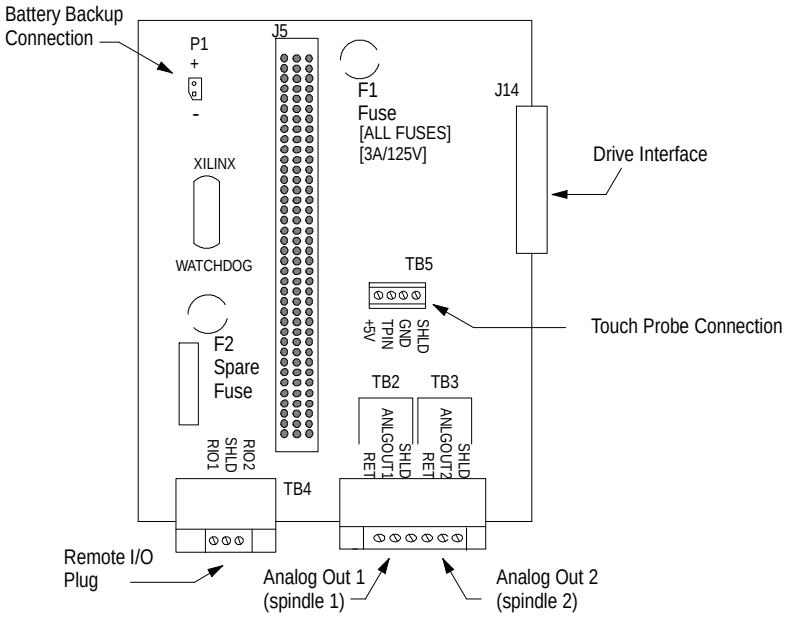
The CNC wiring board provides an easy location to wire additional hardware. It provides connection for:

- analog outputs (typically for spindles)
- touch probe
- remote I/O
- interface between the CNC assembly and power assembly

The main fuse for the 9/440HR CNC assembly is also located on this board.

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Wiring Board



5B.4.1 Wiring a Touch Probe to the 9/440

The 9/440HR system module touch probe connection is made to connector TB5 on the wiring board. Table 5B.A shows the location of this connector and lists its terminal assignments.

Wiring Board

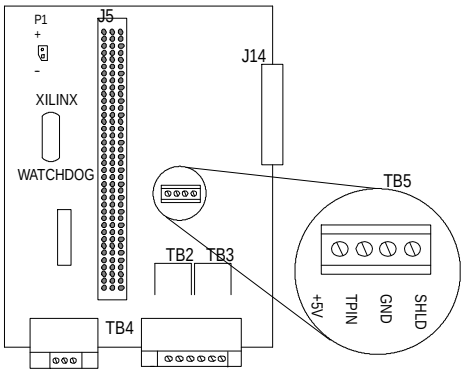


Table 5B.A
TB5 Connector , 4 Plug-type Terminal Block Connections

Terminal	Description	Signal Destination
+5V	Probe Power	Touch Probe
TP IN	Probe Fired Signal[1]	Servo Position Latch
GND	Touch Probe Common	Touch Probe
SHLD	Probe Shield	connect at module only

1 The True level (voltage transition the probe fires) is either "HIGH" or "LOW" as defined by the AMP parameter PROBE TRANSITION. Refer to your AMP reference manual for more information.

Important: The touch probe connector supports only +5V probing device applications.

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The time delay between the 9/440HR receiving the touch probe trigger and latching the current axis position is negligible. However, you should be aware of any external delays that may introduce position "staleness" in the probing operation, especially at high probing speeds.

It is a good idea to establish an offset for the distance between the actual location, as sensed by the probe at a very low speed, and the location sensed by the probe at the intended probing speed. The offset can then be added or subtracted to any future values obtained through probing. This helps make sure that if there are any external delays in the trigger signal, the position staleness shows up as a constant position offset error and is removed from the measurement (assuming the external delay is repeatable).

The touch probe interface is intended for use with units that offer 5V dc compatible solid state relay outputs (see Figure 5B.10). Other configurations can be supported as long as the user operates within the published electrical specifications.

The touch probe circuitry resident on the 9/440HR only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, position data is captured by the module, and additional occurrences of the trigger signal have no effect until the probe is re-enabled under program control.

Refer to the 9/Series CNC AMP Reference Manual, publication 8520-6.4, for more information.

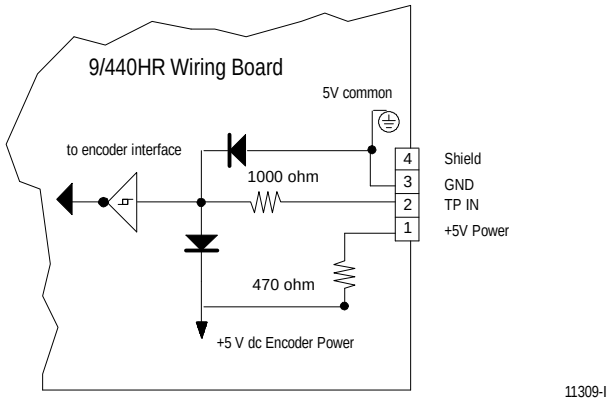


ATTENTION: From a safety standpoint, it is preferred that the touch probe relay be closed at rest and open when the touch probe stylus deflects. Then, if a wire breaks or shorts to ground, it will appear to the system as a probe fired and the probing cycle in process will stop commanding motion towards the part. The user should make every effort towards the fail-safe operation of the touch probe. Not all vendor's touch probe control units conform to this safety consideration.

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Figure 5B.10 shows the internal servo module circuitry that interfaces to the touch probe connector. It is shown here to assist you in determining whether your touch probe hardware is compatible.

Figure 5B.10
Internal Circuitry Supporting the Touch Probe



The following table indicates probing threshold voltages. Maximum Input Threshold (critical if the control has been configured to fire on the falling edge of the probe signal) indicates the voltage that the probe signal must fall below to be considered as “fired”. Minimum Input Threshold (critical if the control has been configured to fire on the rising edge of the probe signal) indicates the voltage that the probe signal must rise above to be considered as fired

Probe Thresholds	Voltage at Threshold
Minimum Input Threshold (probe circuit)	3.06 (min)
Maximum Input Threshold (probe circuit)	2.18V dc (max)

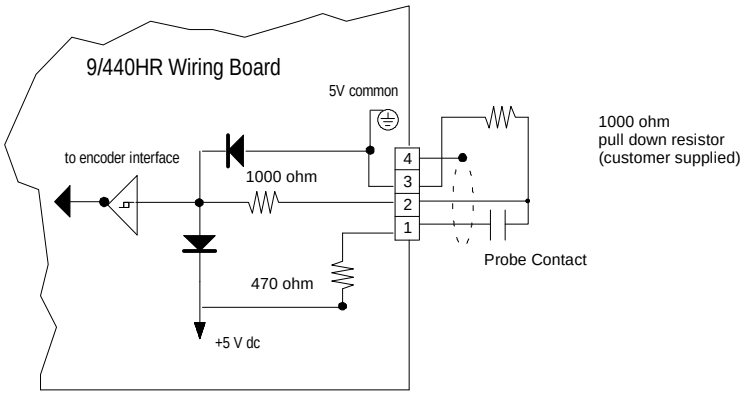
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To avoid misfires use the threshold values from the above table to determine the necessary signal voltage for steady state operation (probe not fired). For probes configured to fire on the falling edge the steady state voltage must remain above 3.06 volts. For probes configured to fire on the rising edge the steady state voltage must remain below 2.18 volts.

Wiring a Probe for Rising Edge Configurations

Typical wiring of a simple contactor type touch probe configured to fire on the rising edge of the probe signal, requires the addition of a 1000 ohm pull down resistor. Figure 5B.11 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

Figure 5B.11
Typical Wiring of a Touch Probe Configured for Rising Edge Trigger

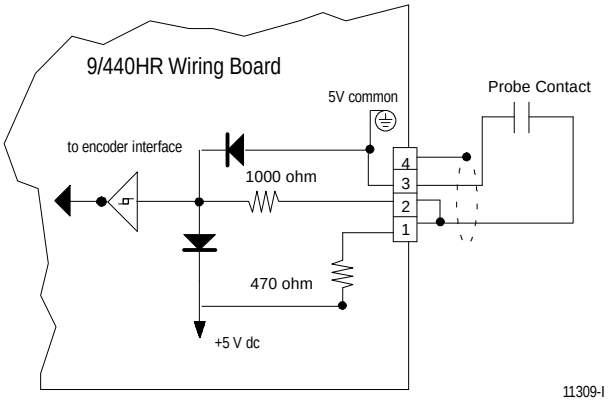


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Wiring a Probe for Falling Edge Configuration

Figure 5B.12 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

Figure 5B.12
Typical Wiring of a Touch Probe Configured for Falling Edge Trigger



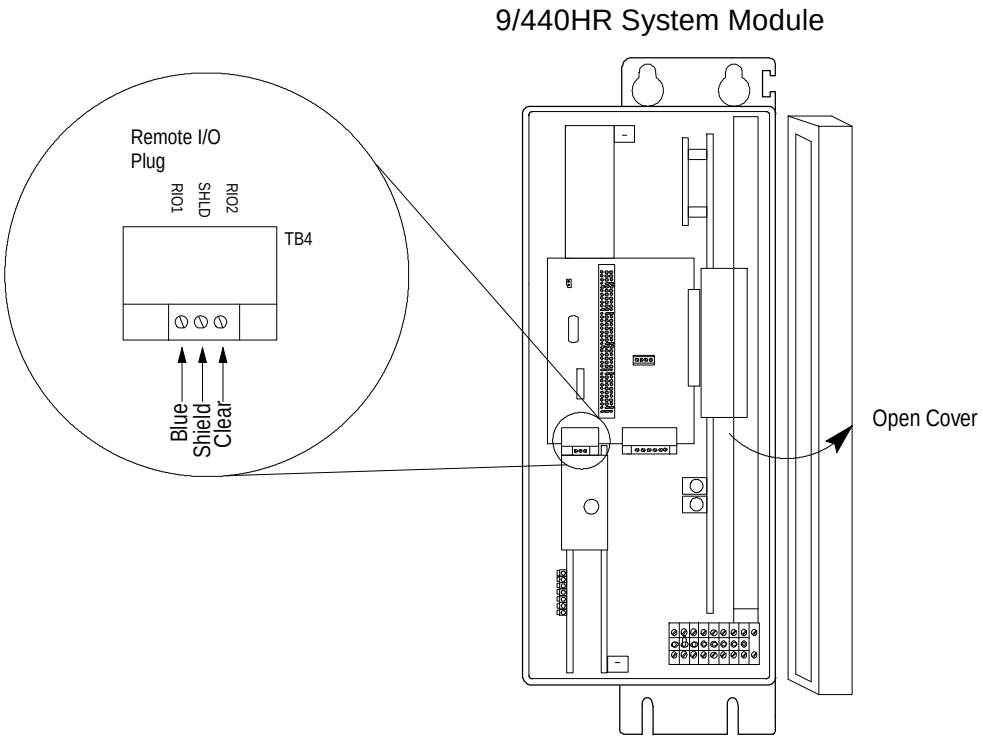
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5B.4.2 9/440HR Remote I/O Connection

The remote I/O circuitry and connector are integral parts of the wiring board in the 9/440HR system module. Figure 5B.13 shows the remote I/O connector mounted on the 9/440HR wiring board.

Wire connections for the remote I/O communications are made through the TB4 NODE ADAPT connector. Connect the wires for remote I/O as shown in the following figure. Refer to your 1771 I/O documentation for details on making remote I/O connections.

Figure 5B.13
Remote I/O Connector in System Module

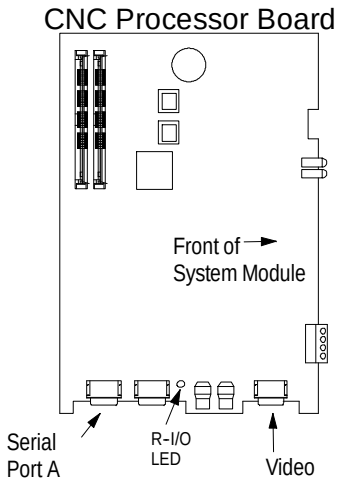


9/440HR Remote I/O LED

Assuming you have:

- made all necessary remote I/O communication connections on your 1771 I/O network
- configured your remote I/O port for the remote I/O network in AMP
- written PAL to set $RMON true during the first PAL foreground execution, and to handle input and output words ($RMI1 – $RMI8 inputs to PAL and $RMO1 – $RMO8 outputs from PAL.)

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You are ready to start receiving and transmitting remote I/O information. An LED is provided on the 9/440HR CNC processor board and is visible from the bottom of the system module. As remote I/O responds to commands, you should see this LED pattern:

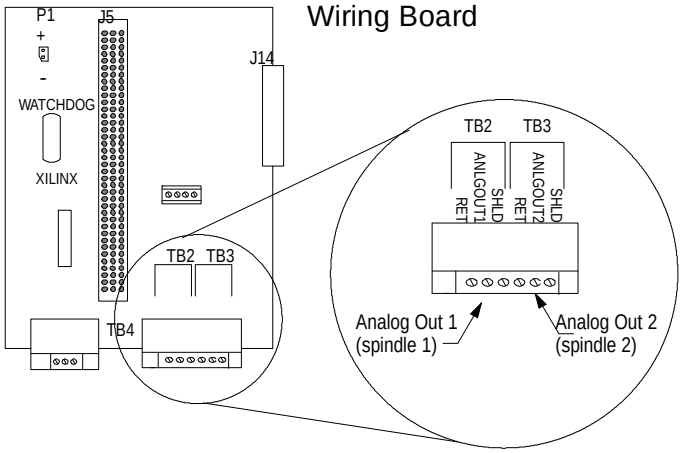
LED	Status	Description
Green R-I/O LED	ON	Active Link to PLC. This is the normal state when the RIO link is active.
	FLASHING	The remote I/O link is active but the PLC is currently in program mode.
	OFF	Remote I/O link is offline. The port is not being used, not configured in AMP correctly, not turned on with $RMON, or not attached to a 1771 device.

5B.4.3 9/440HR Analog Out (TB2 and TB3)

Two auxiliary analog outputs are provided through the connectors labeled TB2 and TB3 of the 9/440HR Wiring Board. These connectors are typically used to command external analog spindle drive systems but can also be configured in AMP to control additional analog servo systems. Figure 5B.14 shows the location of ANALOG OUT connector and lists terminal assignments of this connector.

Important: If positioning feedback is required for the spindle or analog servo system, its corresponding encoder feedback should be wired through one of the encoder feedback connectors and indicated as such in AMP.

Figure 5B.14
Terminal Block TB2 and TB3, Plug-type Terminal Block Connections.



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Connector	Description	Signal Destination
Analog Out	±10V Analog with no feedback	(typically spindle drive)
RET	Signal Return	(typically spindle drive)
SHLD	shield	connect at wiring board only

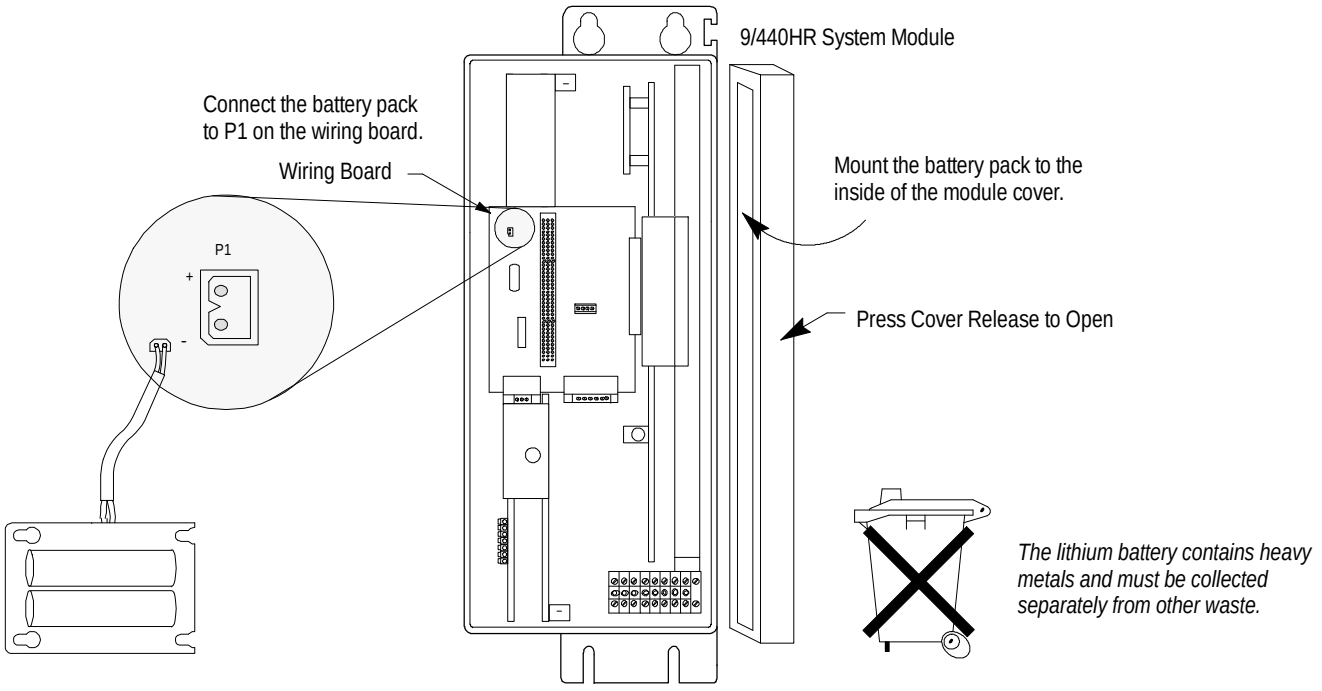
5B.4.4 Battery Backup

The memory for such items as part programs, tool offset/compensation data, and work coordinate offset data is stored on the processor board. In the case of a power failure, there is a super capacitor on the processor board that backs up this data for up to 5 days (at 40 °C) on systems without extended program storage. This super capacitor recharges within 1 hour of power turn on if completely discharged. If you want to extend this backup time install the lithium battery pack that supports the data for:

9/440HR Memory Option:	**Time (at 40 °C Discharge):**
standard	3 years
with extended program storage	1 year

This battery pack is connected to the lithium battery connector (P1) on the wiring board as shown in Figure 5B.15. Batteries and the battery cable are included with the battery replacement kit.

Figure 5B.15
Lithium Battery



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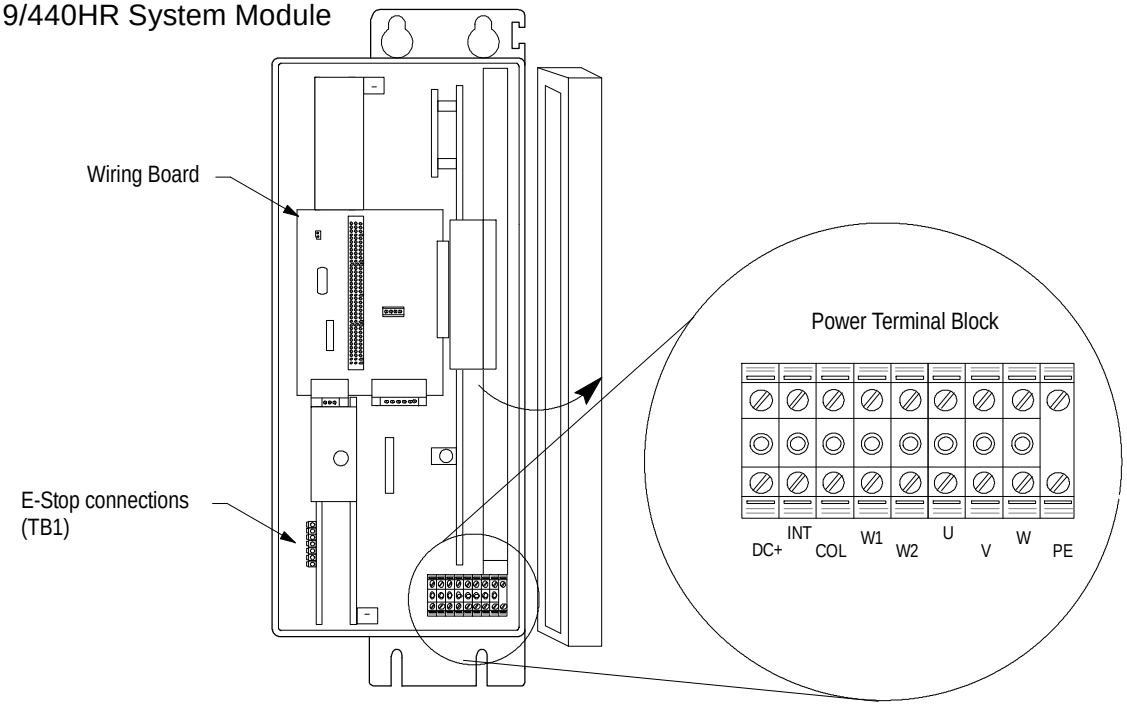
5B.5 Power Terminal Block Connection

All external power connections to the 9/440HR CNC/Drive are wired through the system modules power strip, located behind the front cover in the lower right corner. Input power is wired to this strip in two different voltages:

- 24 V Logic Power – this is 24 V AC or 24 V DC. The logic power is used to operate the processors in the system module, axis module logic boards, and power the encoders.
- Drive Power – this is 324-528 V AC, three phase, 50/60 Hz. The drive power is used to supply the drive portion of the 9/440HR the voltages necessary to power the axis modules and the servo motors.

To this Power Strip Connector	Connect:
W1	+24 V Logic Power
W2	24 V Logic Power common
U, V, W	380/460V AC, three-phase power (not phase sensitive)
PE	System Ground Bar
DC+, INT, COL	Shunt resistor connection. When the jumper exists between INT and COL the internal 200 W shunt is used. When using the optionally purchased 1000 W shunt the jumper is removed and the new shunt is installed between DC+ and COL.
All connectors on the power strip support a maximum of AWG 12 gauge solid wire.	

9/440HR System Module



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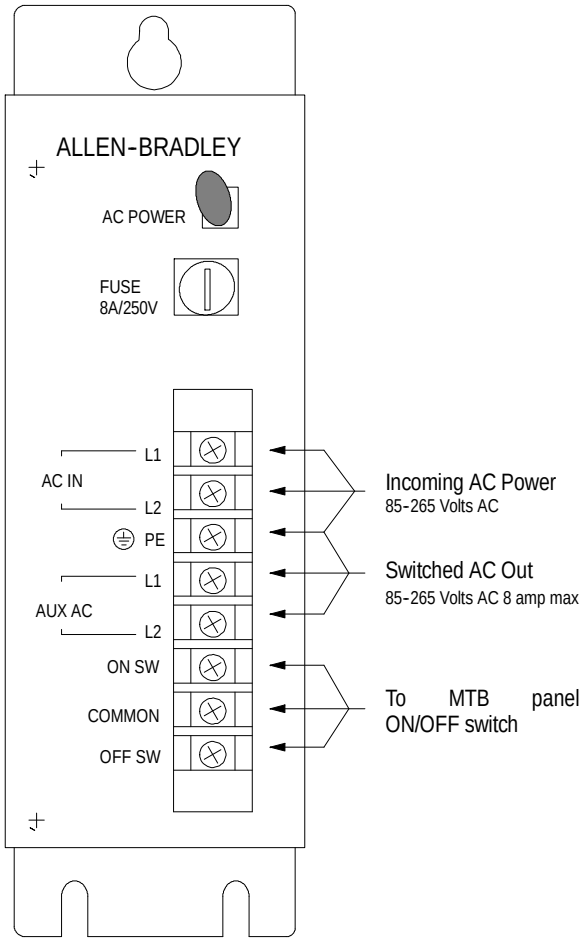
5B.5.1 On/Off Control and 24V Logic Power

24 Volt logic power is supplied to the 9/440HR to run the processor board and axis module logic boards. The 24 volts are provided from a customer supplied transformer. Specifications for this supply are:

Transformer Input Voltage	9/440HR Input Voltage Range (Transformer Output)	Number of Axis Modules			
		1	2	3	4
125/240 V AC (85-265 V AC @50/60 Hz)	24V ac (19 - 28V ac, single phase @50/60 Hz) or 24V dc (18.75 - 31.25V)	3.5 A	4.4 A	5.2 A	6.0 A

On/Off connections are made through the Allen-Bradley On/Off Control assembly (8520-OFC). This assembly allows connection to the standard MTB panel on/off switch and should be used to supply power to your 24 V transformer.

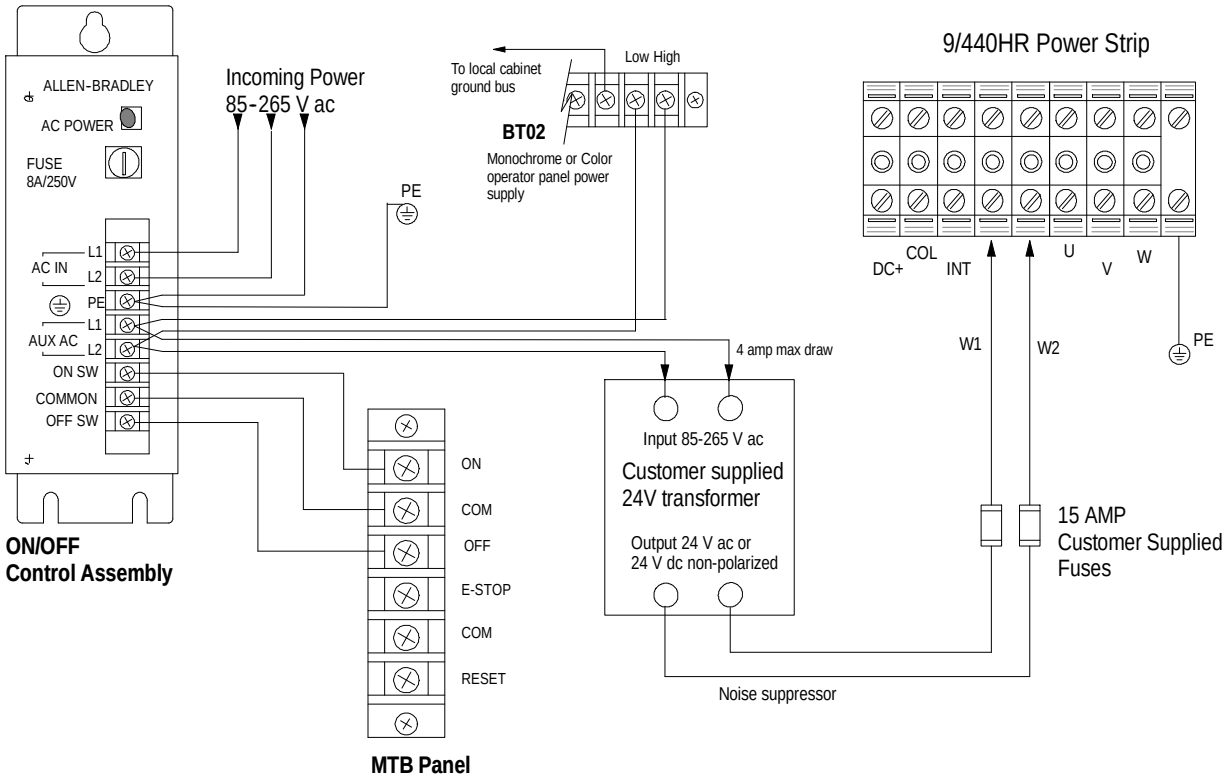
Figure 5B.16
On/Off Control Assembly



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Logic power should be wired so that if the 24 V is not available to the system module, it will open the drive contactors and disable 3 phase drive power (see Figure 5B.20).

Figure 5B.17
Connecting On/Off Power Control Assembly and 24V Transformer

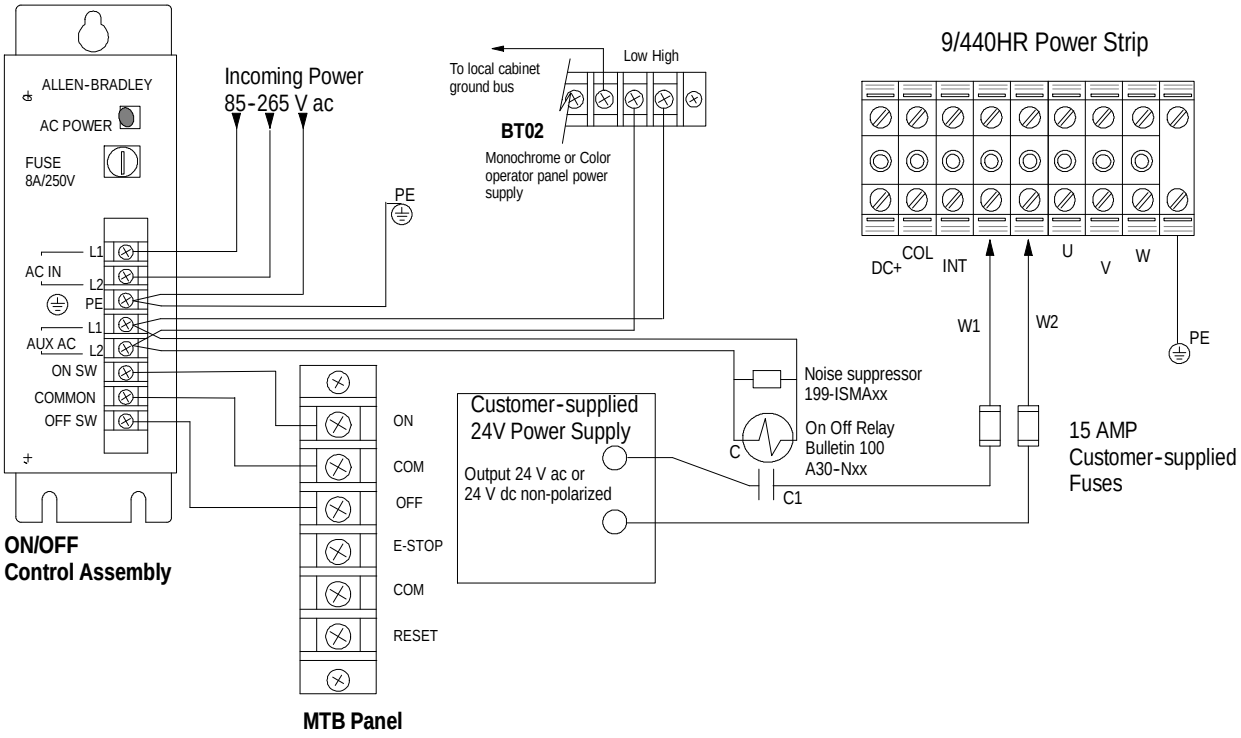


ATTENTION: You must make sure logic power (24V) is applied to the system module and the system module is out of E-STOP before you allow 3 phase power to be enabled.

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If 24 V power is required for other devices in your machine system, you can use a 24 V power supply in place of the 24 V transformer as shown in Figure 5B.18.

Figure 5B.18
Connecting On/Off Power Control Assembly and 24V Power Supply



5B.5.2 Drive Power Three-phase

Three-phase power to the 9/440HR must be 324-528 V AC, 50/60 Hz. The drive power is used to supply the drive portion of the 9/440HR the voltages necessary to power the axis modules and the servo motors.

All power connectors on the 9/440HR power strip accept AWG 12 gauge solid wire. Refer to local codes for required wire type and gauge.

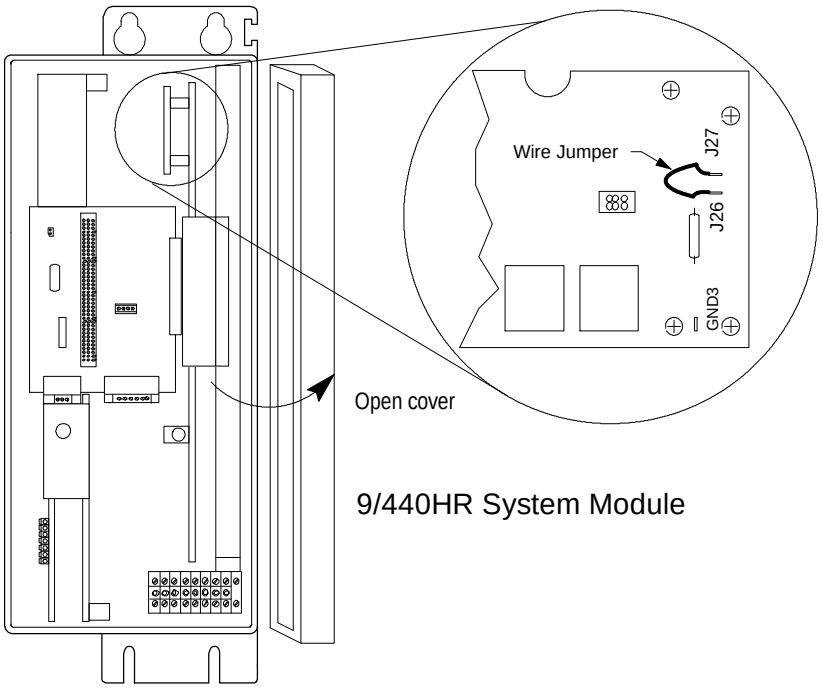
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Grounded vs Ungrounded Three- phase

The 9/440HR CNC/Drive comes from the factory set for three–phase grounded systems. If your facility uses an ungrounded three–phase 360/480 volt system, you must move a jumper in the 9/440HR system module. This jumper will connect an internal resistor that helps keep high voltage static, that can be typical of ungrounded three phase systems, from building up in the system module.

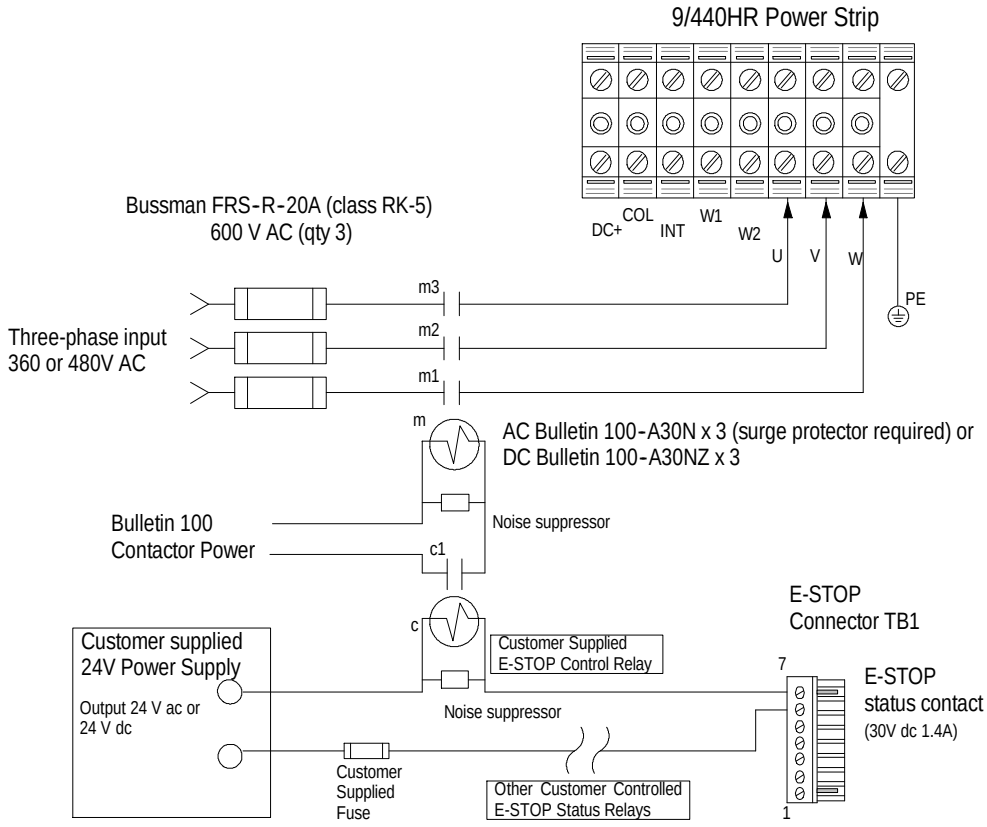
Jumper Setting	Three Phase Power
J27 to J26 (factory setting)	Grounded system
J27 to GND3	Ungrounded systems

Figure 5B.19
Three- phase Jumper



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Figure 5B.20
Recommended Connection of Three- phase Drive Power



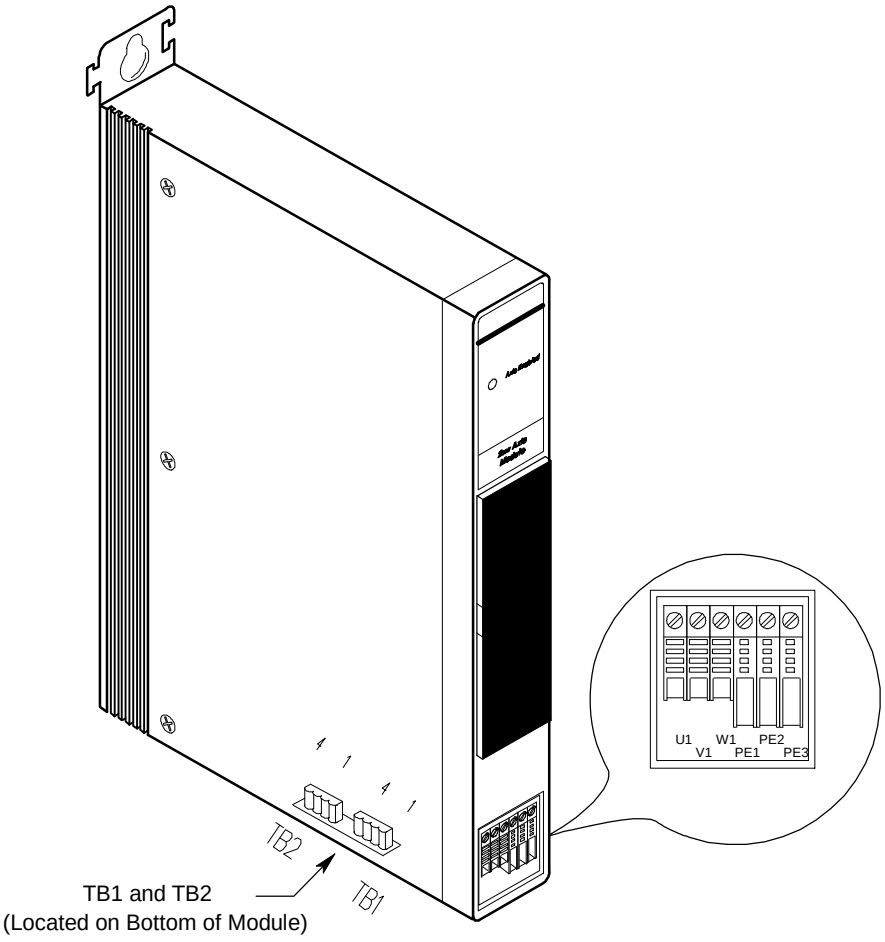
ATTENTION: Brake control should not be directly released by the E-STOP status relay (or your customer supplied E-STOP control relay). Brakes should only be released by the PAL logic when it has determined that the 9/440HR is in full control of the servo motors and the control is out of E-STOP. See the description of the PAL flag $PFLT.15 for detail on how to test drive status.

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5B.6
Connecting Axis Modules

The Axis Module provides terminating points for the motor power, thermal sensor and brake. Axis module wiring is identical for all module ratings. Refer to Figure 5B.21 and the paragraphs that follow for detailed information.

Figure 5B.21
Axis Module Connections



Motor Wiring

Allen-Bradley 1326-CPB1xxx cables must be used for connection to the motor. The motor wiring size is determined by the continuous and overload current requirements (RMS Duty Cycle), NEC and local codes. In general, motors operated with the 1394 should not require wire sizes larger than those accepted by the motor terminal blocks. In addition, the motor leads must be twisted throughout their entire length to minimize radiated electrical noise. The maximum motor wire sizes that the 1394 Axis Module terminal block will accept are dependent upon axis module selection (see your 1394 users manual).

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See page 5B-12 for details on high–resolution feedback device cables (1326-CECU–x).

1326AB servo motors have integral thermal protection. This contact must be connected in the E-STOP string for motor overload protection.

Connections are performed through the front panel terminal block as shown in Figure 5B.21. Refer to the information below and the Interconnect Drawings on page 5B-40 for further information.

Table 5B.B
Motor Power Terminations

Terminal	Description	Wire/Pin Number
U1	Motor Power A	1
V1	Motor Power B	2
W1	Motor Power C	3
PE1	Axis Ground	Ground Bar
PE2	Motor Ground	8
PE3	Overall Shield	7

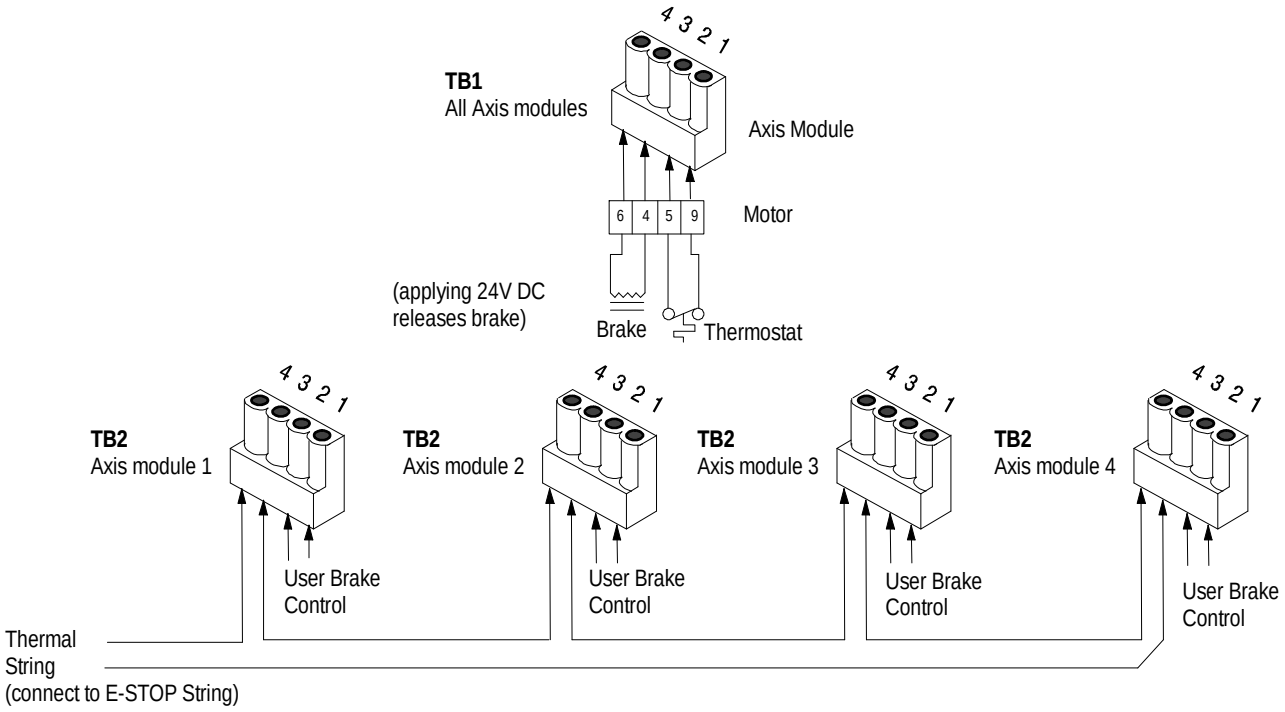
Thermal and Brake Leads

The motor thermal sensor and brake leads (if used) are connected to the Axis Module at TB1 & TB2. See Figure 5B.21 for location and Table 5B.C for terminations.

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Table 5B.C
Thermal Sensor and Brake Terminations

Terminal	Description	Wire/Pin Number
TB1-1, 2	Thermal Sensor Input from Motor Cable	string axis modules
TB1-3, 4	Brake 24V DC Input from Motor Cable	user brake
TB2-1, 2	Brake 24V DC To Brake Control	5, 9
TB2-3, 4	Thermal Sensor Output to Fault System	4, 6



ATTENTION: Brake control should not be directly released by the E-STOP status relay (or your customer supplied E-STOP control relay). Brakes should only be released by the PAL logic when it has determined that the 9/440HR is in full control of the servo motors and the control is out of E-STOP. See the description of the PAL flag $PFLT.15 for detail on how to test drive status.

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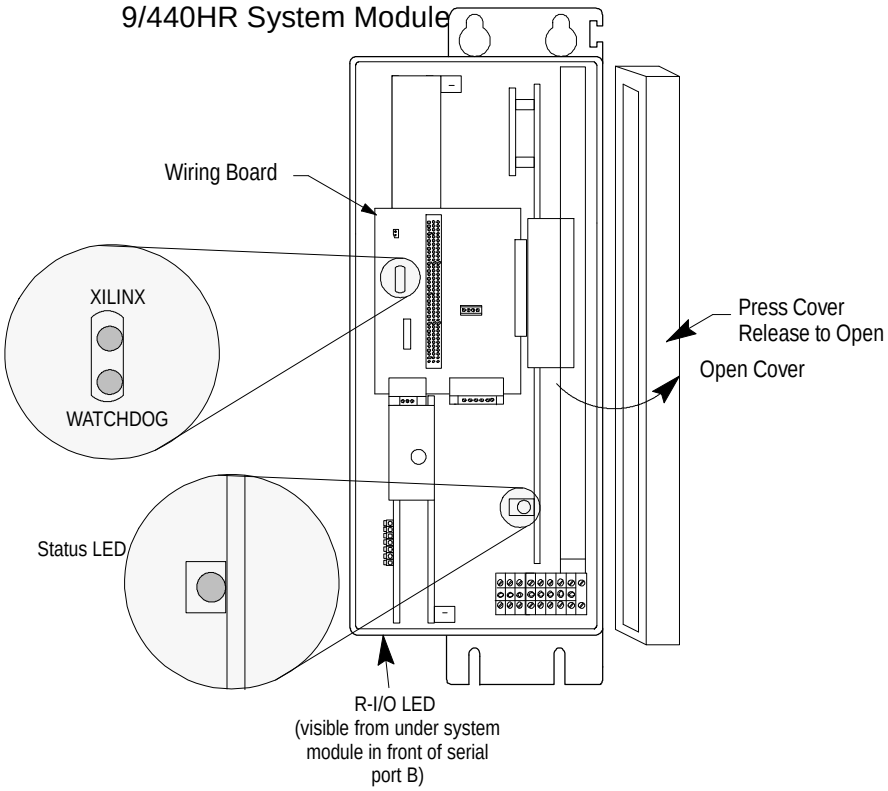
5B.7
9/440HR LEDs

9/440HR CNC/Drive has 4 LEDs on the system module and one LED on each axis module in the system. The LEDs operate as follows.

System Module LEDs

The system module has 4 LEDs. They are:

LED	Indicates
XILINX	Under normal operation this LED is on. If it turns off while the system module is under power it indicates a XILINX hardware fault. Contact your local Allen-Bradley Service.
WATCHDOG	Under normal operation this LED is on. If it turns off while the system module is under power it indicates the watchdog has timed out and a processor failure has occurred. Contact your local Allen-Bradley Service.
R-I/O	Only available on systems with remote I/O. This LED illuminates when the remote I/O link is communicating. See page 5B-27.
STATUS	This is identical to the Watchdog LED but is visible through the system modules front cover.



Check your 9/Series CRT for any drive faults that may have occurred and are displayed as an error.

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Axis Module LEDs

The Axis module has a Status LED visible thru the front cover. It is:

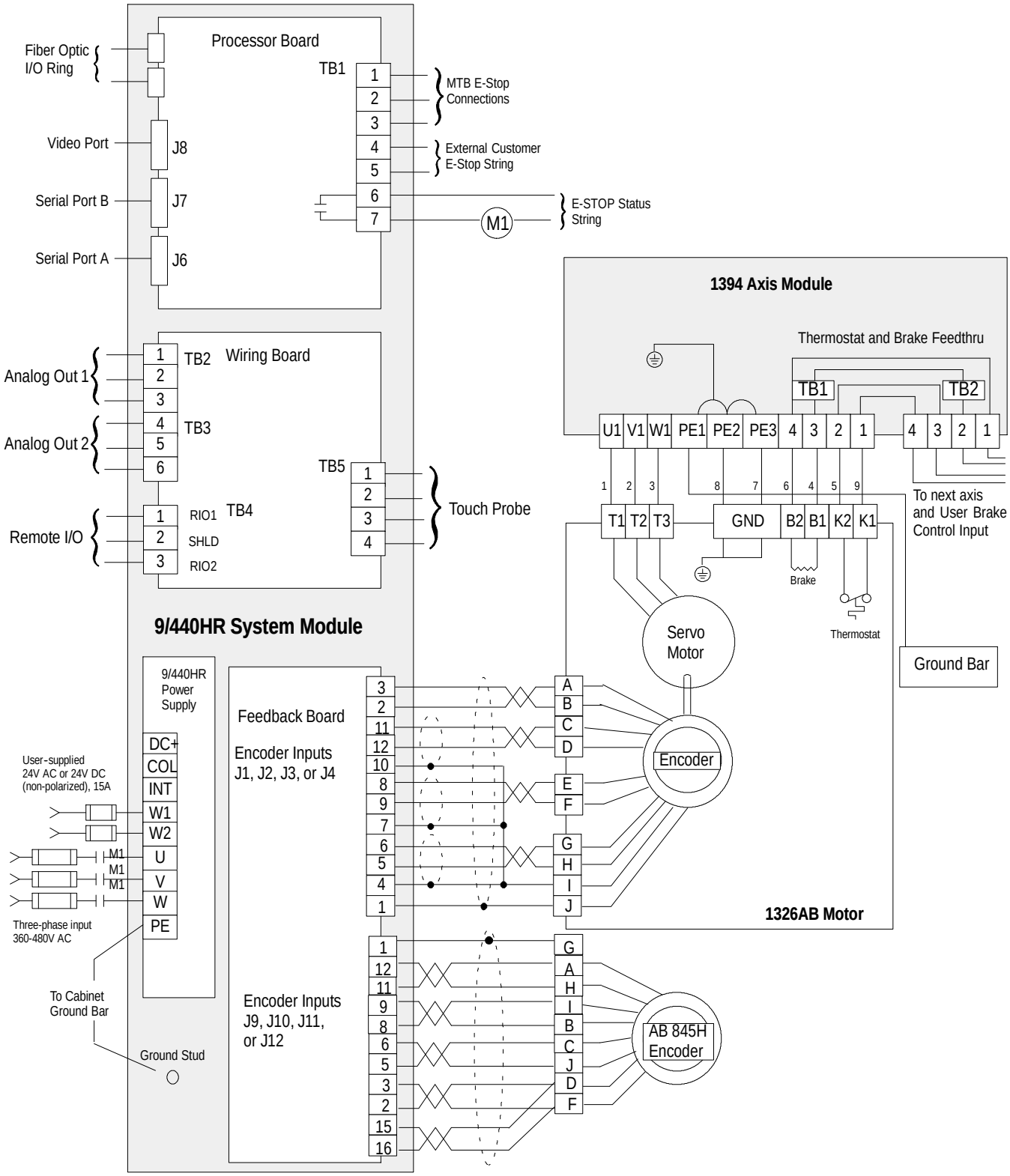
LED	Indicates	
STATUS	Steady Green	bus up, axis enabled
	Flashing Green	bus up, axis not enabled
	Flashing Red/Green	ready, bus not up
	Flashing Red	fault present
	Steady Red	hardware malfunction
For more details on how to diagnose and troubleshoot your axis module refer to the 1394 Digital AC Multi-Axis Motion Control System Users Manual (publication 1394-5.0)		

5B.8 General Wiring Overview

The following figure shows a typical interconnect diagram for a 9/440HR CNC to 1326AB motors. Note this figure illustrates only one servo motor with optional feedback encoder. The 9/440HR CNC can support up to four servo's and two spindle drives.

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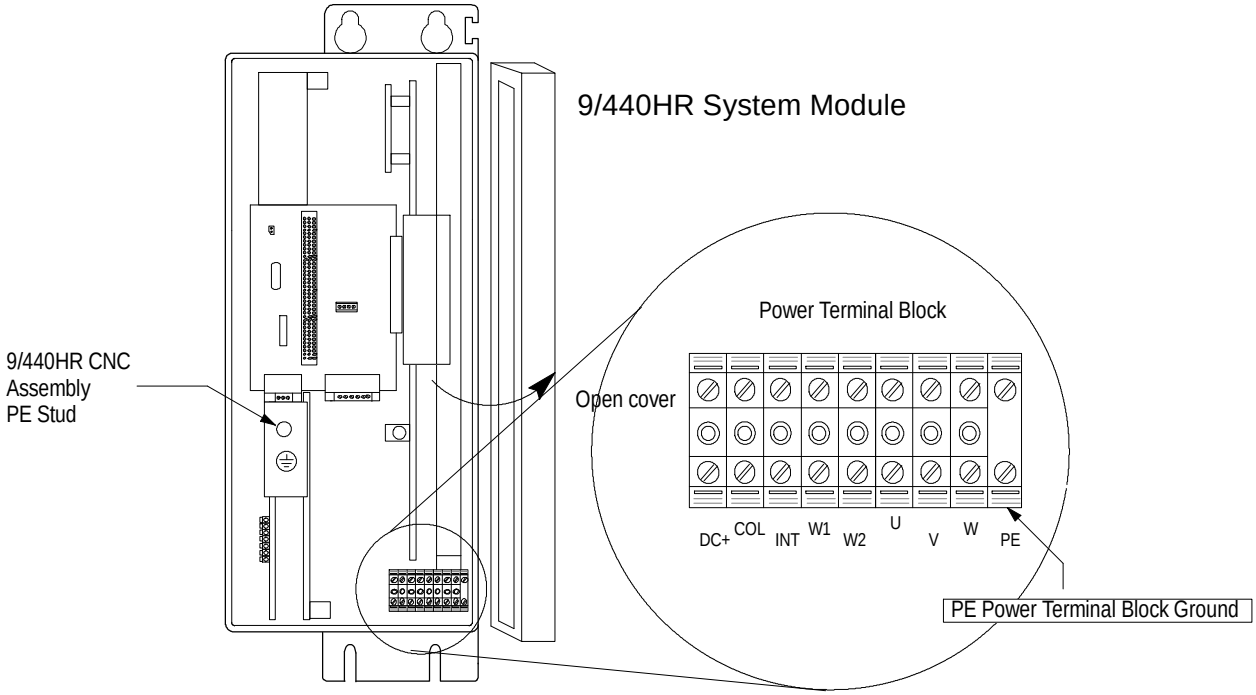
Figure 5B.22
Wiring Overview For 9/440HR CNC



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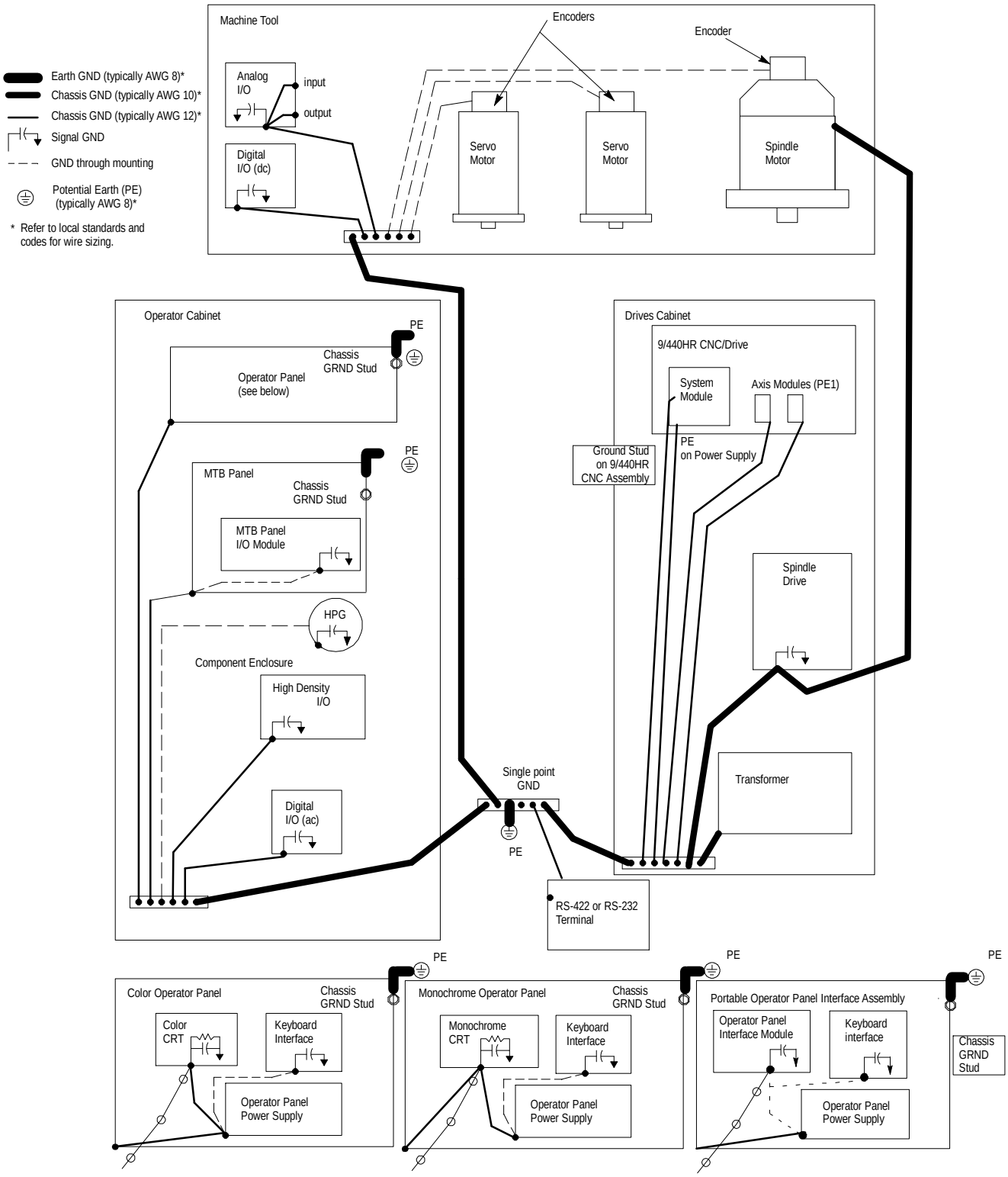
System Grounding

Figure 5B.23 illustrates the recommended 9/440HR grounding scheme. All grounds terminate on a single point. Note there are two separate ground wires going to the system module. One ground connects to PE of the system module power terminal block, the other connects to the ground stud found just beneath the wiring board on the mounting bracket for the 9/440HR CNC assembly.



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Figure 5B.23
System Grounding Diagram for 9/440HR Control



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TAB 6

Emergency STOP Design



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Section 6

Emergency Stop Design

6.0 Section Overview

Emergency stop (E-Stop) is a function of the control that disables all axis and spindle drives if a major anomaly is detected.

To guard against damage to the machine and injury to personnel, the system installer must make the necessary E-Stop connections to the proper terminals on the control components. E-Stop is required to safely de-energize the axes and spindle drives and place all I/O in a safe state (including motor brakes) when an Emergency Stop condition occurs.



ATTENTION: All axis and spindle drives **must** be disabled by the emergency stop. Otherwise uncontrolled axis motion may cause injury to personnel and/or damage to the machine tool.

This section describes connections that must be made to help the control detects emergency situations and responds appropriately. Topics covered include:

- E-Stop Connections
- E-Stop String
- Events when E-Stop occurs

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6.1 E-Stop Connections

Connect the emergency stop circuit to the pluggable E-Stop connector on as illustrated in Figure 6.1.

Figure 6.1
E-Stop Component Connection

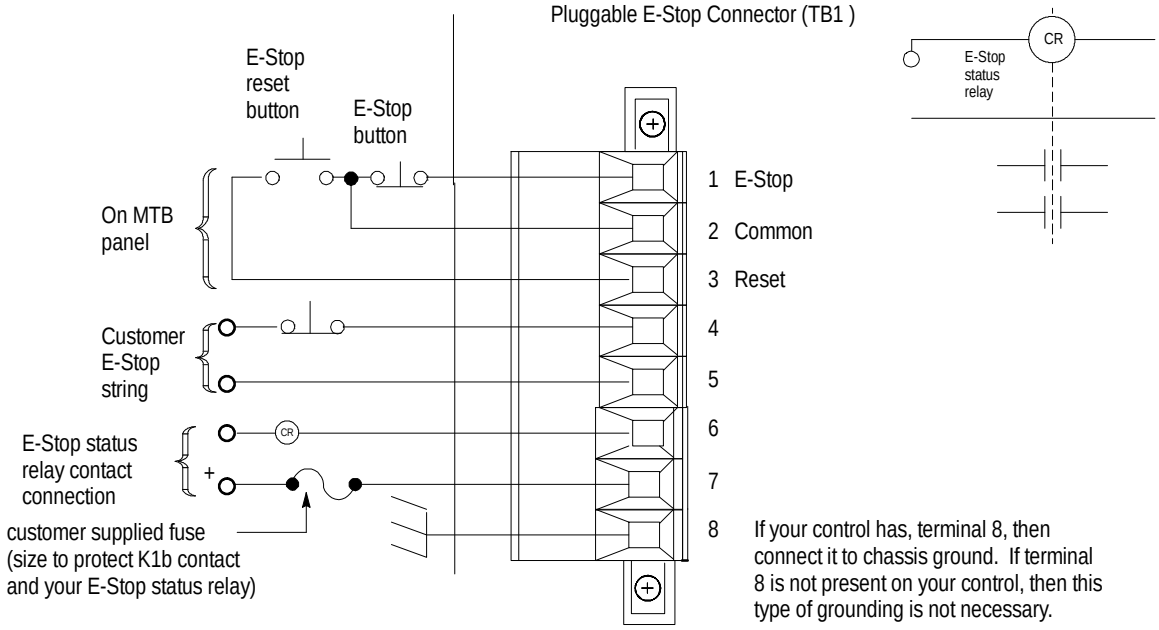
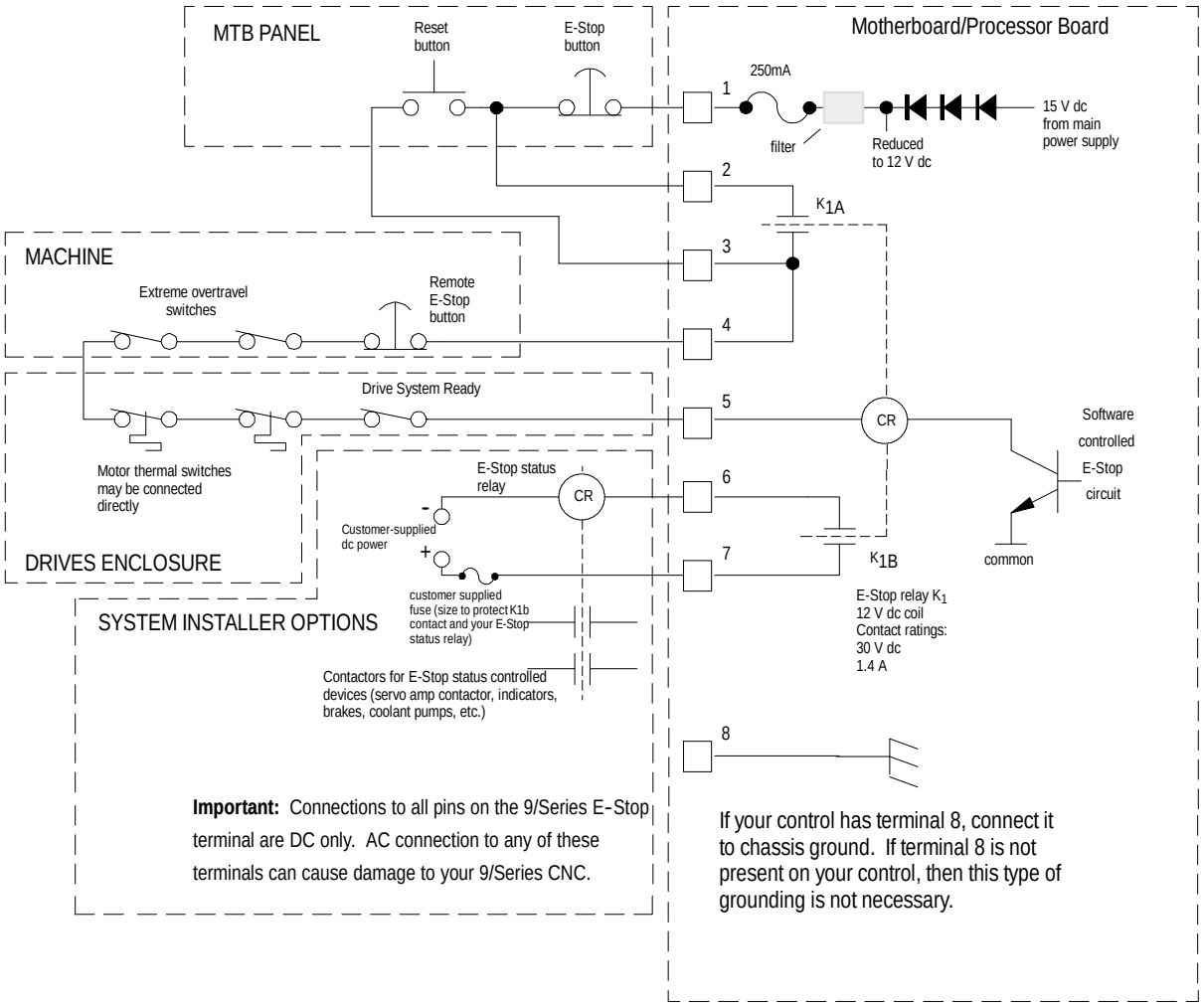


Figure 6.2 shows a typical emergency stop circuit. This varies depending on machine tool configuration, and the devices implemented by the system installer.

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Figure 6.2
Typical Emergency Stop Circuit



Important: We recommend that all contactors used on the 12V E-Stop string are rated for use at low level operation (dry circuit contactors). This may increase initial expense of the circuit but will provide more reliable E-Stop string operation over time. Use of non-dry E-Stop devices may result in nuisance E-Stop faults or failure to establish a closed circuit when the E-Stop reset push button is closed. Corrosion build-up on non-dry contactors are not cleaned by the control's operation. Dry contactors are more immune to corrosive effects.

If non-dry contactor devices are used as elements of the E-Stop string, we recommend the use of a pilot relay in conjunction with a customer-supplied power supply operating independent of the control's 12 Vdc string. Select a pilot relay with a dry contact rated for use in the E-Stop string.

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Important: You may need to add a pilot relay if your E-Stop has one of these characteristics:

- the E-Stop string is very long
- devices on the string cause a such a large line drop in the string that the E-Stop relay will not latch.

In these cases, the control may:

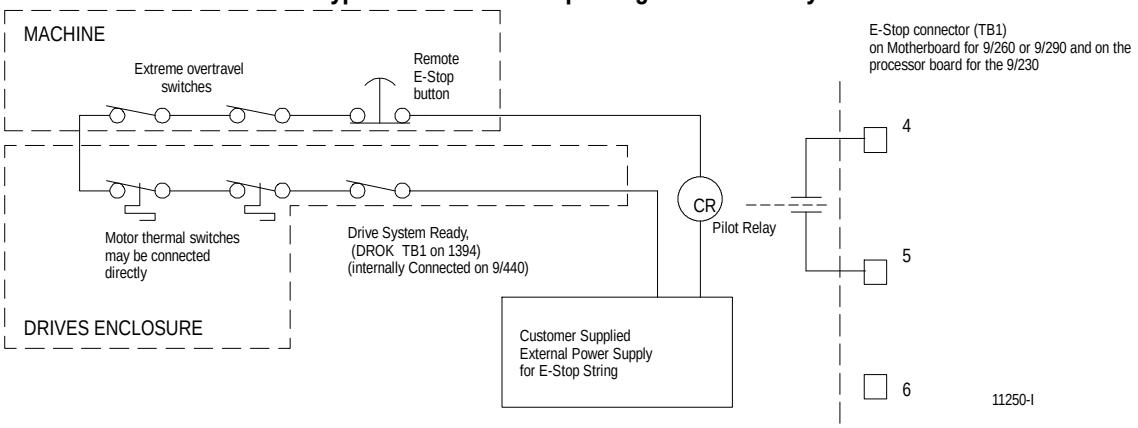
- not come out of E-Stop
- enter E-Stop at different times during operation when the E-Stop string voltage varies slightly

If your application requires a separate E-Stop pilot relay, you must provide an external power supply to power the E-Stop string. The contactors of this pilot relay are used to break the controls 12V E-Stop string. A typical layout for this E-Stop string is shown in Figure 6.3.

ATTENTION: E-Stop wiring with a pilot relay requires circuit continuity for normal operation (a customer's E-Stop string should be a normally closed circuit). Loss of power to the external power supply should constitute an E-Stop condition. Failing to do this may cause injury to personnel or damage to the machine tool.

ATTENTION: Contact ratings on the control are DC only.

Figure 6.3
Typical Customer E-Stop String with Pilot Relay



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6.2 E-Stop String

The E-Stop string begins at the E-Stop connector, then may contain:

- remote E-Stop pushbutton(s) whose contacts open when the button is pushed to cause E-Stop.
- axes overtravel limit switches whose contacts open when an axis travels over the switch.
- auxiliary machine fault detection equipment whose contacts open when an auxiliary device fails.
- contacts associated with the servo drives that open when a fault condition occurs in the drive.
- contacts associated with the spindle that open when a fault condition occurs.
- motor over temperature (thermal) sensors that cause the E-Stop string to open when they sense an over temperature condition.

The E-Stop string terminates on one side of the 12 V dc relay coil. The opposite side of the coil connects to the supply common through a software-controlled E-Stop request transistor. This permits the coil to be energized when there is series continuity through the E-Stop string.



ATTENTION: The E-Stop button is designed to be used in emergency situations to protect equipment or personnel. Make sure that it performs properly by wiring the E-Stop string with the following considerations:

1. The E-Stop string must be **hardwired** and working **before** enabling drives. This provides a safe and reliable way of de-energizing the drives if an E-Stop condition should occur when the drives are enabled.
2. Current always flows through the string when there is no E-Stop condition. This makes sure that the control will go into E-Stop should a wire be broken.
3. Triggering the E-Stop string should be exclusively a hardware function that can be monitored or induced by software, but never dependant on software. This makes sure that a software failure or loss of logic power does not prevent an E-Stop condition.
4. Do not use devices on the fiber optic ring to trigger E-Stop.

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6.3 E-Stop Status

Use the contact on TB1-6,7 in the E-Stop string for status control of peripheral machine tool devices, such as:

- alarms
- emergency braking devices (9/440 systems refer to page 5B-34)
- axes drive equipment
- coolant pumps
- remote status indicators
- spindle drive

Table 6.A
Contact Ratings, 9/230, 9/440, 9/260, and 9/290 E-Stop Relay (K_1)

Item	Rating
Max. Allowable Power (resistive load)	30W
Max. Allowable Voltage	30 Vdc
Max. Allowable Current	1.4A

6.4 Events When E-Stop Occurs

When E-Stop occurs:

- the position loop is disabled and issues no motion commands
- the following error is cleared
- part program execution stops
- it is the OEM's responsibility to assure that the axes decelerate appropriately

Important: Note that E–Stop condition is not the same as a power loss condition or a hardware failure.

Controlled Stop on E-Stop

The controlled stop on E–Stop feature is used for servo systems that use the 9/Series to close the velocity loop on these servo hardware platforms:

- 9/440 systems
- 9/260 and9/290s that use the 8520-ENC4 or 8520-SM4
- 9/230's connected to the 8520 or 1394 digital drive interface.

Important: The controlled stop feature, as described in this section, is only available on standard systems using a system executive of 10.02 or higher (some custom executives may not support controlled stop on E–Stop) and have the appropriate servo hardware.

The controlled-stop feature can be used in conjunction with your own machine-braking system to help decelerate or hold axes in position when an E–Stop event occurs.

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On systems that support the controlled-stop feature, the velocity loop remains enabled and the velocity command is reduced exponentially to zero after an E-Stop occurs. This results in the velocity loop attempting to bring the motor to a stop and/or hold it steady. After 2 seconds, the controls software disables the velocity loop.

The control will also maintain the axis/drive enable signal to 1394 and 8520 digital servo amplifiers for this 2 second interval after E–Stop.

The commands sent to the drive (torque commands) are limited by the torque limits defined for the axis in AMP ("MAXIMUM PERCENT RATED TORQUE...").

Important: If problems (such as amplifier faults) occur from overcurrent conditions caused during a worst case E-Stop (E–Stop during rapid move), you must reduce the AMP configured maximum percent rated torque limits.



ATTENTION: We strongly recommend that the high-voltage input to the amplifiers be disconnected by a contactor when the E-Stop string opens. As a result of this power loss to the drive, the only current available to the drive to bring the motor to a stop and hold it is the residual bus energy stored in the drives. The velocity loop from the control will attempt to stop and hold the axes for 2 seconds after an E-Stop occurs. The amount of time the drive system can actually pull current from the motor to bring the axis to a stop and hold it in position varies depending on machine factors (e.g., the size of the motor, the speed at which it is traveling or its static load, and the amplifier size)

Resetting E-Stop

Once the cause of the error has been corrected, press E-Stop reset.

- the E-Stop string will reset and return system control to system software.
- depending on the value of the AMP parameter **Control Reset on E-Stop Reset**, the control will either execute a control reset, which returns the part program pointer to the top of the program, or leaves the pointer at the block being executed when the E-Stop occurred.

END OF SECTION

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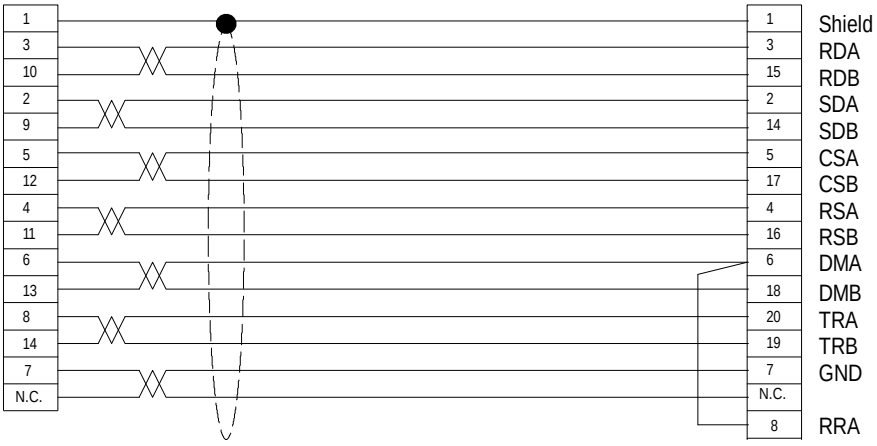
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Making Cables and Noise Prevention Techniques



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Section 7A

Cable Diagrams

7A.0 Connecting the Components and Modules

The following sections contain information to be used when connecting the modules and components. Included is information on intermodule connections, maximum cable lengths, cable types, and connector types. For detailed information on a specific connector, refer to the section that covers the module on which the connector is located.



ATTENTION: Electrostatic discharge can degrade performance or damage the system components. Observe the following precautions to guard against such damage:

- Touch a grounded object to eliminate static discharge from your body before handling any of the components. It is also recommended practice to wear a wrist strap (such as Allen–Bradley cat. no. 8000-ESD) that provides a low resistance path to ground.
- Do not touch the connectors or the connector pins.
- Do not touch other circuit components when you are setting switches or jumpers. If available, use a static-safe workstation.
- Keep the components that are packaged in static-shield bags in their bags when they are not used.

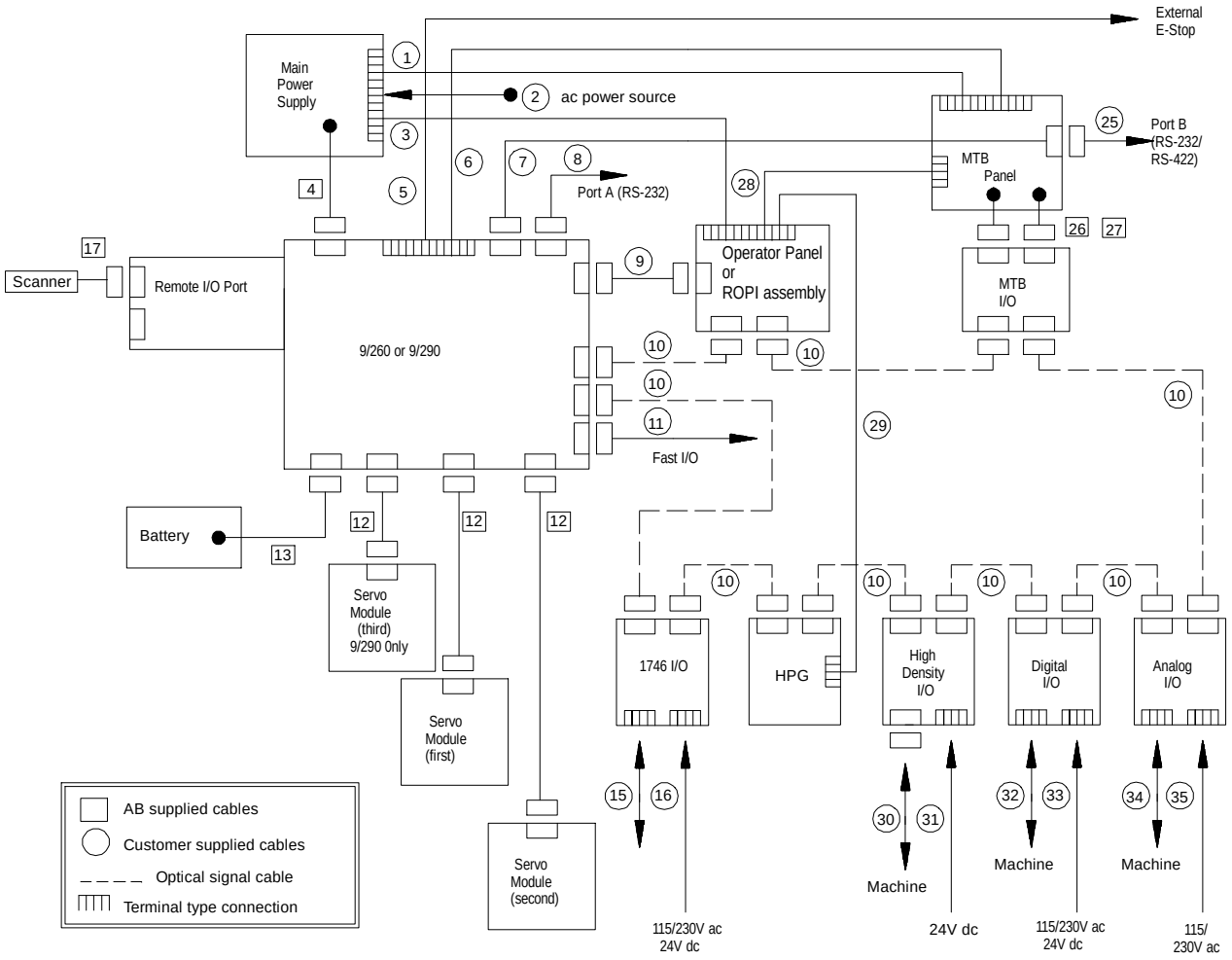
For more information about electrostatic discharge and how to guard against it, refer to publication 8000-4.5.2, Guarding Against Electrostatic Damage: Using the ESD Kit.

7A.1 System Cabling Diagrams

The internal system connection diagram is shown in the following figures. The intermodule and intercomponent connections and their corresponding cables and connectors are covered in the following section.

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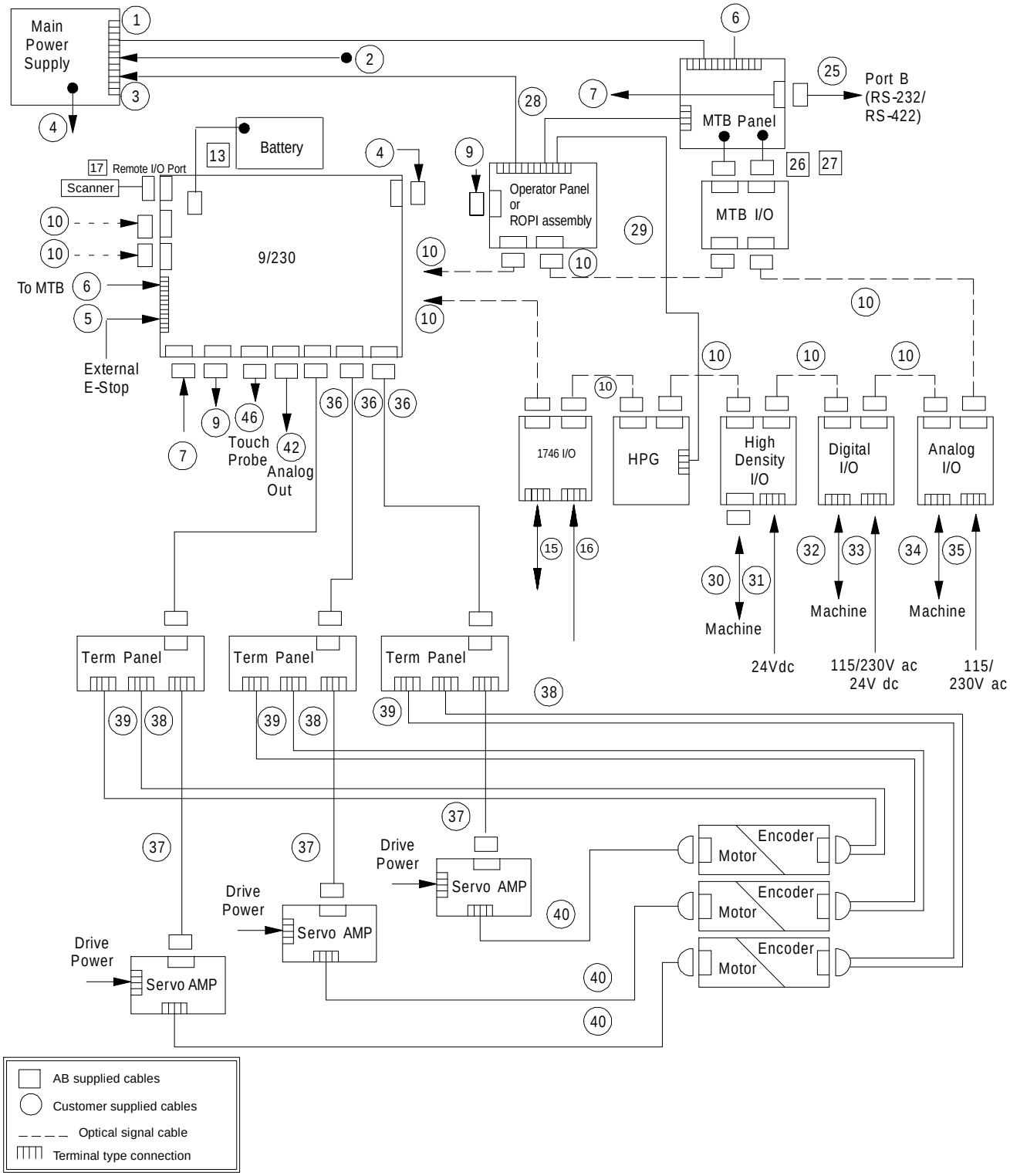
Figure 7A.1
9/260 & 9/290 CNC's System Connection Diagram



Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the system I/O ring. Refer to the 9/Series 9/230, 9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

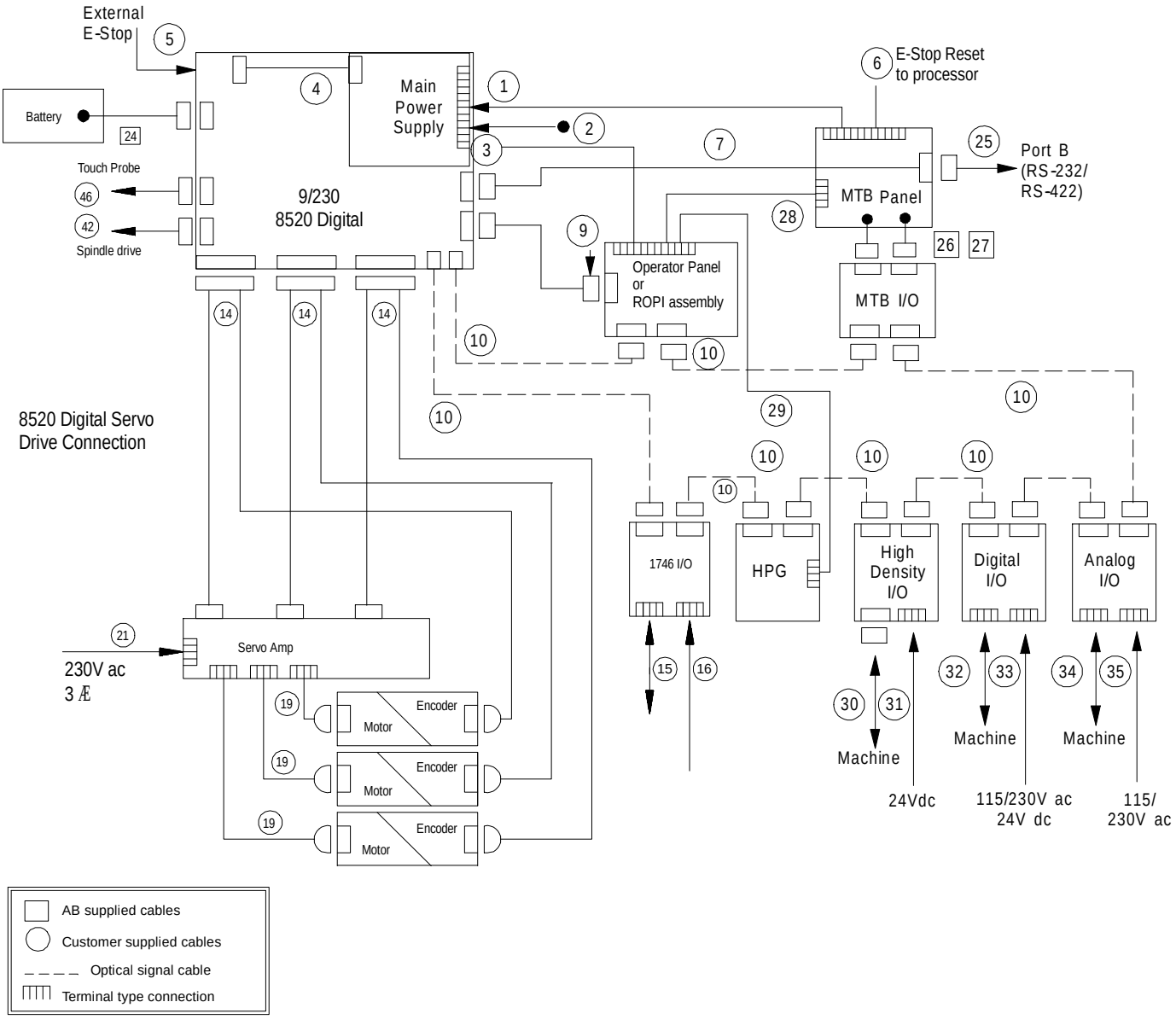
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Figure 7A.2
9/230 Analog CNC System Connection Diagram



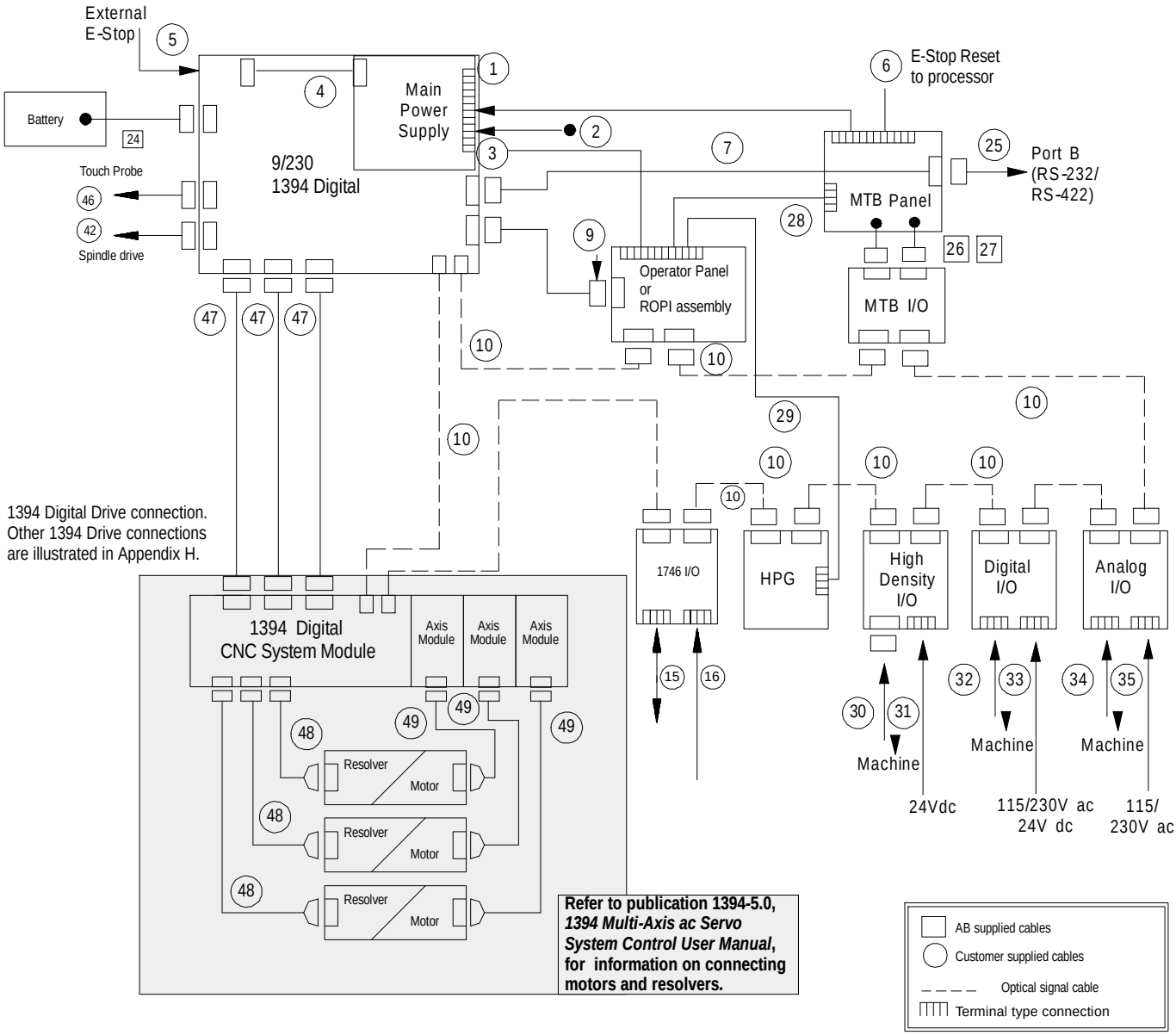
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Figure 7A.3
9/230 8520 Digital CNC System Connection Diagram



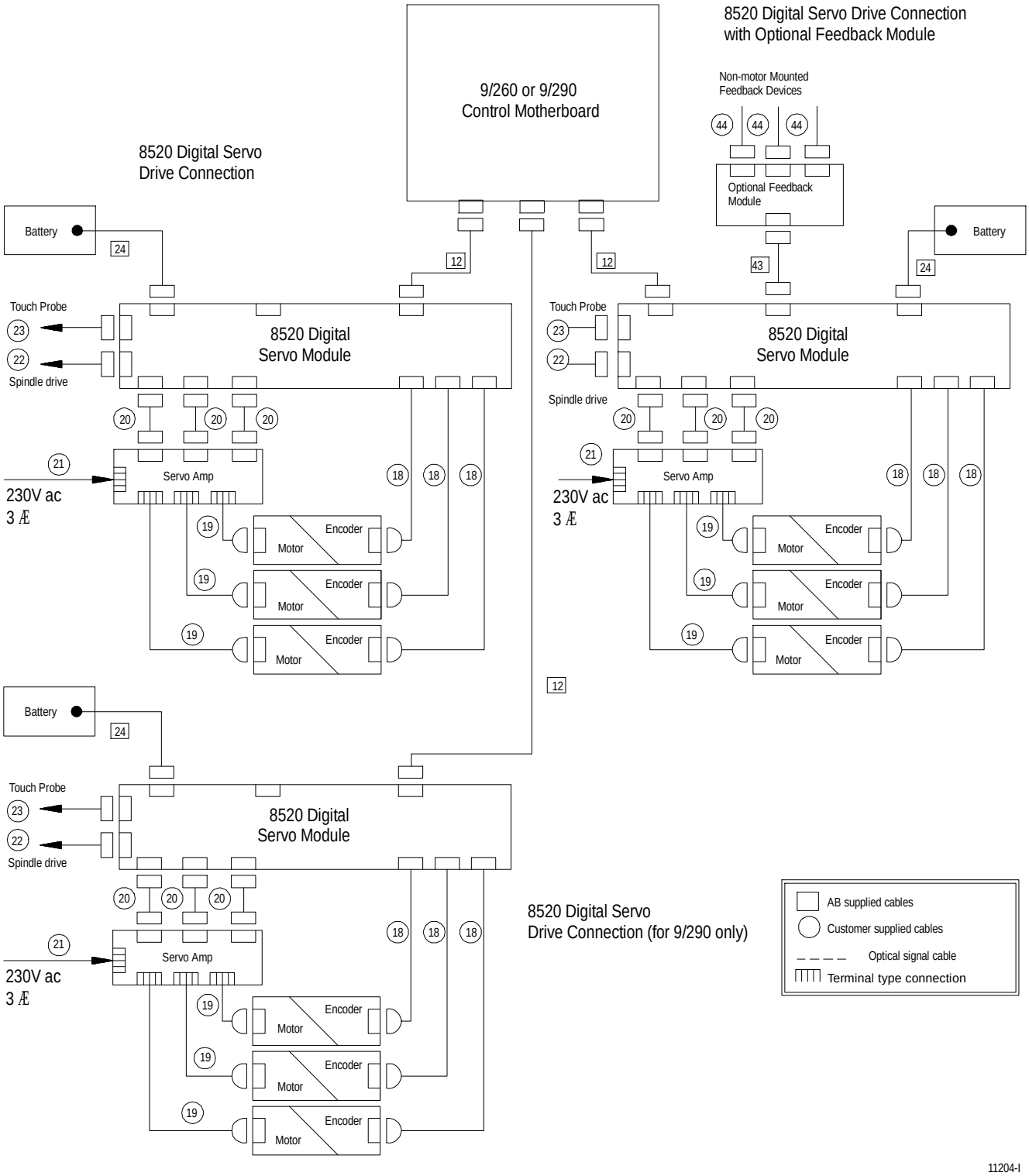
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Figure 7A.4
9/230 1394 Digital CNC System Connection Diagram



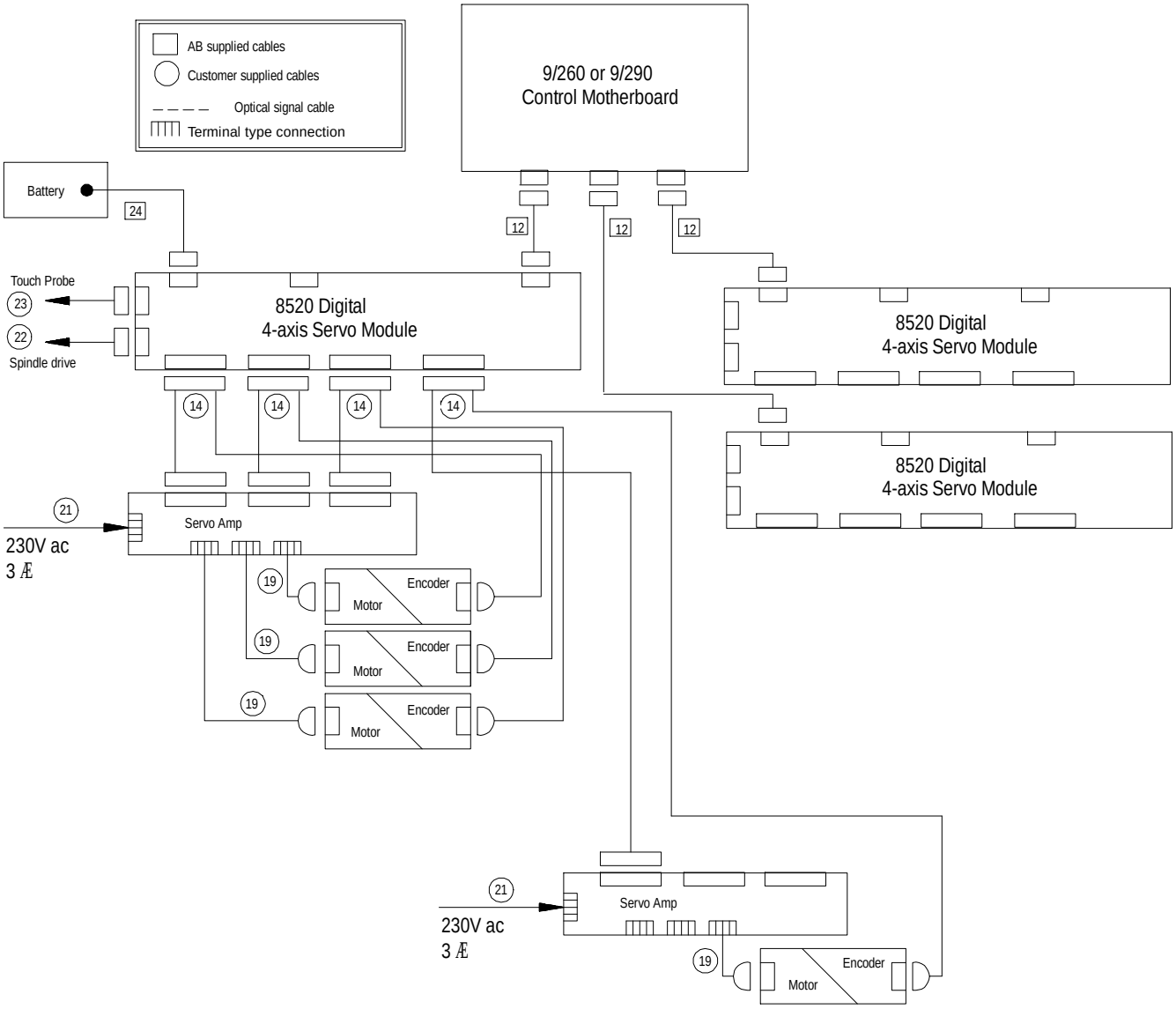
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Figure 7A.5
9/260 and 9/290 Connections from the 3-Axis Servo Module to 8520 Digital Drives



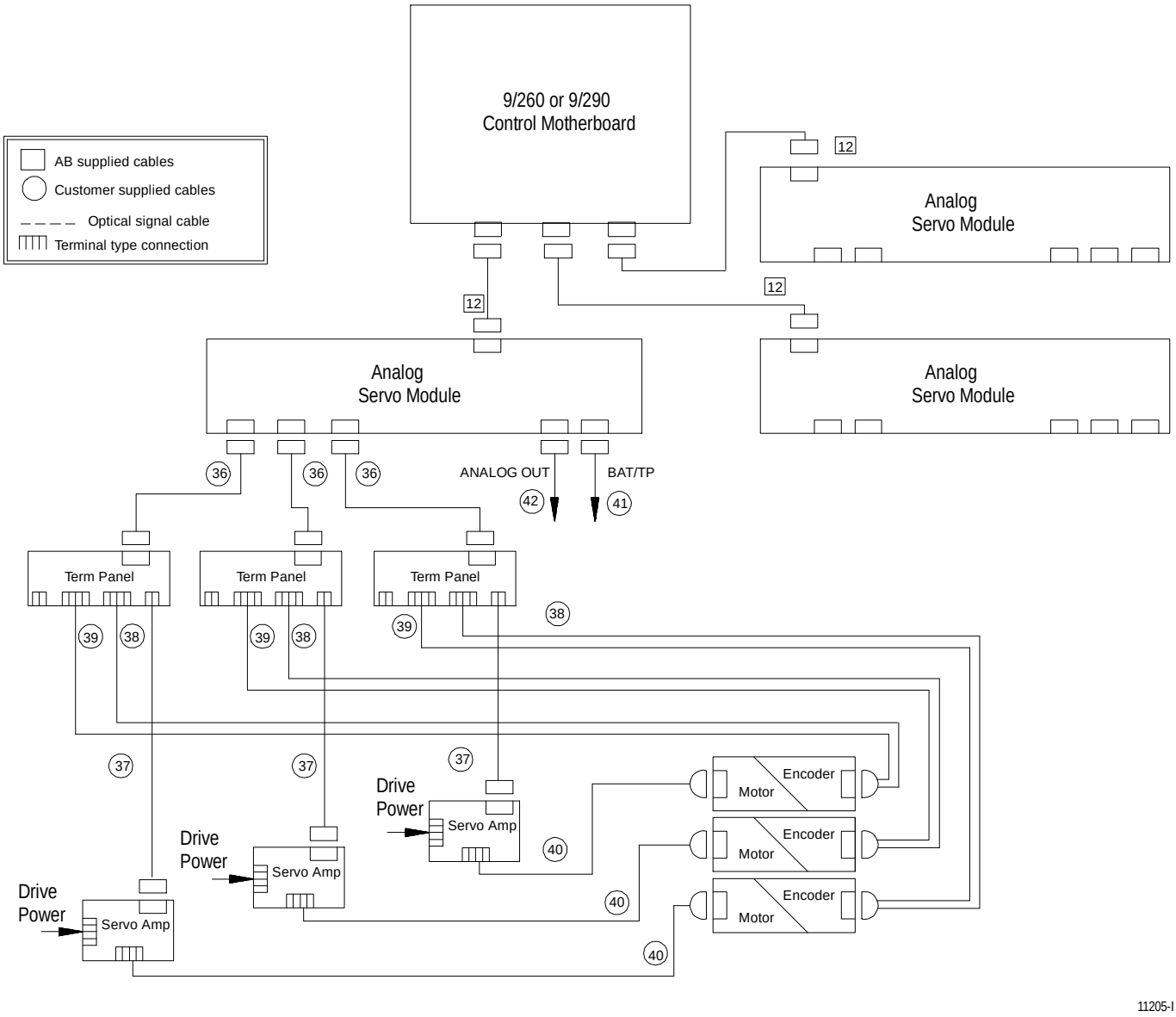
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Figure 7A.6
9/260 and 9/290 Connections from the 4-axis Servo Module to 8520 Digital Drives



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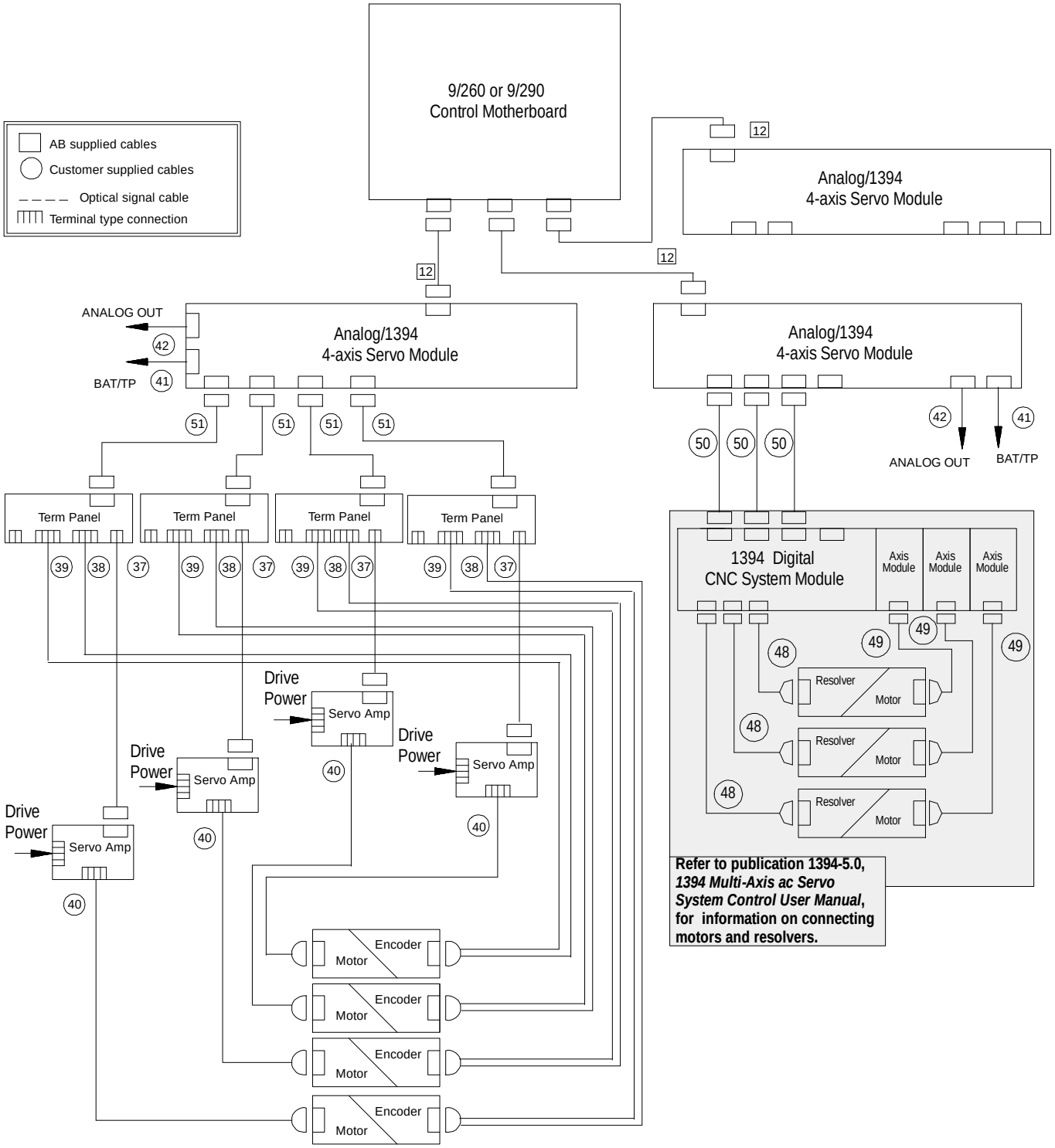
Figure 7A.7
9/260 and 9/290 Connections from the 3-axis Servo Module to Analog Drives



11205-I

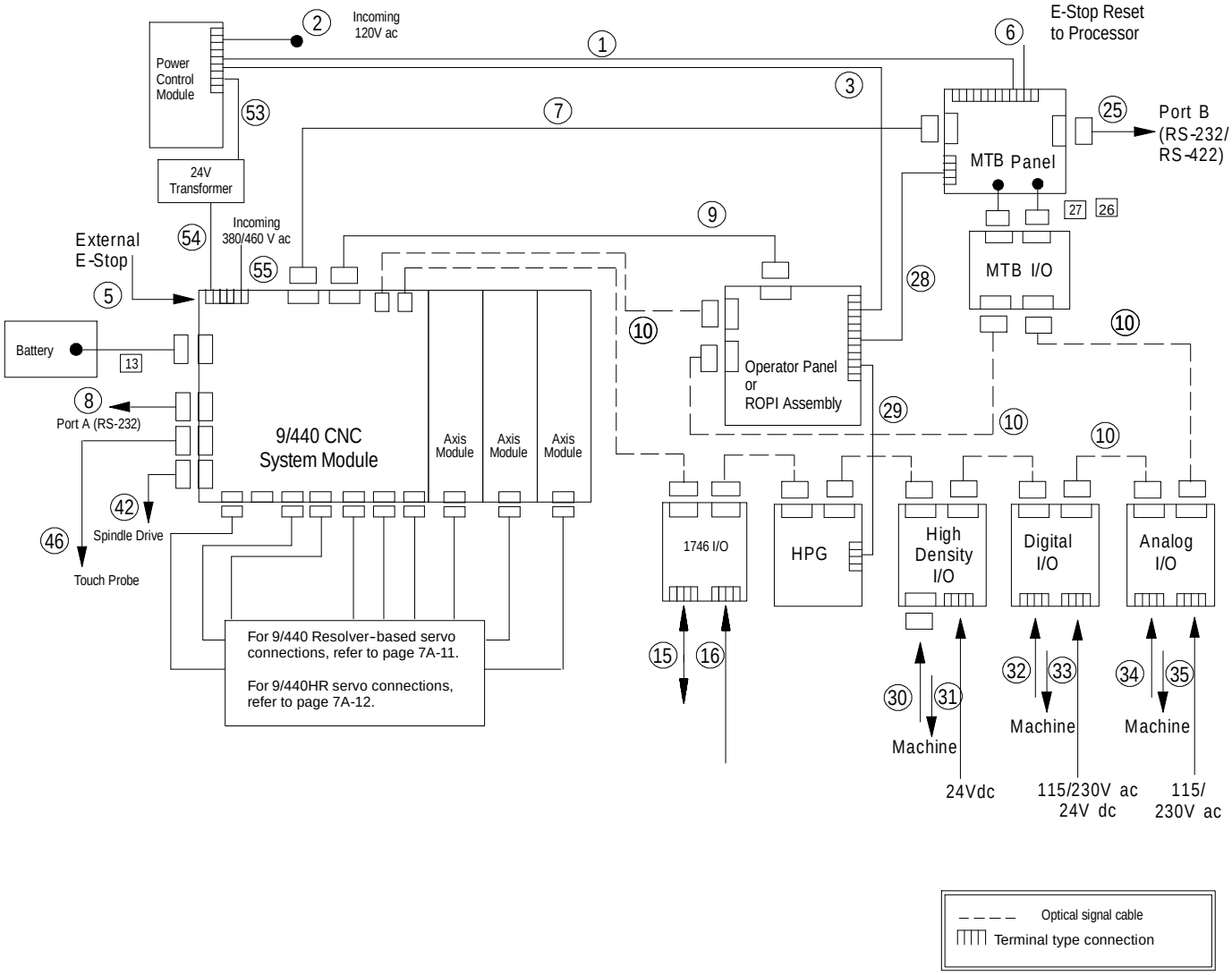
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Figure 7A.8
9/260 and 9/290 Connections from the 4-axis Servo Module to Analog Drives and the 1394 Drive



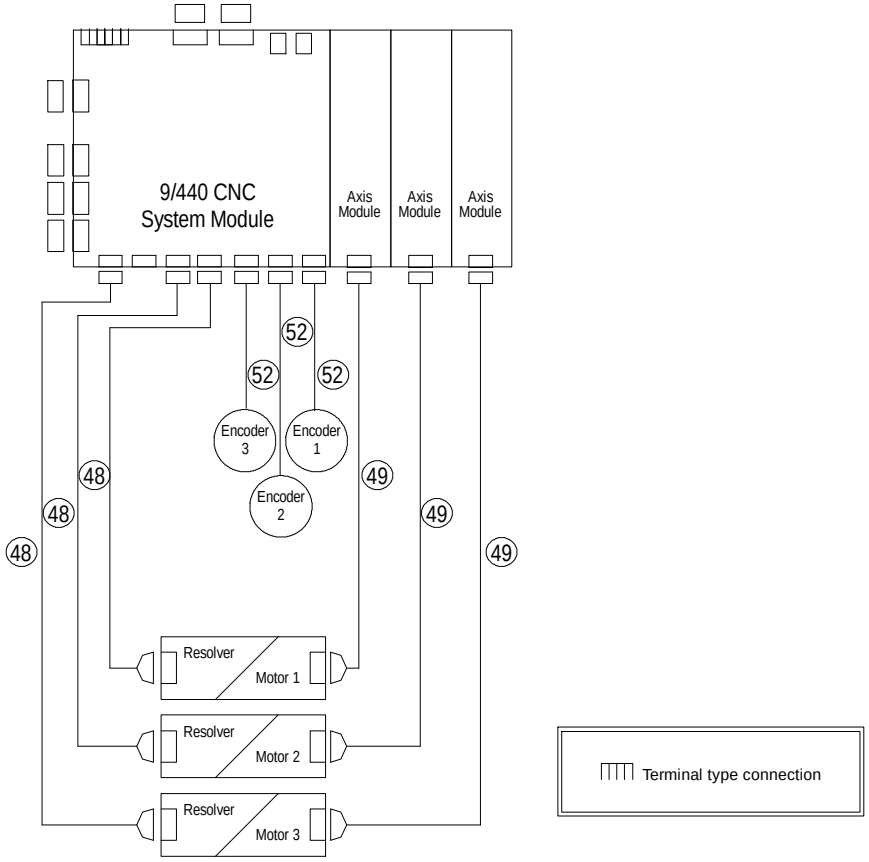
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Figure 7A.9
9/440 CNC System Connection Diagram



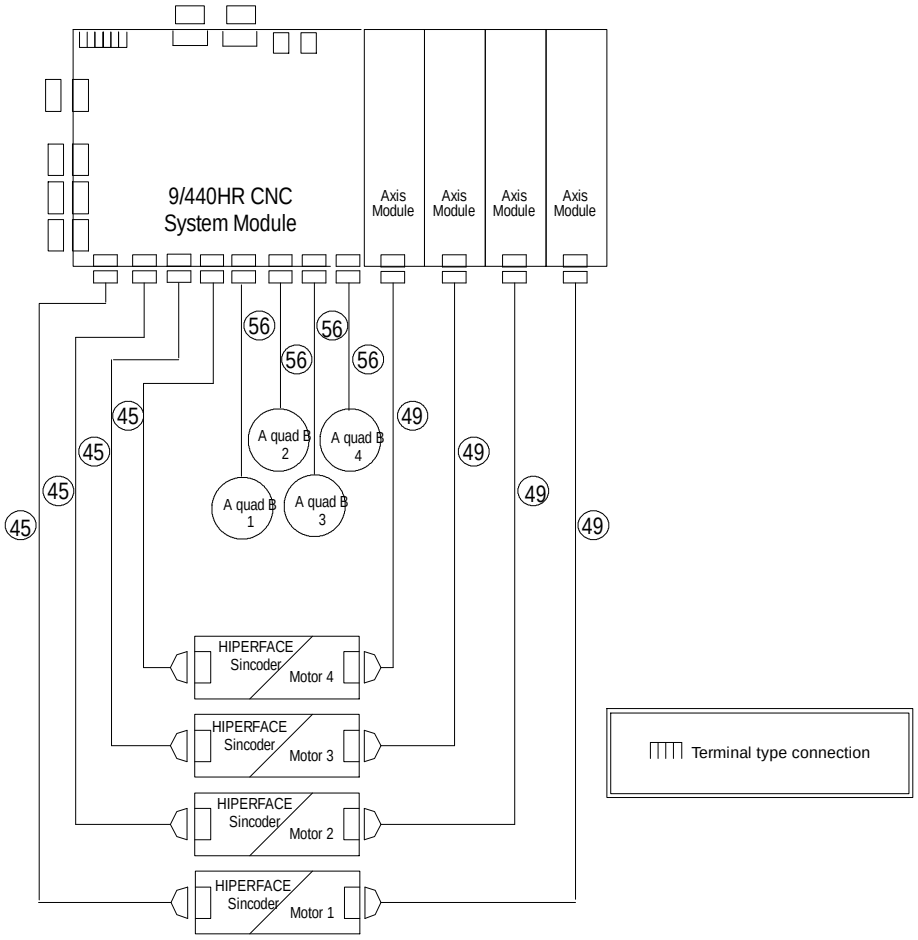
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Figure 7A.10
9/440 Resolver- based Servo Connections



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Figure 7A.11
9/440HR Servo Connections



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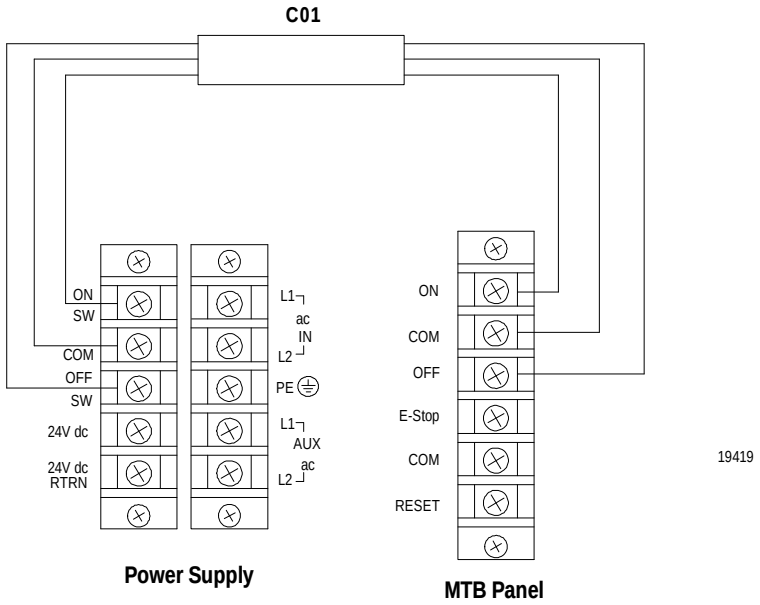
7A.2 Cable Diagrams

The cables and connectors shown in the previous figures are covered in the following table. For detailed information on a specific connector, refer to the section that covers the module on which the connector is located.

ATTENTION: Incorrect wiring of the following cables and connectors may cause damage to their respective modules.

Table 7A.A
Cable and Connector List

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C01	9/230	Main Power Supply BT04	ON/OFF Switch Signal Cable	MTB Panel BT20	Prepared by Customer

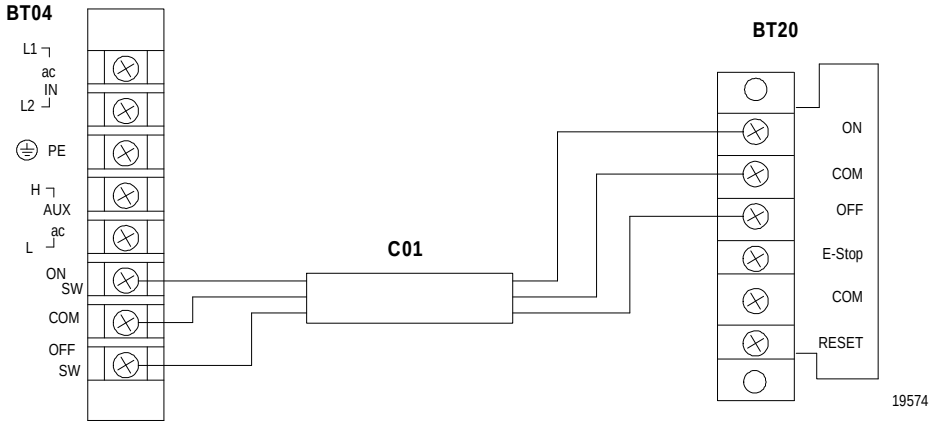


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9491	Miscellaneous	Line Drop Limit

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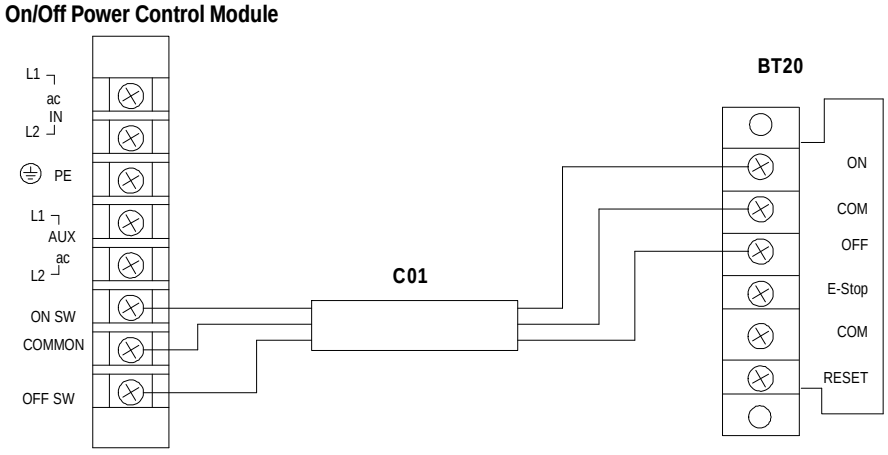
Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C01	9/260 and 9/290 only	Main Power Supply BT04	ON/OFF Switch Signal Cable	MTB Panel BT20	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9491	Miscellaneous	Line Drop Limit

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C01	9/440 (all) only	On/Off Power Control Module	ON/OFF Switch Signal Cable	MTB Panel BT20	Prepared by Customer

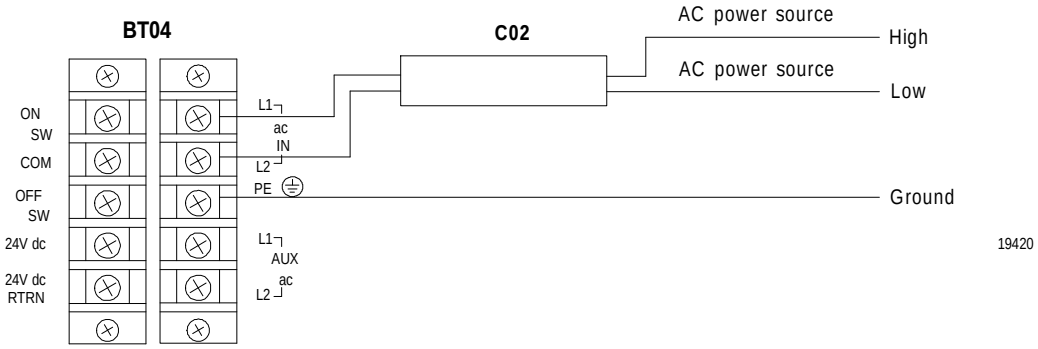


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9491	Miscellaneous	Line Drop Limit

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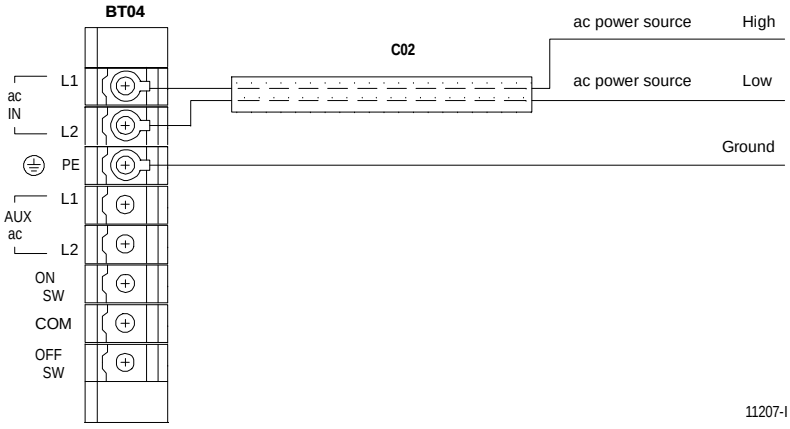
Table 7A.A
Cable and Connector List (continued)

Control	Cable No.	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
9/230	C02	Main Power Supply BT04	ac Power Source Cable	External ac Power Source	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limit

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C02	9/260 and 9/290	Main Power Supply BT04	ac Power Source Cable	External ac Power Source	Prepared by Customer



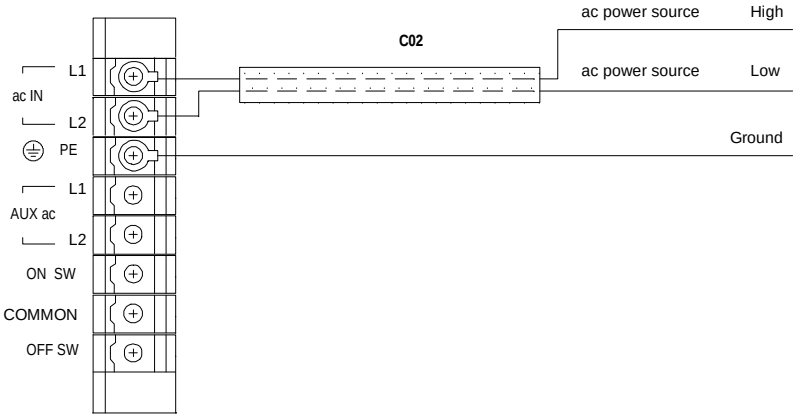
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limit

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C02	9/440 (all)	On/Off Power Control Module	ac Power Source Cable	External ac Power Source	Prepared by Customer

On/Off Power Control Module

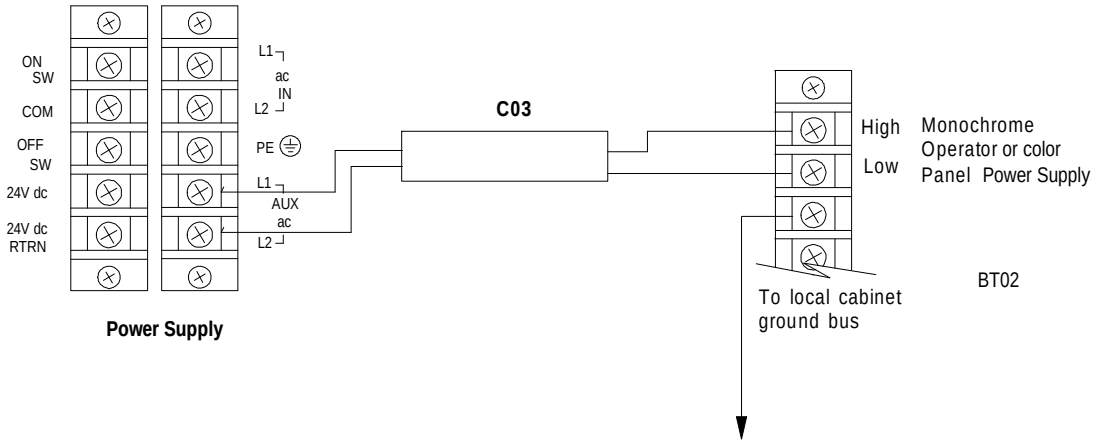


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limit

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C03	9/230	Main Power Supply BT04	Power Supply Cable	Operator Panel Power Supply on Operator Panel or on Removable Operator Panel Interface Assembly	Prepared by Customer

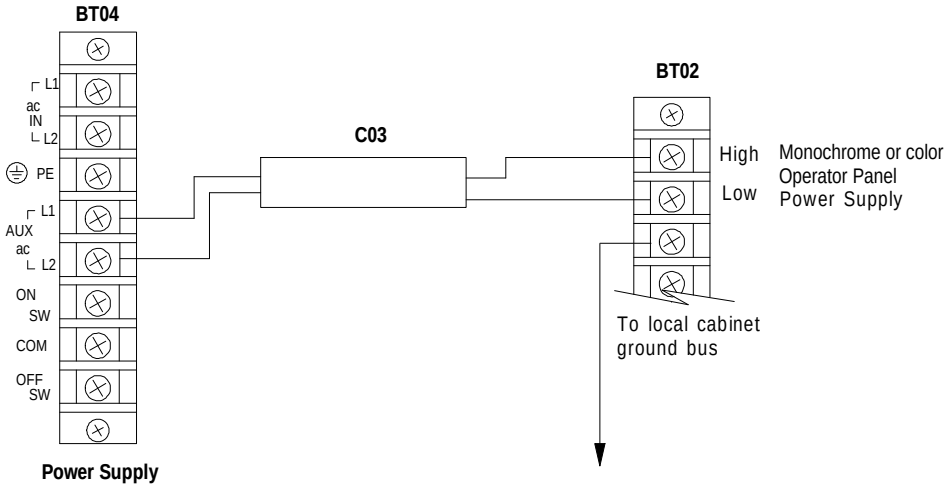


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9409	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C03	9/260 and 9/290	Main Power Supply BT04	Power Supply Cable	Operator Panel Power Supply on Operator Panel or on Removable Operator Panel Interface Assembly	Prepared by Customer

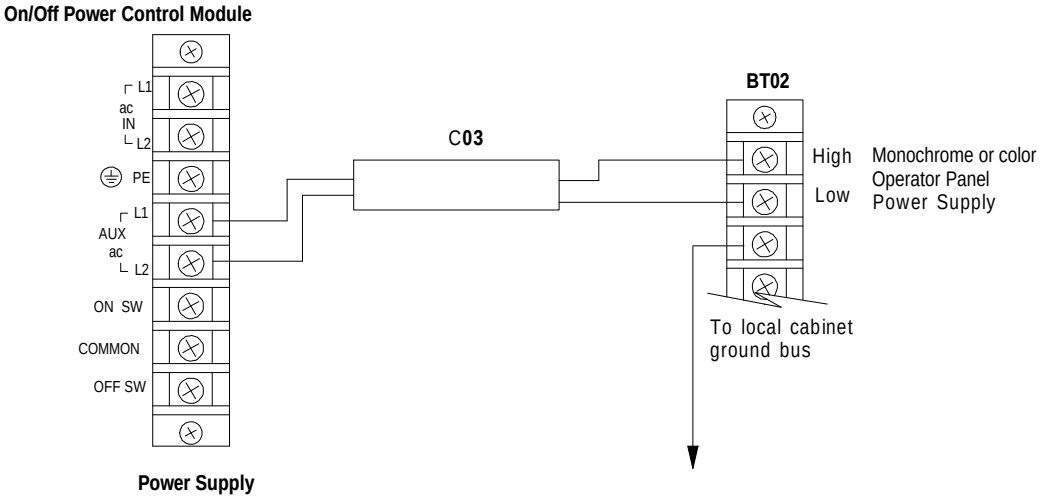


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9409	Miscellaneous	Line Drop Limitation

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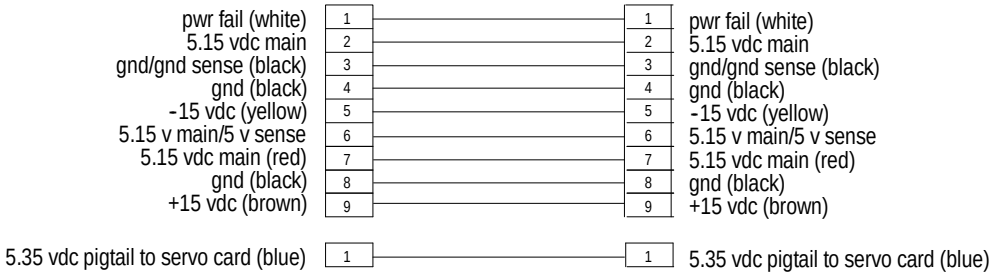
Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C03	9/440 (all)	On/Off Power Control Module	Power Supply Cable	Operator Panel Power Supply on Operator Panel or on Removable Operator Panel Interface Assembly	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9409	Miscellaneous	Line Drop Limitation

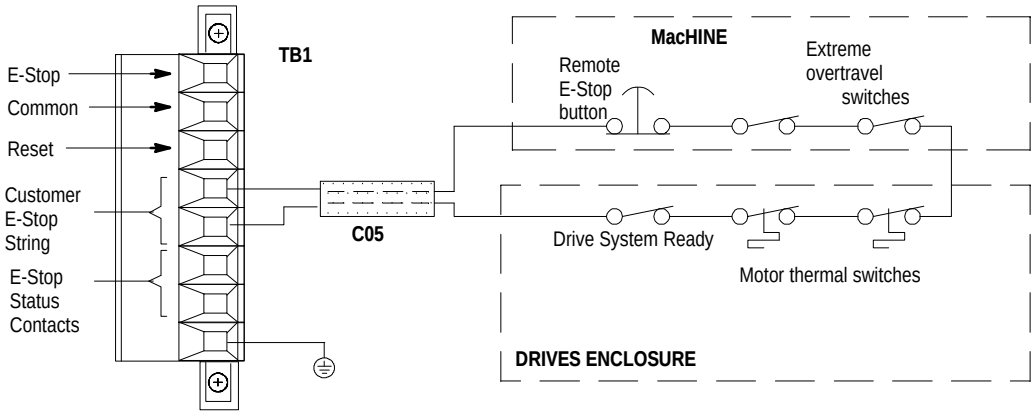
Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C04	9/260 and 9/290	Main Power Supply BT04	dc Output Cable	Motherboard J1	Included with Main Power Supply
	9/230			Processor Board P12	



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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C05	9/260 and 9/290	Motherboard TB1	E-Stop String Cable	Machine Circuits	Prepared by Customer
	9/230	Processor Board TB1			
	9/440 (all)	System Module TB1			



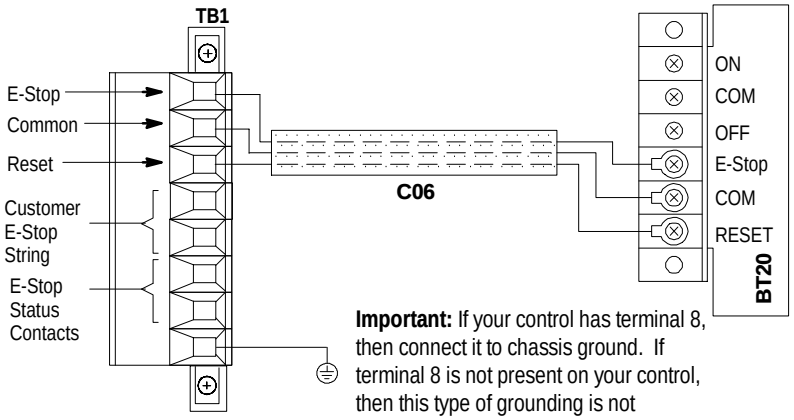
If your control has terminal 8, then connect it to chassis ground. If terminal 8 is not present on your control, then this type of grounding is not necessary.

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9407	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C06	9/260 and 9/290	Motherboard TB1	E-Stop Reset Cable	MTB Panel BT20	Prepared by Customer
	9/230	Processor Board TB1			
	9/440 (all)	System Module TB1			



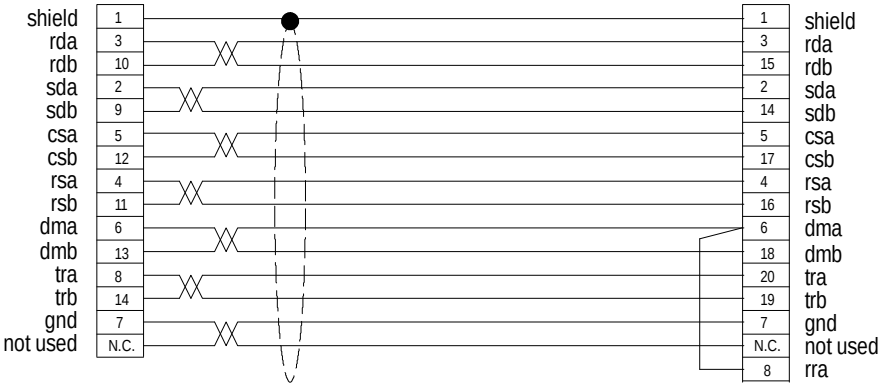
Important: If your control has terminal 8, then connect it to chassis ground. If terminal 8 is not present on your control, then this type of grounding is not necessary.

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9491	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C07	9/260 and 9/290	Motherboard Port B J7	RS-232/RS-422 Serial Interface Cable	MTB Panel CN56F	Prepared by Customer
	9/230	Processor Board Port B J7			
	9/440 (all)	System Module Port B J7			



Belden 9507 - 24 Gauge

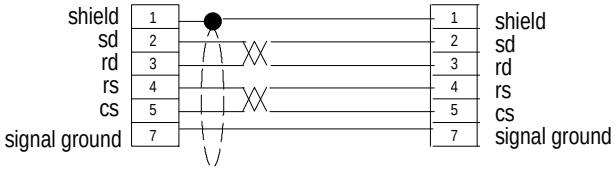
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
15-pin D-shell (has pins) 8520-D15M	Belden 9507	25-pin D-shell (has sockets) 8520-D25FS	[1]

[1] The maximum length of this cable depends on the length of cable C25. The combined length of cables C07 and C25 may not exceed 15 m (50 ft).

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C08	9/260, 9/290, and 9/440 (all)	Port A	RS-232 Serial Interface Cable	I/O Device	Prepared by Customer
-------	N/A on the 9/230	----------	----------	----------	----------

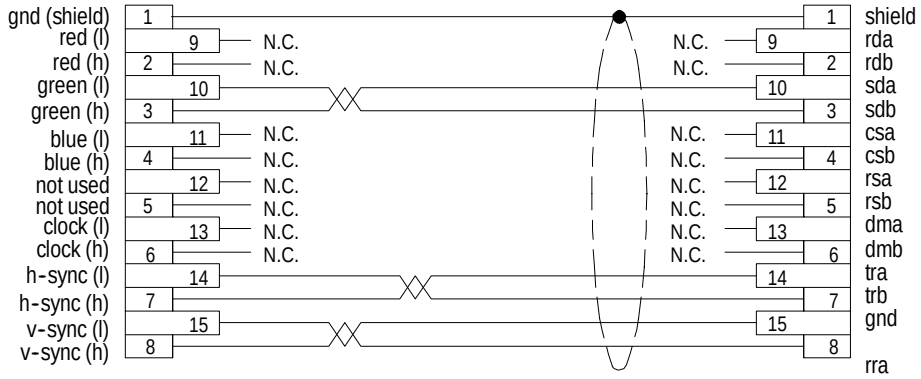


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
15-pin D-shell (has pins) 8520-D25M	Belden 9504	Miscellaneous	15m (50 ft)

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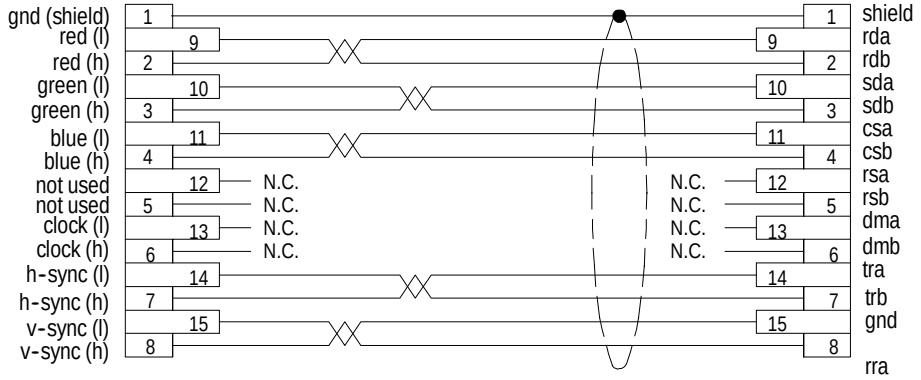
Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C09	9/260 and 9/290	Motherboard J8	Video Signal Cable	CN19M on Operator Panel or on Portable Operator Panel Interface Assembly	Prepared by Customer
	9/230	Processor Board J8			
	9/440 (all)	System Module J8			



Shield (pin 1) on the monochrome operator panel **is not** internally connected to signal common or chassis ground.

Monochrome monitor



Shield (pin 1) on the color operator panel **is** internally connected to signal common and chassis ground.

Color monitor

Indicates twisted pairs

11211-I

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
15-pin D-shell (has pins) 8520-D15M	Belden 9830 (monochrome) Belden 9832 (color)	15-pin D-shell (has sockets) 8520-D15F	15m (50 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C10	9/Series (All)	XMIT Connector (Red)	Fiber Optic Cable	Output Connector (Black)	Prepared by Customer

Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to appendix A for additional information on fiber optic cables and connectors.

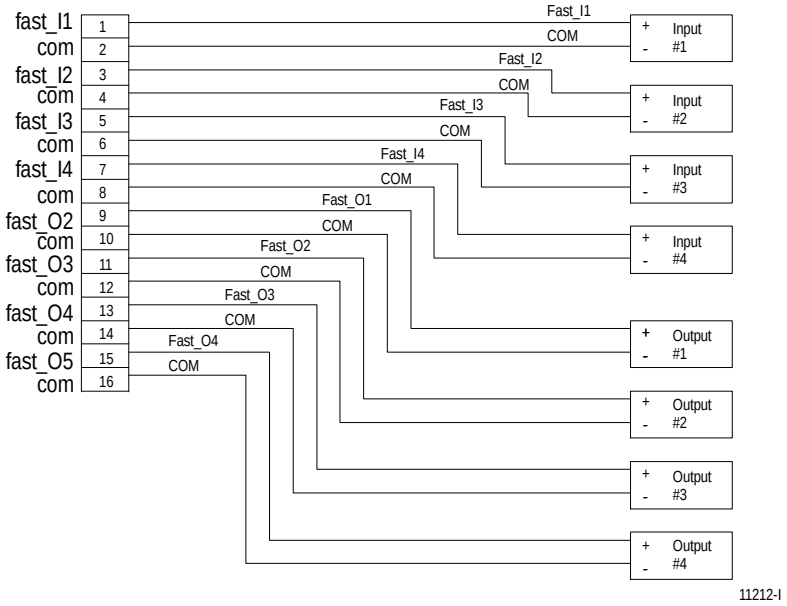
Connector Kit	Cable Type	Connector Kit	Max. Cable Length
8500-FOPS[2]	8500-FOC1 (100 ft) 8500-FOC5 (500 ft)	8500-FOPS[2]	27m (90 ft)

[2] Optical connectors are provided with each module. The catalog number listed under the connector type refers to a spare connector kit. Each kit contains an optical input connector and an optical output connector.

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C11	9/260 and 9/290	Motherboard P3	Fast I/O Interface Cable	Miscellaneous I/O Devices (examples shown)	Purchased by customer from independent vendor.
------	N/A on the 9/230 and 9/440 (all)	----------	----------	----------	----------



Allen-Bradley recommends that you use a terminal block to simplify the wiring of the fast I/O. Refer to the section on fast I/O in 10A-63.

Allen-Bradley also recommends that you purchase a pre-made cable to connect the terminal block to the control.

Important: The Fast I/O feature is an application specific feature. For additional information on this feature contact your Allen-Bradley sales office.

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
16-pin (has sockets)	Ribbon	Miscellaneous	----------

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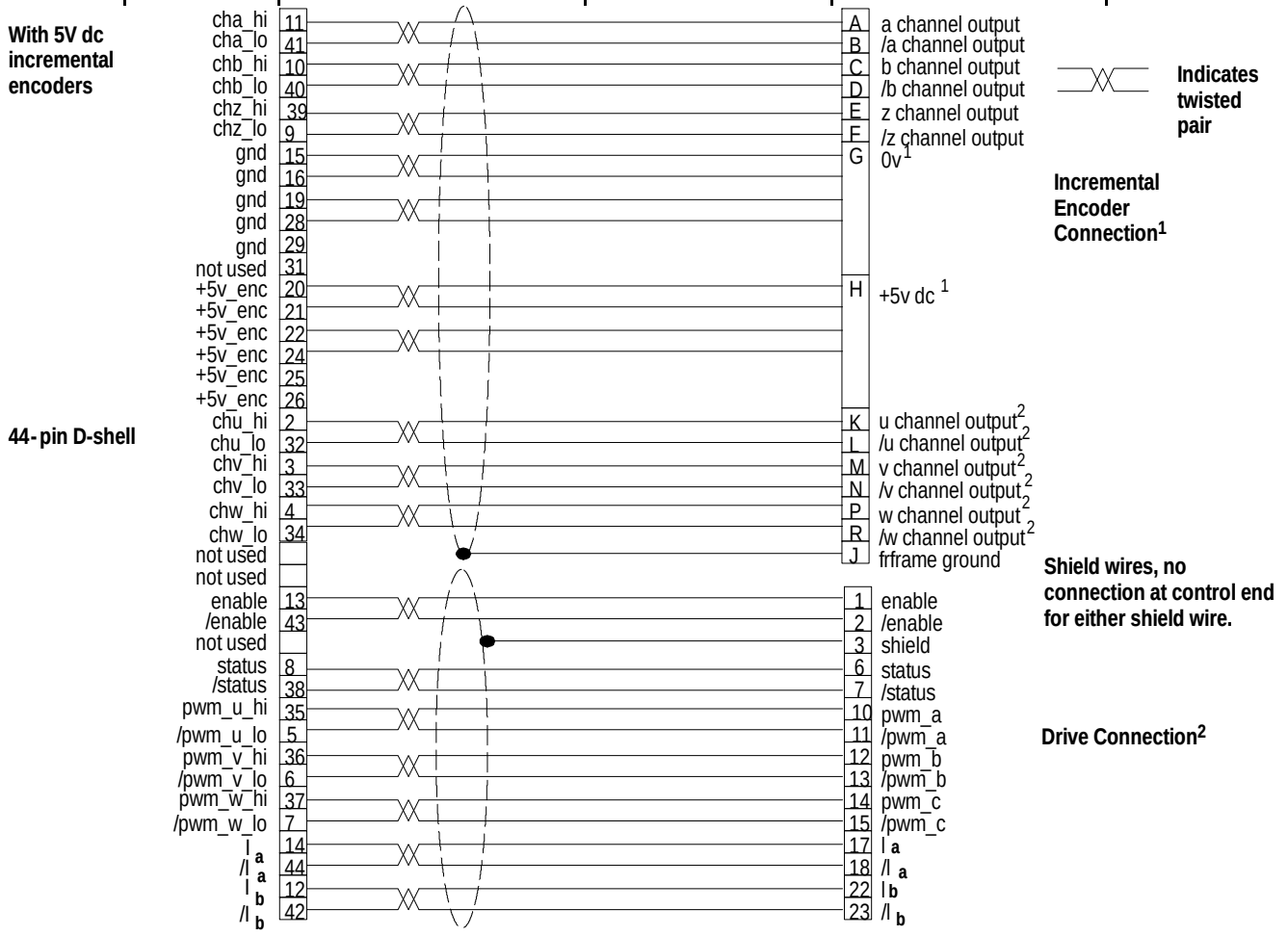
Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C12	9/260 and 9/290	Analog or Digital Servo Module(s) CN1	Servo Module Interface Cable	Motherboard P4, P5, P6 (P5 available on 9/290 only)	Included with Servo Module
------	N/A on the 9/230	----------	----------	----------	----------
C13	9/Series All	Motherboard or Processor Board P1	Battery Backup Cable (dc)	Lithium Battery	Part of Battery Assembly

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C14	9/230, 9/260, 9/290 8520 Digital	9/230 Processor (8520-DSP only) servo connectors (J1,J2, or J3) or 4-axis Digital Servo Module (8520-ENC4) Servo Connector (J1, J2, J3, or J4)	Drive and Inc. Encoder Signal Cable	8500 Servo Motor Encoder and 8520 Digital Servo Amplifier CNA1-CNA3	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
44-pin Miniature D-shell (has pins) 8520-MD44M	Belden 8312 (encoder cable) Belden 9833 (drive signal cable)	MS Style E20-29S 8520-C17F to encoder [1] Honda MR-25LF (has sockets) 8520-H25F to drive[2]	25m (82 ft)

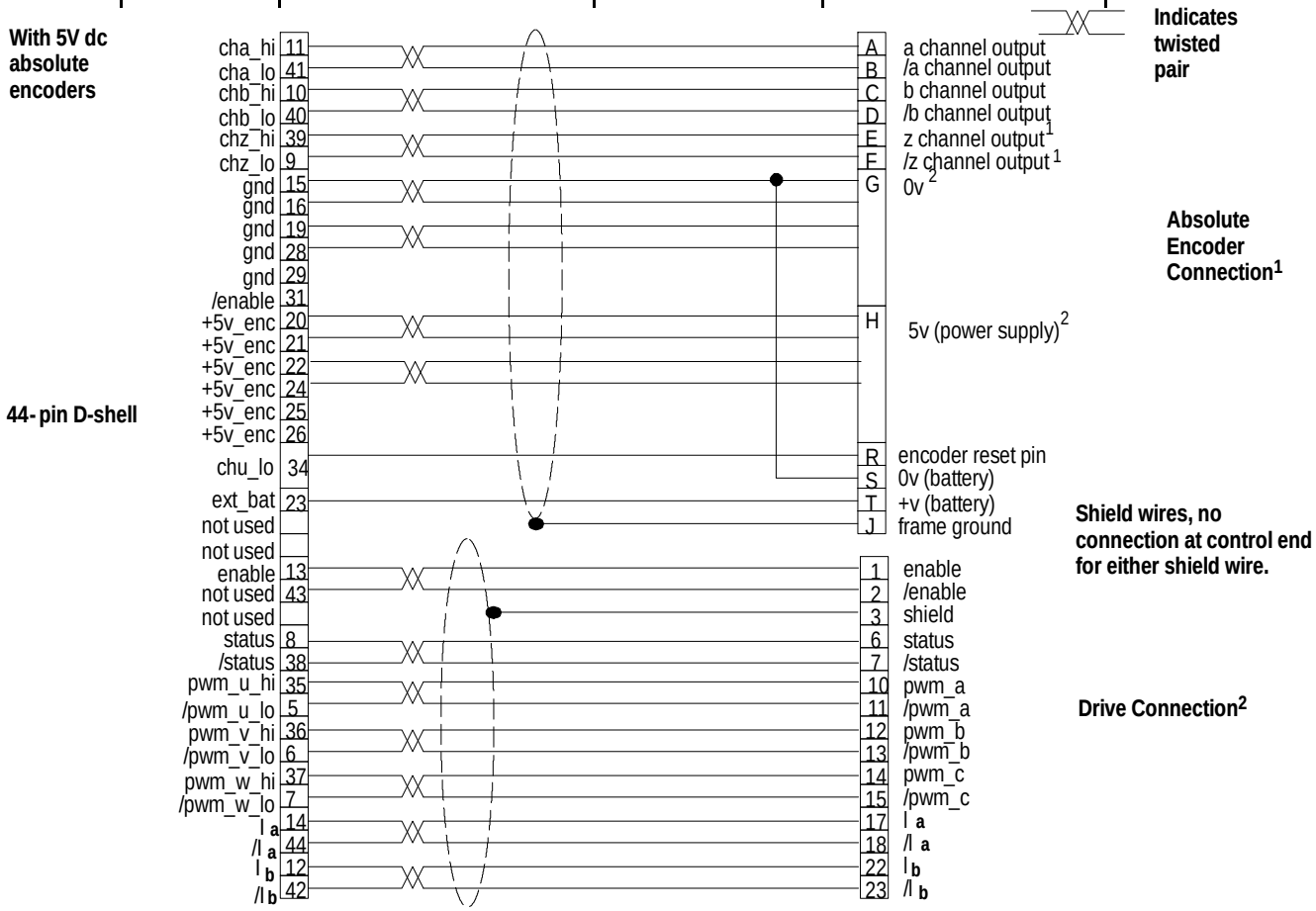
[1] These cables are 22 AWG twisted pairs. Multiple lines (4) must be used to provide the equivalent of 16 AWG encoder power leads.

[2] The U, V, and W channels are used for motor phasing only.

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C14	9/230, 9/260, 9/290 8520 Digital	9/230 Processor (8520-DSP only) servo connectors (J1,J2, or J3) or 4-axis Digital Servo Module (8520-ENC4) Servo Connector (J1, J2, J3, or J4)	Drive and Abs. Encoder Signal Cable	8500 Servo Motor Encoder and 8520 Digital Servo Amplifier CNA1-CNA3	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
44-pin Miniature D-shell (has pins) 8520-MD44M	Belden 8312 (encoder cable) Belden 9833 (drive signal cable)	MS Style E20-29S 8520-C17F to encoder [1] Honda MR-25LF (has sockets) 8520-H25F to drive[2]	25m (82 ft)

[1] The Z channel output is used for the marker signal.

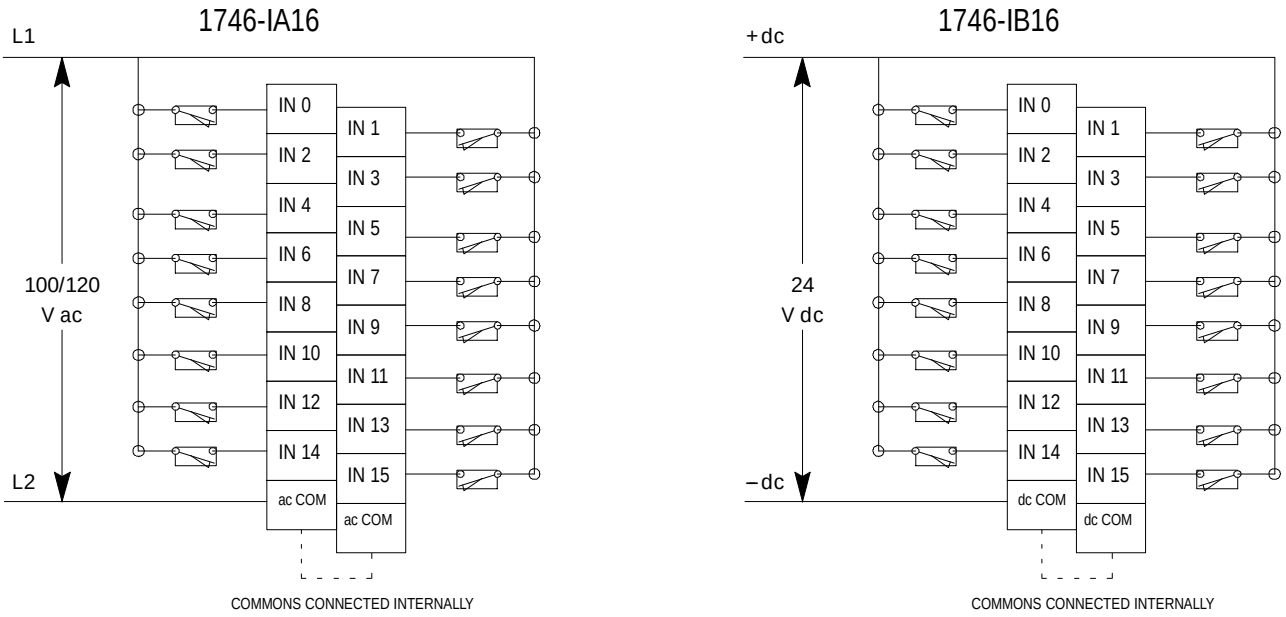
[2] These cables are 22 AWG twisted pairs. Multiple lines (4) must be used to provide the equivalent of 16 AWG encoder power leads.

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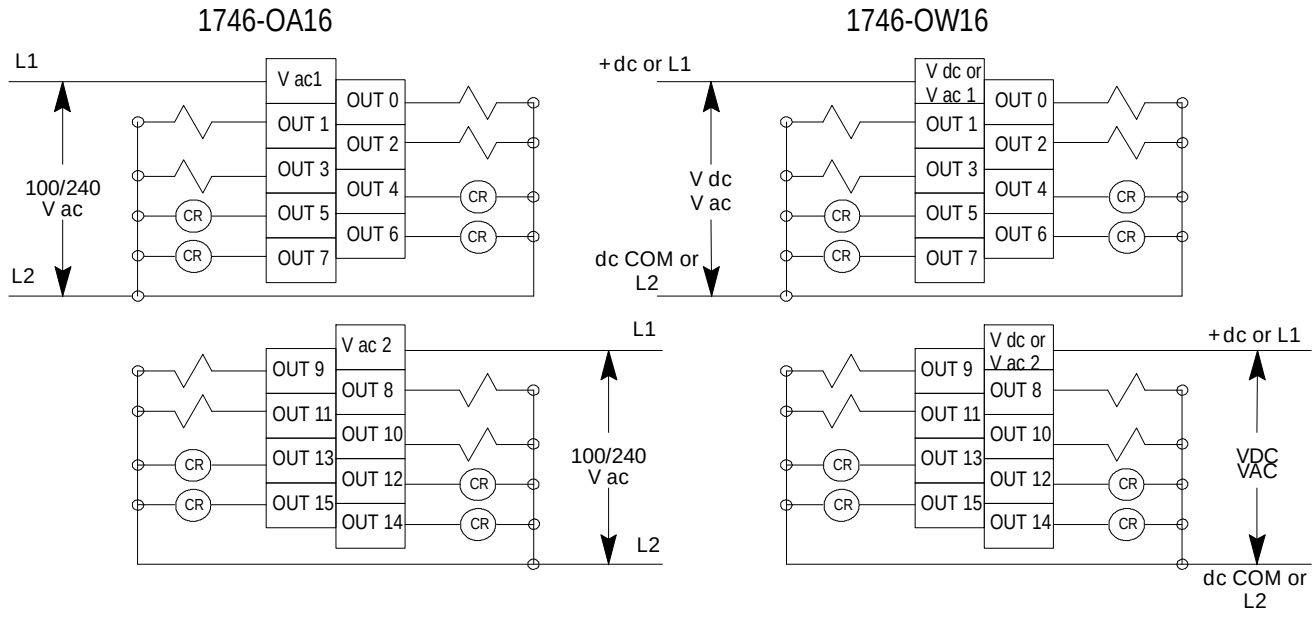
Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C15	All 9/Series	1746 I/O Rack	1746 I/O Device Cable	External I/O (Analog and Digital)	Prepared by Customer

1746 Digital Input Modules



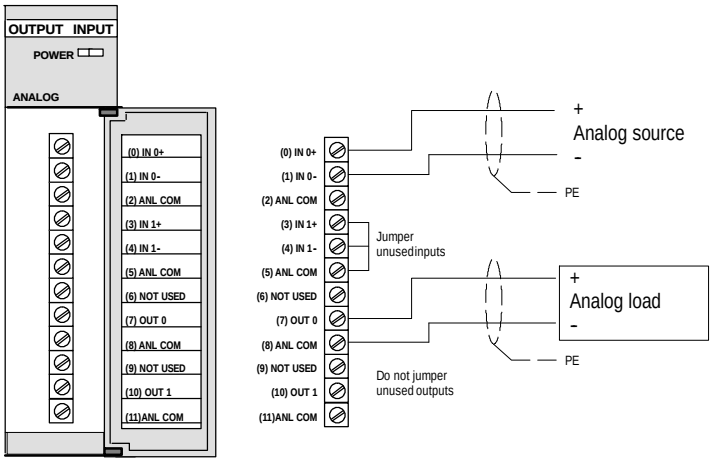
1746 Digital Output Modules



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Table 7A.A
Cable and Connector List (C15 continued)

1746 Analog I/O Modules



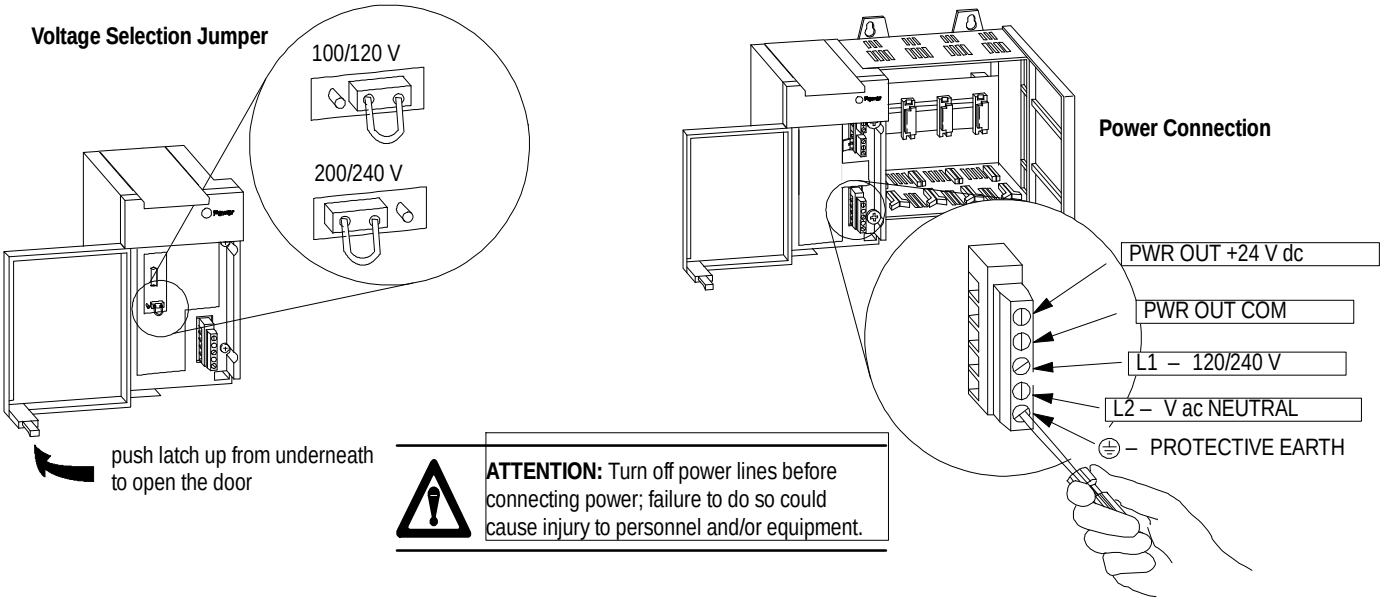
1746-NIO4V

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Terminal Strip	Determined by I/O device	Determined by I/O device	Determined by I/O Device

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C16	All 9/Series	1746 I/O Rack	1746 I/O Power Cable	Customer Power Supply	Prepared by Customer



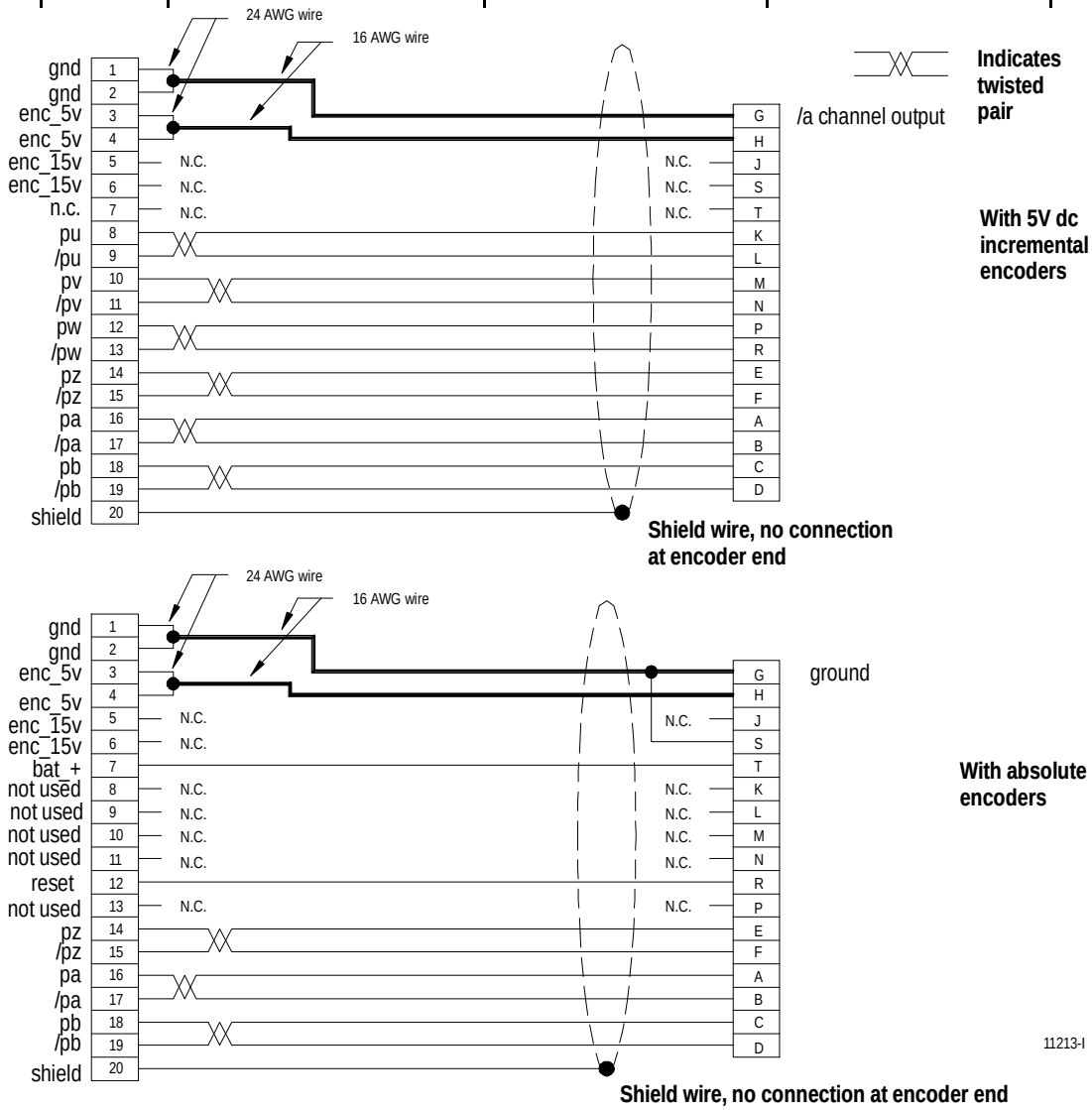
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Supplied	#14 AWG	To customer power supply	N/A

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C17	All 9/Series	Remote I/O Port	1770-CD	PLC Scanner	Purchased from Allen-Bradley Cat. no. 1770-CD

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C18	9/260 and 9/290	3 Axis Digital Servo Module CN5-CN7	Encoder Signal Cable	Servo Motor Encoder	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Honda MR-20LM (has pins) 8520-H20M	Belden 8310 (Incr. encoder) [3] Belden 8308 (Abs. encoder) [3]	MS Style E20-29S 8520-C17F	25m (82 ft)

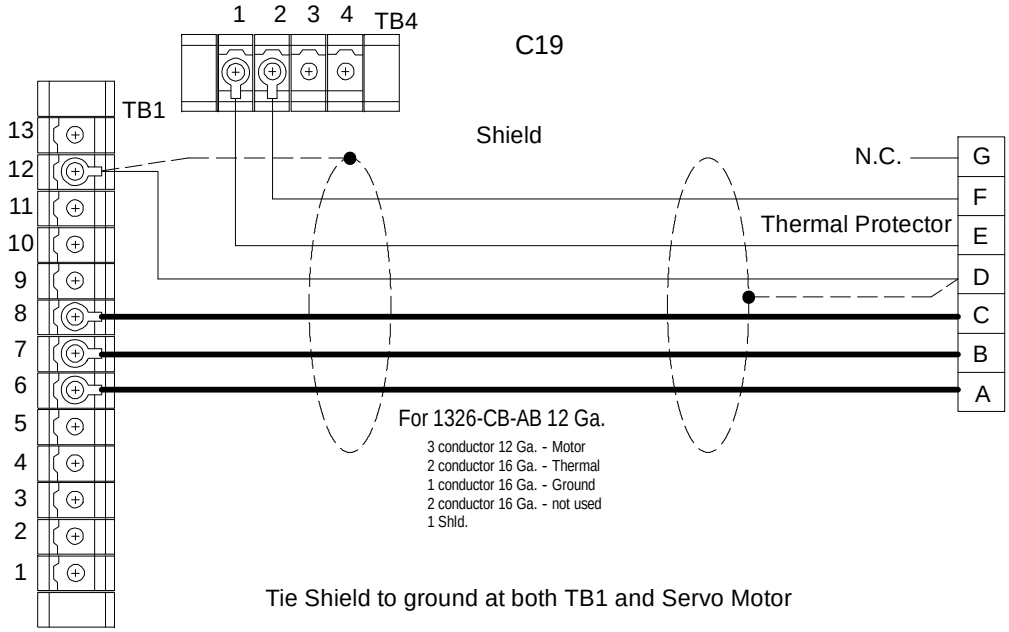
[3] These cables are 22 AWG twisted pairs. Multiple lines (4) must be used to provide the equivalent of the 16 AWG encoder power leads. Instructions are provided in the connector kit.

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C19	9/230, 9/260 and 9/290	8520 Digital Servo Amplifier TB1, TB4	8520 Digital Servo Motor Power Cable (230V ac)	8520 Digital Servo Motor Power Connector	Prepared by Customer

Example for the 2AX-D Amplifier connections to motor one (Series A or B, without brake)



Tie Shield to ground at both TB1 and Servo Motor

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	10 Ga. (TBD) 12 Ga. 1326-CP-AB100 (100 ft) " " -AB200 (200 ft) " " " " 1326-CP-AB1500 (1500 ft)	(E24-10S) (8520-BC7F) MS Style E20-15S 8520-ac7F	20m (65 ft)

An example of the 2AX-D 8520 digital servo amplifier connection to an A and B series 8520 digital servo motor with brake is shown in the next cable drawing.

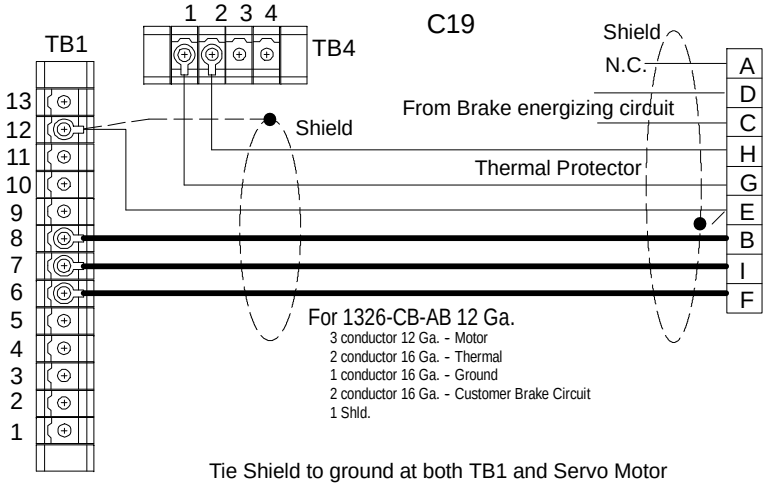
ATTENTION: The pin layout and pin assignments of the connector on the A series servo motor with brake are different than the pin layout and pin assignments of the connector on the B series 8520 digital servo motor with brake. Refer to appendix B for additional information.

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Table 7A.A
Cable and Connector List (continued)

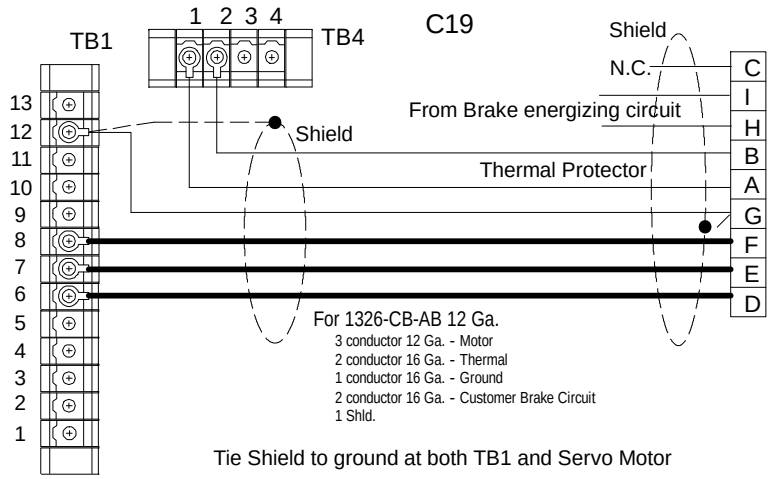
Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C19	9/230, 9/260 and 9/290	8520 Digital Servo Amplifier TB1, TB4	8520 Digital Servo Motor Power Cable (230V ac)	8520 Digital Servo Motor Power Connector	Prepared by Customer
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Example for the 2AX-D Amplifier connectors to motor one (Series A, with brake)



Tie Shield to ground at both TB1 and Servo Motor

Example for the 2AX-D Amplifier connectors to motor one (Series B, with brake)



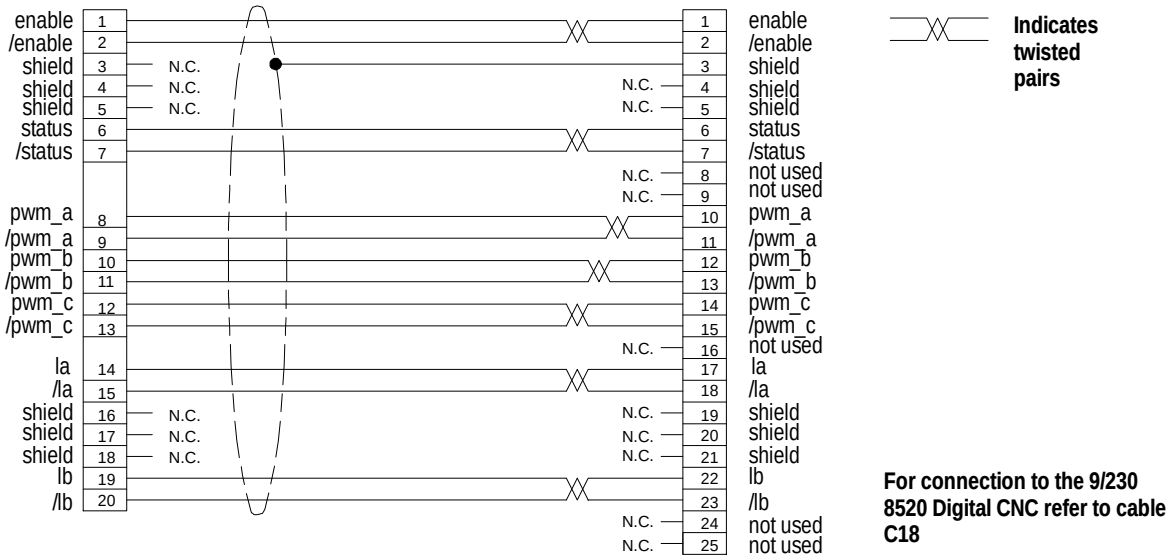
Tie Shield to ground at both TB1 and Servo Motor

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	10 Ga. (TBD) 12 Ga. 1326-CB-AB100 (100 ft) " " -AB200 (200 ft) " " " " 1326-CB-AB1500 (1500 ft)	(E24-11S) (8520-BC9F) MS Style E20-18S 8520-ac9F	20m (65 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C20	9/260 and 9/290	8520 3 Axis Digital Servo Module CN2-CN4	8520 Digital Servo Amplifier Signal Cable (PWM)	8520 Digital Servo Amplifier CNA1-CNA3	Prepared by Customer

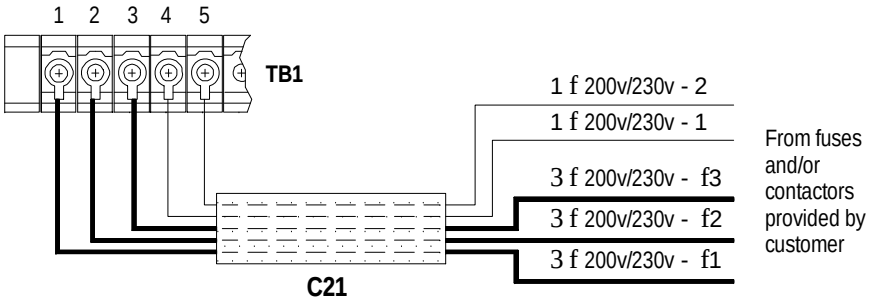


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Honda MR-20LF (has sockets) 8520-H20F	Belden 9508 or Belden 9808	Honda MR-25LF (has sockets) 8520-H25F	25m (82 ft)

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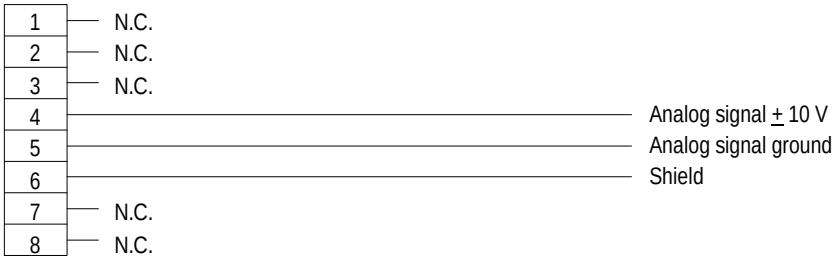
Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C21	9/230, 9/260, 9/290 8520 Digital	8520 Digital Servo Amplifier	8520 Digital Servo Amp. Power Source Cable (230V ac)	External ac Power Source	Prepared by Customer
------	N/A on the 9/230	----------	----------	----------	----------



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limitation

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C22	9/260 and 9/290	8520 3-Axis Digital Servo Module (CN08F)	Analog Spindle Signal Cable	Analog Out Port	Prepared by Customer

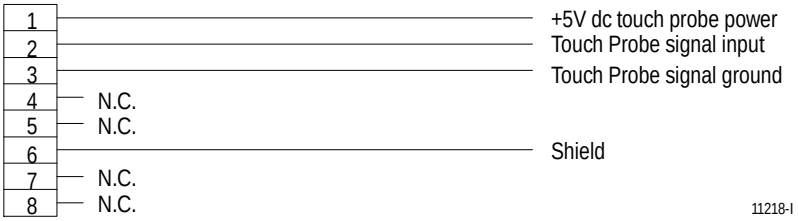


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Honda MR-8LM (has pins) 8520-H8M	Belden 9501	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C23	9/260 and 9/290	8520 3-Axis Digital Servo Module (CN09M)	Touch Probe Signal Cable	Touch Probe	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Honda MR-8LF (has sockets) 8520-H8F	Belden 9502	Miscellaneous	3 m (10 ft)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C24	9/260 and 9/290	Digital Servo Module (CN10M)	Battery Backup Cable (dc)	Lithium Battery	Part of Battery Assembly
C25	All 9/Series	MTB Panel CN56F	RS-232 Serial Interface Cable	I/O Device	Prepared by Customer

For cable wiring examples, refer to page 8-3.

Also refer to the manual included with the I/O device being connected.

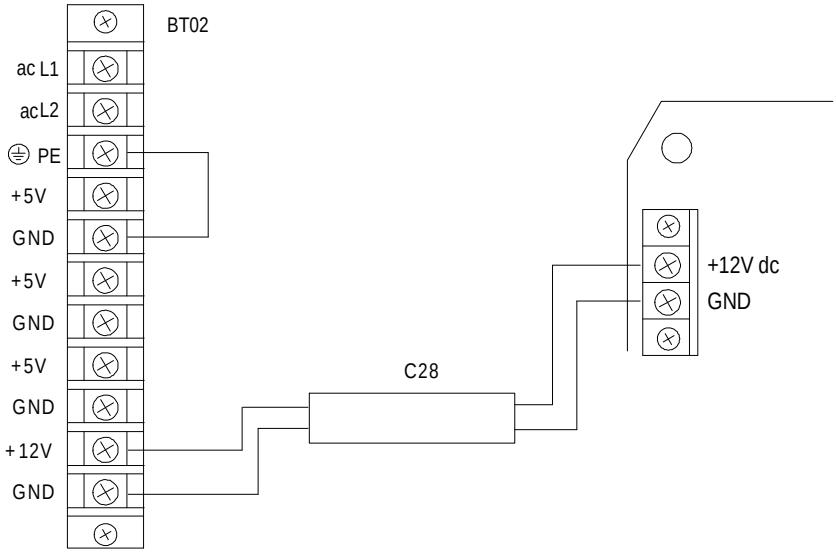
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
25-pin D-shell (has pins) 8520-D25M	Belden 9508	Miscellaneous	[4]

[4] The maximum length of this cable depends on the length of cable C07. The combined length of cables C07 and C25 may not exceed 15 m (50 ft).

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C26	All 9/Series	MTB Panel Input Ribbon Cable	MTB Panel Output Cable	MTB Panel I/O Module CN51	Included with MTB Panel I/O Module
C27	All 9/Series	MTB Panel Output Ribbon Cable	MTB Panel Output Cable	MTB Panel I/O Module CN52	Included with MTB Panel I/O Module
C28	All 9/Series	Power Supply Connector BT02 on Operator Panel or Removable Operator Panel Interface Assembly	MTB Panel I/O Power Cable	MTB Panel I/O Module +12V, GND	Prepared by Customer

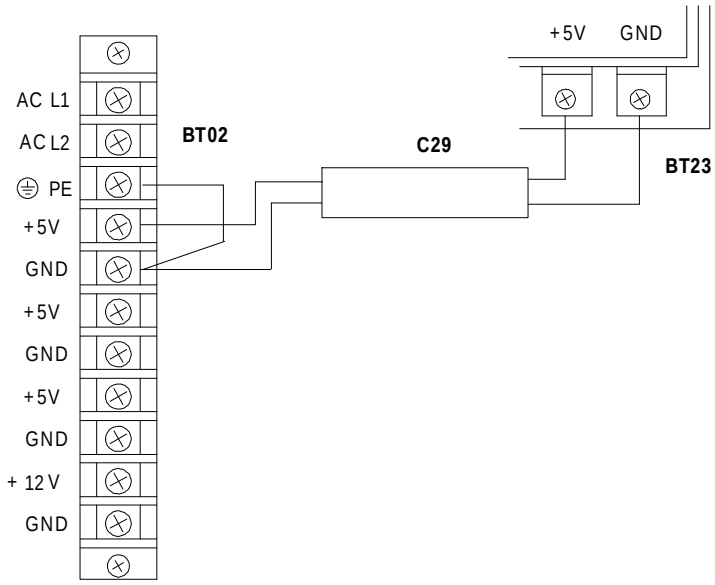


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 8719	Miscellaneous	5m (16 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C29	All 9/Series	Power Supply Connector BT02 on Operator Panel or Removable Operator Panel Interface Assembly	HPG Power Supply Cable	HPG BT23, +5V, GND	Prepared by Customer

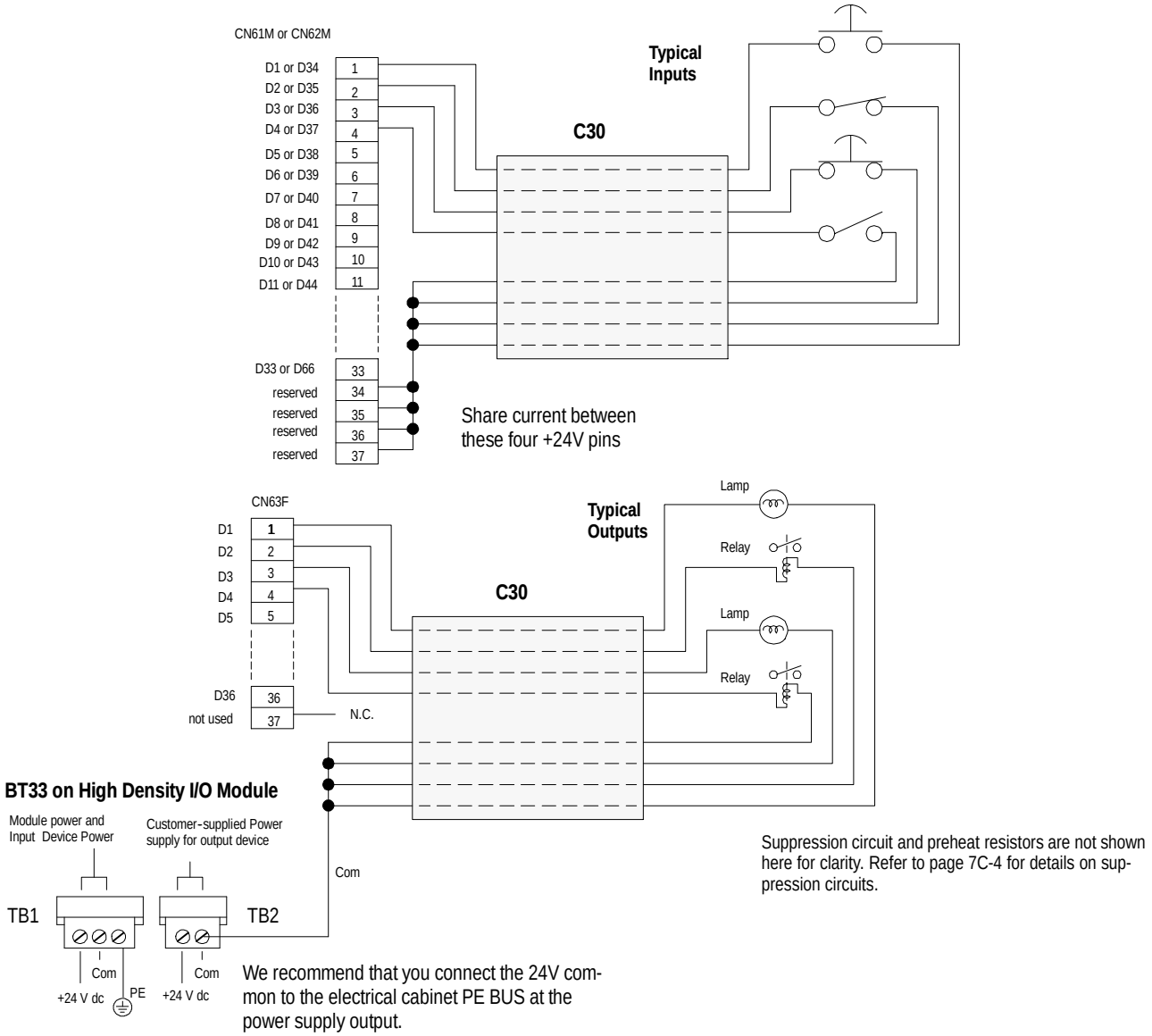


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 8719	Miscellaneous	5m (16 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C30	All 9/Series	High Density I/O CN61M, CN62M, CN63F	High Density Signal Cables	Miscellaneous I/O Devices (examples shown)	Prepared by Customer

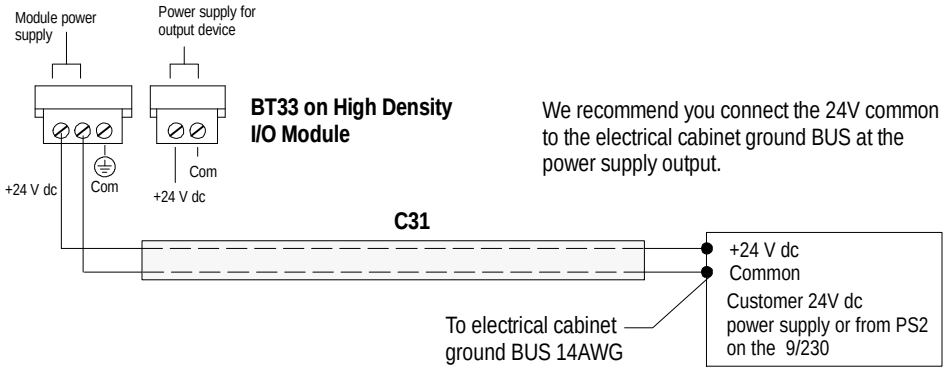


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
37-pin D-shells 2 8520-D37F 1 8520-D37M	Belden 9319	Miscellaneous	Line Drop Limitation
Pins 34, 35, 36, and 37 are reserved for common points.			

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C31	All 9/Series	High Density I/O BT33	High Density I/O Power Source Cable (24V dc)	External dc Power Source	Prepared by Customer



BT33 on High Density I/O Module

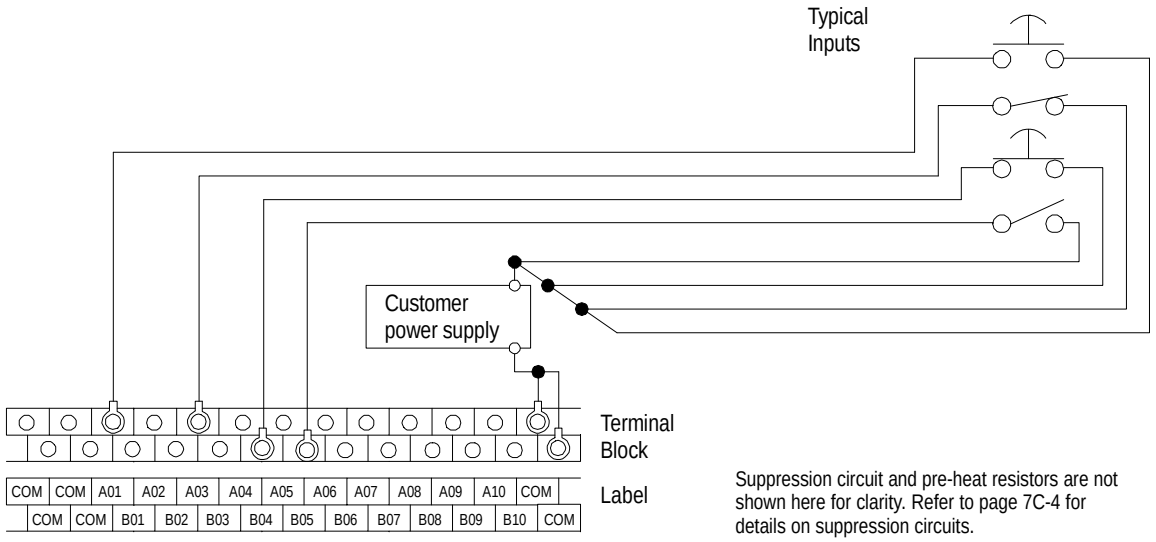
We recommend you connect the 24V common to the electrical cabinet ground BUS at the power supply output.

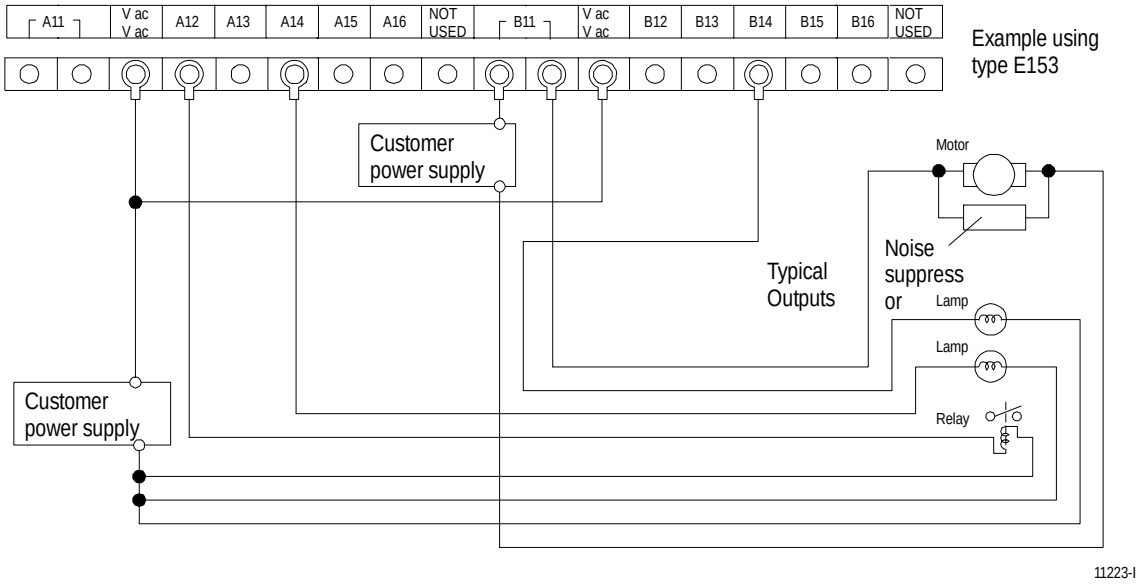
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9411	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C32	All 9/Series	Digital I/O BT31, BT32	Digital I/O Signal Cable	Miscellaneous I/O Devices (examples shown)	Prepared by Customer



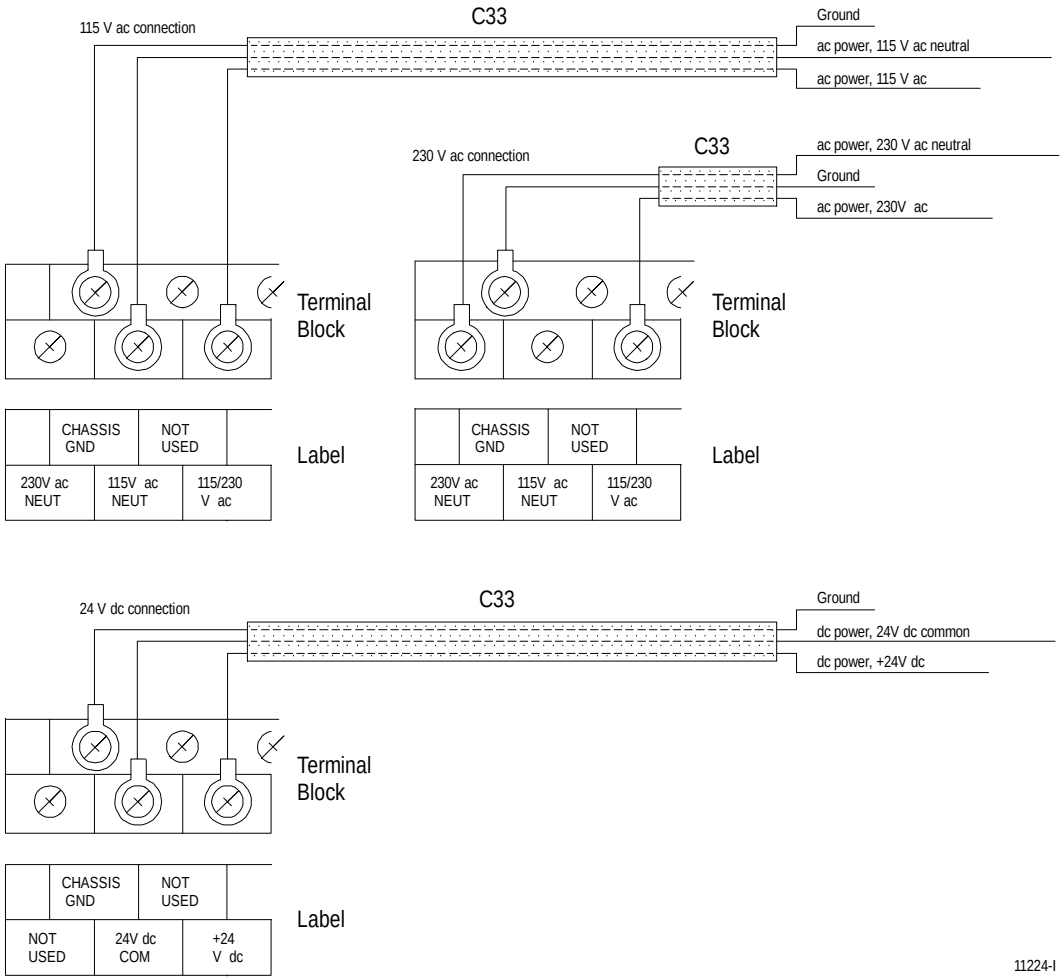


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C33	All 9/Series	Digital I/O BT31	Digital I/O Power Source Cable (115/230V ac, 24V dc)	External ac/dc Power Source	Prepared by Customer

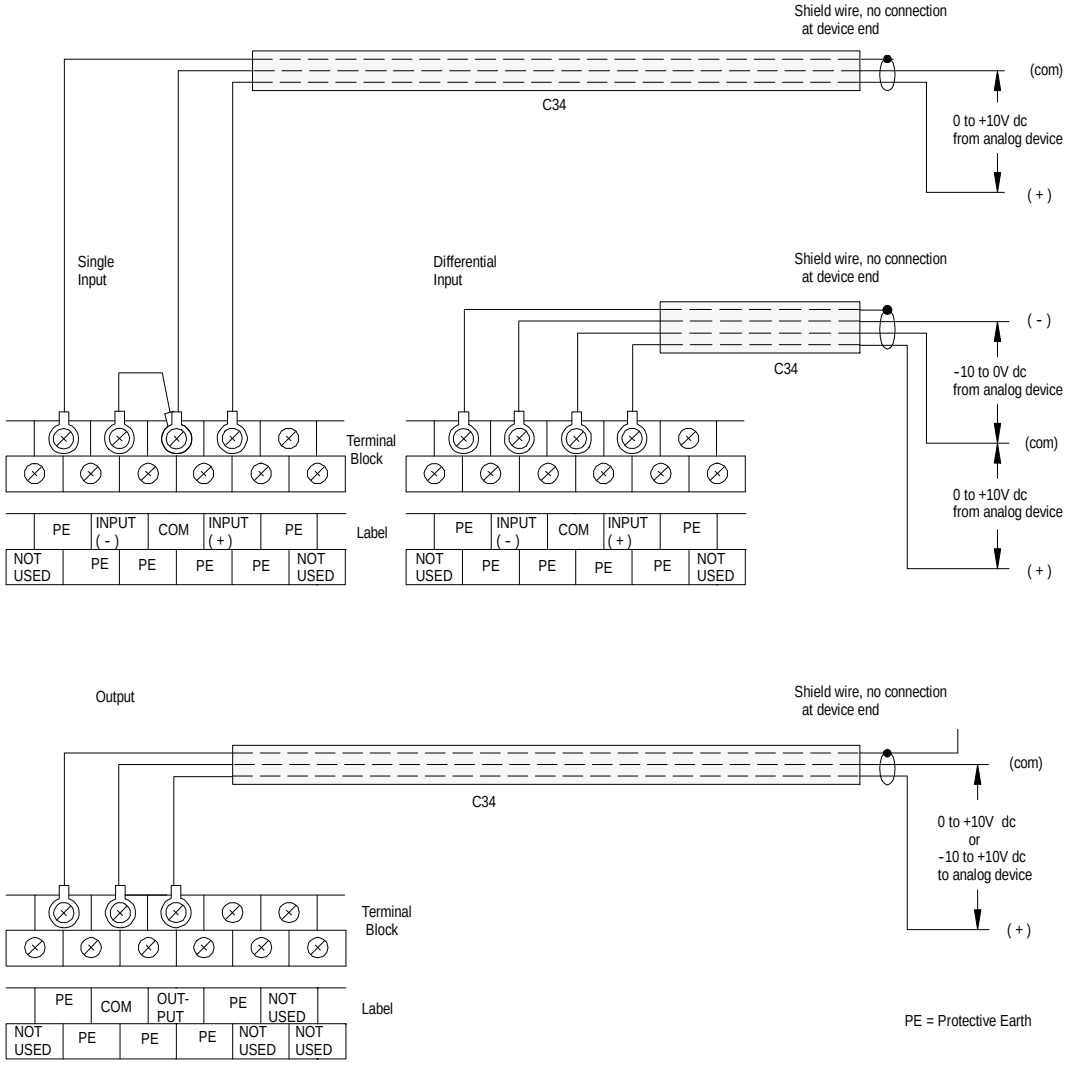


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C34	All 9/Series	E-Series Analog I/O	Analog I/O Signal Cable	Miscellaneous Analog Devices	Prepared by Customer

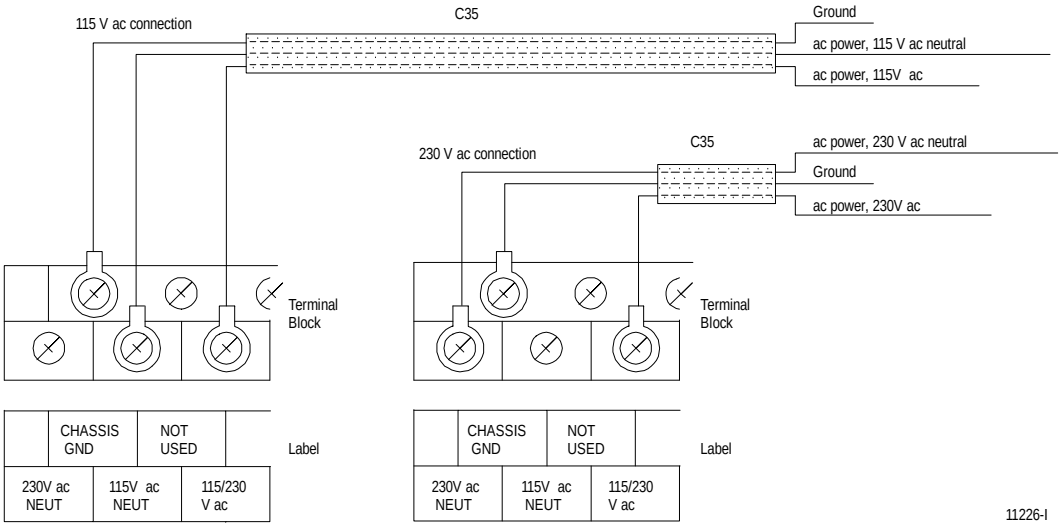


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9501 or 9502	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C35	All 9/Series	E-Series Analog I/O	Analog I/O Power Source Cable (115/230V ac)	External ac Power Source	Prepared by Customer

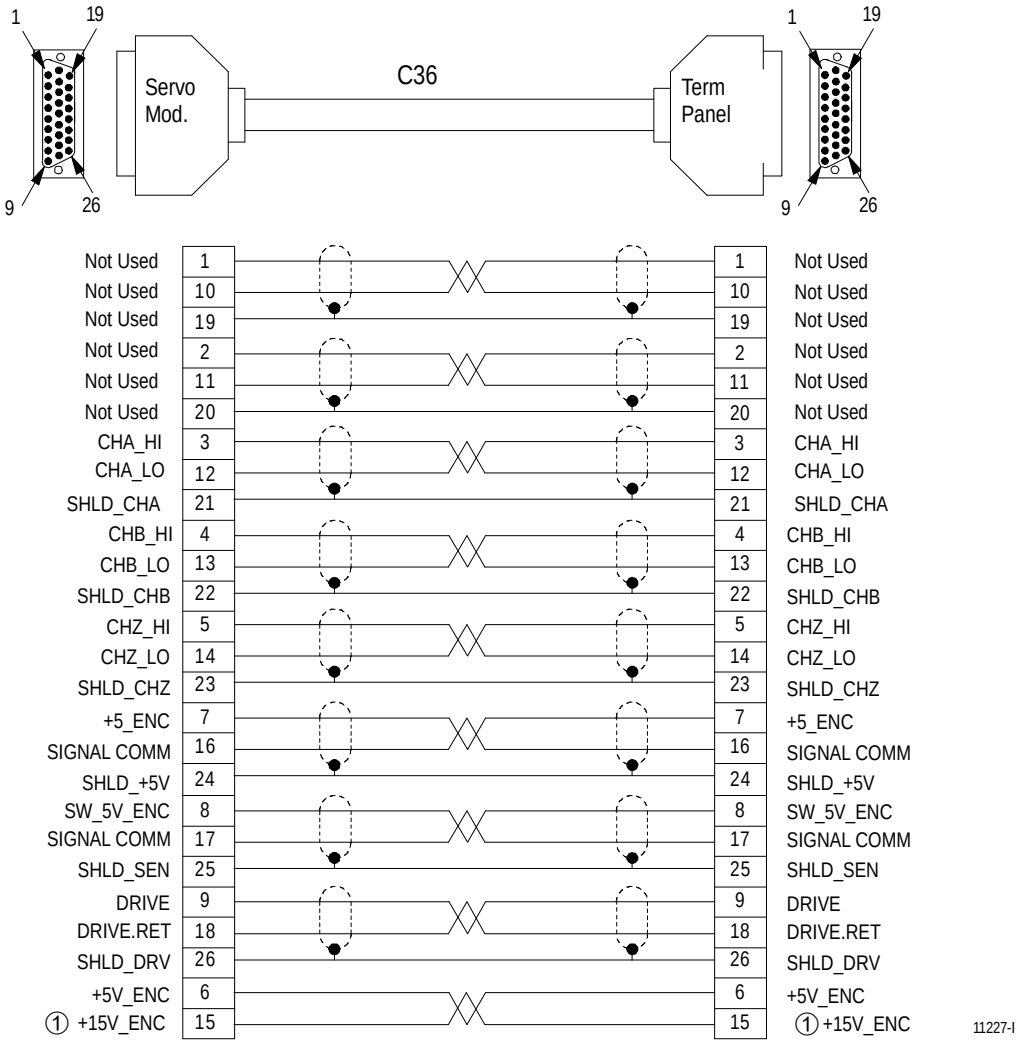


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Per Local Codes	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C36	9/230, 9/260, and 9/290	3-axis Analog Servo Module or Processor Board J1, J2, and J3	Encoder and Analog Drive Signal Cable	1771-HTE Enc. Termination Panel AXIS terminal	Purchased from Allen-Bradley 8500-TPC



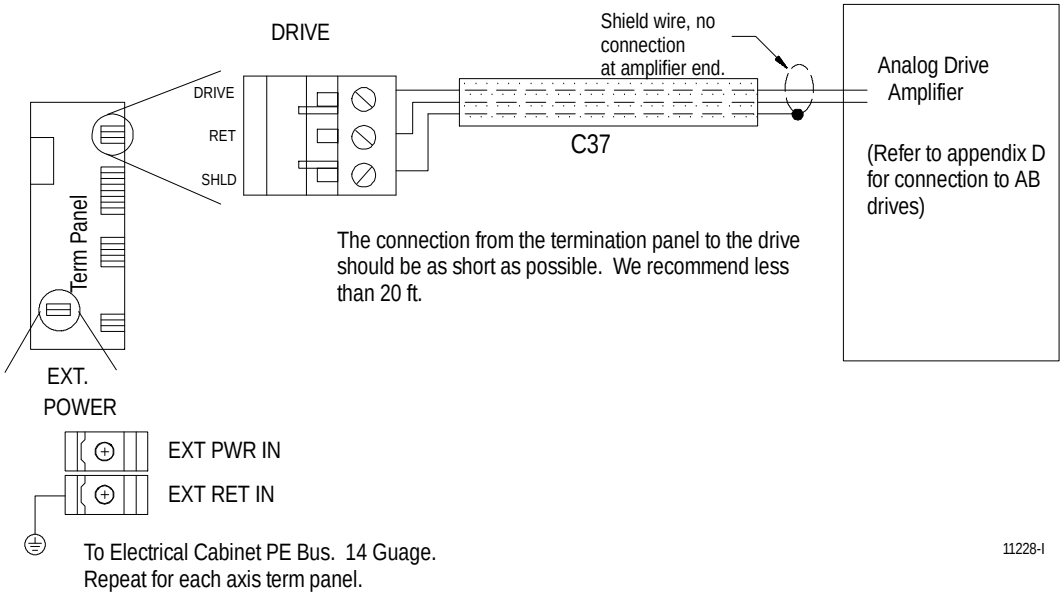
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
26-pin D-shell (has pins)	8500-TP (A-B part number)	26-pin D-shell (has pins)	120 inch +5.5”or -1.5”

① This pin is not connected on the 9/230 CNC

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C37	9/230, 9/260, and 9/290	1771-HTE Enc. Termination Panel DRIVE terminal	Analog Servo Amplifier Signal Cable	Analog Servo Amplifier	Prepared by Customer or purchase with AB-Drives

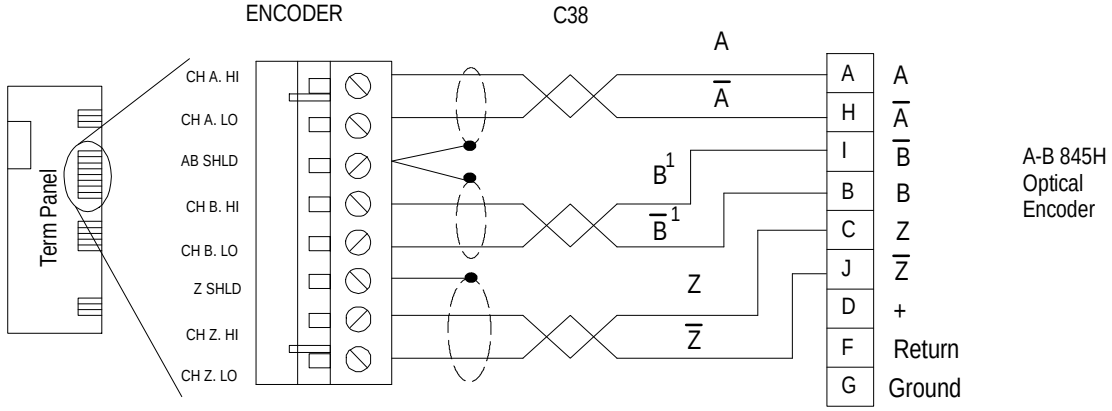


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
none	Belden 9501	Miscellaneous	25 m (82 ft) (measured from TERM panel)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C38	1771-HTE Enc. Termination Panel ENCODER terminal	Analog Servo Feedback Encoder Cable	A-B 845H Optical Encoder	Prepared by Customer or purchase with AB-Drives



[1] To comply with the 9/Series encoder timing, the 845H B high terminal must be connected to the 9/Series B low terminal, and the 845H B low terminal must be connected to the 9/Series B high terminal. For the 9/Series encoder timing diagram refer to the description of parameter **Position Feedback Type** in your AMP reference manual.

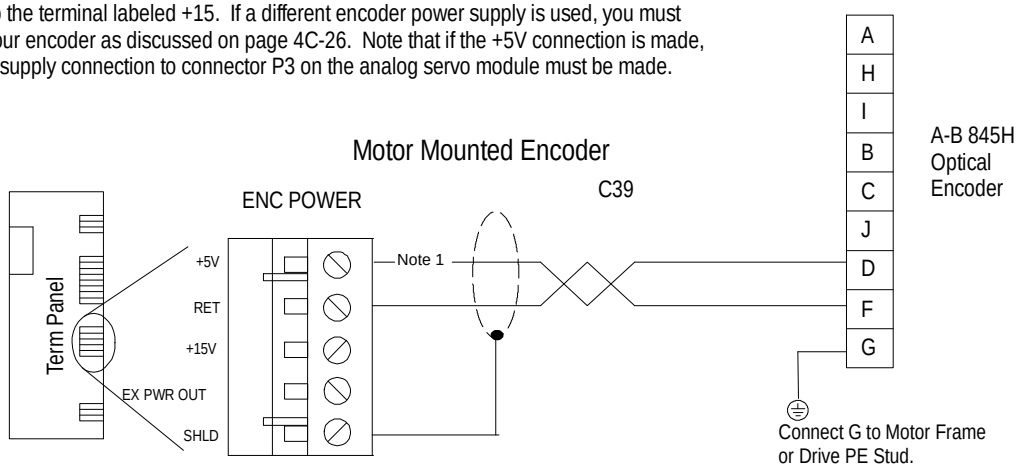
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
none	Belden 9730	Miscellaneous	25 m (82 ft) (measured from TERM panel)

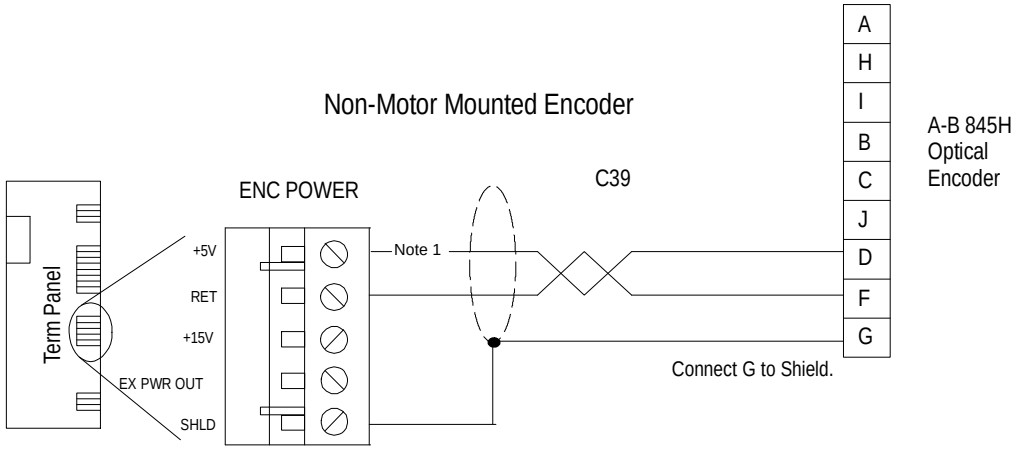
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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C39	9/230, 9/260, and 9/290	1771-HTE Enc. Termination Panel ENC POWER terminal	Analog Servo Encoder Power Cable	A-B 845H Optical Encoder	Prepared by Customer or purchase with AB-Drives

Note 1: Be aware that this connection is dependent on the necessary encoder voltage. If 5V dc encoders are used connect this wire as shown below. If a 15V dc encoder is used, connect this wire to the terminal labeled +15. If a different encoder power supply is used, you must connect your encoder as discussed on page 4C-26. Note that if the +5V connection is made, the power supply connection to connector P3 on the analog servo module must be made.





Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
none	Belden 8719	Miscellaneous	25 m (82 ft)

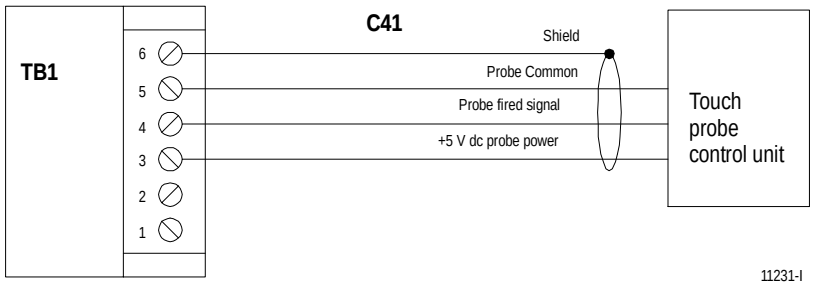
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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C40	9/230, 9/260, and 9/290	Analog Servo Amplifier	Analog Servo Drive Signal Cable	Servo Motor	Prepared by Customer

Refer to Appendix D for A-B drives or refer to drives manual for details.

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C41	9/260, and 9/290	Analog Servo Module BAT/TP (TB1)	Touch Probe Cable	Touch Probe	Prepared by Customer

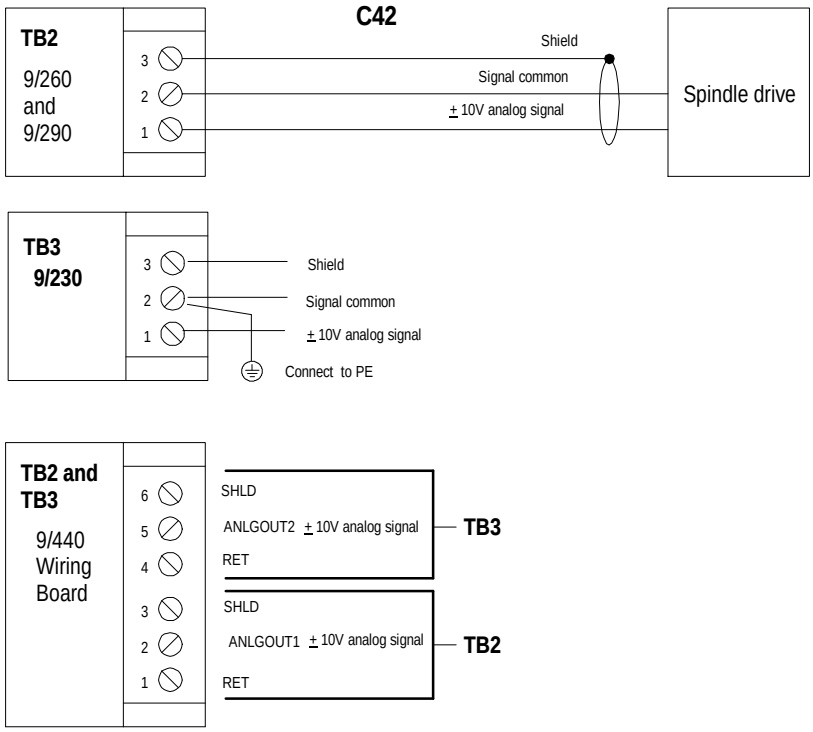


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
None	Belden 9502	Miscellaneous	3 m (10 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C42	9/260, and 9/290	Analog Servo Module ANALOG OUT (TB2)	Analog Servo Module Drive Signal Cable	Analog Drive Spindle Drive Amplifier	Prepared by Customer
C42	9/230	Processor Board ANALOG OUT (TB3)			
C42	9/440 (all)	Wiring Board ANALOG OUT (TB2 and TB3)			



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
None	Belden 9501	Miscellaneous	3 m (10 ft)

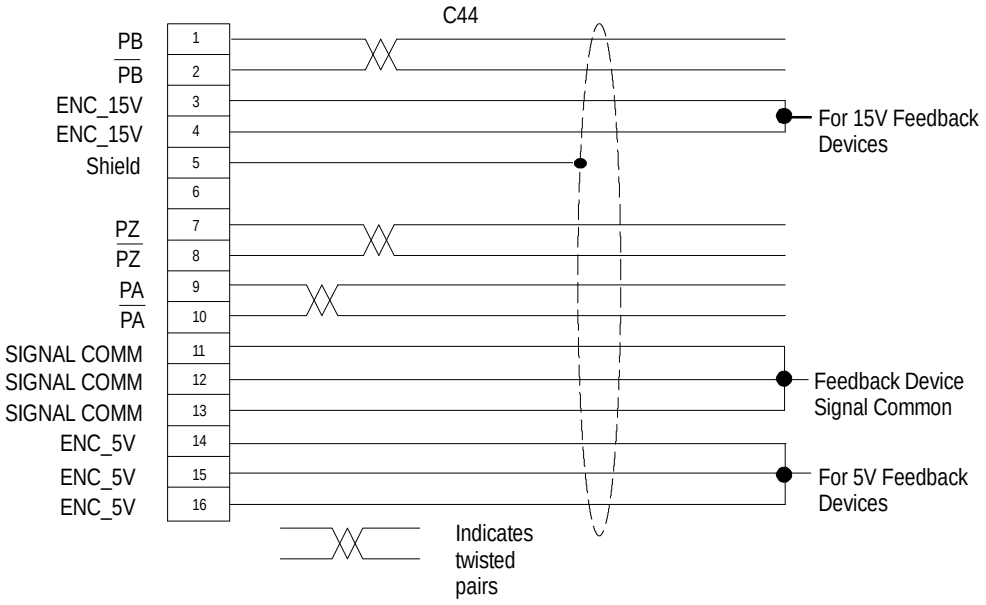
Refer to the drives manual provided with your Spindle Drive Amplifier for details.

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C43	9/260 and 9/290	Optional Feedback Module (CN24M)	+5V dc Encoder Power Supply Cable	8520 3 Axis Digital Servo Module (CN13)	Included with Optional Feedback Module

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C44	9/260 and 9/290	Optional Feedback Module (CN14F, CN15F, CN16F)	Non-motor Mounted Feedback Device Feedback Cable	Non-motor Mounted Feedback Device	Prepared by Customer



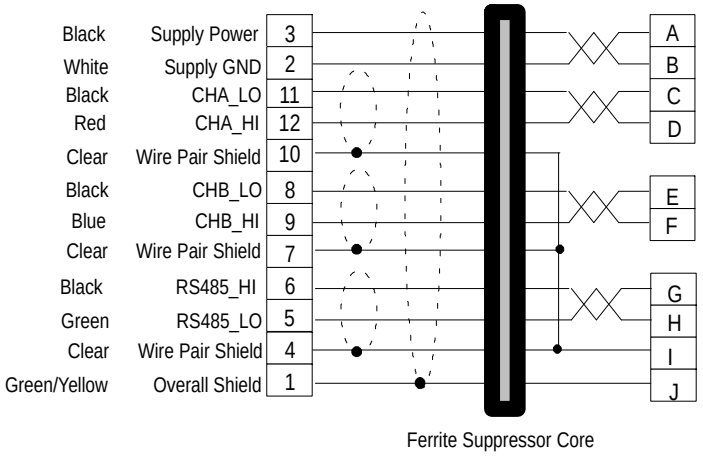
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Honda MR-16LM (has pins) 8520-H16M	Belden 8308 [5]	Miscellaneous	25m (82 ft)

[5] This cable has 22 AWG twisted pairs. Multiple lines (4) must be used to provide sufficient power to the feedback device. Instructions are provided in the connector kit.

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Table 7A.A
Cable and Connector List (continued)

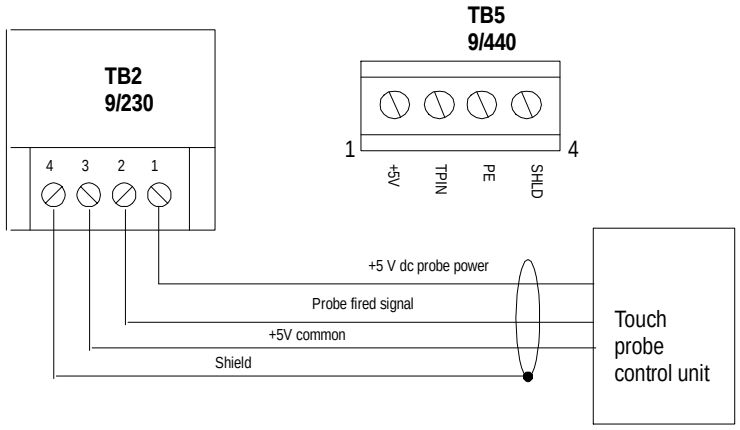
Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C45	9/440HR	9/440HR System Module Feedback Board	9/440HR 1326 Motor-mounted HIPERFACE Feedback Cable	9/440HR 1326 Motor-mounted HIPERFACE	Purchased with System (1326-CCU-xxx)



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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C46	9/230	Processor Board TP (TB2)	Touch Probe Cable	Touch Probe	Prepared by Customer
	9/440 (all)	System Module Wiring Board (TB5)			

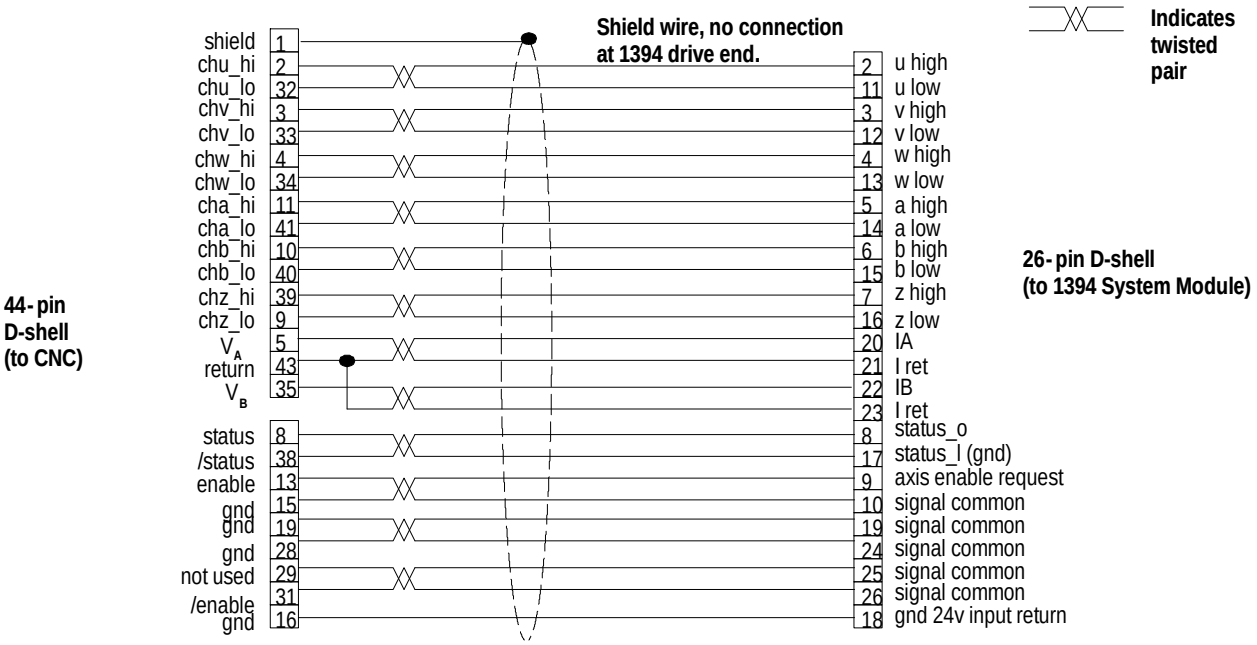


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
None	Belden 9502	Miscellaneous	3 m (10 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C47	9/Series 1394 Digital	9/230 Servo Connector (J1, J2, or J3)	1394 CNC Interface Cable	1394 System Module	8520-DSC

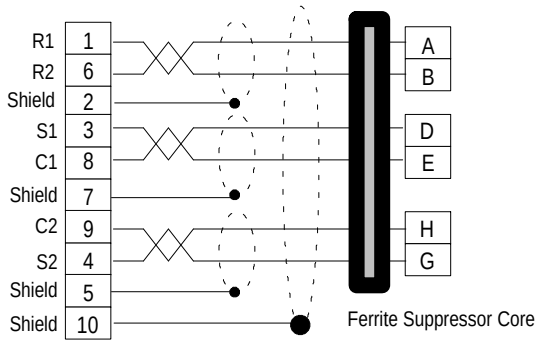


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
44-pin Miniature D-shell (has pins) 8520-MD44M	AB 8520-DSC	26 pin Miniature D-shell (has pins) 8520-MD26M	25m (82 ft) (8520-DSC comes 27 inches standard)

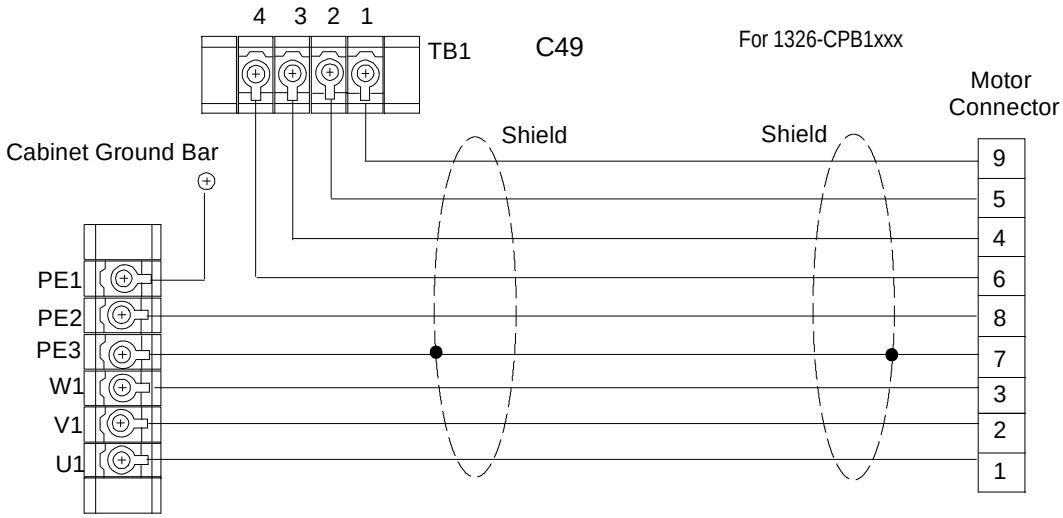
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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C48	1394 Digital Amplifier or 9/440 Resolver-based	1394 CNC System Module	1394 Resolver Interface Cable. (note this cable requires 360 °shielding for CE compliance. See page 17-9 in this manual.)	1326 Motor-mounted Resolver	Purchased with System (1326-CCU-xxx)



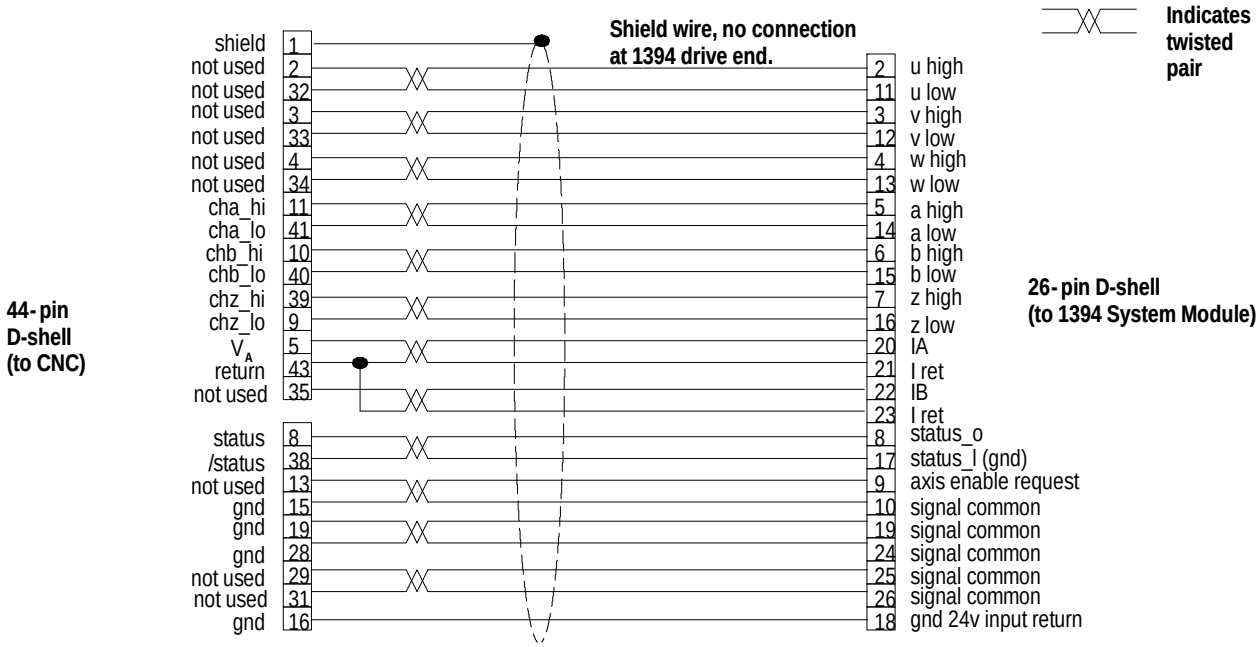
Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C49	1394 Digital Amplifier or 9/440 (all)	1394 Axis Module	1394 Motor Interface Cable (note this cable requires 360 ° shielding for CE compliance. See page 17-9 in this manual.)	1326 Motor	Purchased with System (1326-CPB1xxx)



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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C50	9/260, 9/290	4-axis 1394/Analog Servo Module (8520-SM4)	1394 CNC Interface Cable	1394 System Module	Customer Supplied

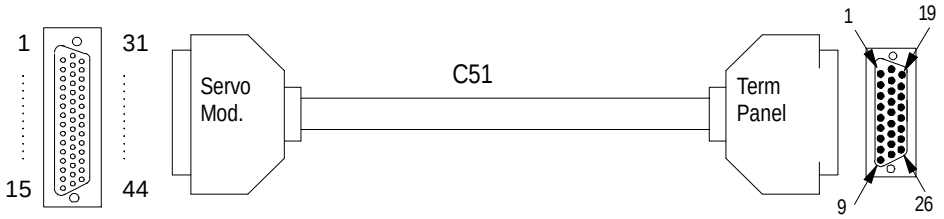


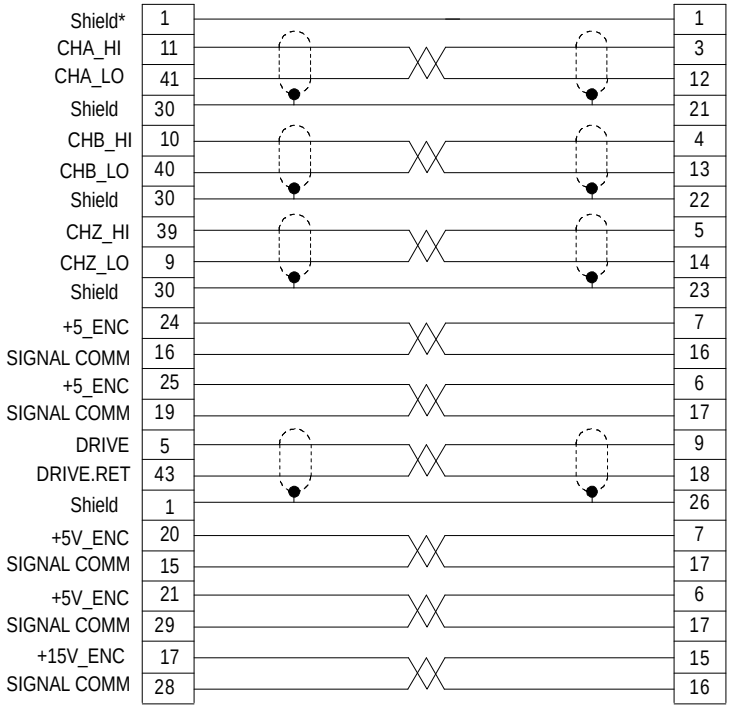
Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
44-pin Miniature D-shell (has pins) 8520-MD44M	Belden 9515	26-pin Miniature D-shell (has pins) 8520-MD26M	25m (82 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C51	9/260, and 9/290	4-axis 1394/Analog Servo Module (8520-SM4)	Encoder and Analog Drive Signal Cable	1771-HTE Enc. Termination Panel AXIS terminal	Customer Supplied





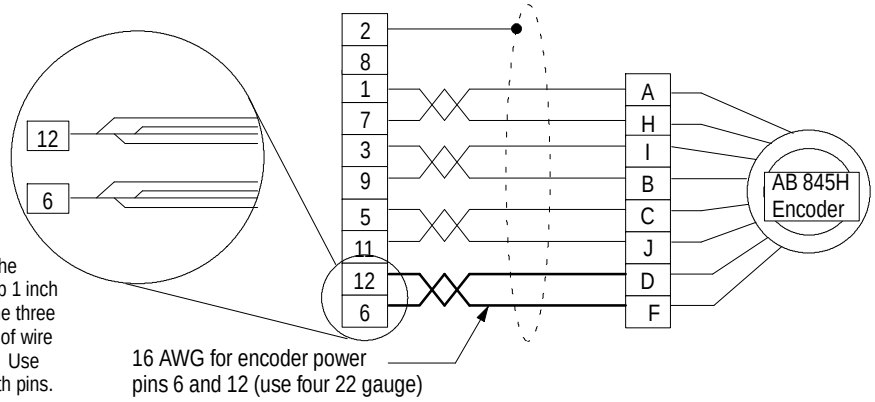
* Use one of the unused drain wires from a twisted pair for the pin one to pin one connection.

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
44-pin D-shell (has pins)	Belden 8774	26-pin D-shell (has pins)	120 in. +5.5 or -1.5 in.

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C52	9/440 Resolver-based	9/440 Resolver-based System Module Feedback Board	Encoder Signal Cable	AB 845H Encoder	Customer Supplied

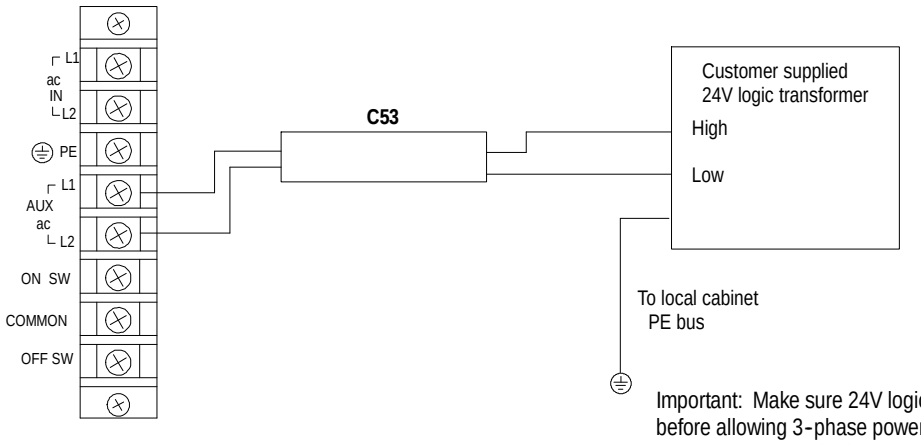


Use four 22 gauge twisted pair to make the power connections to pins 6 and 12. Strip 1 inch of one lead and solder into pin. Solder the three remaining leads to the exposed one inch of wire to make the equivalent of 16 gauge wire. Use the appropriate wire tape. Repeat for both pins.

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
AMP 770581-1	Belden 8307	MS Type	25 m (82 ft.)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C53	9/440 (all)	On/Off Power Control Module	115V Transformer Feed	24V Logic Transformer (customer supplied)	Prepared by Customer

On/Off Power Control Module



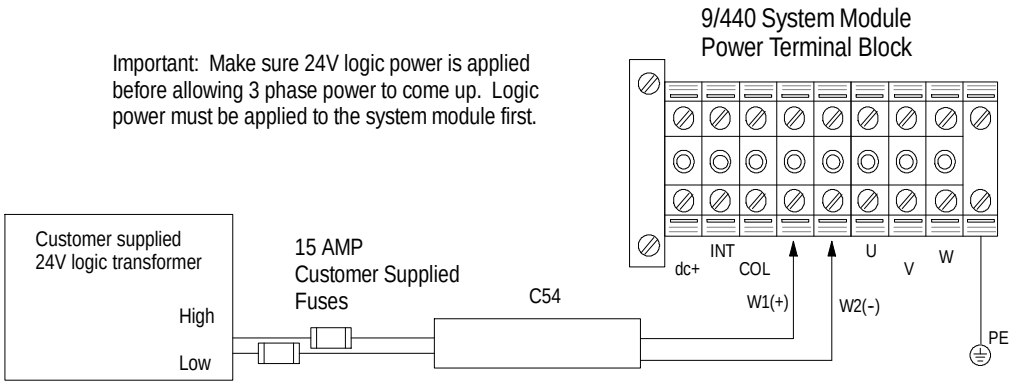
Important: Make sure 24V logic power is applied before allowing 3-phase power to come up. Logic power must be applied to the system module first.

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9409	Miscellaneous	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C54	9/440 (all)	24V Logic Transformer (customer supplied)	24V Logic Power	9/440 System Module Power Terminal Block	Prepared by Customer

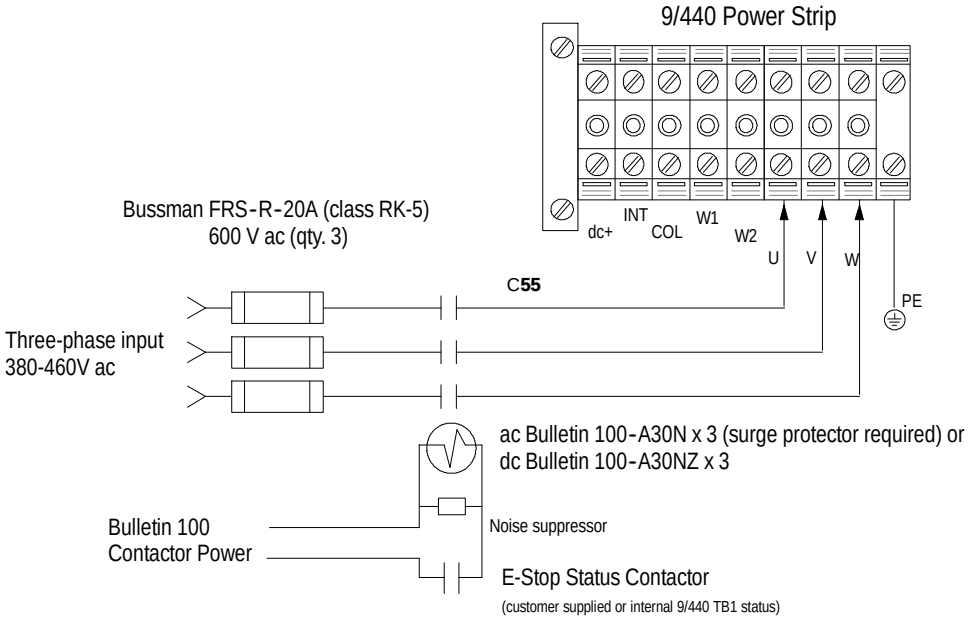


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	Belden 9409	Clamped by terminal screws	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C55	9/440 (all)	External 380/460V Three Phase	Drive Power	9/440 System Module Power Terminal Block	Prepared by Customer



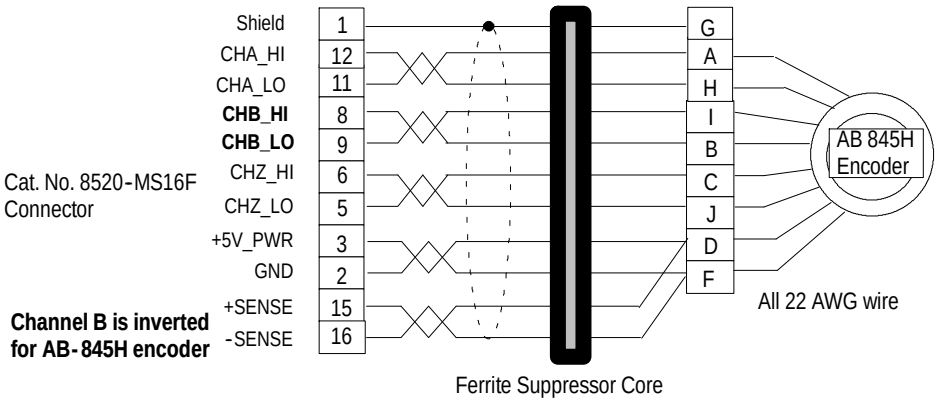
ATTENTION: Brake control should not be directly released by the E-Stop status relay (or your customer supplied E-Stop control relay). Brakes should only be released by the PAL logic when it has determined that the 9/440 is in full control of the servo motors and the control is out of E-Stop. See the description of the PAL flag $PFLT.15 for detail on how to test drive status.

Connector On End of Cable	Cable Type	Connector on End of Cable	Max. Cable Length
Miscellaneous	See Local Codes (12Awg max)	Clamped by terminal screws	Line Drop Limitation

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C56	9/440HR	9/440HR System Module Feedback Board (J9 - J12)	A quad B Optional Feedback Device	AB 845H Encoder	Prepared by Customer

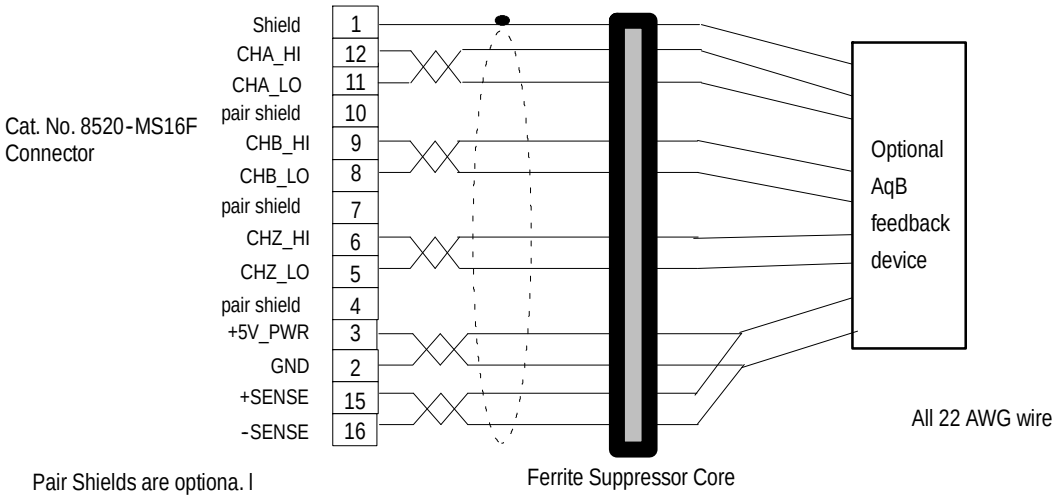


Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Molex 43025-1600	Belden 830	MS Type	25 m (82 ft)

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Table 7A.A
Cable and Connector List (continued)

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C56	9/440HR	9/440HR System Module Feedback Board (J9 - J12)	A quad B Optional Feedback Device	generic AqB Feedback Device	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Molex 43025-1600	Belden 830	MS Type	25 m (82 ft)

END OF SECTION

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Section 7B

Fiber Optic Connections

7B.0 Section Overview

Page 1B-1 begins illustrations of typical small and large system configurations and the modules that can be used. Most inter-module communication is accomplished through fiber optics.

Most I/O devices, including handwheels, the standard MTB panel, and the operator panel, are connected to the control through an "I/O ring". Ring devices each have an optical transmitter and receiver. Optical transmitters are connected to optical receivers using fiber optic cable to form the I/O ring.

The I/O ring must be complete; each transmitter must be connected to a receiver or an I/O ring communications error will occur.

Each module using the I/O ring must be included in the I/O Assignment file. The I/O Assignment file is edited using the I/O Assignments utility of the Offline Development System (ODS).

7B.1 Fiber Optic Cable Specifications

Fiber optic cables can be damaged by excessive bend radii, excessive pulling forces, or crushing forces. If the transmissive core is scratched or nicked, transmission characteristics may deteriorate noticeably and mechanical failure (breakage) of the core will be accelerated.

The following fiber optic cable installation recommendations should be taken into account:

- Avoid pulling cable over sharp edges.
- Do not install cable in areas where it is likely to suffer impact damage (from such things as dropped tools).
- Avoid installing cable in areas where it will experience repeated flexing, particularly with small radii.
- Support cable in long vertical runs.

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- Cable suspended in the air should be supported to withstand the load produced by its own weight.
- DOP, a plasticizer, commonly used with polyvinyl chloride insulated wire (80% of wires) tends to degrade the acrylic core of fiber optic cable. If fiber optic cable is tightly bundled with wire cables and these cables are subjected to high temperature and humidity, the DOP in the wire cable's insulation may leech into the fiber optic cable and degrade the core.

Fiber transmittivity may also be degraded if exposed to organic solvents including, but not limited to:

Common Solvents Degrading Transmittivity	
acetone	methyl ethyl ketone
benzene	toluene
ethyl acetate	trichloroethane
gasoline	trichloroetholene
methanol	

Fiber optic cable can be exposed to the following liquids for long terms without transmittivity being degraded:

Cable Resistant to these Solvents	
NaOH (10%) at 60 ℃	H2SO4 (10%) at 60 ℃
NH4 (5%) at 60 ℃	NaCl (5%) at 60 ℃
chlorinated hydrocarbon cutting oil [1]	distilled water
mineral oil based dielectric fluid [1]	

[1] The PVC jacket of the cable will be affected but fiber attenuation will not be affected.

Fiber optic cable can be exposed to the following liquids for short terms without transmittivity being degraded:

Cable Resistant to these Solvents for Short Term only	
isopropyl alcohol	soap suds (0.5%) at 60 ℃
sodium phosphate based flux cleaners (0.5% sodium phosphate synthetic detergent)	Ammonium hydroxide based flux cleaners

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Table 7B.A shows the specifications for the fiber optic cable used to connect optical transmitters to optical receivers. Table 7B.B shows the fiber optic thermal Specifications and Table 7B.C shows the cable attenuation specifications.

Table 7B.A
Fiber Optic Cable Mechanical Specifications

Fiber Optic Mechanical Specifications	Min	Max	Units
Cable Length	-	27	m
Tensile Load During Installation	-	30	Kg/Cable
Tensile Load in Continuous Use	-	30	Kg/Cable
Bend Radius	50	-	mm
Impact (10mm R 1/2 cyl. of 1Kg mass)	-	5	cm
Twisting	-	5	Twists/m

Table 7B.B
Fiber Optic Cable Thermal Specifications

Fiber Optic Thermal Specifications	Min	Max	Units
Storage Temperature	-40	+85	℃
Application Temperature	0	+70	℃

Table 7B.C
Fiber Optic Cable Attenuation Specifications

Fiber Optic Attenuation Specifications	Min	Max	Units
30 meter (conditions: 660 nm, 25 ℃)	.21	.30	dB/meter
10 meter (conditions: 660 nm, 25 ℃)	.23	.34	dB/meter

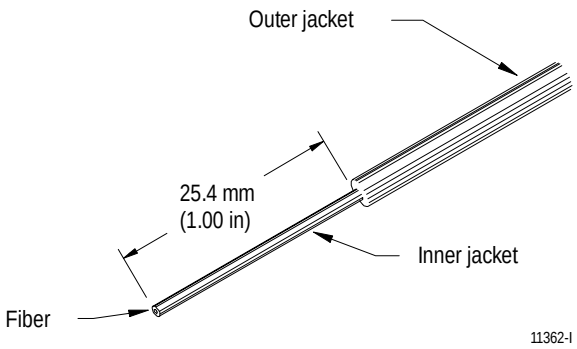
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7B.2 Fiber Optic Cable Construction

1. Fiber Optic Cable Stripping

Before a fiber optic plug can be connected to the end of a fiber optic cable, the end of the cable must be stripped. Use a Thomas & Betts **t** wire stripper no. 007–8990–95 or equivalent to strip away approximately 25 mm (1 in.) of the outer jacket of the fiber optic cable. Set the stripper to strip the outer jacket without damaging the inner jacket.

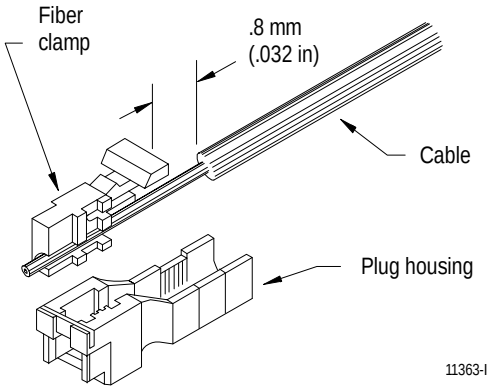
Figure 7B.1
Fiber Optic Cable Stripping



2. Fiber Optic Plug Assembly

Insert the stripped fiber optic cable into the fiber clamp of the fiber optic plug along the fiber clamp guide groove. Leave approximately .8 mm (.032 in) of space between the back of the fiber clamp and the unstripped area of the outer jacket. Allow the stripped portion of the fiber optic cable to protrude several millimeters from the front of the fiber optic plug.

Figure 7B.2
Inserting the Cable into the Clamp

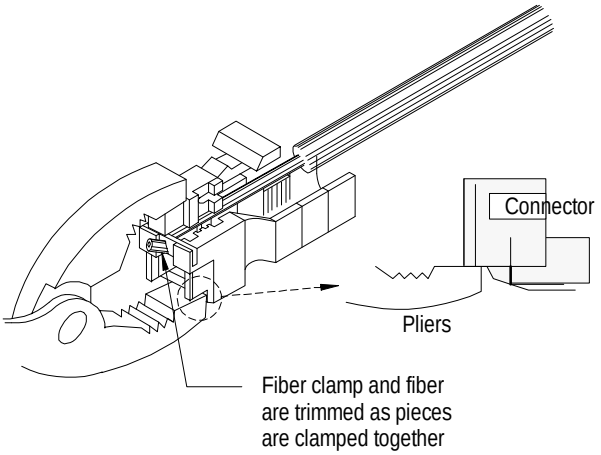


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Squeeze the fiber clamp and the plug together with pliers until the fiber clamp reaches the bottom of the plug.

Important: The lower jaw of the pliers must be seated on the recessed step of the plug housing as shown in Figure 7B.3.

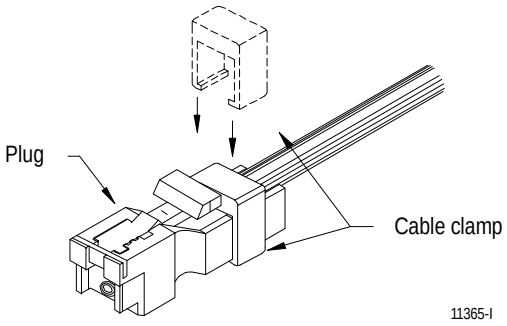
Figure 7B.3
Assembling the Fiber Clamp and the Plug Housing



Important: Once the plug has been clamped it cannot be reclamped or reused.

The cable clamp slides over the fiber optic plug housing to secure the fiber optic cable.

Figure 7B.4
Cable Clamp Mounting

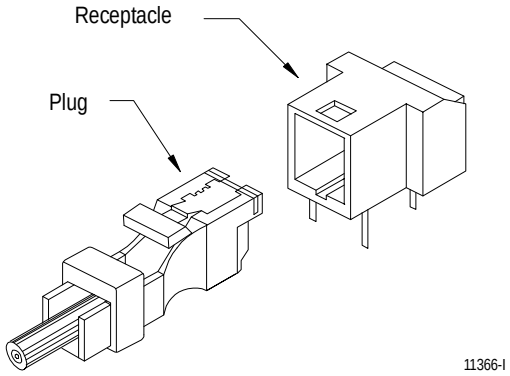


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3. Inserting a Fiber Optic Plug into a Receptacle

Insert the polarized positive-snap retention fiber optic plug into the color coded receptacle. The red receptacles are transmitters, the black receptacles are receivers.

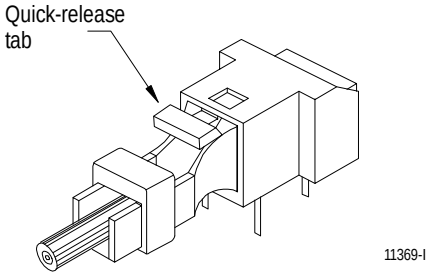
Figure 7B.5
Inserting a Fiber Optic Plug into a Receptacle



4. Removing a Fiber Optic Plug

To remove a fiber optic plug from a receptacle, press the quick release tab on the top of the plug and slide the plug out of the receptacle.

Figure 7B.6
Removing a Fiber Optic Plug



END OF SECTION

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Section 7C

Noise Prevention

7C.0 Section Overview

This section discusses wiring guide lines and techniques that should be followed to help lower system noise susceptibly. Of these guide lines are followed, noise should not be a factor in most 9/Series system applications.

7C.1 Preventing Noise

The first measures to take to protect the electrical system from electrical noise is to provide a protective ground. Proper grounding helps reduce the effects of electrical noise by isolating induced noise voltages to individual ground wires and shunting them to ground. This allows the noise to be directed to the earth instead of being transmitted through the cables. See page 3B-9 (9/230 systems), page 4D-10 (9/260 and 9/290 systems), or page 5A-42 (9/440 systems) for details on proper protective grounding.

In addition to protective grounding, the following noise prevention measures may also be used:

- Signal Grounding
- Mechanical Shielding
- Shielded Cables and Twisted-pair Cables
- Separation of Cable Routes
- Noise Suppressors

To prevent noise related problems, first find the noise transmission route and then take the appropriate noise prevention measures.

Signal Grounding

Signal grounding is used to direct any electrical noise, caused by shorted or leaking high frequency electrical currents, to earth ground. Protective ground, which has a high impedance path for high frequency noise, cannot effectively lead electrical noise from high frequency current to the earth ground.

Signal grounding must be made separately from other protective electronic component grounding. Protective ground and signal ground methods differ from each other in that the type of grounding wire used is different.

Signal noise, which is caused by high frequency current, has strong skin effect and flows only on the surface layer of the grounding wire. Therefore, the wire used for signal grounding should be as thick as possible and as short as possible to minimize resistance and inductance.

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Important: When grounding more than one electronic device, do not serially connect their grounding wires. If connected in series, even low level noises can cause interference, as they accumulate additively. Grounding must be made to a single point.

Mechanical Shielding

Radiated noise generates high frequency noise on high-impedance control inputs. For effective noise prevention, install a low-impedance grounded conductor in the radiated noise transmission route. Normally, installing the control inside a metallic cabinet and providing protective ground to this cabinet will produce satisfactory results.

Shielded Cables and Twisted-pair Cables

Shielded cables are very effective for protecting weak signals such as control signals from electrical noise.

These cables are effective for protecting the signals from full frequency band electrostatic inductive noises and radio frequency band electromagnetic noises. However, they are not as effective for low frequency magnetic inductive noises and electromagnetic inductive noise of frequencies lower than radio frequency band.

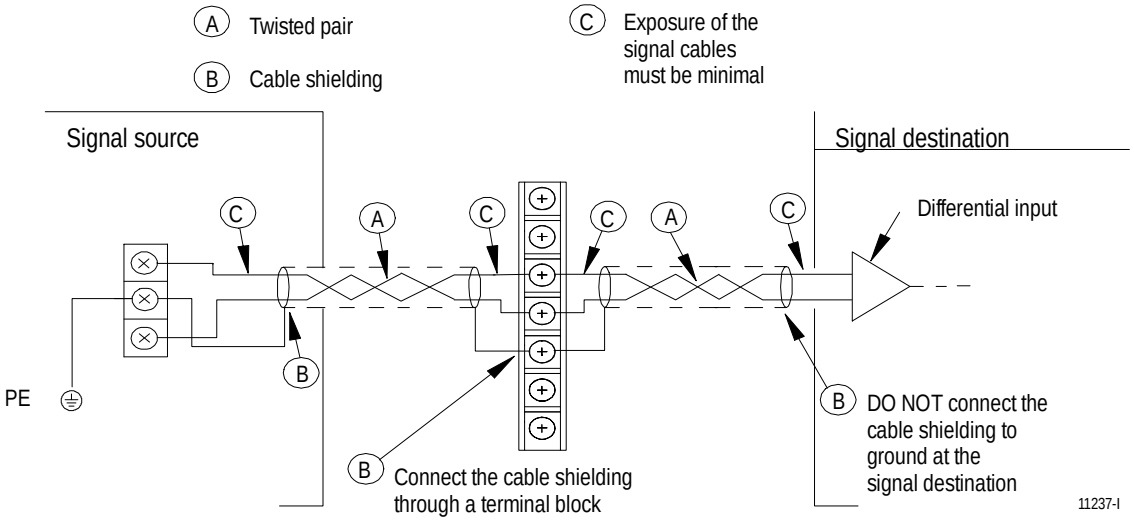
Generally, signal cables carrying signals of similar voltage or current levels are run along the same route. This sometimes causes electrostatic coupling between the signal cables. To prevent such a problem, use shielded cables to carry weak signals, drive signals, and feedback signals, for example. Exposure of signal cables must be kept to a minimum to provide common mode noise rejection and protection. Ground the shielded cable only at one end (usually, the controller or signal source end). The other end of the shield cable should be insulated with tape or shrink tubing.

Important: If both ends of the shielded cable are connected to ground, a ground loop will be formed. This may conduct the noise current through the cabinet frame and the chassis ground, generating noise problems instead of eliminating them.

To carry NC control signals, use twisted–pair cables, as shown in Figure 7C.1, to prevent transmission of noise to the differential input signals.

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Figure 7C.1
Shielded Twisted-pair Cables



When parallel wires are used for carrying control signals, if distances between the noise source and the individual cables differs, one of these two wires will be subject to stronger radiation noise than the other. However, when a twisted–pair cable is used, both wires will be subject to equal radiation noise regardless of the position of the noise source. This means that equal noise voltage is applied to both of the differential input terminals. Thus, the noise applied to the two terminals will cancel each other and reduce the drive circuit noise.

Usually, twisted-pair shielded cables as illustrated in Figure 7C.1 are used to transmit weak signals such as drive signals and feedback signals.

Separation of Cable Routes

Route cables with high power and low power levels (voltages and/or currents) separately. Run cables along opposite sides of the cabinet to minimize the influence of magnetic and electromagnetic induction noises.

Install steel sheet metal wireways between machine application cabinets. Do not use aluminum or other non-ferrous wireways as they do not provide magnetic shielding for the cables. Do not use dissimilar metals as this may lead to noise buildup. In wireways, bundle wires loosely into groups according to similar power levels and functions.

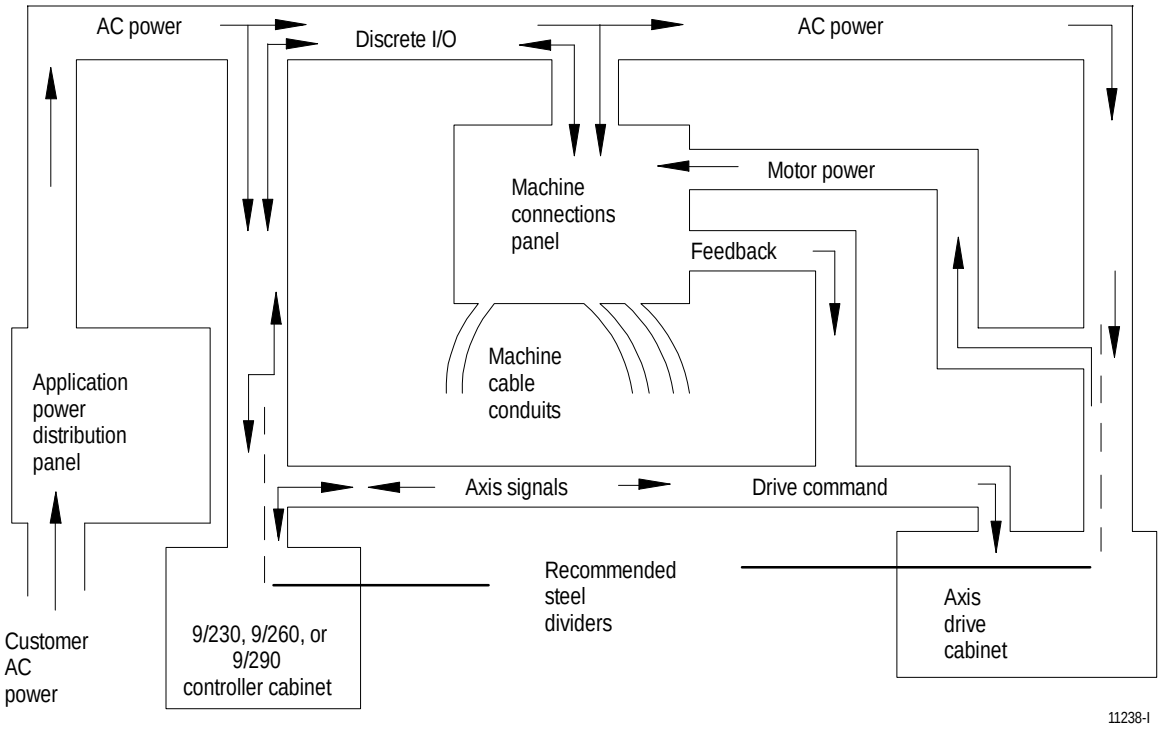
Do not run cables carrying weak signals such as drive signals and feedback signals in parallel with the ac power cables and I/O cables. If they must be run in parallel with each other, pass the weak signal carrying cables in metallic conduit to protect them from the influence of magnetic and

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electromagnetic noise. If there is no electric conductivity between the metallic conduit and the frame or the cabinet, connect them using a conductor.

Important: Run cables carrying weak signals inside metallic conduit whenever possible. Do not use the metallic conduit as the grounding connection for the frame or the cabinet. Use an exclusive conductor for grounding.

Figure 7C.2
Cable Routing



Noise Suppressors

To prevent noise in the ac power line on the power receiving side (controller side), connect a filter or transformer as shown in Figure 7C.3.

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Figure 7C.3
Non-Isolated Conductive Type Noise Suppressing

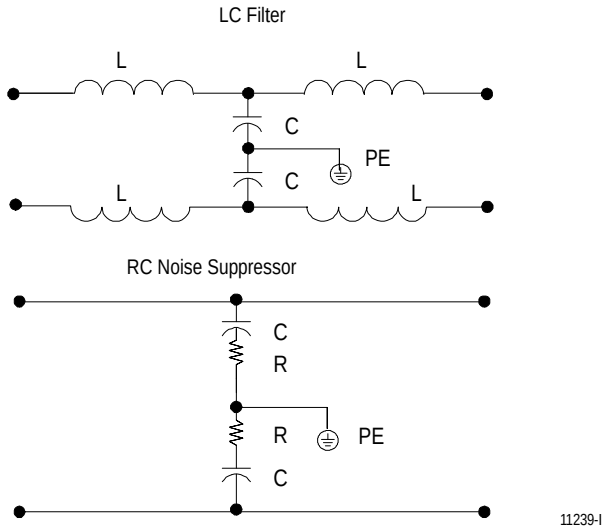
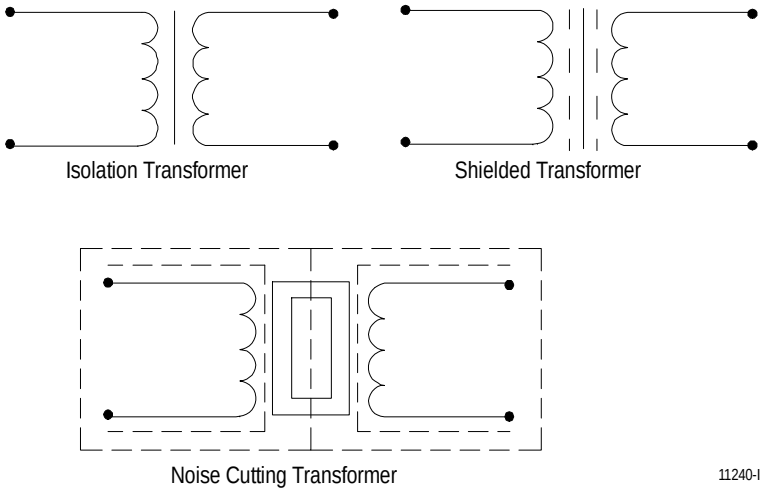


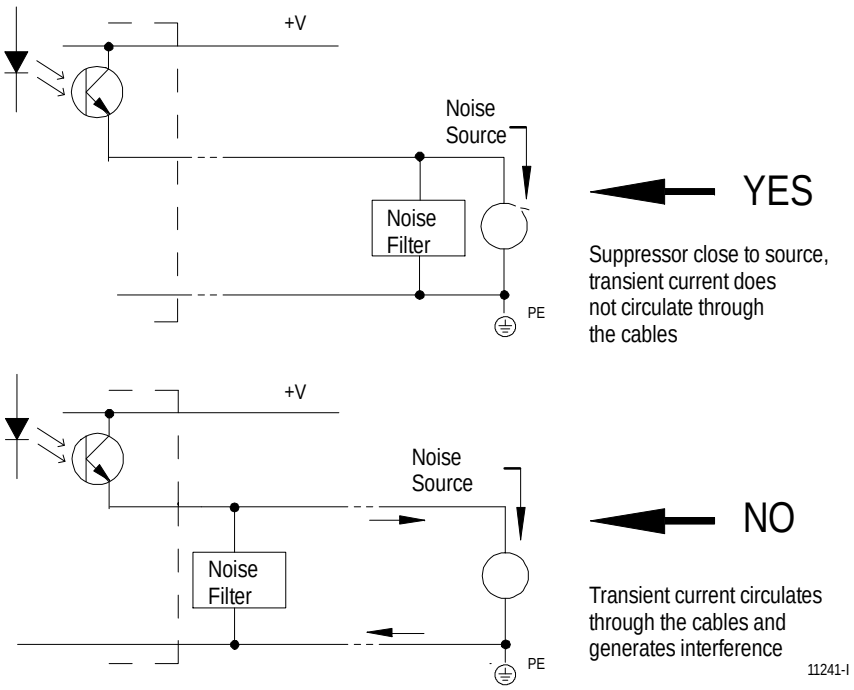
Figure 7C.4
Isolated Insulation Type Noise Suppressing



These noise filters and isolation transformers have different effects depending on noise characteristics (common mode noise, normal mode noise, high frequency noise, low band width noise, high band width noise, etc.). Therefore, select the appropriate noise suppression parts meeting the noise characteristics. Install these parts as close to the controller as possible for them to be most effective.

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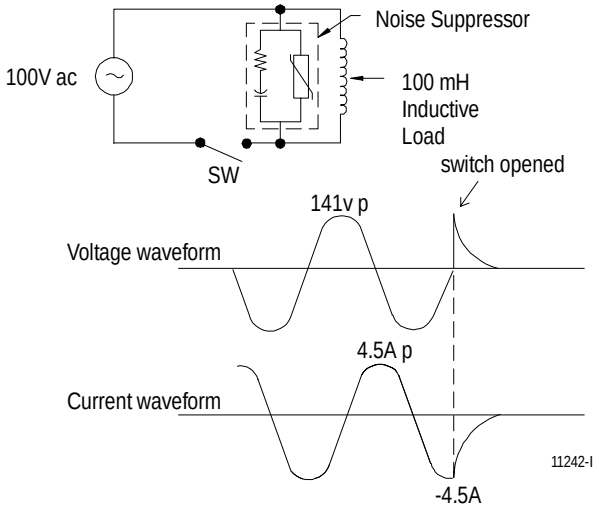
Figure 7C.5
Location of Noise Suppressors



Spike Voltage Noise Suppression

Spike voltage is generated when contacts in an inductive circuit open. To reduce spike voltage, connect a noise suppressor in parallel with the load. This suppresses spike voltage as shown in Figure 7C.6. This also prevents arcing between the contacts due to spike voltage, thereby protecting both the contacts and the internal circuit of the solid state output.

Figure 7C.6
Spike Voltage Noise Suppressing



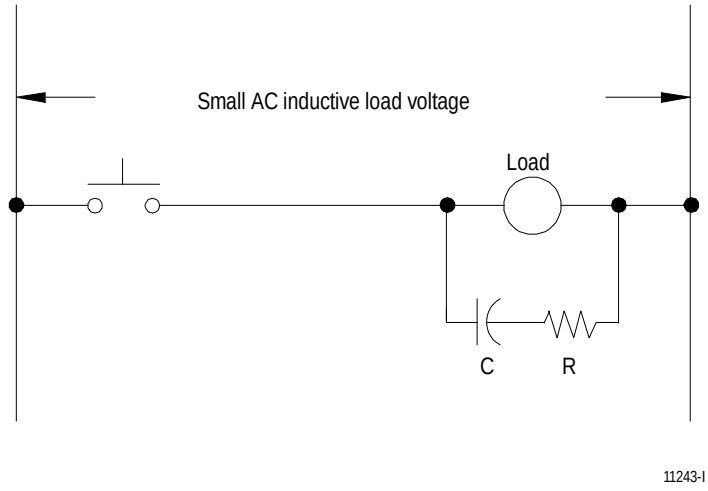
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Inductive Load Noise Suppression

Select the noise suppressor according to load size and applied voltage. Connect the noise suppressor as close to the load as possible.

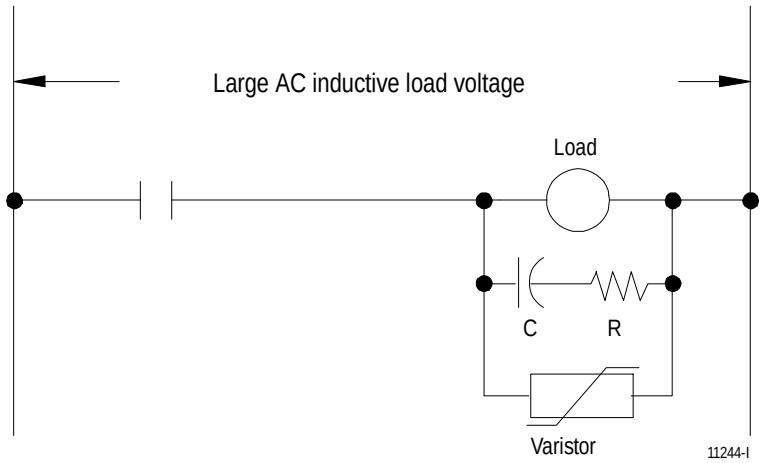
For a small ac inductive load, such as a solenoid operated by a pushbutton switch or a limit switch, connect the RC circuit as shown in Figure 7C.7.

Figure 7C.7
Small AC Inductive Load



For a large ac inductive load, such as a motor operated by a contactor, connect a varistor in parallel with the RC circuit as shown in Figure 7C.8.

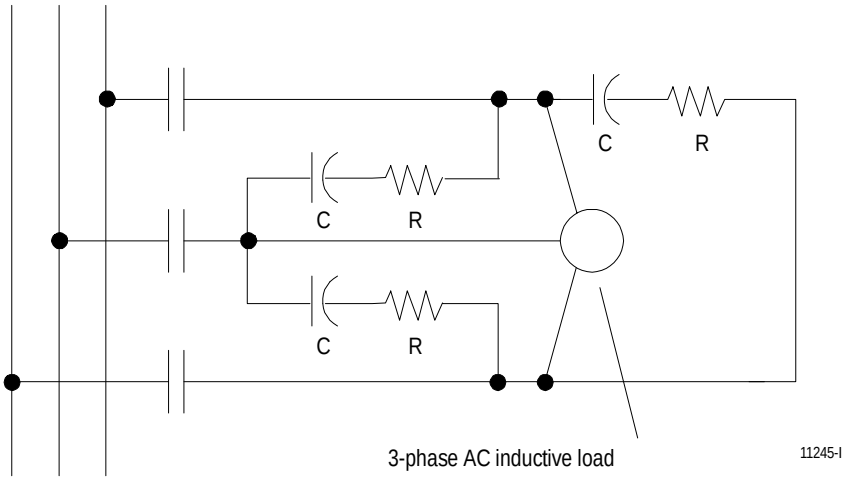
Figure 7C.8
Large AC Inductive Load



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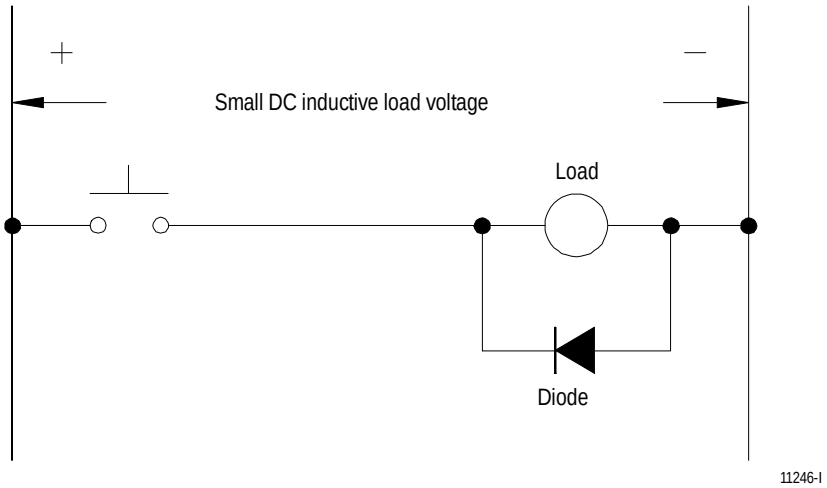
For a three-phase ac inductive load, connect noise suppressors across the individual phases as shown in Figure 7C.9.

Figure 7C.9
Three-phase AC Inductive Load



For a small DC inductive load, such as a miniature relay operated by a switch, connect the diode as shown in Figure 7C.10. The diode must have a peak voltage rating higher than two times that of the applied voltage.

Figure 7C.10
Small DC Inductive Load



Devices used for surge protection should be connected as close to the load device as possible. When Allen-Bradley relays, contactors, and motor starters are used, refer to Table 7C.A.

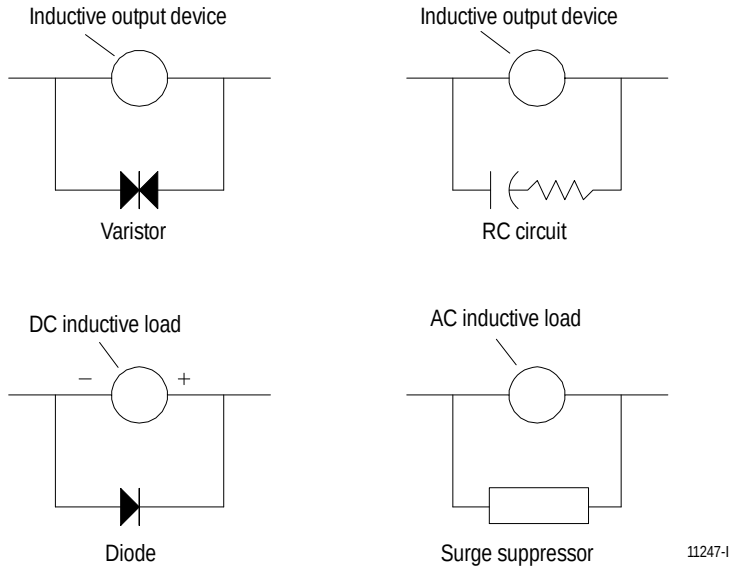
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Table 7C.A
Allen-Bradley Surge Suppressors

Device	Coil Voltage	Surge Suppressor Catalog No.
Bulletin 509 Motor Starter Bulletin 509 Motor Starter	120V ac 240V ac	599-K04 5990KA04
Bulletin 100 Contactor Bulletin 100 Contactor	120V ac 240V ac	199-FSMA1 199-FSMA2
Bulletin 709 Motor Starter	120V ac	1401-N10
Bulletin 700 R, RM Type Relay	ac coil	(surge suppressor not required)
Bulletin 700 R Type Relay Bulletin 700 RM Type Relay	12V dc 12V dc	700-N22 700-N28
Bulletin 700 R Type Relay Bulletin 700 RM Type Relay	24V dc 24V dc	700-N10 700-N13
Bulletin 700 R Type Relay Bulletin 700 RM Type Relay	48V dc 48V dc	700-N16 700-N17
Bulletin 700 R Type Relay Bulletin 700 RM Type Relay	115-125V dc 115-125V dc	700-N11 700-N14
Bulletin 700 R Type Relay Bulletin 700 RM Type Relay	230-250V dc 230-250V dc	700-N12 700-N15
Bulletin 700 N, P Type Relay	150V MAX. ac	700-N24
Electromagnetic device whose sealed power is limited to 35 VA.	150V max. ac or dc	

Typical surge protection circuit examples are shown in Figure 7C.11.

Figure 7C.11
Surge Protection Circuits for Inductive Load



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7C.2 Reducing Noise

The following sections explain different types of noise and measures to reduce them.

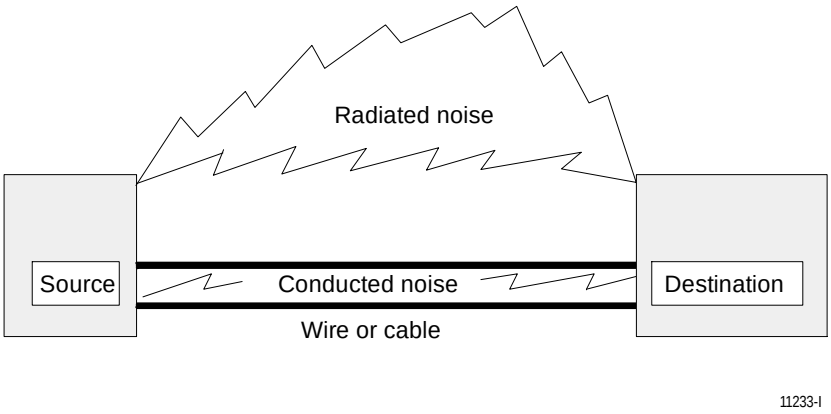
Electrical Noise

Electrical noise can be considered to be unwanted electrical signals, which produce undesirable effects in the circuits of the control systems in which they occur. High intensity noise can interfere with system functioning.

The following sections explain electrical noise and the measures to reduce them.

Electrical noise is transmitted in two ways. One means of transmission is through cables (conducted noise). The other is transmission through the air (radiated noise).

Figure 7C.12
Noise Transmission Routes



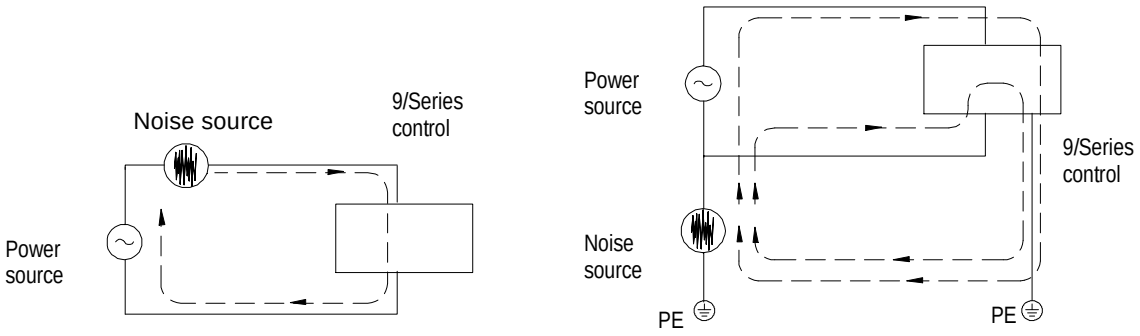
Conducted Noise

Conducted noise is transmitted to the control through conductors such as power source cables, signal cables, and grounding cables. Conducted noise is further divided into two modes; normal mode and common mode.

As shown in Figure 7C.13, normal mode noise reaches the control by passing through the two lines. Common mode noise reaches the control by passing through each line and the conductor that functions as the common potential for the two lines.

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Figure 7C.13
Types of Line Noise



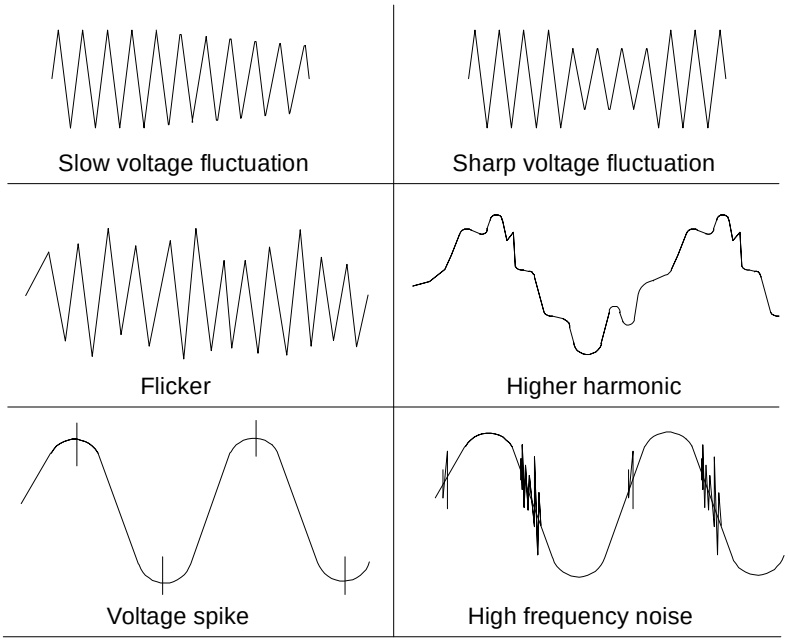
A. Normal mode noise

B. Common mode noise

11234-I

Electrical noise varies in waveforms and magnitude over the entire frequency width. Typical examples of abnormal phenomenon and waveforms observed in the power source line are shown in Figure 7C.14.

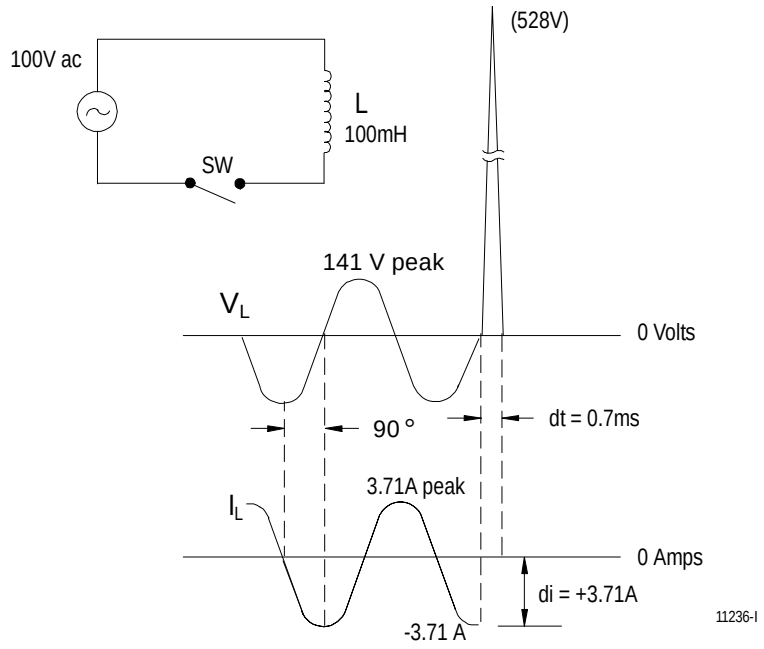
Figure 7C.14
Abnormal Voltage Waveform



One of the sources of electrical noise is a sharp current variation in inductive circuits, as shown in the circuit of Figure 7C.15. In this circuit, voltage V_L applied to the inductive load L (a relay coil, for example) is equivalent to the voltage applied to the circuit while the switch SW is closed. If this switch is opened, the inductive load that prevents current variation, generates a momentary high voltage called a “spike”.

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Figure 7C.15
Spike Voltage 100V ac (rms) Arc Inductive Load



Radiated Noise

Radiated noise reaches the control through the air. The cables and the metallic frames, of the control, function as antennas that receive electrical noise from a variety of sources such as ac power lines, welding arcs, transformers, motors, and radio wave transmission devices.

If a number of electronic components are arranged near the control, the surrounding air will be filled with radiated noise. The control must be shielded to protect it from radiated noise. Radiated noise is composed of three types of noise:

- electrostatic induction noise
- magnetic induction noise
- electromagnetic induction noise

END OF SECTION

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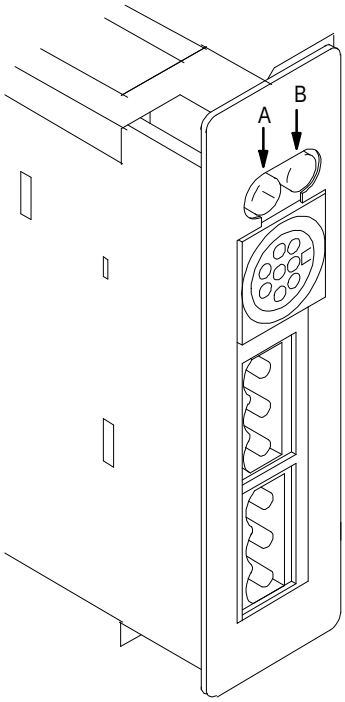
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Rockwell Automation
Allen-Bradley

9/Series Hardware
TAB 8

Communications



9/290 Remote I/O Plug

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Section 8

Communication Interface

8.0 Section Overview

This section covers the connection of peripherals to the control. The following types of interfaces to connect the peripherals to the control:

- RS-232 (ports A or B)
- RS-422 (port B only)

For Information on:	See Page
RS-232 Interface	8-1
RS-232 Signal Description	8-2
Connection of Peripherals	8-3
RS-422 Interface	8-6
RS-422 Description	8-7
Connection of Peripherals	8-9
Protocol	8-9
RS-491 Level 1 Protocol	8-11
Peripherals	8-15

8.1 RS-232 Interface

RS-232 is a common serial interface that uses a single return line for all signals. This interface is often called single ended serial communication because of the single return line and because the "True" (High) and "False" (Low) data bits are positive and negative voltages referenced to the common return.

Control	Port A and location	Port B and location
9/230	----	RS-232/422 on the processor board
9/260	RS-232 on the CPU Module	RS-232/422 on the motherboard
9/290	RS-232 on the CPU Module	RS-232/422 on the motherboard
9/440	RS-232 bottom of system module	RS-232/422 bottom of system module

When you select RS-232, the interface cable cannot be longer than 50 cable feet (15 meters). The length of the interface cable should be kept as short as possible and should be shielded to reduce the possibility of noise interference.

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8.2 RS-232 Signal Description

RS-232 sends and receives the signal codes in Table 8.A to and from the control. The control is a data communication equipment (DCE) device.

Table 8.A
RS-232 Connector Pin Assignment Port A

Pin No.	Signal Code	Signal Name	Signal Type	Description
1	SH	Shield	-	Shield
2	SD	Send Data	Input	This line is used to carry data sent from a peripheral device to the control.
3	RD	Receive Data	Output	This line is used to carry data that is sent from the control to a peripheral device.
4	RS	Request To Send	Input	The peripheral turns this line "ON" to request the control send it data.
5	CS	Clear To Send	Output	The control turns this line "ON" to request the peripheral send it data
6[1]	DSR	Data Set Ready	Output	The control turns this line "ON" when power to the control is applied.
7	GND	Signal Ground	-	Signal Line Ground

[1] Port B Only

Table 8.B indicates the signal conditions for control signal ON/OFF status.

Table 8.B
Control Signal Status

Signal Conditions	Mark	Space
Control Signal	OFF	ON
Logic	1	0
Signal Level	-3 to -15V	+3 to +15V

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8.3 Connection of Peripherals

The figures below show the wiring connections for the RS-232 interface with hardware handshake. The arrows in the following figures indicate the signal flow direction. Figure 8.1 shows the wiring connections when the CNC is a DCE (Data Communication Equipment) device and the peripheral is a DTE (Data Terminal Equipment) device. A DTE device transmits data on pin 2, and a DCE device transmits on pin 3. Figure 8.2 shows the wiring connections when the CNC and the peripheral are both DCE (Data Communication Equipment) devices. On the 9/230 systems all communications connections are made with port B.

Figure 8.1
RS-232 Cable Wiring with Hardware Handshake (DCE to DTE)

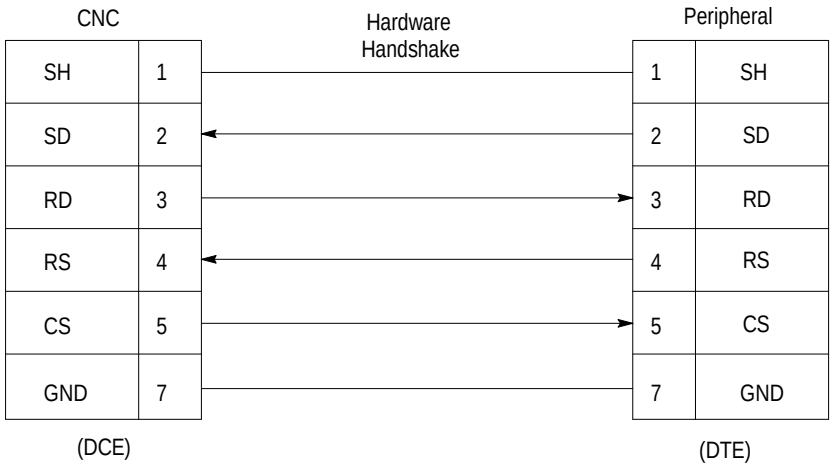
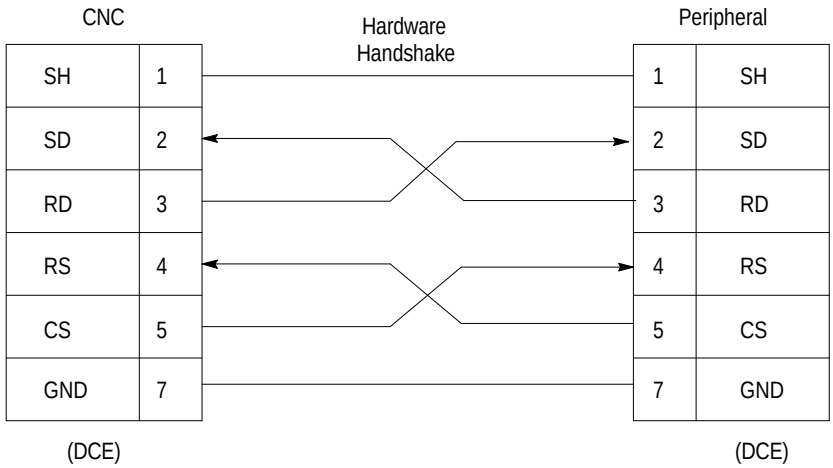


Figure 8.2
RS-232 Cable Wiring with Hardware Handshake (DCE to DCE)



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The figures below show the wiring connections for the RS-232 interface without hardware handshake. The arrows in the following figures indicate the signal flow direction. Figure 8.3 shows the wiring connections when the CNC is a DCE (Data Communication Equipment) device and the peripheral is a DTE (Data Terminal Equipment) device.

Without hardware handshake, if the peripheral needs RR , connect the TR (Terminal Ready) pin to the RR (Received Line Signal Detector - carrier dated) pin on the peripheral. Figure 8.3 and Figure 8.4.

Figure 8.3
RS-232 Cable Wiring without Hardware Handshake (DCE to DTE)

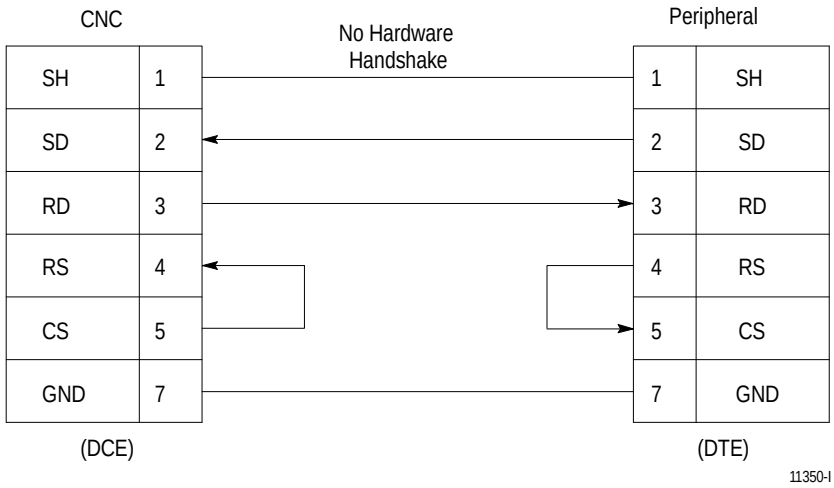
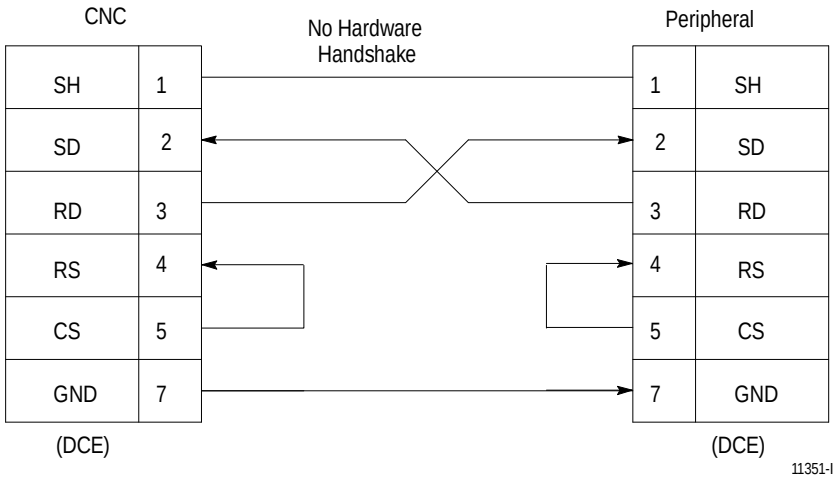


Figure 8.4 shows the wiring connections when the CNC and the peripheral are both DCE (Data Communication Equipment) devices.

Figure 8.4
RS-232 Cable Wiring without Hardware Handshake (DCE to DCE)



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Figure 8.5 through Figure 8.7 show cable wiring examples for the RS-232 interface between the control and Allen-Bradley T45, T47, T35 and T50 workstations.

Figure 8.5
RS-232 Cable Wiring to an Allen-Bradley T45 or T47

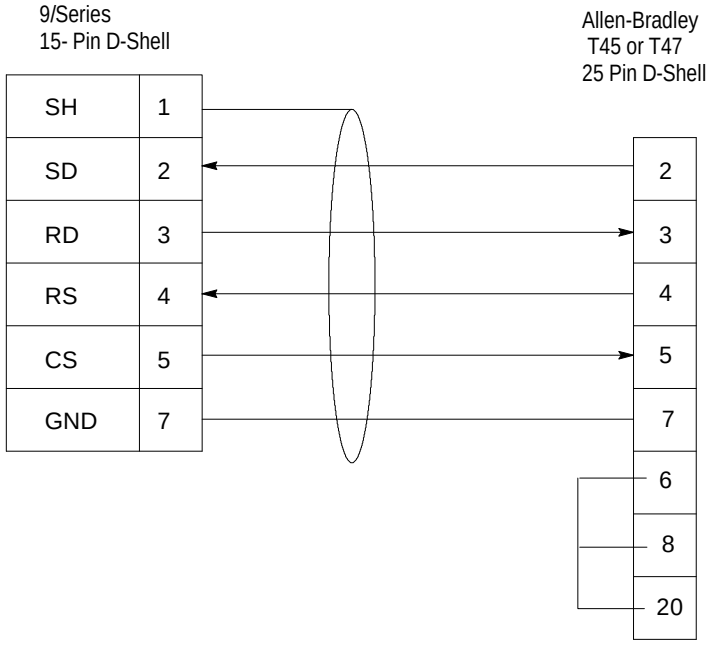
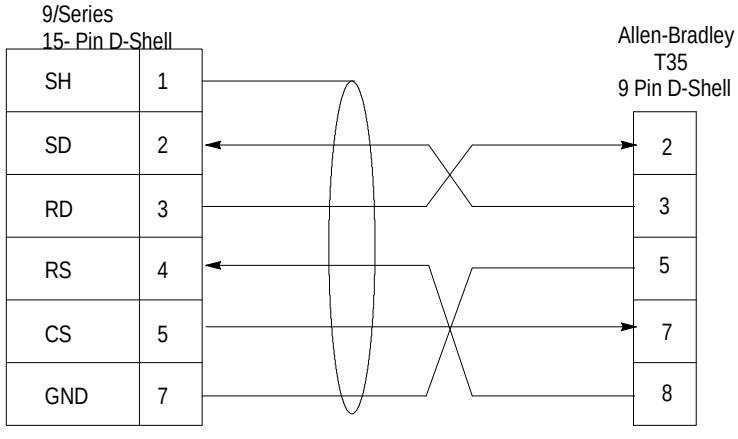
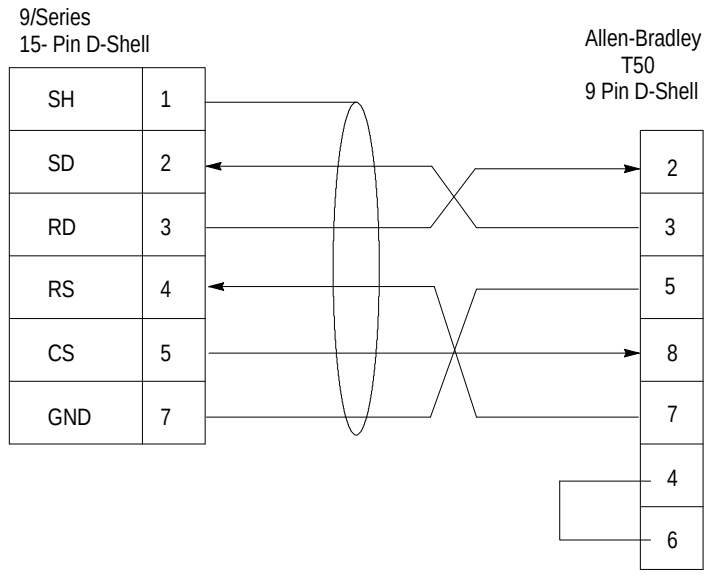


Figure 8.6
RS-232 Cable Wiring to an Allen-Bradley T35



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Figure 8.7
RS-232 Cable Wiring to an Allen-Bradley T50



8.4 RS-422 Interface

RS-422 is used for serial communication between the control and peripherals. RS-422 is also known as complimentary serial I/O. It is available only on port B which is located on the motherboard (for the 9/260 and 9/290 control) and on the processor board for the 9/230 control. This signal is able to resist noise even over long distances. When you use RS-422, the interface cable can be as long as 4000 cable feet (1220 meters). Use shielded, twisted-pair cables to resist noise.

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8.5 RS-422 Signal Description

RS-422 sends and receives the signals in Table 8.C to and from the control. The control is a data communication equipment (DCE) device.

Table 8.C
RS-422 Connector Pin Assignment

Pin No.	Signal Code	Signal Name	Signal Type	Description
1	SH	Shield		Shield
2	SD A	Send data A	Input	Data is sent from the peripheral to the control.
3	RD A	Receive data A	Output	Data is transmitted from a control to a peripheral.
4	RS A	Request to send A	Input	The peripheral turns "ON" when requesting to send data to the control.
5	CS A	Clear to send A	Output	The control turns "ON" when the control is ready to transmit or receive data.
6	DM A	Data set ready A	Output	The peripheral turns "ON" when it is ready to transmit or receive data.
7	SG	Signal Ground		Ground for each signal line.
8	TR A	Data term ready A	Input	Data is transmitted from a peripheral to the control.
9	SD B	Send Data B	Input	Data is sent from the peripheral to the control.
10	RD B	Receive data B	Output	The peripheral turns "ON" when requesting to send data to the control.
11	RS B	Request to send B	Input	The control turns "ON" when data transmission from peripheral to the control is permitted.
12	CS B	Clear to send B	Output	The control turns "ON" when the control is ready to transmit or receive data.
13	DM B	Data set ready B	Output	The peripheral turns "ON" when it is ready to transmit or receive data.
14	TR B	Data terminal ready B	Input	Data is transmitted from a peripheral to the control.

Table 8.D indicates the signal conditions corresponding to control signal ON/OFF status.

Table 8.D
Control Signal Status

Signal Conditions	Mark	Space
Control Signal	OFF	ON
Logic	1	0
Signal Level	A < B	A > B

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8.6 Connection of Peripherals

Figure 8.8 shows the cable connection for the RS-422 interface that uses a hardware handshake.

Figure 8.8
RS-422 Cable Wiring with Hardware Handshake

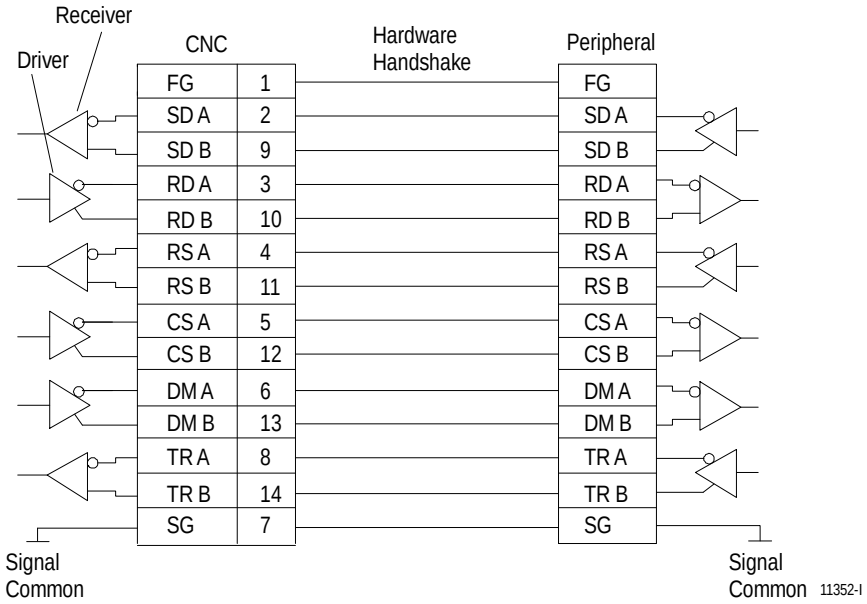
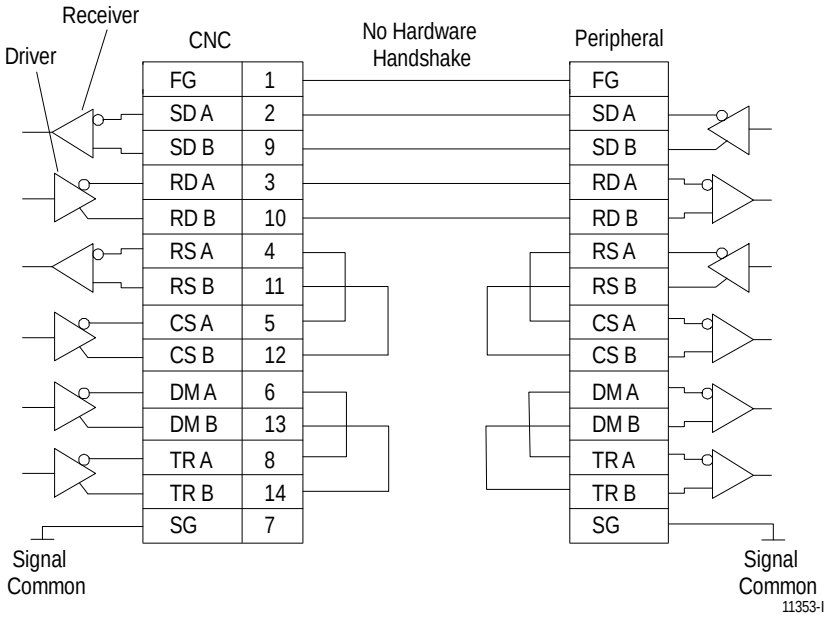


Figure 8.9 shows the cable connection for the RS-422 interface without a hardware handshake.

Figure 8.9
RS-422 Cable Wiring without Hardware Handshake



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8.7 Protocol

RS-491 Level I and Level II protocol are used for data communication between the control and peripherals. They provide a structured process of communication through the RS-232 or RS-422 interface ports.

8.7.1 RS-491 Level 1 Protocol

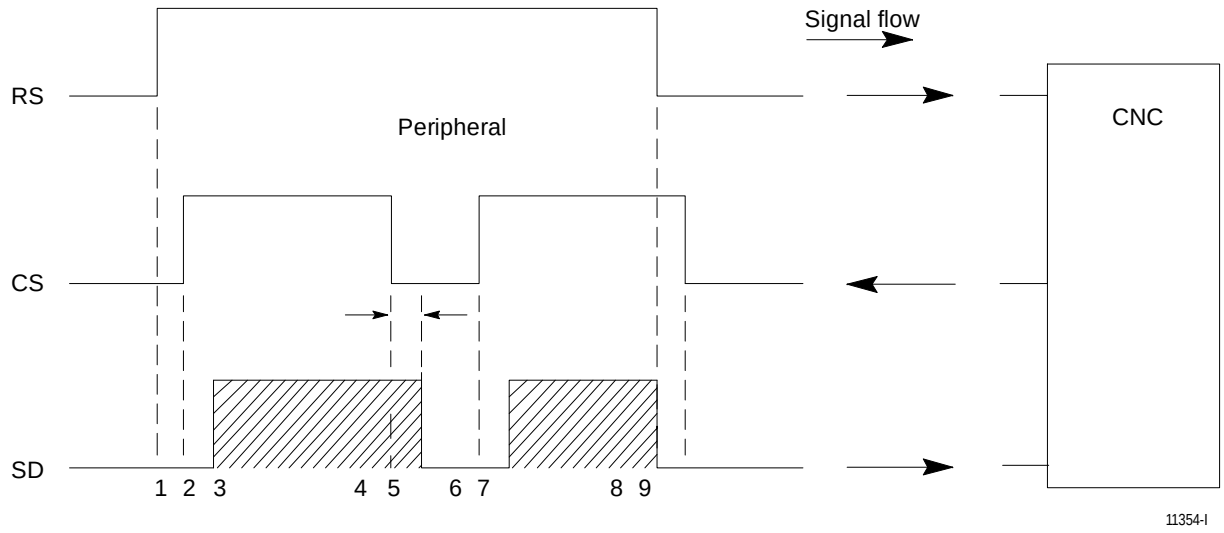
Level I protocol is used for data communication between the control and a simple peripheral, a printer for example. When communication between the control and a simple peripheral has been established, the following three signals are used to control data transmission start/stop:

- RS (request to send)
- CS (clear to send)
- DM (data set ready) Port B only

Data Receiving Sequence

When the control receives data from a peripheral, CS and RS signals are used to control the communication, see Figure 8.10. The peripheral confirms that the control is ready for data reception by the CS (clear to send) signal before it transmits the data.

Figure 8.10
Data Reception Sequence



The control receives data from the peripheral in the following sequence. The numbers correspond to those in Figure 8.10.

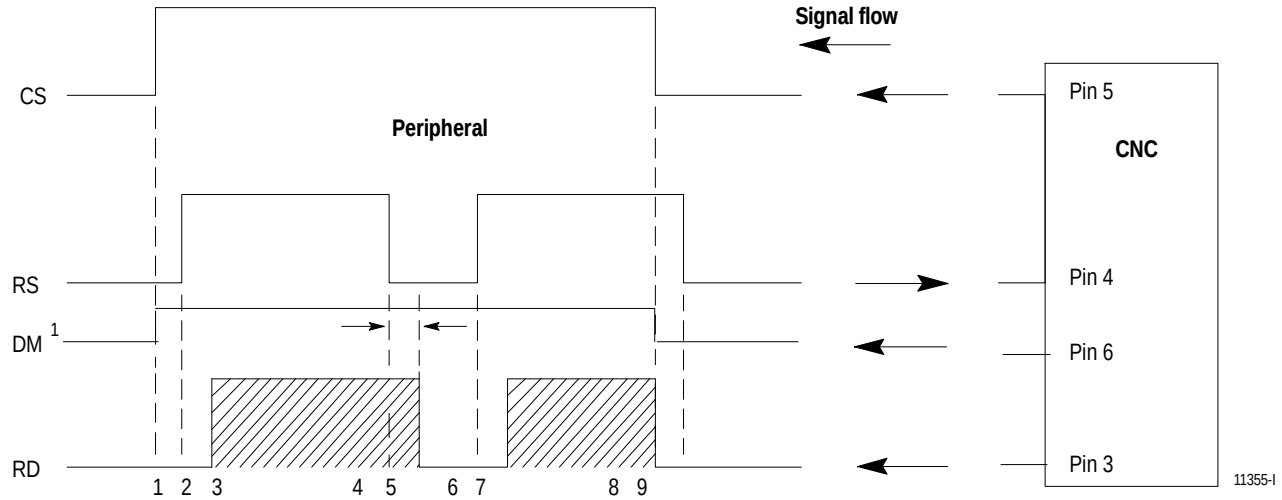
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1. The peripheral (DTE) turns on the RS signal to notify the control (DCE) that there is data to be transmitted.
2. The control turns the CS signal ON to notify the peripheral that it is ready for data reception.
3. The peripheral begins transmitting data to the control.
4. If the control buffer cannot accept the data, the control turns the CS signal OFF to notify the peripheral to stop data transmission.
5. The peripheral, upon recognizing that the CS signal has been turned OFF, stops data transmission within two characters.
6. The control turns the CS signal ON when it can receive data again.
7. The peripheral, upon recognizing that the CS signal has been turned ON, begins data transmission.
8. After transmitting all data to the control, the peripheral turns the RS signal OFF to notify the control that all data has been transmitted.
9. The control turns the CS signal OFF

Data Transmitting Sequence

When the control transmits data to a peripheral, CS and RS signals are used to control the communication, see Figure 8.11. The control confirms that the peripheral is ready for data reception by the TR signal before it transmits the data.

Figure 8.11
Data Transmitting Sequence



1 Port B only

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The control transmits data to the peripheral in the following sequence. The numbers correspond to those in Figure 8.11.

1. The control turns the CS and the DM signals ON to notify the peripheral that there is data to be transmitted.

2. The peripheral turns the RS signal ON to notify the control that it is ready to receive data.

3. The control begins data transmission to the peripheral.

4. If the peripheral buffer cannot accept the data, the peripheral turns the RS signal OFF to notify the control to stop data transmission.

5. The control, upon recognizing the RS signal has been turned OFF, stops transmitting data within two characters.

6. The peripheral turns the RS signal ON when it can receive data again.

7. The control, upon recognizing the RS signal has been turned ON, begins data transmission .

8. After transmitting all data to the peripheral, the control turns the CS and DM signals OFF to notify the peripheral that all data has been transmitted.

9. The peripheral turns the RS signal OFF.

8.7.2 RS-491 Level II Protocol

Level II protocol is used for the communication between the control and a peripheral (tape reader/puncher) or a computer. Level II protocol differs from Level I protocol in that data transmission/reception is controlled by the control codes (DC1, DC2, DC3, DC4, EOT, DLE). The functions of these control codes are shown in Table 8.E.

Devices where the protocol is labeled LEVEL 2* implement a slightly modified version of the protocol. This serves to better match the specific Level 2 device. The device type GENERIC LEVEL 2 implements the full protocol as it is described here.

The 9/Series controls send and receive program data using the data format appropriated for punched tape. This means all ASCII characters have even parity in the eight bit position. EIA characters have their own parity format which is recognized by the control. Characters which do not have the proper parity are not stored in the control. In addition, lower case ASCII data sent to the control is converted into upper case when stored.

RS-491 Level 2 control characters do not have eighth bit parity. The control characters are used for device control only.

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Binary data such as AMP and PAL images do not have eighth bit parity bits attached to them. Because binary files such as AMP and PAL can contain data which correspond to RS-491 Level 2 control characters, these files cannot be output to Level 2 devices. The control characters could halt or otherwise affect the file transfer. The Level 2 tape reader interface on the 9/Series is capable of reading binary files.

A man readable file name is punched to the tape by the 9/Series at the beginning of all files. This is done for all types of devices except the Generic Level 2 device which doesn't output the man-readable header. Care should be taken when transmitting files to the control which contain man-readable headers. Sometimes this part of the tape can contain Level 2 control characters which may halt or other wise affect the file transfer.

Table 8.E
Control Code Functions

Control Code	Function	Description
DC1	Start Xmission	This code is used to begin data transmission from a peripheral to the control. It is also used to restart data transmission which had been interrupted by the DC3 code output from the peripheral or the control.
DC2	Restart	This code is used to begin data transmission from the control to a peripheral.
DC3	Stop Xmission	This code is used to stop data transmission from the transmitting device. It is output from the data receiving device.
DC4	Ignore	The device receiving this code ignores any received data until it receives the DC2 code after the data has been transmitted from the control to the peripheral.
EOT	End of Transmission	This code is used to notify the completion of data transmission.
DLE	Data Link Escape	This code is used to abort the transmission.

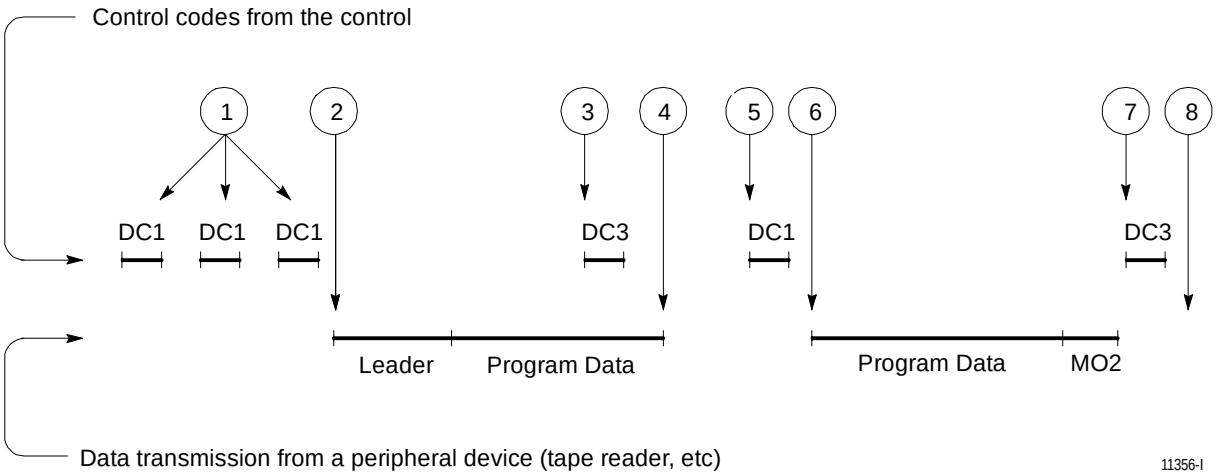
Important: For the EOT code, M02 or M30 is usually used.

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Data Receiving Sequence

Figure 8.12 shows the data receiving sequence of the control.

Figure 8.12
Data Receiving Sequence



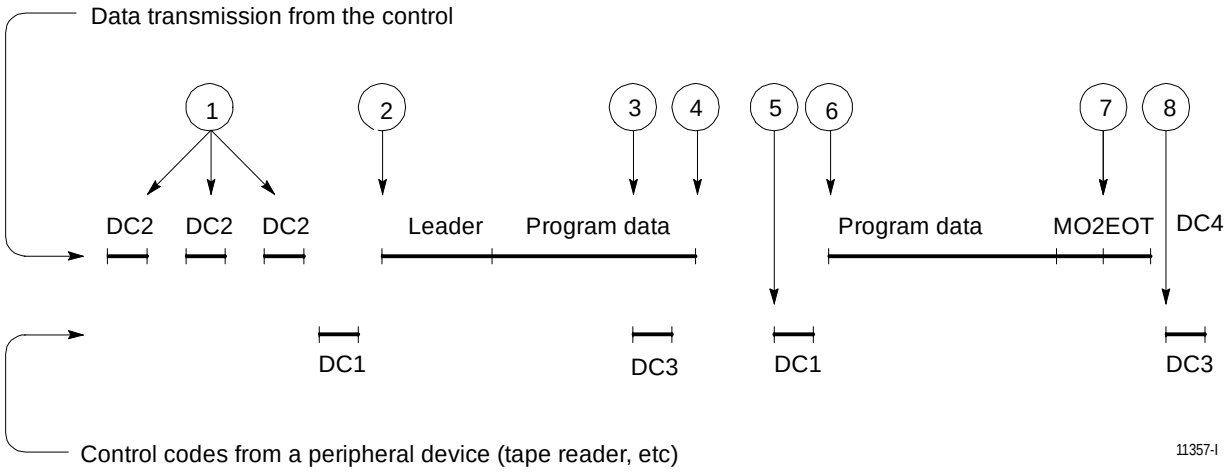
1. The control transmits the DC1 code in three-second intervals until the peripheral begins data transmission.
2. Upon reception of the DC1 code, the peripheral begins data transmission.
3. The control transmits the DC3 code when its buffer cannot accept the received data.
4. Upon reception of the DC3 code, the peripheral stops data transmission within two characters.
5. The control sends the DC1 code when it is ready to receive data again.
6. The peripheral, upon reception of the DC1 code, begins data transmission again.
7. The control stops data reception when it recognizes the M02 or M30 code and outputs the DC3 code.
8. The peripheral stops data transmission when it receives the DC3 code.

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Data Transmitting Sequence

Figure 8.13 shows the data transmission sequence of the control.

Figure 8.13
Data Transmission Sequence



1. The control transmits the DC2 code in three-second intervals until it receives the DC1 code from the peripheral.

2. Upon reception of the DC1 code, the control begins data transmission.

3. The peripheral transmits the DC3 code when its buffer cannot accept the received data.

4. Upon reception of the DC3 code, the control stops data transmission within two characters.

5. The peripheral transmits the DC1 code when it is ready to receive data again.

6. The control, upon reception of the DC1 code, begins data transmission again.

7. The control transmits the DC4 code after it transmits the M02 or M30 code.

8. The peripheral transmits the DC3 code when it receives the DC4 code to end data input.

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8.8 Peripherals

The following table lists the peripherals that can be connected to the 9/Series control. Communication protocol can be altered to accept peripherals other than those listed below.

Table 8.F
Peripheral List

Device	Device Type
Allen-Bradley 1770-SB	Cartridge
Ricoh PTR240R	Reader
Facit N4000	
Decitek AB 8000-XPDR	
DSI SP75	Punch
Facit 4070	
Facit N4000	
Epson LX-810 (USA)	Printer
Epson SP-500 (JAPAN)	
User Punch	User Defined
User Reader	
User Printer	
Teach Pendant	
PAL-RS232 Comm	
ODS	ODS Terminal
Generic Level_2	Computer using only level 2 protocol
Greco Minifile	Intelligent Storage
Intelligent Device	Personal Computer using Communication Software

Table 8.F lists the recommended configuration and connection of the peripherals.

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1. Allen-Bradley 1770-SB Data Cartridge Recorder Connection

The recommended configuration of the Allen-Bradley 1770-SB data cartridge recorder is shown below:

Configuration Parameter	Setting
DEVICE:	ALLEN-BRADLEY 1770-SB
PORT TYPE:	RS232C
BAUD RATE:	1200
PROTOCOL:	LEVEL_2*
PARITY:	NONE
STOP BITS:	1
DATA LENGTH:	8
TIMEOUT:	15 SEC
OUTPUT CODE	N/A

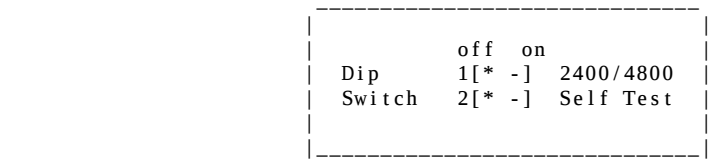
The Allen-Bradley 1770-SB data cartridge recorder is connected to the control using a standard RS-232 with hardware handshake interface cable (see Figure 8.2).

2. Ricoh PTR240R Tape Reader Connection

The recommended configuration of the Ricoh PTR240R tape reader is shown below:

Configuration Parameter	Setting
DEVICE:	RICOH PTR240R
PORT TYPE:	RS232C
BAUD RATE:	2400
PROTOCOL:	LEVEL_2*
PARITY:	EVEN
STOP BITS:	1
DATA LENGTH:	8
TIMEOUT:	15 SEC
OUTPUT CODE	N/A

The switch assembly on the rear of the tape reader must be set to the 2400 baud rate and to the self test mode as shown below:



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3. Facit N4000 Tape Reader/Punch Connection

The recommended configuration of the Facit N4000 Tape Reader/Punch is shown below:

Configuration Parameter	Setting
DEVICE:	FACIT N4000
PORT TYPE:	RS232C
BAUD RATE:	2400
PROTOCOL:	LEVEL_2*
PARITY:	EVEN
STOP BITS:	1
DATA LENGTH:	8
TIMEOUT:	15 SEC
OUTPUT CODE	ASCII

The Facit N4000 Tape Reader/Punch is connected to the control using a standard RS-232 with hardware handshake interface cable (see Figure 8.2).

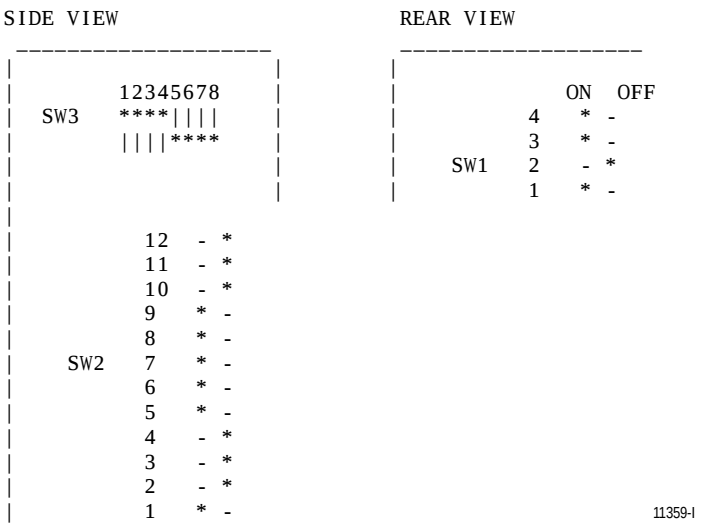
4. Decitek AB 8000- XPDR Connection

The recommended configuration of the Decitek AB 8000-XPDR tape reader is shown below:

Configuration Parameter	Setting
DEVICE:	DECITEK AB 8000-XPDR
PORT TYPE:	RS232C
BAUD RATE:	2400
PROTOCOL:	LEVEL_2*
PARITY:	EVEN
STOP BITS:	1
DATA LENGTH:	8
TIMEOUT:	15 SEC
OUTPUT CODE	N/A

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The switch assemblies on the side and rear of the tape reader must be set as shown below:



* Denotes switch lever location

The Decitek AB 8000-XPDR tape reader is connected to the control using a standard RS-232 with hardware handshake interface cable (see Figure 8.2).

5. DSI SP75 Connection

The recommended configuration of the DSI SP75 tape punch is shown below:

Configuration Parameter	Setting
DEVICE:	DSI SP75
PORT TYPE:	RS232C
BAUD RATE:	600
PROTOCOL:	RAW
PARITY:	EVEN
STOP BITS:	1
DATA LENGTH:	8
TIMEOUT:	15 SEC
OUTPUT CODE	ASCII

The DSI SP75 tape punch is connected to the control using a standard RS-232 with hardware handshake interface cable (see Figure 8.2).

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6. Epson LX-810 Printer Connection

The recommended configuration of the Epson LX-810 printer is shown below:

Configuration Parameter	Setting
DEVICE:	Epson LX-810
PORT TYPE:	RS232C
BAUD RATE:	2400
PROTOCOL:	LEVEL_2*
PARITY:	EVEN
STOP BITS:	1
DATA LENGTH:	8
TIMEOUT:	15 SEC
OUTPUT CODE	N/A

8.9 Remote I/O Modules

The remote I/O modules allow the 9/Series control to appear as a remote I/O rack to the I/O scanner of a PLC processor. There are two separate remote I/O modules, one for 9/260 controls, and one for 9/290 controls. 9/230 and 9/440 controls, equipped with remote I/O, have the remote I/O circuitry and connections mounted directly on the processor or wiring board respectively. Though the remote I/O link performs the same functions and is configured in the same manner for all the 9/Series controls, the installation and appearance is significantly different between processors.

Remote I/O is a feature of Allen-Bradley's 1771 I/O and is beyond the scope of any 9/Series documentation. For details on the operation, configuration, and capabilities of a remote I/O device on the 1771 I/O network refer to documentation that came with your 1771 I/O system. This document only discusses what is necessary to install and troubleshoot the 9/Series remote I/O modules.

Implementing Remote I/O on the 9/Series control

Important: PAL must set the $RMON flag TRUE, during the first foreground execution, to enable the remote I/O connection. Also several remote I/O operating parameters must be setup in AMP to configure the remote I/O communications for your specific network. Refer to your 9/Series AMP and PAL reference manuals for details.

When remote I/O information is sent to the control, it is transmitted as values from eight output words in the PLC processors output image table

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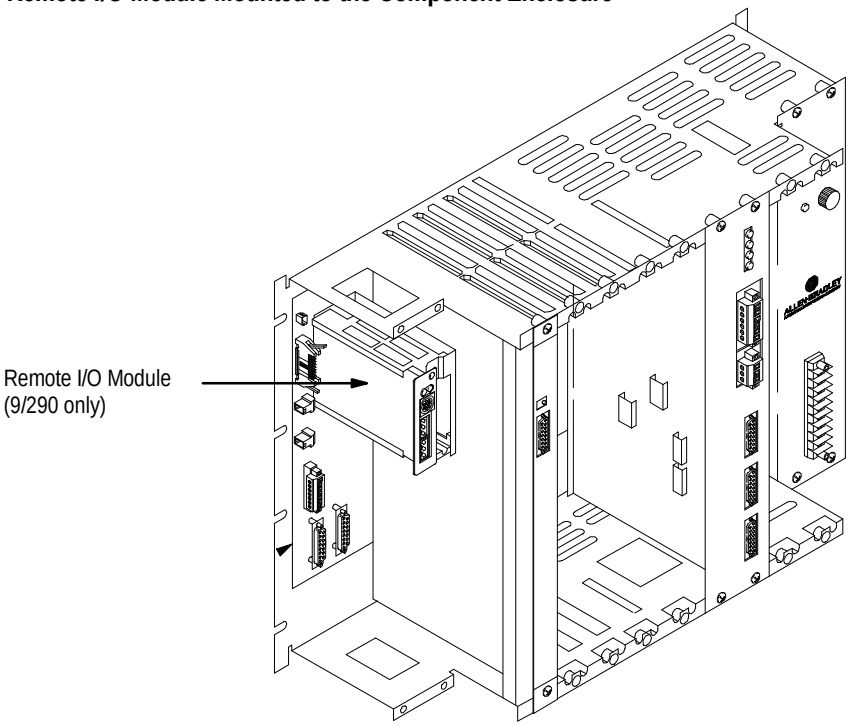
into the 9/Series remote I/O connection. These values are then stored on the control where they are assigned to the remote I/O input PAL flags ($RMI1-$RMI8).

When sending data from the control to a PLC processor, PAL must first assign values to the remote output flags ($RMO1-$RMO8). The control passes these output flag values to the PLC processor where they are loaded into eight input words in the PLC input image table.

8.9.1 9/290 Remote I/O Module

Figure 8.14 shows the remote I/O module as it comes mounted to the component enclosure for 9/290 controls.

Figure 8.14
Remote I/O Module Mounted to the Component Enclosure

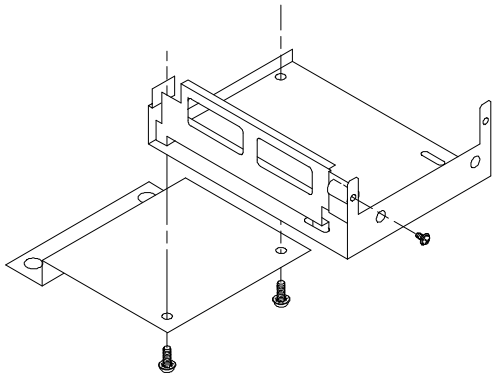


Mounting the Remote I/O Module to the Component Enclosure

If you ordered the remote I/O module with your 9/290 control, it comes already assembled and mounted to the component enclosure. If you have ordered the remote I/O module separately, use this procedure to mount the remote I/O module to the component enclosure:

1. Remove the parts from the bag

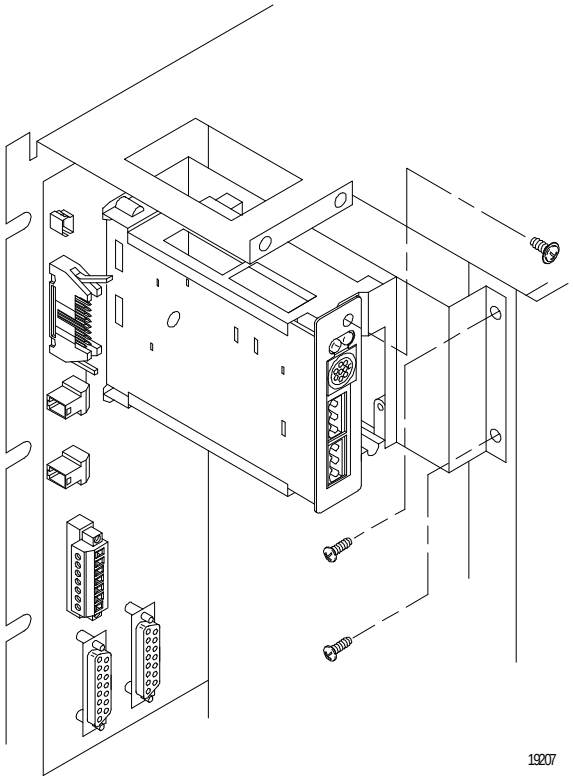
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2. Lay the metal support on a flat surface so that the brackets stand out. Align the plastic track with the full set of brackets and slide it into the metal support. Align metal brace and assemble as shown:

3. Repeat step 2 with the second plastic track. The card guide assembly is complete. Slide the remote I/O module into the assembly.

4. Attach the assembly to the chassis as shown:



Important: Refer to the information provided with your PLC processor or scanner for additional information on connecting the remote I/O module to your PLC processor or PLC scanner. Only port A may be used for remote I/O connection to this module. Port B is not used.

9/290 Remote I/O LEDs

The 9/290 remote I/O module uses only one of its two status indicators to help you troubleshoot remote I/O communications. The second status indicator is not used. Figure 8.15 shows the location of these status indicators. Table 8.G lists these status indicators.

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Figure 8.15
Location of Status Indicators in the Remote I/O Port

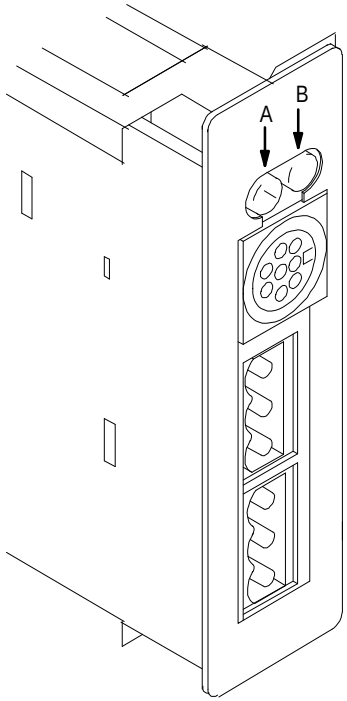


Table 8.G
Remote I/O Module Status Indicators

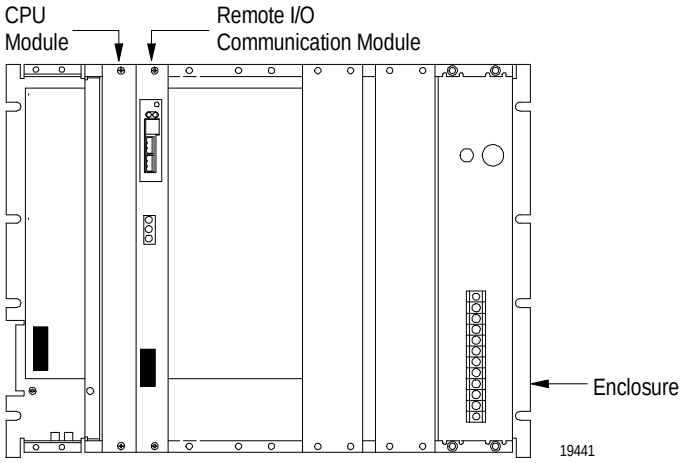
Indicator	Color/State	Description	Probable Cause	Recommended Action
A (B is not used)	green/steady	active link	normal operation	none required
	red/steady	hardware fault at processor	hardware error	Recycle power. Replace the processor. Refer to your processor documentation.
	red/blinking	communication break	AMP is not set correctly	reset AMP parameters to communicate with scanner program
	off	remote I/O port is offline	port is not being used	bring remote I/O port on line

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8.9.2 9/260 Remote I/O Module

Figure 8.16 shows the remote I/O module as it comes mounted in the component enclosure for 9/260 controls.

Figure 8.16
Remote I/O Module Mounted in the Component Enclosure



Mounting the Remote I/O Module in the Component Enclosure

If you ordered the remote I/O module with your 9/260 control, it comes already mounted in the component enclosure. If you have ordered the remote I/O module separately, use this procedure to mount the remote I/O module in the component enclosure.

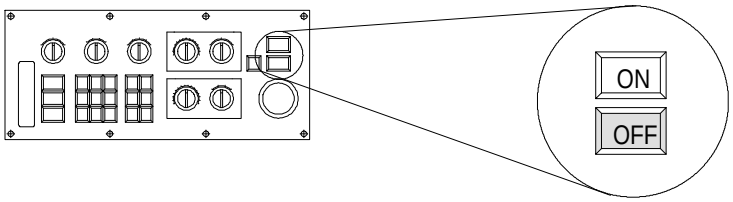
Important: You can not use the remote I/O module in a 9/260 system that contains either a 9/Series Data Highway Plus communication module or a 9/Series MMS/Ethernet communication module. A 9/260 system can contain only one Remote I/O, DH+, or MMS/Ethernet module.

ATTENTION: To prevent damage to the module, wear an ESD wristband while you unpack and install the module. Connect the wristband to the ground screw on the control's component enclosure.

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To install the remote I/O module, follow this procedure:

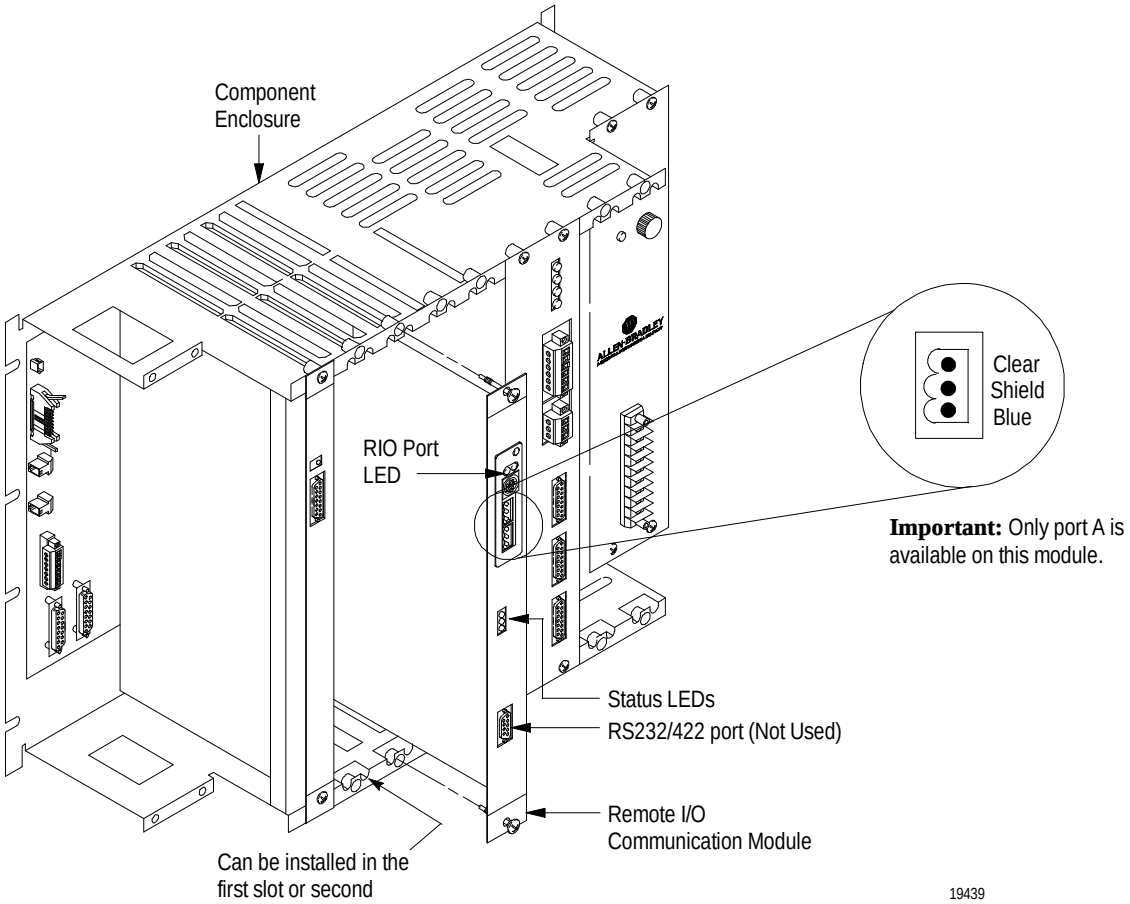
1. Turn off power to the control by pressing the <OFF> pushbutton.



2. Unpack the module from the box. Make sure you are wearing an ESD wristband.

3. Install the module as shown in Figure 8.17.

Figure 8.17
Installing the Module



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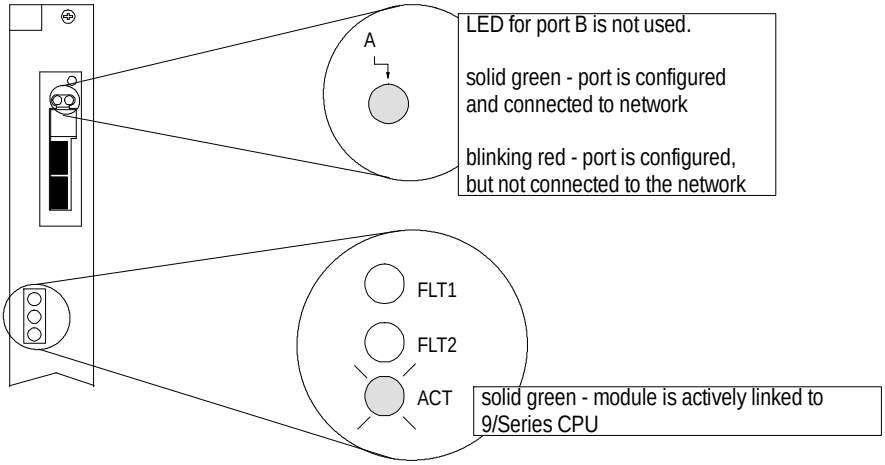
9/260 Remote I/O LEDs

Assuming you have:

- made all necessary remote I/O communication connections on your 1771 I/O network
- configured your module for the network in AMP
- written PAL to set $RMON true and to handle input and output words

you are ready to start receiving and transmitting remote I/O information. As the remote I/O module responds to commands, you should see this LED pattern:

Figure 8.18
LED Pattern You See When You Send a Command



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Use this table if you see a different LED pattern than shown above.

Indicator	Color/State	Description	Probable Cause	Recommended Action
A (B is not used)	green/steady	active link	normal operation	none required
	red/steady	hardware fault at processor	hardware error	cycle power. Replace the processor. Refer to your processor documentation.
	red/blinking	communication break	AMP is not set correctly	reset AMP parameters to communicate with scanner program
	off	remote I/O port is offline	port is not being used	bring remote I/O port on line
ACT	green/steady	active link to 9/Series CPU	normal operation	none required
	off	remote I/O module is not communicating with 9/Series control	remote I/O module is offline	AMP or PAL is not properly configured or your remote I/O network is not configured to communicate with the module.
FLT1	on	major hardware fault	device has failed	if LED remains on after cycling power, contact your Allen-Bradley sales representative
FLT1				

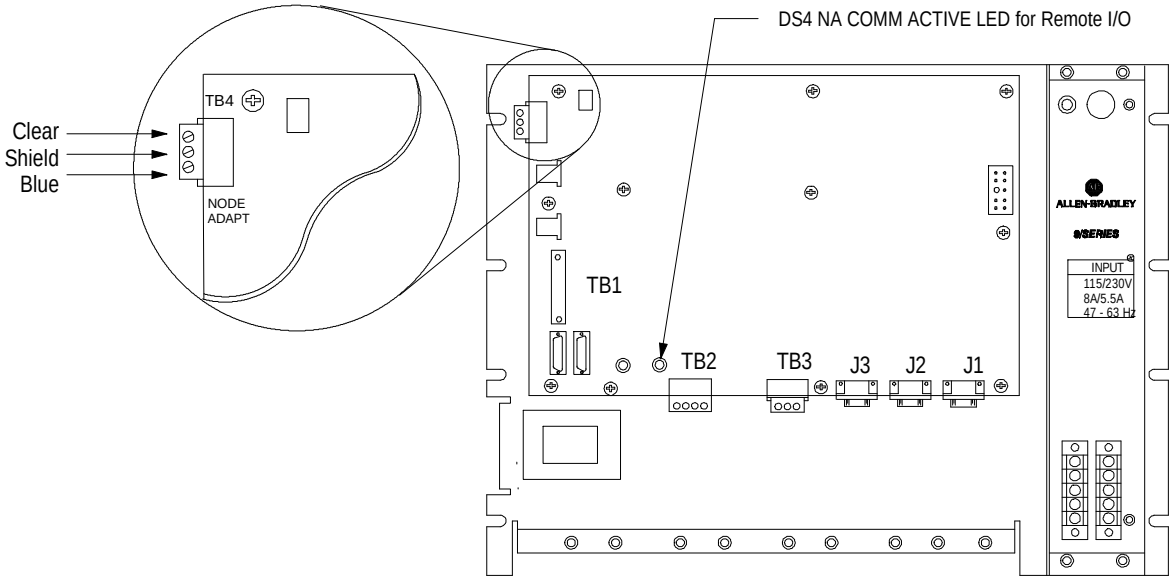
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8.9.3 9/230 Remote I/O Connection

On 9/230 controls the remote I/O circuitry and plug are integral parts of the main board. No external module exists. Figure 8.19 shows the remote I/O connector and LED mounted on the 9/230 mother board.

Wire connections for the remote I/O communications are made through the TB4 NODE ADAPT connector. Connect the wires for remote I/O as shown in the following figure. Refer to your 1771 I/O documentation for details on making remote I/O connections.

Figure 8.19
Remote I/O Module Mounted in the Component Enclosure



The analog 9/230 enclosure

9/230 Remote I/O LED

Assuming you have:

- made all necessary remote I/O communication connections on your 1771 I/O network
- configured your remote I/O port for the remote I/O network in AMP
- written PAL to set $RMON true during the first PAL foreground execution, and to handle input and output words ($RMI1 – $RMI8 inputs to PAL and $RMO1 – $RMO8 outputs from PAL.)

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You are ready to start receiving and transmitting remote I/O information. As the remote I/O module responds to commands, you should see this LED pattern:

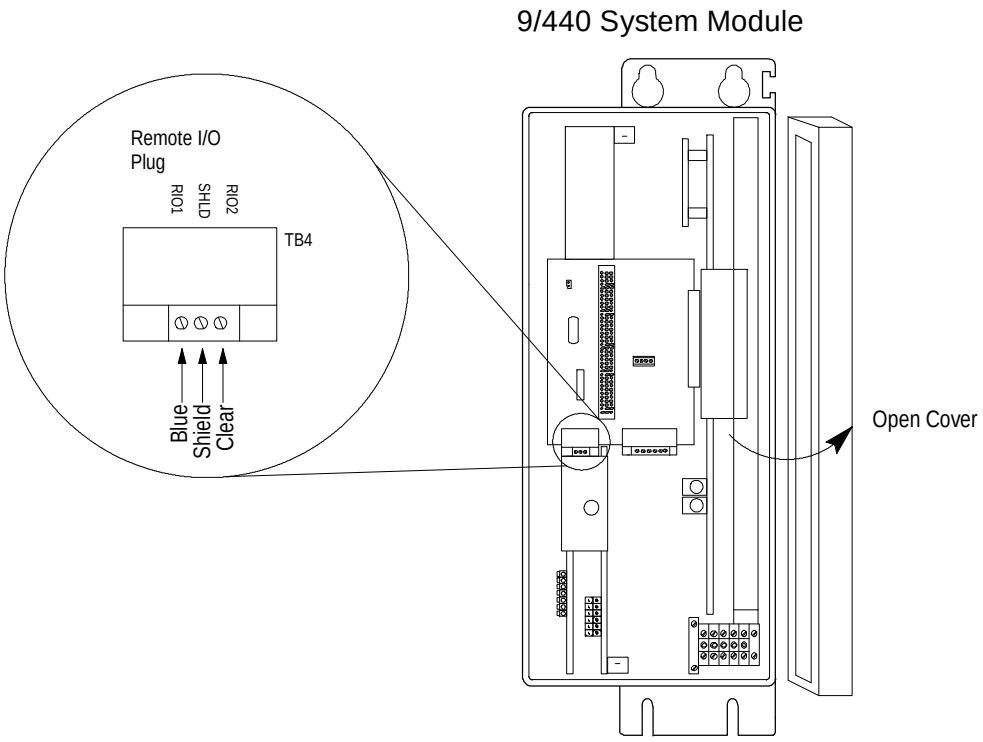
LED	Status	Description
DS4 NA COMM ACTIVE	ON	Active Link to PLC. This is the normal state when the RIO link is active.
	FLASHING	The remote I/O link is active but the PLC is currently in program mode.
	OFF	Remote I/O plug is offline. The port is not being used, not configured in AMP correctly, not turned on with $RMON, or not attached to a 1771 device.

8.9.4 9/440 Remote I/O Connection

The remote I/O circuitry and connector are integral parts of the wiring board in the 9/440 system module. Figure 5A.11 shows the remote I/O connector mounted on the 9/440 wiring board.

Wire connections for the remote I/O communications are made through the TB4 NODE ADAPT connector. Connect the wires for remote I/O as shown in the following figure. Refer to your 1771 I/O documentation for details on making remote I/O connections.

Figure 8.20
Remote I/O Connector in System Module

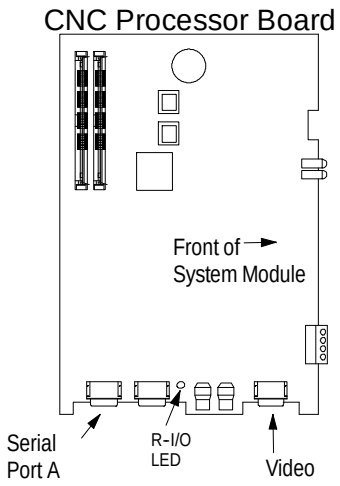


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9/440 Remote I/O LED

Assuming you have:

- made all necessary remote I/O communication connections on your 1771 I/O network
- configured your remote I/O port for the remote I/O network in AMP
- written PAL to set $RMON true during the first PAL foreground execution, and to handle input and output words ($RMI1 – $RMI8 inputs to PAL and $RMO1 – $RMO8 outputs from PAL.)



You are ready to start receiving and transmitting remote I/O information. An LED is provided on the 9/440 CNC processor board and is visible from the bottom of the system module. As remote I/O responds to commands, you should see this LED pattern:

LED	Status	Description
Green R-I/O LED	ON	Active Link to PLC. This is the normal state when the RIO link is active.
	FLASHING	The remote I/O link is active but the PLC is currently in program mode.
	OFF	Remote I/O link is offline. The port is not being used, not configured in AMP correctly, not turned on with $RMON, or not attached to a 1771 device.

8.10 MMS Ethernet Communications

The 9/260 and 9/290 CNCs have an MMS Etherent communications module available that provide MMS Ethernet services. With this module, the software is pre–installed with a set of default communication settings (modifications to these defaults is performed with Allen-Bradley Station Manager software).

A wide range of services are supported that allow you access to PAL and control variables, part program management, CNC status, etc... Details on the MMS Ethernet communications module are provided in a separate 9/Series MMS/Ethernet Communication Module Users Manual (Catalog number 8520-ENETM). Refer to this publication for further details.

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8.11 DH+ Communications

The 9/260 and 9/290 CNCs have a DH+ (Data Highway Plus) communications module available that provide DH+ communications. With this module, the 9/Series can communicate to pass/receive data over DH+ with other Allen–Bradley DH+ compatible devices.

A wide range of services are supported that allow you access to PAL and part program variables, part program management, CNC status, etc... Details on the DH+ communications module are provided in a separate 9/Series Data Highway Plus Communication Module Users Manual (Catalog number 8520-DHM). Refer to this publication for further details.

END OF SECTION

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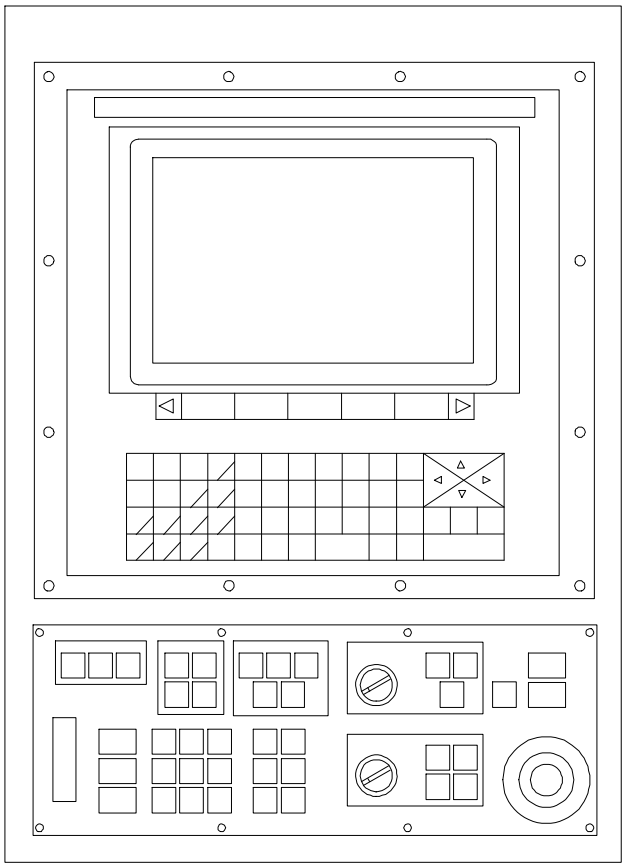
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Rockwell Automation
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9/Series Hardware
TAB 9

Operator Interface



852061-RM009A-EN-P - November 2000 PN-176959

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Section 9A

Operator Interface

9A.0 Section Overview

This section covers the integration of the components that make up the Operator Interface for the 9/Series CNCs. A section is devoted to each of the following components:

- Operator Panel (Display device and keyboard – 3 versions)
  - Mounted Monochrome operator panel
  - Mounted Color panel (CRT and Flat panel)
  - Removable operator panel
- MTB Panel (selector switches and pushbuttons – 3 versions)
  - Standard MTB panel with fiber optic connection
  - LED type Lamp panel with fiber optic connection
  - LED type Lamp panel with Direct 24 V I/O connection
- HPG (Hand pulse generator for manual jogging)

These components work together to enable the machine tool operator to interface with the control. Data entered through the operator panel keyboard, the MTB panel push buttons and switches, and the HPG handwheel is input to the control via the system I/O ring. How the specific components connect and interact with other modules of the control is explained in the following sections.

9A.1 Operator Panel Overview

The operator can edit programs, view system data, perform machine functions, and many other tasks through the operator panel. The operator panel allows an interface to/from the control through:

- 5 softkeys and 2 page keys
- a keyboard with 51 alphanumeric, control, and shift keys
- the display (CRT or TFT)

The display terminal can be either a 9–inch monochrome CRT, a 12–inch color CRT, or the 10.4 inch color flat screen TFT. The system installer must set an AMP parameter to select between the color and monochrome displays (the removable operator panel is always a monochrome display, the flat panel is always configured as a color display). The color displays will use all white characters if the AMP parameter is set incorrectly to “monochrome”. A monochrome display will not display any RED characters if AMP is configured for a color panel. This includes ALL of the system emergency messages.

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The monochrome and the color operator panels are powered by the operator panel power supply. It supplies:

- +12V dc power to the monochrome or color flat panel displays
- +12 V dc power to the MTB panel I/O module
- +5V dc power to the keyboard I/O ring interface
- +5V dc power to the HPGs

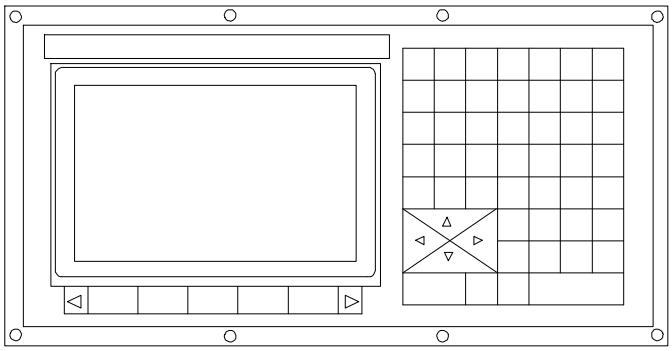
The operator panel power supply receives power directly from the controls main power supply.

The keyboard and softkeys on the operator panel are interfaced into the 9/Series I/O ring through the keyboard I/O interface. Fiber optic cables connect the optical receiver (black) and optical transmitter (red) on the operator panel keyboard I/O ring interface to the I/O ring. For more information on fiber optic cables and connectors refer to page 7B-1.

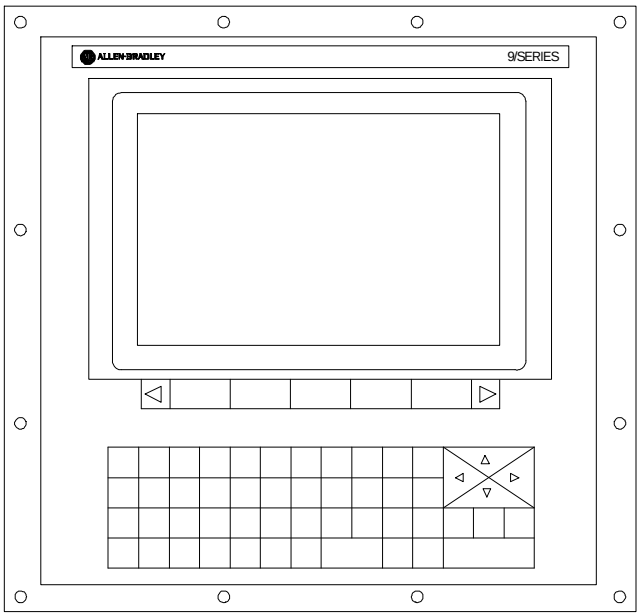
Figure 9A.1 shows the different operator panels.

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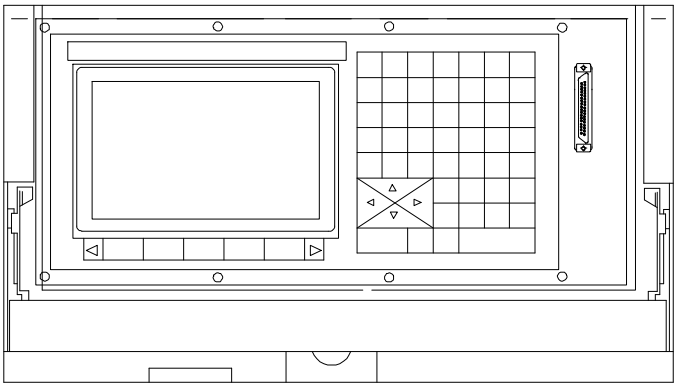
Figure 9A.1
Operator Panels



Monochrome Operator Panel



Color Operator Panels
(CRT and Flat Panel)



Removable Operator Panel

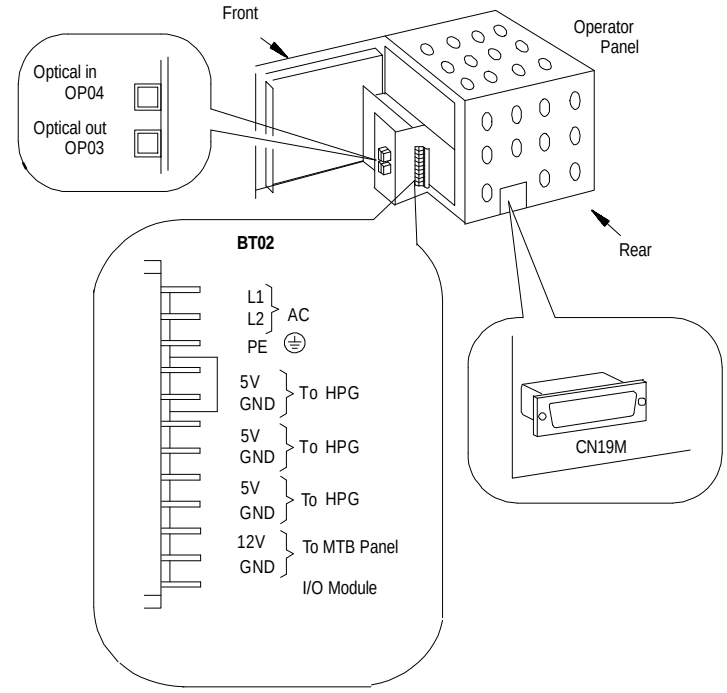
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9A.2 Mounted Operator Panel Installation

The mounted operator panels are typically mounted directly in a cabinet and are fixed in their location. It is directly linked to the 9/Series fiber optic ring, and contains its own power supply. The video signal is connected directly through a cable from the main processor to the CRT.

Figure 9A.2 shows the connectors and terminal blocks of the monochrome operator panel.

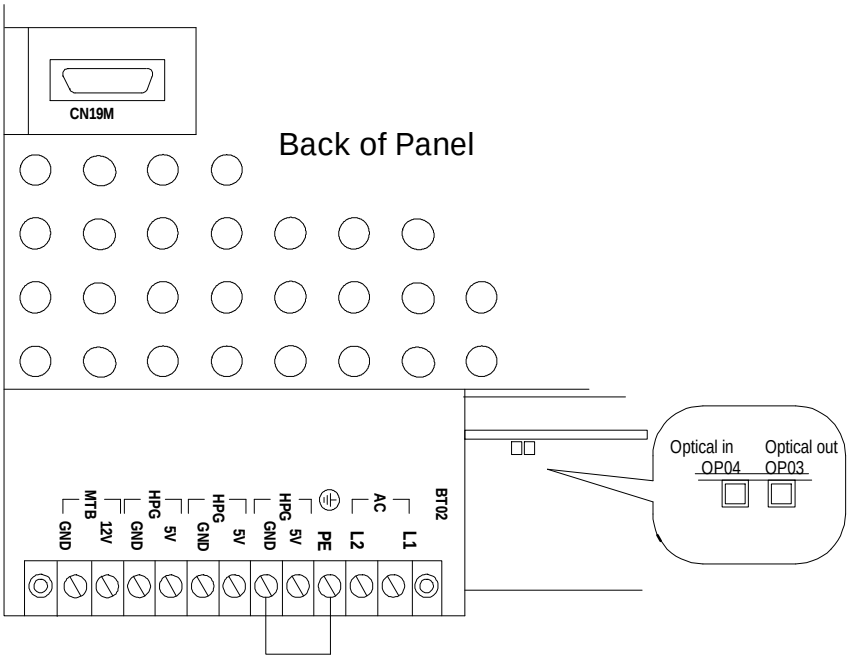
Figure 9A.2
Monochrome Operator Panel Connectors and Terminal Blocks



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Figure 9A.3 shows the connectors and terminal blocks of the CRT color operator panel.

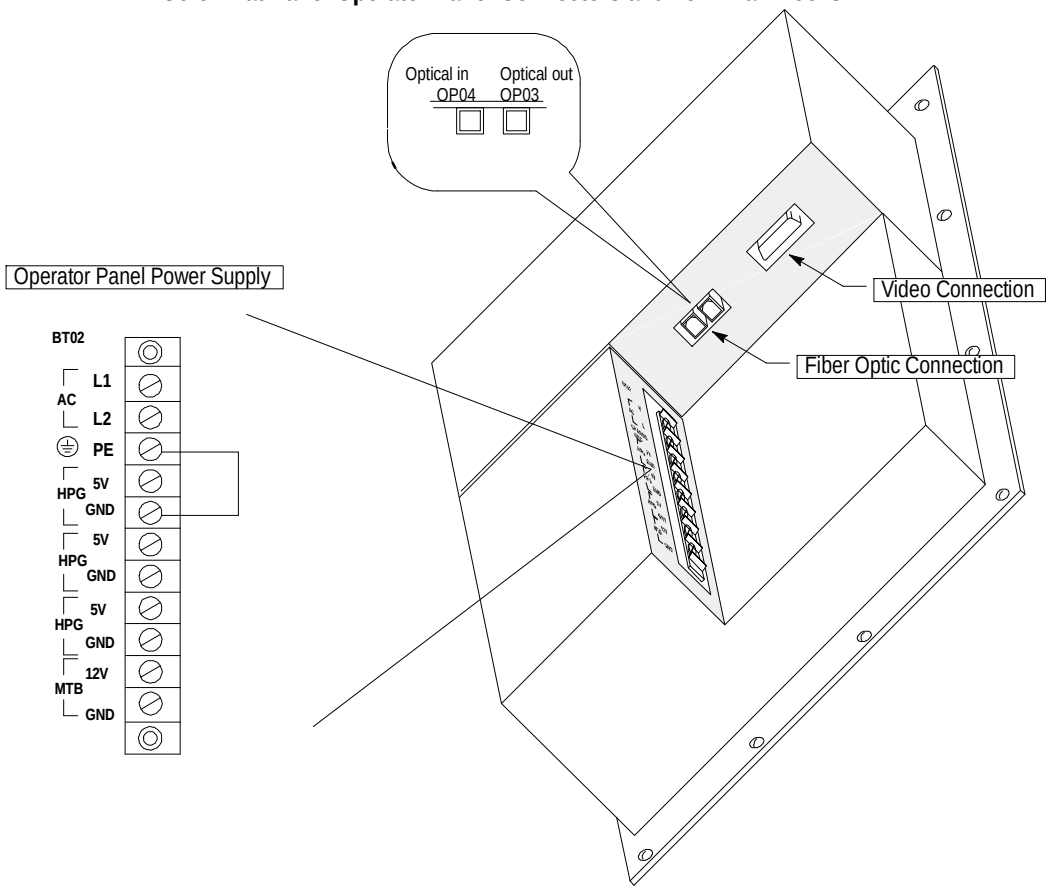
Figure 9A.3
Color CRT Operator Panel Connectors and Terminal Blocks



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Figure 9A.4 shows the connectors and terminal blocks of the color flat panel operator panel.

Figure 9A.4
Color Flat Panel Operator Panel Connectors and Terminal Blocks



9A.2.1 Mounted Operator Panel Video Connector

Table 9A.A shows the mounted operator panel video signal connector CN19M.

Table 9A.A
Operator Panel Video Signal Connection

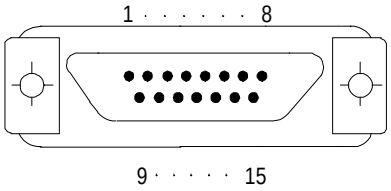
Connector On Operator Panel	Connected To Component	Connector	Cable Number	Remark
CN19M	Motherboard/System Processor	Video	C09	Video Signal

Video connector CN19M is the connector that connects the video monitor with the motherboard (9/260 and 9/290) or processor board (9/230 and 9/440). Figure 9A.5 shows video connector CN19M.

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Figure 9A.5 shows the pin assignments of video connector CN19M.

Figure 9A.5
Video Connector CN19M 15 Pin Male D-Shell Connector (has pins) Pin Assignment



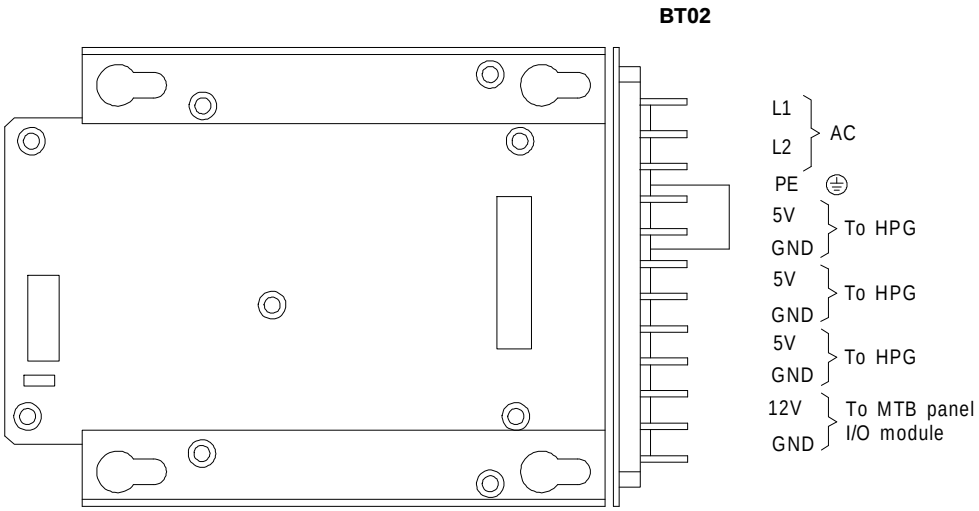
Pin No.	Signal Name	Pin No.	Signal Name
1	GND (SHIELD)	9	RED (L)
2	RED (H)	10	GREEN (L)
3	GREEN (H)	11	BLUE (L)
4	BLUE (H)	12	NC
5	NC	13	CLOCK (L)
6	CLOCK (H)	14	H-SYNC (L)
7	H-SYNC (H)	15	V-SYNC (L)
8	V-SYNC (H)		

9A.2.2 Mounted Operator Panel Power Supply

The monochrome, color, and color flat panel operator panels use the operator panel power supply. It supplies power to the monochrome and color flat panel displays (+12 V dc), the keyboard I/O ring interface (+5 V dc), the HPGs, and the MTB panel I/O module (note the color CRT uses 115V from the main power supply). The operator panel power supply receives power from the main power supply.

Figure 9A.6 shows the operator panel power supply.

Figure 9A.6
Operator Panel Power Supply



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Table 9A.B shows the input and output power connections for the operator panel power supply.

Table 9A.B
Operator Panel Power Supply Connection

Connector On Operator Panel		Connected To Component	Connector		Cable Number	Remark
BT02	AC-L1 AC-L2	Main Power Supply	BT04	AUX-H AC-L	C03	AC Input
	PE	Cabinet Chassis Ground				Earth GND
	+5V dc GND +5 V dc GND +5 V dc GND	HPG (1) HPG (2) HPG (3)	BT23 BT23 BT23	+5V GND +5V GND +5V GND	C29 C29 C29	Output GND Output GND Output GND
	+12V dc GND	MTB Panel I/O Module	MTB I/O	+12V GND	C28	Output GND
CN1		Keyboard I/O Ring Interface	CN23			+5V dc
CN2		Monochrome and Flat Panel Circuit Board				+12V dc

Table 9A.C shows the output specifications of the operator panel power supply. For input specifications and fuse specifications refer to page 4D-5.

Table 9A.C
Operator Panel Power Supply Output Specifications

Item	Specifications	Remark
Outputs	5 V dc (3 terminals) 0.4 A/channel	For 3 HPGs
	12 V dc (1 terminal) 1.5 A	For MTB Panel I/O Module
	5 V dc	For Keyboard I/O Module
	12 V dc	For Monochrome and Flat Panel
Protection Function	Overcurrent protection	
Connection	Terminal Block	

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Important: The color CRT operator panel has an additional internal power supply that is used to power the color CRT. The ac power supply cable, cable C03, provides ac power to the sub power supply terminal on the rear of the color operator panel as shown in Figure 9A.3. The ac power supply is jumpered internally to the color CRT power supply from operator panel power supply.

9A.2.3 Mounted Operator Panel Fiber Optic Connection

Fiber optic connection is made through the operator panel I/O interface card mounted on the back of the operator panel. Table 9A.F shows the connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to page 7B-1 for additional information on fiber optic cables and connectors. Figure 9A.2, Figure 9A.3, and Figure 9A.4 shows the location of these connectors.

Table 9A.D
Operator Panel I/O Connectors

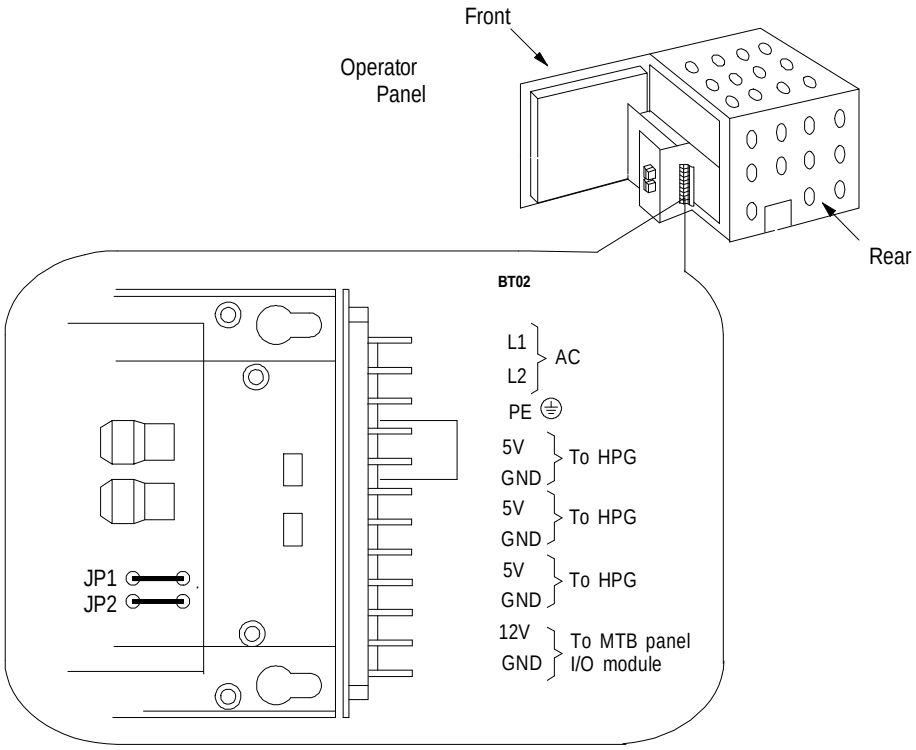
Connector	Connected To	Remark
RED	Receiver on next module in I/O ring	Output (OP03)
BLACK	Transmitter on previous module in I/O ring	Input (OP04)

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9A.2.4 Mounted Operator Panel Node Address Setting

Each operator panel must have a unique node address on the I/O ring. The node address corresponds to a unique address assigned to each operator panel in the I/O assignment file. The node address is selected by cutting the jumpers located on the operator panel. Figure 9A.7 shows the location of the jumpers on the operator panel.

Figure 9A.7
Operator Panel Jumper Location



The preceding figure shows the jumpers located on the keyboard I/O ring interface board of the the monochrome operator panel. This board is also used by the color and color flat panel operator panels. Locate this board by the fiber optic connections.

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Set the node address by cutting the wire jumper(s) according to Table 9A.E shown below.

Table 9A.E
Operator and Removable Operator Panel Node Address Setting

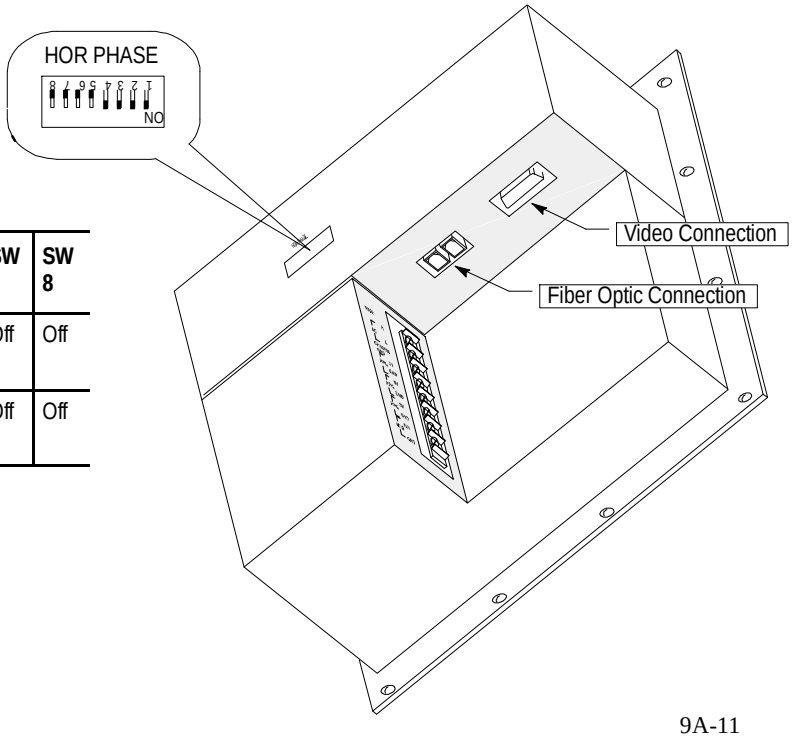
Node Address		Jumper	
Hexidecimal	**Binary**	**JP1**	**JP2**
00	00	Short	Short
01	01	Open	Short
02	10	Short	Open
03	11	Open	Open

The node address may be any number between 00 and 03. You may have a total of 4 interface assemblies on the I/O ring (if the removable operator panel interface is used a separate power supply is required if you use more than 2 assemblies). The same node address can be used for different types of modules, but may not be used more than once for a specific type of module.

9A.2.5 Flat Panel Horizontal Adjustment

The flat screen operator panel has a set of dip switches used to adjust the screens horizontal centering. Screen centering on the flat panel must be adjusted for different connecting control types. Figure 9A.8 illustrates the location and use of these dip switches.

Figure 9A.8
Flat Operator Panel Horizontal Adjustment Dip Switches



For this control type:	Sw 1	Sw 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
9/230, 9/260, and 9/290 CNCs	On	Off	On	Off	Off	Off	Off	Off
9/440 CNCs (factory default)	On	On	On	On	Off	Off	Off	Off

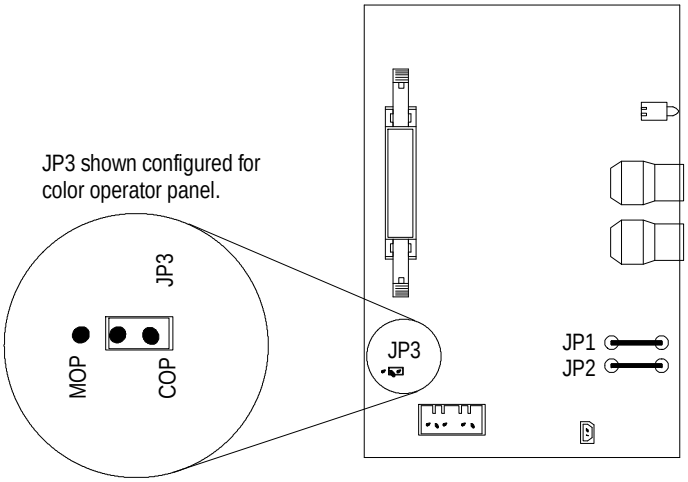
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9A.2.6 Keyboard Interface Jumper JP3

Jumper JP3 on the operator panel keyboard interface is used to determine if the keyboard interface module is attached to a monochrome or color operator panel (note these keyboard configurations are different). This jumper comes preset from the factory in the correct position for your operator panel. Adjustment of this jumper should only be made when replacing the operator panel keyboard interface module.

Set the color or monochrome operator panel jumper (JP3) to match the type of operator panel you have. The following table illustrates proper setting of JP3.

Jumper JP3 Setting	For this Operator Panel:
MOP ●  COP JP3	Color and Flat Panel Operator Panels
MOP  ● COP JP3	Monochrome Operator Panel



9A.2.7 Adjusting Monitor Intensity

Monitor intensity is controlled by adjusting the contrast on monochrome and color CRT systems. No intensity adjustments are available for the flat operator panels.

Monitor intensity adjustment is typically not required on the operator panels as they are adjusted to an acceptable level before shipping from the factory. In the event that you think you must alter the monitor intensity use the following procedure:

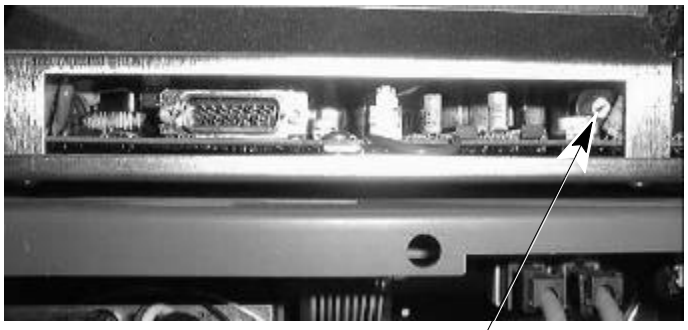
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1. Remove power from the operator panel.

2. Remove the plastic cover from the back of the operator panel. The cover is attached with three plastic snap pins at the bottom of the cover. Pull these pins until they snap free of the operator panel.

3. Using a small screw driver, adjust the contrast or sub contrast pot as shown below. Note these pots are labeled on the printed circuit board:

Color CRTs



Use Sub-Contrast Pot found at far right of video connector (Color CRT only)

Monochrome CRTs



Use Contrast Pot found behind video connector (Monochrome CRT only)

Important: We do not recommend adjusting any of the "Brightness" pots located on either CRT types. The brightness controls are preset at the factory for optimum monitor performance and reliability.

4. Re-attach the plastic cover to the back of the operator panel.

5. Re-establish power to the operator panel.

6. Repeat steps 1 thru 5 until the desired monitor intensity is reached.

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9A.3 Removable Operator Panel Installation

Use the removable operator panel on controls installed in locations where operator/machine interface is not needed often and it is practical for one operator panel to be transported from control to control when necessary. The 9/Series removable operator panel allows the connection and disconnection of the operator panel from the control while the control is running. This connection/disconnection takes place without any interruption to control operation and requires no reconfiguration of the control.

This functionality is made available through the installation of a separate operator panel interface assembly installed in the 9/Series I/O ring. This interface assembly allows the removable operator panel to be attached or detached from the 9/Series I/O ring without physically breaking the I/O ring. You must install an interface assembly in the 9/Series I/O ring wherever you intend to attach a removable operator panel.

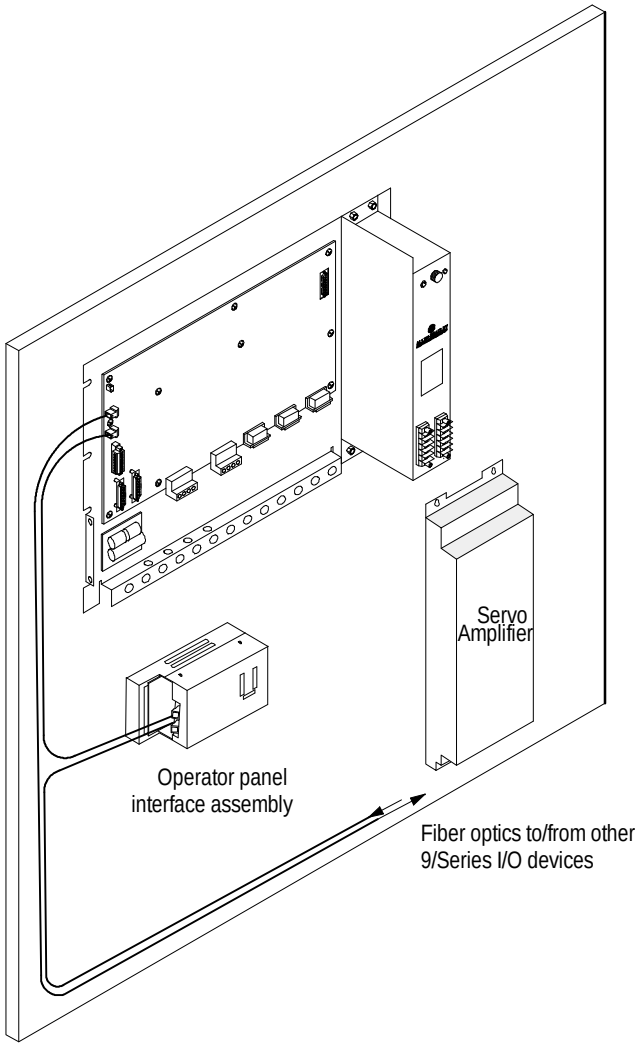
All connections between the 9/Series controller and the removable operator panel are made through a single cable. This cable provides all necessary communications to the 9/Series control (I/O ring interface for the keyboard, video signal, and power).

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9A.3.1 Installing the Removable Operator Panel Interface Assembly

The operator panel interface assembly is used to makes all connections between the 9/Series control and the removable operator panel. Install an interface assembly in the 9/Series fiber optic I/O ring at any location you intend to connect a removable operator panel.

Figure 9A.9
Placing Operator Panel Interface Assemblies



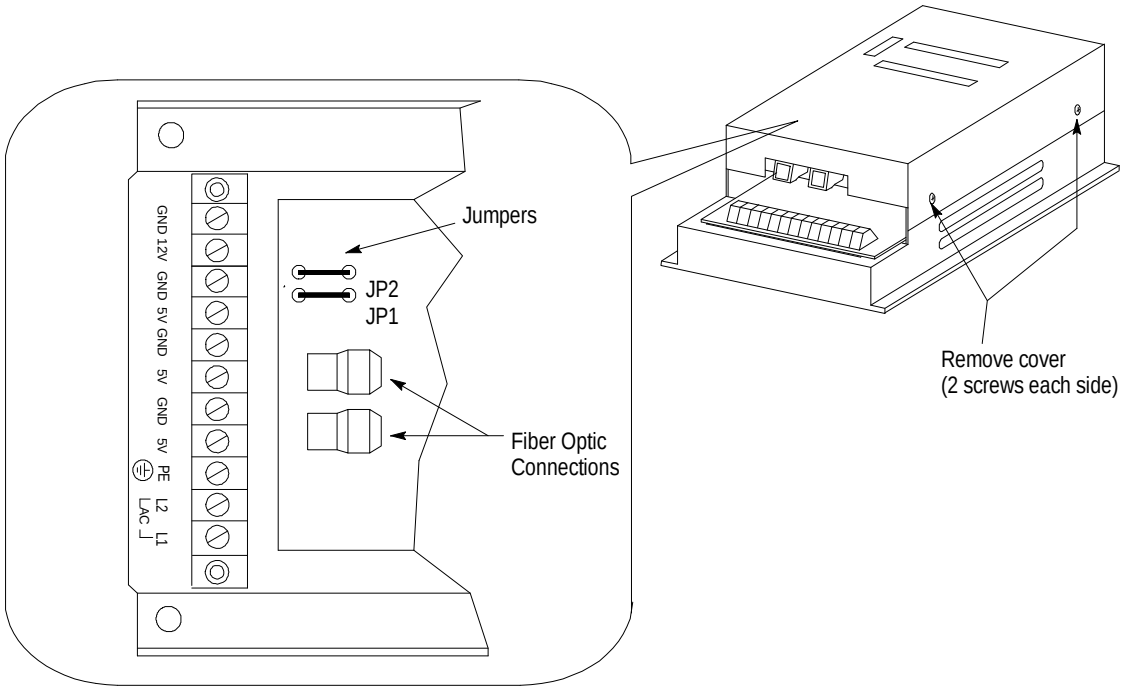
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Assigning a Module Address

Each interface assembly must have a unique node address on the I/O ring. The node address corresponds to a unique address assigned as independent operator panels in the I/O assignment file found in ODS (see your PAL reference manual). The node address is selected by cutting the jumpers located on the interface assembly(s). Figure 9A.10 shows the location of the jumpers on the interface module.

Important: You must remove the cover from the removable operator panel interface assembly to access the node address jumpers. Turn off power to the interface assembly before removing the cover. Make sure to follow proper ESD grounding procedures when working on any 9/Series equipment.

Figure 9A.10
Removable Operator Panel Interface Assembly JP1 and JP2 Jumper Locations



Set the node address by cutting the wire jumper(s) according to Table 9A.E.

The node address may be any number between 00 and 03. You may have a total of 4 interface assemblies in the 9/Series fiber optic I/O ring. The same node address can be used for other types of modules however, each removable operator panel interface assembly must have its own unique address.

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Reinstall the cover on the interface assembly when you have finished setting your address jumpers.

Connecting the Interface Assembly to the Fiber Optic Ring

Fiber optic connection to the keyboard on the removable front panel is made through the interface assembly. Table 9A.F shows the connectors used to make the fiber optic connections to the I/O ring. Each interface assembly connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to page 7B-1 for additional information on fiber optic cables and connectors.

Figure 9A.11
Removable Operator Panel Interface Module Fiber Optic Connections

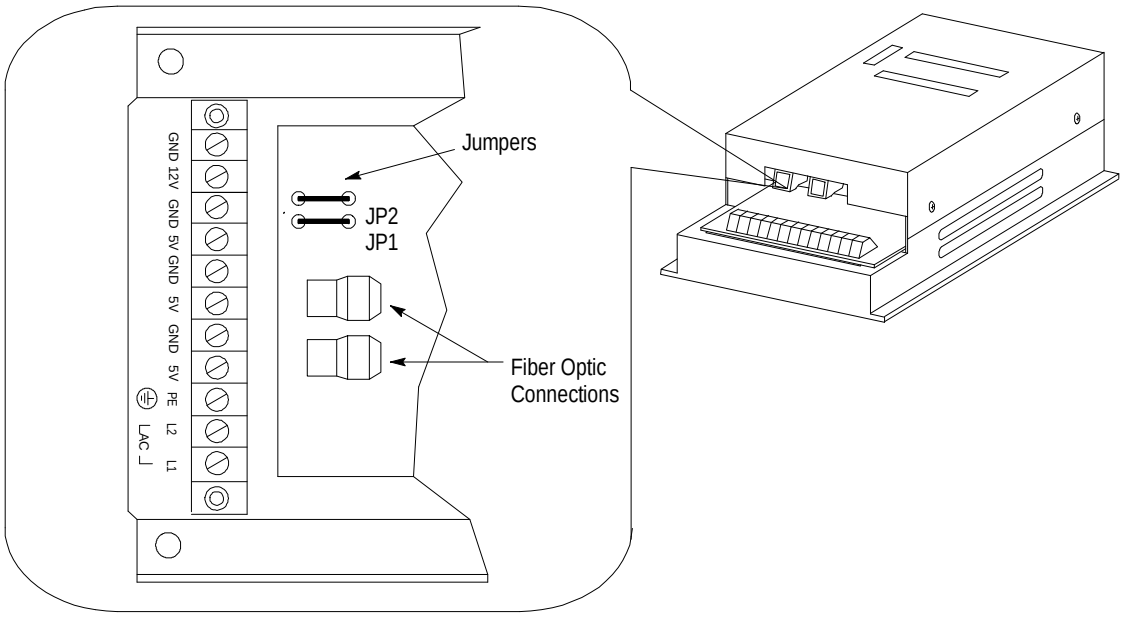


Table 9A.F
Operator Panel I/O Connectors

Connector	Connected To	Remark
RED	Receiver on next module in I/O ring	Output
BLACK	Transmitter on previous module in I/O ring	Input

You must connect both the input and output connectors of all devices on the I/O ring. You can not leave an open connector on any module.

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Interface Assembly Video Connection CN19M

Table 9A.G shows the interface assembly video signal connector.

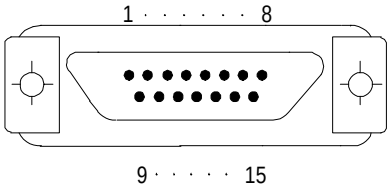
Table 9A.G
Interface Assembly Video Signal Connection

Connector On Motherboard/System Processor	To Connector On Removable Front Panel Interface Assembly	Cable Number (page 7A-24)	Remark
J8 15 pin D-shell	CN19M 15 pin D-shell	C09	Video Signal

Video connector CN19M is the connector that connects the removable operator panel interface module to the motherboard (9/260 and 9/290) or processor board (9/230).

Figure 9A.12 shows the pin assignments of the video connector CN19M.

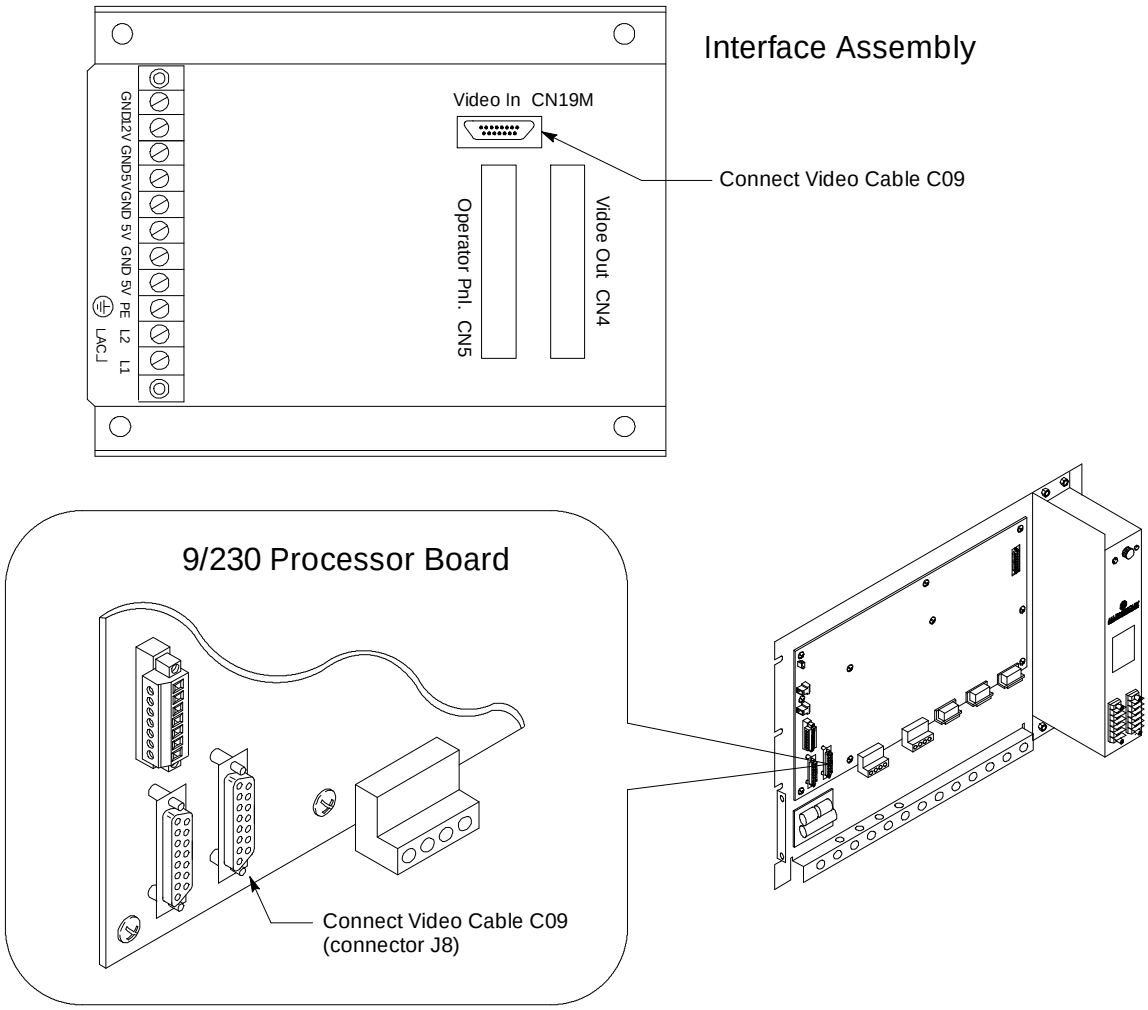
Figure 9A.12
Video Connector CN19M 15 Pin Male D-shell Connector and Pin Assignment



Pin No.	Signal Name	Pin No.	Signal Name
1	GND (SHIELD)	9	NC
2	NC	10	GREEN (L)
3	GREEN (H)	11	NC
4	NC	12	NC
5	NC	13	NC
6	NC	14	H-SYNC (L)
7	H-SYNC (H)	15	V-SYNC (L)
8	V-SYNC (H)		

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Figure 9A.13
Removable Operator Panel Interface Module Video Connections



Removable Operator Panel Interface Assembly Power Supply

Power for the removable operator panel is provided by the interface assembly power supply. The interface assembly also supplies power for HPGs and an MTB panel I/O module. The interface assembly power supply receives power from the main power supply. Connect the ac-H and ac-L terminals on the BT02 terminal strip to the main 9/230 control power supply connector BT04 terminals AUX–H and AUX–L.

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Figure 9A.6 shows the removable operator panel interface assembly power supply.

Figure 9A.14
Operator Panel Power Supply

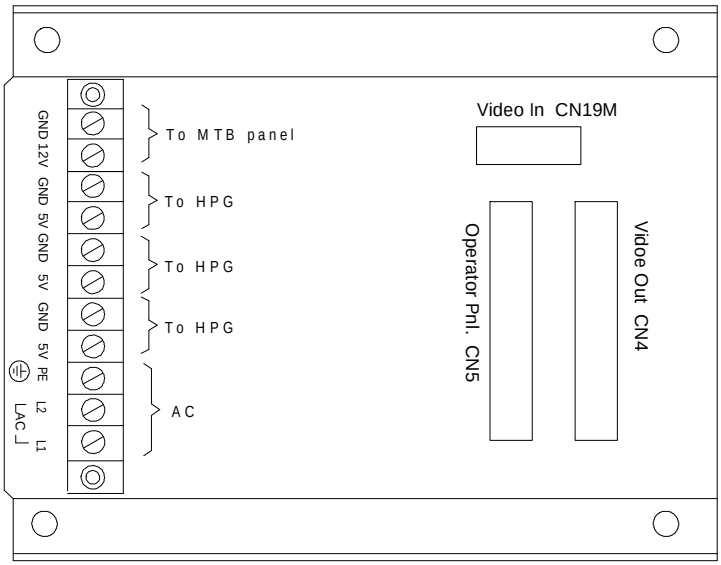


Table 9A.H shows the input and output power connections for the interface assembly power supply.

Table 9A.H
Interface Assembly Power Supply Connection

Connector On Interface Assembly		Connected To Component	Connector		Cable Number	Remark
BT02	ac-L1 ac-L2	Main Power Supply	BT04	Aux-H Aux-L	C03	AC Input
	PE	Cabinet Chassis Ground				Earth GND
	+5V dc	HPG (1)	BT23	+5V	C29	Output
	GND			GND		GND
	+5 V dc	HPG (2)	BT23	+5V	C29	Output
	GND			GND		GND
	+5 V dc	HPG (3)	BT23	+5V	C29	Output
	GND			GND		GND
	+12V dc GND	MTB Panel I/O Module	MTB I/O	+12V GND	C28	Output GND

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Table 9A.I shows the output specifications of the removable operator panel interface power supply. For input specifications and fuse specifications refer to page 4D-5.

Table 9A.I
Interface Assembly Power Supply Output Specifications

Item	Specifications	Remark
Outputs	5 V dc (3 terminals) 0.4 A/channel	For HPGs
	12 V dc (1 terminal) 1.5 A	For MTB Panel I/O Module
	5 V dc	For Keyboard I/O Module
	12 V dc	For Monochrome CRT
Protection Function	Overcurrent protection	
Connection	Terminal Block	

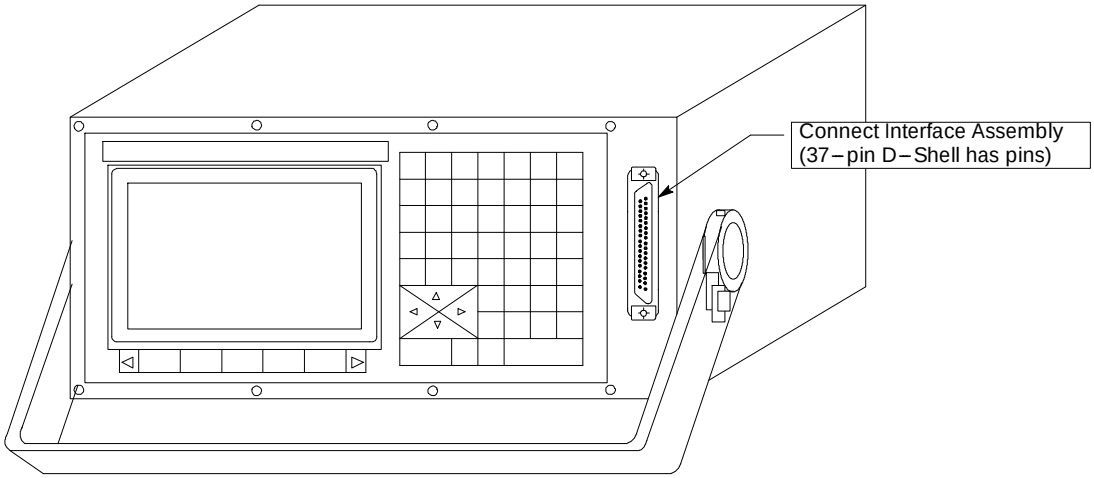
9A.3.2 Connecting/Disconnecting the Removable Operator Panel

Your removable operator panel connects to the 9/Series control through the removable operator panel interface assembly you installed as discussed on page 9A-15. The connection between removable operator panel and interface assembly is made via a 10 ft (max length) cable. This cable is provided with your removable operator panel.

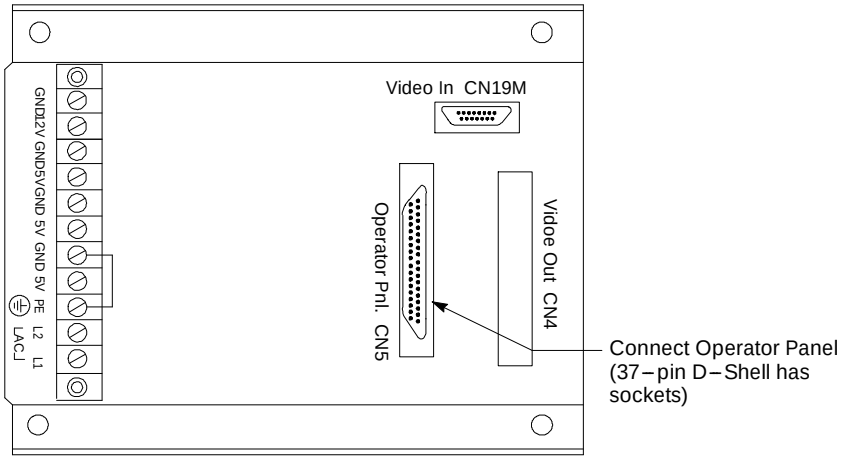
Attach the removable operator panel cable between the interface assembly connector CN5 and the 37-pin D-shell connector on the front of your removable operator panel. You can attach or detach the operator panel at any time. We do not recommend, however, disconnecting this panel while in the middle of editing online or Patch AMP or while editing a part program.

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Removable Operator Panel



Interface Assembly

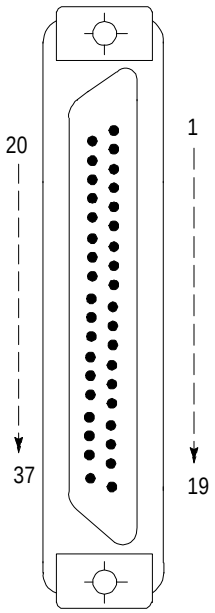


Removable Operator Panel Interface Cable

The removable operator panel interface assembly cable has a 37 pin D shell connector at both ends of the cable. The female end of the cable (has sockets) connects to the removable operator panel. The male end of the cable (has pins) connects to the removable operator panel interface assembly. The pin out connections for this cable are as follows:

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Pin number:	Description:	Pin number:	Description:
1	Shld. Chassis Ground	20	Ground
2	Keyboard Data	21	Video Hi
3	Keyboard Data	22	Video Lo
4	Keyboard Data	23	H - Sync Hi
5	Keyboard Data	24	H - Sync Lo
6	Keyboard Data	25	V - Sync Hi
7	Keyboard Data	26	V - Sync Lo
8	Keyboard Data	27	Ground
9	Keyboard Data	28	12 Vdc
10	Keyboard Data	29	12 Vdc
11	Keyboard Data	30	12 Vdc
12	Keyboard Data	31	12 Vdc
13	Keyboard Data	32	12 Vdc
14	Keyboard Data	33	Ground
15	Keyboard Data	34	Ground
16	Keyboard Data	35	Ground
17	Keyboard Data	36	No Connection
18	Keyboard Data	37	No Connection
19	Keyboard Data		



9A.3.3 Multiple Removable Operator Panel Assemblies

If your machine layout calls for more than one location to plug in your removable operator panel, read this section. Multiple operator panel locations typically require a separate removable operator panel interface assembly at each location. A maximum of four interface modules can exist in the 9/Series fiber optic I/O ring.

The interface assembly provides power to the CRT as well as a keyboard interface to the fiber optic ring.

Important: It is possible to place a mounted fixed location operator panel on the ring with a removable operator interface assembly at some other location. Call your Allen Bradley support group for details on installing this type of system.

For systems with two removable operator panel interface assemblies:

- Wire the power supplies for both interface assemblies
- Connect the KBI interface to the fiber optic ring for both assemblies

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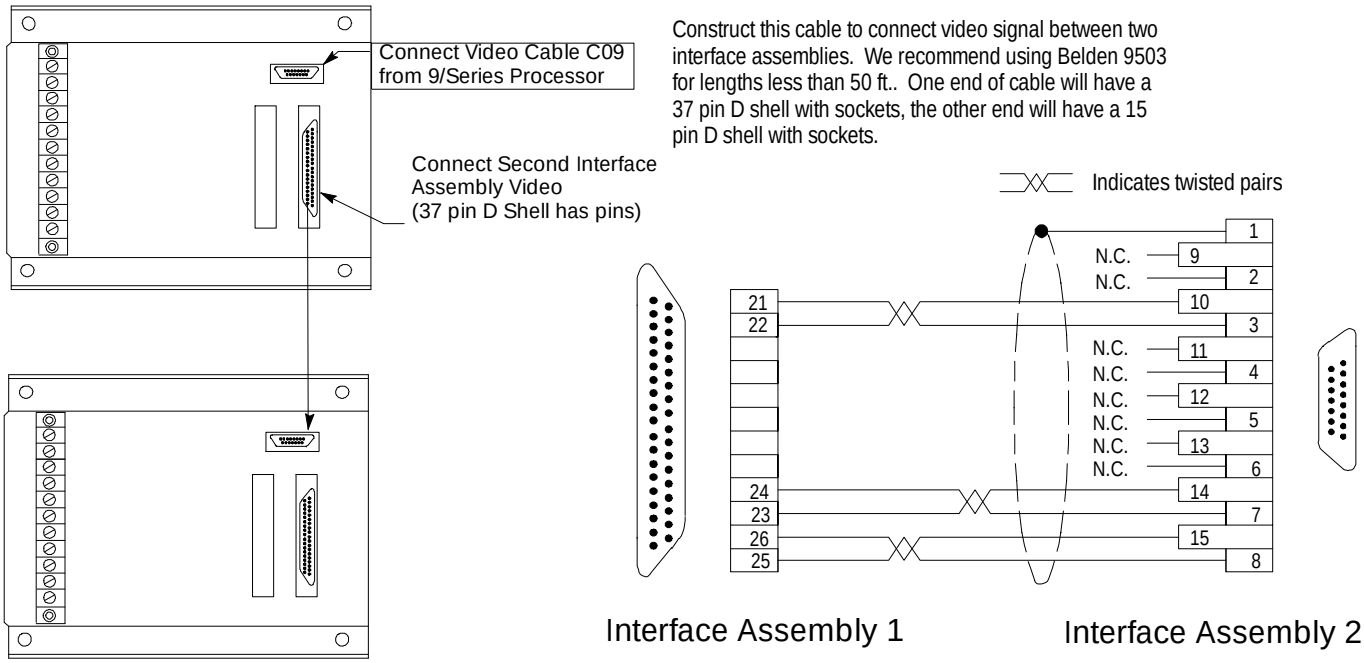
- Connect the video signal cable to only one interface assembly. Construct the cable shown in Figure 9A.15 to jumper the video signal to the second interface assembly.

ATTENTION: Use PAL to select which keyboard is the active keyboard ($KYB_SEL) in conjunction with some external device hardware. PAL should allow an operator to connect his keyboard, and lock out other keyboards from access to the I/O ring. Other keyboards can than be connected to the ring for monitoring but their keyboard inputs will be ignored. Failing to do this check will allow the connection of more than one functioning operator panel at one time which, in some applications, can be dangerous to equipment or personnel.

Use the following procedure to connect multiple removable operator panel interface assemblies.

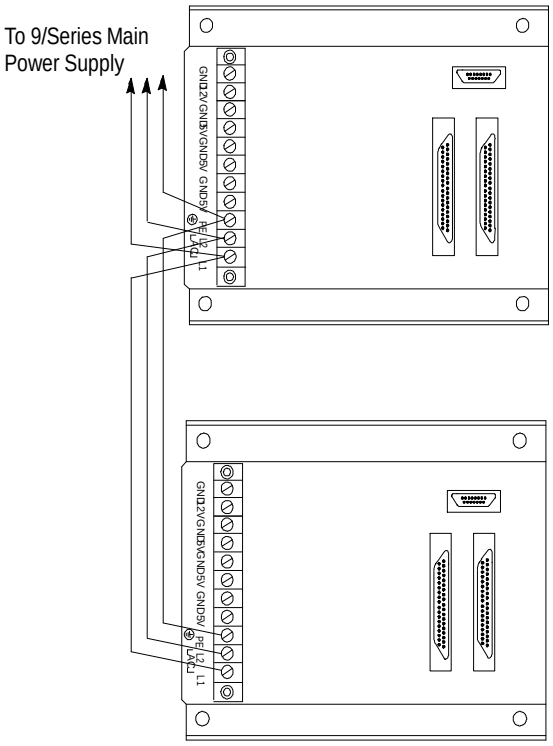
1. Connect the video signal to both interface assemblies. This is accomplished by connecting the video signal from the processor to one interface assembly and jumping the video signal out of CN4 on the interface assembly to the video connection on the second interface assembly. The total video signal cable length must be less than 100 feet (including from processor to interface assembly, between interface assemblies, and to portable operator panel).

Figure 9A.15
Connecting Multiple Removable Operator Panel Interface Assemblies



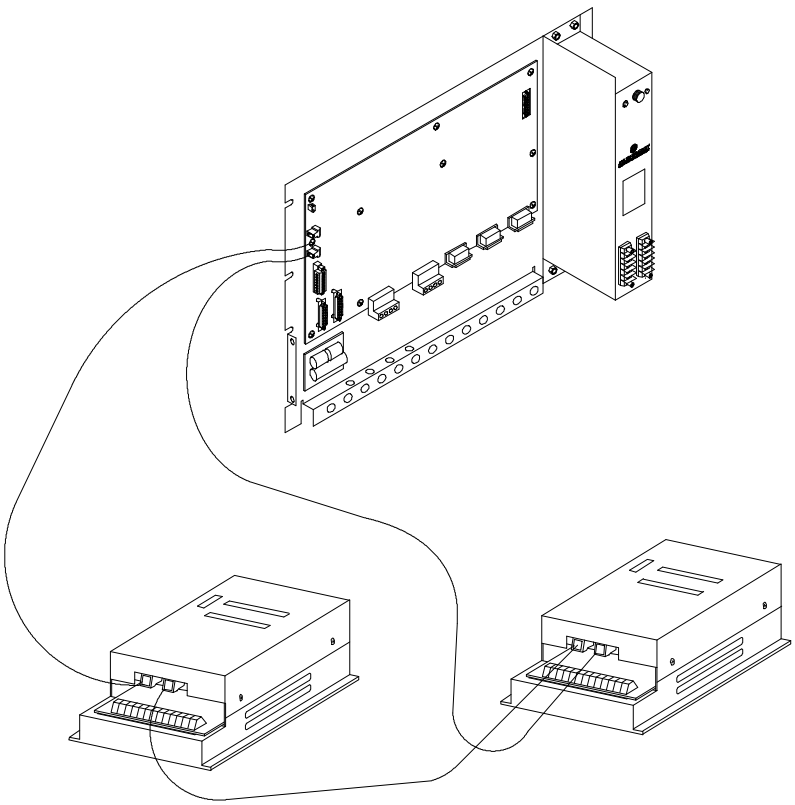
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2. Connect AC power from the main power supply to the interface assemblies. Daisy chain the power between the two assemblies. The standard 9/Series power supply can supply power for two interface assemblies. If your system requires more than two interface assemblies in the same ring you must supply your own external power to the interface assemblies. All interface assemblies in the I/O ring must be powered when the system is running.



3. Connect the 9/Series Fiber optic ring. Other devices can be in the ring at any location but are not shown here for clarity.

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9A.4 MTB Panels

There are three versions of the Pushbutton MTB panel available for use with the 9/Series controls.

- Standard MTB panel – fiber optic (MTB2)
- MTB Panel with LED Lamps – fiber optic (MTBL)
- MTB with LED lamps– direct inputs /outputs (MTB24)

The first two of these panels are identical except for the type of illumination in the push buttons. They both are a combination of machine tool builders (MTB) pushbutton panel and a fiber optic I/O module. This combination provides the push-button MTB panel with direct fiber optic communication to the control.

The third type of MTB panel does not have the fiber optic interface module, but provides connection from the panel using direct 24 V DC inputs and outputs. An external Fiber Optic interface device is required to provide an interface to the control. This panel uses LEDs for the Pushbutton lamps. This version of the MTB panel is used where complex switching of the signals between several CNCs is required.

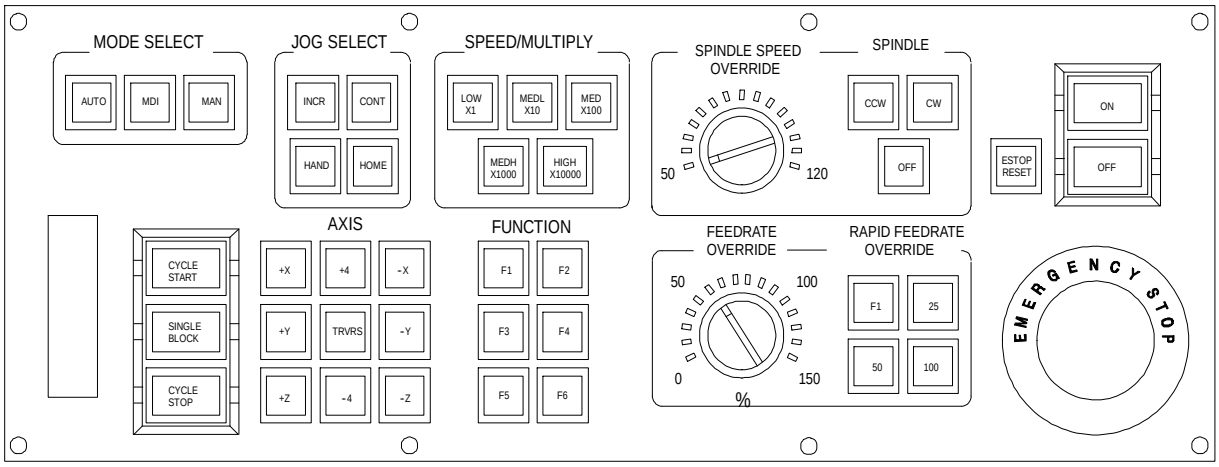
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The push-button MTB panels are used to provide the user with manual control over various system functions. These system functions are selected using the various switches and push buttons on the push-button MTB panel. The selected functions are then interfaced to the control via a fiber optic I/O module.

Important: A PAL module that provides the PAL logic necessary to decode the push-button MTB panel functions is available on Motion Control Bulletin Board. Refer to the 9/Series CNC PAL Reference Manual, publication 8520-4.3, for more information.

Figure 9A.16 shows a front view of all of the push-button MTB panels.

Figure 9A.16
Push-Button MTB panel



19930

Only the three push-button MTB panels are covered in these sections. The system installer may develop custom MTB panels for specific applications. Refer to the system installer's literature for any information on custom MTB panels.

If a custom MTB panel is to be used, the MTB I/O module can be purchased separately to interface a custom MTB panel with the system I/O ring. To use a custom panel with the I/O module, you must set JPR3 to the Custom Panel position.

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9A.4.1 MTB Panel Connectors and Pin Assignments (fiber-optic versions)

Figure 9A.17 shows the terminal blocks and connectors used to connect both versions Fiber–Optic push-button MTB panels (incandescent and LED lamps).

The MTB panel I/O module is interfaced with the system I/O ring using fiber optic cables that are connected to the optical receiver and transmitter on the I/O module. Refer to page 7B-1 for additional information on fiber optic cables and connectors.

The MTB I/O module interfaces the push-button MTB panel with the control. It provides 44 inputs and 18 outputs to the system I/O ring. These inputs and outputs provide communication between the push-button MTB panel and the control.

Figure 9A.17
Push-Button MTB Panel Terminal Block and Connectors

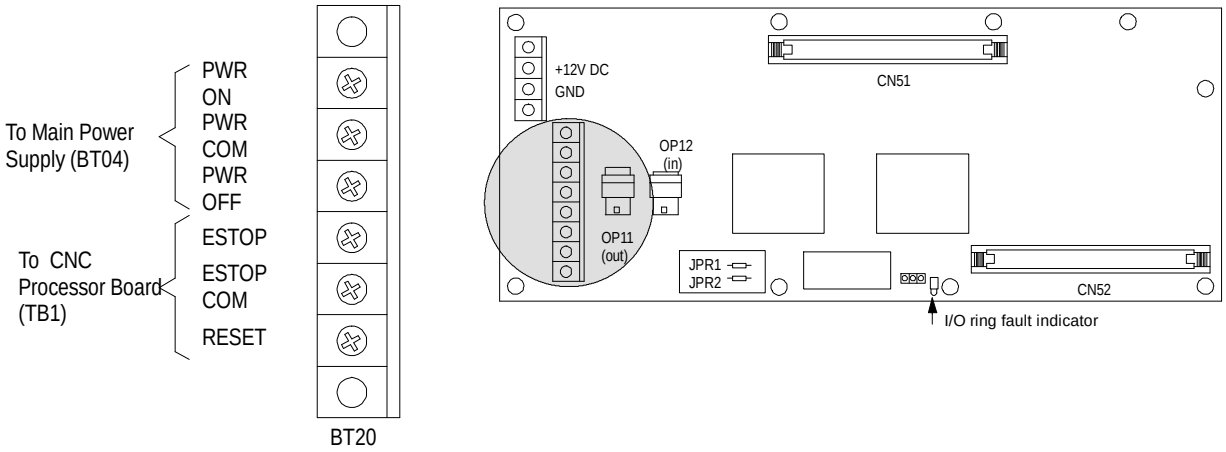


Table 9A.J shows the terminal connector used to connect the push-button MTB panel to the power supply and the CNC processsor.

Table 9A.J
Push-Button MTB Panel Terminal Connector BT-20

Connector On Push-Button MTB Panel		Connected To Component	Connected To Connector		Cable Number
BT-20	PWR ON	Power Supply	BT04	ON	C01
	PWR COM			SW	
	PWR OFF			COM	
	E-STOP	Motherboard/System Processor	BT01	E-STOP	C06
	E-STOP COM			COM	
	RESET			RESET	

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Table 9A.K shows additional connectors of the push-button MTB panel.

Table 9A.K
Push-Button MTB Panel Connectors

Connector On Push-Button MTB Panel	Connected To Component	Connector		Cable Number	Remark
+12V	Operator Panel		+12V		
GND	Power Supply	BT03	GND	C28	
Input Interface Ribbon Cable	Standard MTB	CN51		C26	Input
Output Interface Ribbon Cable	Panel I/O Module	CN52		C27	Output
CN56F	Motherboard/System Processor	CN16F		C07	Port B

Input Interface Ribbon Cable

Input signals from the push-button MTB panel are sent through input interface ribbon cable to connector CN51 on the push-button MTB panel I/O module. These signals are then sent to the motherboard via the fiber optic I/O ring. Table 9A.L shows the pin assignments and functions for input interface ribbon cable on the push-button MTB panel.

PAL expects the push-button MTB panel input signals, which are shown below, to be sent through the push-button MTB panel I/O module on the corresponding pin numbers. If the input signals differ from those listed in Table 9A.L, the PAL I/O assignments file must be altered. Refer to the 9/Series CNC 9/230,9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

The default settings at power-up for the push-button MTB panel are:

Selection	Default
Mode Select	MAN
Jog Select	CONT
Speed/Multiply	X1
Spindle	OFF
Rapid Feedrate Override	F1

Output Interface Ribbon Cable

Output signals from connector CN52 on the push-button MTB panel I/O module are sent to the push-button MTB panel via the output interface ribbon cable. Table 9A.M shows the pin assignments and functions for output interface ribbon cable on the push-button MTB panel. PAL outputs signals to the push-button MTB panel through the push-button MTB panel I/O module on the corresponding pin numbers. If the output signals differ from those listed in Table 9A.M, the PAL I/O assignments file must be altered. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

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Table 9A.L
Push-Button MTB Panel Input Interface Ribbon Cable Pin Assignments

Pin No.	Function	Gray Code	PAL Device Name	Pin No.	Function	Gray Code	PAL Device Name
1	Cycle Stop	N/A	CN51-1	2	+12V	N/A	N/A
3	Cycle Start		CN51-3	4	+12V		
5	Single Block		CN51-5	6	+12V		
7	+X		CN51-7	8	+12V		
9	+Y		CN51-9	10	+12V		
11	+Z		CN51-11	12	+12V		
13	+4		CN51-13	14	AUTO	a	CN51-34
15	-X		CN51-15	16	MDI	b	CN51-32
17	-Y		CN51-17	18	MANUAL		
19	-Z		CN51-19	20	INCR	a	CN51-30
21	-4		CN51-21	22	CONT	b	CN51-28
23	TRVRS		CN51-23	24	HAND		
25	F5		CN51-25	26	HOME		
27	F6		CN51-27	28	X1	a	CN51-40
29	F 1		CN51-29	30	X10	b	CN51-38
31	F 2		CN51-31	32	X100	c	CN51-36
33	F 3		CN51-33	34	X1000		
35	F 4		CN51-35	36	X10000		
37	Feedrate Override “a”	a	CN51-37	38	Rapid Override F1	a	CN51-45
39	Feedrate Override “b”	b	CN51-39	40	Rapid Override 25	b	CN51-47
41	Feedrate Override “c”	c	CN51-41	42	Spindle Speed Override “d”	d	CN51-42
43	Feedrate Override “d”	d	CN51-43	44	Spindle Speed Override “c”	c	CN51-44
45	Not Used	N/A	N/A	46	Spindle Speed Override “b”	b	CN51-46
47				48	Spindle Speed Override “a”	a	CN51-48
49				50	Rapid Override 50		
51	Power Off			52	Rapid Override 100		
53	Power Common			54	CCW	a	CN51-49
55	Power On			56	OFF	b	CN51-50
57	E-stop			58	CW		
59	E-stop Common			60	Reset		N/A

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Table 9A.M
Push-Button MTB Panel Output Interface Ribbon Cable Pin Assignments

Pin No.	Function	PAL Device Name	Pin No.	Function	PAL Device Name
1	Cycle Stop	CN52-1	2	Ground	N/A
3	Cycle Start	CN52-3	4		
5	Single Block	CN52-5	6		
7	+X	CN52-7	8		
9	+Y	CN52-9	10		
11	+Z	CN52-11	12		
13	+4	CN52-13	14		
15	-X	CN52-15	16		
17	-Y	CN52-17	18	F 4	CN52-18
19	-Z	CN52-19	20	F 3	CN52-20
21	-4	CN52-21	22	F 2	CN52-22
23	Trvrs	CN52-23	24	F 1	CN52-24
25	Jog Retract	CN52-25	26	F6	CN52-26
27	Ground	N/A	28	AUTO	N/A
29			30	MDI	
31			32	MANUAL	
33			34	Rapid Override F1	
35			36	Rapid Override 25	
37			38	Rapid Override 50	
39	Not Used		40	Rapid Override 100	
41	X1		42	CCW	
43	X10		44	OFF	
45	X100		46	CW	
47	X1000		48	INCR	
49	X10000		50	CONT	
51	Ground		52	HAND	
53			54	HOME	
55			56	Ground	
57			58		
59			60		

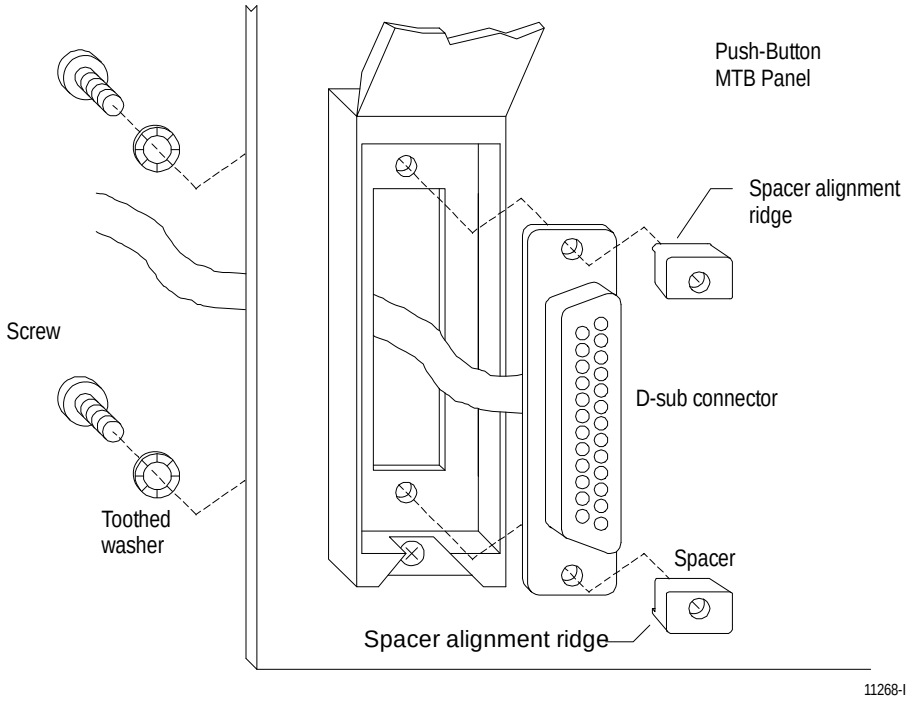
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Serial Interface Connector CN56F

The push-button MTB panel has an optional serial interface connector (CN56F). This connector provides an external interface port for a peripheral's RS 232 or RS 422 interface cable. It is interfaced with Port B (connector J7) on the motherboard/system processor boards by cable C07. Refer to page 7A-22 for additional information on cable C07.

Connector CN56F (8520-D25FS) is a 25 pin D-shell connector that is connected to one end of cable C07. This connector is then mounted on the left side of push-button MTB panel under the connector cover. Figure 9A.18 shows the location and mounting instructions for connector CN56F.

Figure 9A.18
Push-Button MTB Panel Optional Connector CN56F



Important: The two screws with their corresponding spacers and the serial port cover are included with the push-button MTB panel.

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9A.4.1.1 MTB I/O Module Specifications

Power Supply Specifications

Table 9A.N lists the power requirements for the MTB I/O module.

Table 9A.N
MTB I/O Module Power Requirements

Item	Specifications
Rated Input Voltage	12V dc
Power Source Voltage Range	11.5-13.2V dc
Power Consumption	1.3 A typical, 2.6 A maximum

Input Specifications

Table 9A.O lists the input specifications for the circuit that receives the signals from the pushbuttons and the selector switches on the push-button MTB panel.

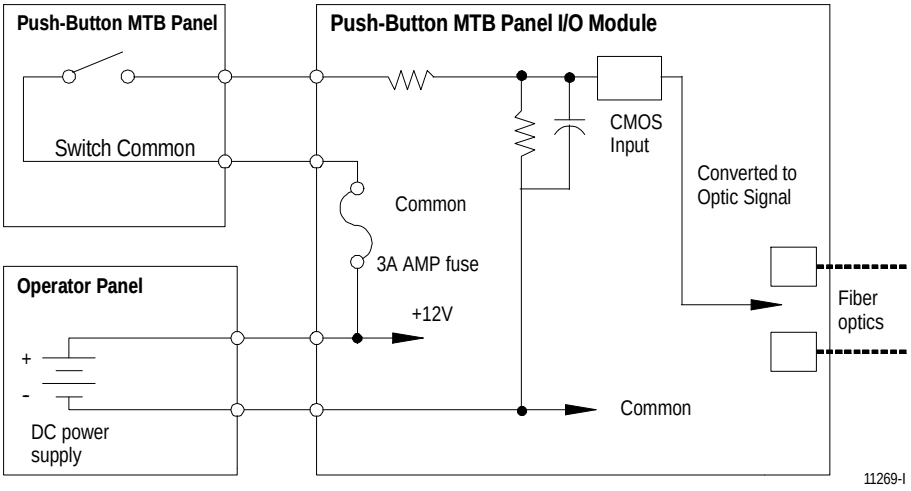
Table 9A.O
MTB I/O Module Input Specifications

Item	Specifications		Remark
	A-B MTB Panel	**Custom MTB Panel**	
Number of Input Points	54	44	Total input signals from all switch groups
Modal Group	19		
Discrete I/O	18		
Rotary Input	8		
Interconnect Group	6		
Unused	3		
	All MTB Panels		
Operating Voltage ON	11.5 to 13.2 V dc		
OFF	0-2V dc		
Allowable Voltage Drop	Less than .5V dc		For External Device
Input Impedance	2.25 K ohms		
Input Current at ON	5mA		With 12V dc Input
Leakage Current at OFF	Less than 1mA		
Response	1-22 msec. Includes Digital Filter Time		OFF ® ON, ON ® OFF
Number of Common Points	6 (per 44 inputs)		Internally connected to Power Supply
Fuse	3A		Protects 12V Power Supply
Isolation	Non-Isolated type		
Connection	60 Pin flat cable connector (CN51)		Max. Length 1m

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Figure 9A.19 shows the input circuit diagram for the MTB I/O module.

Figure 9A.19
MTB I/O Module Input Circuit Diagram



Output Specifications

Table 9A.P lists the output specifications for the circuit that outputs the operation status to the push-button MTB panel.

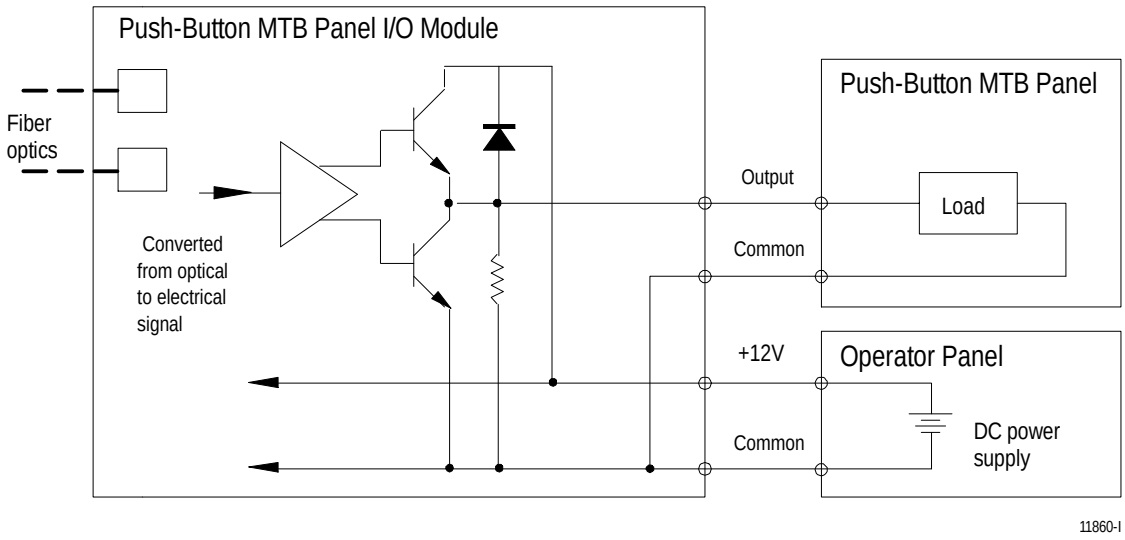
Table 9A.P
MTB I/O Module Output Specifications

Item	Specifications		Remark
	A-B MTB Panel	**Custom MTB Panel**	
Number of Output Points	37	18	
Modal Group Outputs	19		Non-I/O Outputs
Discrete Outputs	18		I/O Outputs
Output Type	Sink/Source		Totem Pole Driver Output
Output Voltage Range	9.3-13.2V dc		
Output Current at ON	Less than 125mA		Per Each Output
Output Voltage Drop at ON	Less than 1 V DC		
Number of Common Points	22		Internally Connected to Power Supply
Isolation	Non-Isolated type		
Connection	60 Pin Flat Cable Connector (CN52)		Max. Length 1m

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Figure 9A.20 shows the output circuit diagram for the MTB I/O module.

Figure 9A.20
MTB I/O Module Output Circuit Diagram



9A.4.1.2 MTB Panel I/O Module Fiber Optic Connection

Table 9A.Q shows the connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring.

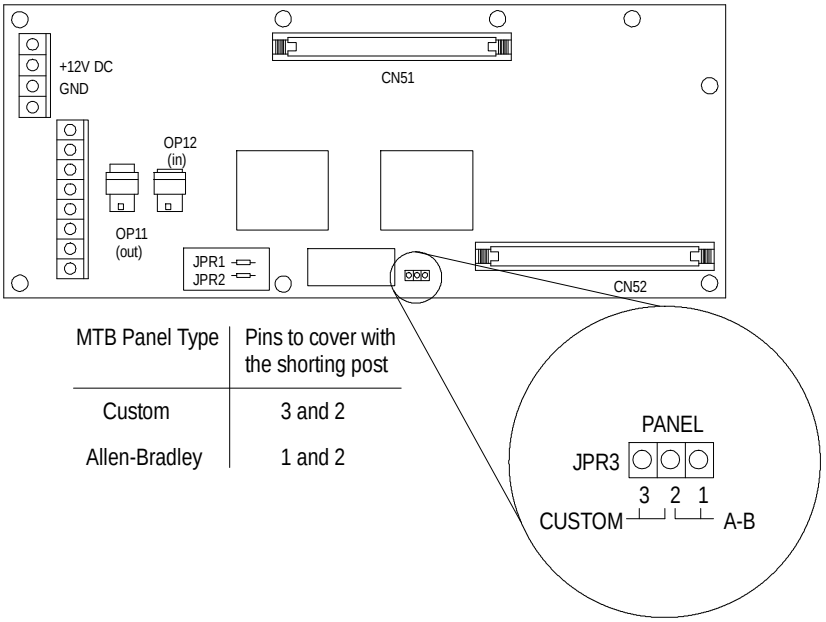
Table 9A.Q
MTB I/O Module Fiber Optic Connectors

Connector On Motherboard	Connected To	Remark
OP11 (RED)	Receiver on next module in I/O ring	Output
OP12 (BLACK)	Transmitter on previous module in I/O ring	Input

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9A.4.1.3 MTB I/O Module Mode Setting

If you are using a custom MTB panel you need to set a jumper so that the I/O module can interface with the MTB panel. If you have an Allen-Bradley MTB panel, you don't need to set this jumper because it is preset. Set the jumper as shown:

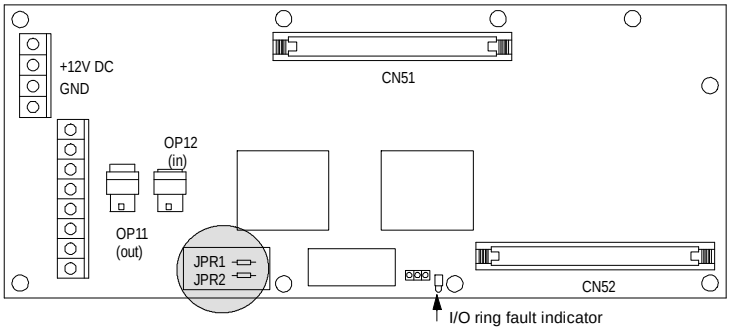


MTB Panel Type	Pins to cover with the shorting post
Custom	3 and 2
Allen-Bradley	1 and 2

9A.4.1.4 MTB I/O Module Node Address Setting

Each push-button MTB panel must have a unique node address on the I/O ring. The node address corresponds to a unique address assigned to each push-button MTB panel I/O module in the I/O assignment file. The node address is selected by cutting the jumpers located on the push-button MTB panel I/O module. Figure 9A.21 shows the location of the jumpers.

Figure 9A.21
MTB I/O Module Jumper Positions



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Set the node address by cutting the wire jumper(s) on the push-button MTB panel I/O module, according to Table 9A.R shown below.

Table 9A.R
MTB I/O Module Node Address Setting

Node Address		Jumper	
Hexidecimal	**Binary**	**JP1**	**JP2**
00	00	Short	Short
01	01	Short	Open
02	10	Open	Short
03	11	Open	Open

The node address may be any number between 00 and 03. You may have a total of 4 MTB panels on the Fiber Optic I/O ring. The same node address can be used for different types of modules, but may not be used more than once for a specific type of module.

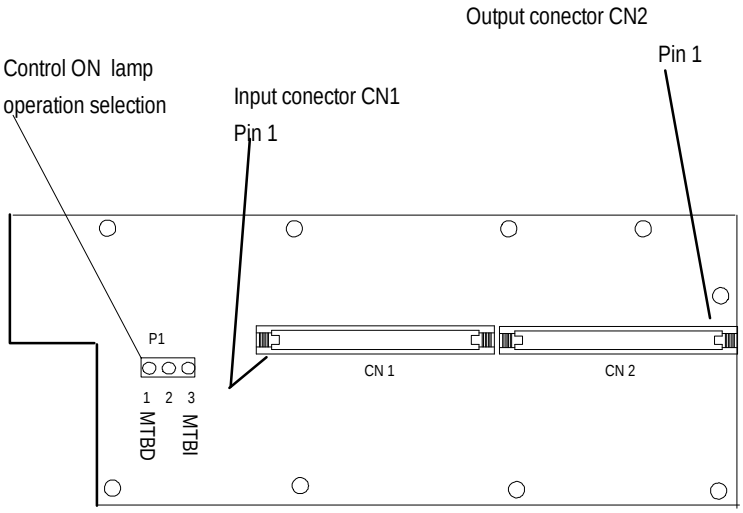
9A.4.2 MTB Panel Connectors and Pin Assignments (Direct I/O version)

Figure 9A.22 shows the connectors used to connect the Direct I/O push-button MTB panel to your I/O system.

The Direct I/O version of the MTB Panel provides for 51 inputs to and 38 outputs from the I/O system. These inputs and outputs provide machine control functions for the operator to affect the Machine logic (PAL) program. A separate I/O ring device must be used to interface this panel to the 9/Series control.

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Figure 9A.22
Direct I/O MTB Panel Connectors



Direct I/O MTB panel integration

1) Note the locations of pin number one (#1) of CN1 and CN2 . Although the pin #1 locations are the same with respect to the connector keying, the connectors are oriented differently.

2) The P1 jumper is used to set the operation of the "control on" Lamp. In the 1–2 position (MTBD) the lamp is controlled by the I/O system (on when 24V is applied to pin CN2–32). In the 2–3 position (MTBI) the lamp is on whenever 24V is applied to the panel.

Input Interface Connector

Input signals from the direct I/O MTB panel are sent through input connector CN 1 . These signals are available for use by the I/O system by pins supplied with this panel. Table 9A.S shows the pin assignments and functions for input interface ribbon cable on the push-button MTB panel.

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Table 9A.S
Direct I/O MTB Panel Input connector (CN 1) Pin Assignments

Pin No.	Function	Pin No.	Function
1	+24 V	2	Cycle Stop
3	+24 V	4	Cycle Start
5	+24 V	6	Single Block
7	+24 V	8	+X
9	+24 V	10	+Y
11	+24 V	12	+Z
13	AUTO	14	+4
15	MDI	16	-X
17	MANUAL	18	-Y
19	INCR	20	-Z
21	CONT	22	-4
23	HAND	24	TRVRS
25	HOME	26	F5
27	X1	28	F6
29	X10	30	F 1
31	X100	32	F 2
33	X1000	34	F 3
35	X10000	36	F 4
37	Rapid Override F1	38	Feedrate Override "a"
39	Rapid Override 25	40	Feedrate Override "b"
41	Spindle Speed Override "d"	42	Feedrate Override "c"
43	Spindle Speed Override "c"	44	Feedrate Override "d"
45	Spindle Speed Override "b"	46	Not Used
47	Spindle Speed Override "a"	48	Not Used
49	Rapid Override 50	50	Not Used
51	Rapid Override 100	52	Power Off
53	CCW	54	On / Off Pushbutton Common
55	OFF	56	Power On
57	CW	58	E-stop
59	Reset	60	E-stop PB Common

Output Interface connector

Output signals from the I/O system are sent to the Lamps on the Direct MTB panel via the output interface connector CN 2. Table 9A.T shows the pin assignments and functions for this connector.

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Table 9A.T
Direct I/O MTB Panel Output connector (CN 2) Pin Assignments

Pin No.	Function	Pin No.	Function
1	Ground	2	Cycle Stop
3	Gnd	4	Cycle Start
5	Gnd	6	Single Block
7	Gnd	8	+ X
9	Gnd	10	+ Y
11	Gnd	12	+ Z
13	Gnd	14	+ 4
15	Gnd	16	- X
17	F 4	18	- Y
19	F 3	20	- Z
21	F 2	22	- 4
23	F 1	24	Trvrs
25	F 6	26	F5
27	AUTO	28	Not Used
29	MDI	30	Not Used
31	MANUAL	32	MANUAL
33	Rapid override F1	34	Contro On (if P1 is set to 1-2)
35	Rapid Override 25	36	Not Used
37	Rapid Override 50	38	Not Used
39	Rapid Override 100	40	Not Used
41	CCW	42	X 1
43	OFF	44	X 10
45	CW	46	X 100
47	INCR	48	X 1000
49	CONT	50	X 10 000
51	HAND	52	GND
53	HOME	54	GND
55	GND	56	GND
57	GND	58	GND
59	GND	60	GND

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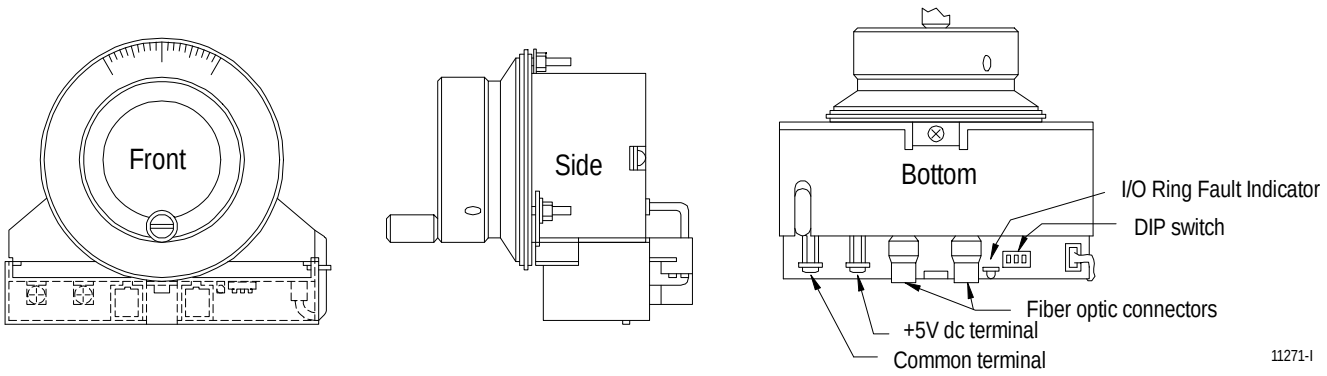
9A.5
HPG (Hand Pulse Generator)

The Hand Pulse Generator (HPG) is a hand wheel used for manual operation of the the control's axes. The HPGs are generally used to jog axes into position. The operator panel power supply provides power for three Hand Pulse Generators.

The HPG is composed of two parts, the HPG itself and the HPG interface board. The HPG interface board is used to interface the HPG with the fiber optic I/O ring. Fiber optic cables are connected to the optical receiver (black) and transmitter (red) on the HPG interface board. The fiber optic cables and connectors are supplied by the system installer. For more information on fiber optics refer to page 7B-1.

Figure 9A.23 shows the HPG (Hand Pulse Generator).

Figure 9A.23
HPG (Hand Pulse Generator)



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9A.5.1 HPG Connectors

Figure 9A.24 shows the connectors and terminal block used to make connections to the HPG interface board.

Figure 9A.24
HPG Interface Board Connectors and Terminal Block

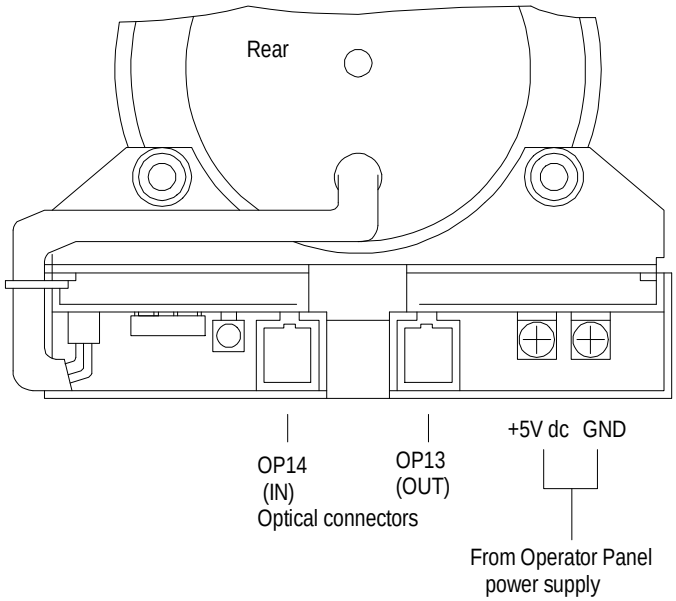


Table 9A.U shows the power supply connections to the HPG interface board.

Table 9A.U
HPG Power Supply Connectors

HPG Connector Terminal		Connected To	Mating Connector		Cable Number	Remark
BT23	+5V	Operator Panel	BT03	5V dc	C28	Input
	GND	Power Supply		GND		Output

Table 9A.V shows the connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to page 7B-1 for additional information on fiber optic cables and connectors.

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Table 9A.V
HPG Fiber Optic Connectors

Connector On Motherboard	Connected To	Remark
OP13 (RED)	Receiver on next module in I/O ring	Output
OP14 (BLACK)	Transmitter on previous module in I/O ring	Input

9A.5.2 HPG Power Requirements

The HPGs require a +5V dc power supply. This is supplied from connector BT03 on the operator panel power supply. If the control uses more than three HPGs the system installer will have to provide an external power supply. Table 9A.W lists the power requirements for the HPG.

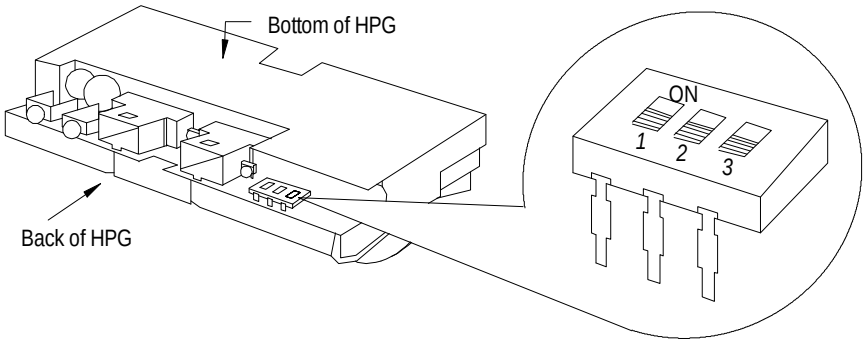
Table 9A.W
HPG Power Requirements

Item	Specifications
Rated Input Voltage	5V dc
Power Source Voltage Range	4.75-5.25V dc
Power Consumption	Less than 0.4A
Connection	2-M3 Terminals
Distance from Power Supply	Less than 5 meters

9A.5.3 HPG Node Address Setting

Each HPG must have a unique node address on the I/O ring. The node address corresponds to a unique address assigned to each HPG in the I/O assignment file. Select the node address using the switch assembly shown in Figure 9A.25. Table 9A.X lists the required switch assembly settings for each possible node address.

Figure 9A.25
HPG Interface Board Switch Assembly Location



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Table 9A.X
HPG Node Address Settings

Node Address		Switch Assembly Position		
Hexadecimal	**Binary**	**1**	**2**	**3**
00	000	OFF	OFF	OFF
01	001	OFF	OFF	ON
02	010	OFF	ON	OFF
03	011	OFF	ON	ON
04	100	ON	OFF	OFF
05	101	ON	OFF	ON
06	110	ON	ON	OFF
07	111	ON	ON	ON

The node address may be any number between 00 and N, with N being the total number of modules allowed for a specific type of module. The same node address may be used for different types of modules, but may not be used more than once for a specific type of module.

END OF SECTION

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Section 9B

Integrating Your Teach Pendant

9B.0 Section Overview

This section describes how to connect and program your teach pendant. For information on how to program PAL to receive messages from the teach pendant, refer to your PAL reference manual.

9B.1 Connecting the Teach Pendant

You connect the teach pendant to port B on the control. Once you have connected the pendant, you have to select it as the active device with the Device Setup Screen:

1. Press SYSTEM SUPORT.

(softkey level 1)

	PRGRAM MANAGE	OFFSET	MACRO PARAM	PRGRAM CHECK	SYSTEM SUPORT →
	FRONT PANEL	ERROR MESAGE	PASS-WORD	SWITCH LANG	→

2. Press the DEVICE SETUP softkey:

(softkey level 2)

↑	PRGRAM PARAM	AMP	DEVICE SETUP	MONI-TOR	TIME PARTS	→
↑	PTOM SI/OEM		SYSTEM TIMING			→

3. Cursor to the SERIAL PORT field. Press the right cursor key until PORT B appears.

4. Cursor to the DEVICE field. Use the left or right cursor key to select TEACH PENDANT. The teach pendant interface software is an option. If you have not purchased it, it does not appear as a device.

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9B.2 Using DF1 Protocol

The teach pendant needs to communicate in DF1 protocol. DF1 is a communication protocol developed by Allen-Bradley that is used by the Data Highway networks. For more information on DF1 protocol, refer to the Data Highway/Data Highway Plus Protocol and Command Set Manual, publication 1770-6.5.16.

9B.3 Programming the Teach Pendant to Send and Receive Messages

All requests and information are sent in DF1 packets. The packets are structured like this:

DLE STX CMD SD1 SD2 SD3 TNS TNS DATA DLE ETX BCC

Field	Description	Size in Bytes
DLE STX	Start of Message	2
CMD	Command field. Determined by CNC or the teach pendant.	1
SD1, SD2, SD3	Special Data 1, 2, and 3. Use for command modifiers or to include data for CMD.	3
TNS TNS	Transaction Number chosen by DF1 driver. PAL cannot access this data for packets its sends or receives. Two packets sent or received in sequence cannot have the same number. If the CNC detects duplicate numbers, it eliminates the packet(s) after the first instance of the number. This field resets to 0 when you turn on power to the CNC. You need to program your teach pendant to perform checks for duplicate numbers, and to fill this field to satisfy the CNC.	2
DATA	Some commands will have a field that contains additional command data. The same type of data that can be put into the special data fields, including commands, can be programmed here as well.	0 - 14
DLE ETX	End of Message	2
BCC	Block Checksum	2

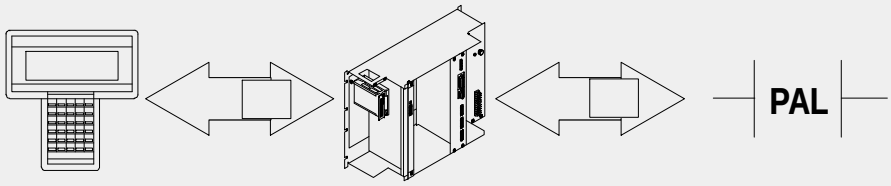
Four types of commands can be sent or received with the teach pendant interface. Some are pre-defined by the teach interface software. Others are defined by the teach pendant and/or PAL programmer.

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These are the 4 command types used by the teach pendant interface:

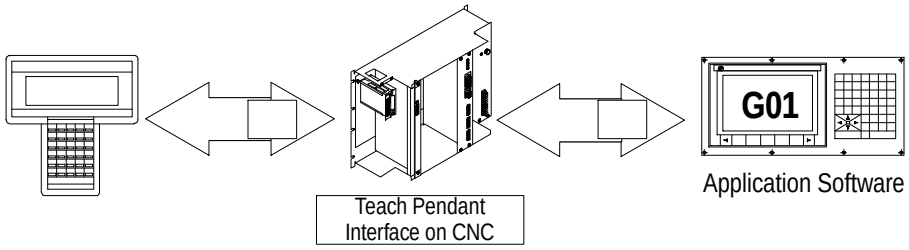
·Teach Pendant ↔ PAL

This type of command is defined by the teach pendant programmer.
The PAL programmer should refer to the PAL reference manual for information on sending and receiving these types of commands.



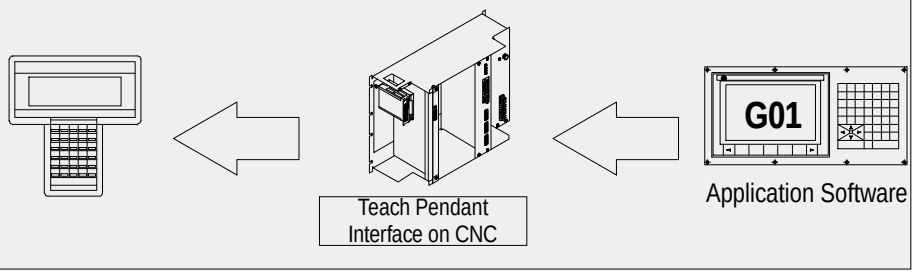
·Teach Pendant ↔ Application

This type of command is pre-defined by the teach interface software.



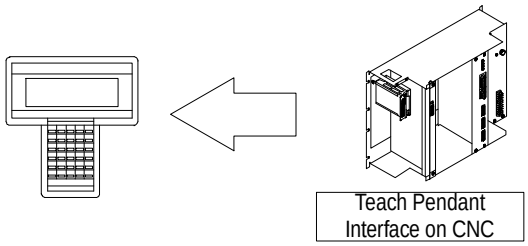
·Teach Pendant → Unsolicited Application Command

This type of command is sent only by the CNC. It includes watchdog and error messages.



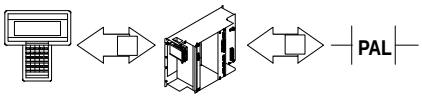
·Illegal Command Received from Teach Pendant

This type of command is sent only by the CNC when the teach pendant attempts to send an illegal command.



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9B.4 Sending Commands to PAL (CMD=60 hex)



To send a command that the PAL program can receive, you send a packet with 60 hex in the command (CMD) field. The teach pendant and PAL programmers define the values in the special data (SD) and DATA fields and map those values to a teach pendant function.

You can use the SD1, SD2, and SD3 fields for requests that require minimal data. The SD1 field is seen as an integer in PAL, but when it is received from PAL, it contains only the least significant byte of the PAL flag. SD2 and SD3 are stored as a single integer to PAL, with SD2 being the most significant byte and SD3 the least significant byte. You can send a maximum of 7 integers to PAL in the DATA field.

For example, let's say that the programmer has defined the SD fields as:

Field	Definition
SD1	Request Type: Jog (1), Home (2), or Data (3)
SD2	Axis Number: 1 through 9
SD3	Motion Type: Absolute (1) or Incremental (2)

A keystroke combination defining Incremental Jog for Axis 6 would then send this command to PAL when pressed:

		CMD	SD1	SD2	SD3	TNS	TNS	DATA			
DLE	STX	60	01	06	02	05	02	[position]	DLE	ETX	BCC

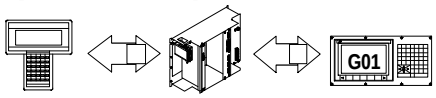
When the CNC receives the message, the teach interface software acknowledges the message by sending a DLE ACK (DF1 protocol) to the pendant. The interface software checks PAL's message input buffers to see if they are clear.

If they are clear, the interface software moves the message into the buffers and sets the PAL flag $TPRECV. PAL must decode the message to jog axis 6 incrementally according to the position information in the DATA field. The PAL programmer decides if PAL responds with a message back to the teach pendant.

If the buffers are not clear, the interface software sets the Input Buffer Overflow flag, $TPOFLOW, but does not send a message back to the teach pendant. PAL would have to notify the teach pendant of the overflow by initiating a transmission if the pendant needs to take action.

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9B.5 Sending Commands to the Application Software (CMD=61 hex)



You use this type of command to take advantage of functions supplied in the teach interface software. For this type of command, SD1 and SD2 have specific definitions:

Field	Definition
SD1	Type of Request
SD2	Sub-process. For single process systems, you can use any value for this field. For multi-process systems, set at 1 for sub-process 1, and set at 2 for sub-process 2.

Sending to a Process

If you're sending to a multi-process system, use the SD2 field to indicate the process. For example, if you send a request for the current block to process 2

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	61	01	02	00	03	00	DLE	ETX	BCC

and the application software responds with this message packet:

		CMD	SD1	SD2	SD3	TNS	TNS	DATA			
DLE	STX	61	01	02	00	04	02	N00001G71	NULL	DLE	ETX	BCC
								ASCII				

You don't have to indicate the process for requests to display error messages or requests that end the display of error messages on the teach pendant.

Requesting the Current Block: SD1=01

To request the current block, send a message with CMD=61 (hex) and SD1=01. For example:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	61	01	00	00	00	01	DLE	ETX	BCC

the application software responds with this message packet:

		CMD	SD1	SD2	SD3	TNS	TNS	DATA			
DLE	STX	61	01	00	00	00	03	N00001G71	NULL	DLE	ETX	BCC
								ASCII				

The current block information is an ASCII string of up to 128 characters ending with a NULL. If there is no block active, no active program, or no active MDI block, then the application software returns a NULL.

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Requesting the Active Program Name: SD1=02

To request the active program name, send a message with CMD=61 (hex) and SD1=02. For example:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	61	02	00	00	04	01	DLE	ETX	BCC

the application software responds with:

		CMD	SD1	SD2	SD3	TNS	TNS	DATA			
DLE	STX	61	02	00	00	00	03	PROGRAM1	NULL	DLE	ETX	BCC
								ASCII				

The active program is an ASCII string of 8 characters (maximum) ending with a NULL. If there is no active program, a NULL is returned.

Requesting the Block Number: SD1=03

To request the block number, or the last N word that was executed, send a message with CMD=61 (hex) and SD1=03. For example:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	61	03	00	00	01	02	DLE	ETX	BCC

the application software responds with:

		CMD	SD1	SD2	SD3	TNS	TNS	DATA			
DLE	STX	61	03	00	00	02	01	N12345	NULL	DLE	ETX	BCC
								ASCII				

The block number is an ASCII string of 5 characters (maximum, with leading zeros suppressed) ending with a NULL. This value is the same value that's displayed on the operator panel's CRT. If no value is displayed, the software returns a NULL.

Transmit Error Messages to the Teach Pendant: SD1=04

To have the system error messages transmitted to the pendant, send a message with CMD=61 (hex) and SD1=04. For example:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	61	04	00	00	00	06	DLE	ETX	BCC

The application software responds by sending error messages as they occur.

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Suspend Transmission of Error Messages to the Teach Pendant: SD1=05

To stop sending error messages to the teach pendant, send a message with CMD=61 (hex) and SD1=05. For example:

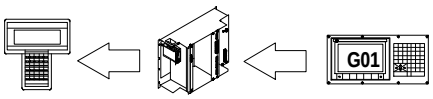
		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	61	05	00	00	00	06	DLE	ETX	BCC

The application software responds by ending the transmission of error messages to the teach pendant.

This request is useful if alternating error messages are being displayed on the CRT. The teach pendant is sent a message every time the message toggles on the CRT. This operation uses much of the serial band width.

This is the default at power turn-on.

9B.6 Receiving Unsolicited Messages from the Control (CMD=62 hex)



The control can be commanded to send error messages. It always sends watchdog signals to the teach pendant. Since these messages are not individually requested by the teach pendant, they are called unsolicited messages. These messages send specific data in the DF1 command fields:

Field	Description for Unsolicited Messages
CMD	62 hex indicates an unsolicited message
SD1	identifies the message as watchdog signal or error message

Receiving Watchdog Signals

The control sends this watchdog signal to the teach pendant according to the time interval specified in PAL flag $TPWDFQ:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	62	01	00	00	00	02	DLE	ETX	BCC

The teach pendant must respond to the message before the next one is sent or the watchdog timeout PAL flag is set to true. Here is a recommended response:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	62	01	00	00	00	01	DLE	ETX	BCC

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If the teach pendant does not respond, a watchdog timeout occurs and:

- $TPTO is set
- an error message is displayed on the operator panel CRT
- PAL can control the activities in response to the timeout
- system continues to send watchdog signals to try and reestablish communication. When the system receives a correct response packet, the control sets $TPTO to false.

A watchdog timeout can also occur if 3 ENQs are sent to the teach pendant in response to NAKs.

Receiving Error Messages

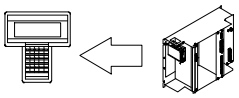
If requested by the teach pendant with a CMD 61 (hex) and SD1=04, when the control displays an error message, it also sends the message in ASCII to the teach pendant:

		CMD	SD1	SD2	SD3	TNS	TNS	DATA			
DLE	STX	62	02	00	00	00	04	PAL DOES NOT EXIST NULL	DLE	ETX	BCC

ASCII

The teach pendant does not have to respond to the message. It only has to send an ACK or a NAK.

9B.7 Receiving the Illegal Request Message from the CNC (CMD=63 hex)



If you send an illegal request from the teach pendant to the control, the control sends a message back telling you about the illegal request. In the message from the control the SD2 and SD3 fields contain the information that identifies the illegal request:

This Field	Contains this Information about the Illegal Request
SD2	CMD value received
SD3	SD1 value received

For example, if the teach pendant sends this illegal request:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	71	02	00	00	00	41	DLE	ETX	BCC

The teach interface software responds with:

		CMD	SD1	SD2	SD3	TNS	TNS			
DLE	STX	63	00	71	02	00	21	DLE	ETX	BCC

To the teach interface software, an illegal request is any request that does not match those defined in this section.

END OF SECTION

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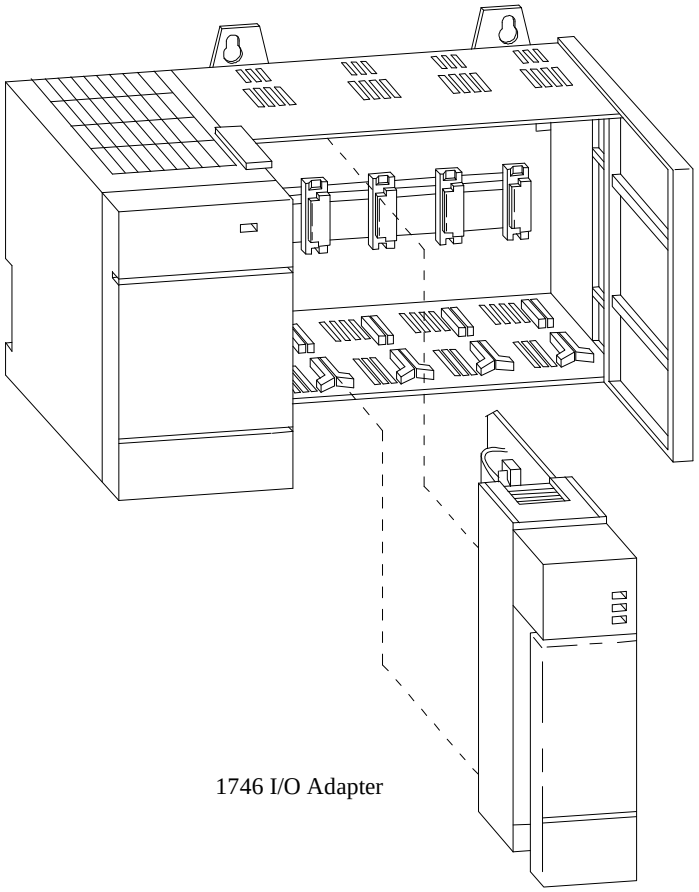
Publication 852062-RM009A-EN-P - November 2000
Supercedes Publication 8520-6.2.9 - August 1997
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9/Series Hardware
TAB 10

I/O Interface



1746 I/O Adapter

8520–6.2.10 – February 1997

PN–176041

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Section 10A

I/O Interface

10A.0 Section Overview

This section covers the devices that provide an I/O interface with the control. I/O devices transmit inputs from external switches, sensors, etc. to the executing PAL program for processing. Outputs originating from the PAL program are transmitted through the I/O devices to external lamps, relays, valves, etc.

The I/O devices are connected either directly to the control or through a fiber optic I/O ring that provides serial communication with the control. The devices on the I/O ring convert electrical signals to optical signals for transmission through the I/O ring. These optical signals are converted back to electrical signals at the CPU board for use by the PAL program. This entire process is reversed for outputs originating from the PAL program.

The following I/O devices can be installed on the I/O ring:

- Push-Button MTB Panel I/O Module
- Digital I/O
- High-density I/O Module
- Analog I/O
- 1746 I/O Ring Adapter
- 1771 I/O Ring Adapter
- HPG
- Operator Panel
- 1394 Digital Drive

In addition, the following I/O devices can be connected directly to the motherboard (it does not transmit through the fiber optic ring):

- Fast I/O (9/260 and 9/290 only)
- Remote I/O Port

The size of the I/O ring is limited in how many I/O devices it can support. This limitation is imposed to make sure that the I/O data used by PAL is updated within the time period allotted for PAL foreground execution. Refer to the 9/Series CNC 9/230,9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

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ATTENTION: When the control faults or loses power, all I/O devices remain in their last state. I/O devices do not automatically reset to an off state. It is the system installers responsibility to make sure that all I/O is in a safe state when a control shut down occurs. 1771 I/O devices have a dip switch on the backplane that determines the shutdown state for I/O in that 1771 I/O chassis when used with a PLC-5 processor. This dip switch does not have any effect when 1771 I/O devices are used with a 9/Series control.

Each I/O device requires a specific amount of update time regardless of the number of inputs and outputs actually connected to the device. This is because devices on the I/O ring use Asynchronous Serial Ring Network circuits (referred to as ASRN "chips") for input and output transmission. These chips are constantly scanned through the fiber optic ring by the control. Table 10A.A lists the number of ASRN "chips" per device and the number of I/O points per device.

Important: The total number of ASRN chips allowed on the fiber optic ring is dependent on your processor as shown in Table 10A.B. Exceeding this number creates an E-STOP condition. Since your system scan time is configurable in AMP it is possible to set the system scan time so low that the control will not complete the I/O scan of all the ASRNs in your ring. When this occurs old data may be made available to PAL. On systems with large I/O rings and low system scan times, the PAL flag $RNGS should be used to test if the system has completed the I/O scan and made all the necessary ring I/O updates.

Table 10A.A
I/O Ring Modules Connectors

I/O Ring Modules	Number of ASRN Chips	Number of I/O Points
Operator Panel (standard non-portable)	1	1 8-bit Input
Portable Operator Panel Interface Assembly	1	1 8-bit Input
HPG	1	1 6-bit Input
Pushbutton MTB Panel I/O Module	4	44 Digital Inputs; 18 Digital Outputs
Digital I/O	2	20 Digital Inputs; 12 Digital Outputs
High-density I/O Module	6	66 Digital Inputs; 33 Digital Outputs
Analog I/O	2	1 12-bit Analog Input; 1 12-bit Analog Output
1394 Digital Drive	2	21 Digital Inputs (see appendix H for addressing)
1746 24V dc Digital I/O Assembly (S24)	3	32 inputs, 16 outputs
1746 110V ac Digital I/O Assembly (S115)	3	32 Inputs, 16 Outputs
1746 Analog I/O Assembly (SANL)	6	2 analog input channels, 2 analog output channels
Other 1746 or 1771 I/O Chassis	see page 10B-10	Depends upon modules used

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Table 10A.B
Max Number of ASRN Chips

9/Series Control	ASRN
9/230	65
9/260	65
9/290	85
9/440	65

ASRN Chip Used by 1746 or 1771 I/O Chassis

The number of ASRN chips used by a 1746 or 1771 I/O chassis will vary depending on the chassis size and the number and type of digital/analog I/O cards installed in the chassis. Refer to page 10B-10 for information on calculating the number of ASRN chips used by one of these racks.

The number of ASRN “chips” used by the 1746 or 1771 I/O chassis must be added to the total number of ASRN “chips” used by all the I/O devices on the current I/O ring.

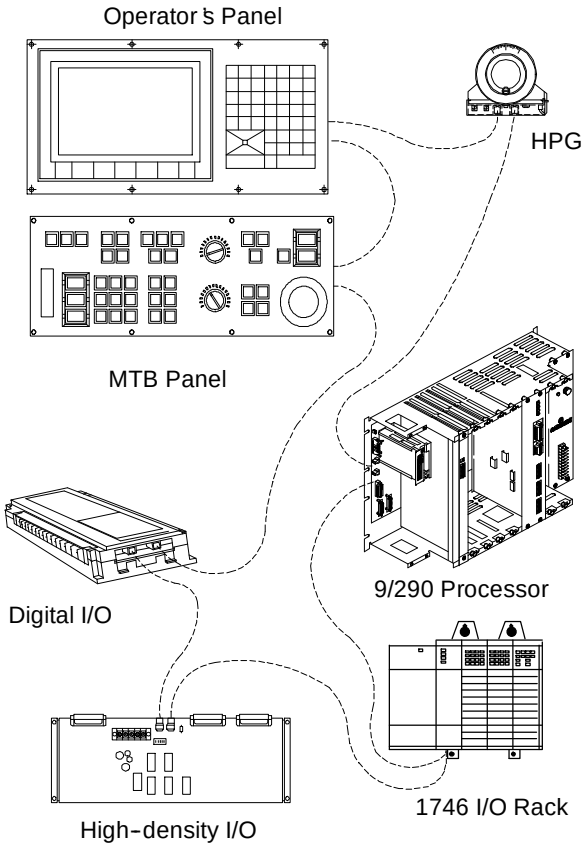
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10A.1 Fiber Optics

I/O devices are connected either directly to the control or through a fiber optic I/O ring that provides serial communication with the control. The I/O devices on the I/O ring convert electrical signals to optical signals for transmission through the I/O ring. These optical signals are converted back to electrical signals at the sub processor board for use by the PAL program. This entire process is reversed for outputs originating from the PAL program.

Each I/O device connected to the I/O ring has an transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. A typical ring layout is shown below.

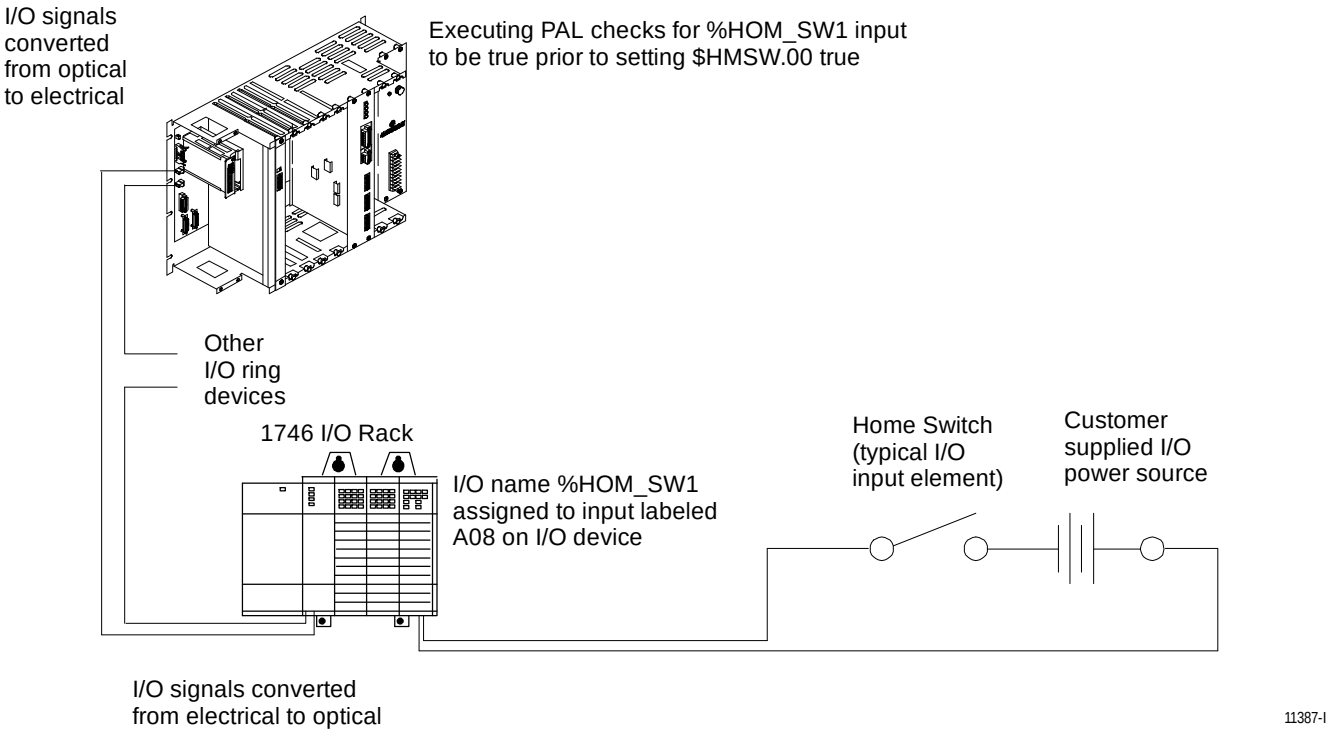
Figure 10A.1
Typical Layout of a Multiple Device Fiber Optic I/O Ring



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The devices on the fiber optic I/O ring convert electrical signals to optical signals for transmission through the I/O ring. These optical signals are converted back to electrical signals at the sub processor board for use by the PAL program. An example of the input process is shown in Figure 10A.2.

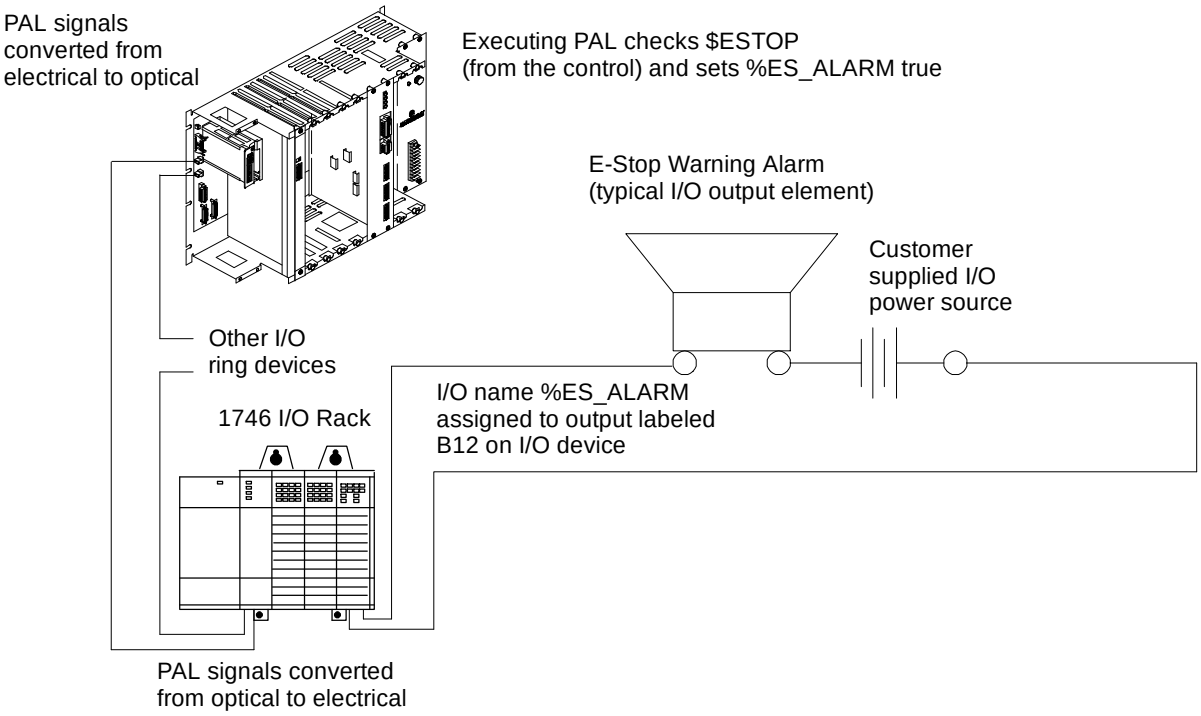
Figure 10A.2
PAL Fiber Optic Input Process



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This entire process is reversed for outputs originating from the PAL program. An example of the output process is shown in Figure 10A.3.

Figure 10A.3
PAL Fiber Optic Output Process



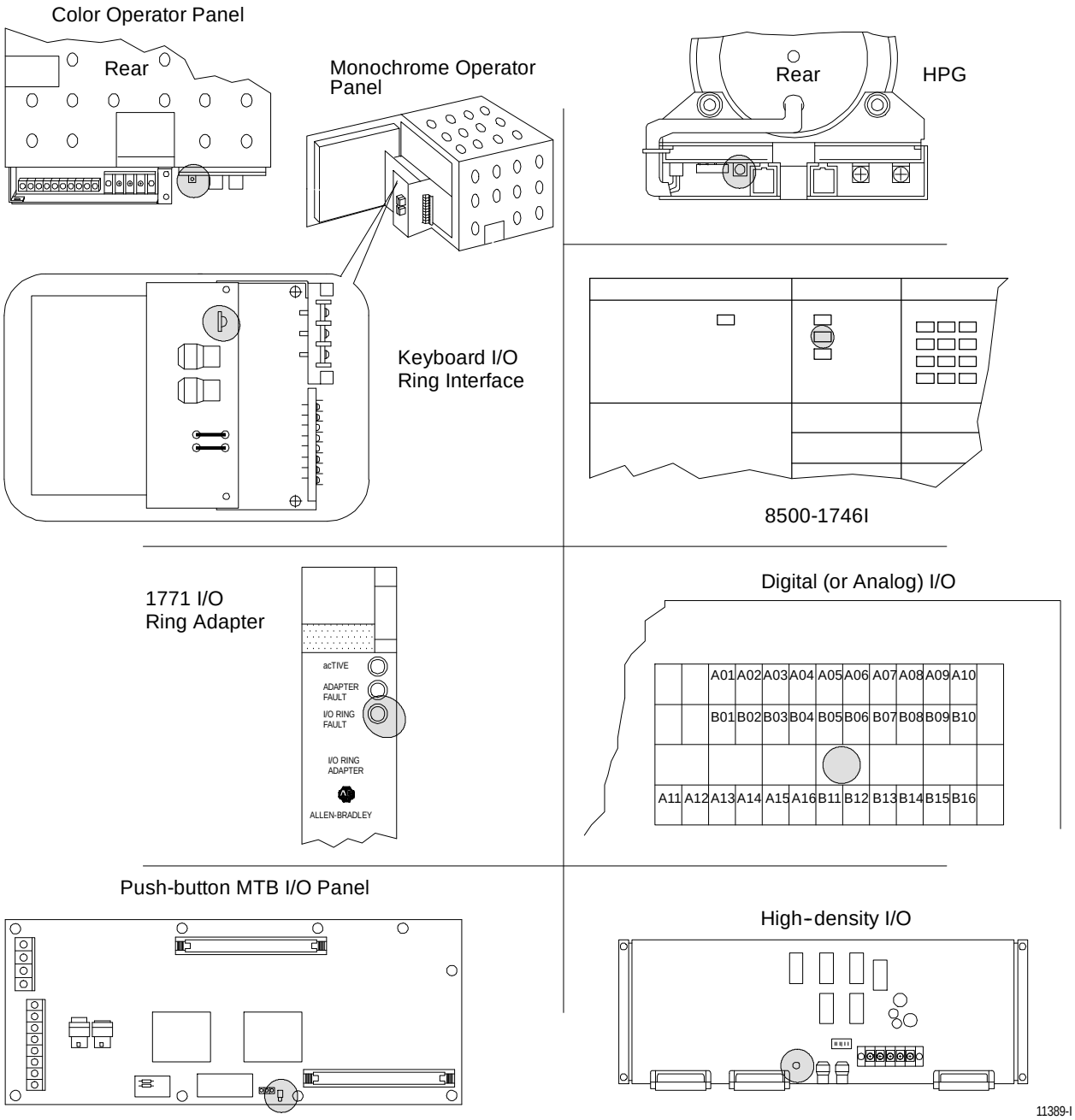
All I/O devices on the I/O ring must be assigned a position that corresponds to the physical location of that device on the I/O ring. Their corresponding input and output terminals must be assigned variable names. These assignments are listed in the I/O Assignment file.

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10A.1.1 Fiber Optic Ring Device Fault Indicators

Each I/O interface device connected to the I/O ring has a fault indicator (LED) located on it. Some examples of these indicators are shown in the following figure. The fault indicators on the I/O devices will be lit whenever there is a ring communication error.

Figure 10A.4
Fiber Optic Interface Device Fault Indicators



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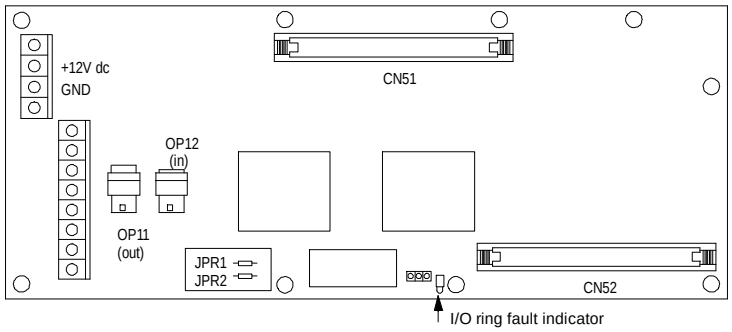
10A.2 Push-Button MTB Panel I/O Module

The push-button MTB panel I/O module is included with the push-button MTB panel. It can also be purchased separately to interface a custom MTB panel to the control. This module provides 44 inputs and 18 outputs to the I/O ring.

The push-button MTB panel I/O module is interfaced with the system I/O ring through fiber optic cables, which are connected to the optical receiver and transmitter on this module. Refer to Appendix A for additional information on fiber optic cables and connectors.

Figure 10A.5 shows the external appearance of the push-button MTB panel I/O module.

Figure 10A.5
Push-Button MTB Panel I/O Module External Appearance



10A.2.1 Push-Button MTB Panel I/O Module Pin Assignments

Table 10A.C lists the connectors used to connect the push-button MTB panel I/O module to the operator panel power supply and a custom MTB panel.

Table 10A.C
Push-Button MTB Panel I/O Module Connectors

Connector On MTB I/O Module	Connected To Module	Connected To Connector	Cable Number	Remark
+12V GND	Operator Panel Power Supply (or External Power Supply)	+12V BT03 GND	C28	
CN51M	Custom MTB Panel			Input
CN52M				Output

Input Interface Ribbon Cable

MTB panel data is sent to the push-button MTB panel I/O module via the input interface ribbon cable. It is then sent to the control via the fiber optic I/O ring. Table 10A.D lists the pin assignments for the input interface ribbon cable for a custom MTB panel. If you are using an Allen-Bradley MTB panel refer to page 9A-30 for the pinouts of this cable.

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Pin Assignments for Use with Custom MTB Panels

The connector pins that are reserved for supplying power to the push-button MTB panel I/O module are indicated. Any pins that are not reserved can be assigned to custom MTB panel functions or an external I/O device. Use the blank space beside each pin number to indicate any pin assignments that are made. The pin assignments will have to correspond to the pin assignments of the push-button MTB panel I/O module in the PAL I/O Assignment file. The I/O assignment file will have to be edited if the pin assignments do not correspond. Refer to the 9/Series CNC 9/230,9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

Table 10A.D
Input Interface Cable Pin Assignments for Custom MTB Panels (Connector CN51)

Pin No.	MTB Input Functions	Pin No.	MTB Input Functions
1		2	+12V
3		4	+12V
5		6	+12V
7		8	+12V
9		10	+12V
11		12	+12V
13		14	
15		16	
17		18	
19		20	
21		22	
23		24	
25		26	
27		28	
29		30	
31		32	
33		34	
35		36	
37		38	
39		40	
41		42	
43		44	
45		46	
47		48	
49		50	
51	Power Off	52	Reserved for use with A-B MTB Panels
53	Power Common	54	
55	Power On	56	
57	E-Stop	58	
59	E-Stop Common	60	Reset

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Output Interface Ribbon Cable

The data from the push-button MTB panel I/O module is sent to the MTB panel via the output interface ribbon cable. Table 10A.E lists the pin assignments for output interface ribbon cable. If you are using an Allen-Bradley MTB panel refer to page 9A-31 for the pinouts of this cable.

Pin Assignments for Use with Custom MTB Panels

The connector pins that are reserved for grounding are indicated. Any pins that are not reserved can be assigned to a custom MTB panel function or an external I/O device. Use the blank space beside each pin number to indicate any pin assignments that are made.The pin assignments will have to correspond to the pin assignments of the push-button MTB panel I/O module in the PAL I/O Assignment file. The I/O assignment file will have to be edited if the pin assignments do not correspond. Refer to the 9/Series CNC 9/230,9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

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Table 10A.E
Output Interface Ribbon Cable Pin Assignments (Connects to CN52)

Pin No.	MTB Input Functions	Pin No.	MTB Input Functions
1		2	GND
3		4	
5		6	
7		8	
9		10	
11		12	
13		14	
15		16	
17		18	
19		20	
21		22	
23		24	
25		26	
27	GND	28	Reserved for Use with A-B MTB Panel
29		30	
31		32	
33		34	
35		36	
37		38	
39	Unused	40	
41	Reserved for Use with A-B MTB Panel	42	
43		44	
45		46	
47		48	
49		50	
51	GND	52	
53		54	
55		56	GND
57		58	
59		60	

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10A.2.2 Push-Button MTB Panel I/O Module Specifications

Power Source Specifications

Table 10A.F lists the power requirements for the push-button MTB panel I/O module.

Table 10A.F
MTB Panel I/O Module Power Requirements

Item	Specifications
Rated Input Voltage	12 V dc
Input Voltage Range	11.5 - 13.2 V dc
Power Consumption	1.3A Typ., 2.6A Max.
External Connection	Terminal Block

Input Specifications

Table 10A.G lists the input specifications for the circuits that receive the signals from the pushbuttons and the selector switches on the push-button MTB panel.

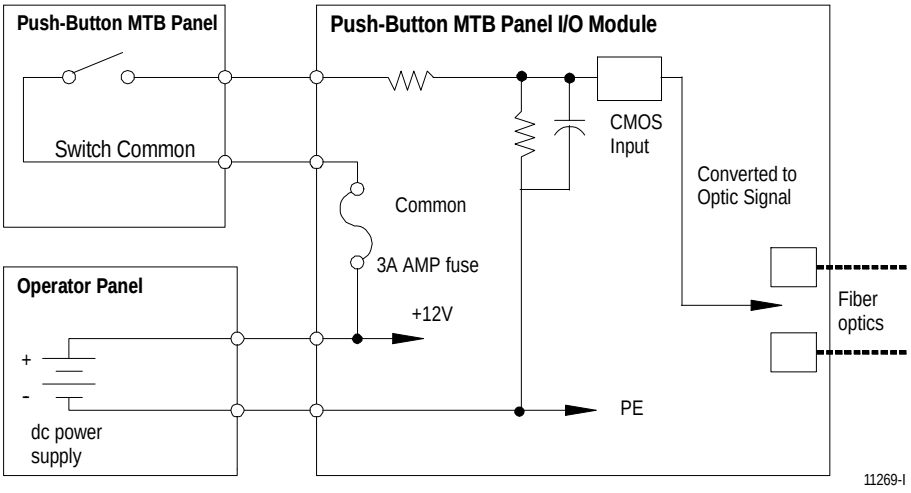
Table 10A.G
Push-Button MTB Panel I/O Module Input Specifications

Item	Specifications		Remark
	A-B MTB Panel	**Custom MTB Panel**	
Number of Input Points	54	44	Total input signals from all switch groups
Modal Group	19		
Discrete I/O	18		
Rotary Input	8		
Interconnect Group	6		
Unused	3		
	All MTB Panels		
Operating Voltage ON	11.5 to 13.2 V dc		
OFF	0-2V dc		
Allowable Voltage Drop	Less than .5V dc		For External Device
Input Impedance	2.25 K ohms		
Input Current at ON	5mA		With 12V dc Input
Leakage Current at OFF	Less than 1mA		
Response	1-22 msec. Includes Digital Filter Time		OFF ® ON, ON ® OFF
Number of Common Points	6 (per 44 inputs)		Internally connected to Power Supply
Fuse	3A		Protects 12V Power Supply
Isolation	Non-Isolated type		
Connection	60 Pin flat cable connector (CN51)		Max. Length 1m

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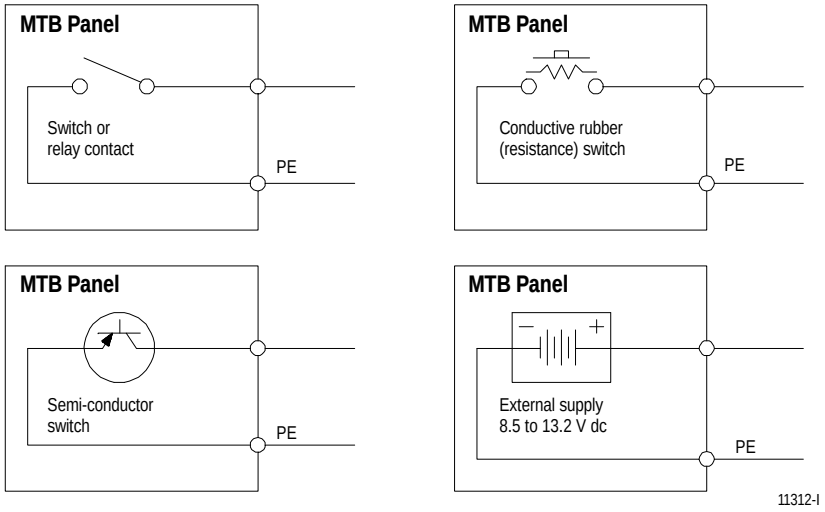
Figure 10A.6 shows a typical input circuit diagram for the push-button MTB panel I/O module.

Figure 10A.6
Push-Button MTB Panel I/O Module Input Circuit Diagram



The MTB I/O module inputs can be energized by a number of different switching devices, provided that the input specifications listed in Table 10A.G are met. Figure 10A.7 shows some typical input device options.

Figure 10A.7
Input Device Options for the Rotary MTB Panel I/O Module



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Output Specifications

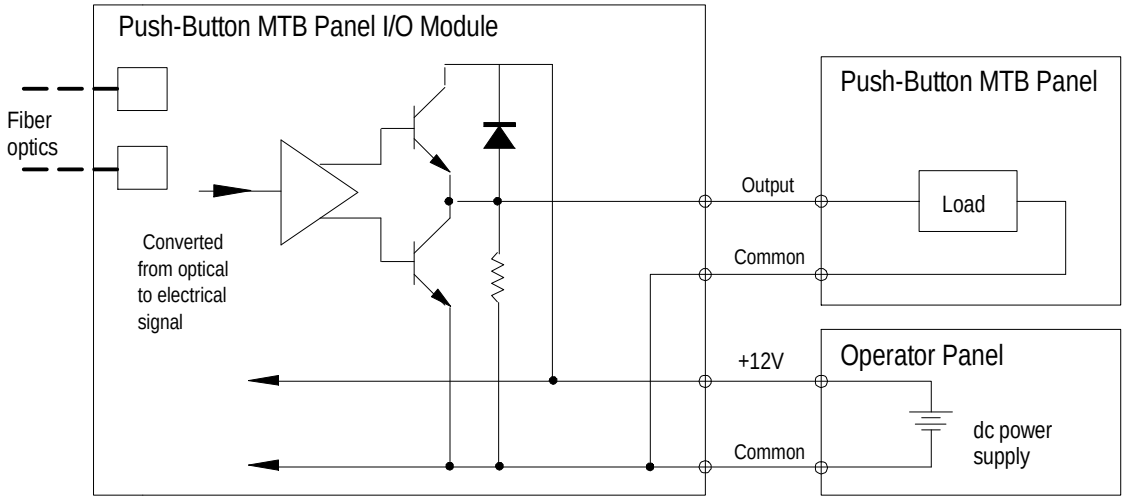
Table 10A.H lists the output specifications of the MTB I/O module.

Table 10A.H
Push-Button MTB Panel I/O Module Output Specifications

Item	Specifications		Remark
	A-B MTB Panel	**Custom MTB Panel**	
Number of Output Points	37	18	
Modal Group Outputs	19		Non-I/O Outputs
Discrete Outputs	18		I/O Outputs
Output Type	Sink/Source		Totem Pole Driver Output
Output Voltage Range	9.3-13.2V dc		
Output Current at ON	Less than 125mA		Per Each Output
Output Voltage Drop at ON	Less than 1 V dc		
Number of Common Points	22		Internally Connected to Power Supply
Isolation	Non-Isolated type		
Connection	60 Pin Flat Cable Connector (CN52)		Max. Length 1m

Figure 10A.8 through Figure 10A.9 show typical output circuit diagrams for the push-button MTB panel I/O module.

Figure 10A.8
Push-Button MTB Panel I/O Module Output Circuit Diagram

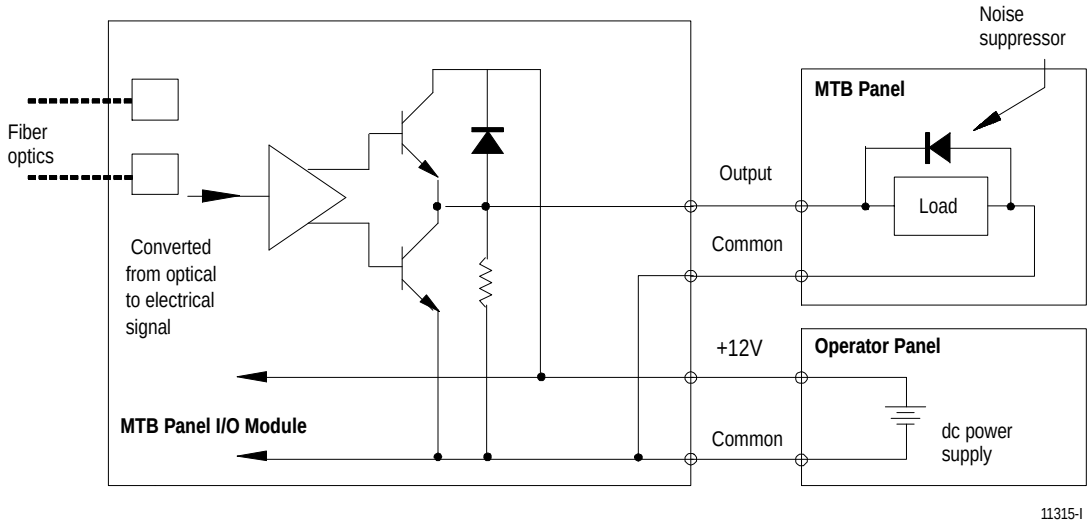


Important: A protection resistor is not required with this module.

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Important: When an inductive load (a relay, for example) is directly connected to the output circuit, connect a noise suppressor in the circuit, parallel with the load.

Figure 10A.9
Output Device Requiring a Noise Suppressor



10A.2.3 Push-Button MTB Panel I/O Module Fiber Optic Connection

Table 10A.I lists the connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to Appendix A for additional information on fiber optic cables and connectors.

Table 10A.I
Push-Button MTB Panel I/O Module Fiber Optic Connectors

Connector on Rotary MTB Panel I/O Module	Connected To	Remark
OP11 (RED)	Receiver on next module in I/O ring	Output
OP12 (BLacK)	Transmitter on previous module in I/O ring	Input

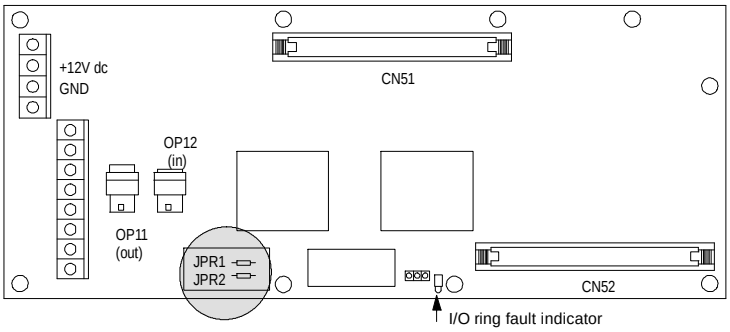
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10A.2.4 Push-Button MTB Panel I/O Module Node Address Setting

Each push-button MTB panel I/O module must have a unique node address on the I/O ring. The node address corresponds to a unique address assigned to each push-button MTB panel I/O module in the I/O assignment file. The node address is selected by cutting the jumpers located on the push-button MTB panel I/O module.

Figure 10A.10 shows the location of the node address jumpers on the MTB I/O module.

Figure 10A.10
Push-Button MTB Panel I/O Module Jumper Positions



Set the node address by cutting the jumper(s) on the push-button MTB panel I/O module according to Table 10A.J.

Table 10A.J
Push-Button MTB Panel I/O Module Node Address Setting

Node Address		Jumper	
Hexadecimal	**Binary**	**JP1**	**JP2**
00	00	Short	Short
01	01	Short	Open
02	10	Open	Short
03	11	Open	Open

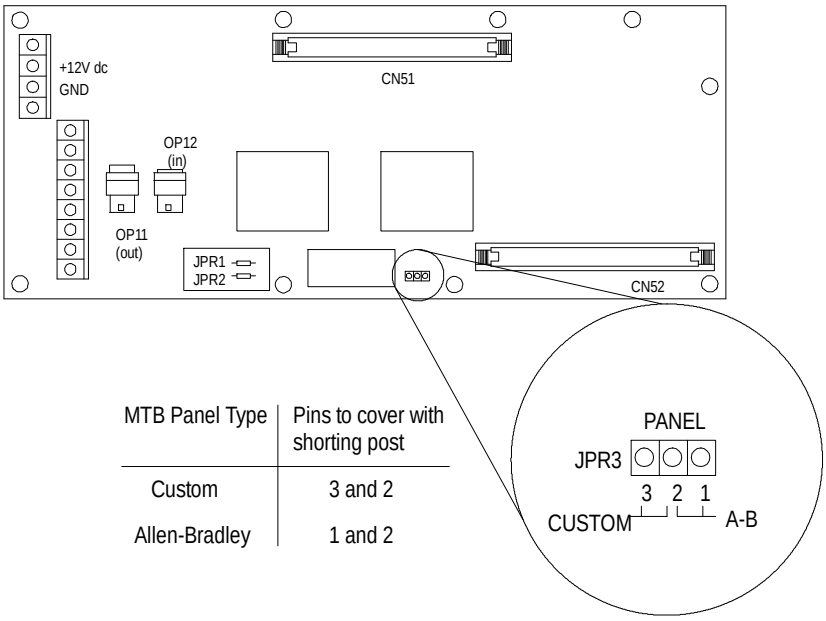
The node address may be any number between 00 and 03. You may have a total of 4 modules with the MTB panel. The same node address can be used for different types of modules, but may not be used more than once for a specific type of module.

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10A.2.5 Setting the Push-Button MTB Panel I/O Module for a Custom MTB Panel

If you are using the push-button MTB panel I/O module with custom MTB panel, you need to set some jumpers. Figure 10A.11 locates and defines the jumpers.

Figure 10A.11
Setting the Jumpers on the Push-Button MTB I/O Panel for a Custom MTB Panel



MTB Panel Type	Pins to cover with shorting post
Custom	3 and 2
Allen-Bradley	1 and 2

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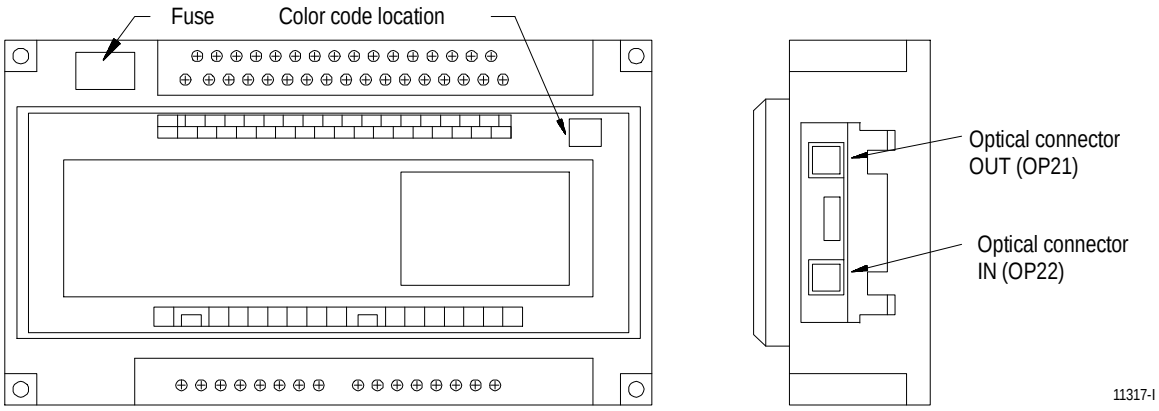
10A.3 Digital I/O

The Digital I/O provides for an additional 20 inputs and 12 outputs to the system I/O ring. The digital I/O interface circuits are designed to interface this I/O device with the fiber optic I/O ring. These circuits use a fiber optic transmitter and receiver to provide communication with the fiber optic I/O ring.

The digital I/O receives input signals from external devices assigned to its input terminals. These signals are sent to PAL, through the I/O ring, to be used in the ladder logic process. PAL generates signals that are then sent through the I/O ring to the digital I/O. The digital I/O outputs these signals to external devices assigned to its output terminals.

This section covers the specifications, connection and the settings for the digital I/O. Figure 10A.12 shows the digital I/O.

Figure 10A.12
Digital I/O



There are four types of digital I/O. The four types have different combinations of power supply and I/O specifications.

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Table 10A.K list the four types of digital I/O that can be selected according to individual machine applications.

Table 10A.K
Digital I/O Types

Type	Power Required [3]	Input Points [4]	Output Points [5]	[1] Color Code
E151	115/230 V ac	20@ 100/115 V ac 50-60HZ	[2] 10 Triacs: 85-265V ac 2 Relays: 10-250 V ac/ 10-125V dc	RED
E152	115/230 V ac	20@ 200/230 V ac 50-60 Hz	[2] 10 Triacs: 85-265V ac 2 Relays: 10-250 V ac/ 10-125V dc	BLacK
E153	115/230 V ac	20@ 24V dc	12 Relays: 10-250 V ac/ 10-125V dc	BLUE
E154	24 V dc	20@ 24V dc	10 Transistors: 10-50 V dc 2 Relays: 10-250 V ac/ 10-125V dc	GREEN

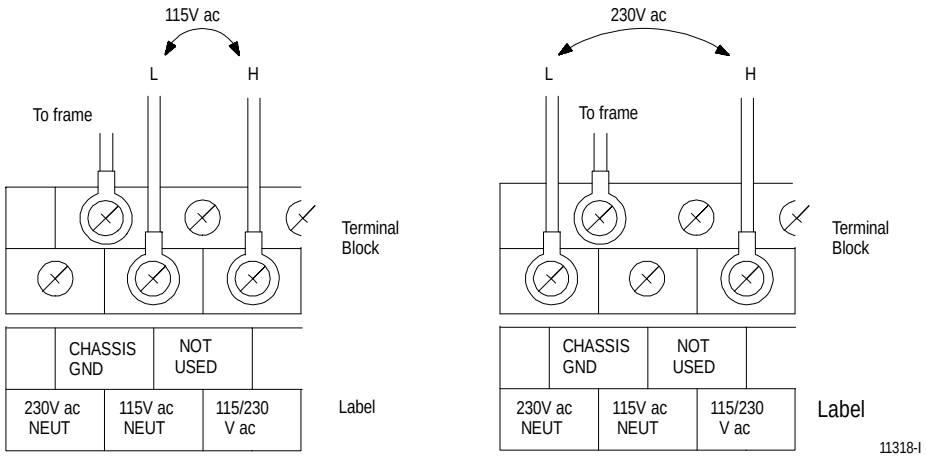
1 The color code appears in the upper right corner on the front of the unit.
2 10 Triac Outputs of sufficient capacity to energize size 0 - 3 contactors. Two Isolated Relay Outputs.
3 Refer to table 10. M
4 Refer to table 10.N
5 Refer to tables 10.O-10.S

10A.3.1 Digital I/O Connection

Power Connection

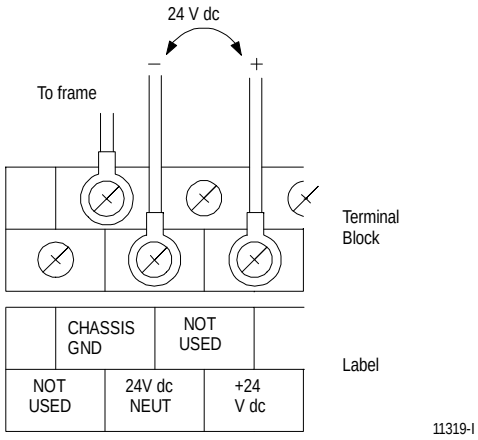
Figure 10A.13 and Figure 10A.14 show the power connection diagram for the digital I/O.

Figure 10A.13
Power Connection (E151, E152, E153)



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Figure 10A.14
Power Connection (E154)



ATTENTION: Incorrect wiring can cause damage to the digital I/O power supply. Do not jumper the 115V ac NEUT and the 230 V ac NEUT together. Do not jumper the 115V ac NEUT or the unused 230V ac to the Chassis GND terminal.

Input Device Connection

Table 10A.L lists the terminals of the digital I/O input terminal strips. You can assign an input device to each terminal. Use the blank space beside each terminal number to indicate any terminal assignments that are made.

The terminal assignments will have to correspond to the terminal assignments of the digital I/O in the PAL I/O Assignment file. The I/O assignment file will have to be edited if the terminal assignments do not correspond. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

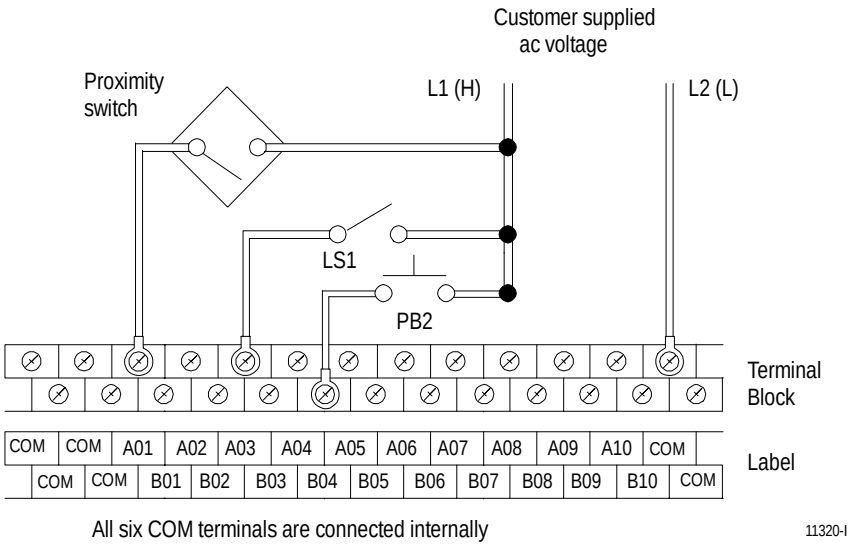
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Table 10A.L
Digital I/O Input Terminals

Terminal No.	Digital Input Functions	Terminal No.	Digital Input Functions
A01		B01	
A02		B02	
A03		B03	
A04		B04	
A05		B05	
A06		B06	
A07		B07	
A08		B08	
A09		B09	
A10		B10	

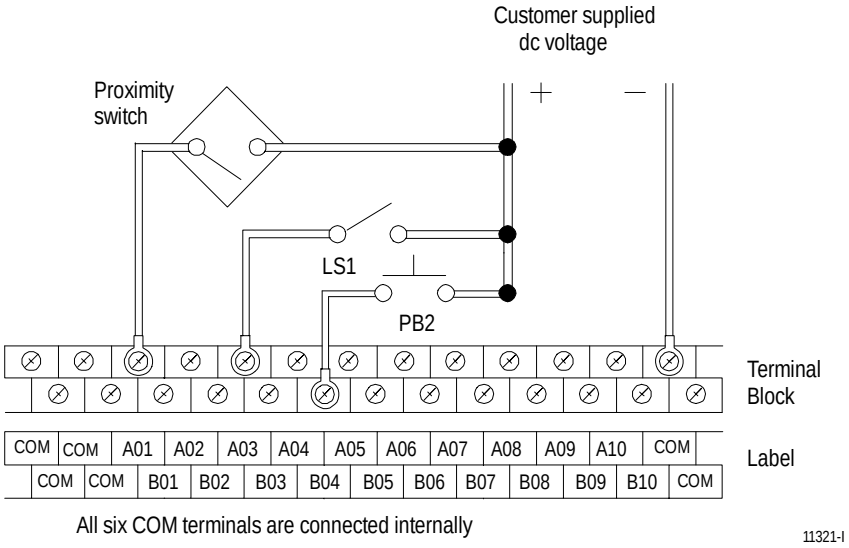
Figure 10A.15 and Figure 10A.16 show the input device connection diagrams for the digital I/O.

Figure 10A.15
ac Input Device Connection (E151, E152)



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Figure 10A.16
dc Input Device Connection (E153, E154)



Output Device Connection

Table 10A.M lists the terminal of the digital I/O output terminal strip. Each terminal may have an output device connected to it. Use the blank space beside each terminal number to indicate any terminal assignments that are made.

Table 10A.M
Digital I/O Output Terminals

Terminal No.	Digital Output Functions	Terminal No.	Digital Output Functions
A11		B11	
A12		B12	
A13		B13	
A14		B14	
A15		B15	
A16		B16	

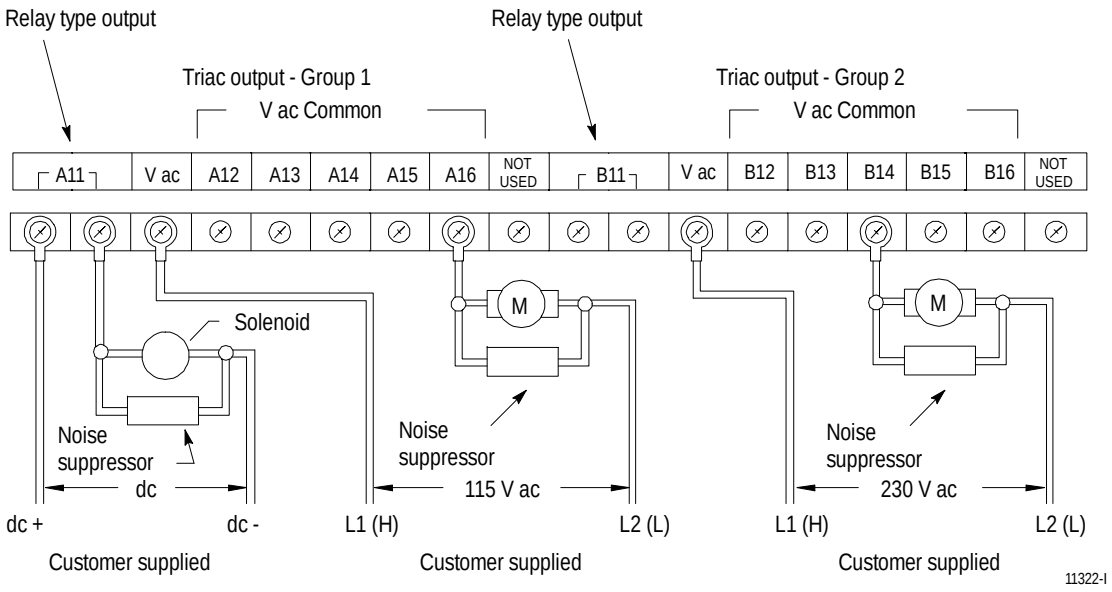
The terminal assignments will have to correspond to the terminal assignments of the digital I/O in the PAL I/O Assignment file. The I/O assignment file will have to be edited if the terminal assignments do not correspond.

Refer to the 9/Series CNC 9/230, 9/260, and 9/290 PAL Reference Manual, publication 8520-4.3, for more information.

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Figure 10A.17 shows a triac output connection diagram.

Figure 10A.17
Triac Output Connection (E151, E152)



Important: Triac outputs are isolated by means of a photocoupler. They are also protected from transient current by a varistor.

To reduce leakage current, it may be necessary to connect a load resistor or additional noise suppressor. When a triac output is connected with a hard contact to control an inductive load, it is recommended that a varistor be used. Do not use suppressors having RC networks, since damage to triacs could occur.

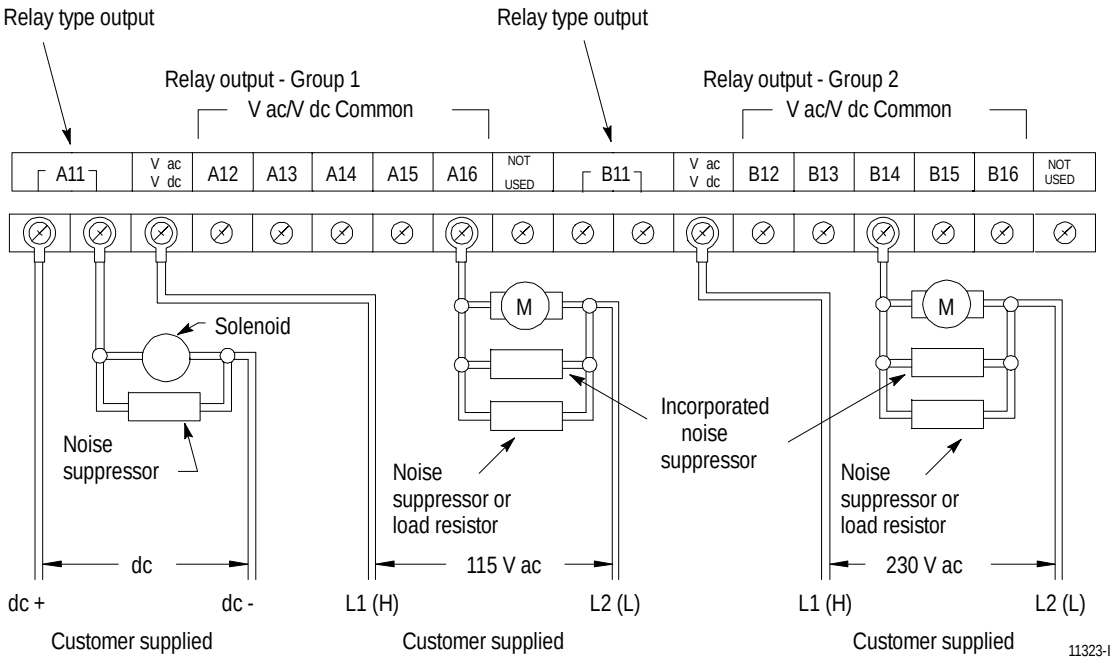
Important: A noise suppressor is not incorporated in the relay type output circuit (terminals A11, B11).

Connection of an external surge suppressor is recommended to protect the relay contact from a transient voltage spike, which occurs when an inductive device is turned off.

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Figure 10A.18 shows a relay type output connection diagram.

Figure 10A.18
Relay Type Output Connection (E153)



Important: The relay type output circuits of Group 1 (A12 - A16) and Group 2 (B12 - B16) incorporate a noise suppressor.

Important: Surge suppression reduces arcing of an output contact and is recommended for most applications, particularly when switching an inductive load off.

Relay contacts A11 and B11 do not have built-in suppression and may exhibit 50% of the relay life of contacts A12-A16 and B12-B16.

The contact life of relays used in the output circuits of the E153 module can be significantly reduced if surge suppression is not connected across the load. Performance testing indicates that contact life may be reduced by as much as 30% without surge suppression across the load.

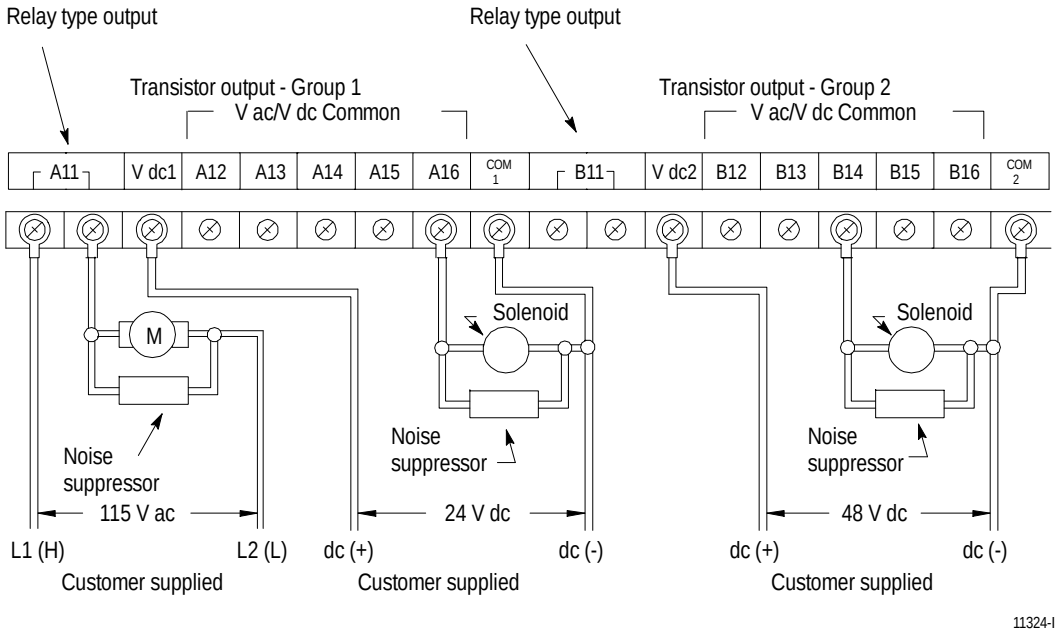
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The relay life of output contacts used in the E153 depends on the load being controlled. The following shows contact performance for a load that has surge suppression applied across it:

Load	Switching Voltage	Relay Life
Allen-Bradley Bulletin 500 Size 1 ac Contactor	120V ac	2,500,000 (operations)

Figure 10A.19 showing the output device connection diagram, shows a transistor output connection.

Figure 10A.19
Transistor Output Connection (E154)



Important: Transistor output is a source type output, which is isolated by means of a photocoupler. An external surge suppressor should be connected to protect transistors from a transient voltage spike, which occurs when an inductive device is turned off.

Important: A noise suppressor is not incorporated in the relay type output circuits (terminals A11 and B11). Connection of an external surge suppressor is recommended to protect the relay contact from a transient voltage spike, which occurs when an inductive device is turned off.

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10A.3.2 Digital I/O Specifications

Table 10A.N lists the power requirements for the 4 types of digital I/O.

Table 10A.N
Digital I/O Power Requirements

Item	Digital I/O Types	
	E151, E152, E153	E154
Rated Input Voltage	115/230 V ac 50/60 Hz	24 V dc
Input Voltage Range	85-132/170-265 V ac 47-63 Hz	10-30 V dc
Power Consumption	Less than 15 VA	Less than 9 VA
Fuse Rating	315mA/250V	1.6A/250V
Fuse Type	Glass-tube-filled (f6.35 ´ 31.8 mm)	
Power ON Indicating LED	Lights up when +5V is supplied to the internal circuit	
Connection	Terminal Block	

Table 10A.O lists the input specifications for the 4 types of digital I/O. All input circuits include optical isolation as well as filtering to guard against high voltage transients from external input devices.

Table 10A.O
Digital I/O Input Specifications

Item		Digital I/O Types			
		E151	E152	E153	E154
Number of Inputs		20 Input Terminals (pins: A01-A10, B01-B10)			
Rated Input Voltage		85-132 V ac 50/60 Hz	170-265 V ac 50/60 Hz	10-30 V dc	
Operating Voltage	ON	85-132 V ac	170-265 V ac	10-30 V dc	
	OFF	Less than 30 V ac	Less than 50 V ac	Less than 4 V dc	
Leakage Current at OFF		Less than 2mA		Less than 1mA	
Input Current		Approximately 8mA		Approx. 4mA at 12 V dc	
				Approx. 8mA at 24 V dc	
Maximum Inrush Current		Less than 0.8A			
Response	ON to OFF	3-13 msec [1]		4-8 msec [1]	
	OFF to ON	9-18 msec [1]		4-8 msec [1]	
Operation Indication		LED ON when power is ON			
Connection		Terminal Block			
Number of Common Points		6 points per 20 input points [2]			
Dielectric Strength		Higher than 1500V [3]			

[1] Excluding digital filter time.

[2] All common lines are internally connected to each other.

[3] Across input terminal - control logic circuit.

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Figure 10A.20 and Figure 10A.21 show the digital I/O input circuit diagrams for ac and dc applications.

Figure 10A.20
Digital I/O ac Input Circuit Diagram (E151, E152)

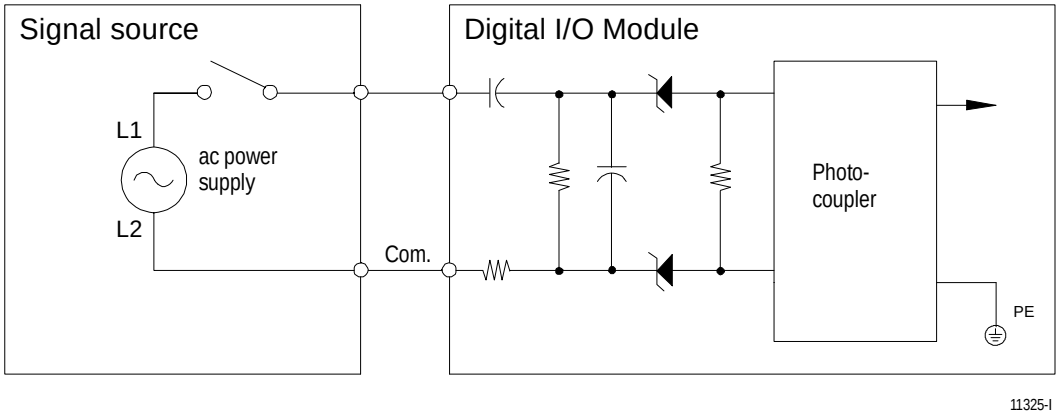


Figure 10A.21
Digital I/O dc Input Circuit Diagram (E153, E154)

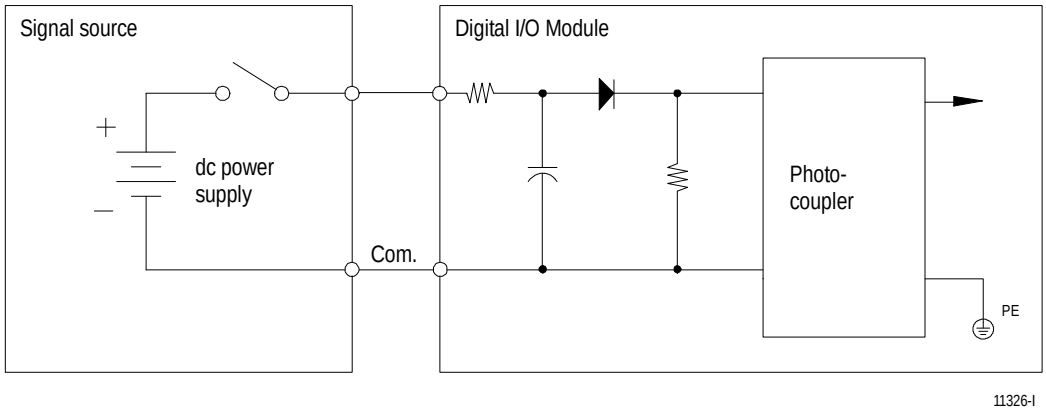


Table 10A.P through Table 10A.T list the output specifications for the 4 types of digital I/O. It is recommended that some type of surge suppressor be used when switching inductive load devices with hard contact outputs.

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Table 10A.P
Digital I/O Output Specifications

Item	Digital I/O Types			
	E151	E152	E153	E154
Number of Output Points	12			
Output Type	Triac type: 10 points Relay Type: 2 points		Relay Type: 12 points	Transistor Type: 10 points Relay Type: 2 points
Maximum Output Capacity	1440 VA/total output			
Connection	Terminal Block			

E151, E152: Triac Output: A12 - A16, B12 - B16
Relay Type Output: A11, B11 (without RC circuit)

E153: Relay Type Output: A12 - A16, B12 - B16 (with RC circuit)
A11, B11 (without RC circuit)

E154: Transistor Output: A12 - A16, B12 - B16
Relay Type Output: A11, B11 (without RC circuit)

Table 10A.Q
Triac Output Specifications

Item	Rating	Remark
Triac Type	Non-Zero Cross Type	With Snubber Circuit
Output Voltage Range	85 - 265 V ac	
Continuous Output Current per Circuit	1.0A at 30 ℃	
	0.5A at 60 ℃	
Continuous Output Current Per Chassis	10.0A at 30 ℃	
	5A at 60 ℃	
Surge Current	10A/25 msec	1 surge/sec (30 ℃) 1 surge/2 sec (60 ℃)
Minimum Load Current	10mA	
Maximum OFF State Leakage Current	2mA	
OFF to ON Response Time	0.1 msec (max.)	Non-Zero Cross
Zero-Cross Turn-On Timing Accuracy	±500 microseconds	
Saturation Voltage Drop	1.5 V at 1.0A	
Electrical-Optical Isolation	1500 V	Between Output Voltage and Control Logic
Recommended Output Fusing	San-O: SOC ST4-3A Bussman: MSL-2A	Or Equivalent

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Specifications for hard contact relay outputs are shown below. It is recommended that some type of noise suppressor be used when switching inductive load devices with hard contact outputs.

Table 10A.R
Relay Type Output Specifications

Item	Rating	Remark
Voltage Range	10-125 V dc 50/60 Hz	
Contact Resistance	20 milliohms	
Electrical-optical Isolation	2000 V	Between Output Contacts and Control Logic

Digital I/O types E151, E152, and E154 have 2 hard contact relay outputs, at terminals A11 and B11. These outputs do not have internal arc suppression circuitry.

Digital I/O type E153 has 12 hard contact relay outputs. Relay outputs at terminals A12 through A16 and B12 through B16 have internal arc suppression circuitry. Relay outputs at terminals A11 and B11 do not have internal arc suppression circuitry.

Table 10A.S
Contact Ratings

Volts	Amperes		Amperes	Voltamperes	
	Make	Break	Continuous	Make	Break
240 V ac	7.5A	0.75A	2.5A	1800 VA	180 VA
120 V ac	15A	1.5A			
125 V dc	0.22A		1.0A	28 VA	
24 V dc	1.2A		2.5A	28 VA	

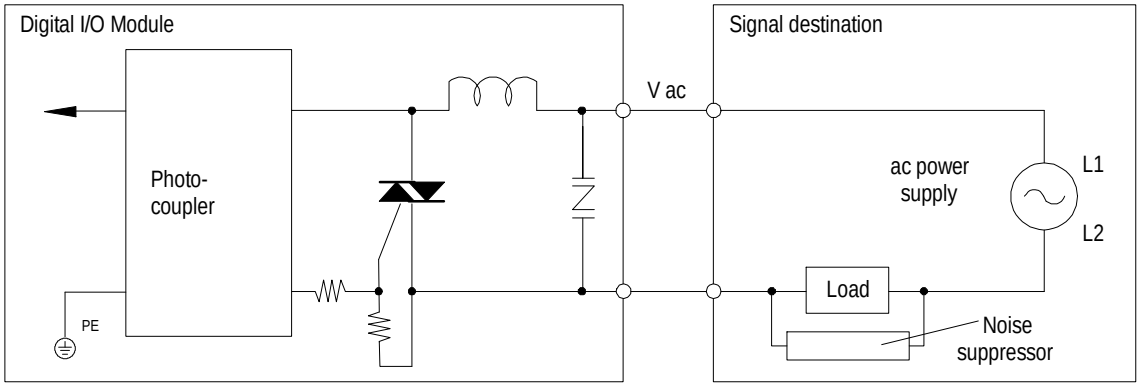
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Table 10A.T
Transistor Output Specifications

Item	Rating	Remark
Output Voltage Range	10 - 50 V dc	
Continuous Output Current per Circuit	1.0A at 30 ℃	
	0.5A at 60 ℃	
Continuous Output Current Per Chassis	10.0A at 30 ℃	
	5A at 60 ℃	
Surge Current	3.0A/20 msec	1 surge/sec (30 ℃) 1 surge/2 sec (60 ℃)
Minimum Load Current	1.0mA	
Maximum OFF State Leakage Current	0.1mA	
OFF to ON Response Time	100 microseconds	
Maximum ON State Voltage Drop	1.5 V at 1.0A	
	0.8 V at 0.5A	
Electrical-Optical Isolation	1500 V	Between Output Voltage and Control Logic
Recommended Output Fusing	San-O: SOC ST4-2A	Or Equivalent

Figure 10A.22 through Figure 10A.23 show the digital I/O output circuit diagrams. In Figure 10A.23 consider that the relay type outputs, A11 and B11 terminals of E151, E152, E153, and E154 are not provided with a noise suppressor.

Figure 10A.22
Digital I/O Triac Output Circuit Diagram (E151, E152)



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Figure 10A.23
Digital I/O Relay Output Circuit Diagram (E151, E152, E153, E154)

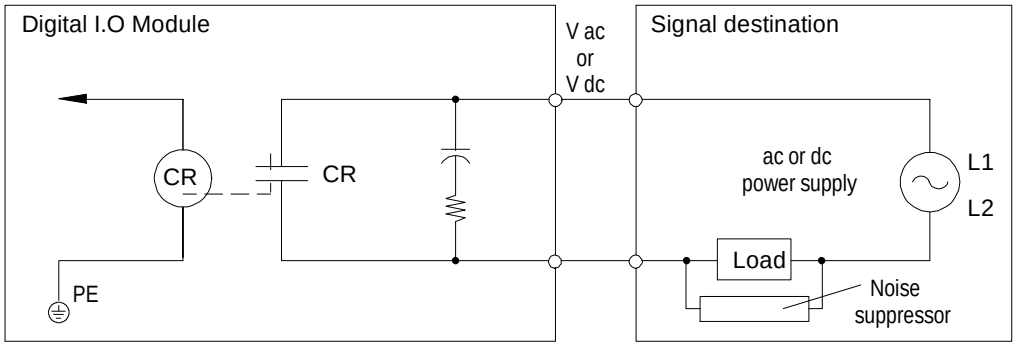
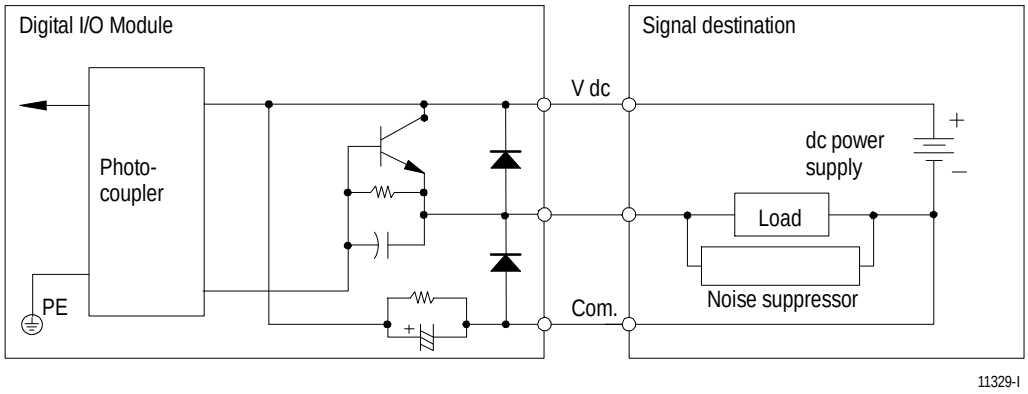


Figure 10A.24
Digital I/O Transistor Output Circuit Diagram (E154)



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10A.3.3 Digital I/O Fiber Optic Connections

Table 10A.U lists the connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to Appendix A for additional information on fiber optic cables and connectors.

Table 10A.U
Digital I/O Fiber Optic Connectors

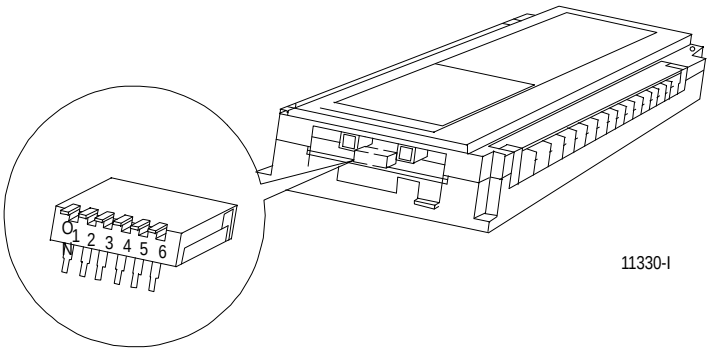
Connector on Digital I/O	Connected To	Remark
OP21 (RED)	Receiver on next module in I/O ring	Output
OP22 (BLacK)	Transmitter on previous module in I/O ring	Input

10A.3.4 Digital I/O Node Address Setting

Different types of I/O devices can have the same node address, but devices of the same type must each have a unique node address. Each digital I/O is assigned a unique node address in the I/O assignment file of ODS. This address corresponds to a switch setting on the device itself.

Figure 10A.25 shows the location of the node address switch assembly on the digital I/O.

Figure 10A.25
Digital I/O Switch Assembly Location



Set the switch assembly to correspond to the node address as shown in Table 10A.V.

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Table 10A.V
Digital I/O Node Address Setting

Node Address		Switch Assembly Position					
Hexadecimal	**Binary**	**1**	**2**	**3**	**4**	**5**	**6**
00	00 0000	OFF	OFF	OFF	OFF	OFF	OFF
01	00 0001	OFF	OFF	OFF	OFF	OFF	ON
02	00 0010	OFF	OFF	OFF	OFF	ON	OFF
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
3D	11 1101	ON	ON	ON	ON	OFF	ON
3E	11 1110	ON	ON	ON	ON	ON	OFF
3F	11 1111	ON	ON	ON	ON	ON	ON

10A.4 High-density I/O Module

The high-density I/O module provides for an additional 66 inputs and 36 outputs to the system I/O ring.

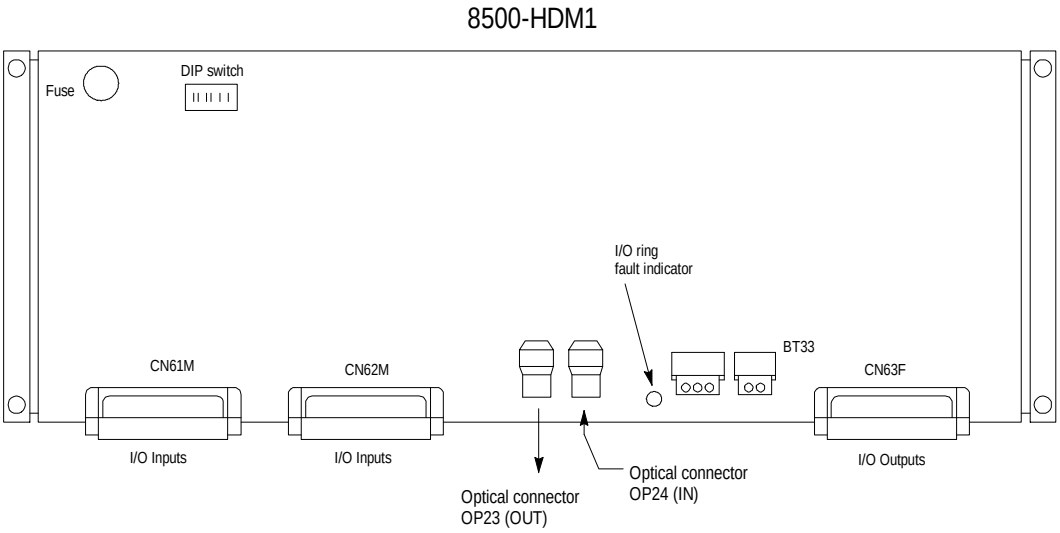
The high-density I/O module receives input signals from external devices assigned to its input terminals. These signals are sent to PAL, through the I/O ring, to be used in the ladder logic process. PAL generates signals that are then sent through the I/O ring to the high-density I/O module. The high-density I/O module outputs these signals to external devices assigned to its output terminals.

This section covers the specifications, connection and the settings of the high-density I/O module (cat. nos. 8500-HDM).

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Figure 10A.26 shows the high–density I/O module.

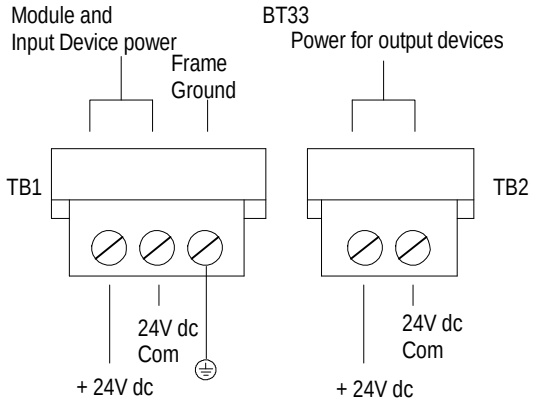
Figure 10A.26
High- density I/O Module



10A.4.1 High Density I/O Module Connection

Figure 10A.27 shows the power connections for the high–density I/O module.

Figure 10A.27
High- density I/O Module Power Connections



Important: The + 24V dc power for the high–density I/O module and its output devices may originate from the same power source. However, power sources with excessive noise or poor voltage regulation should not be used to power the high–density I/O module.

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Figure 10A.28 shows typical input device connections to connectors CN61M or CN62M of the high–density I/O module.

Figure 10A.28
High- density I/O Module Input Device Connection

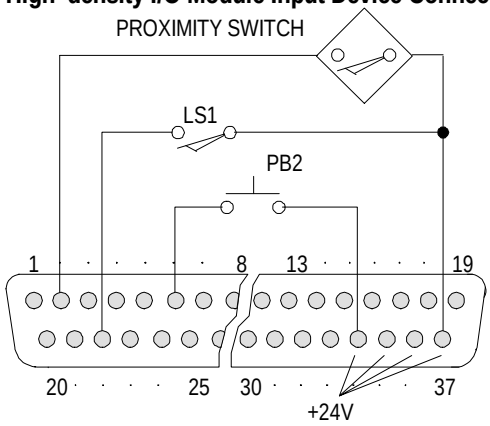


Table 10A.W and Table 10A.X show the relationship between the input data and the pins of connectors CN61M and CN62M.

Table 10A.W
Relationship of Input Data to Connector CN61M Pins

Connector CN61M					
Input Data	**Connector Pin No.**	**Input Data**	**Connector Pin No.**	**Input Data**	**Connector Pin No.**
D1	1	D12	12	D23	23
D2	2	D13	13	D24	24
D3	3	D14	14	D25	25
D4	4	D15	15	D26	26
D5	5	D16	16	D27	27
D6	6	D17	17	D28	28
D7	7	D18	18	D29	29
D8	8	D19	19	D30	30
D9	9	D20	20	D31	31
D10	10	D21	21	D32	32
D11	11	D22	22	D33	33

Important: Pins 34, 35, 36, and 37 are a fused +24 volt power used for input device circuits. If you chose to use an external power source to power input device circuits, do not make connections to these four pins. Additionally any external power supply used for input devices must have its common tied to the same potential as the common at TB1.

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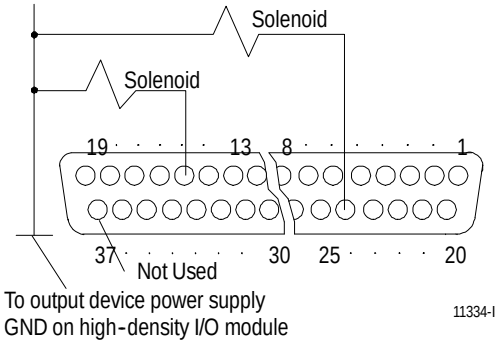
Table 10A.X
Relationship of Input Data to Connector CN62M Pins

Connector CN26M					
Input Data	**Connector Pin No.**	**Input Data**	**Connector Pin No.**	**Input Data**	**Connector Pin No.**
D34	1	D45	12	D56	23
D35	2	D46	13	D57	24
D36	3	D47	14	D58	25
D37	4	D48	15	D59	26
D38	5	D49	16	D60	27
D39	6	D50	17	D61	28
D40	7	D51	18	D62	29
D41	8	D52	19	D63	30
D42	9	D53	20	D64	31
D43	10	D54	21	D65	32
D44	11	D55	22	D66	33

Important: Pins 34, 35, 36, and 37 are a fused +24 volt power used for input device circuits. If you chose to use an external power source to power input device circuits, do not make connections to these four pins. Additionally any external power supply used for input devices must have its common tied to the same potential as the common at TB1.

Figure 10A.29 shows typical output device connections to connector CN63F.

Figure 10A.29
High-density I/O Module Output Device Connection



Important: When a lamp is directly connected to an output circuit, connect a protection resistor to reduce inrush current.

Important: A noise suppressor is incorporated in the output circuits.

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Table 10A.Y lists the relationship between the output data and the sockets of connector CN63F.

Table 10A.Y
Relationship of Output Data to Connector CN63F Sockets

Connector CN63M			
Output Data	**Connector Pin No.**	**Output Data**	**Connector Pin No.**
D1	1	D19	19
D2	2	D20	20
D3	3	D21	21
D4	4	D22	22
D5	5	D23	23
D6	6	D24	24
D7	7	D25	25
D8	8	D26	26
D9	9	D27	27
D10	10	D28	28
D11	11	D29	29
D12	12	D30	30
D13	13	D31	31
D14	14	D32	32
D15	15	D33	33
D16	16	D34	34
D17	17	D35	35
D18	18	D36	36

Important: Pin 37 is not used.

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10A.4.2 High Density I/O Module Specifications

Power Supply Specifications

Table 10A.Z lists the power requirements for the high–density I/O module.

Table 10A.Z
High-density I/O Module Power Requirements

Item	Specifications
Rated Input Voltage	24 V dc
Input Voltage Range	18-30 V dc
Current Consumption	Less than 1.2A (Excluding Output Power)
Connection	Phoenix Connector or Terminal Block

Important: The power requirements listed above are for the logic power of the high–density I/O module only.

Important: Power supplies with excessive noise or poor voltage regulation should not be used to power the high–density I/O.

Input Specifications

Table 10A.AA lists the input specifications for the high–density I/O module.

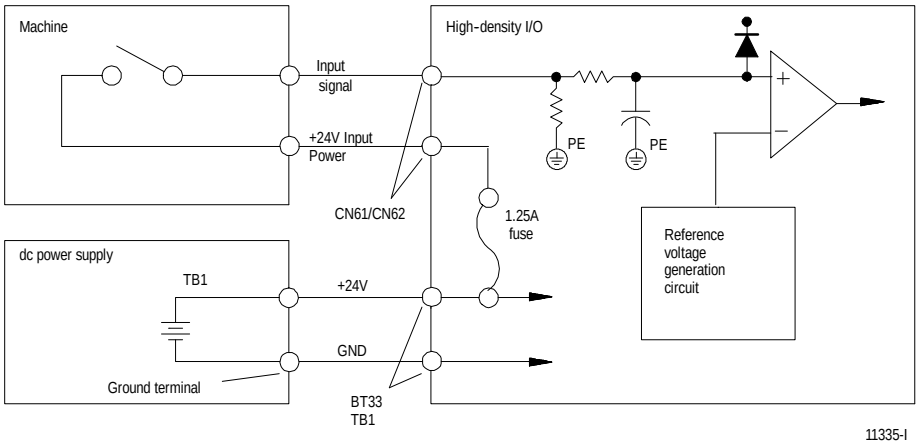
Table 10A.AA
High-density I/O Module Input Specifications

Item		Specifications	Remark
Number of Input Points		66	Pin Number
Operating Voltage	ON	10-30 V dc	
	OFF	0-5 V dc	
Allowable Voltage Drop		Max. 6 V dc	For external device
Input Impedance		3 K ohms	
Input Current	ON	Approx. 4.0mA	With 12 V dc Inputs
	OFF	Approx. 8.0mA	With 24 V dc Inputs
Leakage Current	OFF	Less than 1mA	
Response		0.1-23msec Including Digital Filter Time	OFF to ON, ON to OFF
Number of Common Points		4 per each 33 inputs	All common points are internally connected to each other
Fuse		1.25 A	1 for all inputs*
Isolation		Non-Isolated type	
Input Connection		2 37-Pin, D-Shell Connectors	Male type
* Fuse is used only for inputs using 24V module power from pins 34, 35, 36, and 37 of CN61 or CN62			

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The input circuit diagram for the high–density I/O module is shown in Figure 10A.30.

Figure 10A.30
High-density I/O Module Input Circuit Diagram



Output Specifications

The output specifications for the high–density I/O module are listed in Table 10A.AB.

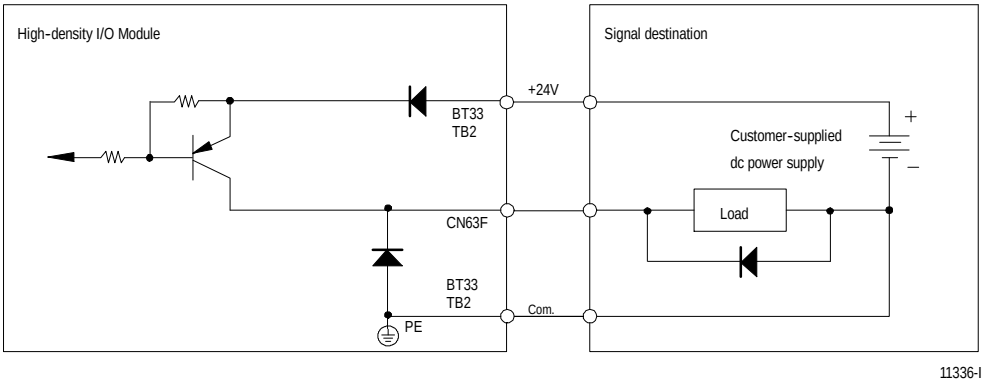
Table 10A.AB
High-density I/O Module Output Specifications

Item	Specifications	Remark
Number of Outputs	36	PNP Transistor
Output Type	Open Collector Output	Source Type
Rated Output Voltage	24 V dc	
Output Voltage Range	18-30 V dc	
Output Current at ON	Less than 250mA	Per each output
Maximum Output Capacity	9A	All outputs "ON"
Voltage Drop at ON	Less than 1.5 V	
Leakage Current at OFF	Less than 0.1mA	
Number of Ground Points	1	
Isolated	Non–Isolated Type	
Output Connection	37- Pin D-Shell Connector	+24 V dc (COM), GND

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Figure 10A.31 shows the output circuit diagram for the high–density I/O module.

Figure 10A.31
High-density I/O Module Output Circuit Diagram



10A.4.3 High-density I/O Module Fiber Optic Connection

Table 10A.AC lists the connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to Appendix A for additional information on fiber optic cables and connectors.

Table 10A.AC
High-density I/O Module Fiber Optic Connectors

Connector on Digital I/O	Connected To	Remark
OP23 (RED)	Receiver on next module in I/O ring	Output
OP24 (BLACK)	Transmitter on previous module in I/O ring	Input

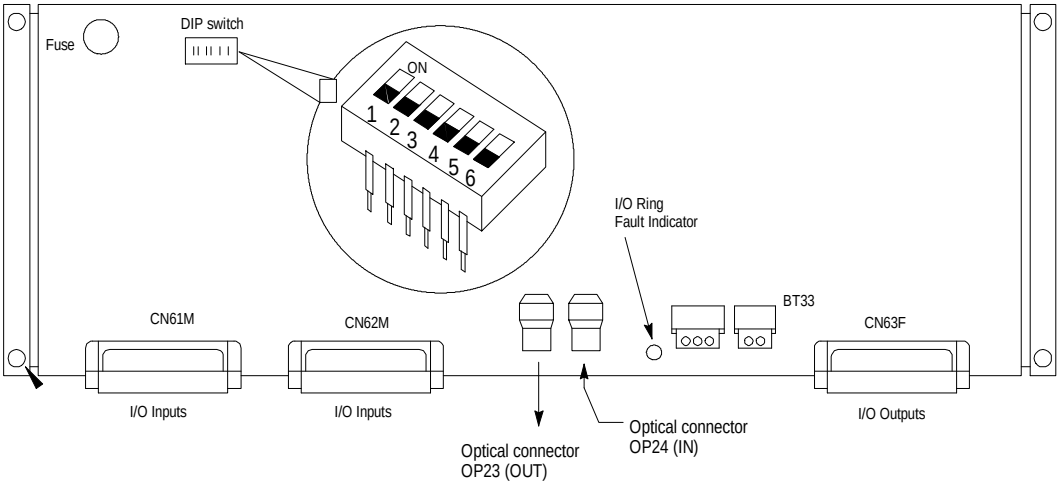
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10A.4.4 High Density I/O Module Node Address Setting

Different types of I/O devices can have the same node address, but devices of the same type must each have a unique node address. Each high–density I/O module is assigned a unique node address in the I/O assignment file of ODS. This address corresponds to a switch setting on the high–density I/O module.

Figure 10A.32 shows the location of the node address switch assembly on the high–density I/O.

Figure 10A.32
High-density I/O Module Switch Assembly Location



Set the switch assembly to correspond to the node address as shown in Table 10A.AD.

Table 10A.AD
High-density I/O Module Node Address Setting

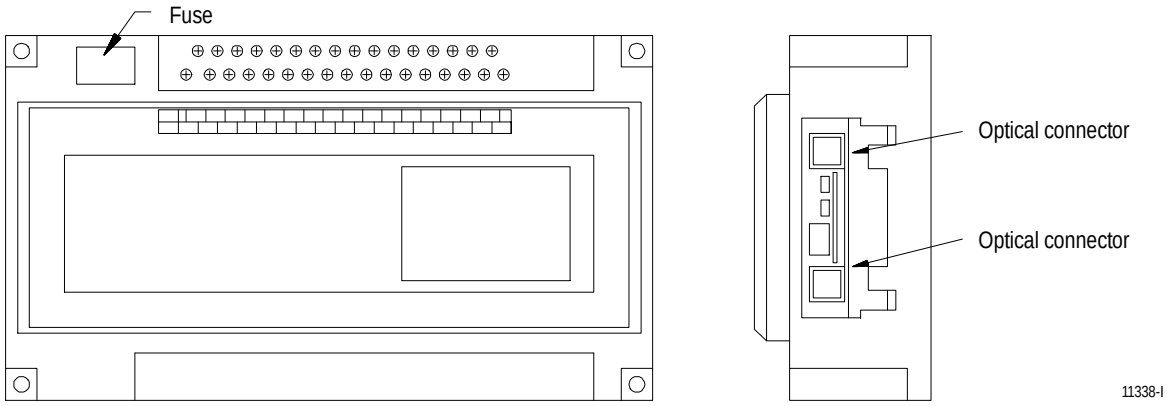
Node Address		Switch Assembly Position					
Hexadecimal	**Binary**	**1**	**2**	**3**	**4**	**5**	**6**
00	00 0000	OFF	OFF	OFF	OFF	OFF	OFF
01	00 0001	OFF	OFF	OFF	OFF	OFF	ON
02	00 0010	OFF	OFF	OFF	OFF	ON	OFF
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
3D	11 1101	ON	ON	ON	ON	OFF	ON
3E	11 1110	ON	ON	ON	ON	ON	OFF
3F	11 1111	ON	ON	ON	ON	ON	ON

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10A.5
E - Series Analog I/O

This section only discusses the use of the E–Series analog I/O module. If you are using a 1746 analog I/O device, refer to page 10B-10 for installation and operation details. The Analog I/O provides analog input and output to the control through the system I/O ring. It converts analog inputs to digital inputs and digital outputs to analog outputs for transmission to and from the control via the I/O ring. Each analog I/O provides 1 input channel and 1 output channel.

Figure 10A.33
E- Series Analog I/O External Appearance



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10A.5.1 E-Series Analog I/O Specifications

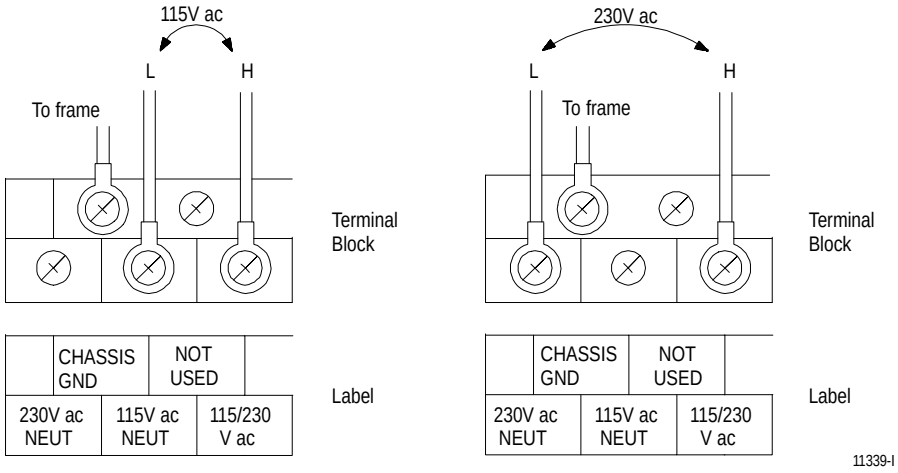
Table 10A.AE lists the power requirements for the analog I/O.

Table 10A.AE
E-Series Analog I/O Power Requirements

Item	Specifications
Rated Input Voltage	115/230 V ac 50/60 Hz
Input Voltage Range	85-132 V ac, 170-265 V ac, 47 Hz-63Hz
Power Consumption	Less than 15 VA
Fuse Rating	315mA/250V
Power ON Indicator	Lights up when +5V and ±15V are supplied to internal circuit
Connection	Terminal Block

Figure 10A.34 shows the terminals of analog I/O terminal block used for power source connection.

Figure 10A.34
E-Series Analog I/O Power Source Connection



ATTENTION: Incorrect wiring can cause damage to the analog I/O power supply. Do not jumper the 115V ac NEUT and the 230 V ac NEUT together. Do not jumper the 115V ac NEUT or the unused 230V ac to the Chassis GND terminal.

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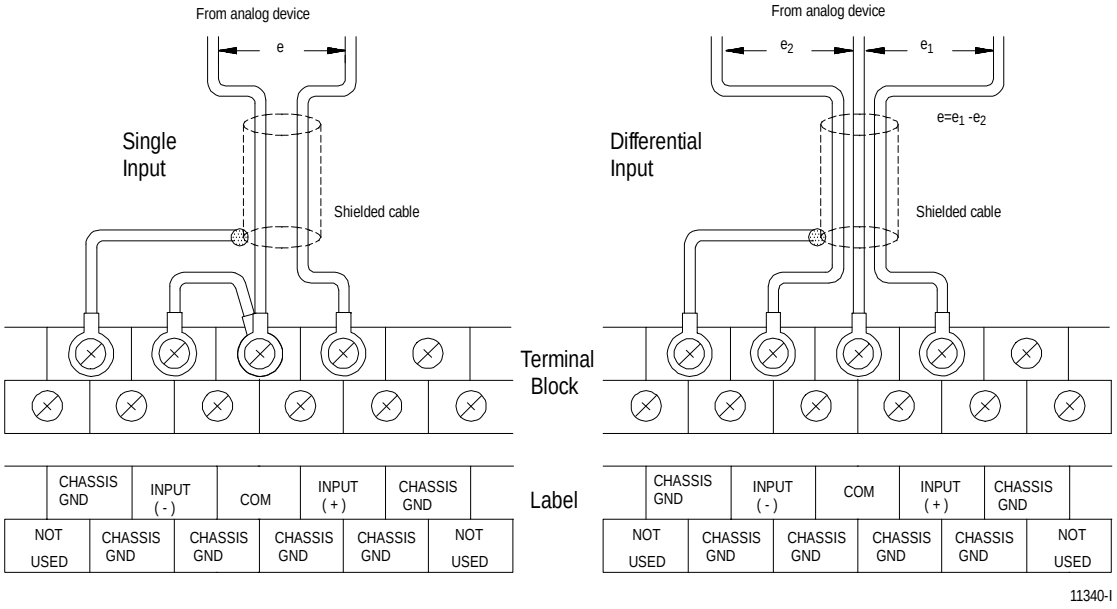
Table 10A.AF lists the input specifications for the analog I/O.

Table 10A.AF
E- Series Analog I/O Input Specifications

Item	Specifications	Remark
Number of Input Points	1	
Input Voltage Range	Bipolar: -10 to +10 V dc Unipolar: 0 to +10V dc	Range selected by switch next to the node address switch on the analog I/O
Resolution	12 bit binary	
Input Impedance	More than 100 Kohms	-10V to +10V
Conversion Rate	Interval: Less than 100 msec Time: Less than 30 msec	Approx. 64 msec Approx. 20 msec
Maximum Input Voltage	±25 V dc	
Common Mode Rejection	More than 70dB	From dc to 60 Hz
Connection	Terminal Block	
PAL Variable Values	Bipolar: 0 - 2047 (0 to +10V dc) 2048 - 4096 (-10 to 0 V dc) Unipolar: 0 - 4096 (0 to +10V dc)	The PAL variable name is determined in your I/O configuration using ODS.

Figure 10A.35 shows a typical analog I/O input device connection.

Figure 10A.35
E- Series Analog I/O Input Device Connection



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Table 10A.AG lists the output specifications for the analog I/O.

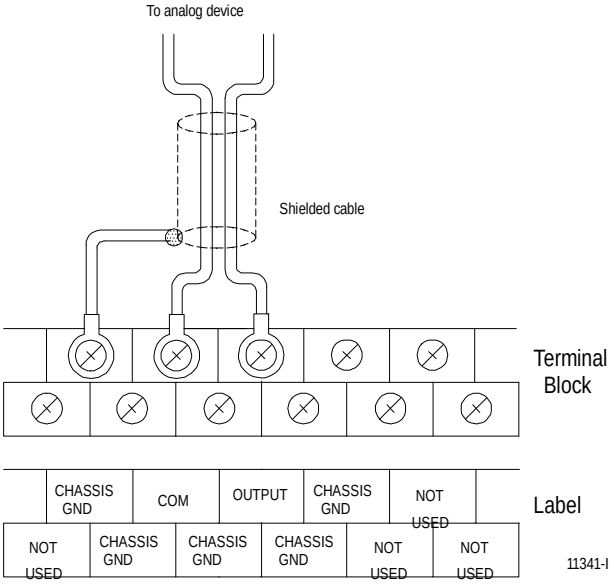
Table 10A.AG
E-Series Analog I/O Output Specifications

Item	Specifications	Remark
Number of Output Points	1	
Operating Voltage	Bipolar: -10 to +10 V dc Unipolar: 0 to +10V dc	Range selected by switch next to the node address switch on the analog I/O
Resolution	12 bit binary	
Load Drive Capability	Maximum 10 mA	No Sustained Oscillation
	Maximum 1 mF	
	Maximum mF	
Response Rate	Less than 200 msec	
Connection	Terminal Block	
PAL Variable Values	Bipolar: 0 - 2047 (0 to +10V dc) 2048 - 4096 (-10 to 0 V dc) Unipolar: 0 - 4096 (0 to +10V dc)	The PAL variable name is determined in your I/O configuration using ODS.

Figure 10A.36 shows a typical analog I/O output device connection.

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Figure 10A.36
E-Series Analog I/O Output Device Connection



10A.5.3 E-Series Analog I/O Fiber Optic Connection

Table 10A.AH lists the analog I/O connectors used to make the fiber optic connections to the I/O ring. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to Appendix A for additional information on fiber optic cables and connectors.

Table 10A.AH
E-Series Analog I/O Fiber Optic Connectors

Connector on Digital I/O	Connected To	Remark
OP25 (RED)	Receiver on next module in I/O ring	Output
OP26 (BLacK)	Transmitter on previous module in I/O ring	Input

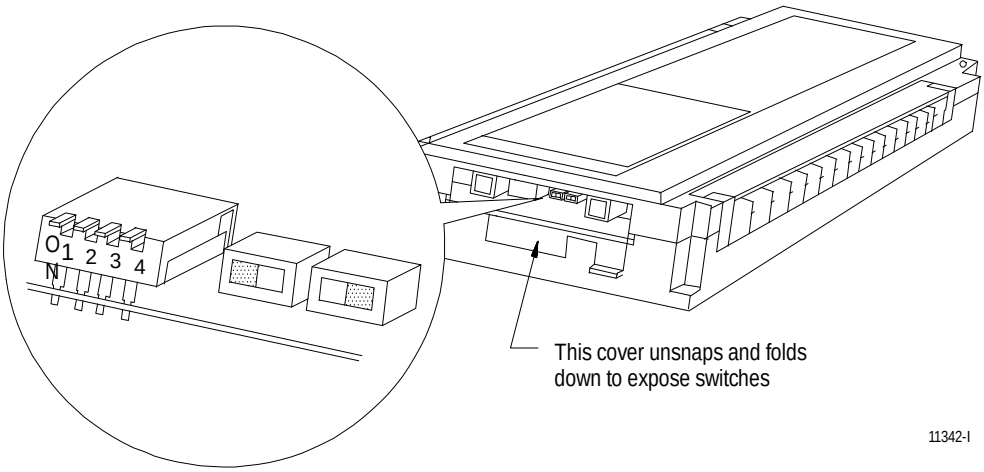
10A.5.4 E-Series Analog I/O Node Address Setting

Different types of I/O devices can have the same node address, but devices of the same type must each have a unique node address. Each analog I/O is assigned a unique node address in the I/O assignment file of ODS. This address corresponds to a switch setting on the analog I/O device.

Figure 10A.37 shows the location of the node address switch assembly on the analog I/O.

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Figure 10A.37
E-Series Analog I/O Node Address Switch Assembly Location



Set the node address switch assembly to correspond to the node address as shown in Table 10A.AI.

Table 10A.AI
E-Series Analog I/O Node Address Setting

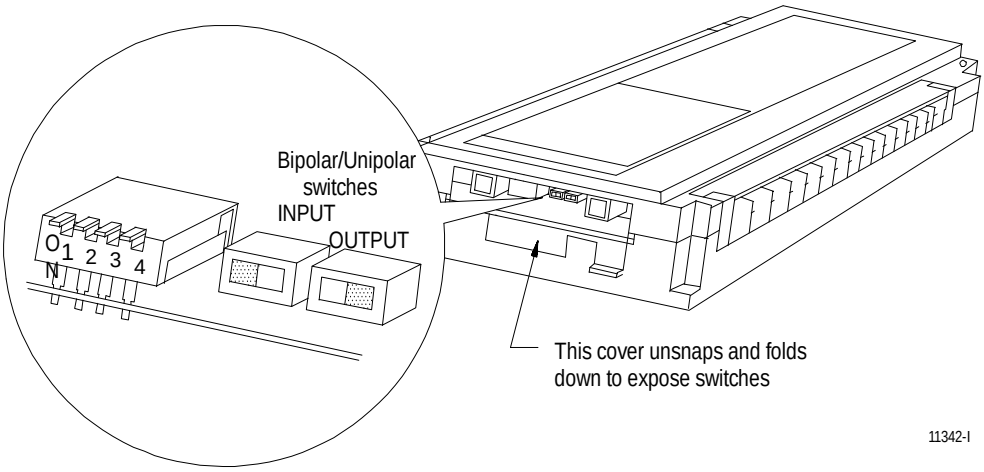
Node Address		Switch Assembly Position			
Hexadecimal	**Binary**	**1**	**2**	**3**	**4**
00	0000	OFF	OFF	OFF	OFF
01	0001	OFF	OFF	OFF	ON
02	0010	OFF	OFF	ON	OFF
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
0D	1101	ON	ON	OFF	ON
0E	1110	ON	ON	ON	OFF
0F	1111	ON	ON	ON	ON

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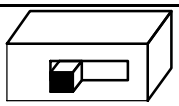
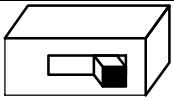
10A.5.5 E-Series Analog I/O Bipolar/Unipolar Configuration

The E–Series analog I/O module allows you to select between bipolar operation (–10V to +10V dc) and unipolar operation (0V to +10V dc). Select this using a dip switch located next to the node address switch (see Figure 10A.38). Bipolar or unipolar can be selected independently for the input and output channels.

Figure 10A.38
E Series Analog I/O Node Address Switch Assembly Location



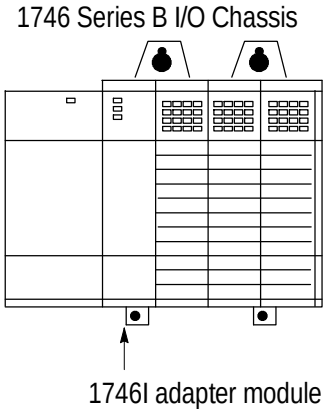
Switch positions are as follows:

	Unipolar (0 V dc to +10 V dc)
	Bipolar (-10 V dc to +10 V dc)

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10A.6 1746 I/O

You can place several 1746I modules with 1746 I/O chassis in the 9/Series fiber-optic ring. Each 1746 I/O chassis must contain its own 1746I module (daisy chaining racks together using one 1746I module is not allowed). The number of I/O points/chassis is limited to the number of ASRN chips supported by the 9/Series fiber–optic ring. Use page 10B-10 to calculate how many ASRN chips are required for each I/O chassis. A maximum of 16 chassis are allowed on the 9/Series fiber-optic I/O ring.



Three different fully equipped 1746 I/O chassis are available for the 9/Series I/O ring. These chassis contain the following I/O devices:

Table 10A.AJ
Standard 9/Series 1746 I/O Catalogs

Catalog Number 8500-S115		**Catalog Number 8500-S24**		**Catalog Number 8500-SANL**	
(1) 1746-A4	4 Slot Chassis	(1) 1746-A4	4 Slot Chassis	(1) 1746-A4	4 Slot Chassis
(1) 1746-P1	115/230V ac Power Supply	(1) 1746-P1	115/230V ac Power Supply	(1) 1746-P1	115/230V ac Power Supply
(1) 8500-1746I	I/O Ring Interface Adapter Module	(1) 8500-1746I	I/O Ring Interface Adapter Module	(1) 8500-1746I	I/O Ring Interface Adapter Module
(2) 1746-IA16	16 point 115V ac Input Module	(2) 1746-IB16	16 point 24V dc Input Module	(1) 1746-NIO4V	Analog Input Module
(1) 1746-OA16	16 point 115V ac Output Module	(1) 1746-OW16	16 point 24V dc Output Module	(1) 1746-N2	2 Empty Slot Covers
(1) set fiber optic connectors	for connection to I/O ring	(1) set fiber optic connectors	for connection to I/O ring	(1) set fiber optic connectors	For connection to I/O ring
Total I/O	**32 115V ac Inputs 16 115V ac Outputs 3 ASRN chips**	**Total I/O**	**32 24V dc Inputs 16 24V dc Outputs 3 ASRN chips**	**Total I/O**	**2 analog input chnls. 2 analog output chnls 6 ASRN chips**

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10A.6.1 Removing/Installing 1746 Modules

The following procedure covers how to remove modules from your 1746 I/O chassis. In some cases it is necessary to remove a module to set or check dip switch settings.

ATTENTION: Never install, remove, or wire modules with power applied to the chassis.

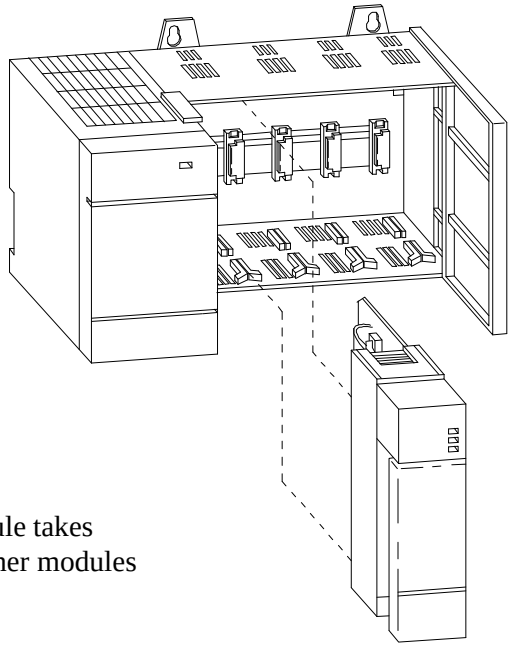
Removing a Module

1. Label and remove any wiring or removable terminal blocks.
2. Gently press in on both the top and bottom latches of the module to be removed.
3. Slide the module out of the rack.

Installing a Module

1. Align the circuit board of the module with the card guide in the chassis.

   Important: You must install the 1746I module in the first slot of the chassis (slot immediately next to the power supply). The 1746I module takes the place of a CPU module or a ASB adapter module in this slot. Other modules should be returned to the same slot they were removed from.



2. Gently slide the module in until both top and bottom latches are latched.
3. Reconnect wires or removable terminal blocks.

Cover all unused slots with a Card Slot Filler, Catalog Number 1746-N2.

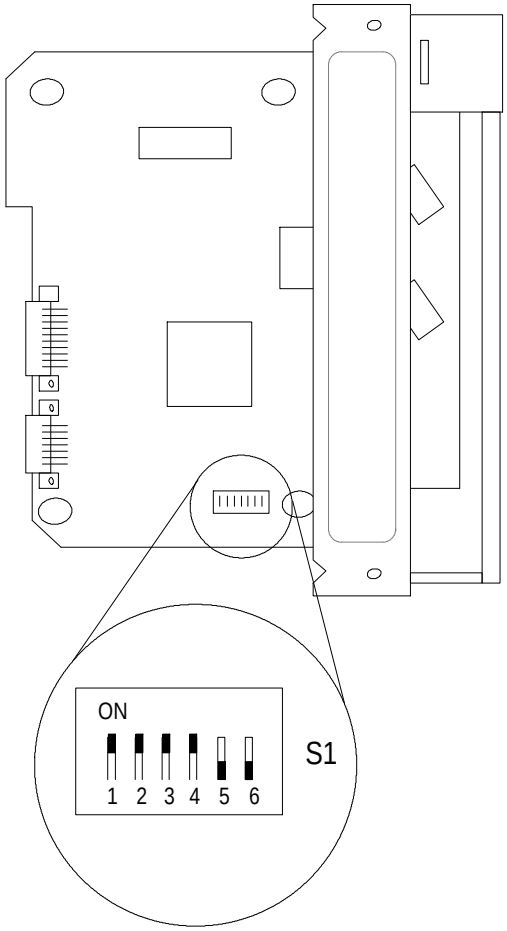
10A.6.2 1746I I/O Ring Adapter Node Address Setting

To install the 1746I module in the 9/Series I/O ring you must first assign the module an address on the 9/Series I/O ring. If the module is already installed in your 1746 I/O chassis, you must remove the module to set the module address. Remove the module by pressing in on the locking tabs on the top and bottom of the 1746I module and sliding the module out of the chassis.

Assign an address to the module using the dip switch S1 found on the side of the 1746I module. Figure 10B.4 shows the location of the node address switch assembly on the 1746I module.

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Figure 10A.39
1746 I/O Ring Adapter Switch Assembly Locations



Other 9/Series I/O devices (such as an HPG or MTB panel) on the 9/Series fiber-optic ring can have the same node address as the 1746I module. However, devices of the same type (multiple 1746I modules) must each have a unique node address. Each 1746 I/O ring adapter is assigned a unique node address in the I/O assignment file of ODS (refer to your PAL reference manual). This address corresponds to switch assembly S1 on the 1746I module.

Set switch assembly S1 to correspond to the node address as shown in Table 10A.AK.

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Table 10A.AK
1746I I/O Ring Adapter Node Address Setting

Node Address		Switch Assembly Position			
Hexadecimal	Binary	1	2	3	4
00	0000	OFF	OFF	OFF	OFF
01	0001	OFF	OFF	OFF	ON
02	0010	OFF	OFF	ON	OFF
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
0F	1111	ON	ON	ON	ON

Important: Switch 5 and 6 of S1 must remain in the OFF position for normal operation.

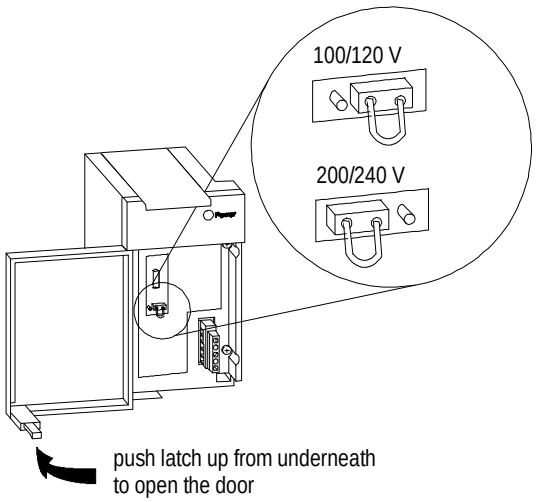
10A.6.3 1746P1 Power Supply

The following are the specifications and wiring instructions for the 1746 P1 power supply.

Set the Input Voltage Jumper

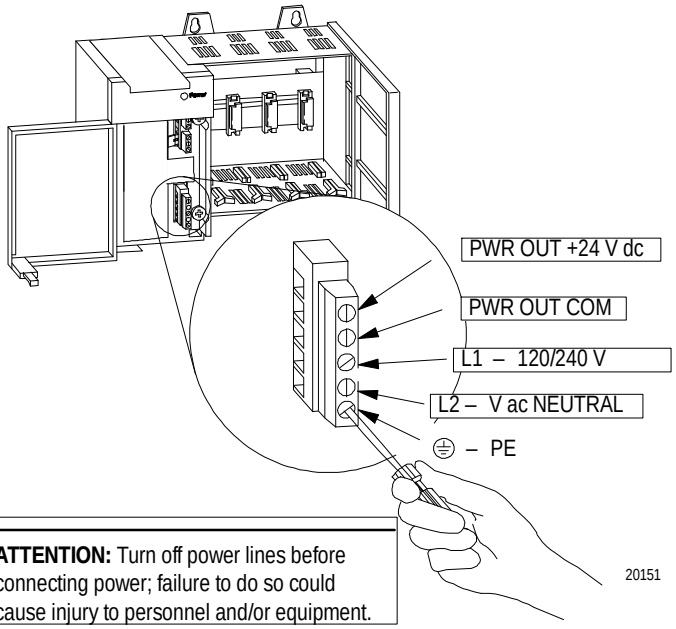
1. Locate the input voltage jumper. If necessary, remove and reinstall the jumper to match the external voltage available.

ATTENTION: Set the input jumper before applying power. Hazardous voltage is present on exposed pins when power is applied: contact with the pins may cause injury to personnel.



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2. Wire the power supply terminals as shown below. These terminals accept two #14AWG wires.



ATTENTION: Turn off power lines before connecting power; failure to do so could cause injury to personnel and/or equipment.

Table 10A.AL
1746 P1 Power Supply Specifications

Description:	Specification:
Line Voltage	85-132/170-265 V ac 50/60 Hz
Typical Line Power Requirement	135 VA
Internal Current Capacity	2 AMP at 5 V dc 0.46 AMP at 24 V dc
User Current Capacity	24 V dc - 0.2 AMP
Fuse Protection	3 AMPs
Ambient Operating Temperature Rating	0 to +55 °C (Current capacity derated by 5% at +60 °C)
Humidity Rating	5 - 95% (noncondensing)
Wiring	#14 AWG

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10A.6.4 1746 I/O Ring Adapter Fiber Optic Connection

The connectors used to make the fiber optic connections to the I/O ring are listed in Table 10A.AM. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to Appendix A for additional information on fiber optic cables and connectors.

The fiber-optic connectors are located under the front door of the 1746I module for easy access. Run the fiber-optic cables out the bottom of the 1746I module to allow the front door of the module to close after the cables have been installed.

Table 10A.AM
1746 I/O Ring Adapter Fiber Optic Connectors

Connector on Digital I/O	Remark	Connected To
I/O (RED)	Output	Receiver on next module in I/O ring
I/O (BLACK)	Input	Transmitter on previous module in I/O ring

10A.7 1746 Discrete I/O Racks

The following tables give input and output specifications for the standard 1746 I/O modules available for the 9/Series fiber-optic I/O ring. Contact your Allen-Bradley sales representative for details on any modules not listed here. See page 10B-8 for details on other 9/Series compatible 1746 I/O modules.

General 1746 Discrete I/O Module Specifications

Description:	Specification
Noise Immunity	NEMA-Standard ICS 2-230
Vibration (operating)	Displacement - .015 inch peak to peak at 5 - 57 Hz
	Acceleration - 2.5 G at 57 - 2000 Hz
Shock (operating)	30 G
Isolation	1500 V
Environmental conditions	
Operating temperature	0 to +60 °C (+32 °to +140 °F)
Storage temperature	-40 °to +85 °C (-40 °to +185 °F)
Humidity rating	5 to 95% (noncondensing)
Certification	UL listed, CSA approved
Hazardous Environment Classification	Class I, Division 2 Hazardous Environment.①

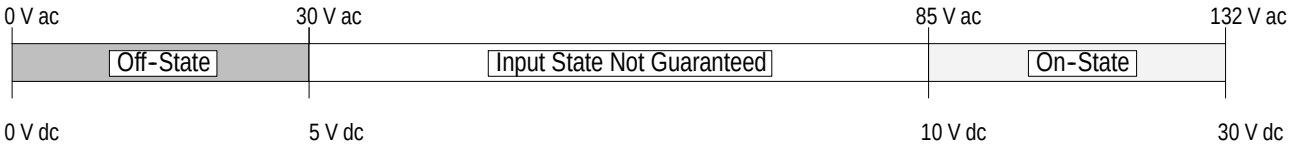
① *Some modules are excluded from this certification. Refer to the following tables for a complete listing.*

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Discrete Input Module Specifications

Catalog Number	Voltage Category	Operating Voltage	Number of Inputs	Points Per Common	Backplane Current Draw 5V	Backplane Current Draw 24V	Signal Delay (ms. max)	Off-State Current (max)	Off-State Voltage (max)	Nominal Input Current	Inrush Current (max)
1746-IA16 (RTB)	100/120 V ac	85-132	16	16	0.085	0	on=35 Off=45	2 mA	30 V ac	12 mA at 120 V ac	0.8 A
1746-IB16 (RTB)	24 V dc	10-30	16	16	0.085	0	On=8 Off=8	1 mA	5.0 V dc	8 mA at 24 V dc	n/a

1746-IA16



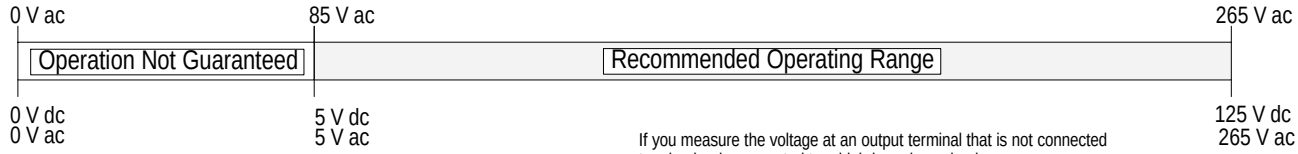
1746-IB16

Measure voltage between common terminal and input terminal.

Discrete Output Module Specifications

Catalog Number	Voltage Category	Operating Voltage	Number of Outputs	Points per Common	Backplane Current Draw 5v	Backplane Current Draw 24V	Signal Delay (ms. max)	Off State Leakage (max)	Load Current at 5 V dc (min.)	Continuous Current per Point (max.)	Continuous Current per Module (max.)
1746-OA16 (RTB)	120/240 V ac	85-265	16	8	0.370	0	On=0.10 Off=11.0	2 mA	10 mA	0.50 A at 30 °C 0.25 at 60 °C	8 A at 30 °C 4 A at 60 °C
1746-OW16① (RTB)	V ac/V dc Relay	5-265 V ac 5-125 V dc	16	8	0.170	0.180	On=10.0 Off=10.0	0 mA	10 mA	See contact rating chart below.	16.0 A ac 8.0 A/ common

1746-OA16



1746-OW16

If you measure the voltage at an output terminal that is not connected to a load or is connected to a high-impedance load, you may measure as much as 100 V ac even though the output is off.

1746-OW16 Relay Contact Rating Chart

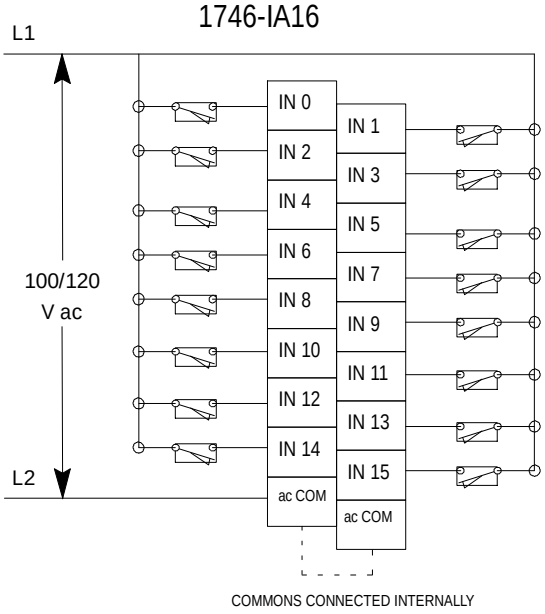
Type	Maximum Volts	Ampere① Make	Ampere① Break	Amperes Continuous ③	Voltamperes Make	Voltamperes Break
Relay Contact Ratings for 1746-OW16	240 V ac 120 V ac	7.5 A 15.0 A	0.75 A 1.50 A	2.5 A	1800 VA	180 VA
	125 V dc	0.22 A②		1.0 A	28 VA	
	24 V dc	1.2 A②		2.0 A	28 VA	

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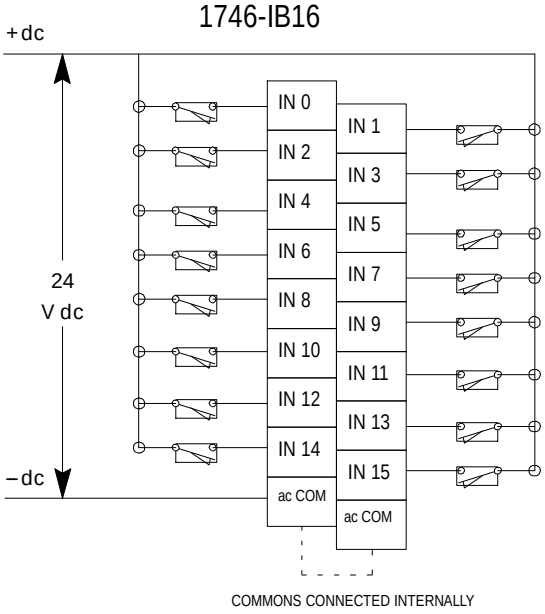
10A.7.1 Wiring 1746 Discrete I/O

All modules are UL 508 listed and CSA 22.2 142 approved. These modules meet requirements for Class I division 2 hazardous location requirements of both Underwriter's Laboratory and the Canadian Standards Association.

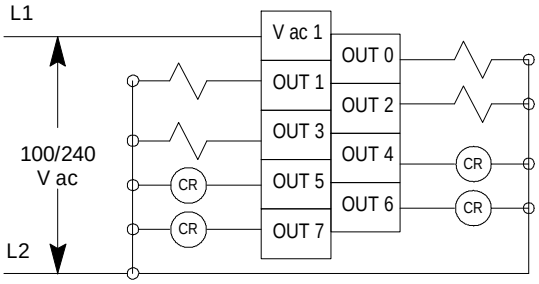
1746-IA16



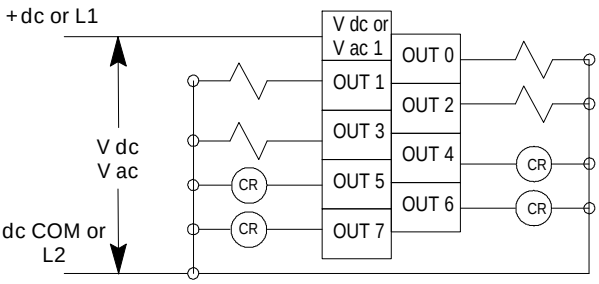
1746-IB16

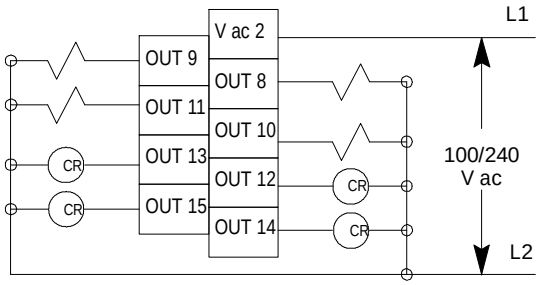


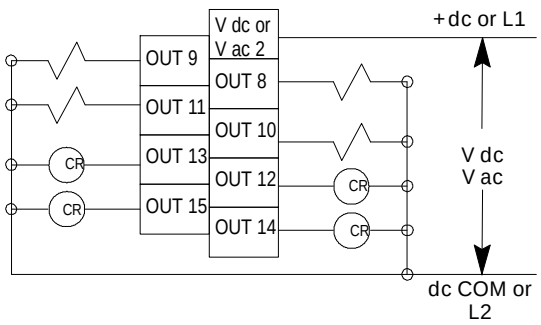
1746-OA16



1746-OW16







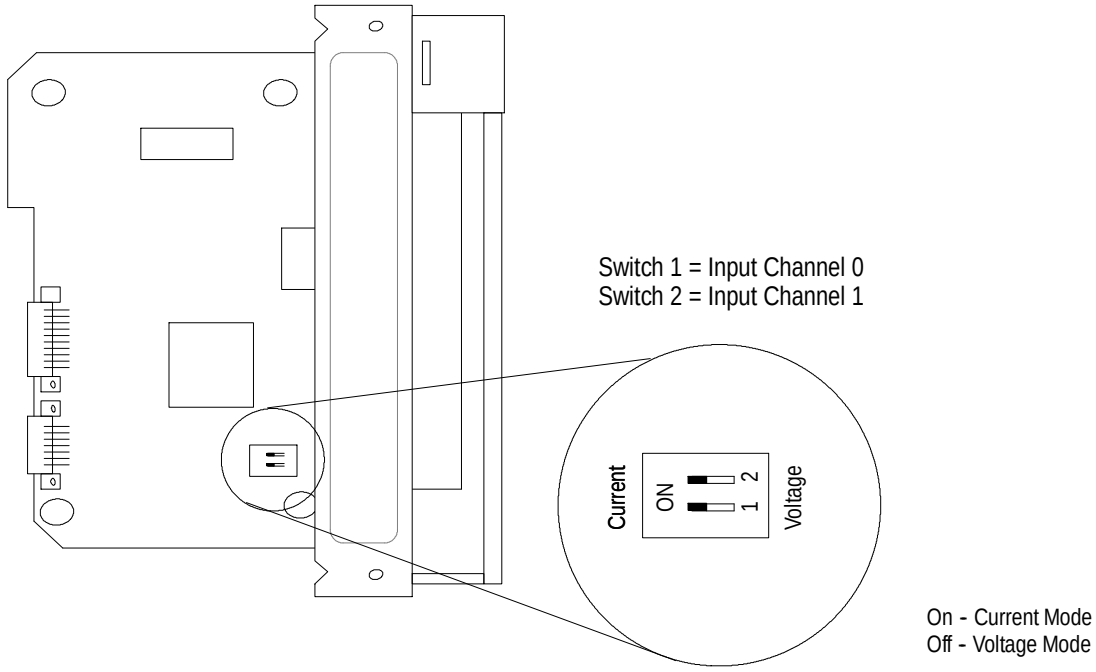
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10A.8
1746 Analog I/O

Selecting Voltage or Current Mode

The NIO4V analog module has a user selectable DIP switch setting which allows you to configure the input channels as either current or voltage inputs. The switches are located on the analog module board.

ATTENTION: Care should be taken to avoid connecting a voltage source to a channel configured for current input. Improper module operation or damage to the module can occur.



The module has two individual switches labeled 1 and 2. These switches control the input mode of input channel 0 and 1. A switch in the ON position configures the channel for current input. A switch in the OFF position configures the channel for voltage input.

Output channels are always voltage mode and can not be configured.

Wiring 1746 Analog I/O

Belden cable #8761 is recommended when wiring analog modules. Use the following guidelines in planning the system wiring for the analog modules:

- all analog common terminals (ANL COM) are electrically connected inside the modules. ANL COM is not connected to earth ground inside the module.

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- voltages on IN+ and IN– terminals terminals must remain within ±20 Volts with respect to ANL COM for proper input channel operation. This is true for current and voltage input channel operation.
- voltage outputs (OUT 0 and OUT 1) are referenced to ANL COM. Load resistance (R1) for a voltage output channel must be equal to or greater than 1K ohms.
- current output channels (OUT 0 and OUT 1) source current that returns to ANL COM. Load resistance (R1) for a current output channel must remain between 0 and 500 ohms.
- input connections for single-ended or differential inputs are the same.



ATTENTION: Before wiring any analog module, disconnect power from the chassis and from any other source to the analog module.

Grounding Your Cable

Belden cable #8761 has two signal wires (black and clear), one drain wire and a foil shield. The drain wire and foil shield must be grounded at one end of the cable. Do not earth ground the drain wire and foil shield at both ends of the cable.

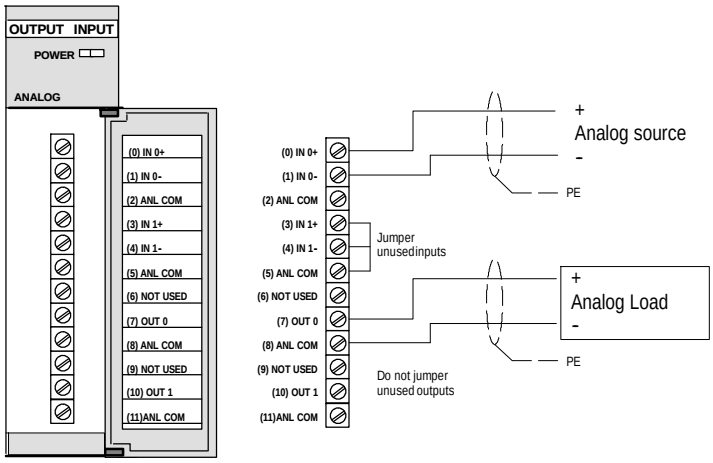
Input Channel – Ground the drain wire and foil shield near the sourcing device.

Output Channel – Use a rack mounting tab as a ground for the drain wire and foil shield.

Important: If you cannot ground the input channel at the sourcing device, ground the drain wire and foil shield at the rack mounting tab. Do not connect the foil shield or drain wire to the analog terminal block. They must be connected to an earth ground, which is not provided at the analog module.

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Analog Module NIO4V



1746-NIO4V

Reading/Writing Analog Data

The analog I/O module passes values to PAL through the I/O ring. The variable used to read/write the analog I/O module data is assigned using the PAL I/O assigner (refer to your 9/Series PAL Reference Manual for details). The following table shows the values of these PAL variables:

Table 10A.AN
Analog Input Decimal Values (to PAL)

Voltage/Current Range	Decimal Representation	Number of Significant Bits	Resolution per LSB
- 10V to + 10V (1LSB)	-32,768 to + 32,767	16 bits	305.176mV
0V to 10 V (1LSB)	0 to 32,767	15 bits	
0V to 5V	0 to 16,384	14 bits	
1V to 5V	3,277 to 16,384	13.67 bits	
-20mA to +20mA	-16,384 to +16,384	15 bits	1.22070mA
0 to +20mA	0 to 16,384	14 bits	
4 to +20 mA	3,277 to 16,384	13.67 bits	

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To determine an approximate voltage that an input value represents, use one of the following equations:

$$\frac{10\ V}{32{,}768}\ (\text{input value}) = \text{input voltage (V)}$$

or for current

$$\frac{20\ mA}{16{,}384}\ (\text{input value}) = \text{input voltage (V)}$$

For example, if an input value of -16,021 is in the input image, the calculated input voltage is:

$$\frac{10\ V}{32{,}768}\ (-16{,}021) = -4.889221\ V$$

This is the calculated value. The actual value may vary within the accuracy limitations of the module.

Table 10A.AO
Analog Output Decimal Values (from PAL)

Voltage/Current Range	Decimal Representation	Number of Significant Bits	Resolution per LSB
- 10V to + 10V (1 LSB)	-32,768 to + 32,767	14 bits	1.22070mV
0V to 10 V (1 LSB)	0 to 32,767	13 bits	
0V to 5V	0 to 16,384	12 bits	
1V to 5V	3,277 to 16,384	11.67 bits	
0 to +21mA	0 to +32,764	13 bits	2.56348mA
0 to +20mA	0 to 31,208	12.92 bits	
4 to +20 mA	6,242 to 31,208	12.6 bits	

To determine a value for the PAL variable of an analog output to produce a desired output, use one of the following equations:

$$\frac{32{,}768}{10\ V\ dc}\ (\text{desired voltage output V}) = \text{output decimal value}$$

or for current

$$\frac{32{,}768}{21\ mA}\ (\text{desired current output mA}) = \text{output decimal value}$$

For example, if an output voltage of +1 V dc is desired, the value to be put in the corresponding PAL variable would be:

$$\frac{32{,}768}{10V\ dc}\ (+1V\ dc) = 3277$$

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10A.8.1 Analog I/O Specifications (1746-NIO4V)

Features

- High resolution – 16 bit input and 14 bit output converters provide accurate control capabilities.
- Backplane powered – No external power supply required, reducing system cost.
- User selectable inputs – Configurable per channel for current or voltage inputs.
- Input channel filtering – Rejects high frequency noise that couples into an analog input signal.
- Image maps directly into the 1746I adapter.
- Isolation – All analog modules are isolated from each other and from the backplane.

Description	Specification
Input Channels per Module	2 differential, voltage or current selectable per channel
Output Channels per Module	2 voltage outputs, not individually isolated
Backplane Current Draw	55mA at 5V dc 115mA at 24 V dc
Communication Format	16 bit Two's Complement Binary
Field Wiring to Backplane Isolation	500 V dc
Conversion Time	512ms for all channels in parallel
Current/Voltage Ranges NIO4V	±10 V dc or ±20 mA (input) ±10 V dc (output)
Step Response Input Output	 60 ms at 95% 2.5 ms at 95%
Maximum Wire Size	#14 AWG
Terminal Block	Removable
Noise Immunity	NEMA Standard ICS 2-230
Environmental Conditions Operating temperature Storage temperature Humidity rating	 0 to +60 °C (+32 °to +140 °F) -40 °C to +85 °C (-40 °to +185 °F) 5 to 95% (noncondensing)
Recommended Cable	Belden #8761
Certification	UL 508 listed, CSA 22.2 142 approved
Hazardous Environment Classification	Class I, Division 2 Hazardous Environment

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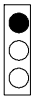
10A.9 1746 I/O Fault Status

If the 9/Series fiber optic I/O ring should fault or any other fault should occur within the 1746 I/O rack, the 1746I module will attempt to maintain all of its I/O in the same state condition. This holds all output devices in the chassis to their present state. (Outputs already ON remain ON, outputs already OFF remain OFF, and analog modules maintain their present output voltage).

Wire your I/O devices accordingly considering all safety issues.

10A.9.1 Troubleshooting the 1746I Communication Module

This section provides diagnostic information for troubleshooting your 1746 I/O chassis using the LED's on the front of the 1746I module. Also in this section is information on using test modes to diagnose any problems with the fiber-optic connections.

○ OFF ● ON ◍ Flashing **This LED Status**	**Indicates this possible cause:**
 Run LED On	· The I/O ring and the 1746 I/O rack are communicating properly and the rack is functioning.
 Rack LED On	· RAM or ROM failure at power turn on. · Device in rack failed or is not seated properly. · Internal error in the 1746I adapter.
 Rack LED Flashing	· A card type was found in the rack at power turn on that is not supported by the 1746I module.
 Ring LED On	· Connection or device has failed in the I/O ring for a device before the 1746I in the ring. · Power turned off at the CNC. · Transmitter and receiver cables are reversed.
 Ring LED Flashing	· Connection or device has failed in the I/O ring for a device after the 1746I in the ring.
 All LEDs Off	· Power turned off at the CNC while the ring was up and running. · Connection of I/O ring broken before this 1746I module while the ring was up and running.

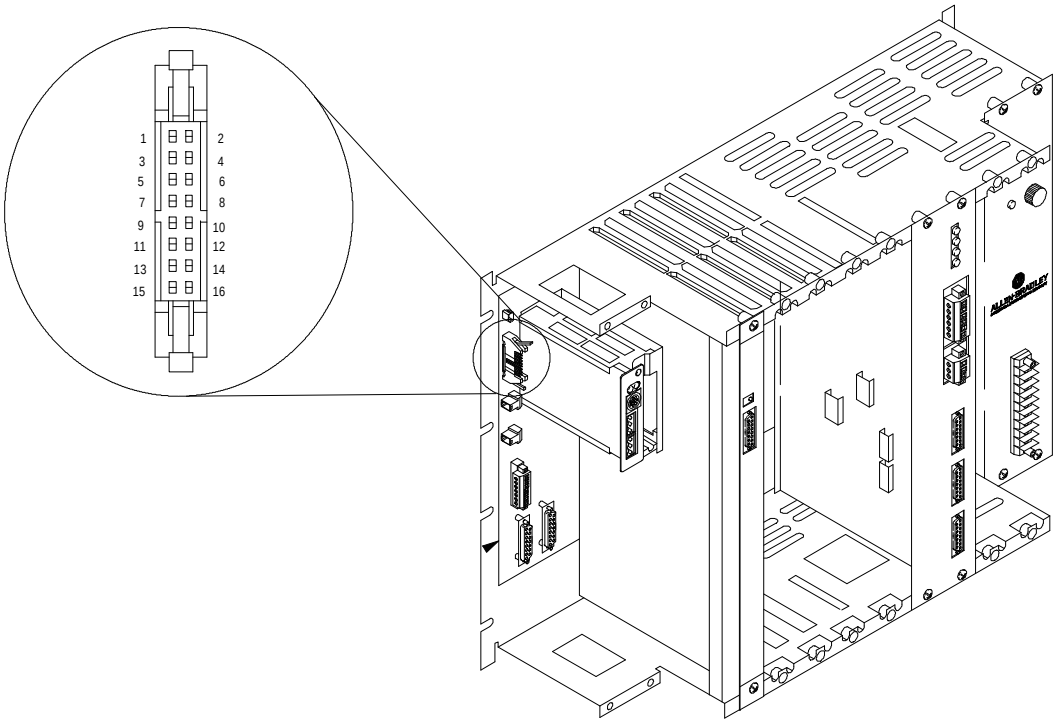
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10A.10 Fast I/O (9/260 and 9/290 only)

The Fast I/O feature provides 4 inputs to and 4 outputs from the control. This feature is used to make changes in PAL that will take effect the next iteration of the PAL program. Using the fast I/O feature, the operator can input values to the PAL program using the PAL flag $HSIN and output values using the PAL flag $HSOUT.

The fast I/O connector on the motherboard provides an interface port for fast input and output to and from the control. This connector interfaces with cable C11. Refer to page 7A-26 for additional information on cable C11. Figure 10A.40 and Table 10A.AP show the connector and its pin assignments.

Figure 10A.40
Fast I/O Connector (has pins)



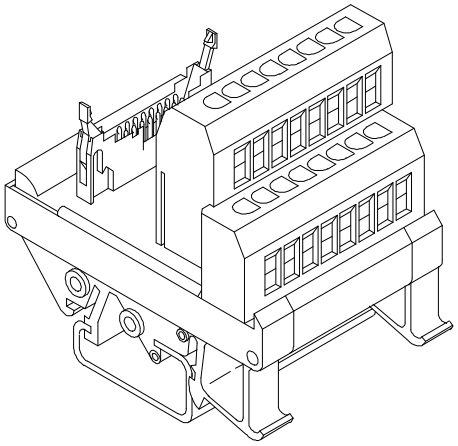
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Table 10A.AP
Pin Assignments for the Fast I/O Connector (P3)
(Not available on the 9/230 and 9/440 control)

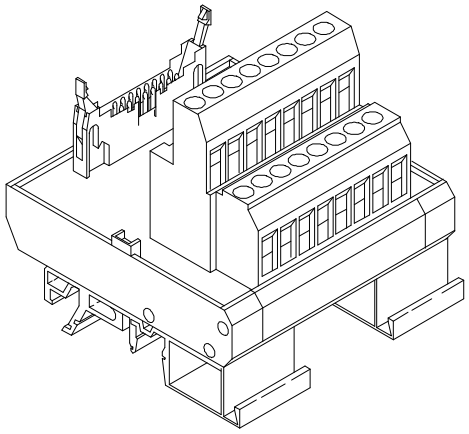
Pin No.	Signal Name	Pin No.	Signal Name
1	FAST_I1	9	FAST_O1
2	COM	10	COM
3	FAST_I2	11	FAST_O2
4	COM	12	COM
5	FAST_I3	13	FAST_O3
6	COM	14	COM
7	FAST_I4	15	FAST_O4
8	COM	16	COM

Allen-Bradley recommends that you use the terminal blocks shown in Figure 10A.41 to simplify the wiring between your control and the fast I/O. The fast I/O cable connects to the connector on the block. Use the pin assignments in Table 10A.AP to wire the terminal connections.

Figure 10A.41
Recommended Terminal Blocks for Fast I/O Wiring



Weidmueller RI-16 Idc R (rail-mounted)
Cat. No. 914892
Weidmueller RI-16 Idc P (panel-mounted)
Cat. No. 914903



Phoenix FLKM 16
Order No. 22 81 02 1

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Figure 10A.42 shows the fast I/O circuit.

Figure 10A.42
Fast I/O Circuit
(Not available on the 9/230 control)

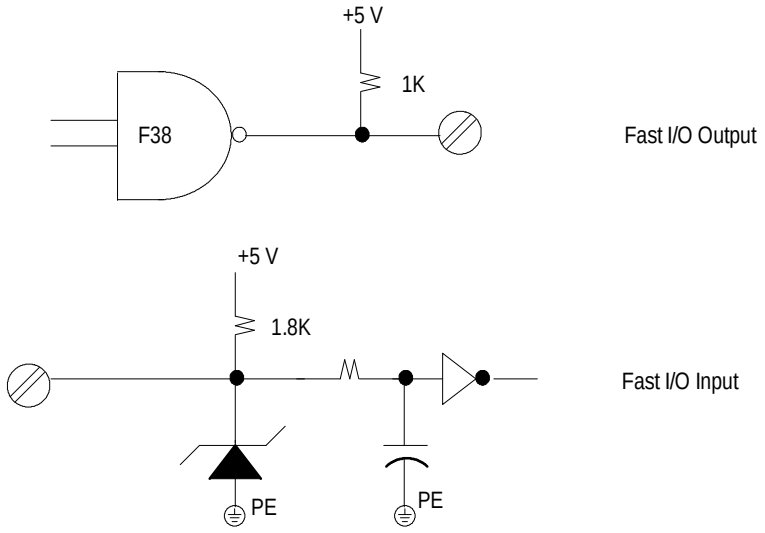


Table 10A.AQ lists the input specifications for the fast I/O.

Table 10A.AQ
Fast I/O Input Specifications

Item	Specification	Remark
Maximum Input Current - Low	I_{IL} = 6mA/input	Source
Maximum Input Voltage - Low	V_{IL} = 0.45V/input	-

Table 10A.AR lists the output specifications for the fast I/O.

Table 10A.AR
Fast I/O Output Specifications
Not available on the 9/230 control

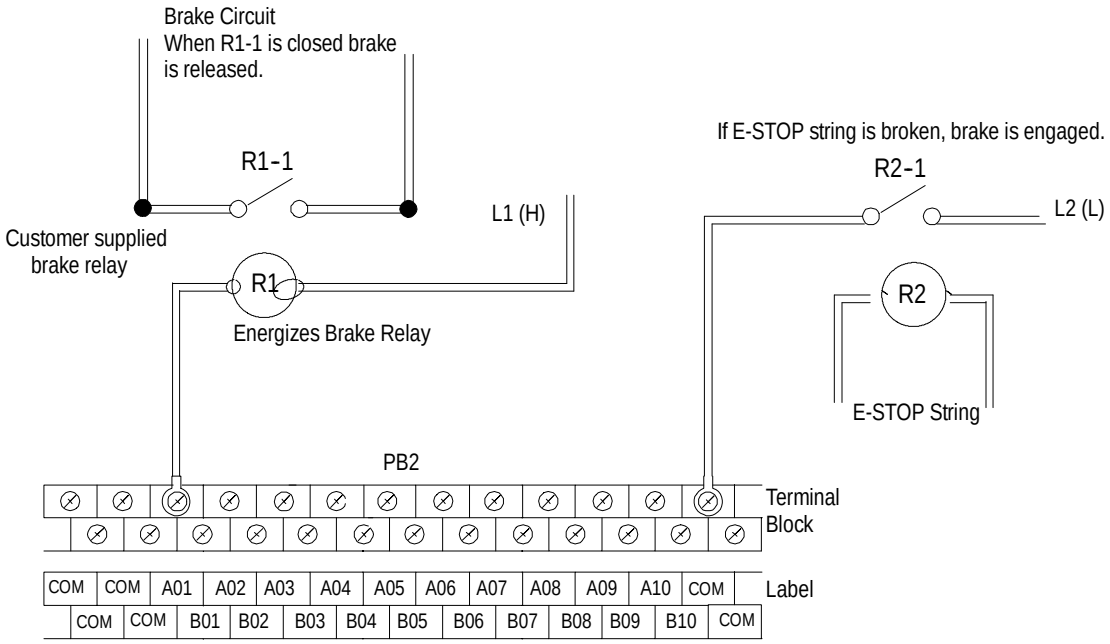
Item	Specification	Remark
Minimum Output Voltage - High	V_{OH} = 4.25V/output	-
Minimum Output Current - High	I_{OH} = 300mA/output	Source
Maximum Output Voltage - Low	V_{OL} = 0.5V/output	-
Maximum Output Current - Low	I_{OL} = 13mA/output	Sink

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10A.11 Wiring I/O Safely

Many safety issues present themselves to the machine tool builder when wiring I/O devices. Typically, 9/Series I/O devices attempt to maintain their current status in the event of a system failure, I/O ring fault, or E-STOP condition. Make sure that this is a safe state for your machine by following these guidelines.

- Make sure I/O is wired so power failure places the device in a safe condition. For example if an output point controls an axis brake, you would typically want the brake applied when the I/O device fails or loses power.
- Make sure I/O is wired so E-STOP condition places the device in a safe condition. Remember E-STOP conditions do not reset I/O devices. I/O devices attempt to maintain their last state when E-STOP occurred. For example if an output point controls an axis brake, you would typically want the brake applied when the E-STOP condition occurs.



Important: Notice in the above figure the E-STOP string only kills power to the terminal blocks of the I/O module which in turn de-energizes the brake relay. The actual I/O module on the I/O ring remains powered. Killing power to the I/O device itself while the fiber optic ring is still running can cause I/O ring fault errors.

END OF SECTION

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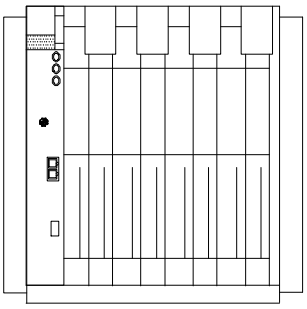
Section **10B**

9/Series Adapter Modules for 1771 and 1746 I/O Devices

10B.0 Section Overview

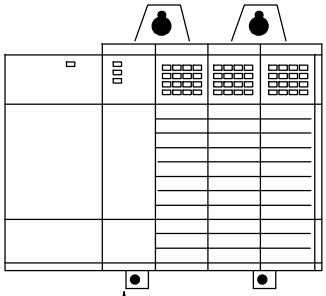
This section discusses using I/O adapter modules for the 9/Series I/O ring. These adapter modules allow you to use Allen-Bradley's 1746 I/O or 1771 I/O modules in the 9/Series I/O ring. This is accomplished by placing an adapter module in the I/O chassis that will interface to the 9/Series fiber optic I/O ring. These modules always reside in the first slot of the I/O chassis and replace the logic controller CPU or ASB adapter module that would typically reside in the first slot.

1771 Series B I/O Chassis



1771 XIOC adapter module

1746 Series B I/O Chassis



1746I adapter module

10B.1 1771 I/O Ring Adapter Module

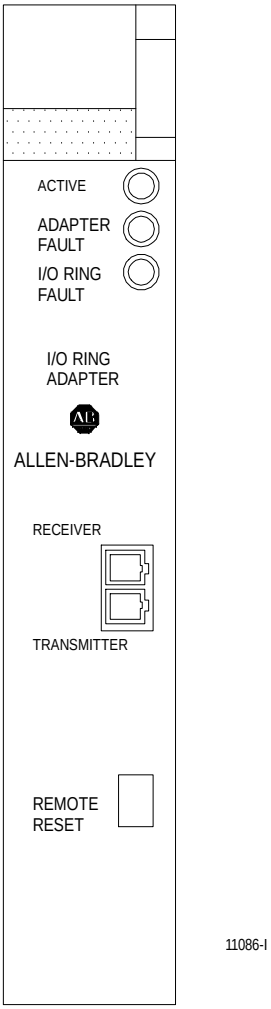
Use the 1771 I/O Ring Adapter Module to interface an Allen-Bradley 1771 series B I/O chassis with the control. The 1771 I/O ring adapter module provides the system installer with the option of using a 1771 series B I/O chassis for discrete inputs and discrete outputs to the control (only discrete I/O cards are compatible with the 1771 adapter module). Use page 10B-10 to calculate how many ASRN chips are required for each I/O chassis.

The adapter module must be placed in the first slot of the 1771 series B I/O chassis. The 1771 series B I/O chassis is then interfaced with the fiber-optic I/O ring of the control using the fiber optic connectors on the adapter module. Refer to the Allen-Bradley 1771 I/O Ring Adapter Module Product Data Sheet, publication 8500-4.5.1, for additional information on this module. No more than 16 1771 I/O adapter modules can exist on the 9/Series I/O ring.

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Figure 10B.1 shows the 1771 I/O ring adapter module.

Figure 10B.1
1771 I/O Ring Adapter



10B.1.1 1771 I/O Ring Adapter Fiber Optic Connection

The connectors used to make the fiber optic connections to the I/O ring are listed in Table 10B.A. Each module connected to the system I/O ring has an optical transmitter and receiver. Fiber optic cables connect transmitters to receivers to form the I/O ring. Refer to Appendix A for additional information on fiber optic cables and connectors.

Table 10B.A
1771 I/O Ring Adapter Fiber Optic Connectors

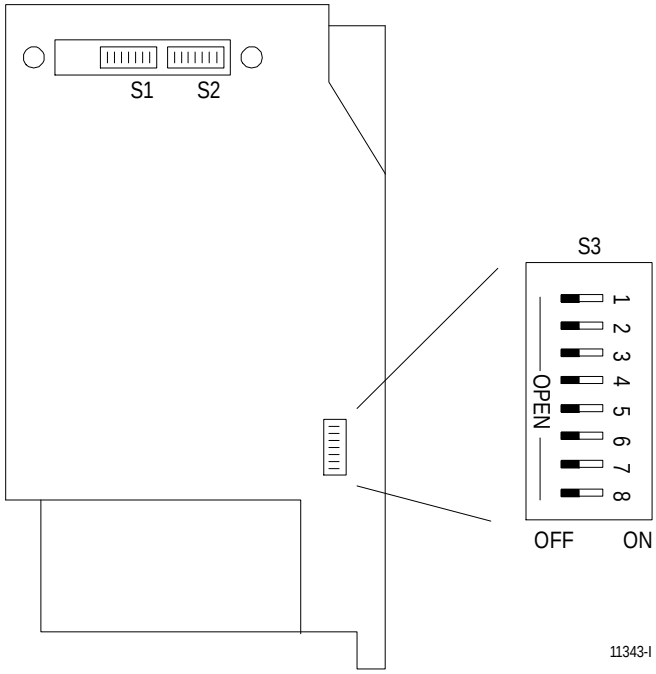
Connector on Digital I/O	Remark	Connected To
I/O (RED)	Output	Receiver on next module in I/O ring
I/O (BLACK)	Input	Transmitter on previous module in I/O ring

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10B.1.2 1771 I/O Ring Adapter Node Address Setting

Different types of I/O devices can have the same node address, but devices of the same type must each have a unique node address. Each 1771 I/O ring adapter is assigned a unique node address in the I/O assignment file of ODS. This address corresponds to a switch setting on the device itself. Up to 16 addresses are available. Figure 10B.2 shows the location of the node address switch assembly on the 1771 I/O ring module.

Figure 10B.2
1771 I/O Ring Adapter Switch Assembly Locations



Important: Switch assemblies S1 and S2 indicate which slots in the I/O chassis have modules installed and operating. Refer to the Allen-Bradley 1771 I/O Ring Adapter Module Product Data Sheet, publication 8500-4.5.1, for additional information on this module.

Set switch assembly S3 to correspond to the node address as shown in Table 10B.B.

Important: Switch numbers 7 and 8 of switch assembly S3 are not used. Their position should not be altered.

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Table 10B.B
1771 I/O Ring Adapter Node Address Setting

Node Address		Switch Assembly Position					
Hexadecimal	**Binary**	**6**	**5**	**4**	**3**	**2**	**1**
00	00 0000	OFF	OFF	OFF	OFF	OFF	OFF
01	00 0001	OFF	OFF	OFF	OFF	OFF	ON
02	00 0010	OFF	OFF	OFF	OFF	ON	OFF
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
0F	00 1111	OFF	OFF	ON	ON	ON	ON

Important: The 3D, 3E, and 3F node addresses are used for diagnostics purposes only.

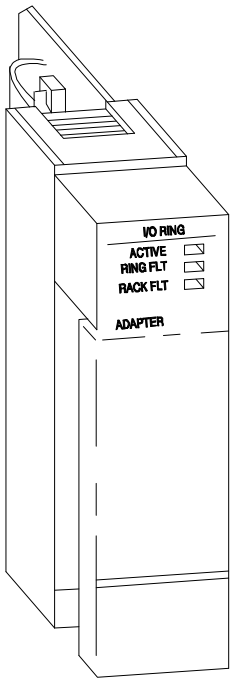
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10B.2 1746 I/O Ring Adapter Module

Use the 1746 I/O Ring Adapter Module to interface Allen-Bradley 1746 I/O devices with your 9/Series control. The 1746 I/O ring adapter module provides the system installer with the option of using 1746 I/O devices in the 9/Series fiber–optic I/O ring.

The adapter module must be placed in the first slot (slot 0) of the 1746 series B I/O chassis. The 1746 I/O ring adapter module provides the interface between the 1746 I/O chassis and the fiber-optic I/O ring of the control using the fiber–optic connectors on the adapter module.

Figure 10B.3
1746I I/O Ring Adapter



You can place several 1746I modules with 1746 I/O chassis in the 9/Series fiber-optic ring. Each 1746 I/O chassis must contain its own 1746I module (daisy chaining racks together using one 1746I module is not allowed). The number of I/O points/chassis is limited to the number of ASRN chips supported by the 9/Series fiber–optic ring. Use page 10B-10 to calculate how many ASRN chips are required for each I/O chassis. A maximum of 16 chassis are allowed on the 9/Series fiber-optic I/O ring.

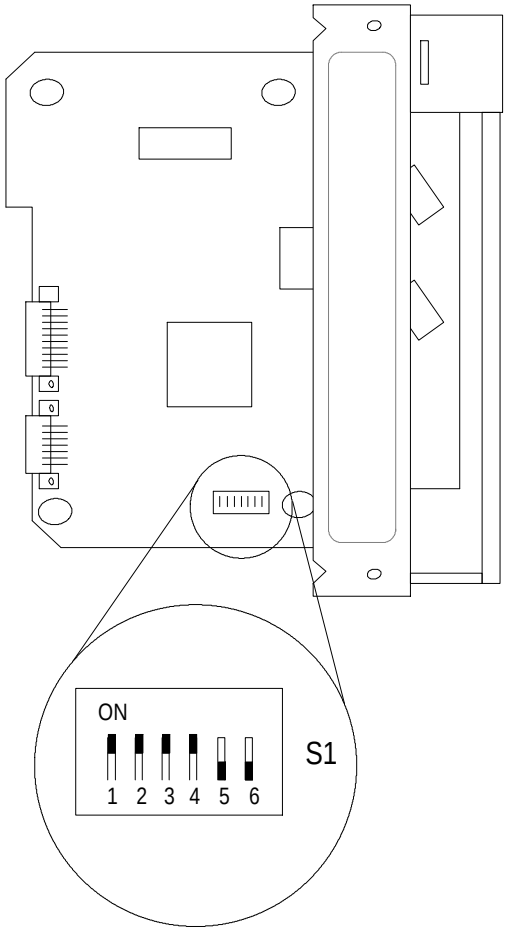
10B.2.1 1746I I/O Ring Adapter Node Address Setting

To install the 1746I module in the 9/Series I/O ring you must first assign the module an address on the 9/Series I/O ring. If the module is already installed in your 1746 I/O chassis, you must remove the module to set the module address. Remove the module by pressing in on the locking tabs on the top and bottom of the 1746I module and sliding the module out of the chassis.

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Assign an address to the module using the dip switch S1 found on the side of the 1746I module. Figure 10B.4 shows the location of the node address switch assembly on the 1746I module.

Figure 10B.4
1746 I/O Ring Adapter Switch Assembly Locations



Other 9/Series I/O devices (such as an HPG or MTB panel) on the 9/Series fiber-optic ring can have the same node address as the 1746I module. However, devices of the same type (multiple 1746I modules) must each have a unique node address. Each 1746 I/O ring adapter is assigned a unique node address in the I/O assignment file of ODS (refer to your PAL reference manual). This address corresponds to switch assembly S1 on the 1746I module.

Set switch assembly S1 to correspond to the node address as shown in Table 10B.C.

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Table 10B.C
1746I I/O Ring Adapter Node Address Setting

Node Address		Switch Assembly Position			
Hexadecimal	**Binary**	**1**	**2**	**3**	**4**
00	0000	OFF	OFF	OFF	OFF
01	0001	OFF	OFF	OFF	ON
02	0010	OFF	OFF	ON	OFF
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
0F	1111	ON	ON	ON	ON

Important: Switch 5 and 6 of S1 must remain in the OFF position for normal operation.

10B.2.2 1746 I/O Fault Status

If the 9/Series fiber optic I/O ring should fault or any other fault should occur within the 1746 I/O rack, the 1746I module will attempt to maintain all of its I/O in the same state condition. This holds all output devices in the chassis to their present state. (Outputs already ON remain ON, outputs already OFF remain OFF, and analog modules maintain their present output voltage). This does not necessarily apply if the 1746I module is the cause of the fault.

Wire your I/O devices accordingly considering all safety issues.

10B.2.3 9/Series 1746 I/O Catalogs

Three different fully equipped 1746 I/O chassis are available for the 9/Series I/O ring. See page 10A-49 for details on these I/O devices.

Catalog Number 8500-S115		**Catalog Number 8500-S24**		**Catalog Number 8500-SANL**	
(1) 1746-A4	4 Slot Chassis	(1) 1746-A4	4 Slot Chassis	(1) 1746-A4	4 Slot Chassis
(1) 1746-P1	115/230V ac Power Supply	(1) 1746-P1	115/230V ac Power Supply	(1) 1746-P1	115/230V ac Power Supply
(1) 8500-1746I	I/O Ring Interface Adapter Module	(1) 8500-1746I	I/O Ring Interface Adapter Module	(1) 8500-1746I	I/O Ring Interface Adapter Module
(2) 1746-IA16	16 point 115V ac Input Module	(2) 1746-IB16	16 point 24V dc Input Module	(1) 1746-NIO4V	Analog Module
(1) 1746-OA16	16 point 115V ac Output Module	(1) 1746-OW16	16 point 24V dc Output Module	(1) 1746-N2	2 Empty Slot Covers
(1) set fiber optic connectors	For connection to I/O ring.	(1) set fiber optic connectors	For connection to I/O ring.	(1) set fiber optic connectors	For connection to I/O ring.
Total I/O	**32 115V ac Inputs 16 115V ac Outputs 3 ASRN chips**	**Total I/O**	**32 24V dc Inputs 16 24V dc Outputs 3 ASRN chips**	**Total I/O**	**2 analog input chnls. 2 analog output chnls 6 ASRN chips**

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10B.2.4 Other Compatible 1746 I/O Modules

The following 1746 chassis and I/O modules are compatible when used with a 1746I module on the 9/Series fiber-optic I/O ring. Other modules not listed here may also be compatible. Call your Allen-Bradley sales office for details on compatibility with any 1746 I/O modules not listed here.

Catalog Number:	Description:
Chassis	
1746-A4	4-Slot Chassis
1746-A7	7-Slot Chassis
1746-A10	10-Slot Chassis
1746-A13	13-Slot Chassis
Power Supplies	
1746-P1	Power Supply (120/240V ac)(2amp @ 5V dc)(.46amp @ 24V dc)
1746-P2	Power Supply (120/240V ac)(5amp @ 5V dc)(.96amp @ 24V dc)
1746-P3	Power Supply (24V dc)(3.6amp @ 5V dc)(.87amp @ 24V dc)
120V ac Input Modules	
1746-IA4	120V ac 4 Input Module
1746-IA8	120V ac 8 Input Module
1746-IA16	120V ac 16 Input Module
240V ac Input Modules	
1746-IM4	240V ac 4 Input Module
1746-IM8	240V ac 8 Input Module
1746-IM16	240V ac 16 Input Module
24V dc Input Modules	
1746-IB8	24V dc 8 Input module (sink)
1746-IB16	24V dc 16 Input Module (sink)
1746-IB32	24V dc 32 Input Module (sink)
1746-IV8	24V dc 8 Input Module (source)
1746-IV16	24V dc 16 Input Module (source)
1746-IV32	24V dc 32 Input Module (source)
120V ac Output Modules	
1746-OA8	120V ac 8 Output Module
1746-OAP12	120V ac 12 Output Module
1746-OA16	120V ac 16 Output Module
24V dc Output Modules	
1746-OB8	24V dc 8 Output Module (source)
1746-OB16	24V dc 16 Output Module (source)
1746-OB32	24V dc 32 Output Module (source)
1746-OV8	24V dc 8 Output (sink)

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Catalog Number:	Description:
1746-OV16	24V dc 16 Output Module (sink)
1746-OV32	24V dc 32 Output Module (sink)
V ac/V dc Relay Output Modules	
1746-OW4	V ac/V dc Relay 4 Output Module
1746-OW8	V ac/V dc Relay 8 Output Module
1746-OW16	V ac/V dc Relay 16 Output Module
1746-IO4	120V ac 2 Inputs & ac/dc Relay 2 Outputs
1746-IO8	120V ac 4 Inputs & ac/dc Relay 4 Outputs
1746-IO12	120V ac 6 Inputs & ac/dc Relay 6 Outputs
Analog I/O Modules	
1746-NI4	Analog 4 Input Module (-20ma to +20ma) or (-10V dc to +10V dc)
1746-NIO4I	Analog 2 Inputs (-20ma to +20ma) or (-10V dc to +10V dc) & 2 Outputs (0 to 20ma)
1746-NIO4V	Analog 2 Inputs (-20ma to +20ma) or (-10V dc to +10V dc) & 2 Outputs (-10V dc to + 10V dc)
1746-NO4I	Analog 4 Output Module (0 to 20ma)
1746-NO4V	Analog 4 Output Module (-10V dc to +10V dc)
Specialty I/O Modules	
1746-IG16	5V dc/TTL 16 Input Module (source)
1746-OG16	5V dc/TTL 16 Output Module (sink)
1746-OBP16	24V dc 16 Output Module (enhanced source)
1746-IN16	24V ac/V dc 16 Input Module (source)
1746-OX8	ac/dc Isolated Relay 8 Output Module

Important: To configure a 12-bit I/O module using the I/O assignments application, you must select a 16-bit device, while only assigning the first 12 I/O points.

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10B.2.5 Troubleshooting the 1746I Communication Module

This section provides diagnostic information for troubleshooting your 1746 I/O chassis using the LEDs on the front of the 1746I module. Also in this section is information on using test modes to diagnose any problems with the fiber-optic connections.

○ OFF **This LED Status** ● ON ◍ Flashing	**Indicates this possible cause:**
 Run LED On	· The I/O ring and the 1746 I/O rack are communicating properly and the rack is functioning.
 Rack LED On	· RAM or ROM failure at power turn on. · Device in rack failed or is not seated properly. · Internal error in the 1746I adapter.
 Rack LED Flashing	· A card type was found in the rack at power turn on that is not supported by the 1746I module.
 Ring LED On	· Connection or device has failed in the I/O ring for a device before the 1746I in the ring. · Power turned off at the CNC. · Transmitter and receiver cables are reversed.
 Ring LED Flashing	· Connection or device has failed in the I/O ring for a device after the 1746I in the ring.
 All LEDs Off	· Power turned off at the CNC while the ring was up and running. · Connection of I/O ring broken before this 1746I module while the ring was up and running.

10B.3 1771 and 1746 I/O adapter ASRN Use

Use this section to calculate the number of ASRN chips used by the 1771 or 1746 I/O chassis in your system. Each chassis uses a different number of ASRN chips depending on the size of the chassis and the number and types of I/O devices in the chassis.

Each different 9/Series control supports a limited number of ASRN chips on its I/O ring. Refer to Table 10A.B for the number of ASRN chips supported on the ring for your specific 9/Series processor.

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The following section describes how to calculate how many ASRN chips are used by either the 1771 or 1746 I/O devices. Refer to page 10A-2 for information on the number of ASRN chips used by other 9/Series I/O ring devices.

ASRN Chip Used by 1771 and 1746 I/O Chassis

The number of ASRN chips used by a 1746 or 1771 I/O chassis will vary depending on the chassis size and the number and type of I/O cards installed in the chassis. Different size chassis have a minimum number of ASRN chips required (regardless of the number of I/O points) and different I/O devices in the chassis require different numbers of ASRN.

To determine the number of ASRN "chips" used by the I/O chassis in a specific I/O ring application, use the following procedure:

1. Determine "A", the minimum chassis ASRN requirements:

1746 I/O Chassis		1771 I/O Chassis	
Chassis Size:	**Minimum number of ASRN chips:**	**Chassis Size:**	**Minimum number of ASRN chips:**
4 slot (1746-B4)	A = 3	4 slot	A = 3
7 slot (1746-B7)	A = 4	8 slot	A = 5
10 slot (1746-B10)	A = 6	12 slot	A = 7
13 slot (1746-B13)	A = 7	16 slot	A = 8

2. Calculate "B" chassis input requirements:

$$\frac{\text{(discrete inputs) + (16)(number of analog input channels)}}{11} = \text{B (round up)}$$

3. Calculate "C" chassis output requirements:

$$\frac{\text{(discrete outputs) + (16)(number of analog output channels)}}{6} = \text{C (round up)}$$

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Important: Each analog channel on an analog module must be counted. Even if the channel is not used or jumpered out it must be counted as a channel on the ring.

The largest of A, B, or C determines the total number of ASRN "chips" for the 1746 and 1771 I/O configuration.

Example: A 1746 4-slot chassis, one 16-point input card, one 8-point output card, and an analog module with two input and two output channels (1746-NIO4V).

A = 4 slot chassis = (3 ASRN)

$$B = \frac{(16) + (16)(2)}{11} = 4.36 \text{ (5 ASRN)}$$

$$C = \frac{(8) + (16)(2)}{6} = 6.66 \text{ (7 ASRN)}$$

The 1746 chassis in this example will use 7 ASRN "chips" (the largest value of A, B, or C).

The number of ASRN "chips" used by the chassis must be added to the total number of ASRN "chips" used by all the I/O devices on the current I/O ring. Refer to page 10A-2 for information on the number of ASRN chips used by other 9/Series I/O ring devices.

Important: The total number of ASRN chips allowed on the fiber optic ring is shown in Table 10A.B for each processor type. Exceeding this number creates an E-STOP condition. Since your system scan time is configurable in AMP it is possible to set the system scan time so low that the control will not complete the I/O scan of all the ASRNs in your ring. When this occurs old data may be made available to PAL. On systems with large I/O rings and low system scan times, the PAL flag $RNGS should be used to test if the system has completed the I/O scan and made all the necessary ring I/O updates.

END OF SECTION

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9/Series Hardware
TAB 11

1394 Digital Drive Systems



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Section 11A

Connecting 1394 Digital Drive Systems

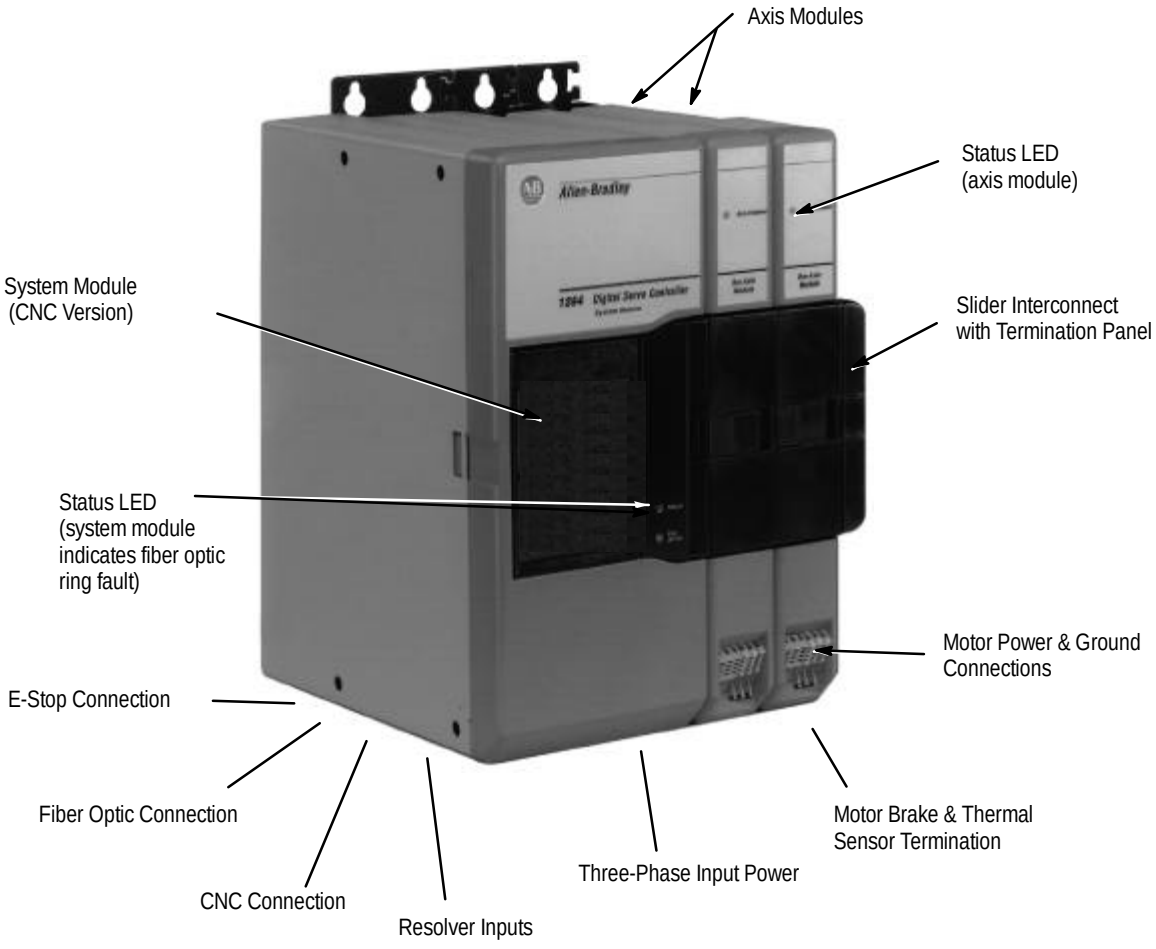
11A.0 Section Overview

This section gives general information on connections to the CNC version of the Allen-Bradley 1394 Digital Drive. More detailed information can be found in the 1394 Digital AC Multi-Axis Motion Control System Users Manual (publication 1394-5.0).

This drive is designed to interface to the Allen-Bradley 9/230 1394 Digital CNC or 9/260, 9/290 1394 4 axis digital servo cards (8520-SM4). This section does not discuss connecting to an analog version of the 1394 drive system nor does it discuss general 1394 drive installation/connection. This section only covers connection to the 9/Series CNC.

11A.1 Hardware Overview

The 1394 Digital Drive (CNC version) consists of the following major components:



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- System Module – This is the largest module in the 1394 Digital Drive system (left most module). It contains the following circuit boards:

  - CNC Interface Board – This board provides the interface to the Allen-Bradley 9/230 Digital 1394 CNC. Drive commands from the CNC are wired to this board. Feedback from the 1326 motor resolver is passed to the CNC through this board after being converted from the 1326 motor resolver signal into encoder type A quad B and U/V/W. Fiber optic connection to the 9/Series fiber optic I/O ring is provided through this board.

  - CNC Wiring Board – The 1326 motors' resolver is wired to this board which also provides power for resolver excitation. The Drive OK relay contacts are also available on this board for connection to the 9/Series E-Stop string.

  - Power Supply – This supplies power to the system module as well as the axis modules. Attach incoming AC three-phase power here.



- Axis Module - Connect up to four axis modules to the 1394 system. Axis modules convert the DC power supplied by the system module to a variable AC voltage (460V AC input provides 460 AC out, derated 380V AC input provides 380V AC out). This voltage will have controlled phase, amplitude and frequency for regulating the speed, torque and direction of the 1326 AC Servomotors. The axis modules are available in a wide range of power ratings with continuous peak capabilities of 200% of continuous rating for short durations.

  Make motor connections for power, ground, brake, and thermal sensor to each axis module. Each motor is wired to its own axis module.



- 1326 motors are described in the 1394 Digital AC Multiaxis Motion Control System Users Manual. The 1326 series of motors operate at either 460V AC or 380V AC. Connection of these motors is made directly to the Axis Module.

  Each 1326 motor is equipped with a resolver for motor commutation. Resolvers are connected to the Wiring Board found in the system module. Resolver signals are converted to a A quad B and U/V/W encoder type signal on the CNC interface board before they are sent to the CNC.

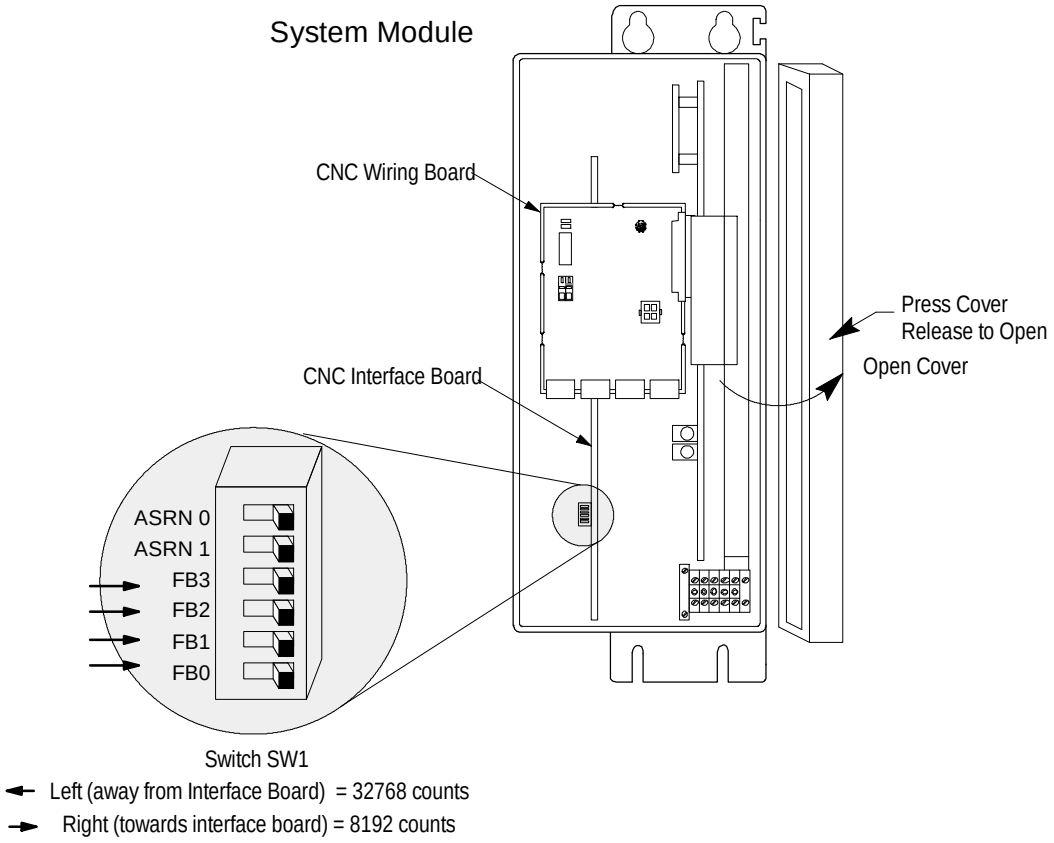
For details/dimensions/specification/etc. on any of these components, refer to your 1394 Digital AC Multi-Axis Motion Control System Users Manual.

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11A.2 Resolver Feedback

The 1326 servo motors that interface to the 1394 drive rely on resolvers mounted directly to the motor for proper commutation. For these resolvers to be properly interfaced to the 9/Series CNC their feedback must be converted to an A quad B signal. This is accomplished by the CNC interface board which takes the resolver feedback from the wiring board and converts it into an A quad B signal before sending this signal on to the 9/Series CNC.

A dip switch (SW1) on the CNC interface board determines the number of encoder counts per revolution this resolver feedback is translated into. The bottom four switches of dip switch SW1 selects between 8192 or 32768 counts per motor revolution as follows:



These switches set the number of counts per/rev for each feedback device connected to this 1394 drive. CNC1 corresponds to the feedback device connected to FB0, CNC2 corresponds to the feedback device connected to FB1, etc.. You must also indicate your dip switch selections by selecting the appropriate number of counts per motor revolution in AMP for each servo.

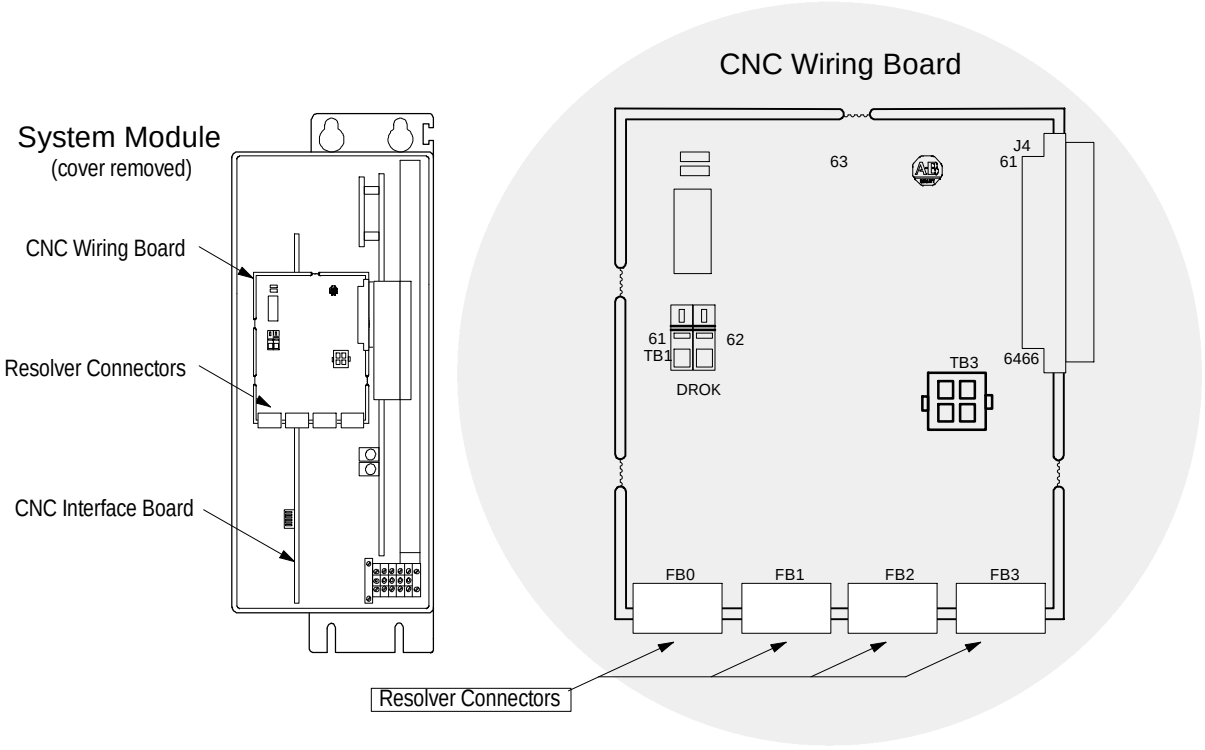
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Maximum Axis Speeds

Maximum axis speeds are limited by the CNC interface boards ability to decode resolver feedback and convert it into encoder A quad B feedback. The maximum motor RPM when set for 32768 counts/rev is 3000 RPM. Actual final axis speed is based on gearing and lead screw pitch. Exceeding this motor speed can result in feedback overflow on the CNC interface board and a feedback error will be generated.

Connecting Resolver Feedback

Resolver feedback is wired directly from the motor mounted resolver to the CNC wiring board found in the system module. This cable can be purchased directly from Allen-Bradley (cat no 1326-CCU-xxx).



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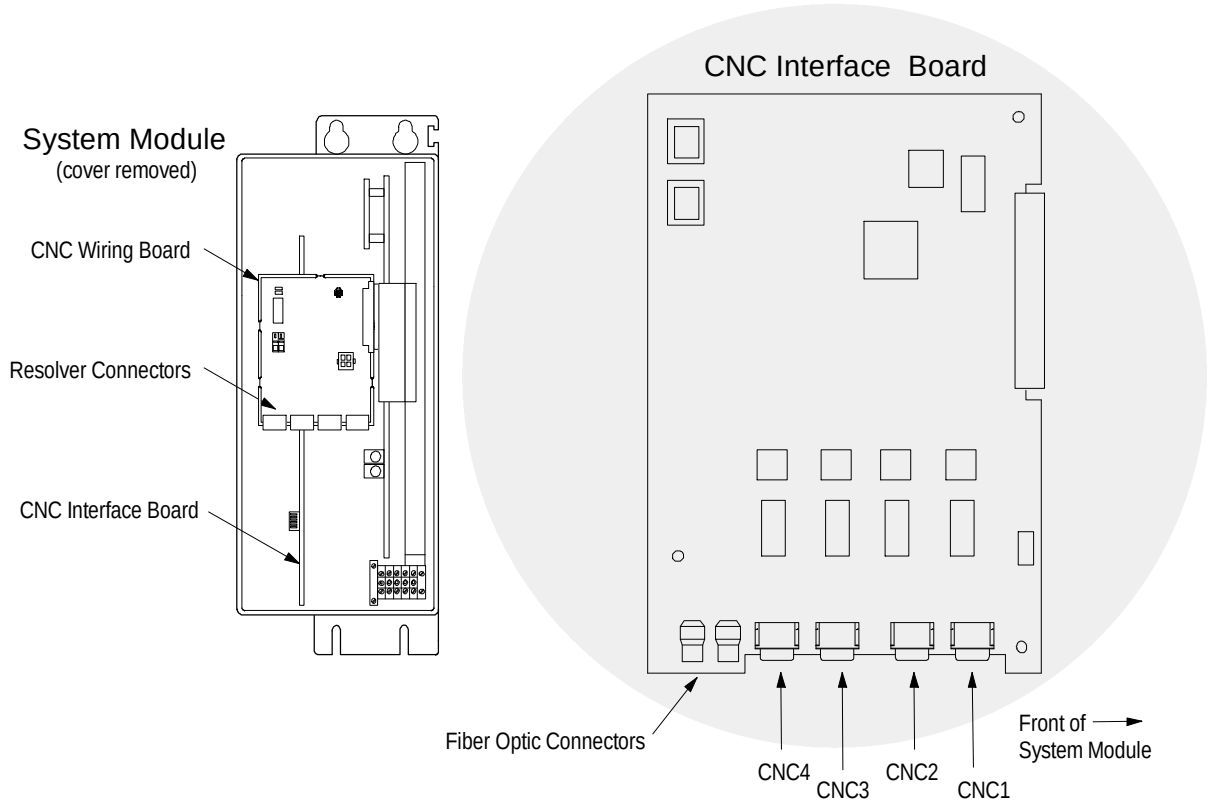
We recommend wiring feedback as follows:

Resolver (attached to motor from axis module):	Connect to feedback board:	Outputs A quad B to CNC interface board:
1 (slot zero in AMP)	FB0	CNC 1
2 (slot one in AMP)	FB1	CNC 2
3 (slot two in AMP)	FB2	CNC 3
4 (slot three in AMP)	FB3	CNC 4

11A.3 Connecting the 9/Series

Connect your 9/Series CNC directly to the 1394 system module using Allen Bradley cable 8520-DSC. This cable carries drive signals from the 9/Series CNC to the 1394 drive system. It also returns motor feedback to the CNC from the resolvers (after it has been converted to A quad B on the CNC interface board). Cable connections are made easily through the bottom of the system module.

Connect this cable between the CNC interface board (connectors CNC1 to CNC4) and either the 1394 digital 9/230 (connectors J1 to J3) or the four axis 1394 digital servo card on the 9/260 or 9/290 (connectors J1 to J4).



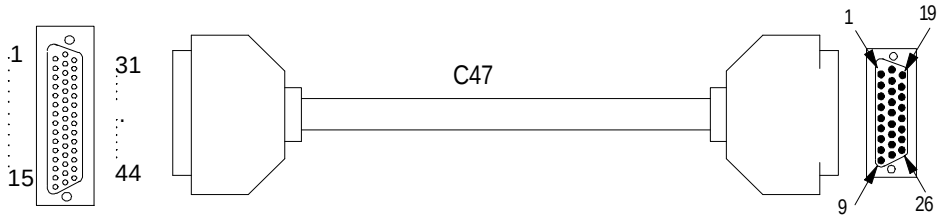
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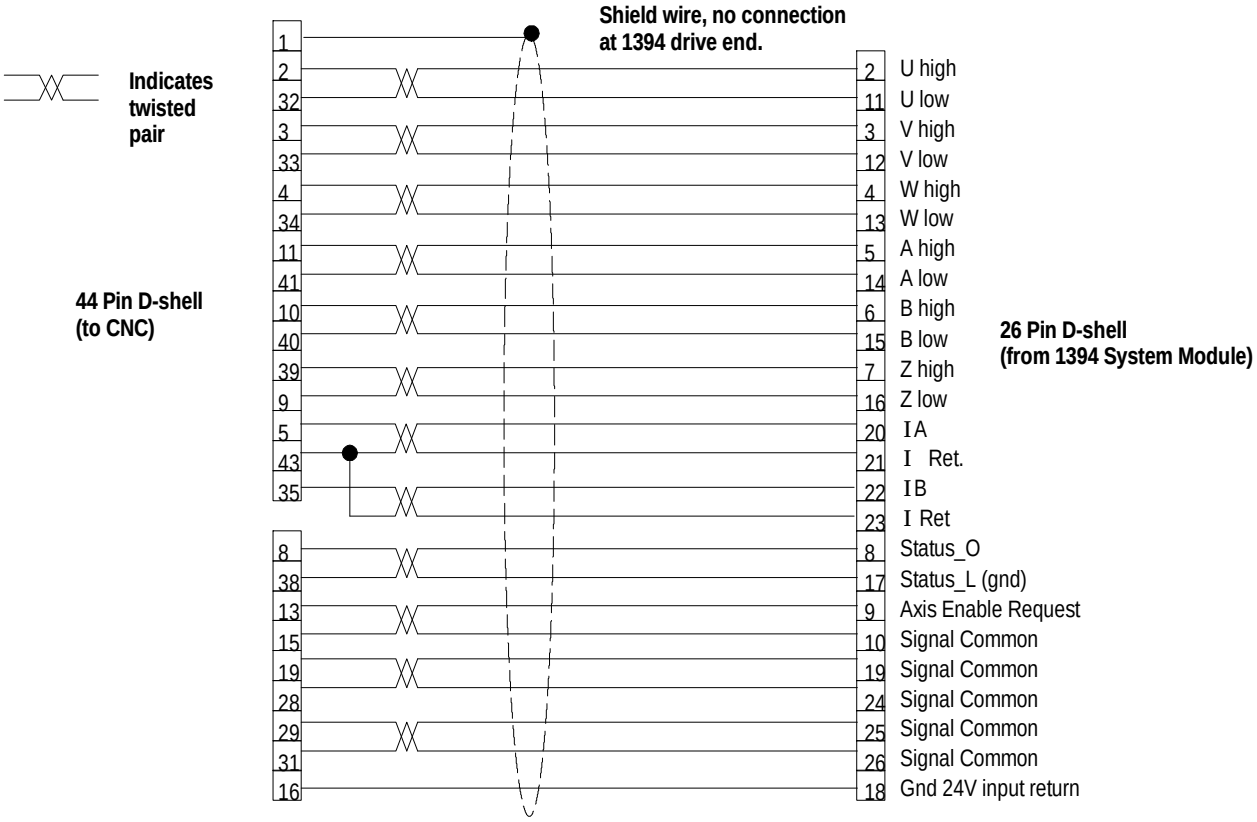
Each of these CNCx connectors on the CNC interface board corresponds to the motor and feedback device (if the feedback is wired to the CNC wiring board correctly) of the axis module (x). For example CNC1 is used for axis module 1 and FB0. CNC2 is for axis module2 and FB1. Ultimately the connector and feedback combinations you decide to use for each axis is configured in AMP however we recommend the following configuration:

Axis Number	CNC Interface Board	Four Axis 1394 Digital Servo Card	1394 Digital 9/230 CNC
1	CNC 1	J1	J1
2	CNC 2	J2	J2
3	CNC 3	J3	J3
4	CNC 4	J4	N/A

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The CNC interface cable, 8520-DSC, terminates with a 44 pin miniature D-shell at the CNC and a 26 pin D-shell at the 1394 CNC interface board. This cable is 27 inches long. Pinouts are shown below:





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11A.4 1394 Addressing and Fiber Optic Connections

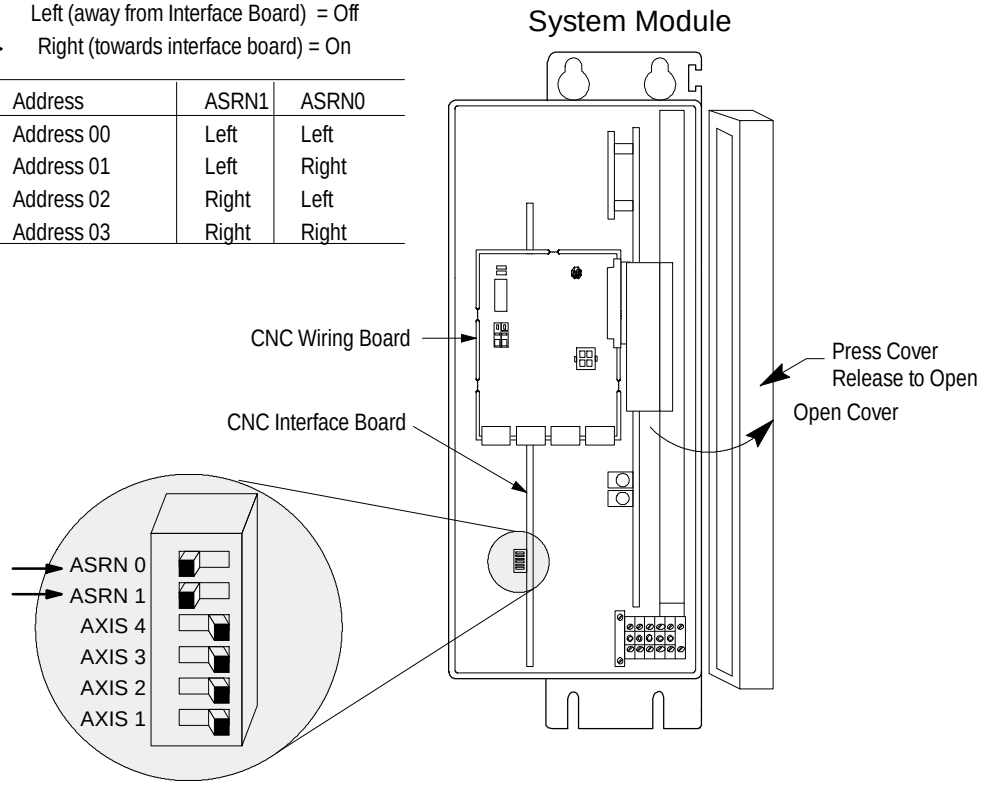
The 1394 digital drive **must** be placed in the 9/Series fiber optic ring. Configure this drive into the I/O ring using the I/O configuration utility as discussed in your 9/Series PAL Reference Manual. Since multiple 1394 drives (up to four) are allowed into the 9/Series I/O ring each drive must be given an independent ASRN address on the ring. This ASRN ring address is selected using a dip switch on the CNC interface module.

Switch SW1

← Left (away from Interface Board) = Off

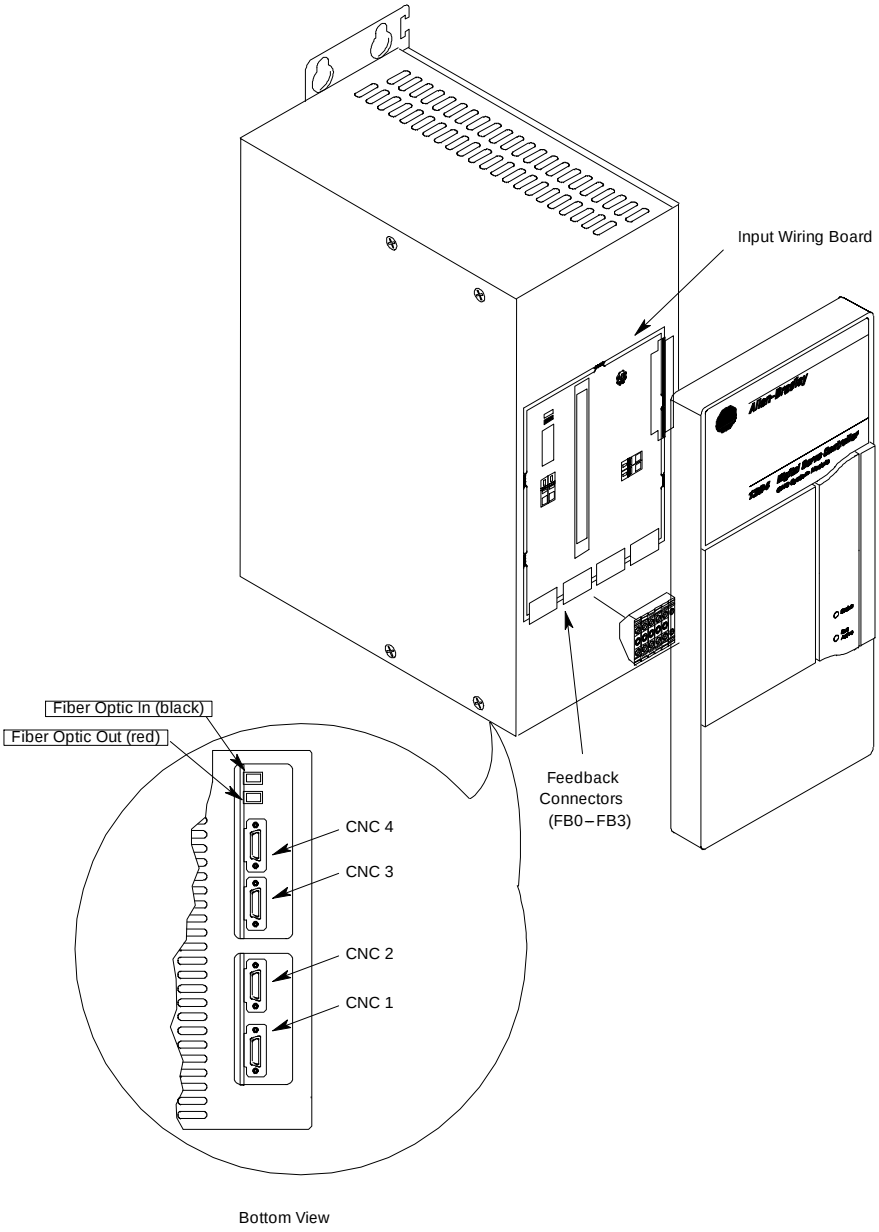
→ Right (towards interface board) = On

Address	ASRN1	ASRN0
Address 00	Left	Left
Address 01	Left	Right
Address 02	Right	Left
Address 03	Right	Right



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The 1394 digital drive receives configuration information through the 9/Series fiber optic ring. The drive also has the ability to pass drive error and status back to the CNC through this fiber optic connection. Connections to the fiber optic ring are made on the bottom of the system module to the back of the CNC interface board. Refer to NO TAG for details on constructing fiber optic cables.



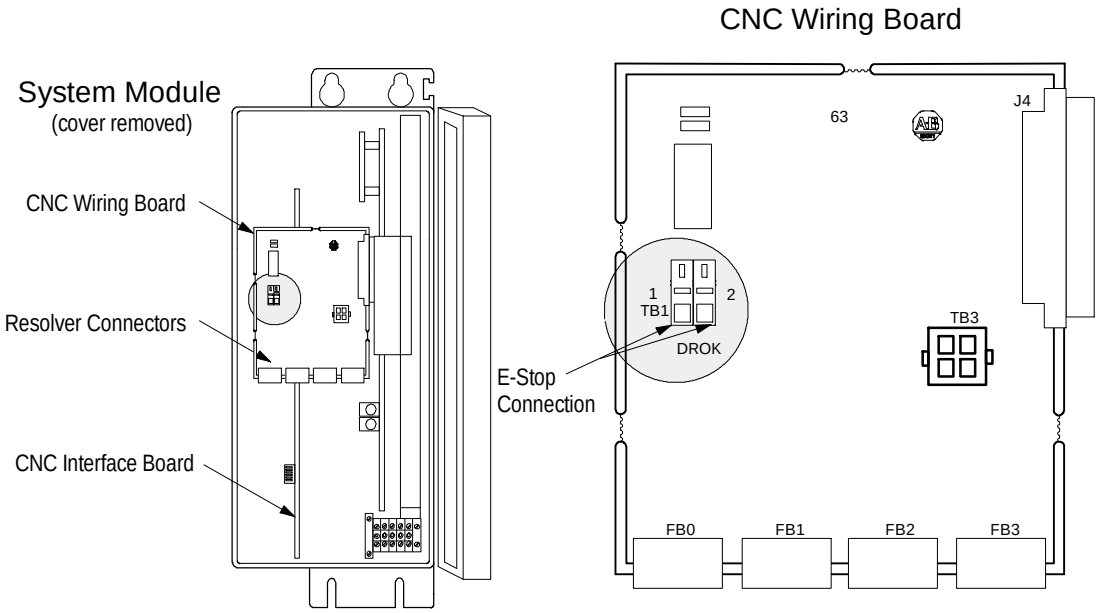
Important: I/O ring diagnostics for the 1394 Digital Drive is available and discussed on page 15A-29.

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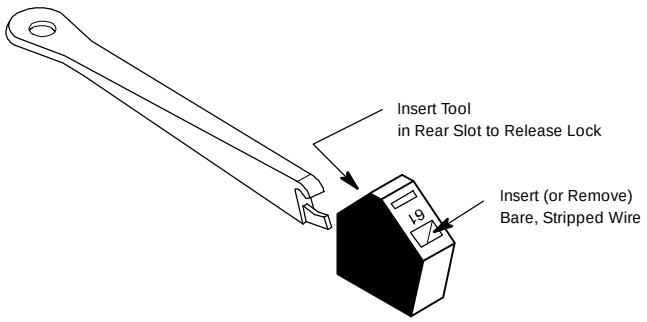
11A.5 1394 Drive E-Stop Connection (TB1)

E–Stop connection is made to the 1394 CNC wiring board drive okay contactor (TB1 DROK). This relay contact is closed when 24V drive power (W1, W2) is applied and no faults are present on the drive. This relay is opened when a drive fault occurs or 24V drive power is lost.

DROK Specs.
115V AC/24V DC
1Amp (Inductive Load)

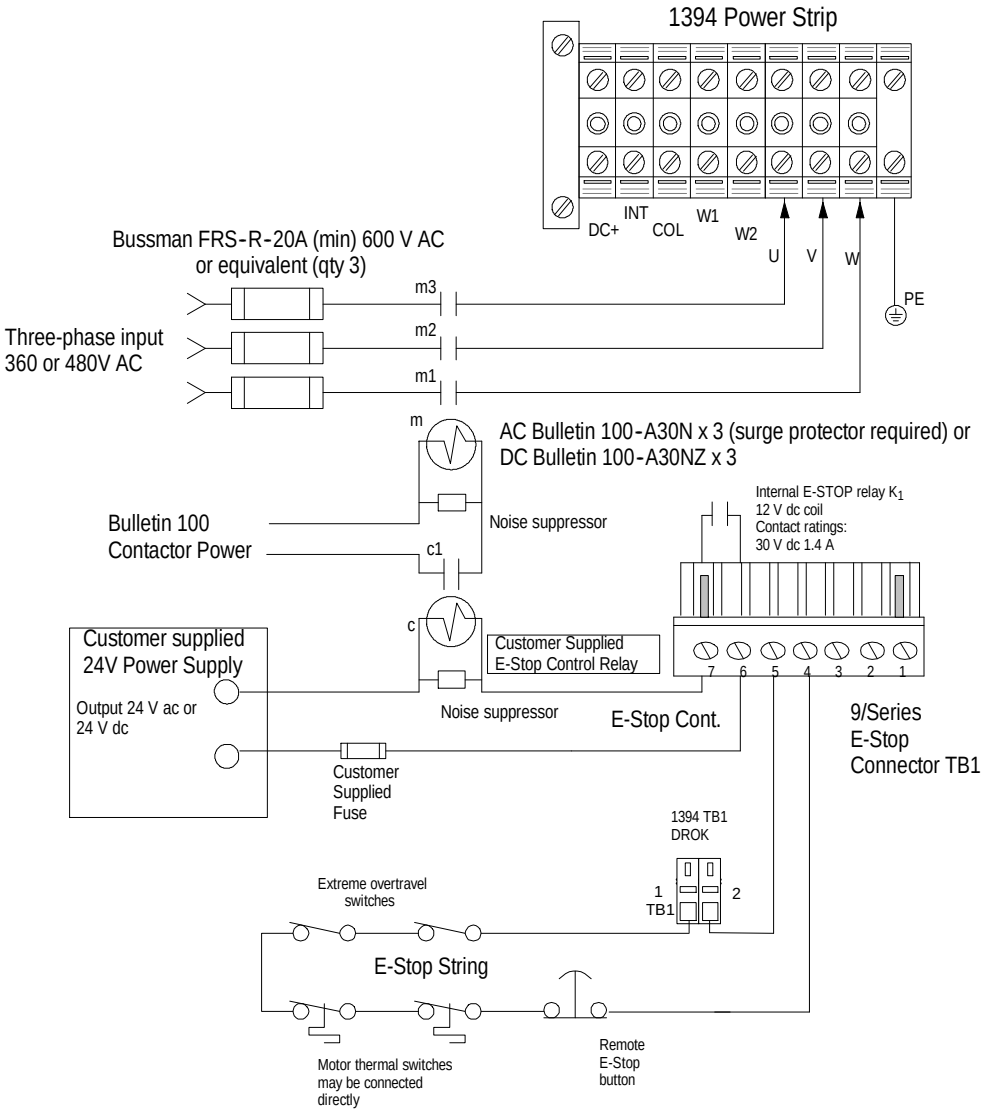


Important: To help you insert and remove wires on the Input Wiring Board, the supplied "Terminal Block Operating Tool" (pictured below) should be used as shown.



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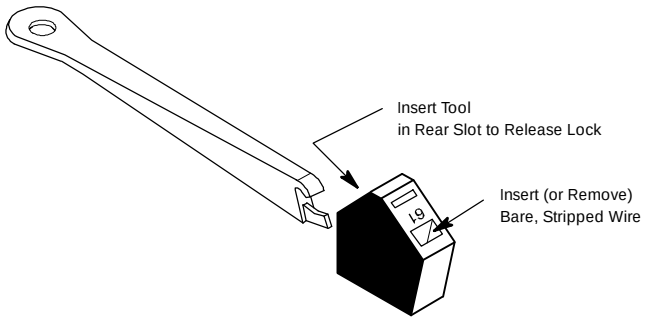
Figure 11.5
Recommended Connection of 3-phase Drive Power



ATTENTION: Brake control should not be directly released by the E-Stop status relay (or your customer supplied E-Stop control relay). Brakes should only be released by the PAL logic when it has determined that three phase power is available to the axis modules long enough for the motors to have sufficient power to hold position and the control is out of E-Stop.

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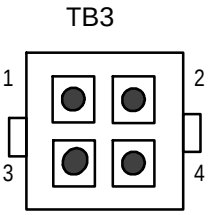
Important: To help you insert and remove wires on the Input Wiring Board, the supplied "Terminal Block Operating Tool" (pictured below) should be used as shown.

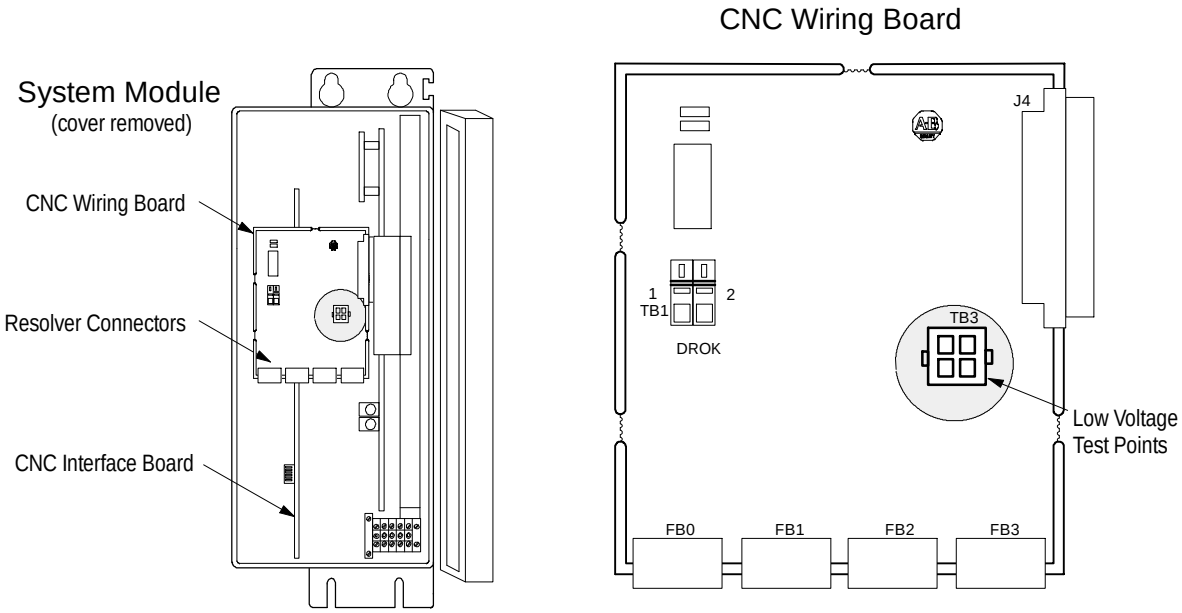


11A.6 1394 Low Voltage Test Points (TB3)

TB3 contains four test points used for testing power supply voltage on the CNC interface board. Test voltages are as follows:

TB3 Test Point	Voltage
TB3-1	+5V dc
TB3-2	Common
TB3-3	+15Vdc
TB3-4	-15Vdc





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If the correct voltages are not present at these test points, and incoming power to the drive is turned on, contact your local Allen-Bradley sales office for service information.

11A.7 1394 LEDs

Two sets of LEDs are available on the 1394 drive CNC interface. One on the system module, and one on each axis module.

System Module LED

The system module LED (labeled STATUS) is used to indicate the status of the fiber optic I/O ring. If the LED is on (red) the fiber optic ring has failed at some point before the 1394 system module. If it is flashing, the fiber optic ring has failed at some point after the 1394 system module.

Axis Module LED

Each axis module has one LED visible from the front of the module (labeled STATUS). Read this LED as follows:

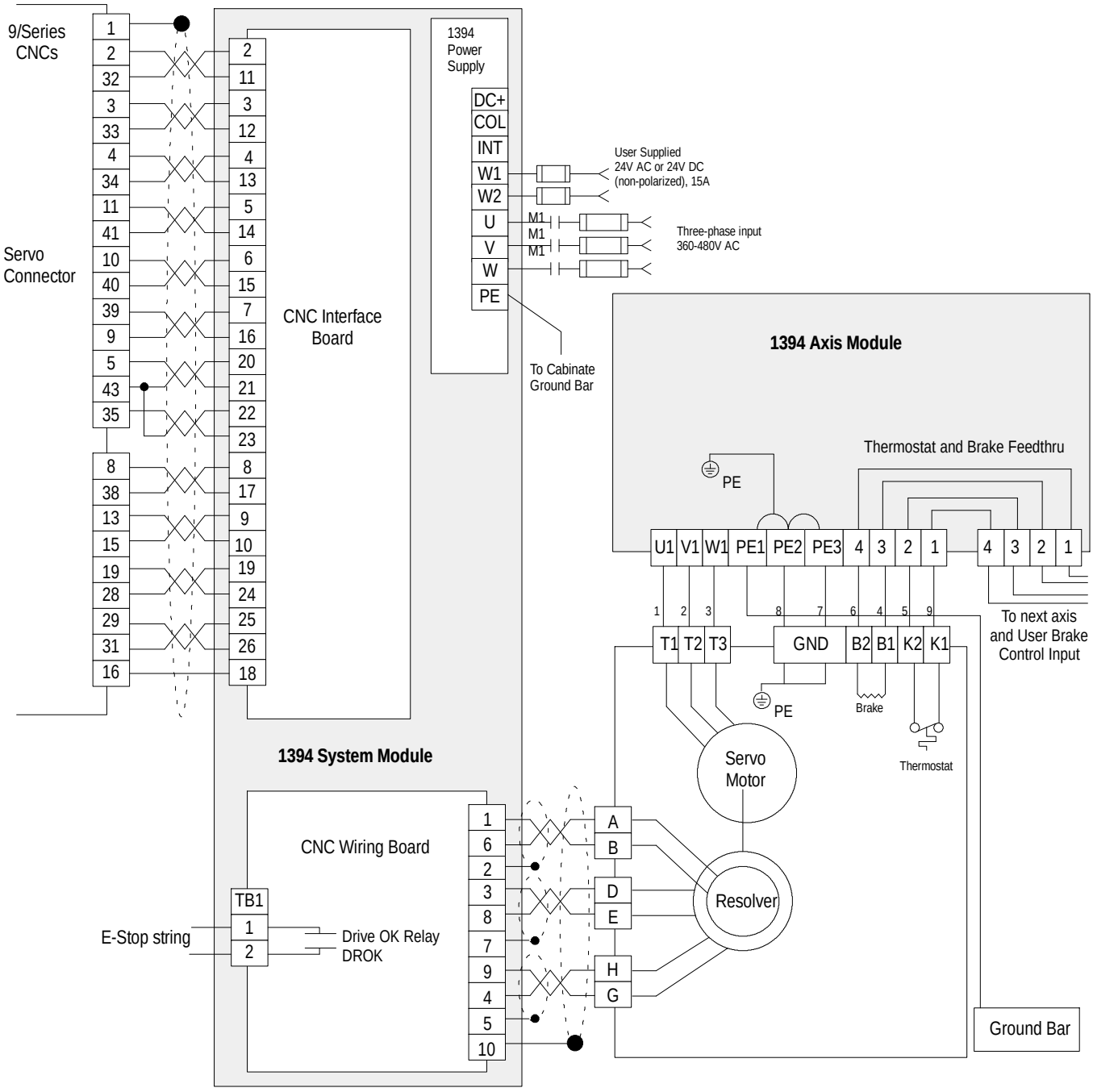
Steady Green	bus up, axis enabled
Flashing Green	bus up, axis not enabled
Flashing Red/Green	ready, bus not up
Flashing Red	fault present
Steady Red	hardware malfunction

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11A.8 General Wiring Overview

The following figure shows a typical interconnect diagram for a 9/Series CNC to a 1394 drive. Note this figure only illustrates one servo connection, each 1394 drive can support up to four servos.

Figure 11.1
Wiring Diagram For Series 1394 Drives



END OF SECTION

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9/Series Hardware
TAB 12

Analog Servo Drive Connection



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Section 12

Wiring A-B Analog Drives

12.0 Section Overview

This section discusses the wiring of Allen-Bradley Analog servo drive amplifiers. This manual is not intended to be used in place of documentation that accompanies an A-B drive but should be used with such documentation. The following table lists the Allen-Bradley drives supported by the control that are covered in this section.

Table 12.A
A-B Drives Selection Guide References

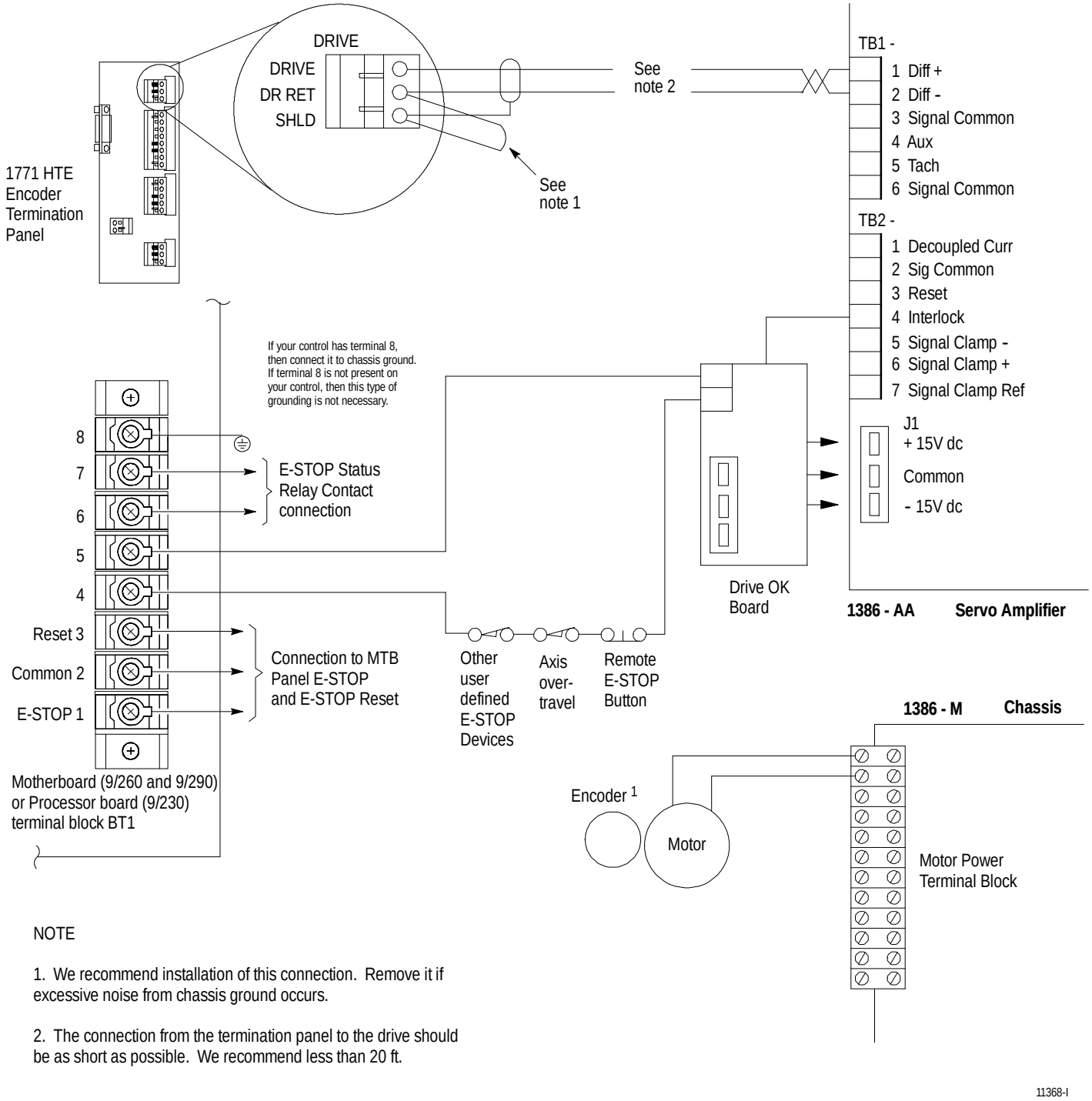
A-B Drive	Publication No.	Figure No.	Title
1386	1386-5.0	Figure 12.1	DC PWM Servo Drive (Multi-Axis)
1387B	1387-5.0	Figure 12.2	DC Spindle Drive (Analog) Product Data
1388	1388-5.1	Figure 12.3	DC PWM Servo Drive (Single Axis) Product Data Series B
1389	1389-5.1	Figure 12.5	AC Servo Amplifier (Multi-Axis) Product Data
1391	1391-5.0	Figure 12.6	AC Servo Amplifier (Single Axis) Product Data
1392	1392-5.1	Figure 12.4	High Performance AC Drive (460V and 230V) Product Data

For digital drive systems, refer to sections beginning on page 13A-1 (for 8520 systems) or page 11A-1 (for 1394 systems). For non A-B analog drives, refer to documentation prepared by the drive manufacturer along with the analog specifications given in this manual for your specific processor.

The figures in this section emphasize the wiring between the termination panel and E-STOP string to the drives. They do not show complete detailing of the drives. You should have your drive manual handy when you use these figures.

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Figure 12.1
Wiring Diagram for Series 1386 Drives



NOTE

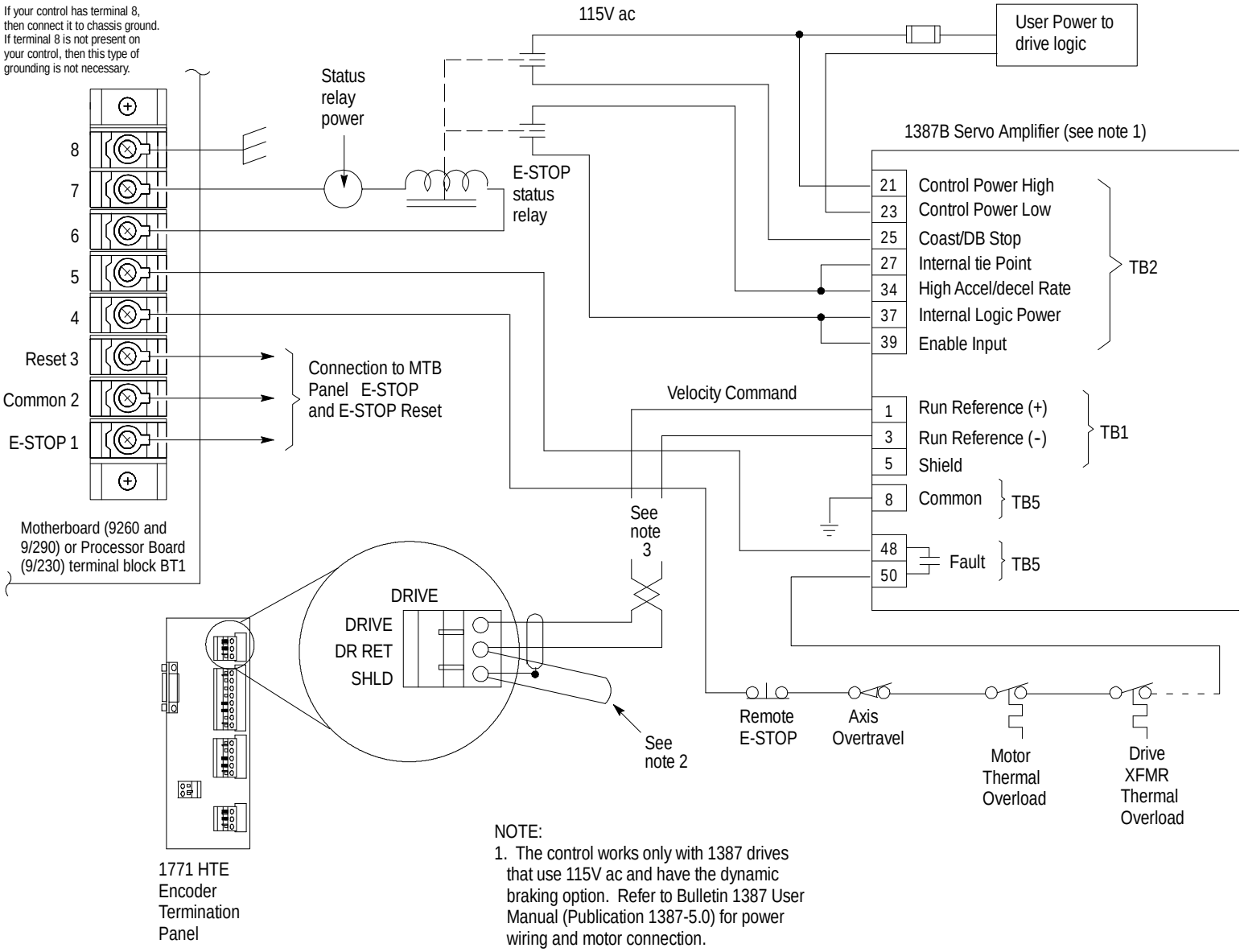
1. We recommend installation of this connection. Remove it if excessive noise from chassis ground occurs.

2. The connection from the termination panel to the drive should be as short as possible. We recommend less than 20 ft.

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Figure 12.2
Wiring Diagram For Series 1387B Drives



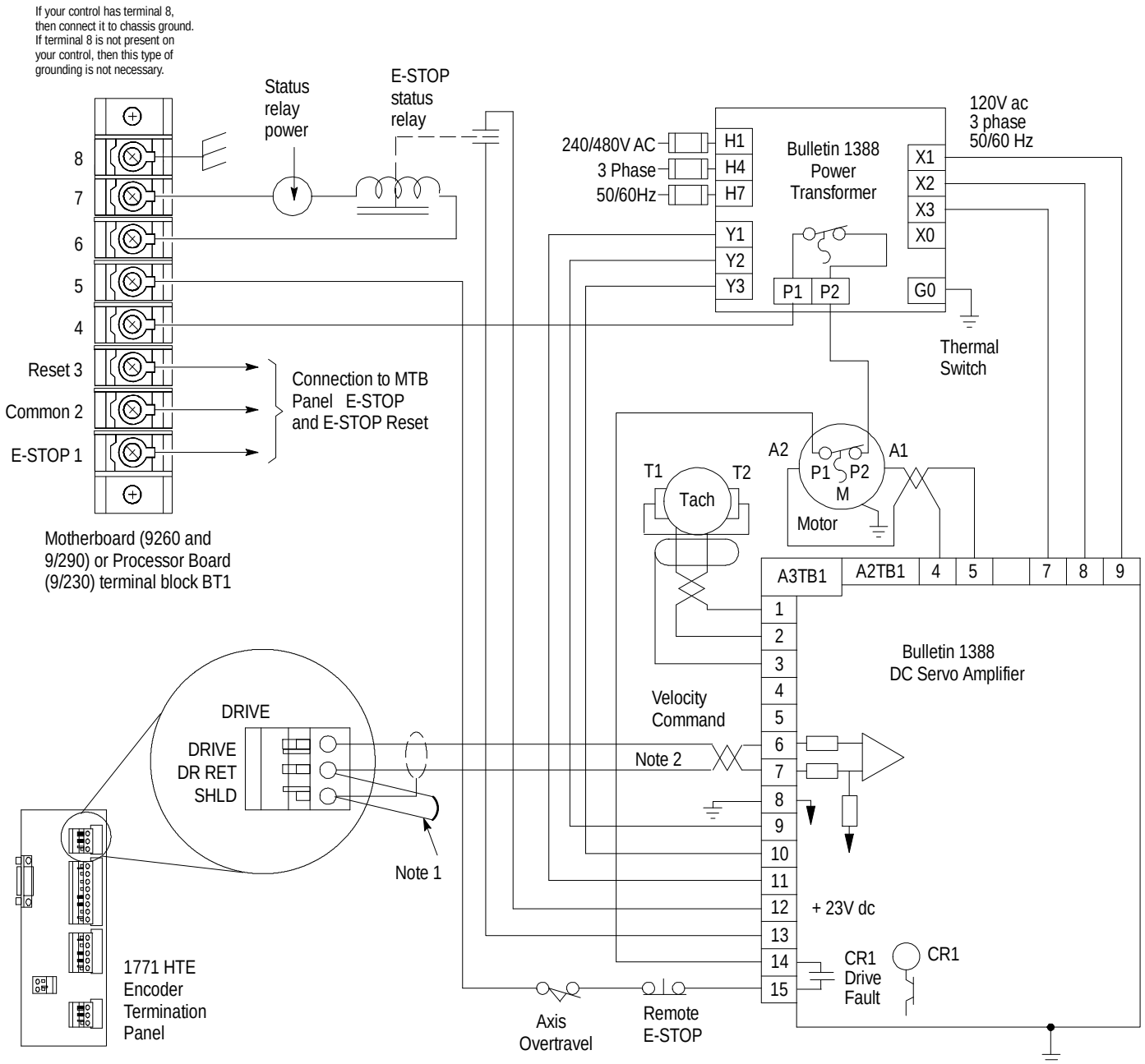
NOTE:
1. The control works only with 1387 drives that use 115V ac and have the dynamic braking option. Refer to Bulletin 1387 User Manual (Publication 1387-5.0) for power wiring and motor connection.

2. We recommend installation of this connection. Remove it if excessive noise from chassis ground occurs.

3. The connection from the termination panel to the drive should be as short as possible. We recommend less than 20 ft.

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Figure 12.3
Wiring Diagram For Series 1388 Drives

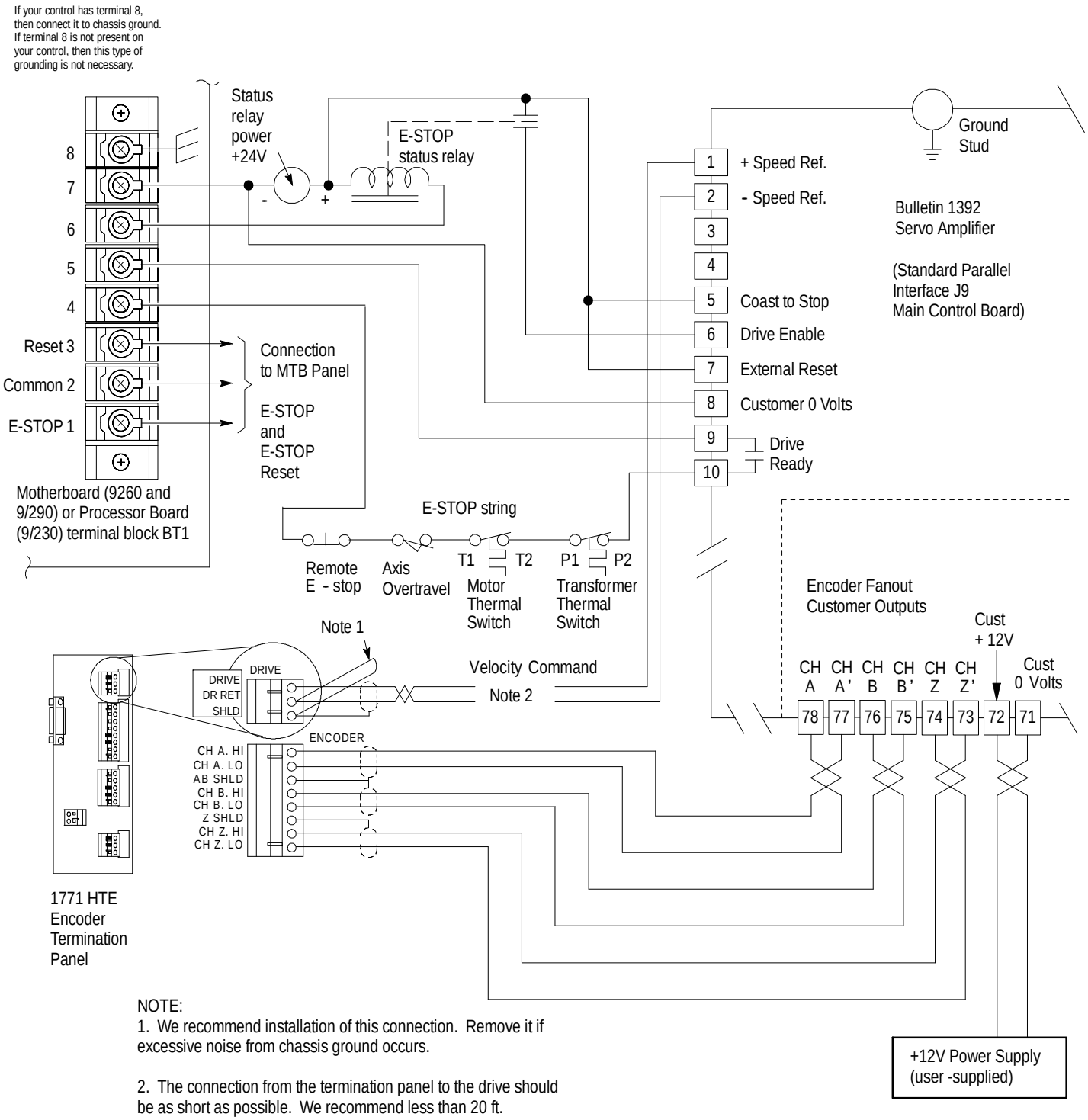


NOTE:
1. We recommend installation of this connection. Remove it if excessive noise from chassis ground occurs.

2. The connection from the termination panel to the drive should be as short as possible. We recommend less than 20 ft.

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Figure 12.4
Wiring Diagram For Series 1392 Drives

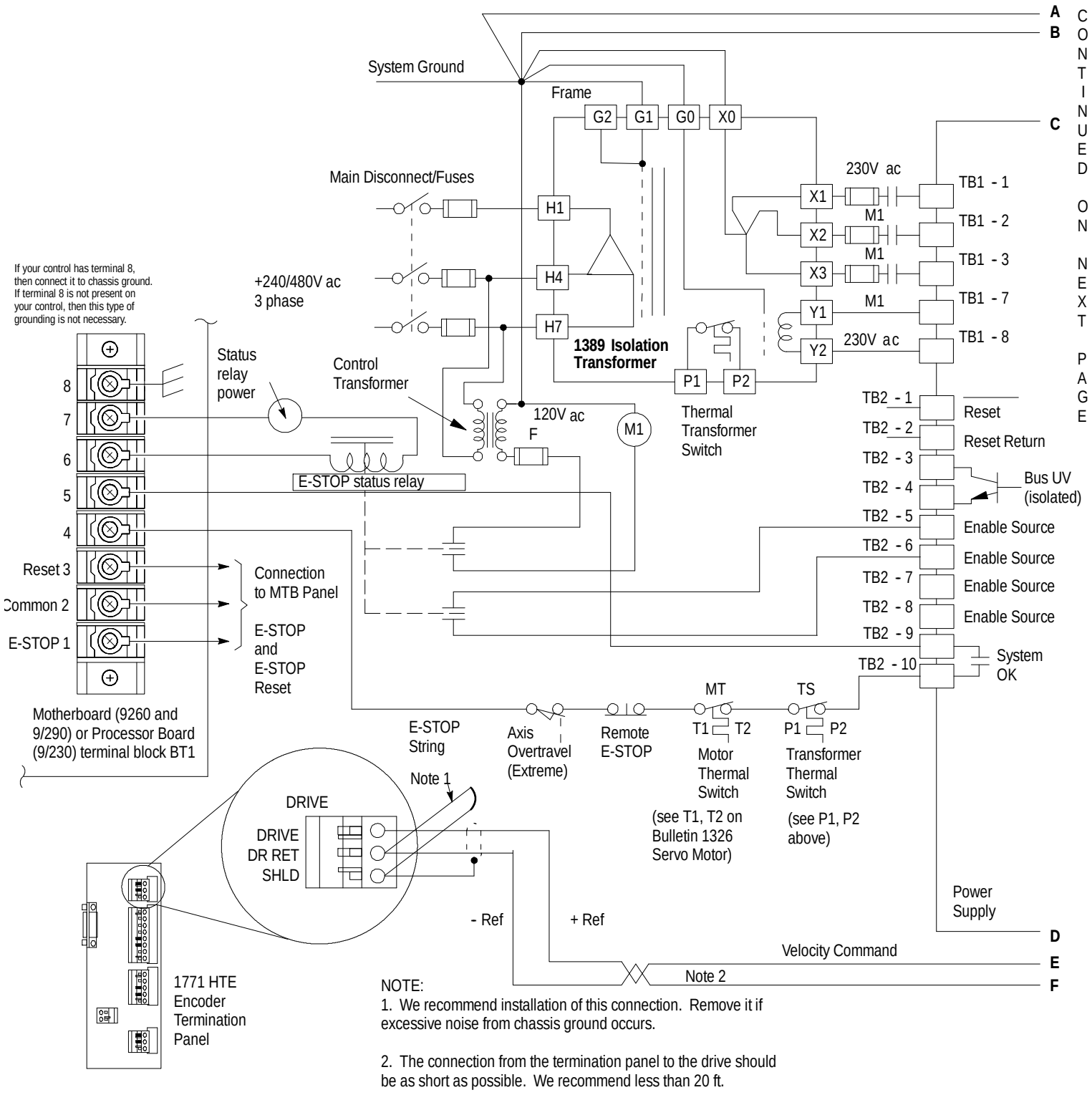


NOTE:
1. We recommend installation of this connection. Remove it if excessive noise from chassis ground occurs.

2. The connection from the termination panel to the drive should be as short as possible. We recommend less than 20 ft.

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Figure 12.5
Wiring Diagram For Series 1389 Drives



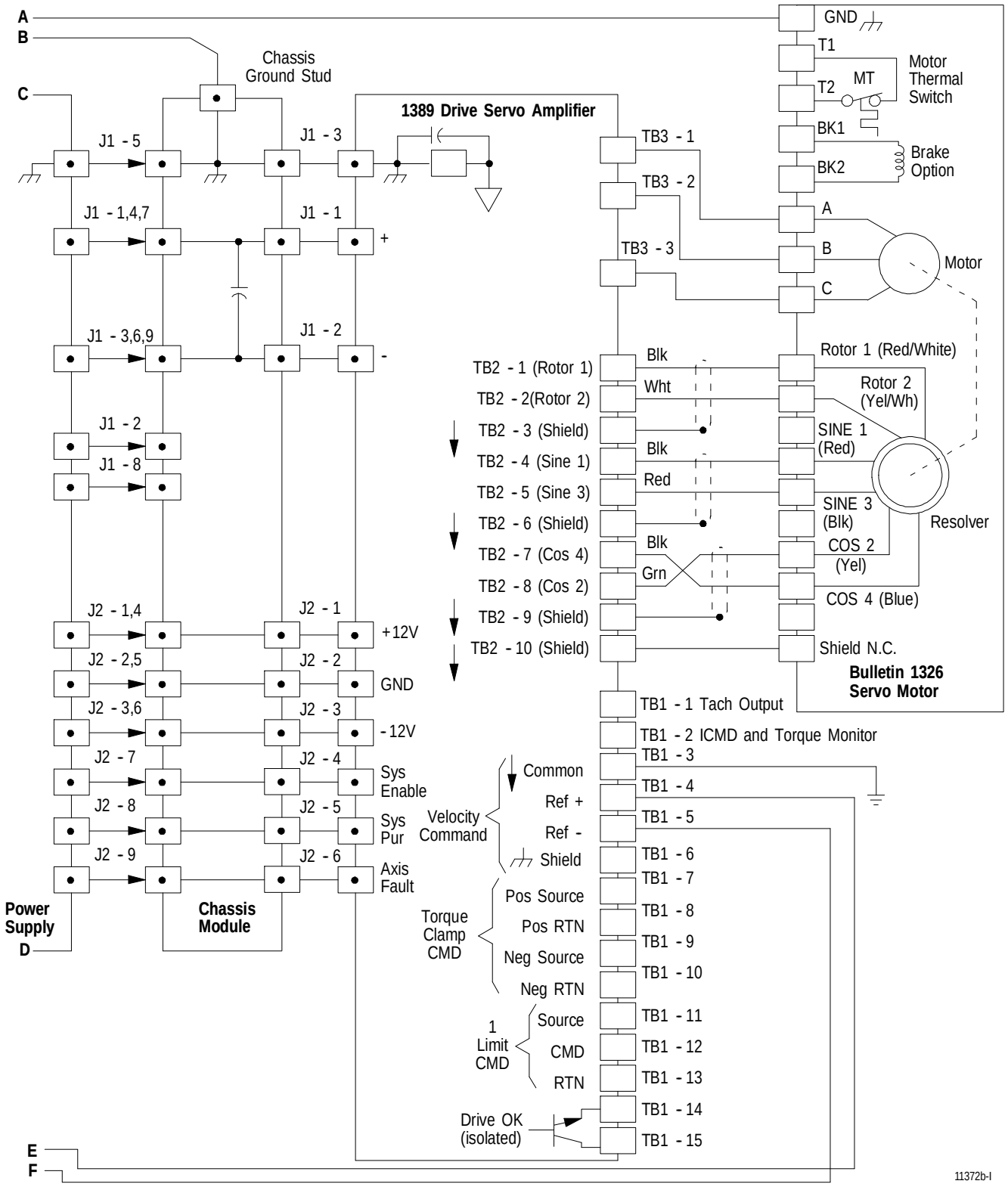
NOTE:
1. We recommend installation of this connection. Remove it if excessive noise from chassis ground occurs.

2. The connection from the termination panel to the drive should be as short as possible. We recommend less than 20 ft.

11372-I

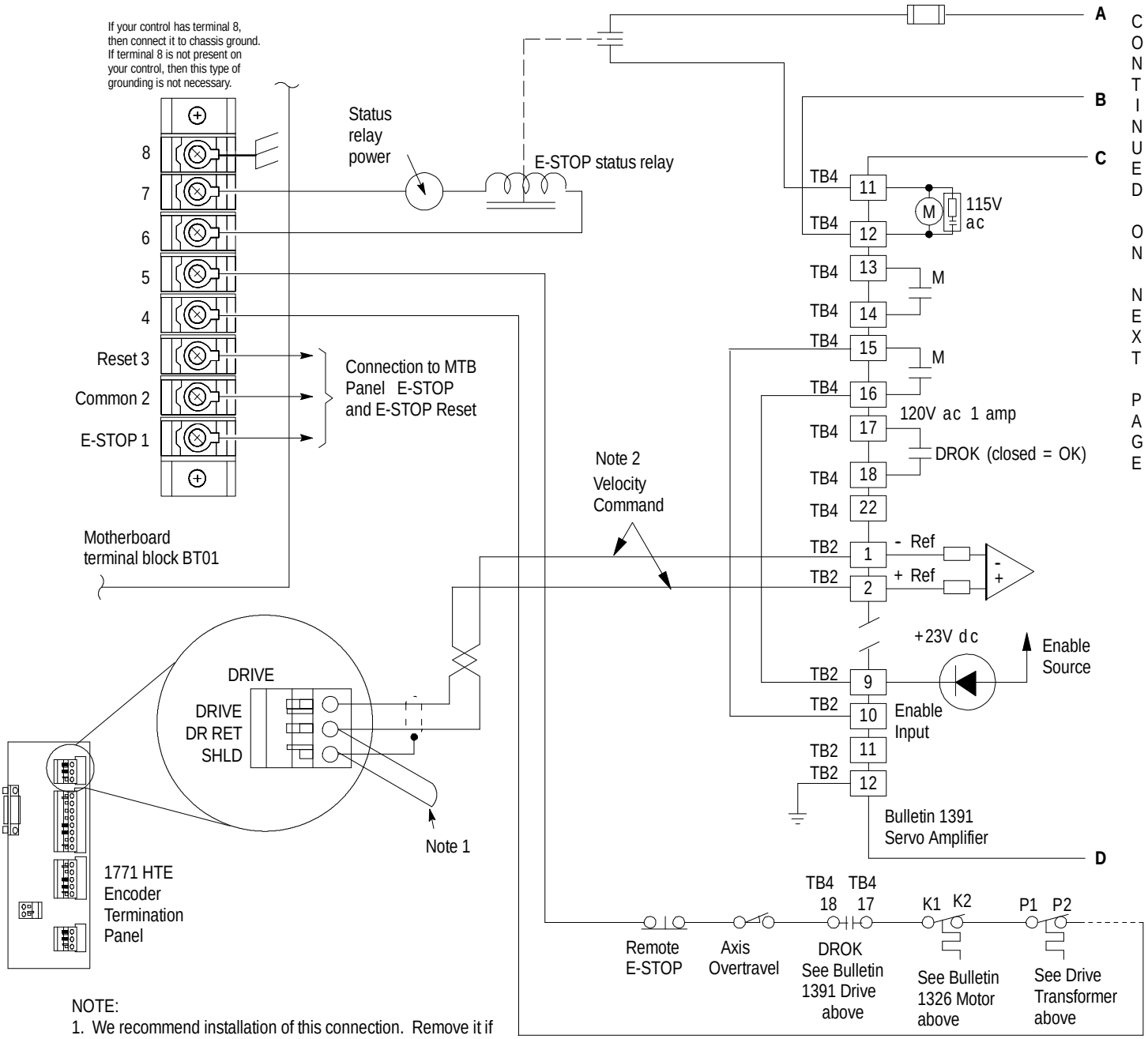
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Figure 12.5 (continued)
Wiring Diagram For Series 1389 Drives



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Figure 12.6
Wiring Diagram For Series 1391 Drives

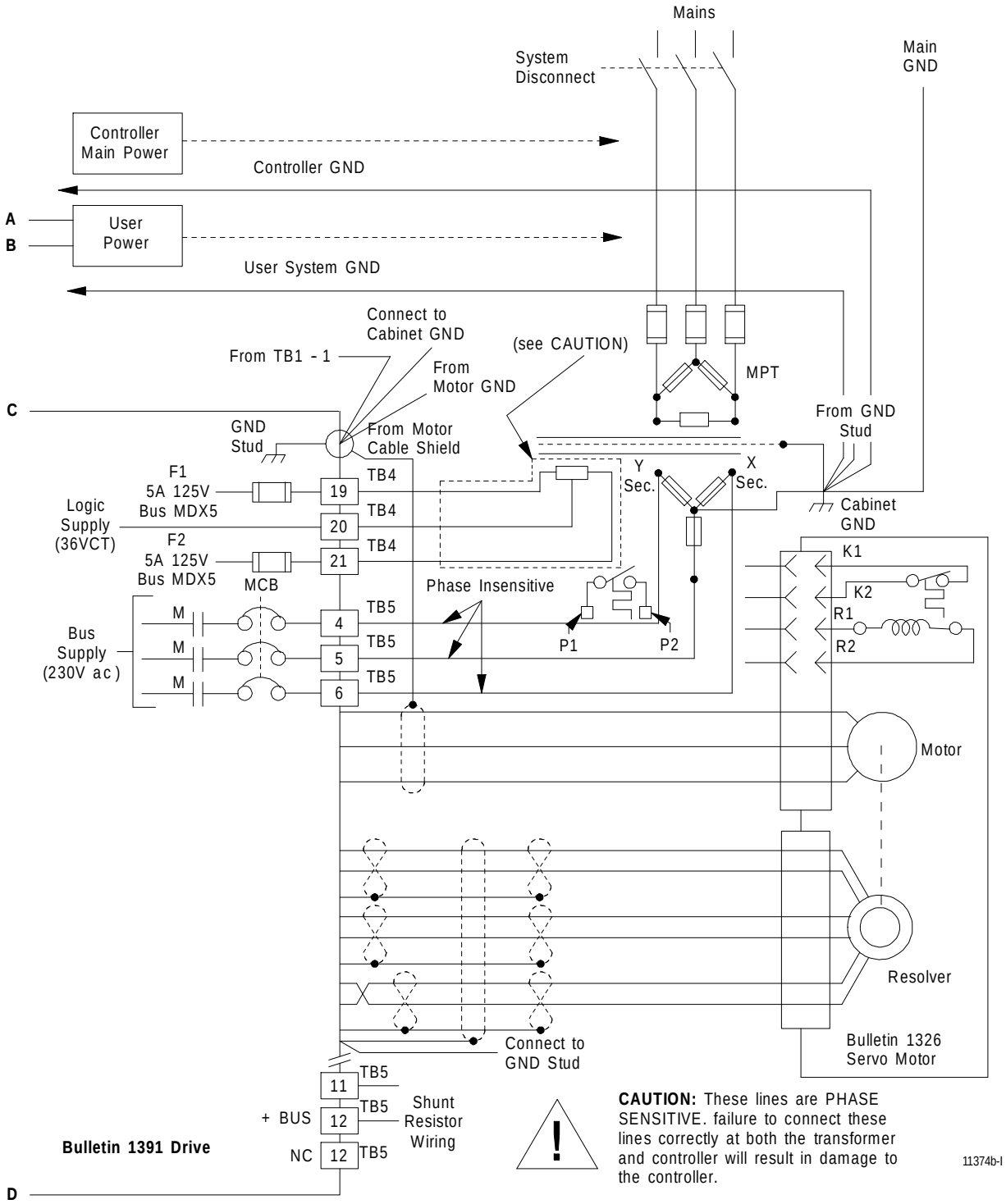


NOTE:
1. We recommend installation of this connection. Remove it if excessive noise from chassis ground occurs.

2. The connection from the termination panel to the drive should be as short as possible. We recommend less than 20 ft.

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Figure 12.6 (continued)
Wiring Diagram For Series 1391 Drives



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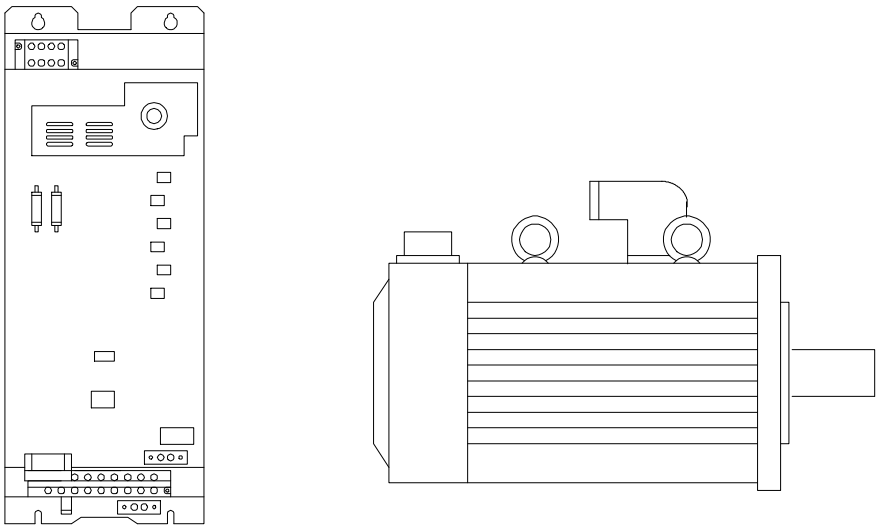
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9/Series Hardware
TAB 13

8520 Digital Drive Systems



Series 8520 Digital Drives and Series 8500 Digital Servo Motors

8520-6.2.13 – August 1998 PN–176443

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Section 13A

Connecting 8520 Digital Drive Systems

13A.0 Section Overview

This section details the connections for the 8520-AX-D digital drive.

For Information:	See Page:
8520 Digital Servo Amplifiers Option Specifications	13A-2
Selecting a Three Phase Transformer	13A-11
8520 Digital Servo Amplifiers Fault Indicators	13A-14
8520 Digital Servo Amplifiers Jumper Settings	13A-16
8520 Digital Servo Amplifiers Shunt Specifications	13A-19
8500 Digital Servo Motors	13A-24
Feedback Devices	13A-28

13A.1 8520 Digital Servo Amplifiers

The 8520 Digital Servo Amplifier receives low-level Pulse Width Modulated (PWM) command signals from the servo module and translates them to drive the axis servo motors. At the same time, it constantly senses the amount of current being used by each motor and returns this information to the 8520 digital servo module for use in determining motor load.

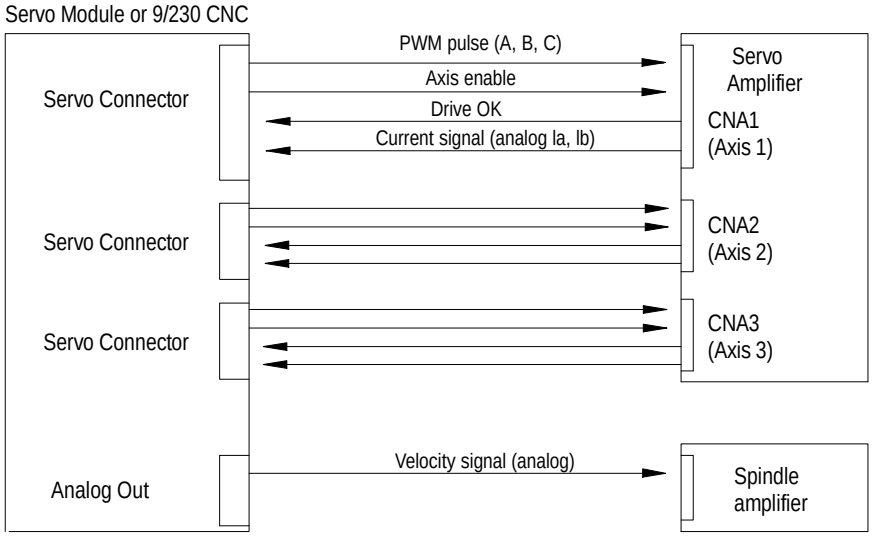
The 8520 digital servo amplifier also receives an “Axis enable” signal from the servo module and returns a “Drive OK” signal if certain protection and motor tests are successful.

Important: The 8520 digital servo amplifier should be separated or isolated from the servo module and CPU boards because of the electrical noise it generates. Refer to page 2A-10 for unit mounting spacing and other noise prevention techniques that will have to be followed when installing this unit.

Figure 13A.1 shows the interface between the 8520 digital servo module and the servo amplifier.

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Figure 13A.1
8520 Digital Servo Amplifier Interface



Important: The configuration of the 8520 digital servo module output ports with the 8520 digital servo amplifier connectors will vary depending on the AMP configuration of the system. Refer to the 9/Series CNC 9/230, 9/260, and 9/290 AMP Reference Manual, publication 8520-6.4, for more information.

13A.2 8520 Digital Servo Amplifier Options Specifications

There are three 8520 digital servo amplifier options available. These can be connected in any combination to drive up to nine digital servo axes (9/290). Configurations should be based on motor size and take into consideration the per axis rated current limitations of each amplifier.

Table 13A.A lists the 8520 digital servo amplifier options and their corresponding specifications.

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Table 13A.A
8520 Digital Servo Amplifier Options

Specifications		Amplifier Options		
		1AX-D	**2AX-D**	**3AX-D**
Number of Controllable Axes		1	2	3
Rated Current A(rms)/axis		21.0	6.0	12.0
Max. Output Current A(rms)/axis		42.0	12.0	24.0
With Internal Fan		Yes	No	No
External Input Power Source Fuse Rating		15A	10A	20A
Input Power Source	Main Circuit	3 Phase 170-253 V ac 50/60 Hz		
	Control Circuit	Single Phase 170-253 V ac 50/60 Hz		
Control Method		Transistor PWM Control		
Dynamic Brake/Shunt Resistor		Internal/External	Internal/External	Internal/External
Ambient Temperature		0 to 55 ℃		
Humidity		95% or less (No Dew Condensation)		
Weight Kg (lbs)		10.1 (4.6)	9.6 (4.35)	15 (6.8)

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13A.2.1 1AX-D Servo Amplifier Connectors and Pin Assignments

Figure 13A.2 shows the 1AX-D (1 axis) 8520 digital servo amplifier connectors and terminal blocks.

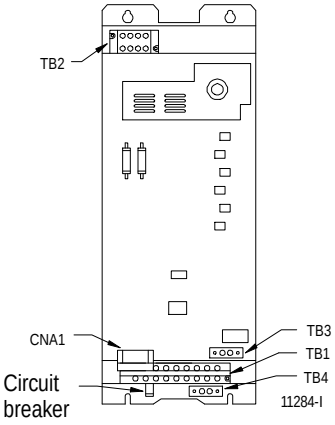


Figure 13A.2
1AX-D Servo Amplifier Connectors and Terminal Blocks and Pin Assignments

Connector on 1AX-D Amplifier	Connected To	Mating Connector
CNA1	3-axis Digital Servo Module	CN2/CN3/CN4
CNA1	4-axis Digital Servo Module	J1/J2,/J3 /J4
TB1	Power Source and Motor	
TB2	External Shunt Resistor	
TB3	System Ready on E-STOP String	
TB4	Thermal Switch on Motor	

Figure 13A.3
8520 Digital Servo Amplifier Connector CNA1, Honda MR-25RMA and 1AX-D Servo Amplifier Connector CNA1 Pin Assignments

Pin No.	Connection	Pin No.	Connection
1	ENABLE	14	PWM_C
2	/ENABLE	15	/PWM_C
3	Shield	16	N.C.
4	Shield	17	Ia
5	Shield	18	/Ia
6	STATUS	19	Shield
7	/STATUS	20	Shield
8	N.C.	21	Shield
9	N.C.	22	Ib
10	PWM_A	23	/Ib
11	/PWM_A	24	N.C.
12	PWM_B	25	N.C.
13	/PWM_B		

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Table 13A.B
1AX-D Servo Amplifier Terminal Block TB1 Terminal Assignments

Term.	Connection	Term.	Connection
1	3 f 200v/230v- f1	6	Motor 1- fA
2	3 f 200v/230v- f2	7	Motor 1- fB
3	3 f 200v/230v- f3	8	Motor 1- fC
4	1 f 200v/230v-1 f-1	9	Motor 1-F Ground and Shield
5	1 f 200v/230v-1 f-2		

Table 13A.C
1AX-D Servo Amplifier Terminal Block TB2 Terminal Assignments

Term. No.	Connection
1	DC+
2	DC-
3	Shunt
4	External

Table 13A.D
1AX-D Servo Amplifier Terminal Block TB3 Terminal Assignments

Term. No.	Connection
1	SYSTEM READY (Contact Output)
2	SYSTEM READY (Contact Input)

Typically TB3 is used as a relay in your E-STOP string. Terminal 1 and Terminal 2 is in a closed connection when the drive is operating correctly and in an open connection when the drive is in a fault condition.

Table 13A.E
System Ready Contact Ratings

DC	AC
up to 24V max. up to 1.4 A up to 30 Watts max.	up to 230V max. up to 1.4 A up to 30 Watts max.

Table 13A.F
1AX-D Servo Amplifier Terminal Block TB4 Terminal Assignments

Term. No.	Connection
1	TSW1-1 (For Motor 1)
2	TSW1-2 (For Motor 1)

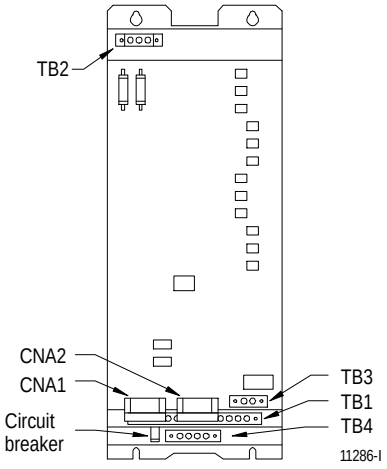
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Important: Terminal block TB4 is an optional connector that provides a convenient connection to the thermal overload switches of the servo amplifier. This terminal block is typically used to interface the thermal overload switches with PAL or the system E-STOP string. The servo amplifier will operate normally without any external connections to terminal block TB4.

13A.2.2 2AX-D Servo Amplifier Connectors and Pin Assignments

Figure 13A.4 shows and lists the 2AX-D 8520 digital servo amplifier connectors and terminal blocks.

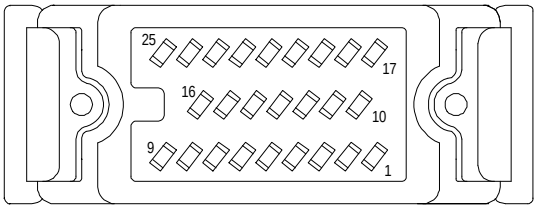
Figure 13A.4
2AX-D Servo Amplifier Connectors and Terminal Blocks



Connector on 2AX-D Amplifier	Connected To	Mating Connector
CNA1	3-axis Digital Servo Module	CN2/CN3/CN4
CNA2	3-axis Digital Servo Module	CN2/CN3/CN4
CNA1	4-axis Digital Servo Module	J1/J2,/J3 /J4
CNA2	4-axis Digital Servo Module	J1/J2,/J3 /J4
TB1	Power Source and Motors	
TB2	External Shunt Resistor	
TB3	System Ready on E-STOP String	
TB4	Thermal Switches on Motors	

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Figure 13A.5
8520 Digital Servo Amplifier Connectors CNA1 and CNA2, Honda MR-25RMA and Pin Assignments



11285-I

Pin No.	Connection	Pin No.	Connection
1	ENABLE	14	PWM_C
2	/ENABLE	15	/PWM_C
3	Shield	16	N.C.
4	Shield	17	Ia
5	Shield	18	/Ia
6	STATUS	19	Shield
7	/STATUS	20	Shield
8	N.C.	21	Shield
9	N.C.	22	Ib
10	PWM_A	23	/Ib
11	/PWM_A	24	N.C.
12	PWM_B	25	N.C.
13	/PWM_B		

Table 13A.G
2AX-D Servo Amplifier Terminal Block TB2 Terminal Assignments

Term. No.	Connection	Term. No.	Connection
1	3 f 200v/230v- f1	8	Motor 1- fC
2	3 f 200v/230v- f2	9	Motor 2- fA
3	3 f 200v/230v- f3	10	Motor 2- fB
4	1 f 200v/230v-1 f-1	11	Motor 2- fC
5	1 f 200v/230v-1 f-2	12	Motor F Ground -1 and Shield
6	Motor 1- fA	13	Motor F Ground-2 and Shield
7	Motor 1- fB		

Table 13A.H
2AX-D Servo Amplifier Terminal Block TB2 Terminal Assignments

Term. No.	Connection
1	DC+
2	DC-
3	External

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Table 13A.I
2AX-D Servo Amplifier Terminal Block TB3 Terminal Assignments

Term. No.	Connection
1	SYSTEM READY (Contact Output)
2	SYSTEM READY (Contact Input)

Typically TB3 is used as a relay in your E-STOP string. Terminal 1 and Terminal 2 is an open connection when the drive is in a fault condition and a closed connection when the drive is operating correctly.

Table 13A.J
System Ready Contact Ratings

DC	AC
up to 24V max. up to 1.4 A up to 30 Watts max.	up to 230V max. up to 1.4 A up to 30 Watts max.

Table 13A.K
2AX-D Servo Amplifier Terminal Block TB4 Terminal Assignments

Term. No.	Connection
1	TSW1-1 (For Motor 1)
2	TSW1-2 (For Motor 1)
3	TSW2-1 (For Motor 2)
4	TSW2-2 (For Motor 2)

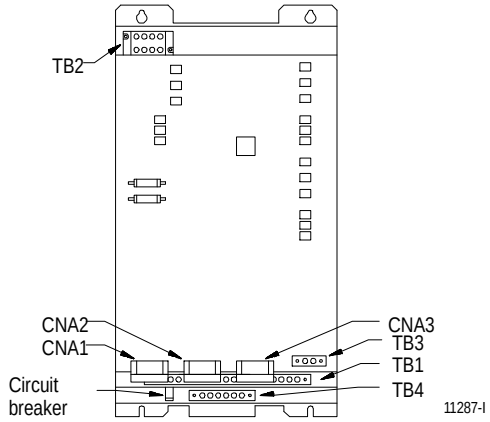
Important: Terminal block TB4 is an optional connector that provides a convenient connection to the thermal overload switches of the servo amplifier. This terminal block is typically used to interface the thermal overload switches with PAL or the system E-STOP string. The servo amplifier operates normally without any external connections to terminal block TB4.

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13A.2.3 3AX-D Servo Amplifier Connectors and Pin Assignments

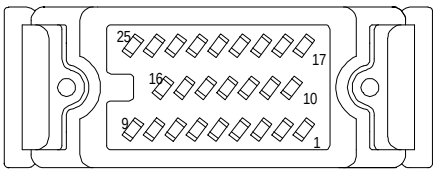
Figure 13A.6 shows and lists the 3AX-D (3 axis) 8520 digital servo amplifier connectors and terminal blocks.

Figure 13A.6
3AX-D Servo Amplifier Connectors and Terminal Blocks



Connector on 3AX-D Amplifier	Connected To	Mating Connector
CNA1	3-axis Digital Servo Module	CN2/CN3/CN4
CNA2	3-axis Digital Servo Module	CN2/CN3/CN4
CNA3	3-axis Digital Servo Module	CN2/CN3/CN4
CNA1	4-axis Digital Servo Module	J1/J2,/J3 /J4
CNA2	4-axis Digital Servo Module	J1/J2,/J3 /J4
CNA3	4-axis Digital Servo Module	J1/J2,/J3 /J4
TB1	Power Source and Motors	
TB2	External Shunt Resistor	
TB3	System Ready on E-STOP String	
TB4	Thermal Switches on Motors	

Figure 13A.7
8520 Digital Servo Amplifier Connectors CNA1, CNA2 and CNA3,Honda MR-25RMA and Pin Assignments



Pin No.	Connection	Pin No.	Connection
1	ENABLE	14	PWM_C
2	/ENABLE	15	/PWM_C
3	Shield	16	N.C.
4	Shield	17	Ia
5	Shield	18	/Ia
6	STATUS	19	Shield
7	/STATUS	20	Shield
8	N.C.	21	Shield
9	N.C.	22	Ib
10	PWM_A	23	/Ib
11	/PWM_A	24	N.C.
12	PWM_B	25	N.C.
13	/PWM_B		

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Table 13A.L
3AX-D Servo Amplifier Terminal Block TB1 Terminal Assignments

Term. No.	Connection	Term. No.	Connection
1	3 f 200v/230v- f1	10	Motor 2- fA
2	3 f 200v/230v- f2	11	Motor 2- fB
3	3 f 200v/230v- f3	12	Motor 2- fC
4	1 f 200v/230v-1 f-1	13	Motor 2-F Ground and Shield
5	1 f 200v/230v-1 f-2	14	Motor 3- fA
6	Motor 1- fA	15	Motor 3- fB
7	Motor 1- fB	16	Motor 3- fC
8	Motor 1- fC	17	Motor 3-F Ground and Shield
9	Motor 1-F Ground and Shield		

Table 13A.M
3AX-D Servo Amplifier Terminal Block TB2 Terminal Assignments

Term. No.	Connection
1	DC+
2	DC-
3	Shunt
4	External

Table 13A.N
3AX-D Servo Amplifier Terminal Block TB3 Terminal Assignments

Term. No.	Connection
1	SYSTEM READY (Contact Output)
2	SYSTEM READY (Contact Input)

Typically TB3 is used as a relay in your E-STOP string. Terminal 1 and Terminal 2 is in a closed connection when the drive is operating correctly and in an open connection when the drive is in a fault condition.

Table 13A.O
System Ready Contact Ratings

DC	AC
up to 24V max. up to 1.4 A up to 30 Watts max.	up to 230V max. up to 1.4 A up to 30 Watts max.

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Table 13A.P
3AX-D Servo Amplifier Terminal Block TB4 Terminal Assignments

Term. No.	Connection
1	TSW1-1 (For Motor 1)
2	TSW1-2 (For Motor 1)
3	TSW2-1 (For Motor 2)
4	TSW2-2 (For Motor 2)
5	TSW3-1 (For Motor 3)
6	TSW3-2 (For Motor 3)

Important: Terminal block TB4 is an optional connector that provides a convenient connection to the thermal overload switches of the servo amplifier. This terminal block is typically used to interface the thermal overload switches with PAL or the system E-STOP string. The servo amplifier operates normally without any external connections to terminal block TB4.

13A.3 Selecting an A-B 1389 Transformer for 8520 Digital Servo Amplifiers

This section gives you the information you need to determine which A-B 1389 transformer to use with your application. Its also gives the dimensions of each type of A-B 1389 transformer.

Important: The 9/230, 9/260, and 9/290 8520 digital servo amplifier is compatible only with an Allen-Bradley 1389 transformer.

Table 13A.A provides the formulas you need to size the type of transformer for the application.

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Table 13A.A
Formulas for Determining Transformer Size

If you are using a machine tool application with:	Use this formula to calculate the minimum transformer KVA	
Varying loads on the motor	Number of Axes	Machine Tool Duty
(Machine Tool Duty)	1	KW (Largest Motor) x 0.43 + 0.2
	2	KW (Largest Motor) x 0.61 + 0.4
	3	KW (Largest Motor) x 0.86 + 0.6
	4	KW (Largest Motor) x 1.28 + 0.8
	5	KW (Largest Motor) x 1.82 + 1.0
	6	KW (Largest Motor) x 2.60 + 1.2
Constant acceleration and deceleration	Number of Axes	Rapid Accel/Decel Duty
(Rapid Accel/Decel Duty)	1	KW (Largest Motor) x 0.60 + 0.2
	2	KW (Largest Motor) x 0.85 + 0.4
	3	KW (Largest Motor) x 1.20 + 0.6
	4	KW (Largest Motor) x 1.80 + 0.8
	5	KW (Largest Motor) x 2.50 + 1.0
	6	KW (Largest Motor) x 3.50 + 1.2
Motors that perform continuously at or near peak capacity	Number of Axes	Continuous Duty
(Continuous Duty)	All	KW (Total of All Motors) x 1.2 + 1.0

If you are using 8520 digital servo amplifiers, select a transformer from this list of Allen-Bradley 1389 transformers. Base your selection on the calculated minimum transformer KVA rating such that the selected transformer's KVA rating is equal to or larger than the calculated value:

Catalog Number	Rating (KVA)	Primary Voltage and Frequency
1389-T015DA	1.5	240/480V ac, 3 f 60Hz
1389-T035DA	3.5	
1389-T050DA	5.0	
1389-T100DA	10.0	
1389-T125DA	12.5	
1391-TA2	NEMA 1 Transformer Enclosure	

The dimensions of the Allen-Bradley 1389 transformers are shown in Figure 13A.8 and Figure 13A.9.

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Figure 13A.8
Allen-Bradley 1389 Transformer Dimensions

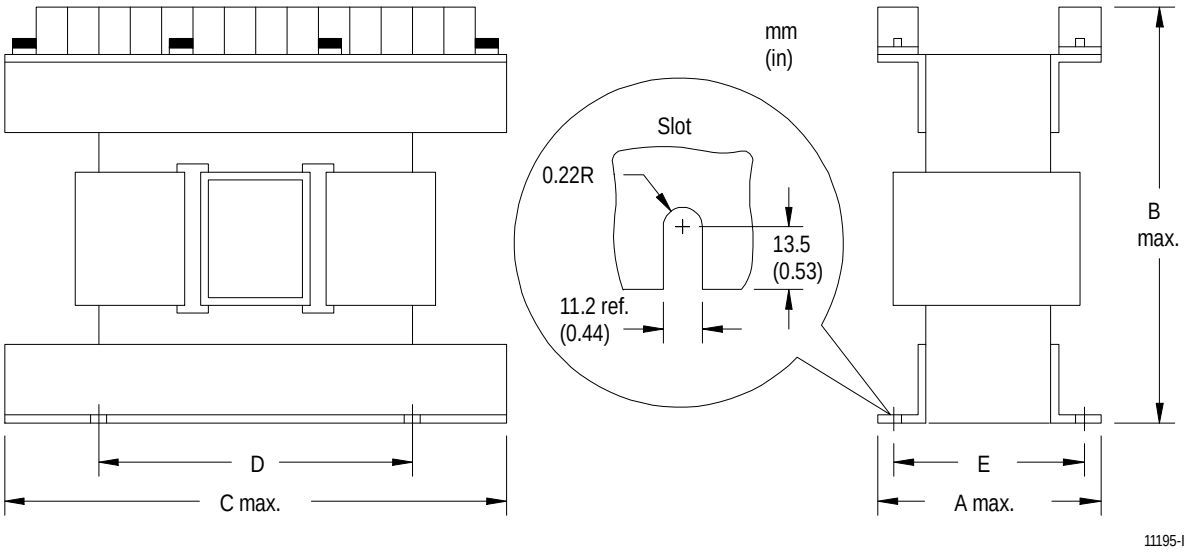
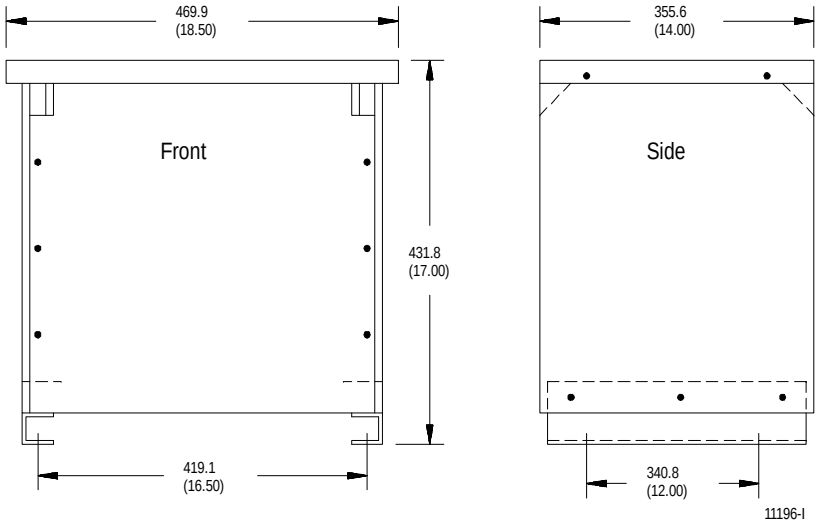


Table 13A.B
Allen-Bradley 1389 Transformer Dimensions mm (in.)

1389-	A	B	C	D	E	Weight
T015DA	228 mm (9 in)	254 mm (10 in)	330 mm (13 in)	127 mm (5 in)	79 mm (3.10 in)	12.7 kg (28 lbs)
T035DA	279 mm (11 in)	279 mm (11 in)	356 mm (14 in)	152 mm (6 in)	114 mm (4.5 in)	27.2 kg (60 lbs)
T050DA	279 mm (11 in)	279 mm (11 in)	356 mm (14 in)	152 mm (6 in)	133 mm (5.25 in)	34.0 kg (75 lbs)
T100DA	305 mm (12 in)	317 mm (12.5 in)	406 mm (16 in)	203 mm (8 in)	149 mm (5.85 in)	50.8 kg (112 lbs)
T125DA	305 mm (12 in)	317 mm (12.5 in)	406 mm (16 in)	203 mm (8 in)	143 mm (5.63 in)	59.5 kg (131 lbs)

Figure 13A.9
Allen-Bradley 1389 Transformer Dimensions



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13A.4 8520 Digital Servo Amplifier Fault Indicators

This section discusses faults and how they are detected on the 8520 digital servo amplifier.

System Ready Faults

The system checks that the servo amplifier is ready using two methods:

System Ready Connector (TB3)
The System Ready (on TB3) contact makes sure that the control board of the servo amplifier is ready, the power circuit of the DC bus is ready, and the system relay is closed.

Table 13A.C
System Ready Contact Ratings

DC	AC
24V dc @ 1.4 A (max. 30 W)	230V ac @ 1.4 A (max. 30 W)

Axis status output (CNA1, CNA2, and CNA3)

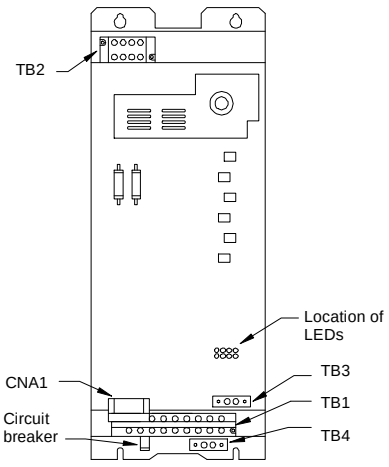
The Axis status output contact is connected to the servo module and is checked by the servo module's CPU on a per axis basis. If this contact is not active, the servo module recognizes that the amplifier is in a fault condition and sends the message "SERVO AMPLIFIER FAULT" sent to the control. This is pre-wired through servo cable CN20.

LED Indicators

Table 13A.D through Table 13A.F lists the symbol, indication, and color of the 8520 digital servo amplifier fault and ready status indicators (note the LED indicators are numbered on the 3AX-D servo amplifier).

Table 13A.D
1AX-D (1 axis) Servo Amplifier Indicators

Symbol	Fault or Ready Indication	Color
OT	Over Temperature	Red
UV	Bus Undervoltage	Yellow
OC	Over Current	Red
AXF	Axis 1 Fault	Red
RDY	System Ready	Green
OV	Bus Overvoltage	Red
CVF	Control Voltage Fault	Red
EAX1	Axis 1 Enable	Green



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Table 13A.E
2AX-D (2 axis) Servo Amplifier Indicators

Symbol (block 1)	Fault or Ready Indication	Color
CVF	Control Voltage Fault	Red
RDY	System Ready	Green
UV	Bus Undervoltage	Yellow
OT	Over Temperature	Red
OV	Bus Overvoltage	Red
AX1F	Axis 1 Fault	Red
AX2F	Axis 2 Fault	Red
OC	Over Current	Red

Symbol (block 2)	Fault or Ready Indication	Color
EAX1	Axis 1 Enable	Green
EAX2	Axis 2 Enable	Green

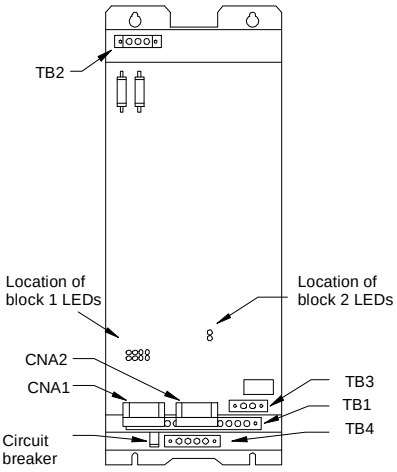
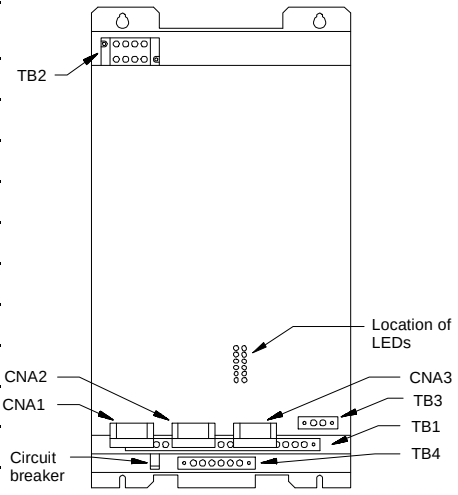


Table 13A.F
3AX-D (3 axis) Servo Amplifier Indicators

Symbol	Fault or Ready Indication	Color
RDY	System Ready	Green
OT	Over Temperature	Red
OV	Bus Overvoltage	Red
UV	Bus Undervoltage	Yellow
CVF	Control Voltage Fault	Red
OC	Over Current	Red
AX1F	Axis 1 Fault	Red
AX2F	Axis 2 Fault	Red
AX3F	Axis 3 Fault	Red
EAX1	Axis 1 Enable	Green
EAX2	Axis 2 Enable	Green
EAX3	Axis 3 Enable	Green



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13A.5 8520 Digital Servo Amplifier Jumper Settings

Table 13A.G through Table 13A.L list the 8520 digital servo amplifier jumper settings. These jumpers are used to configure the 8520 digital servo amplifier to supply 200% or 300% of the motor rated current, enable or disable the servo motors, latch or unlatch the bus under voltage fault detector, and select the internal or external shunt resistor.



ATTENTION: Incorrect jumper settings can cause damage to the servo motors and/or servo amplifiers.

Table 13A.G
1AX-D (1 axis) Servo Amplifier Jumper Settings

Axis 1 - - CNA1		J1	J2	J3	J4	J7	J8	J9	J10
Motor Rated Current									
200%	300%								
1.3	1.3								
2.6	2.6	•				•			
3.9	3.9		•				•		
5.2	5.2	•	•			•	•		
6.5	6.5			•				•	
7.8	7.8	•		•		•		•	
9.1	9.1		•	•			•	•	
10.4	10.4	•	•	•		•	•	•	
11.8	11.8				•				•
13.1	13.1	•			•	•			•
14.4	>AMP Limit		•		•		•		•
15.7	>AMP Limit	•	•		•	•	•		•
17.0	>AMP Limit			•	•			•	•
18.3	>AMP Limit	•		•	•	•		•	•
19.6	>AMP Limit		•	•	•		•	•	•
20.9	>AMP Limit	•	•	•	•	•	•	•	•

" • " Denotes jumper short

For 200% of motor rated current, the following jumpers are shorted:

- AXIS 1: J5, J6, J11, J12

For 300% of motor rated current, the following jumpers are open:

- AXIS 1: J5, J6, J11, J12

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Table 13A.H
1AX-D Servo Amplifier Jumper Settings (continued)

J13	Short - Enable Axis Motor
	Open - Disable Axis Motor
J14	Short - Bus Under Voltage FAULT not Latched
	Open - Bus Under Voltage FAULT Latched
J15	Short - Internal Shunt Resistor Used
	Open - External Shunt Resistor Used

Table 13A.I
2AX-D (2 axis) Servo Amplifier Jumper Settings

Axis 1 - - CNA1		**J1**	**J2**	**J3**	**J4**	**J7**	**J8**	**J9**	**J10**
Axis 2 - - CNA2		**J13**	**J14**	**J15**	**J16**	**J19**	**J20**	**J21**	**J22**
Motor Rated Current									
200%	**300%**								
0.4	0.4								
0.7	0.7	•				•			
1.1	1.1		•				•		
1.5	1.5	•	•			•	•		
1.9	1.9			•				•	
2.2	2.2	•		•		•		•	
2.6	2.6		•	•			•	•	
3.0	3.0	•	•	•		•	•	•	
3.4	3.4				•				•
3.7	3.7	•			•	•			•
4.1	>AMP Limit		•		•		•		•
4.5	>AMP Limit	•	•		•	•	•		•
4.9	>AMP Limit			•	•			•	•
5.2	>AMP Limit	•		•	•	•		•	•
5.6	>AMP Limit		•	•	•		•	•	•
6.0	>AMP Limit	•	•	•	•	•	•	•	•

" • " Denotes jumper short

For 200% of motor rated current, the following jumpers are shorted:

- AXIS 1: J5, J6, J11, J12 AXIS 2: J17, J18, J23, J24

For 300% of motor rated current, the following jumpers are open:

- AXIS 1: J5, J6, J11, J12 AXIS 2: J17, J18, J23, J24

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Table 13A.J
2AX-D Servo Amplifier Jumper Settings (continued)

J25	Short - Enable Axis 1 Motor
	Open - Disable Axis 1 Motor
J26	Short - Enable Axis 2 Motor
	Open - Disable Axis 2 Motor
J27	Short - Bus Under Voltage FAULT not Latched
	Open - Bus Under Voltage FAULT Latched
J28	Short - Internal Shunt Resistor Used
	Open - External Shunt Resistor Used

Table 13A.K
3AX-D (3 axis) Servo Amplifier Jumper Settings

Axis 1 - - CNA1		**J1**	**J2**	**J3**	**J4**	**J7**	**J8**	**J9**	**J10**
Axis 2 - - CNA2		**J13**	**J14**	**J15**	**J16**	**J19**	**J20**	**J21**	**J22**
Axis 3 - - CNA3		**J25**	**J26**	**J27**	**J28**	**J31**	**J32**	**J33**	**J34**
Motor Rated Current									
200%	**300%**								
0.7	0.7								
1.5	1.5	·				·			
2.2	2.2		·				·		
3.0	3.0	·	·			·	·		
3.7	3.7			·				·	
4.5	4.5	·		·		·		·	
5.2	5.2		·	·			·	·	
5.9	5.9	·	·	·		·	·	·	
6.7	6.7				·				·
7.5	7.5	·			·	·			·
8.2	>AMP Limit		·		·		·		·
9.0	>AMP Limit	·	·		·	·	·		·
9.7	>AMP Limit			·	·			·	·
10.4	>AMP Limit	·		·	·	·		·	·
11.2	>AMP Limit		·	·	·		·	·	·
11.9	>AMP Limit	·	·	·	·	·	·	·	·

" · " Denotes jumper short

For 200% of motor rated current, the following jumpers are shorted:

- AXIS 1: J5, J6, J11, J12 AXIS 2: J17, J18, J23, J24
- AXIS 3: J29, J30, J35, J36

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For 300% of motor rated current, the following jumpers are open:

- AXIS 1: J5, J6, J11, J12 AXIS 2: J17, J18, J23, J24
- AXIS 3: J29, J30, J35, J36

Table 13A.L
3AX-D Servo Amplifier Jumper Settings (continued)

J37	Short - Enable Axis 1 Motor
	Open - Disable Axis 1 Motor
J38	Short - Enable Axis 2 Motor
	Open - Disable Axis 2 Motor
J39	Short - Enable Axis 3 Motor
	Open - Disable Axis 3 Motor
J40	Short - Bus Under Voltage FAULT not Latched
	Open - Bus Under Voltage FAULT Latched
J41	Short - Internal Shunt Resistor Used
	Open - External Shunt Resistor Used

13A.6 8520 Digital Servo Amplifier Shunt Specifications

When the servo amplifier is installed as recommended and E-STOP occurs, the control sets the velocity command to zero. If the axes are in motion at that time, they will coast to a stop rather than being rapidly decelerated as they would be under servo amplifier control.

To improve axis stopping time when E-STOP occurs, the 8520 digital servo amplifier employs a dynamic brake. This brake is in the form of a power resistor that is shunted across the motor terminals. Power generated by the motor is dissipated through this resistor, thereby driving the motor to a rapid stop even though the 8520 digital servo amplifier is off.

There are three shunt resistor options that can be used with the 8520 digital servo amplifiers. One involves using the internal shunt resistor supplied with the amplifiers, while the others require purchase and installation of an external shunt resistor.

The following equations should be used to size a shunt resistor for the desired application. First, use these equations to solve for the peak power **P**, and the average power **W**. Then apply those values to the chart below to determine the appropriate shunt option.

$$P = (.00054)\ (J)\ (N^2)$$

$$W = \frac{(.0000108)\ (J)\ (N^2)}{(T)}$$

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Where:

- J = total motor and axis inertia measured at motor shaft, summed for all motors connected to the servo amplifier [Kg cm s^2]
- N = maximum motor speed [rpm]
- T = desired deceleration time from maximum motor speed to stop [sec.]

Important: These equations are for approximating shunt resistor requirements. They can produce worst case data that is unrealistic for most applications. For example, in most machine tool applications it is unlikely that all axes will ever be traveling simultaneously at their maximum speed. Factor the type of duty expected for your machine into these equations.

Shunt Resistor Selection Chart

	P < 1100	1100 £ **P** < 1800	1800 £ **P**
W < 180	Shunt Option #1	Shunt Option #2	[1]
180 £ **W** < 540	Shunt Option #2	Shunt Option #2	[1]
540 £ **W** < 810	Shunt Option #3	Shunt Option #3	[1]
810 £ **W**	[2]	[2]	[2]

[1] Not possible with current configuration. Move one or more motors to another servo amplifier, or reduce inertia, or reduce motor speed.

[2] Not possible with current configuration. Move one or more motors to another servo amplifier, or reduce inertia, or reduce motor speed, or increase time from maximum speed to stop.

Table 13A.M lists the internal/external shunt resistor, contactor, and fuse specifications.

Table 13A.M
Internal/External Shunt Specifications

Specifications	**Shunt Options**		
	Option #1	**Option #2**	**Option #3**
Shunt Location	Internal	External	External
Shunt Resistance	16 ohms	10 ohms	10 ohms
Shunt Continuous Rating	196 watts	600 watts	900 watts
Shunt Duty Cycle Limit (determined by servo amplifier jumper settings)	2 sec	5 sec	5 sec
Shunt Fuse Rating		15A/600V non-time delay	
Shunt Contactor Size	15A/600V or greater		

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After determining system shunt requirements, terminal block (BT2) on each of the 8520 digital amplifiers should be jumpered for either an internal shunt resistor or an external shunt resistor.

Figure 13A.10 and Figure 13A.11 illustrate this procedure.

Figure 13A.10
Shunt Resistor Connections for 2AX-D Servo Amplifiers

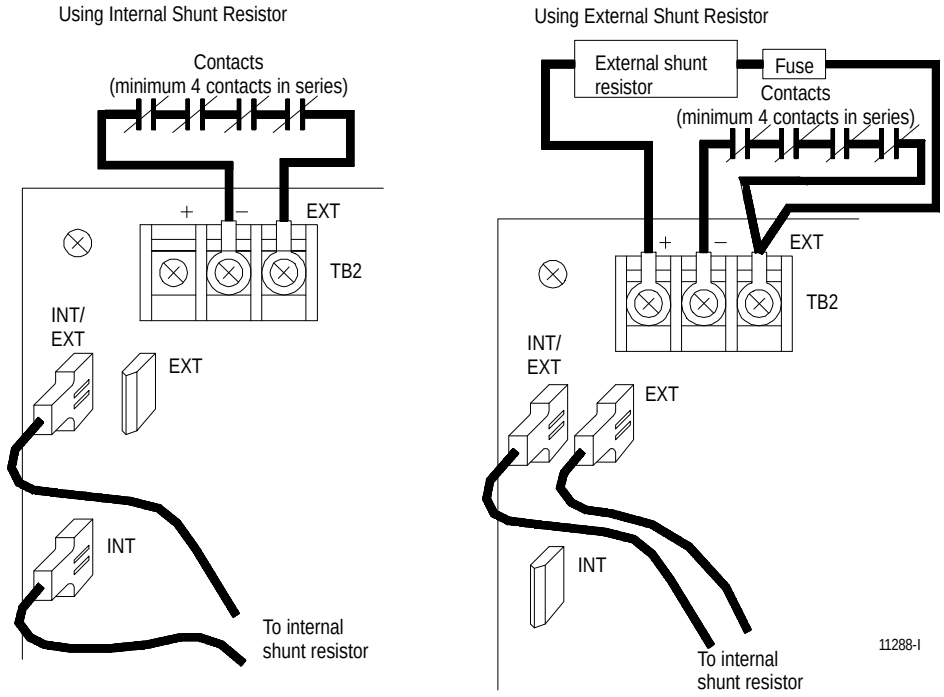
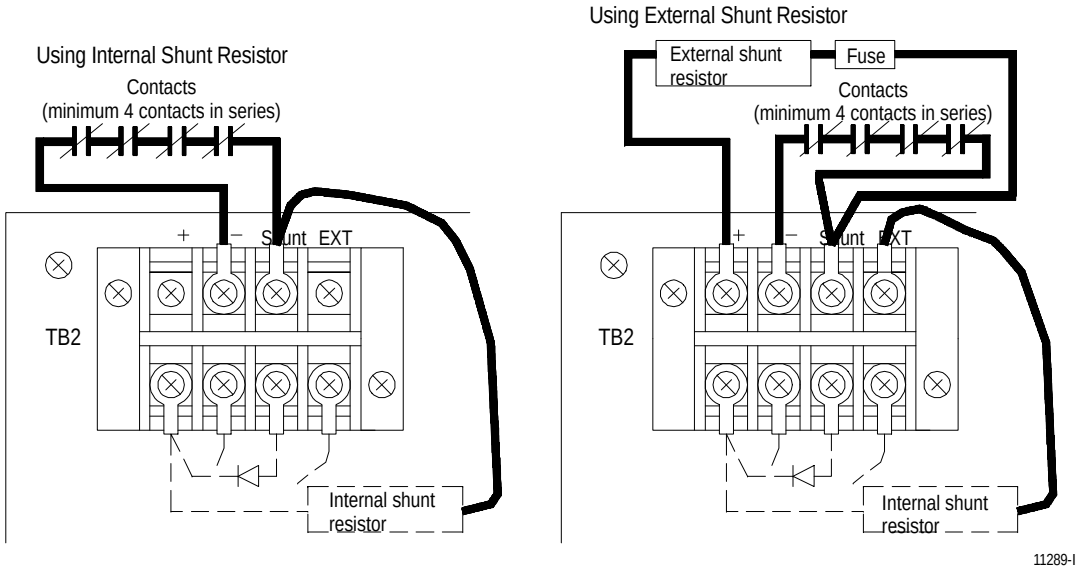


Figure 13A.11
Shunt Resistor Connections for 1AX-D and 3AX-D Servo Amplifiers



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Normally-closed contacts must be installed as shown in Figure 13A.10 and Figure 13A.11. These four contacts should be held open whenever the 8520 digital servo amplifier is energized and should be closed by the emergency stop circuitry. You must wire at least four contacts in series to safely break this connection. Allen-Bradley 100-A30ND3 contactors with added deck 195-FAD4 are recommended. Refer to a 1389 transformer manual for special requirements and additional information on the normally-closed contactor. Details on emergency stop wiring start on page 6-1.



ATTENTION: The four normally closed contacts shown in Figure 13A.10 and Figure 13A.11 should not be used on machines with large non-counter balanced vertical axes. No contacts are required. Under a normal shut down, leaving these contacts out allows the drive to maintain torque for a longer period of time. This provides more time for holding brakes to set.

Important: Jumpers on the 8520 digital servo amplifier circuit boards must be set for internal or external shunt resistor. These jumpers control the duty cycle (amount of continuous "on" time) for the shunt resistors.

Important: The external shunt resistor should be mounted in an area where the heat it generates will not adversely affect other components of the control.

Important: The shunt contacts should not be closed while 3-phase power is applied to the drive amplifier. The shunt circuitry is sized to dynamic braking of the axis when E-stop is applied and 3-phase power is removed from the amplifier.

13A.7 8520 Drive Power Distribution

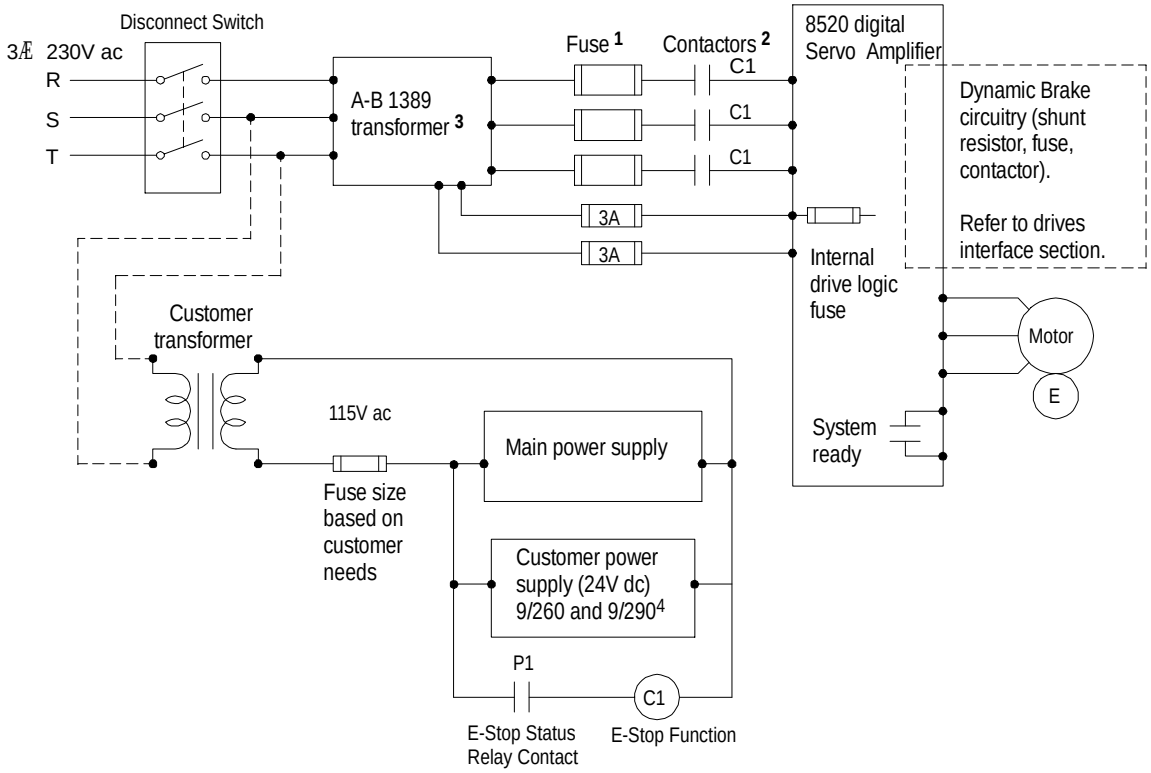


ATTENTION: To guard against electrical shock hazards, never make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

Figure 13A.1 shows how power is distributed from the supply to the transformer and amplifier.

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Figure 13A.1
Power Distribution from the Supply to the Transformer and Amplifier



1 Main power circuit fuse sizing is determined by the following equation:

$$\text{Fuse capacity (A)} = \frac{(Tr) \times 974.3}{V}$$

Where:
Tr = Transformer size calculated on page 13A-12 (in kW)
V = minimum 3 phase input voltage (V ac)

2 Contactor sizing is such that its capacity is greater than that of the fuses.

3 Refer to section 4.2 to size the transformer.

4 May not be necessary on PS2 24V is part of the power supply.

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13A.8 8500 Digital Servo Motors

The 8500 digital servo motors are used to drive the axes of the 8520 digital servo drive system. The 8500 digital servo motors have a feedback device mounted on them that provides position and velocity data to the servo module. A second feedback device can be mounted directly on the axis (such as a linear slide) to provide greater precision for positioning feedback. On these systems with multiple feedback devices, the motor mounted encoder is used for motor commutation and velocity feedback.

13A.8.1 8500 Digital Servo Motor Options

The control uses a digital velocity command scheme to improve motor performance and efficiency. This requires the use of servo motors designed for 8520 digital drive application.

The 8520 digital servo drive system can be configured to handle various 8500 digital servo motors. Table 13A.N lists the 1000/2000 RPM servo motor options and their specifications.

Table 13A.N
1000/2000 RPM 8500 Digital Servo Motor Options and Specifications

Specifications		1000/2000 RPM 8500 Digital Servo Motor Options				
		8500-A1C	**8500-A2C**	**8500-B1C**	**8500-B2C**	**8500-B3C**
Rated Output/Axis	kW (HP)	0.3 (0.4)	0.6 (0.8)	1.2 (1.6)	2.0 (2.7)	3.0 (4.1)
Rated Torque	kg· cm (lb · in)	29 (25)	58 (50)	117 (102)	195 (169)	290 (252) [1]
Continuous Max. Torque	kg· cm (lb · in)	30 (26)	60 (52)	120 (104)	220 (191)	330 (286)
Instantaneous Max. Torque	kg· cm (lb · in)	87 (76) [2]	174 (151) [2]	351 (305) [2]	390 (339) [2]	703 (610) [2]
Rated Current	Arms	3.0	5.8	11.7	18.8	26 [1]
Rated Revolution	rpm	1000				
Maximum Rated Revolution	rpm	2000				
Torque Constant	kg· cm/A (lb · in/A)	10.3 (8.9)	10.6 (9.2)	10.4 (9.0)	10.9 (9.5)	11.8 (10.2)
Rotor Inertia						
(J)	g · cm · s^2 (lb · in s^2x10^{-3})	13.8 (12.0)	24.8 (21.5)	68.2 (59.2)	112 (97.2)	146 (126.7)
($GD^2/4$)	kg · cm^2 (lb · in^2)	13.5 (4.61)	24.3 (8.31)	66.8 (22.8)	110 (37.6)	143 (48.9)
Power Rate	kW/s	6.1	13.3	19.7	33.2	57.0
Mechanical Time Constant	ms	8.3	5.9	6.9	5.2	4.1
Electrical Time Constant	ms	4.2	5.4	10.4	12.9	15.3
Number of Pole	poles	8				
Weight	kg (lb)	10 (15)	15 (33)	24 (53)	32 (71)	43 (95)

[1] The rated current available for the 8500-B3C digital servo motor is limited to 21 amps (rms) by the amplifiers maximum output rating. This limits the available rated torque to 232 kg.cm (203 lb.in).

[2] These values will vary depending on the amplifier selected to operate these motors. You may need to recalculate these values based on your amplifier selection.

Important: 8500 digital servo motor mounting dimensions start on page 13B-1.

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Table 13A.O lists the 1500/2500 RPM 8500 digital servo motor options and their specifications.

Table 13A.O
1500/2500 RPM 8500 Digital Servo Motor Options and Specifications

Specifications		1500/2500 RPM 8500 Digital Servo Motor Options				
		8500-A1D	**8500-A2D**	**8500-A3D**	**8500-B1D**	**8500-B2D**
Rated Output/Axis	kW (HP)	0.45 (0.6)	0.85 (1.2)	1.3 (1.8)	1.8 (2.4)	2.9 (3.9)
Rated Torque	kg· cm (lb · in)	29 (25)	55 (48)	85 (74)	117 (102)	190 (165)
Continuous Max. Torque	kg· cm (lb · in)	30 (26)	60 (52)	90 (72)	120 (104)	230 (200)
Instantaneous Max. Torque	kg· cm (lb · in)	87 (76) [1]	165 (143) [1]	255 (221) [1]	234 (203) [1]	380 (330) [1]
Rated Current	Arms	3.8	6.2	9.7	15	20
Rated Revolution	rpm	1500				
Maximum Rated Revolution	rpm	2500				
Torque Constant	kg· cm/A (lb · in/A)	8.2 (7.1)	9.4 (8.2)	9.4 (8.2)	8.4 (7.3)	10.0 (8.7)
Rotor Inertia						
(J)	$g \cdot cm \cdot s^2$ ($lb \cdot in\ s^2 x10^{-3}$)	13.8 (12.0)	24.8 (21.5)	37.4 (32.5)	68.2 (59.2)	112 (97.2)
($GD^2/4$)	$kg \cdot cm^2$ ($lb \cdot in^2$)	13.5 (4.61)	24.3 (8.31)	36.7 (12.5)	66.8 (22.8)	110 (37.6)
Power Rate	kW/s	6.0	12	18.9	19.7	31.5
Mechanical Time Constant	ms	8.3	5.7	4.7	6.8	5.1
Electrical Time Constant	ms	4.2	5.5	6.4	10.4	13.0
Number of Pole	poles	8				
Weight	kg (lb)	10 (22)	15 (33)	21 (46)	24 (53)	32 (71)

[1] These values will vary depending on the amplifier selected to operate these motors. You may need to recalculate these values based on your amplifier selection.

Important: 8500 digital servo motor mounting dimensions start on page 13B-1.

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Table 13A.P lists the general motor specifications that apply to all of the previously listed 8500 digital servo motors.

Table 13A.P
8500 Digital Servo Motor General Specifications

Item	Specification
Ambient Temperature	0 ℃ to +40 ℃
Ambient Humidity	20-80% (No Dew Condensation)
Brake Voltage	90V dc
Brake Holding Torque	A Series - 90 Kg - cm 16.2 watts
	B Series - 360 Kg - cm 31 watts
Drive Method	Direct Drive
Enclosure	Totally-enclosed, Self-Cooled (Equivalent to IP-55 Rating)
Excitation Method	Permanent Ferrite Magnet
Isolation Voltage	1500 V ac, 1 min.
Insulation Resistance	500 V dc, 10M Ohms or more
Mounting	Flange Mounted
Oil Seal	Nitril Rubber [1]
Thermostat	N.C. - Opens at 155 ℃ ±5 ℃ - Closes at 110 ℃ ±20 ℃

[1] Oil sealed motors should be operated under the following conditions:
- Optimum oil level should be below the oil seal lip
- Oil should be splashed to oil seal

All 8500 digital servo motors listed are equipped with thermal overload switches. These are normally closed switches that open when the motor temperature exceeds a safe limit.

The system installer has two choices for implementing these safety switches. They can be wired directly into the E-STOP string, or they can cause an input to PAL through an I/O device.

Wiring these switches directly into the E-STOP string provides an immediate and very reliable response to over-temperature conditions. The disadvantage in doing this is that the drives will be shut down no matter where the machine is in an operation and cannot be restarted until the over-temperature condition is resolved.

If the over-temperature switches are wired as inputs to PAL, the PAL program can be written to handle the situation in a controlled manner. PAL can be programmed to allow the completion of an operation, or to move the axes to a safe position before shutting down the machine.

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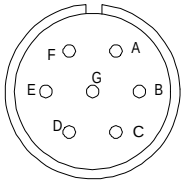
13A.8.2 8500 Digital Servo Motor Connector and Pin Assignments

The 8500 digital servo motor leads must be connected as shown below. The servo motor rotation, as viewed from the shaft end, will depend on the value of the SIGN OF FEEDBACK AMP parameter. Refer to the 9/260-9/290 AMP Reference Manual, publication 8520-6.4, for more information.

Important: The A series 8500 digital servo motor connector (without brake) is slightly smaller than the B series servo motor connector (without brake). The pin layout of these connectors is the same.

Figure 13A.2 lists the pin assignments for the 8500 digital servo motor connector without brake.

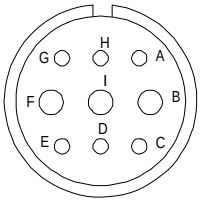
Figure 13A.2
A and B Series 8500 Digital Servo Motor Connector Pin Assignments (without brake)



Pin	Signal	Pin	Signal
A	PHASE A (U)	E	Thermal Protector
B	PHASE B (V)	F	Thermal Protector
C	PHASE C (W)	G	
D	Ground and Shield	-	

Figure 13A.3 shows the pin layout for the A series 8500 digital servo motor connector with brake.

Figure 13A.3
A Series 8500 digital Servo Motor Connector Pin Assignments (with brake)



Pin	Signal	Pin	Signal
A	-	F	Phase A (U)
B	Phase C (W)	G	Thermal Protector
C	Brake Terminal	H	Thermal Protector
D	Brake Terminal	I	Phase B (V)
E	Ground and Shield		

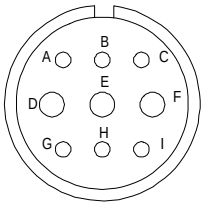
Important: The A series 8500 digital servo motor connector (with brake) is slightly smaller and its pin layout is different than the B series 8500 digital servo motor connector (with brake).

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Figure 13A.3 lists the pin assignments for the A series 8500 digital servo motor connector with brake.

Figure 13A.4 shows the pin layout and pin assignments for the B series 8500 digital servo motor connector with brake.

Figure 13A.4
B Series 8500 Digital Servo Motor Connector and Pin Assignments (with brake)



Pin	Signal	Pin	Signal
A	Thermal Protector	F	Phase C (W)
B	Thermal Protector	G	Ground and Shield
C	-	H	Brake Terminal
D	Phase A (U)	I	Brake Terminal
E	Phase B (V)		

13A.9 Feedback Devices

Each servo motor is equipped with a feedback device that is mounted on the end of the motor that is opposite the shaft end. This feedback device can be either an absolute or an incremental encoder. The servo module supplies these encoders with their required +5V power supply.

Each servo motor may also be equipped with a second feedback device for greater accuracy for positioning feedback. This second feedback device is normally mounted directly to the moving axis member to avoid inaccuracies caused by the motor gearing and drive components. When a second feedback device is used the motor mounted encoder must remain and is used for velocity feedback as well as motor commutation.

The spindle motor can also be equipped with a feedback device. This feedback device must be an incremental encoder with A quad B format. The servo module can supply the spindle encoder with +5V or +15V power.

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Table 13A.Q lists the servo encoder specifications.

Table 13A.Q
Servo Encoder Specifications

	Absolute Encoder	Incremental Encoder
Number of Pulse	8192 pulse/rev	6000 pulse/rev
Number of Multi-turning	±99999 turns	
Resolution	8192 ´ 4 = 32768 counts/rev	6000 ´ 4 = 24000 counts/rev
Supply Voltage	+5V (+10%, -1%)	+5V (+10%, -1%)
Battery Backup Voltage	2.9V to 4.5V	N/A
Weight	500 g	500 g

Incremental Encoders

Incremental encoders provide coarse axis position feedback to the servo module. These encoders also provide U, V, and W motor phase signals for use in motor commutation until the first marker is detected. After the first marker is detected, the servo module determines incremental axis position from the A, B, and C signals which are output by the encoder.

After initial power-up, the control must determine motor phasing by finding the encoder marker. Until this marker is found, phasing is estimated using the U, V, and W phase signals. This limits motor power to approximately 85% of maximum.

After the first marker is detected, the exact electrical position is known. Since precise commutation is now possible, full power is possible.

An axis homing cycle is required to establish axis position after the motor is phased. Once axis position is established, axis position feedback is transmitted back to the servo module in an A quad B format with marker. This feedback transmission takes place on an incremental basis.



ATTENTION: Do not adjust encoder alignment. Commutation requires the encoder marker to be aligned with the windings of the servo motor. This alignment process is done during the mounting of the incremental or absolute encoder to the servo motor.

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Absolute Encoders

Absolute encoders are an “intelligent” feedback device that provide absolute axis position feedback to the servo module. These encoders incorporate a turns counter register and an absolute single turn encoder. The turns counter register holds the number of turns the motor has made since the motor was last homed. The absolute single turn encoder holds the number of pulses encountered, since the marker was last detected to the present position.

The servo module requests position data from the absolute encoder after power up. The values contained in the turns counter register and the single turn encoder are sent to the servo module on the A channel of the encoder signal cable. These values are used by the servo module to calculate the absolute axis position.

Once the absolute axis position is determined, the absolute encoder transmits axis position feedback just like an incremental encoder. Precise commutation is possible immediately after power up when using the absolute encoder. Motor winding position is determined using the data provided by the absolute single turn encoder.

The absolute encoder is supplied with battery backup. This allows the absolute encoder to retain the absolute position of an axis even after power to the control is turned off. This eliminates the need to home axes every time the control is turned on, and also provides a means for limited recovery from a power failure during machining operations.

The battery power originates from the batteries plugged into the servo module. Even if battery backup fails, or the encoder cable is temporarily disconnected, the encoder will still maintain position data for up to 24 hours. This also allows for battery replacement without loss of data.

When an encoder other than the standard incremental or absolute encoder provides feedback to the servo module, typically the spindle feedback device, the maximum encoder channel frequency will have to be determined.

The following formula is used to calculate the maximum encoder channel frequency:

$$\text{Maximum Encoder Channel Frequency} = \frac{5 \times 10^{6}}{\left(\frac{360}{90\text{-Eq}}\right) \times 1.15}$$

Where:

5×10^{6} = Control’s Feedback Clock Frequency
E_Q = Encoder Quadrature Error in Degrees
1.15 = Feedback Clock Safety Factor

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This value is then compared to the actual A channel frequency of the encoder which is determined by the following formula:

(Lines/Rev.) x (Max. Operating RPM) x (min./60sec.)

As long as the actual encoder A channel frequency does not exceed the maximum encoder channel frequency calculated above, the servo module should process the encoder feedback data without a quadrature fault.

13A.9.1 Incremental Encoder Feedback Interface

Figure 13A.5 shows the interface between the 8500 digital servo module and servo motors with incremental encoders.

Figure 13A.5
Incremental Encoder to 8520 Digital Servo Module Interface

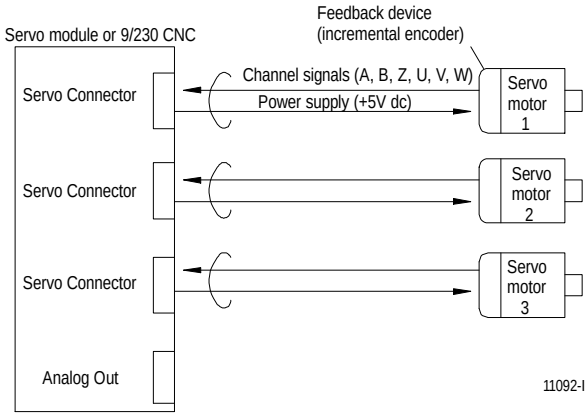
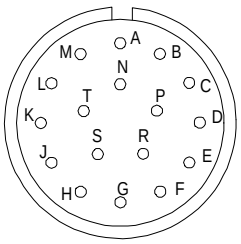


Figure 13A.6 shows the connector and pin assignments used to interface the incremental encoder with the 8520 digital servo module.

Figure 13A.6
Incremental Encoder Feedback Connector and Pin Assignments



Incremental Encoder			
Pin	**Signal**	**Pin**	**Signal**
A	A Channel Output	K	U Channel Output [2]
B	/A Channel Output	L	/U Channel Output [2]
C	B Channel Output	M	V Channel Output [2]
D	/B Channel Output	N	/V Channel Output [2]
E	Z Channel Output [1]	P	W Channel Output [2]
F	/Z Channel Output [1]	R	/W Channel Output [2]
G	0V	S	----------
H	+5V dc	T	----------
J	Frame Ground	-	----------
Connector Type: Cannon MS3102A20-29P			
Signal Output Circuit: Differential Line Driver			

[1] The Z channel output is used for the marker signal.
[2] The U, V, and W channels are used for motor phasing only

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13A.9.2 Absolute Encoder Feedback Interface

Figure 13A.7 shows the interface between the 8520 digital servo module and the 8500 digital servo motors with absolute encoders.

Figure 13A.7
Absolute Encoder to 8520 Digital Servo Module Interface

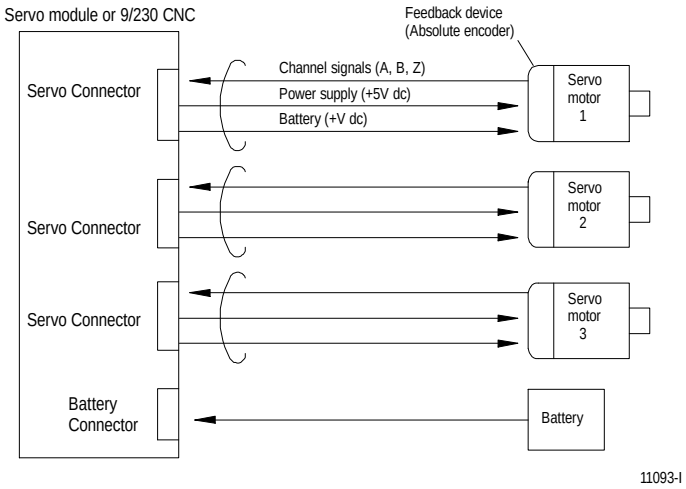
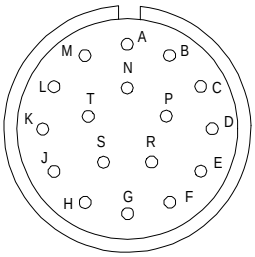


Figure 13A.8 shows the connector and lists the pin assignments used to interface the absolute encoder with the 8520 digital servo module.

Figure 13A.8
Absolute Encoder Feedback Connector and Pin Assignments



Absolute Encoder			
Pin	**Signal**	**Pin**	**Signal**
A	A Channel Output	K	----------
B	/A Channel Output	L	----------
C	B Channel Output	M	----------
D	/B Channel Output	N	----------
E	Z Channel Output [1]	P	----------
F	/Z Channel Output [1]	R	Encoder Reset Pin
G	0V	S	0V (battery)
H	5V (power supply)	T	+V (battery)
J	Frame Ground	-	----------
Connector Type: Cannon MS3102A20-29P			
Signal Output Circuit: Differential Line Driver			
[1] The Z channel output is used for the marker signal			

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13A.9.3 Resetting Absolute Encoders on an 8500 Digital Servo Motor

The turns counter register of an absolute encoder can be reset to zero at system start up **or** if the absolute encoder's battery backup has failed.

Resetting an Absolute Encoder on the 9/230

At the control:

1. Move the axis that the absolute encoder is configured for in AMP to the desired zero coordinate position for that axis.

2. Turn OFF the control and the main ac power switch.

ATTENTION: Never adjust the control unless the main AC disconnect switch is open (off) and locked.

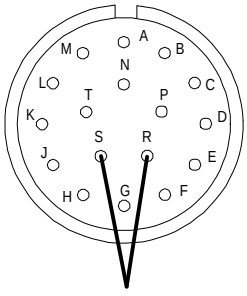
3. Disconnect the battery that supplies battery backup to the absolute encoder being reset.

4. Determine whether it is easier to disconnect and access connectors at the servomotor or at the control.

If accessing connectors at the 8500 digital servo motor:

a. Remove the cable that is connected to the absolute encoder to be reset.

b. At the **encoder,** use a jumper to short pin R to pin S of the absolute encoder for at least **2** minutes.

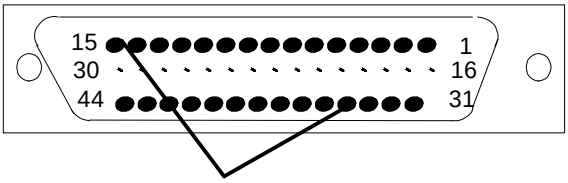


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If accessing connectors at the control:

a. Disconnect the absolute encoder signal cable from the servo connector on the control (J1, J2, or J3).

b. At the **cable**, use a jumper to short pin 16 to pin 34 (which connect to pins S and R of the absolute encoder) for at least **2** minutes.



After shorting the pins together for the required time:

1. Make sure the control is OFF.

2. Reconnect the encoder cable to the control.

3. Make sure the battery that supplies battery backup to the absolute encoders is good and reconnect it.

ATTENTION: Battery power must be supplied to the absolute encoders prior to turning the control "ON". Power turn-on without first connecting the absolute encoder battery may result in a "Servo AMP Error." The control remains in E-STOP and E-STOP reset is ignored. To recover from this condition, follow the procedure for resetting absolute encoders.

---

4. Leave the motor connected to the backup battery through the feedback cable for at least 1 second before turning the control ON.

The axis is then ready to be homed.

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Resetting an Absolute Encoder on the 9/260 and 9/920

Important: The following procedure is no necessary if you are using distance–coded markers or a Stegmann feedback device.

At the control:

1. Move the axis that the absolute encoder is configured for in AMP to the desired zero coordinate position for that axis.

2. Turn OFF the control and the main ac power switch.

ATTENTION: Never adjust the control unless the main AC disconnect switch is open (off) and locked.

At the servo module:

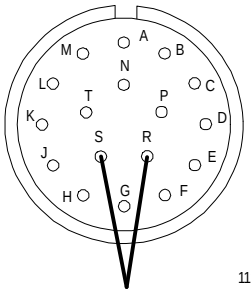
1. Disconnect the battery that supplies battery backup to the absolute encoder being reset.

2. Determine whether it is easier to disconnect and access connectors at the servomotor or at the servo module.

If accessing connectors at the 8500 digital servo motor:

a. Remove the cable that is connected to the absolute encoder to be reset.

b. At the **encoder,** use a jumper to short pin R to pin S of the absolute encoder for at least **2** minutes.

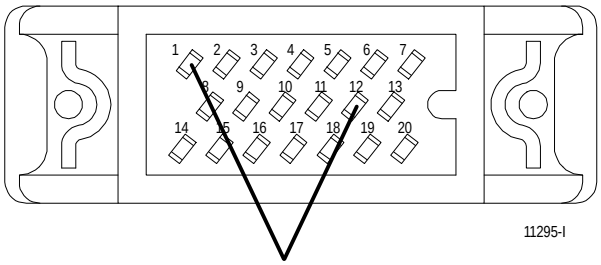


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If accessing connectors at the 8520 digital servo module:

a. Disconnect the absolute encoder signal cable from the encoder feedback port on the servo module (CN5, CN6, or CN7).

b. At the **cable**, use a jumper to short pin 12 to pin 1 (which connect to pins S and R of the absolute encoder) for at least **2** minutes.



After shorting the pins together for the required time:

1. Make sure the control is OFF.

2. Reconnect the encoder cable to the control.

3. Make sure the battery that supplies battery backup to the absolute encoders is good and reconnect it.

ATTENTION: Battery power must be supplied to the absolute encoders prior to turning the control "ON". Power turn-on without first connecting the absolute encoder battery may result in a "Servo AMP Error." The control remains in E-STOP and E-STOP reset is ignored. To recover from this condition, follow the procedure for resetting absolute encoders.

---

4. Leave the motor connected to the backup battery through the feedback cable for at least 1 second before turning the control ON.

The axis is then ready to be homed.

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13A.9.4 Using a Second Feedback Device

A second feedback device can be attached to your machine (normally mounted directly to the moving axis member to avoid inaccuracies caused by the motor gearing).

When using a second feedback device, the incremental or absolute encoder mounted on the 8500 digital servo motor provides current and velocity loop feedback while a non-motor mounted second feedback device provides axis position feedback.

In many cases a system may not have enough feedback ports for all the closed loop axes and also to support additional second feedback devices. In these cases extra positioning feedback ports are available for the 8520 digital servo module using the optional feedback module. The optional feedback module is available only on the 9/260 and 9/290 controls that use the 3-axis servo module. The optional feedback module is not supported by the 4-axis servo module.

For detals on using a second feedback device with an 8500 Series motor refer to the section covering your specific 9/Series processor or servo card.

END OF SECTION

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Section 13B

8500 Digital Motor Dimensions

13B.0 Section Overview

The control may use either 8500 or 1326 digital servos or analog servos. This section is dedicated only to the mechanical dimensions of the 8500 digital servo motors that can be configured with the control. There are many variations of two basic 8500 digital servo motor configurations, with holding brake and without holding brake. This section is divided into two sections:

- **Section 13B.1 lists 8500 digital servo motors with a holding brake**
- **Section 13B.2 lists 8500 digital servo motors without a holding brake**

A motor dimension table follows the motor and shaft illustrations in both of these sections.

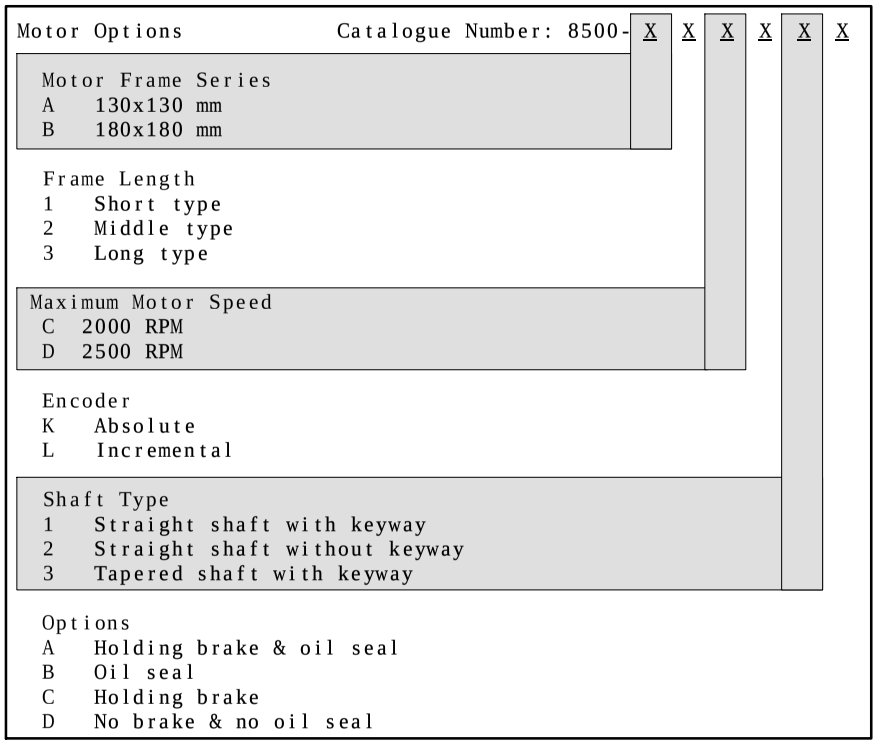
When determining which 8500 digital servo motor will best suit your needs, save time by first referring to page 13A-24. This section provides options and specifications information for the 1000/2000 RPM and 1500/2500 RPM 8500 digital servo motors. When you have chosen the appropriate motor(s), then return to this section for specific dimensions and additional motor options.

Important: This section only lists 8500 motors that are stocked at Allen-Bradley. Other motors are available as special order. Contact your local Allen-Bradley sales office for details on other available motors.

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Use the key below to decode the catalogue numbers, which provide information on motor frame series, frame length, maximum motor speed, encoder type, shaft type, and options.



For example: An 8500 digital servo motor with the catalogue number **8500–A1CL1A** is built as follows:

```
A = 130x130 motor frame series
1 = short frame length
C = maximum motor speed of 2000 RPM
L = incremental encoder
1 = straight shaft with keyway
A = holding brake & oil seal
```

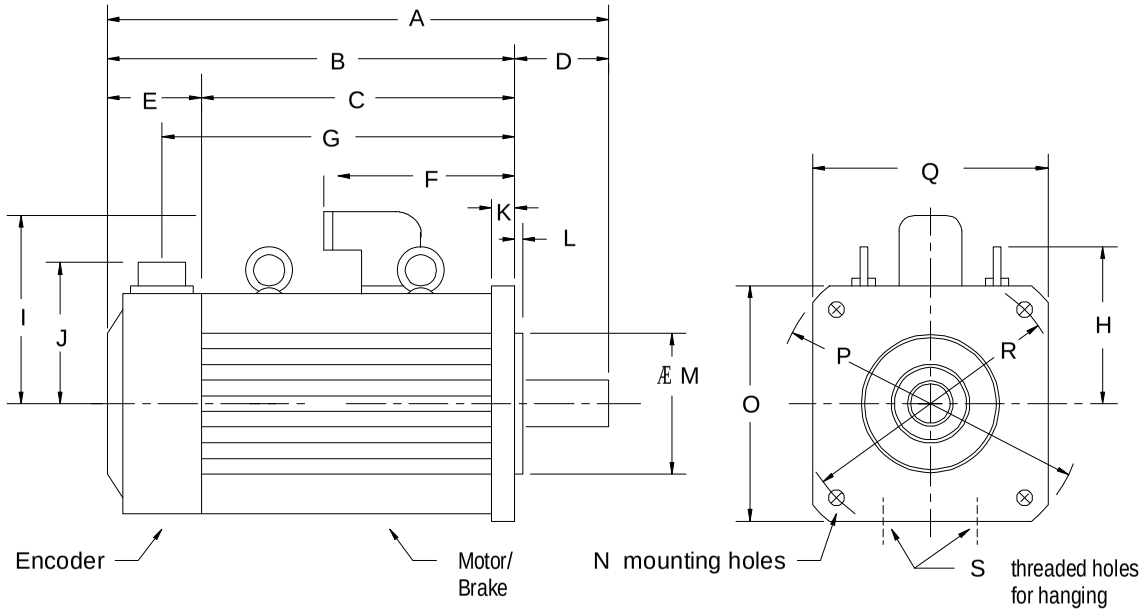
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This section is broken into two parts. Section 13B.1 discusses motors that come equipped with a holding brake. Section 13B.2 discusses motors that do not come equipped with a holding brake. Refer to the section discussing the motor that is applicable for your specific machine.

13B.1 8500 Digital Servo Motors With Holding Brake

Figure 1 shows a 8500 digital servo motor with the holding brake. Refer to section 13B.2 on page 13B-9 for details on 8500 digital motors without the holding brake option.

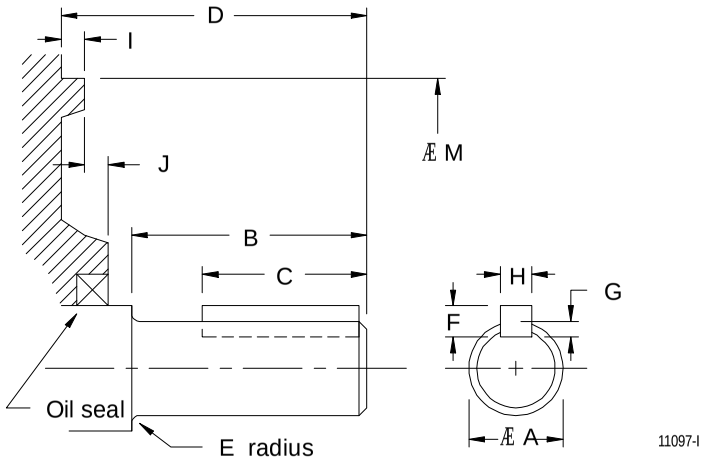
Figure 1
8500 Digital Servo Module with Holding Brake



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Figure 2 shows the shaft for standard 8500 digital servo motors with brake.

Figure 2
Straight Shaft with Keyway



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* Catalog Number	Motor and Shaft	See Figures on pgs 13B-3 and 13B-4	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Motor	Fig. 1	365	307	265	58	42	116	283	***	113	93	12	6	110 $^{+0.000}_{-0.035}$	4-Æ 9	130	165	130	145	--
8500-A2DL1A	Shaft	Fig. 2	19 $^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 1	366	308	253	58	55	118	280	***	113	92	12	6		4Æ 9	130	165	130	145	--
8500-A2DL1AN	Shaft	Fig. 2	19 $^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	6	--	--		--	--	--	--	--	
	Motor	Fig. 1	393	335	293	58	42	116	311	***	113	93	12	6		4-Æ 9	130	165	130	145	--
8500-A2DK1A	Shaft	Fig. 2	19 $^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 1	455	397	355	58	42	116	373	***	113	93	12	6		4-Æ 9	130	165	130	145	--
8500-A3DL1A	Shaft	Fig. 2	22 $^{+0.000}_{-0.013}$	40	25	58	1	6	3.5	6	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 1	436	378	323	58	55	118	350	***	113	92	12	6		4-Æ 9	130	165	130	145	--
8500-A3DL1AN	Shaft	Fig. 2	22 $^{+0.000}_{-0.013}$	40	25	58	1	6	3.5	6	6	6	--	--		--	--	--	--	--	
	Motor	Fig. 1	463	405	363	58	42	116	381	***	113	93	12	6		4-Æ 9	130	165	130	145	--
8500-A3DK1A	Shaft	Fig. 2	22 $^{+0.000}_{-0.013}$	40	25	58	1	6	3.5	6	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 1	429	350	276	79	74	165	311	124	143	110	18	3.2	114.3 $^{+0.000}_{-0.025}$	4-Æ 13.5	180	230	180	200	2-M8
8500-B1CL1A	Shaft	Fig. 2	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	422	343	289	79	54	164	315	123	143	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B1CL1AN	Shaft	Fig. 2	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	

* All dimensions are in millimeters *** Motor hooks are not available -- Dimension is not applicable

* Catalog Number	Motor and Shaft	See Figures on pgs 13B-3 and 13B-4	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Motor	Fig. 1	429	350	276	79	74	165	311	124	143	110	18	3.2	$114.3^{+0.000}_{-0.025}$	4-Æ 13.5	180	230	180	200	2-M8
8500-B1CK1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	429	350	276	79	74	165	311	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B1DL1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	422	343	289	79	54	164	315	123	143	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B1DL1AN	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	429	350	276	79	74	165	311	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B1DK1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	493	414	340	79	74	165	375	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B2CL1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	486	407	353	79	54	164	379	123	143	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B2CL1AN	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	493	414	340	79	74	165	375	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B2CK1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	

* All dimensions are in millimeters *** Motor hooks are not available -- Dimension is not applicable

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* Catalog Number	Motor and Shaft	See Figures on pgs 13B-3 and 13B-4	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Motor	Fig. 1	493	414	340	79	74	165	375	124	143	110	18	3.2	$114.3^{+0.000}_{-0.025}$	4-Æ 13.5	180	230	180	200	2-M8
8500-B2DL1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	486	407	353	79	54	164	379	123	143	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B2DL1AN	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	493	414	340	79	74	165	375	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B2DK1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	574	495	421	79	74	165	456	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B3CL1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	567	488	434	79	54	164	460	123	143	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B3CL1AN	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
	Motor	Fig. 1	574	495	421	79	74	165	456	124	143	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
8500-B3CK1A	Shaft	Fig. 2	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	

* All dimensions are in millimeters *** Motor hooks are not available -- Dimension is not applicable

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13B.2
8500 Digital Servo Motors Without Holding Brake

Figure 3 shows a 8500 digital servo motor without the holding brake. Refer to section 13B.1 for details on motors that come equipped with a holding brake.

Figure 3
8500 Digital Servo Motor Without Holding Brake

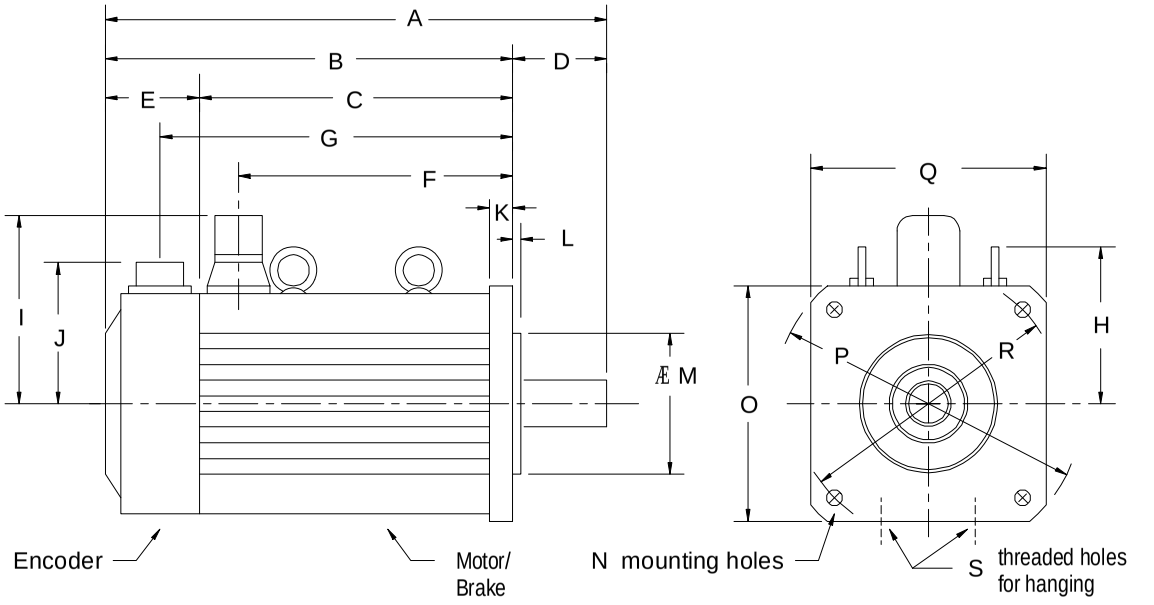
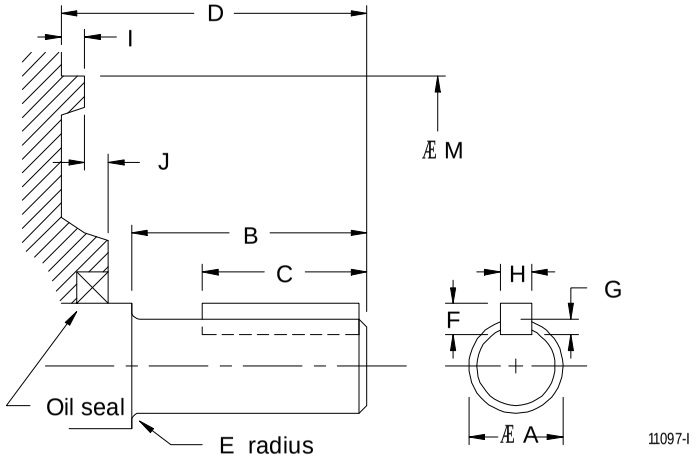


Figure 4 shows the shaft for standard 8500 digital servo motors without brakes.

Figure 4
Straight Shaft with Keyway



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* Catalog Number	Motor and Shaft	See Figure on pgs 13B-8 and 13B-9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Motor	Fig. 3	261	203	157	58	46	124	176	***	112	93	12	6	$110^{+0.000}_{-0.035}$	4-Æ 9	130	165	130	145	--
8500-A1DL1B	Shaft	Fig. 4	$19^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 3	263	205	150	58	55	127	177	***	109	92	12	6		4-Æ 9	130	165	130	145	--
8500-A1DL1BN	Shaft	Fig. 4	$19^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	6	--	--		--	--	--	--	--	
	Motor	Fig. 3	286	228	182	58	46	124	201	***	112	93	12	6		4-Æ 9	130	165	130	145	--
8500-A1DK1B	Shaft	Fig. 4	$19^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 3	318	260	214	58	46	181	233	***	112	93	12	6		4-Æ 9	130	165	130	145	--
8500-A2DL1B	Shaft	Fig. 4	$19^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 3	320	262	207	58	55	184	234	***	109	92	12	6		4-Æ 9	130	165	130	145	--
8500-A2DL1BN	Shaft	Fig. 4	$19^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	6	--	--		--	--	--	--	--	
	Motor	Fig. 3	343	285	239	58	46	181	258	***	112	93	12	6		4-Æ 9	130	165	130	145	--
8500-A2DK1B	Shaft	Fig. 4	$19^{+0.000}_{-0.013}$	40	25	58	1	5	3	5	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 3	406	348	302	58	46	250	322	***	112	93	12	6		4-Æ 9	130	165	130	145	--
8500-A3DL1B	Shaft	Fig. 4	$22^{+0.000}_{-0.013}$	40	25	58	1	6	3.5	6	6	8	--	--		--	--	--	--	--	
	Motor	Fig. 3	389	331	276	58	55	253	303	***	109	92	12	6		4-Æ 9	130	165	130	145	--
8500-A3DL1BN	Shaft	Fig. 4	$22^{+0.000}_{-0.013}$	40	25	58	1	6	3.5	6	6	6	--	--		--	--	--	--	--	

* All dimensions are in millimeters *** Motor hooks are not available -- Dimension is not applicable

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* Catalog Number	Motor and Shaft	See Figure on pgs 13B-8 and 13B-9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
8500-A3DK1B	Motor	Fig. 3	416	358	312	58	46	254	331	***	112	93	12	6	$110^{+0.000}_{-0.035}$	4-Æ 9	130	165	130	145	--
	Shaft	Fig. 4	$22^{+0.000}_{-0.013}$	40	25	58	1	6	3.5	6	6	8	--	--		--	--	--	--	--	
8500-B1CL1B	Motor	Fig. 3	350	271	197	79	74	172	237	***	137	110	18	3.2	$114.3^{+0.000}_{-0.025}$	4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B1CL1BN	Motor	Fig. 3	344	265	211	79	54	172	237	***	139	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B1CK1B	Motor	Fig. 3	350	271	197	79	74	172	237	***	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B1DL1B	Motor	Fig. 3	350	271	197	79	74	172	237	***	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B1DL1BN	Motor	Fig. 3	344	265	211	79	54	172	237	***	139	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B1DK1B	Motor	Fig. 3	350	271	197	79	74	172	237	***	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	$35^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	

* All dimensions are in millimeters *** Motor hooks are not available -- Dimension is not applicable

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* Catalog Number	Motor and Shaft	See Figure on pgs 13B-8 and 13B-9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
8500-B2CL1B	Motor	Fig. 3	407	328	254	79	74	229	294	124	137	110	18	3.2	114.3 $^{+0.000}_{-0.025}$	4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B2CL1BN	Motor	Fig. 3	401	322	268	79	54	229	294	123	139	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B2CK1B	Motor	Fig. 3	407	328	254	79	74	229	294	124	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B2DL1B	Motor	Fig. 3	407	328	254	79	74	229	294	124	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B2DL1BN	Motor	Fig. 3	401	322	268	79	54	229	294	123	139	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B2DK1B	Motor	Fig. 3	407	328	254	79	74	229	294	124	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B3CL1B	Motor	Fig. 3	492	413	339	79	74	314	379	124	137	110	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	
8500-B3CL1BN	Motor	Fig. 3	486	407	353	79	54	314	379	123	139	92	18	3.2		4-Æ 13.5	180	230	180	200	2-M8
	Shaft	Fig. 4	35 $^{+0.010}_{-0.000}$	76	60	79	1	8	5	10	3.2	--	--	--		--	--	--	--	--	

* All dimensions are in millimeters *** Motor hooks are not available -- Dimension is not applicable

END OF SECTION

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Allen-Bradley Headquarters, 1201 South Second Street, Milwaukee, WI 53204 USA, Tel: (1) 414 382-2000 Fax: (1) 414 382-4444

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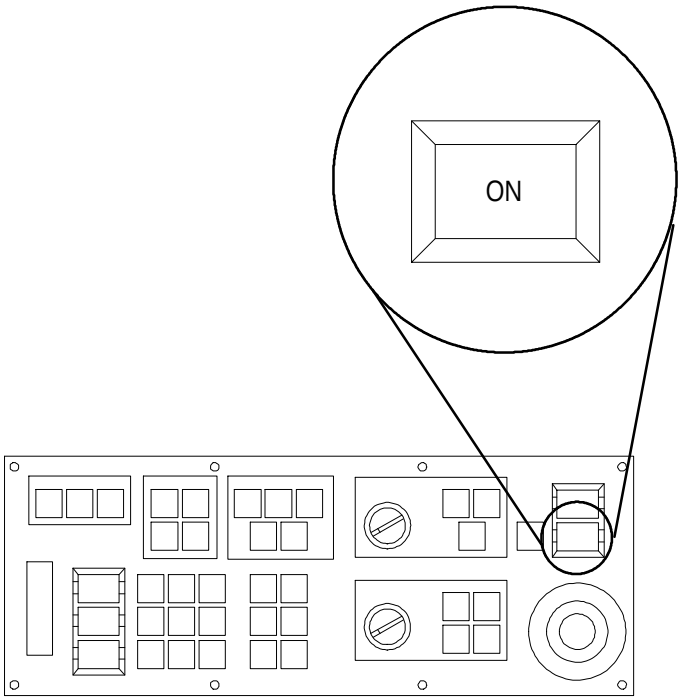
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Rockwell Automation
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9/Series Hardware
TAB 14

System Startup



852062-RM014A-EN-P - November 2000 PN-176962

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Section 14A

System Start-Up

14A.0 Section Overview

This section discusses the recommended 9/Series start up procedure. We recommend following this procedure where it is appropriate for your application. Additional start up procedures for deskew axes are also available in section 14B.

14A.1 Initial Control Power Up and Servo Start-Up Procedures

Once all the components of the control have been installed, the control can be turned on. The following procedure is recommended:

Important: The following procedure is designed to provide a basic start up procedure for standard motors. Contact the Rockwell Automation Web based Bulletin Board System . . . .

(http:// www. ab. com/ mem/ technotes/ techmain. html)

for start up information on non-standard motors and motor tuning procedures. Should there be any problems connecting to the bulletin board, please contact the Rockwell Automation / Allen-Bradley CNC Technical support group at 440–646–6800.



ATTENTION: It is recommended that the motors be mechanically disconnected from the axes during initial power up. If your system contains a split axis, both servos of the split axis must be reconfigured as independent axes for this procedure.

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Prior to pressing the "ON" button on the MTB panel:

1. Check all wiring connections, both electrical and fiber optic. Make sure inter-module connections correspond to the system wiring diagram covered starting on page 7A-1. Make sure grounding is adequately wired as directed on page 4D-10. If absolute encoders are used make sure the battery for absolute feedback is connected.

2. Check the external ac power supply. Make sure it will supply 115/230 V ac to the main power supply. Also test that the servo amplifiers are receiving proper voltage. If an analog servo system is being used refer to the manufactures documentation for amplifier power requirements. If a digital servo system is being used, the 8520 servo amplifiers should be receiving 3 Æ 220-240 V ac, and the 1394 or 9/440 system should be receiving 3 Æ 380 or 460 V ac.

3. Turn "ON" the circuit that supplies the external ac power. Do not push the power "ON" button on the MTB panel. Make sure the ac POWER indicator located on the front top of the main power supply is illuminated.

4. Make sure the E-Stop button is depressed.

5. Check the terminal block connections and the jumper settings of the servo amplifier. For an analog system refer to drives documentation provided by the manufacturer. For a digital system check against the terminal block connection and jumper setting tables starting on page 13A-1 (for 8520 drives), 11A-1 (for 1394 drives), or 5A-28 (for 9/440 CNCs).

6. Check the incoming ac for logic power to the servo amplifiers. For an analog system refer to documentation provided by the drives manufacturer. For a digital drive system, verify that the voltage listed below is present at the following terminals of the servo amplifier using a volt meter:

- 8520 Drives
  TB1-4 to TB1-5 170 to 253 V ac

The 8520 digital servo amplifier circuit board contains a green SYSTEM READY indicator light and a yellow BUS UNDER VOLTAGE indicator light. Both of these indicators should be illuminated. The SYSTEM READY indicator light indicates that the servo amplifier is receiving logic power. The BUS UNDER VOLTAGE indicator light indicates that 3 Æ 230 V ac motor power is not present at the TB1 terminal block.

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- 1394 Drive
  Power terminal block
  W1 and W2 24 V ac or dc

  and check test points on the wiring board:

TB3 Test Point	Voltage
TB3-1	+5V dc
TB3-2	Common
TB3-3	+15Vdc
TB3-4	-15Vdc

  The status LEDs on the axis modules should flash red and green alternately, indicating the system is ready and waiting for full bus voltage. The Status LED on the system module should be red. The system module LED only illuminates when a fiber optic ring fault occurs. It should be off anytime the CNC is powered up.

- 9/440 CNC/drive systems
  Assuming you wired your 9/440 as discussed starting on page 5A-28, power should be applied to your on/off control assembly but no drive power should be present. Both 24 V logic power and three phase should not be available to the system module at this point.

After performing the above checks:

7. Make sure the E-Stop button is depressed. Using the "ON" button on the MTB panel, turn on power to the control. The main menu screen should appear after the CRT warms up. For 1394 systems, the system module LED should turn off provided the fiber optic ring is functioning correctly. On 9/440 CNC systems, the status LED as well as the Xilinx and Watchdog LED should all be on.

8. If using a 1394 digital drive (not available for 9/440 CNC) check the 1394 I/O device monitor page to check fault status and addressing (see page 15A-29).

9. Using ODS, assign the AMP parameter values for each axis, then download the prepared AMP file to the control. Refer to the download section in the AMP manual for more information on downloading AMP files.

10. Download a "minimum" PAL program to the control. Refer to the download section in the PAL manual for more information on downloading a PAL program. This program should contain basic rungs to handle MTB panel, E-Stop, axis unclamp, etc.

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Important: The control will not come out of E-Stop if there is no PAL program available for execution.

11. If the error message "SERVO POWER UP SEQUENCE ERROR" is displayed on the operator panel CRT, verify that the AMP parameters match the servo cabling.

12. Verify polarity of position feedback. Access the axis monitor page. Feedback should count up when the axis is moved in the positive direction and count down when the axis is moved in the negative direction, when the encoder/resolver is installed. This is all relative to axis direction assignment, rotation direction changes through gearing, and encoder phasing.

Manually rotate the feedback device, check the axis direction and corresponding feedback count. If the feedback count is counting up when it should be counting down or counting down when it should be counting up, then the value of AMP parameter SIGN OF POSITION FEEDBACK should be changed to Minus.

13. Verify polarity of velocity feedback. On analog systems and digital systems with one feedback device, the AMP parameter SIGN OF VELOCITY FEEDBACK should always be the same as SIGN OF POSITION FEEDBACK**.** On the system with more than one feedback device, velocity feedback polarity should be determined by turning the motor shaft and watching the sign of axis monitor display parameter for Average Velocity Error.

14. Do a position calibration check. With the control in E-Stop, rotate the servo until the marker found is indicated on the monitor page. Record the position. While remaining in E-Stop, rotate the servo until the axis moves a measured distance. Record the monitor position. If the difference in monitor readings did not reflect the correct axis displacement, AMP must be adjusted. Typically this is the result of either axis calibration errors, incorrect number of position feedback counts/rev entered, or incorrect gear ratio between gear on motor shaft/lead screw thread pitch, etc...

15. If no error messages are displayed on the operator panel CRT, push the E-Stop Reset button on the MTB panel. Check the CRT for messages and watch for motor rotation. There should be no error messages or motor rotation. If a motor rotates without a command, immediately push the E-Stop button and check the motor and encoder wiring for correct phasing.

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16. Check the 3 Æ V ac incoming power to the servo amplifiers. For an analog system refer to documentation provided by the drives manufacturer. For a digital drive system, verify that the voltages listed below are present at the following terminals of the servo amplifier using a volt meter:

8520 Drives

- TB1-1 to TB1-2 170 to 253 V ac
- TB1-1 to TB1-3 170 to 253 V ac
- TB1-2 to TB1-3 170 to 253 V ac

The green SYSTEM READY indicator light should be illuminated. The yellow BUS UNDER VOLTAGE indicator light should be off.

1394 and 9/440 CNC/Drives

- Power terminal block
  U to PE 324 – 528 V ac
  V to PE 324 – 528 V ac
  W to PE 324 – 528 V ac

- The green axis module LEDs should now be solid green (not flashing).

17. Select manual jog mode and jog the selected axis at low speed. Check that the motor rotates with a low jog speed in the selected jog direction.

If the motor speed is correct but the motor rotation direction is incorrect, change the AMP parameter **SIGN OF POSITION FEEDBACK** for the selected axis to the opposite polarity setting. Change the parameter SIGN OF VELOCITY FEEDBACK if it no longer matches SIGN OF POSITION FEEDBACK. Download the new version of AMP to the control.

If the motor rotation direction is correct but the motor speed is uncontrollable, check that the feedback wiring at the servo module matches the phasing leads. Check the wiring from the power amplifier to motor and from motor feedback to servo module.

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18. Mechanically connect the motors to the axes.

If configuring a split axis the encoder marker alignment procedure must be performed before proceeding. This procedure may require you to leave your servos mechanically disconnected from the axis. Refer to page 14B-1 for details on aligning markers on a split axis.



ATTENTION: If configuring a split axis make sure that the axis is reconfigured with Deskew and homed before proceeding. Do not attempt to home the split axis unless the marker alignment procedure has been completed as discussed on page 14B-1.

19. Select incremental jog mode and jog the selected axis a known distance. Check that the motor rotates the correct numbers of turns and the machine moves the correct distance. If it does not, check the AMP parameters LEAD SCREW THREAD PITCH, TEETH ON GEAR FOR POSITION FEEDBACK and TEETH ON LEAD SCREW FOR POSITION FEEDBACK. If any adjustments are made, download the new version of AMP to the control.

20. Adjust the AMP parameters INITIAL GAIN OF POSITION LOOP**,** GAIN BREAK POINT, ACC/DEC RAMP and other motor specific parameters necessary to properly tune your system. After each adjustment, download the new version of AMP to the control. Continue to adjust these parameters until the desired response curve is obtained with no overshoot at various levels of cutting speeds.

21. Check the velocity response at various levels of the jog feedrate. Adjust the AMP parameter ACC/DEC RAMP until the control can be accelerated and decelerated without any problems. After each adjustment, download the new version of AMP to the control.

22. Using the value obtained for the INITIAL GAIN OF POSITION LOOP parameter, determine and enter correct values for the AMP parameters:

- INPOSITION BAND
- FEEDRATE SUPPRESSION POINT
- EXCESS ERROR

23. Download the new version of AMP to the control.

24. Repeat this procedure for each axis.

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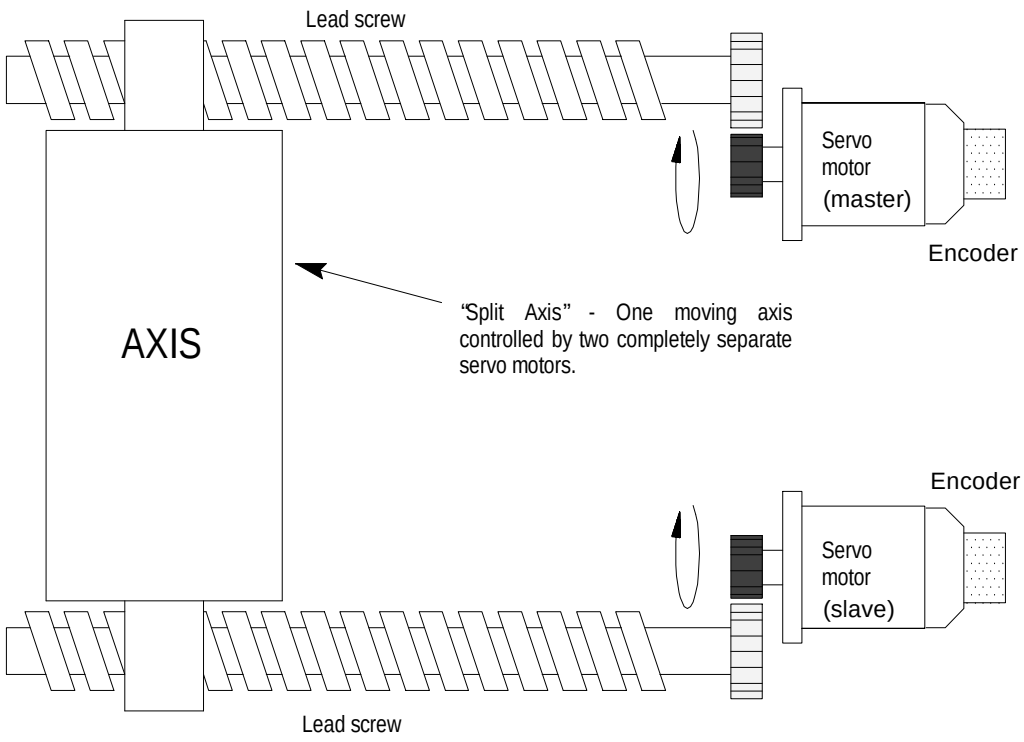
Section **14B**

Integrating a Split Axis with Deskew

14B.0 Section Overview

A split axis is a single axis that, due to size or precision requirements, is positioned by two separate servo motors. This section describes the servo connections, start up procedure, home marker alignment and motion considerations for a split axis.

Figure 14B.1
Split Axis Configuration



ATTENTION: Verify that you have purchased a control with the split axis option. If you configure a split axis (using deskew parameters in AMP) and your control is not equipped with the split axis option, the control will not come out of E-Stop.

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Skew is the difference between the position of the split axis master servo and the split axis slave servo. If the skew is too large, the axis or its drive components may be damaged due to mechanical binding.

To minimize axis skew, there are a number of "Deskew" parameters that are configured through AMP. The Deskew parameters are used to assign the master and slave axes, and to prevent damage from axis misalignment.

14B.1 Split Axis Servo Connections

Wire the servos motors of the split axis up to the servo module ports as defined in AMP. Wiring requirements are outlined starting on page 7A-1 of this manual. When configuring servo ports keep the following in mind.

If	then the slave	and the master servo
A spindle is configured to a port:	must be connected to the port directly before the spindle (spindle must be last port used on a system)	can be connected to any port before the slave port
A spindle is not configured to a port:	must be connected to the last port used in the system	can be connected to any port before the slave port

Port configuration is defined in AMP with the servo parameters. Your wiring must match your AMP configuration. Servos are designated as slave or master axes through the AMP Deskew parameters.

An example of the port assignments for a three axis system with a spindle and a split axis is shown below. This configuration uses two analog servo modules so that there are enough ports to provide output to the drives for the master and slave servo motors that move the X axis.

Port Connector	Axis Name (name of servo)	Configuration
J1	X	Configured as Deskew Master Servo Name
J2	Y	Normal Servo Configuration
J3	Z	Normal Servo Configuration
J1 (second module)	U	Configured as Deskew Slave Servo Name
J2 (second module)	C	Configured as Spindle

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14B.2 Split Axis Start up Procedure

The start up procedure for a split axis requires that both servos be tested separately. This means mechanically disconnecting the drive train of both servos and temporarily redefining them as independent axes in AMP. This can be done by setting the master and slave servo names in the AMP Deskew parameter group to “none”. Remember, AMP changes can be made either in ODS or through Patch AMP.

Once you have disconnected and redefined the split axis servo motors, perform the Initial Control and Servo Start Up Procedures starting on page 14A-1.



ATTENTION: Do not perform any homing operations during this start up procedure. Special homing considerations are given in the following section.

At step 18. of the start up procedure (on page 14A-6) you are instructed to complete the homing marker alignment if you are working on a split axis. At that point, return to the alignment procedure starting on page 14B-3 of this section. After you complete the marker alignment, you can return to step 19. (on page 14A-6) and complete the start up procedure.

14B.3 Split Axis Marker Alignment

To assure that minimal skew exists between servos of a split axis it is imperative that as small amount of skew as possible exists after the axes are homed. Once homed with minimal skew, the control can make sure the master and slave servo’s positions relative to each other remains constant. This requires that both servos of a split axis return to the same repeatable home position.



ATTENTION: Do not attempt to perform this procedure until the normal start up procedure has been started as discussed in the previous section.

At this point, you should have completed through step 18. of the start up procedure in 14A-6. You should have mechanically reconnected both servo motors to the axis and redefined those servos as master and slave using the AMP Deskew parameters.

Both servos of a split axis home off of the same single home switch. The homing sequence is almost the same for an axis with deskew as it is for a single servo axis. The axis moves to the switch, stops, moves off of the switch in the AMP specified direction, stops again, and then moves to the nearest encoder null marker.

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The difference for a split axis is that the distance to the nearest marker is calculated independently for the two servos and their home calibrations are configured separately. The move to the calibrated home position is calculated and executed independently and simultaneously on the master servo and slave servo.

In order for this home position for both servos to be one where minimum axis skew exists, it is necessary to align encoder markers. The recommended method of aligning markers is as follows:

1. Physically position the axis so that minimal skew exists. Measure skew on the axis with a precision square, dial indicator, or any device you find to be the most precise for your application.

2. Turn power to the control off and on again. When power is turned back on the servos will assume that they are in position and will hold the axis at minimal skew.



ATTENTION: Do not home the axis at this time. Any attempt to home the axes can result in large skew error and damage the servo drive components.

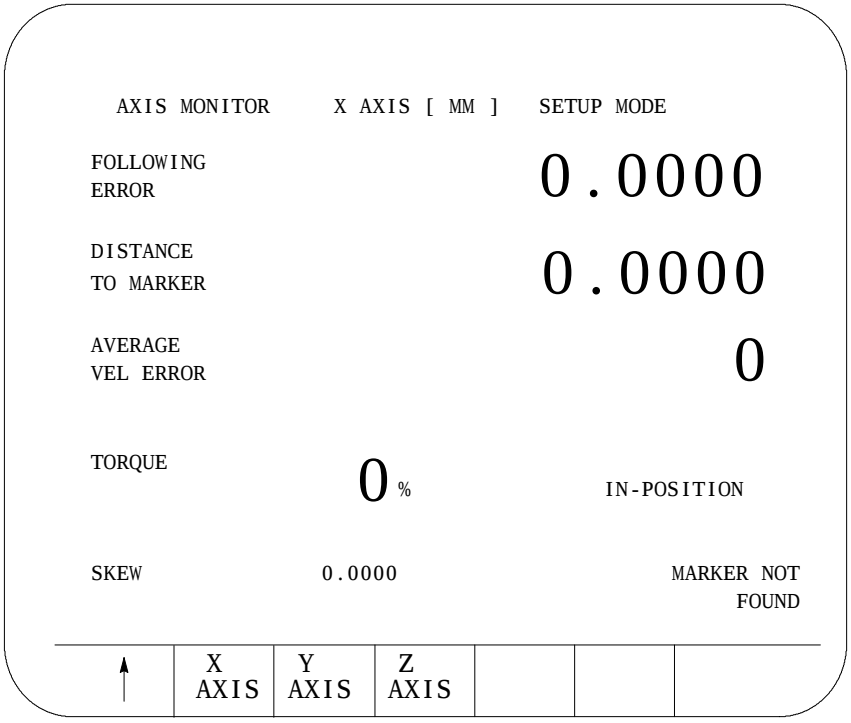
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3. Access the axis monitor screen using the following softkey strokes.

- **a.** Press the [SYSTEM SUPORT] softkey.
- **b.** Press the [MONITOR] softkey.
- **c.** Press the [AXIS MONITOR] softkey.

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Figure 14B.2
Axis Monitor Screen



4. Find the encoder marker for the master servo. First select the master axis name from the softkeys so that you are looking at data for the master axis. Then slowly jog the split axis (using the axis name defined in AMP as the master axis) while watching the lower right hand corner of the axis monitor screen. Jog the axis only until "marker found" is displayed.

5. Find the encoder marker for the slave servo. This time select the slave axis name from the softkeys so that you are looking at data for the slave axis. Then slowly jog the split axis (still using the axis name defined in AMP as the master axis) while watching the lower right hand corner of the axis monitor screen. Again, jog the axis only until "marker found" is displayed.

6. Physically secure the axis so that it cannot be moved. Use weights, clamps, or whatever is necessary to prevent axis skew from occurring while you work on the encoders.

7. Place the control in E-Stop and verify that power to the drives is turned off.

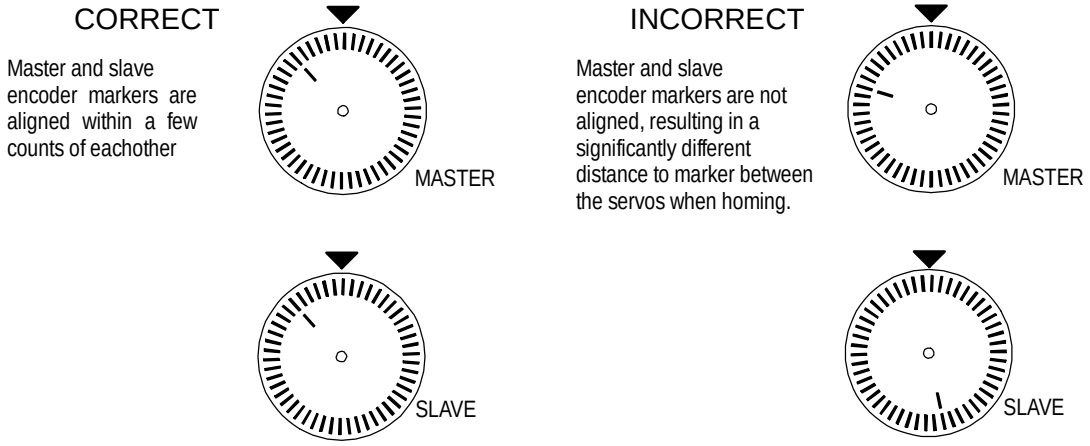
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8. Loosen the encoders for both servos. In most cases, you can loosen the encoder casing from its mounting without disengaging the encoder shaft. This way you can rotate the encoder and change its position reading without moving the axis.

Important: On all digital servo motors and some analog servo systems, rotation of the encoder relative to the motor is not possible. The encoder is mounted relative to the motor shaft at a specific location and cannot be moved. In these cases it is necessary to disconnect the servo drive linkage and rotate the motor shaft to align encoder markers.

9. Align the two servos' encoder markers. Align the encoder markers by rotating the encoder casing until the DISTANCE TO MARKER value on the display for each servo is as close to the same value as possible. Refer to Figure 14B.3.

Figure 14B.3
Aligning Master and Slave Encoder Markers



10. Tighten the encoders for both servos. This will assure that both servos are approximately the same distance from their markers when there is minimal axis skew.

11. Loosen the clamps or remove the weight you used to secure the axis in step 6.

12. Turn power to the control off and then back on again. When power is turned back on the servos will assume that they are in position and will hold the axis at minimal skew, this time with encoder markers aligned.

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Important: If you are doing this procedure on an absolute encoder and that encoder is attached to an axis that has been homed on this machine at any time in the past, DO NOT come out of E-Stop until you have completed the procedure discussed in section E.4.

13. Jog the split axis to the approximate area at which you want it to home. It should be within the adjustment range of your home limit switch. Check the axis monitor screen to see if "marker found" is displayed for either the master or slave servo. If it is, turn the control off and then back on again.

14. Slowly jog the split axis again, while watching the lower right hand corner of the axis monitor screen, until "marker found" is displayed for either the master or slave servo. Stop jogging immediately. Verify that you are still within range of the home limit switch. If not, jog the axis back to where it was, turn power to the control off and then back on again, and repeat this step jogging in the opposite direction.

At this point the encoders for both servos of your split axis are in a good position for homing. Verify that the axis position is a satisfactory home position and that the home limit switch can be mounted so that it just turns off at the current axis position.

Also review the Home Parameters chapter in the AMP reference manual to confirm your home parameter setup. Of special importance at this time are the "direction to home" and "direction to move off limit switch" parameters. Verify that they are compatible with your current axis configuration.



ATTENTION: The steps and figures in this section explain how to avoid conditions that can create excessive axis skew. Failure to follow this procedure this could result in serious damage to the machine and may cause personal injury.

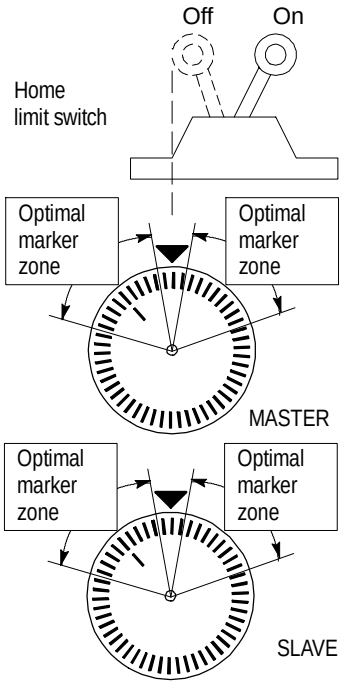
Figure 14B.4 illustrates the encoder alignment situation we have created and how we want to position it relative to the home limit switch.

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Figure 14B.4
Encoder Marker Positioning Relative to the Home Limit Switch

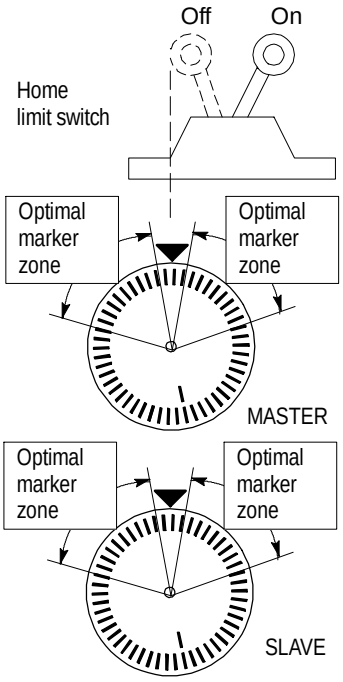
CORRECT

Master and slave encoder markers are aligned and positioned slightly away from where the home limit switch transitions from on to off. This insures that both servos will rotate a short distance in the same direction to find the nearest marker.



INCORRECT

Master and slave encoder markers are aligned but are positioned nearly 180 ° from the home limit switch transition. This results in a lot of servo motion to find the nearest marker and makes it unpredictable which way each servo will rotate.



Important: The following step is crucial to attain a repeatable home position and to assure both servos home to the same relative location. If the home switch cannot be moved, you should attempt to re-align the encoder markers (repeat steps 4. through 10.) to a location close to the home limit switch.

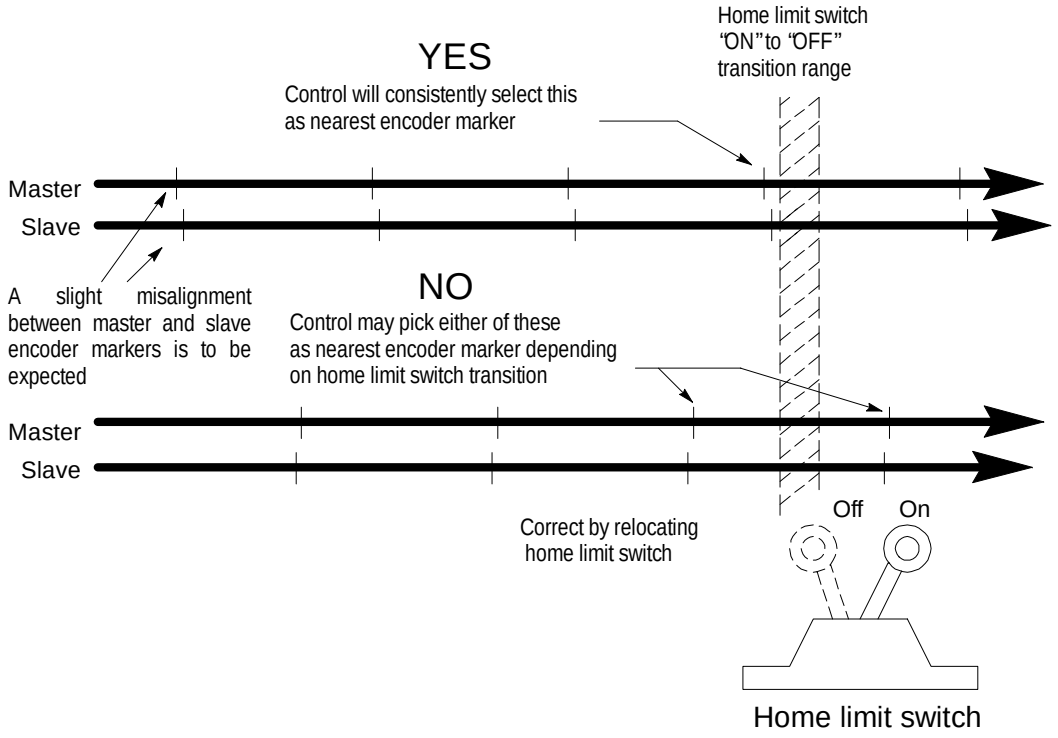
15. Position the home limit switch. Loosen the home limit switch and slide it against the axis or switch dog until it switches on. Then move it away from the axis until it just switches off. Move it a slight distance further and tighten it securely. (You may have to alter this step to accommodate the “direction to home” and “direction to move off limit switch” parameter settings for your machine.)

When the control homes an axis, it homes to the closest marker at the instant the home limit switch transitions from on to off. You should position the encoder markers close to but not directly at the trip point for the home limit switch as shown in Figure 14B.4.

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If the markers are close to zero degrees or 180 degrees away when the home switch is tripped, it is difficult to predict which way each servo will rotate to find the closest marker (see Figure 14B.5). This can create the undesirable situation in which the master and slave servos move in opposite directions to find the nearest marker. The worst case situation would be if the markers were close to 180 degrees away from the home switch and moved in opposite directions to find the nearest marker.

Figure 14B.5
Repeatable Motion to Encoder Marker



16. Home the split axis. This may be performed using either manual or automatic (G28) homing.

17. Fine tune the home position of each servo. If a small amount of misalignment exists between the two servos, adjustments can be made using the **Home Calibration** AMP parameter. Adjust the home calibration value for the servo with its marker closest to the home limit switch after homing. Home Calibration can adjust each servo's home position relative to its encoder marker. It does not adjust master and slave servo home positions relative to each other.

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For example, assume you have determined that the master servo is moving .012 farther than the slave servo when finding its marker during homing. This results in a .012 skew on the split axis that is undetectable to the control. Entering a value of .012 as the Home Calibration distance for the slave servo will compensate for the misalignment of markers. Be aware that the sign (+ or –) of the value you enter here as it determines which direction the slave axis will move from its marker.

Large amounts of skew should not be compensated for using the **Home Calibration** parameter. If a large amount of misalignment exists repeat the entire alignment procedure and get the master and slave encoder markers closer together.

After completing the alignment procedure described in this section, return to step 19. of the startup procedures from page 14A-6.

14B.4 Replacing an Absolute Encoder with Deskew

Do not attempt to come out of E-Stop after you have replaced an absolute encoder on an axis with deskew until you have read this section. When you replace an absolute encoder, there is no easy way to know the absolute position of either the replaced or existing encoders. Consequently the difference in the encoders absolute positions is seen to the control as a skew amount.



ATTENTION: Do not attempt to come out of E-Stop after you have replaced an absolute encoder without first zeroing any existing skew value. When E-Stop is reset the control attempts to remove any skew amount by driving the slave axes. Depending on the amount, and direction of the apparent skew created when an encoder is replaced, it may actually drive the axes in the wrong direction increasing the real skew and damaging the machine.

You must still perform the encoder marker alignment procedure discussed on page 14B-3 however do not bring the axes out of E-Stop.

The apparent skew amount created from absolute encoder replacement is not removed until the axes are homed. If this skew amount is greater than the configured maximum skew, then the control will not come out of E-Stop and you will be unable to perform a homing operation. The existing skew amount is zeroed by the following keyboard operation performed from the axis monitor page. Access the axis monitor page as follows:
{SYSTEM SUPORT} ® {MONI-TOR} ® {AXIS MONTOR}.

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Once on the axis monitor page, the skew amount is shown on the slave servo of a deskew axis. Zero the deskew amount by first pressing the [S] key by itself. Then while holding down the [SHIFT] key, press the axis name softkey of either the master or any slave servo in the deskew axis. This zeros any existing value of deskew for that deskew axis. It does not move the axes and does not remove any existing physical skew.

After you have zeroed the skew amount, you can bring the control out of E-Stop. The deskew axis absolute positions will be invalid however you can now perform a homing operation on the deskew axis. This will re-align the encoder markers, remove any skew amount, and compensate for the difference in absolute position between the absolute encoders.

14B.5 Split Axis Motion

The majority of screens on the control will not display any information for the slave of a split axis. In fact, to the end user only master servo information will be displayed. For part programming, jogging, and MDI operations the user commands motion using the master axis name. Both servos of the split axis respond equally. Requests to move the slave axis independent of the master axis are ignored.

A skew condition (one servo is out of position relative to the other servo) can result from unbalanced mechanical forces acting upon a split axis. It can also occur if some servo drift occurs when the system is in E-Stop. Skew amount is monitored as the difference in position between the master and slave servos (including any difference in following error while positioning). Any skew amount between the servos is displayed on the axis monitor screen of the slave servo (see Figure 14B.2).

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When motion requests are made to the master servo, both the slave and master always move to the same location at the same feedrate except in two cases:

- E-Stop when a skew condition exists

  The maximum skew amount is set in AMP with the parameter Excess Skew Limit. When this skew amount is reached the control is forced into E-Stop and can not be taken out of E-Stop until the axes are manually moved so that the skew amount is less than the Excess Skew Limit set in AMP.

  Anytime E-Stop is reset and some skew exists within the skew limit, the control will automatically eliminate the skew. The control automatically sends separate positioning commands to the slave servo to drive it to a position where zero skew exists between the master and slave servos.

- When Homing

  When homing the split axis, a single home limit switch is used. The distance from that limit switch to the home position is dependent on the closest marker position and the value entered for **Home Calibration**. The difference between the two home calibration values and the direction and distance to the closest marker are independent for both axes. This means they can receive different positioning commands to reach the home position.

END OF SECTION

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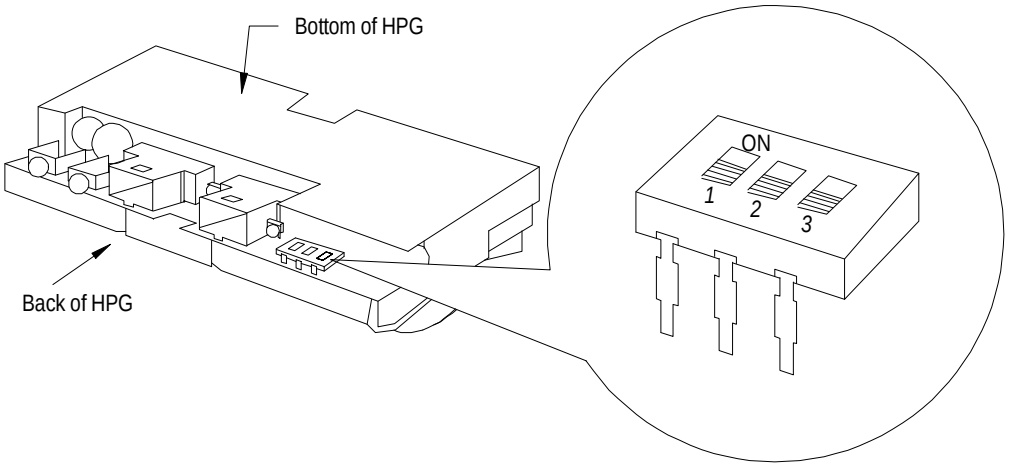
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9/Series Hardware
TAB 15

Troubleshooting and Replacement Procedures



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Section 15A

Troubleshooting the Control

15A.0 Section Overview

This Section presents some features available to you to help troubleshoot your control. These features include:

- System Initialization Software - This feature allows you to initialize the control to default AMP parameters and/or remove the existing PAL logic program.
- Search Monitor (online) – This optional feature allows you to search and monitor the PAL program using the operator panel.
- System Diagnostic Screens. Description and operation.
    - I/O ring diagnostics displays
    - remote I/O diagnostic displays
    - Fast I/O diagnostic displays (9/260 and 9/290 only)
    - Servo system diagnostic displays
    - Serial I/O diagnostics
    - data scope monitor

Additional troubleshooting features are available in other sections of this manual that include :

- A listing of error and status messages for identifying incorrect commands and configurations on the control is available at the end of this manual. Since electro-mechanical devices on the machine tool can also malfunction, these messages and their recoveries can also locate certain problems outside of the control.
- Offline Search Monitor – This feature is similar to the Online Search Monitor feature found on the control except the offline search monitor must interface through ODS and is displayed on the ODS workstation, not the operator panel. Refer to your 9/Series PAL reference manual for details.

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15A.1 System Initialization Software

This section describes the operation of a software utility supplied with your 9/Series ODS disks. This utility allows you to initialize the control to Default AMP parameters and /or remove the PAL logic program.

Use of this utility may become necessary if during power turn on (PTO) the CRT is blank and system watch-dog LED is not on, or if the PTO screen is displayed with no error messages and pressing "transmit" does not change the display. For example you may need to use this utility when a PAL program downloaded to the control requires a foreground scan time that is incompatible with the AMP defined "system scan time" parameter.

15A.1.1 Loading the Utility

This initialization utility is not activated in the same way that other ODS functions are called (pull-down menus). It must be converted from the compacted form as it is stored on the original ODS floppies to the hard disk of the workstation (PC).

1. Create a directory to be used for this utility, and "CHANGE DIRECTORY" to this directory. For example:

MKDIR TEMP
makes the directory called temp.

CD TEMP
changes to the temp directory.

2. Depending on the floppy disk size you are using, copy one of the files listed below from the original ODS disk to the new directory (TEMP in our example):

- INIT33.ZIP from the 3 1/2 inch disk #3
- For example:

COPY B:INIT33.ZIP C:\TEMP
copies the init33.zip file from the B: drive to the temp directory on the C: drive

3. While in the newly created directory (temp in our example), uncompress the Initialize utility using PKUNZIP. PKUNZIP is found on disk #1 of your ODS disks. Place disk #1 in the disk drive and enter the appropriate command based on which "INIT..." file was copied. For example:

B:PKUNZIP INIT33.ZIP
uncompresses the initialize utility

The initialize utility is now ready to use.

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15A.1.2 Using the Utility

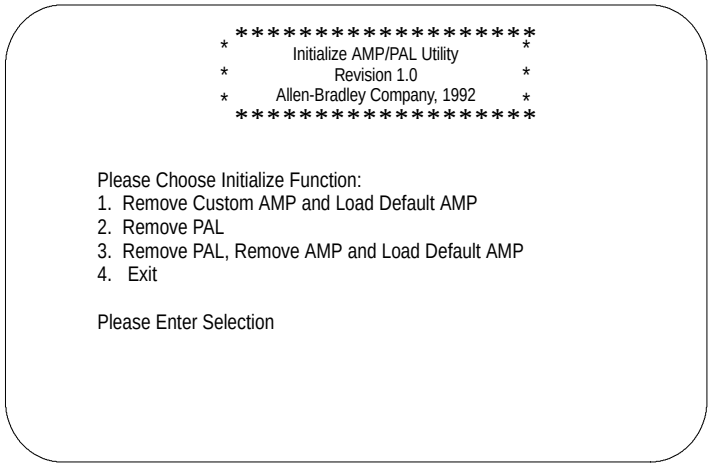
The following steps are for executing the Initialization utility.

1. While still in the selected directory, enter the command:

- *INIT9S*

  This will run the file INIT9S.EXE

2. The following should be displayed on the workstation screen:



Important: Note that the selections having to do with AMP cause both the AMP in RAM and the AMP in BACKUP to be removed from the control. This in turn will cause the DEFAULT AMP to be loaded to RAM.

Important: Note that the selections having to do with PAL will cause the PAL program in FLASH memory to be deleted.

3. At this point, you should power-down the CNC, if you have not already done so.

4. Make a selection (1-4) on the workstation. The workstation screen displays informative messages, and instructions.

5. Connect the workstation's serial port "COM1" to PORT B on the CNC.

6. Power-up the CNC. Then "press a key when ready" as indicated on the workstation (PC). This will start the process of deleting the AMP and/or PAL as selected in step 4.

7. The Workstation and CNC screens will display the status of the executing"INIT9S" utility. When complete, the utility is automatically exited.

8. Now cycle power to the CNC. This will load the default AMP (if AMP was cleared).

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This utility can remain on the workstation hard disk, and will not affect the operation of ODS. You can delete the file INIT33.ZIP or INIT57.ZIP from the hard disk.

15A.2 Search Monitor (online)

The search monitor utility is provided as a maintenance and debugging tool. It allows you to search and monitor the active PAL program using the control's operator panel. This feature is similar to the ODS PAL monitor utility however the search monitor utility does not require an independent workstation to monitor the PAL logic.

Important: For the search monitor feature to function, you must have previously downloaded the PAL source code along with your PAL program using the download "Control with source" option from ODS. Refer to your PAL reference manual for details on how to download the PAL source code.

If your PAL program with source is larger than the control has memory to store, ODS will selectively not download the source code for certain modules. Any modules that ODS has not downloaded the source code for can not be monitored using the search monitor utility. Identify modules that have not had their source code downloaded using the select module search option discussed on page 15A-9. Modules that have not had their source code downloaded with them are identified with the words "Source Not Included" displayed next to the module name.

The search monitor utility is an option on your 9/Series control. Refer to your original invoice to determine if you have purchased the search monitor option group.

The search monitor can also be password protected to prevent unauthorized access. Protecting the search monitor utility with password protection disables not only the softkey access to the utility, but the hotkey access as well. If however you password protect only the System Suport softkey, access to the search monitor utility is still available using the hotkey. Password protecting System Suport only prevents softkey access to the search monitor utility. Refer to your 9/Series Operation and Programming manual for details on password protection.

15A.2.1 Selecting Search Monitor

There are two methods to access the search monitor utility. The first method is using the softkeys and is discussed below. You can also access the search monitor utility using the hotkey discussed on page 15A-11. Access the search monitor utility using softkeys as follows:

Important: You can not use the [DISP SELECT] key to select displays when the search monitor utility is active. Additionally you can not use the search monitor hotkey if you have the [DISP SELECT] keys active. If you need to use the display select functions you must select the display prior to entering any of the search monitor screens.

1. Press the {SYSTEM SUPORT} softkey.

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(softkey level 1)

	PRGRAM MANAGE	OFFSET	MACRO PARAM	QUICK CHECK	SYSTEM SUPORT	→

2. Press the {MONI-TOR} softkey.

(softkey level 2)

↑	PRGRAM PARAM	AMP	DEVICE SETUP	MONI-TOR	TIME PARTS	→
↑	PTOM SI/OEM					→

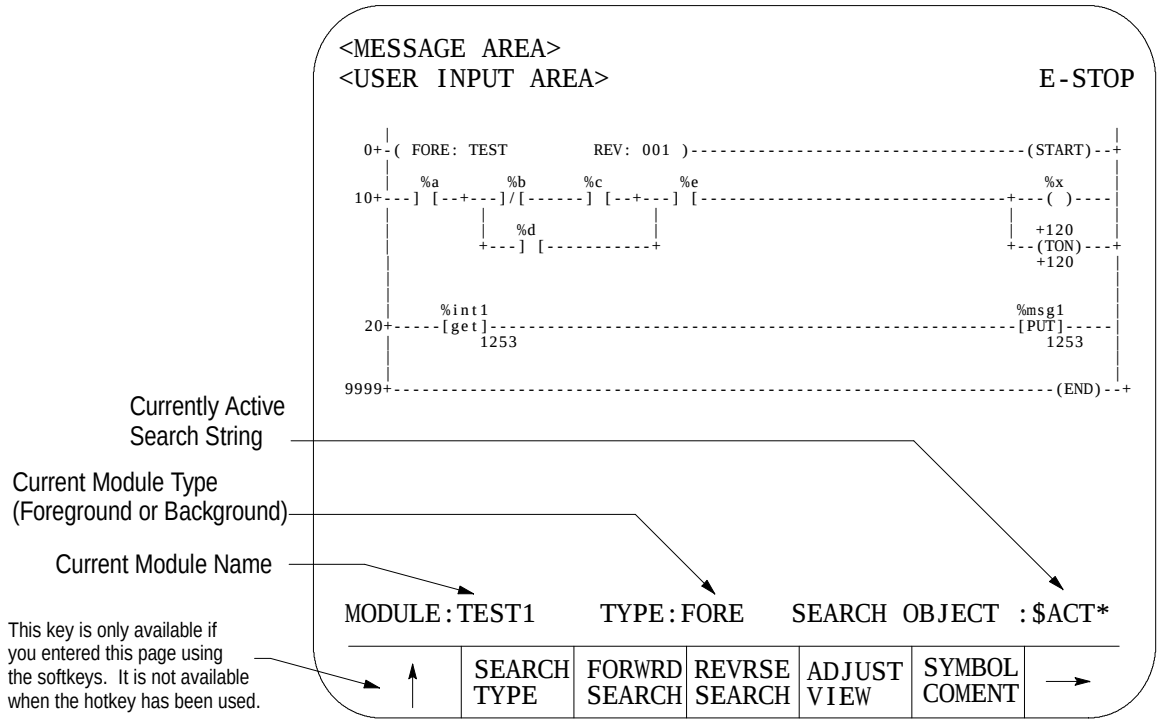
3. Press the {SEARCH MONITR} softkey to display the search monitor screen.

(softkey level 3)

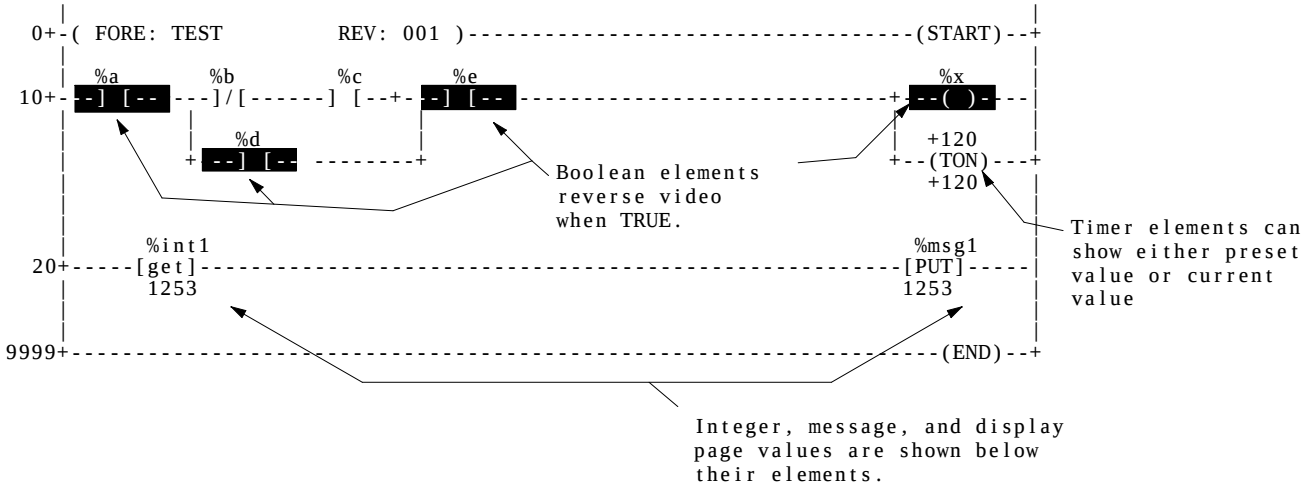
↑	RING I/O	REMOTE I/O	FAST I/O	AXIS MONTOR	SERIAL I/O	→
↑	DATA SCOPE	SEARCH MONITR				→

The search monitor utility is automatically enabled when you access the search monitor screen. The first rungs of the first PAL module are displayed when you access the search monitor utility. The following is an example search monitor screen:

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Boolean rung elements displayed on the monitor are shown in reverse video if they are “TRUE” as the control executes the currently active PAL program. The current values of the integer, message, and display page rung elements are displayed underneath their corresponding rung elements. The search monitor utility can be configured to display timer elements as either their preset value or their current value. The following is an example of a PAL rung being monitored.



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Important: While monitoring, the last executed rung that contains a specific rung element determines the value displayed for that rung element throughout the module. *For example, if a rung element in rung 10 is set "TRUE" but the same rung element is set "FALSE" in rung 200, it is displayed as "FALSE" in both rungs.*

While the monitor is active the following operator panel keys are available:

If you want to:	Press this key on the operator panel:
move up or down one rung at a time. If the monitor is at the last rung of a module, pressing the down cursor key will cause the monitor to move to the top of the next module of the same type. If the monitor is at the first rung of a module, pressing the up cursor key will cause the monitor to move to the bottom of the previous module of the same type. If the next module is not of the same type (foreground/background) you will be prompted to answer if it is okay to change module types.	[Up] Cursor [Down] Cursor
jump to the beginning or end of the module or jump to the next or previous module. If the next module is not of the same type (foreground/background) you will be prompted to answer if it is okay to change module types.	[Shift + Up] Cursor [Shift + Down] Cursor

15A.2.2 Using Search Functions

The search features of the search monitor utility allow you to search for a specific section of your PAL program.

There are 5 different searches available. Most search operations (with the exception of select rung and select module) all require a search string be selected prior to performing the search. Once the search string is entered, the search is performed by pressing the {FORWRD SEARCH} or {REVRSE SEARCH} softkeys. All of these search types are accessed by pressing the {SEARCH TYPE} softkey.

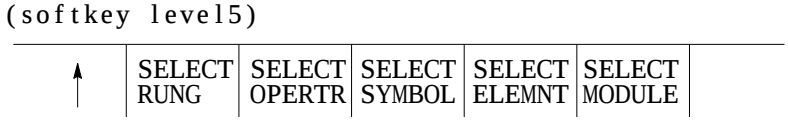


If the search fails to find the search string in the current module, it proceeds in the direction you have specified and searches the next module. If the next module is not of the same type (foreground module or background module) the search monitor utility asks if its okay to change module types. Answer yes to continue the search in the other module type. Answer no to abort the search.

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For example, your PAL program consists of three foreground modules and two background modules. You are currently in the second foreground module and you want to search for the symbol $ESTOP only in foreground. You enter the symbol $ESTOP as the symbol search type and press {FORWRD SEARCH}. This searches the rest of the second foreground module and the third foreground module. If it is not found in that direction when the utility reaches the first background module it prompts, SEARCH BACKGROUND MODULES (Y/N). Answering NO aborts the search and leaves the cursor at the original starting position. The search string is still in memory. Select {REVRSE SEARCH}. This searches the second foreground module from the cursor to the beginning of the module and the first foreground module. If the search string is still not found, the OBJECT NOT FOUND IN PROGRAM message appears and the search string does not exist in any foreground modules.

The five different types of searches are as follows:



Select Rung
Use this search type when you know the rung number that you want to monitor. When you press the {SELECT RUNG} softkey, the control will prompt you to enter a rung number. Enter a rung number between 1 and 9999 and press transmit (wild cards are not permitted with this search type). If it does not find the rung number in the current module, the message RUNG NUMBER DOES NOT EXIST is displayed. The search monitor utility will only attempt to find this rung number in the currently selected module. To search other modules you must change the active module using the Select Module option, or cursor keys.

Select Operator
Use this search when you need to search the PAL program for a specific operator (such as a GTO or TON). Refer to your PAL reference manual for details on these specific operators. To select an operator search press the {SELECT OPERTR} softkey. The search monitor utility displays a listing of the available operators. Use the cursor keys to select an operator and press transmit. Then select the direction you wish to search in using the {FORWRD SEARCH} or {REVRSE SEARCH} softkeys.

Select Symbol
Use this search when you need to search the PAL program for a specific symbol. This search operation allows the use of one wildcard character (*). Select the symbol search by pressing the {SELECT SYMBOL} softkey. The control will prompt you to enter a symbol. Enter that symbol name and press transmit. Then select the direction you wish to

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search in using the {FORWRD SEARCH} or {REVRSE SEARCH} softkeys.

Wildcards are permitted in symbol searches so you do not always have to know the full name of an element being searched for. Valid symbol search strings are a maximum of eight characters and can contain one wildcard. The wildcard character is the asterisk (*) symbol. Only one wildcard is permitted in a search string. The wildcard must come as either the first or last character in the search string. For example:

Valid Search Strings:		**Invalid Search Strings:**	
Search String:	**Finds symbols:**	**Search String:**	**Is Bad Because the search string:**
$S*	beginning with $S and ending with anything	*BRAKE*	can not have two wildcards
*GAGE	ending with gage and starting with anything	*TOOLARGE	can not be more then eight characters
!A*	symbol beginning with !A and ending with anything	$*S	wildcard must be the first or last character

Select Element
Use this search when you need to search the PAL program for the entire element. This includes both the operator (such as a normally closed (-]/[-) or normally open (-] [-) operator) combined with a symbol name (such as $ESTOP). You can use a wildcard character in the symbol name if desired (as discussed under symbol search). Refer to your PAL reference manual for details on these specific elements. To select an element search press the {SELECT ELEMNT} softkey. The search monitor utility displays a listing of the available operators and prompts you for the symbol name. Use the cursor keys to select an operator, key in the symbol name and press transmit. Then select the direction you wish to search in using the {FORWRD SEARCH} or {REVRSE SEARCH} softkeys.

Select Module
Typically a PAL program is broken up into smaller segments called modules. Use this search when you need to select a specific PAL module. To select a module press the {SELECT MODULE} softkey. The search monitor utility displays a listing of the modules in the current PAL program (foreground modules first followed by background modules). Use the cursor keys to select a module and press transmit. The first rungs of the module you have selected are displayed.

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15A.2.3 Displaying Symbol Comments

The {SYMBOL COMENT} softkey is only displayed if your system has had the PAL logic program downloaded with symbol comments. This softkey allows you to view or hide the comments that have been assigned to each logic symbol by the your system integrator. When symbol comments are displayed, each branch of a logic rung occupies nine lines on the display.
When Symbol comments are displayed, only two branches, of the possible seven, can be seen on the screen at one time. Use the {ADJUST VIEW} softkey to see the remianing branches (see the next section)



15A.2.4 Adjusting View

One PAL rung can contain up to seven branches, each branch using three lines of the display. This can result in a PAL rung that is three lines more than the 19-line display of the 9/Series monitor will allow. Use the {ADJUST VIEW} softkey to move the display up or down to allow you to quickly show the three lines that are not displayed at the end of a seven branch rung. The display toggles between showing the three lower and three upper lines of the displayed ladder rung each time the {ADJUST VIEW} softkey is pressed.
If you are displaying the symbol comments (see previous section) the {ADJUST VIEW} softkey will move the display down a up to three times to allow you to view all seven branches of every rung. Pushing this softkey when you are displaying the last branch of the rung will return the display to the first branch of the rung.



15A.2.5 Timer Displays

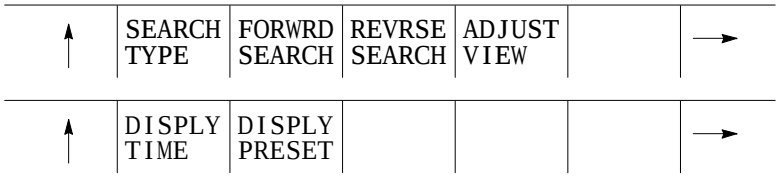
Rungs with timers can be configured to display either their preset values, or their current value in PAL. You can not display both the preset, and the current value at the same time. When you choose to display current value or preset for a timer, you are choosing the display format of all timer rungs. All timer rungs either display their preset, or their current value.

Display Time
Pressing the {DISPLY TIME} softkey will display the current value of the timer as it executes in PAL. The timers value is shown just below the timer element and changes as the timer is running.

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Display Preset
Pressing the {DISPLY PRESET} softkey displays the preset values assigned to the timer. The value just above the timer element shows the default preset value assigned to the timer when PAL was originally written. The actual preset value (since the preset can be modified with a –(PUT)– command) is shown just below the timer element. Typically both these preset values are the same.

(softkey level4)



The softkey of the current mode being displayed for timers is shown in reverse video.

15A.2.6 Using the Search Monitor Hotkey [SHIFT] + {® }

This feature of the search monitor utility is designed to allow you to quickly switch between most 9/Series screens and the search monitor utility. Using this feature of search monitor, you can jump directly from your current screen to the search monitor and return quickly. This is performed with a hotkey.

Use the search monitor hotkey as follows:

1. Select the screen to view using the normal softkey path.

2. You can now jump between the selected screen and the search monitor utility using the hotkey sequence which consists of [SHIFT] + {® } keys simultaneously (hold the shift and press the "more" softkey). Each time you press the hotkey, the search monitor utility will toggle between the search monitor screen and the selected screen.

Refer to the accessing the search monitor utility on page 15A-4 for details on how the search monitor information is interpreted and other search monitor restrictions.

Important: You can not use the [DISP SELECT] key to select displays when the search monitor utility is active. Additionally you can not use the search monitor hotkey if you have the [DISP SELECT] keys active. If you need to use the display select functions you must select the display prior to entering any of the search monitor screens.

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If you have designed custom screens through PAL (PAL display pages), you can not use the hotkey to jump to and from the search monitor utility from these screens.

The search monitor can also be password protected to prevent unauthorized access. Protecting the search monitor utility with password protection disables not only the softkey access to the utility, but the hotkey access as well. If however you password protect the System Suport softkey, access to the search monitor utility is still available using the hotkey. Password protecting System Suport only prevents softkey access to the search monitor utility. Refer to your 9/Series Operation and Programming manual for details on password protection.

15A.3 Setup Diagnostics

This section defines the setup diagnostic functions available to assist with integrating the control to the machine tool. The diagnostics can be run any time the control is powered up and the fiber optic ring is correctly connected.

The diagnostic functions are used to check and monitor all I/O devices. It can also be used to monitor individual axis parameters such as following error, torque, and others.

To access the control's diagostic functions:

1. Press the {SYSTEM SUPORT} softkey.

(softkey level 1)

	PRGRAM MANAGE	OFFSET	MACRO PARAM	QUICK CHECK	SYSTEM SUPORT	→

	FRONT PANEL	ERROR MESAGE	PASS-WORD	SWITCH LANG		→

If the control determines (through password identification) that the current user is allowed access, then the {MONITOR} softkey appears on the second softkey level. If this softkey does not appear, refer to the password and/or access control section of your operation and programming manual.

2. Press the {MONITOR} softkey.

(softkey level 2)

↑	PRGRAM MANAGE	AMP	DEVICE SETUP	MONI-TOR	TIME PARTS	→

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The diagnostic menu softkeys that will appear after pressing the {MONITOR} softkey are shown below.

```
(softkey level 3)
```

↑	RING I/O	REMOTE I/O	FAST I/O	AXIS MONTOR	SERIAL I/O

15A.4 I/O Ring Diagnostics

When the {RING I/O} softkey is pressed on the Main Diagnostics Menu screen, the Ring I/O screen will appear. At the top of the screen is the message "USE CURSOR FOR SELECTION", followed by "RING I/O" to identify the screen.

Figure 15A.1
Ring I/O Diagnostics Menu Screen

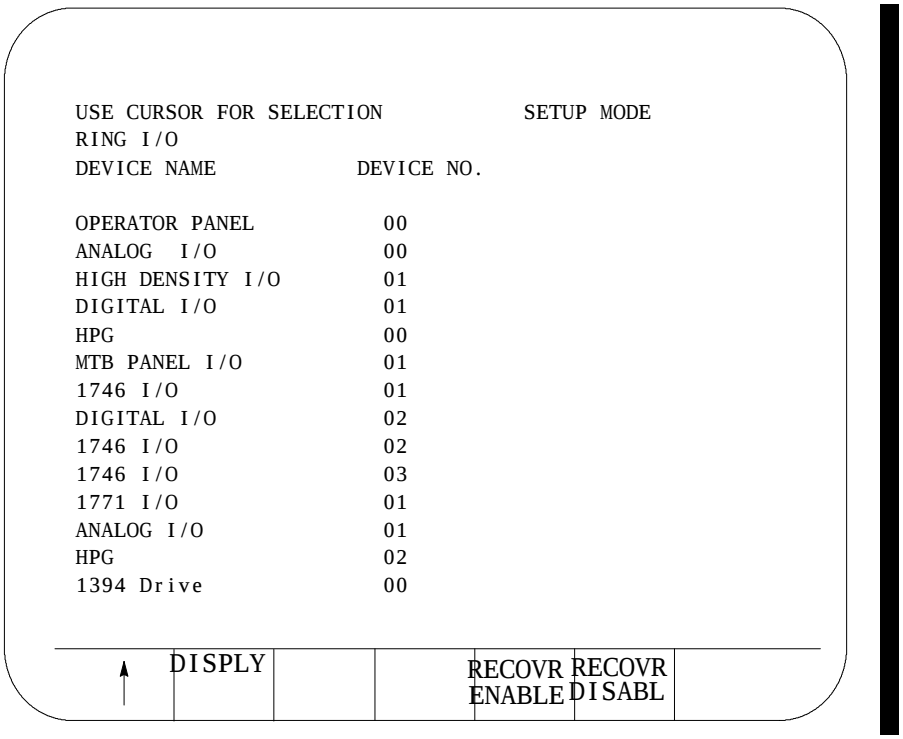


Figure 15A.1 is an example of a Ring I/O screen with a relatively large number of different devices.

The devices resident on the I/O ring are displayed in the order that they are physically connected on the ring. One screen displays up to 14 devices. If more than 14 devices are connected to the I/O Ring, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key to display another page of I/O Ring devices.

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Displayed to the right of the device is the device number. Assigning device numbers is explained starting on page 10A-1. Different types of I/O devices can have the same device number, however, when more than one of the same type of device is resident on the I/O Ring, each one must have a unique device number.

A device can be selected for diagnostic viewing by using the up or down cursor keys on the operator panel keyboard. If the cursor down key is pressed while the cursor is on the bottom line, the next page of devices is displayed (if more devices exist).

Pressing the {DISPLY} softkey after the desired device has been selected, will result in an I/O status screen being displayed, which may be used to monitor the selected device.

The {RECVRY -DISABLE} and {RECVRY -ENABLE} softkeys determine how the I/O ring will operate if the data integrity checks indicate a bad set of data from the ring.

- {RECVRY -ENABLE} : This is the Power Turn On mode. When active, the control will try to RECOVER by re-sending / re-reading the ring data. If the remains for a fixed number of retrys, an E-STOP is generated. After the E-stop is generated the control CONTINUES to re-try. This may result in the ring recovering after the E-stop and error message are generated. While this fault tolerent operation is normally good, it makes trouble shooting of an intermittent I/O ring difficult.

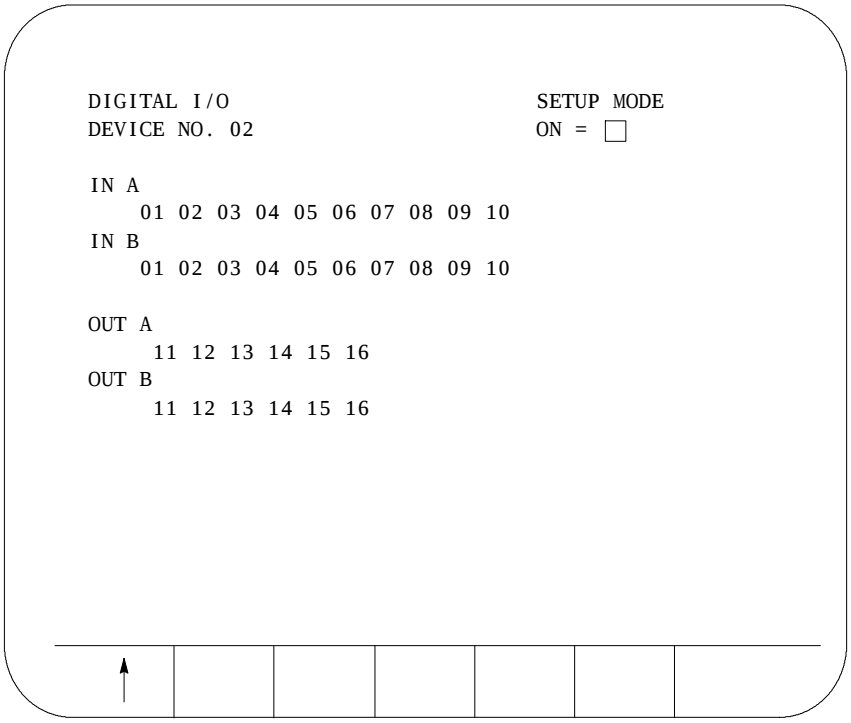
- {RECVRY -DISABLE} : This mode of ring operation can be selected for diagnostic purposes. When active, the control will not try to recover when a fault in the I/O ring data integrity is detected. It will immediately cause an E-STOP and do no retrys of the ring data. This allows the faulty Ring device to be more easily identified.

15A.4.1 Digital I/O

If a Digital I/O device is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the Digital I/O Diagnostics screen appears. Figure 15A.2 is an example of this screen.

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Figure 15A.2
Digital I/O Diagnostics Screen



The device number of the selected Digital I/O appears under the "DIGITAL I/O" heading. This will be a decimal number from 00 to 63.

This screen displays the inputs and outputs that correspond to the terminal numbers on the Digital I/O. These are IN A (1 through 10), IN B (1 through 10), OUT A (11 through 16) and OUT B (11 through 16).

If an input or output is "ON", its terminal number appears in inverse video. This is a real time display, and its response is limited only by delays in screen updates.

If more than one Digital I/O device is on the I/O Ring, a diagnostics screen for each of these devices can be displayed. To display a diagnostics screen for the next digital I/O on the ring, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key.

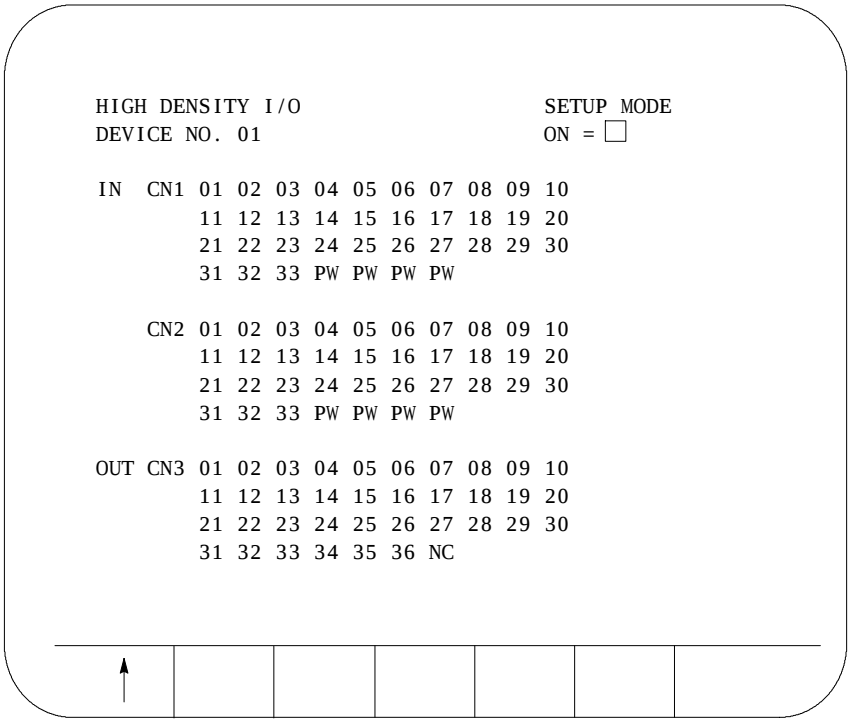
Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

15A.4.2 High Density I/O

If a High Density I/O device is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the High Density I/O Diagnostics screen appears. Figure 15A.3 is an example of this screen.

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Figure 15A.3
High Density I/O Diagnostics Screen



The device number of the selected High Density I/O device appears under the "HIGH DENSITY I/O" heading. This will be a decimal number from 00 to 63.

This screen displays the inputs and outputs that correspond to the pin numbers listed for the various connectors on the High Density I/O module. These are IN CN1 (01 through 37), IN CN2 (01 through 37) and OUT CN3 (01 through 37).

If an input or output is "ON", its pin number appears in inverse video. This is a real time display, and its response is limited only by delays in screen updates. The following abbreviated symbols may appear:

NC = no connection

PW = power connection

If more than one High Density I/O device is on the I/O Ring, a diagnostics screen for each of these devices can be displayed. To display a diagnostics screen for the next high density I/O on the ring, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key.

Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

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15A.4.3 1746 I/O Ring Adapter

If a 1746I I/O Adapter is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the 1746I I/O Adapter Diagnostics screen appears. Since the 1746I I/O Adapter is available in four different configurations, 4–slot Chassis, 7–slot Chassis, 10–slot Chassis, and 13–slot Chassis, there are four possible screens. Examples are shown in Figure 15A.4 and Figure 15A.5.

Figure 15A.4
1746 I/O Adapter Diagnostics Screen, 4 Slot Rack

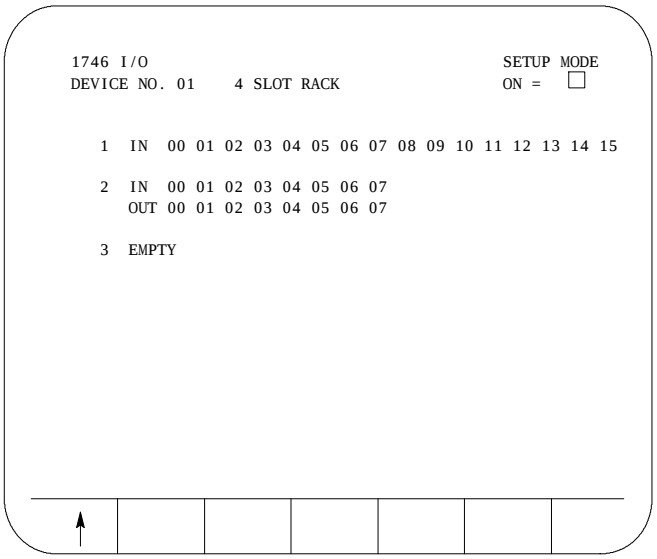
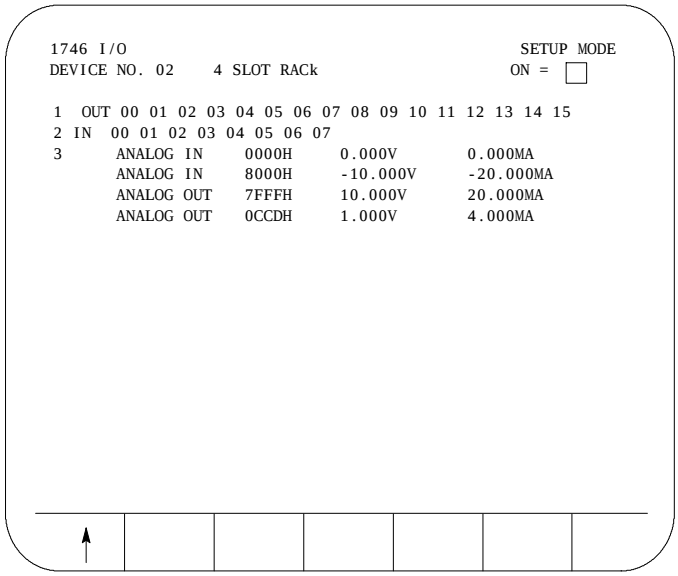


Figure 15A.5
1746 I/O Adapter Diagnostics Screen, 4 Slot Rack



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The device number of the selected 1746 I/O Adapter device appears under the "1746 I/O ADAPTER" heading. This number is selected on the 1746I module using a dip switch (refer to page 10B-4 for details) and used in the I/O assigner in PAL. Following the number is the message indicating whether it is a 4, 7, 10, or 13 slot rack.

If the selected device is a 7, 10, or 13 slot rack, two or three screens may be required to display all of the I/O data. When additional screens are available, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key to access additional screens with I/O data from the same 1746 I/O Adapter. Cursoring down below the last row on each screen will also access the next screen if it exists.

The 1746 I/O Adapter Diagnostic screen displays the inputs and outputs that correspond to the terminal numbers on the 1746 I/O Adapter module. They are listed in rows with each row representing a slot in the rack.

If an input or output is "ON", its terminal number appears in inverse video. If there is no I/O module in a slot, "EMPTY" follows the slot number. This is a real time display, and its response is limited only by delays in screen updates. Values for analog modules are displayed using four lines of the display.

If more than one 1746 I/O Adapter is on the I/O Ring, a diagnostics screen for each of these devices can be displayed. To display a diagnostics screen for the next 1746 I/O adapter on the ring, while on the last page of the current 1746 I/O adapter press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key.

Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

15A.4.4 1771 I/O Ring Adapter

If a 1771 I/O Adapter is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the 1771 I/O Adapter Diagnostics screen appears. Since the 1771 I/O Adapter is available in four different configurations, 4 Slot Rack, 8 Slot Rack, 12 Slot Rack, and 16 Slot Rack, there are four possible screens. Examples are shown in Figure 15A.6 and Figure 15A.7

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Figure 15A.6
1771 I/O Adapter Diagnostics Screen, 4 Slot Rack

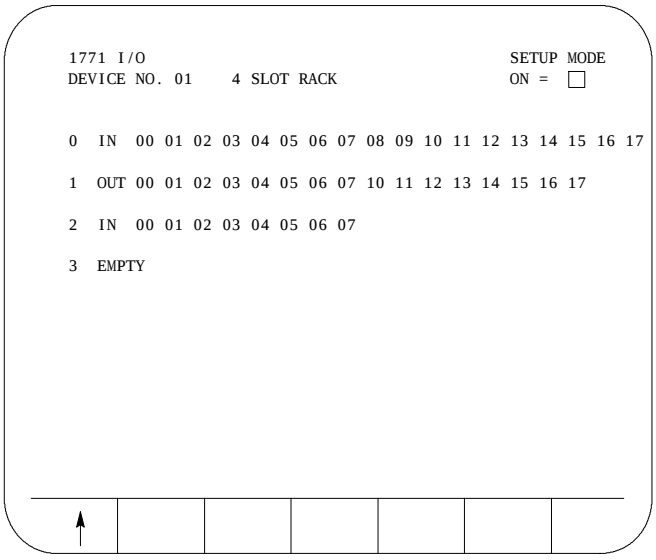
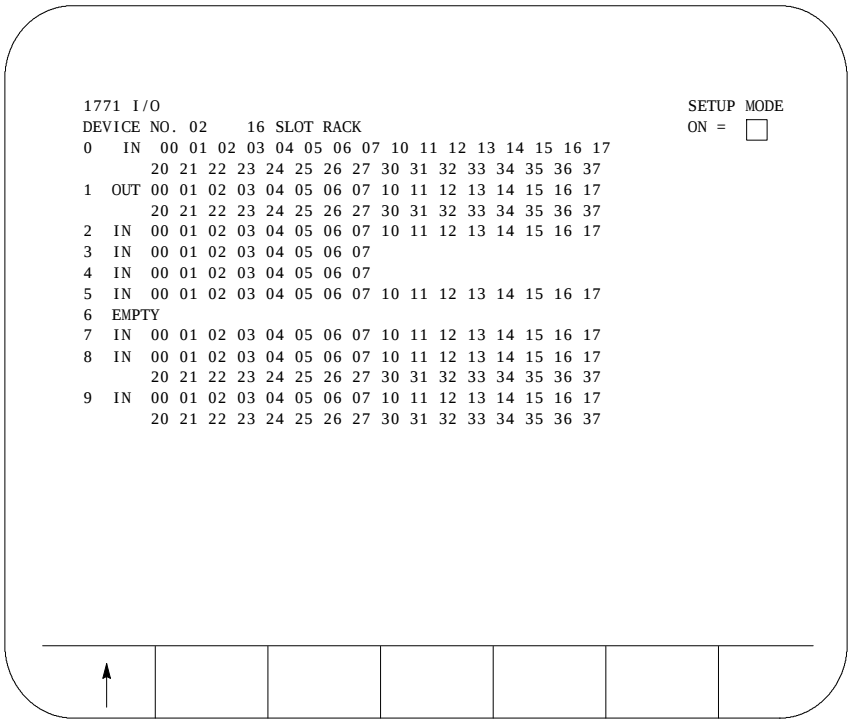
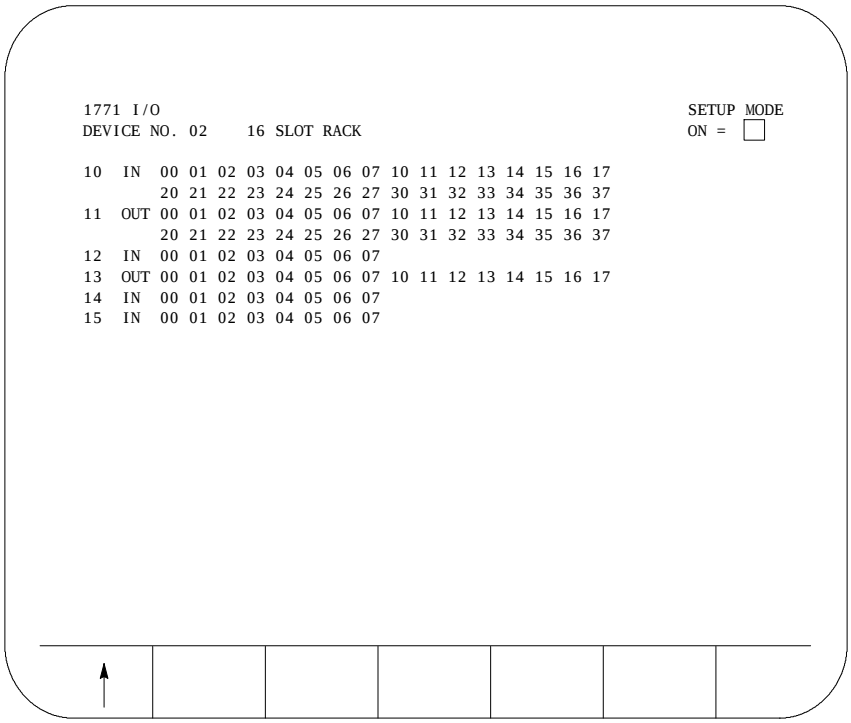


Figure 15A.7
1771 I/O Adapter Diagnostics Screen, 16 Slot Rack



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Figure 15A.7
1771 I/O Adapter Diagnostics Screen, 16 Slot Rack (continued)



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The device number of the selected 1771 I/O Adapter device appears under the "1771 I/O ADAPTER" heading. This will be a decimal number from 00 to 60. Following the number is the message indicating whether it is a 4, 8, 12, or 16 slot rack.

If the selected device is a 8, 12, or 16 slot rack, two or three screens may be required to display all of the I/O data. When additional screens are available, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key to access additional screens with I/O data from the same 1771 I/O Adapter. Cursoring down below the last row on each screen will also access the next screen if it exists.

The 1771 I/O Adapter Diagnostic screen displays the inputs and outputs that correspond to the terminal numbers on the 1771 I/O Adapter module. They are listed in rows with each row representing a slot in the rack. Since there can be 8, 16, or 32 terminals per slot, the 32 terminal slots will require two rows of the display.

If an input or output is "ON", its terminal number appears in inverse video. If there is no I/O module in a slot, "EMPTY" follows the slot number. This is a real time display, and its response is limited only by delays in screen updates.

If more than one 1771 I/O Adapter is on the I/O Ring, a diagnostics screen for each of these devices can be displayed. To display a diagnostics screen for the next 1771 I/O adapter on the ring, while on the last page of the current 1771 I/O adapter press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key.

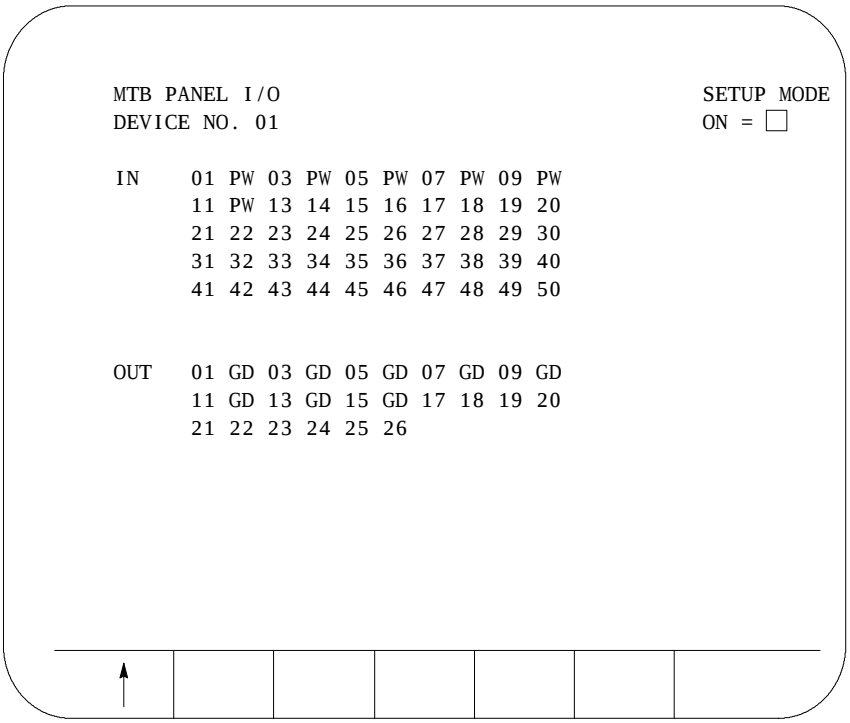
Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

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15A.4.5 MTB Panel I/O Diagnostics Screen

If a MTB Panel I/O device is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the MTB I/O Diagnostics screen appears. Figure 15A.8 is an example of this screen.

Figure 15A.8
MTB Panel I/O Diagnostics Screen



The device number of the selected MTB Panel I/O device appears under the “MTB PANEL I/O” heading. This will be a decimal number from 00 to 03.

This screen displays the input and output pin assignments that correspond to the input and output connectors on the MTB Panel I/O module.

If an input or output pin is “ON”, it appears in inverse video. This is a real time display, and its response is limited only by delays in screen updates. The following abbreviated symbols may appear:

PW = power connection

GD = ground connection

If more than one MTB Panel I/O device is on the I/O Ring, a diagnostics screen for each of these devices can be displayed. To display a diagnostics screen for the next MTB panel I/O device on the ring, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key.

Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

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Using the MTB Panel I/O Diagnostics Screen with the Push-Button MTB Panel

The signals from the push-button MTB panel are interpreted differently than those received by the rotary MTB panel. Since the MTB Panel I/O Diagnostics Screen displays only the pins for the rotary MTB panel, you need to use Table 15A.A and Table 15A.B to perform diagnostics on the push-button MTB panel with this screen.

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Table 15A.A
Push-Button MTB Panel Input Interface Ribbon Cable Pin Assignments

Pin No.	Function	Gray Code	PAL Device Name	Pin No.	Function	Gray Code	PAL Device Name
1	Cycle Stop	N/A	CN51-1	2	+12V	N/A	N/A
3	Cycle Start		CN51-3	4	+12V		
5	Single Block		CN51-5	6	+12V		
7	+X		CN51-7	8	+12V		
9	+Y		CN51-9	10	+12V		
11	+Z		CN51-11	12	+12V		
13	+4		CN51-13	14	AUTO	a	CN51-34
15	-X		CN51-15	16	MDI	b	CN51-32
17	-Y		CN51-17	18	MANUAL		
19	-Z		CN51-19	20	INCR	a	CN51-30
21	-4		CN51-21	22	CONT	b	CN51-28
23	TRVRS		CN51-23	24	HAND		
25	F5		CN51-25	26	HOME		
27	F6		CN51-27	28	X1	a	CN51-40
29	F 1		CN51-29	30	X10	b	CN51-38
31	F 2		CN51-31	32	X100	c	CN51-36
33	F 3		CN51-33	34	X1000		
35	F 4		CN51-35	36	X10000		
37	Feedrate Override “a”	a	CN51-38	37	Rapid Override F1	a	CN51-45
39	Feedrate Override “b”	b	CN51-40	39	Rapid Override 25	b	CN51-47
41	Feedrate Override “c”	c	CN51-42	41	Spindle Speed Override “d”	d	CN51-42
43	Feedrate Override “d”	d	CN51-44	43	Spindle Speed Override “c”	c	CN51-44
45	Not Used	N/A	N/A	46	Spindle Speed Override “b”	b	CN51-46
47				48	Spindle Speed Override “a”	a	CN51-48
49				50	Rapid Override 50		
51	Power Off			52	Rapid Override 100		
53	Power Common			54	CCW	a	CN51-49
55	Power On			56	OFF	b	CN51-50
57	E-stop			58	CW		
59	E-stop Common			60	Reset		N/A

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Table 15A.B
Push-Button MTB Panel Output Interface Ribbon Cable Pin Assignments

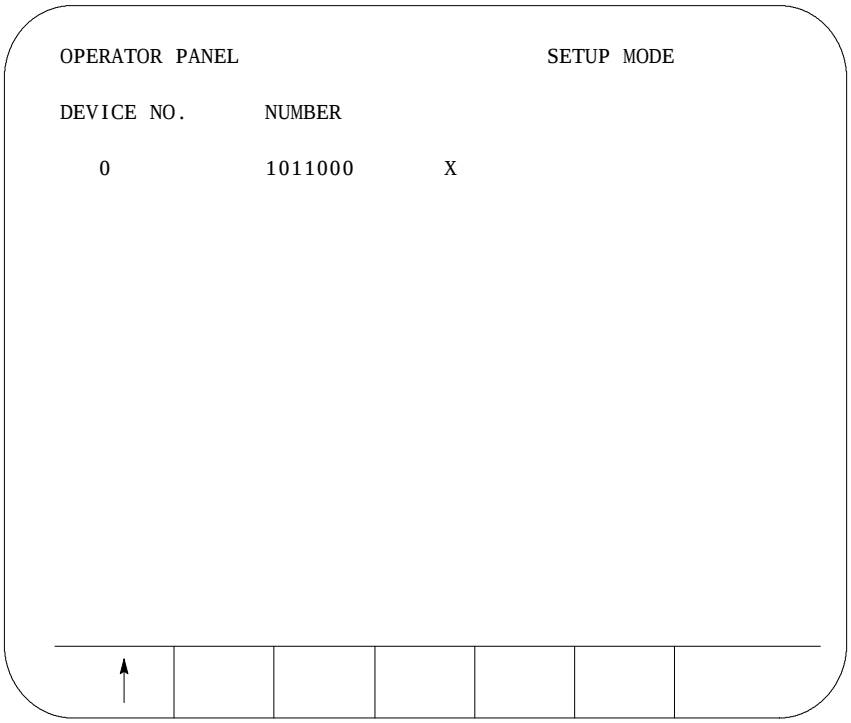
Pin No.	Function	PAL Device Name	Pin No.	Function	PAL Device Name
1	Cycle Stop	CN52-1	2	Ground	N/A
3	Cycle Start	CN52-3	4		
5	Single Block	CN52-5	6		
7	+X	CN52-7	8		
9	+Y	CN52-9	10		
11	+Z	CN52-11	12		
13	+4	CN52-13	14		
15	-X	CN52-15	16		
17	-Y	CN52-17	18	F 4	CN52-18
19	-Z	CN52-19	20	F 3	CN52-20
21	-4	CN52-21	22	F 2	CN52-22
23	Trvrs	CN52-23	24	F 1	CN52-24
25	F5 Jog Retract	CN52-25	26	F6 Block Retrace	CN52-26
27	Ground	N/A	28	AUTO	N/A
29			30	MDI	
31			32	MANUAL	
33			34	Rapid Override F1	
35			36	Rapid Override 25	
37			38	Rapid Override 50	
39	Not Used		40	Rapid Override 100	
41	X1		42	CCW	
43	X10		44	OFF	
45	X100		46	CW	
47	X1000		48	INCR	
49	X10000		50	CONT	
51	Ground		52	HAND	
53			54	HOME	
55			56	Ground	
57			58		
59			60		

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15A.4.6 Operator Panel Keyboard Diagnostics Screen

If an Operator Panel Keyboard (OPERATOR PANEL) device is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the Operator Panel Keyboard (OPERATOR PANEL) Diagnostics screen appears. Figure 15A.9 is an example of this screen.

Figure 15A.9
OPERATOR PANEL Diagnostics Screen



The device numbers of all operator panel devices that are on the I/O Ring will appear under the "OPERATOR PANEL" heading. These may be any decimal numbers from 0 to 3.

To the right of the device number is a number that represents the binary output from each of the operator panel keys. This number changes as the operator panel keys are depressed. The symbol of the key that is depressed will be displayed to the right of this number.

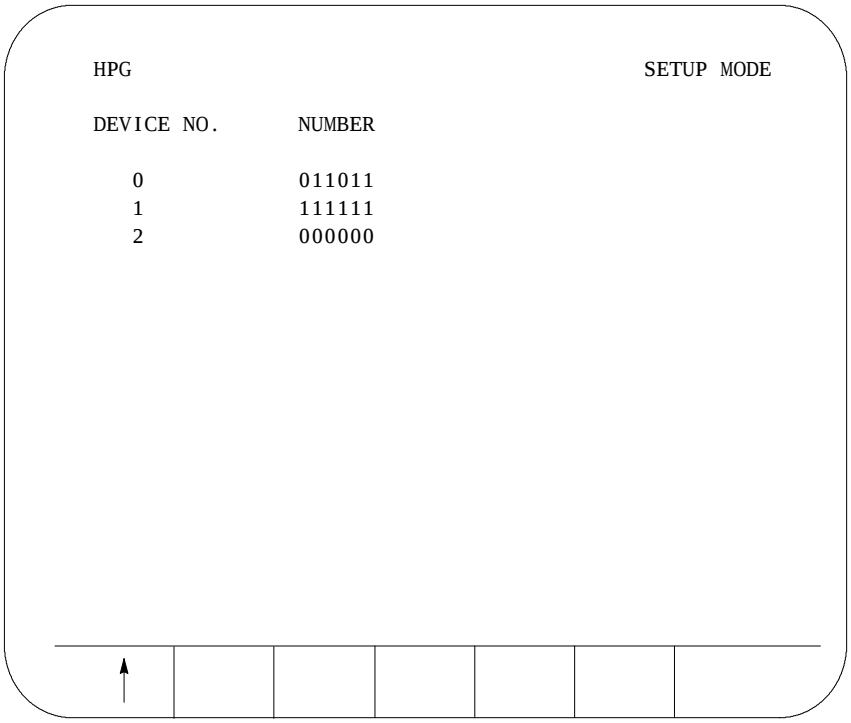
To verify key actuation, place a volt meter or oscilloscope probes between test points TP1 (GND) and TP2 (KEY_ON) located on the keyboard interface module. A logic high or +5V dc measured between TP1 and TP2 indicates a key actuation.

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15A.4.7 HPG Diagnostics

If a Hand Pulse Generator (HPG) device is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the HPG Diagnostics screen appears. Figure 15A.10 is an example of this screen.

Figure 15A.10
HPG Diagnostics Screen



The device numbers of all HPG devices that are on the I/O Ring will appear under the "HPG" heading. These may be any decimal numbers from 00 to 07.

To the right of each device number is a number for each of the HPG's. This is the pulse count value of the pulse counter that counts from 0 to 63 and then rolls over. Even though the number of pulse counts displayed for each HPG is limited to 64, the total pulse count of each HPG, which is stored internally by the system software, is unlimited.

Since this is a real time display, its response is limited only by delays in screen updates.

Only HPG devices connected to the I/O Ring are displayed on this screen.

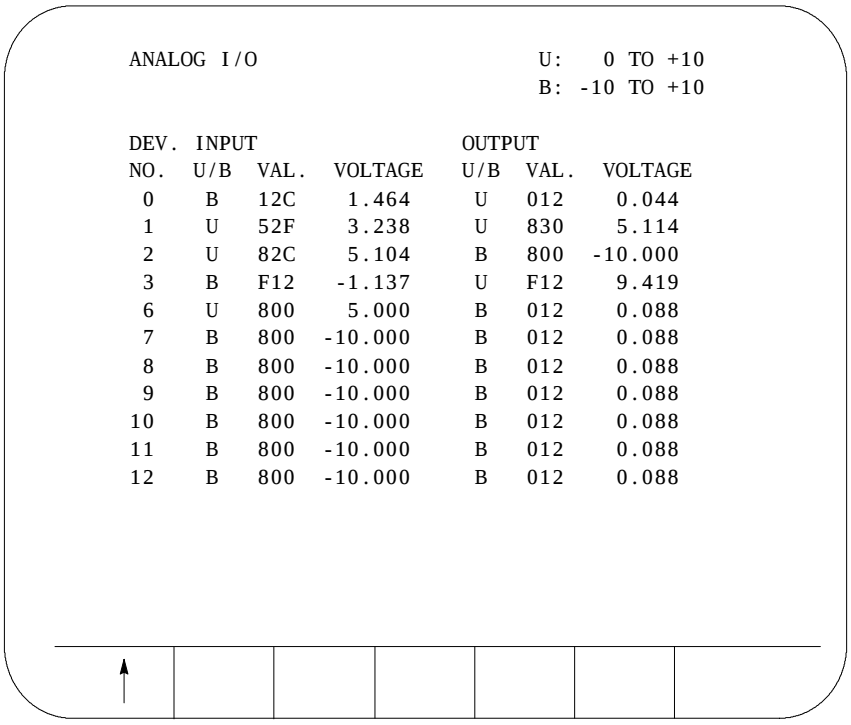
Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

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15A.4.8 Analog I/O Diagnostics Screen

If an 9/Series Analog I/O device is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the Analog I/O Diagnostics screen appears. Figure 15A.11 is an example of this screen. 1746 Analog I/O devices are discussed on page 15A-17.

Figure 15A.11
Analog I/O Diagnostics Screen



The device numbers for all Analog I/O devices that are on the I/O Ring will appear under the “ANALOG I/O” heading. These will be decimal numbers from 00 to 15.

If more than 13 Analog I/O devices are connected to the I/O Ring, press and hold the [**SHIFT**] key and press the [**DOWN-ARROW**] key to access the remaining devices. Pressing these keys or cursoring below the last device on the screen will cause the next Analog I/O Diagnostics screen to appear.

Each device listed is followed by several columns of diagnostic values. These columns are:

U/B	This indicates whether the device is Unipolar (0 to 10 volts) or Bipolar (-10 to 10 volts) as determined by device switch settings.
VAL.	This is the HEX representation of the digital equivalent of the analog voltage level from or to the device.
VOLTAGE	This is the voltage level from or to the device.

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These columns are duplicated for INPUT and OUTPUT for each device. The voltage values shown represent real time values with response limited only by delays in screen updates.

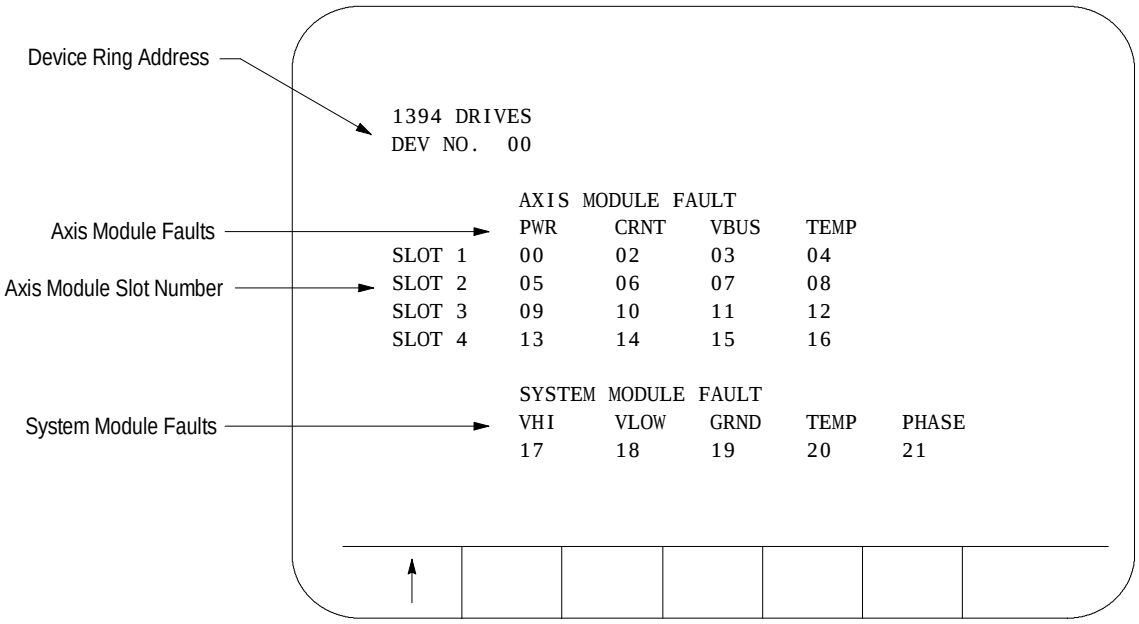
Pressing the exit softkey (up arrow) at any time displays the Ring I/O Menu screen.

15A.4.9 1394 Drives Diagnostics Screen

If a 1394 Drive is selected on the Ring I/O screen and the {DISPLY} softkey is pressed, the 1394 Drives Diagnostics screen appears. Figure 15A.12 is an example of this screen. 1394 drives are discussed on page 11A-1.

Important: This page only applies to 1394 drives that are present on the 9/Series fiber optic I/O ring. It does not apply to 9/440 CNC systems that are integrated into the 1394 drive.

Figure 15A.12
1394 Drive Diagnostics Screen



Note that the fault is active when the I/O number for that fault is shown in reverse video. The following table lists the axis module and system module faults and gives a description.

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Faults Axis Module	**Description**
PWR	The axis module hardware has faulted from an over current condition. The current through the power output transistors is monitored. If the current exceeds a fixed level (greater than 300% of controller rating) this fault will appear. Typical causes are a shorted lead, motor malfunction, or malfunctioning power IGBTs.
CRNT	One of the axis modules of your 1394 drive has been requested to provide too much current. This is typically caused by: Accel/Decel command from the CNC is requiring peak current for an excessive amount of time, the machine friction or inertial/viscous load is excessive, the motor has been improperly sized, a short circuit exists across the drive output terminals, logic supply circuits have malfunctioned, or AC input is incorrectly wired.
VBUS	The DC bus supply was lost to the axis module. Check slider connections/termination strip or there could be a blown link fuse.
TEMP[1]	The 1394 contains a thermal sensor which senses the internal ambient temperature. Causes could be: that the cabinet ambient temperature is above rating. The machine duty cycle requires an RMS current exceeding the continuous rating of the controller. The airflow access to the 1394 is limited or blocked.
Faults System Module	**Description**
VHI	The 1394 system module bus voltage exceeds the maximum operating voltage. The DC power bus is continuously monitored. If it exceeds a preset level (810 Vdc), a fault is sensed and the power supply is disabled. This can be caused by an under sized shunt requirement, shunt regulator fuse has blown, the shunt regulator transistor has malfunctioned, the power driver board is malfunctioning and incorrectly sensing the bus voltage, the CNC acc/dec rate is incorrectly set, the input line voltage is excessive, the system inertia is too high causing excessive energy to be returned to the power supply bus, or a vertical axis with insufficient counterbalancing is overdriving the servomotor and causing excessive energy to be returned to the power supply bus.
VLOW	The 1394 system module voltage does not meet the minimum operating voltage. The DC power buss shall activate the under voltage limit when the bus drops to 275 VDC or less. It will clear at 300 Vdc. Typical causes include low voltage on the three phase input.
GRND	The 1394 system module has detected a ground fault. The system generates a ground fault when there is an imbalance in the DC bus of greater than 5A. This drive error can be caused by incorrect wiring (verify motor and ground wiring), motor malfunction, or an axis module IGBT malfunction.
TEMP[1]	The 1394 contains a thermal sensor which senses the internal ambient temperature. Causes could be: that the cabinet ambient temperature is above rating. The machine duty cycle requires an RMS current exceeding the continuous rating of the controller. The airflow access to the 1394 is limited or blocked.
PHASE	The 1394 system module has detected a loss of one of the input power phases. The three-phase input line is monitored and a fault will be issued when a phase loss is detected. Typical causes include, one or more input line fuses have opened, contactor malfunction, or incorrect wiring.
1 Over Temperature Indicators are for the system module and axis modules only. They do not reflect any motor over temperatures that may occur. Motor thermal switches (if available) should be wired into the E-STOP string.	

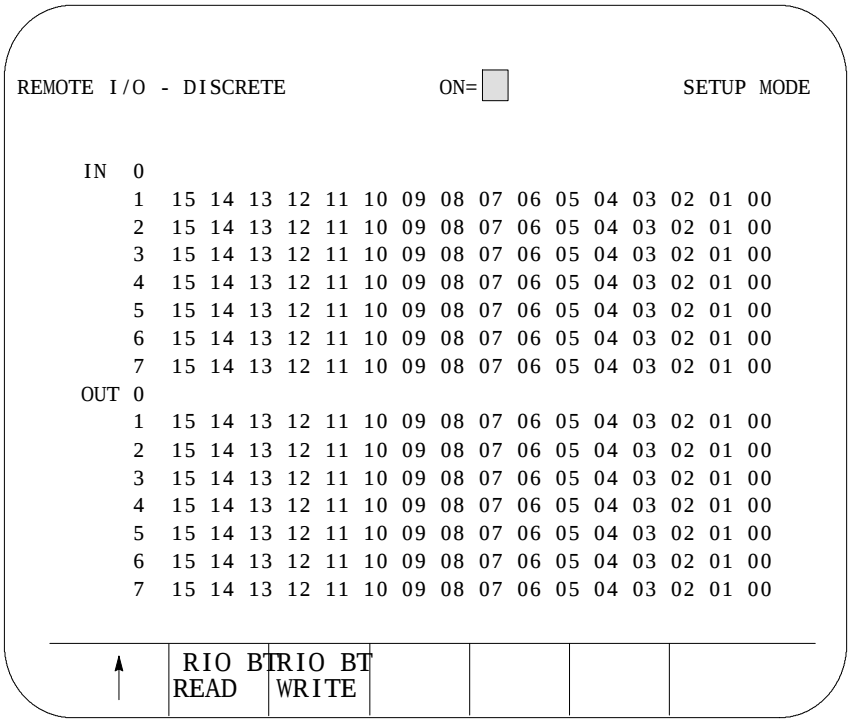
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15A.5
Remote I/O Diagnostics

When the {REMOTE I/O} softkey is pressed (only available on systems with remote I/O) on the Main Diagnostics Menu screen, the Remote I/O monitor screen appears. This first screen displays only single transfer remote I/O words. "REMOTE I/O" appears at the top to identify the screen, along with the "SETUP MODE" message indicating that the control is in setup diagnostics mode.

Figure 15A.13 shows an example of the Remote I/O screen.

Figure 15A.13
Remote I/O Diagnostics Screen



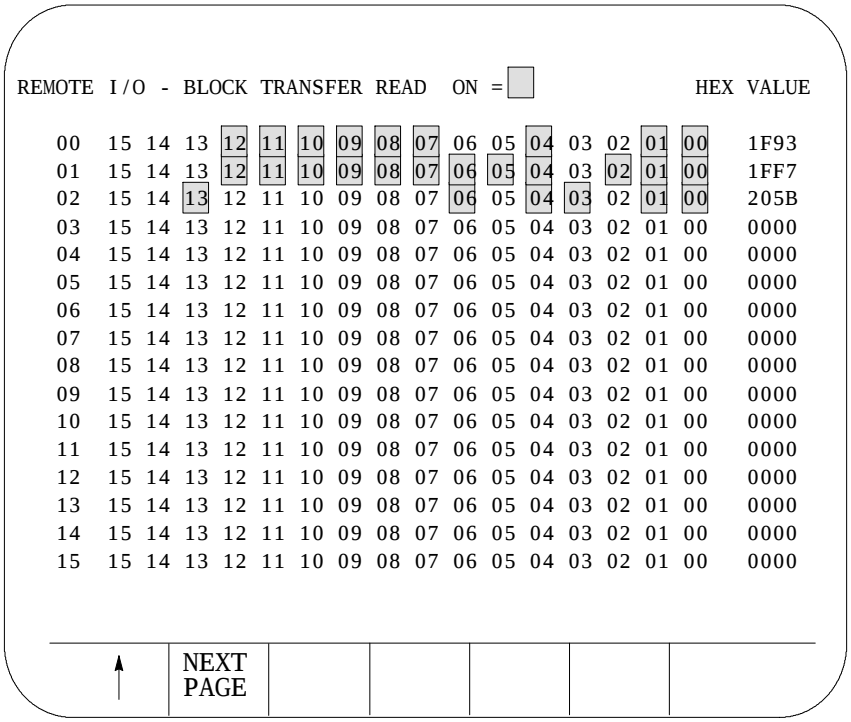
The screen displays the eight input and eight output ports available. Following each port number are numbers 15 to 00 which correspond to the bit numbers for each I/O point on the port. If an input or output bit number is "ON", it appears in inverse video. This is a real time display, response is limited only by delays in screen updates. The screen only shows the remote I/O words available on this system based on your rack size and starting address (as configured in AMP).

Pressing the exit softkey (up arrow) at any time displays the Main Diagnostics Menu screen.

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If block transfers are enabled (in AMP or using softkey) the first address in the rack (word 0 on above screen) will not be shown and the two RIO BT diagnostic softkeys appear. This first word is reserved for block transfer status information and can not be accessed by PAL. Pressing either the {RIO BT READ} or {RIO BT WRITE} softkeys displays the following screens:

Figure 15A.14
Remote I/O Block Transfer Read Diagnostics Screen



The block transfer write screen is similar to the above read screen. In addition to displaying the set bits of each word in reverse video, the right column of these screens display the hex equivalent value of the word. These screens display 16 words at a time of the total 64 block transfer words. Pressing the {NEXT PAGE} softkey displays the next 16 words. There are 32 block transfer read words and 32 block transfer write words.

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For 9/230, 9/440 and 9/290 systems with the remote I/O option using revision 10.01 or later firmware, both single, block transfer, and pass through remote I/O should be available depending on your AMP, PAL or softkey selection. The remote I/O module on the 9/260 is a standalone module with its own I/O processor and firmware revision. The following table illustrates some common 9/260 Remote I/O configuration errors.

	9/260 Remote I/O card Plugged into a 9/290	**PAL flag $RMON Not set in first PAL scan**	**$RMON is set but block transfer is disabled in AMP**	**$RMON s set and block transfer is enabled in AMP**
9/260 RIO card (01.01 or earlier) 9/Series Firmware prior to release 10.01	"FCM Revision Check Failure" displayed. Remote I/O is Disabled.	RIO Not Enabled	RIO is enabled for single transfers only. No block transfers or pass through.	N/A (AMP parameter did not exist)
9/260 RIO card (01.01 or earlier) 9/Series firmware that supports block transfers (10.01 or later)	"FCM Revision Check Failure" displayed. Remote I/O is Disabled.	"FCM Revision Check Failure" displayed. Remote I/O is Disabled.	RIO is enabled for single transfers only. No block transfers or pass through.	"FCM Revision Check Failure" displayed. Only single transfers enabled.
9/260 RIO card that supports block transfer (02.01 or later) 9/Series firmware that supports block transfers (10.01 or later)	"FCM Revision Check Failure" displayed. Remote I/O is Disabled.	Pass through enabled. RIO data unavailable to PAL logic.	RIO is enabled for single transfers. No block transfers. Pass through can be enabled using softkey.	Single transfers, block transfers, and pass through enabled. Softkey is not available.

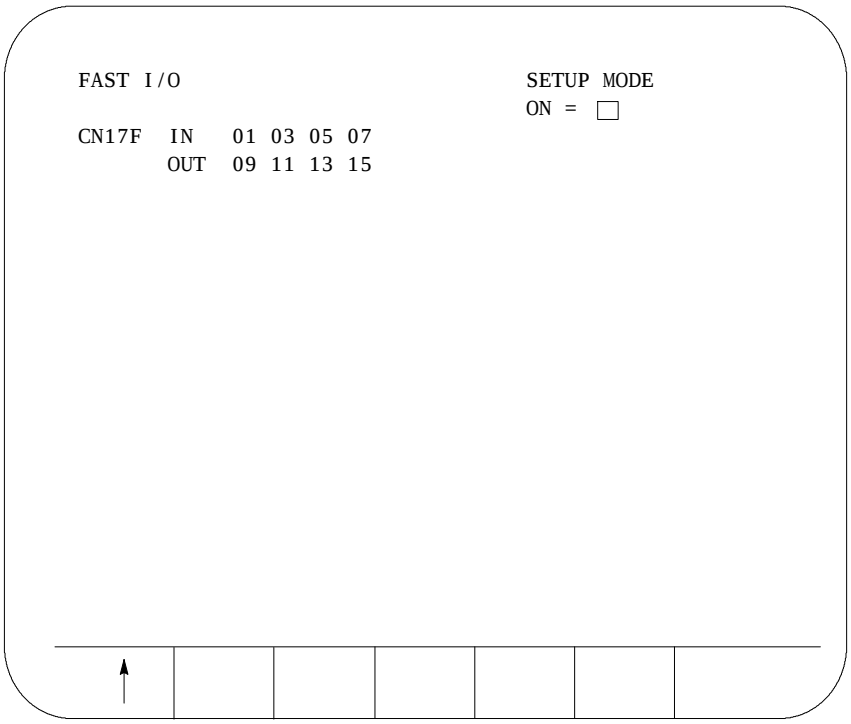
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15A.6 Fast I/O Diagnostics (9/260 and 9/290 Only)

When the {FAST I/O} softkey is pressed on the Main Diagnostics Menu screen, the Fast I/O screen appears. "FAST I/O" appears at the top to identify the screen, along with the "SETUP MODE" message indicating that the control is in setup diagnostics mode.

Figure 15A.15 shows an example of the Fast I/O screen.

Figure 15A.15
Fast I/O Diagnostics Screen



The screen shows connector CN17F, which is the Fast I/O connector number. It is followed by the four input terminals (01, 03, 05, and 07) and the four output terminals (09, 11, 13, and 15).

If an input or output is "ON", its terminal number appears in inverse video. This is a real time display, and its response is limited only by delays in screen updates.

Pressing the exit softkey (up arrow) at any time displays the Main Diagnostics Menu screen.

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15A.7 Servo Diagnostic Displays

There are two sets of diagnostic screens that provide detailed information on the operation and status of the servo system.

- Axis monitor diagnostic screens
- 1394 Drive status screens

The axis monitor screens are available on all 9/Series controls. The "1394 DRIVE" status screen described here is available only on 9/440 systems. Note that there are comparable screens for the 9/260 and 9/290 under the "RING I/O" monitor screens.

To access these two types of servo system displays, make the following softkey selections : [SYSTEM SUPPORT]

(softkey level 1)

	PRGRAM MANAGE	OFFSET	MACRO PARAM	QUICK CHECK	SYSTEM SUPORT →

	FRONT PANEL	ERROR MESAGE	PASS-WORD	SWITCH LANG	→

then [MONITOR].

(softkey level 2)

↑	PRGRAM MANAGE	AMP	DEVICE SETUP	MONI-TOR	TIME PARTS	→

Subsequent selections are detailed in the following sections .

15A.7.1 Axis Monitor Diagnostics

When the {AXIS MONTOR} softkey is pressed on the Main Diagnostics Menu screen, the Axis Monitor screen appears. "AXIS MONITOR" appears at the top to identify the screen, along with the "SETUP MODE" message indicating that the control is in setup diagnostics mode.

(softkey level 3)

↑	RING I/O	REMOTE I/O	FAST I/O	AXIS MONTOR	SERIAL I/O	→

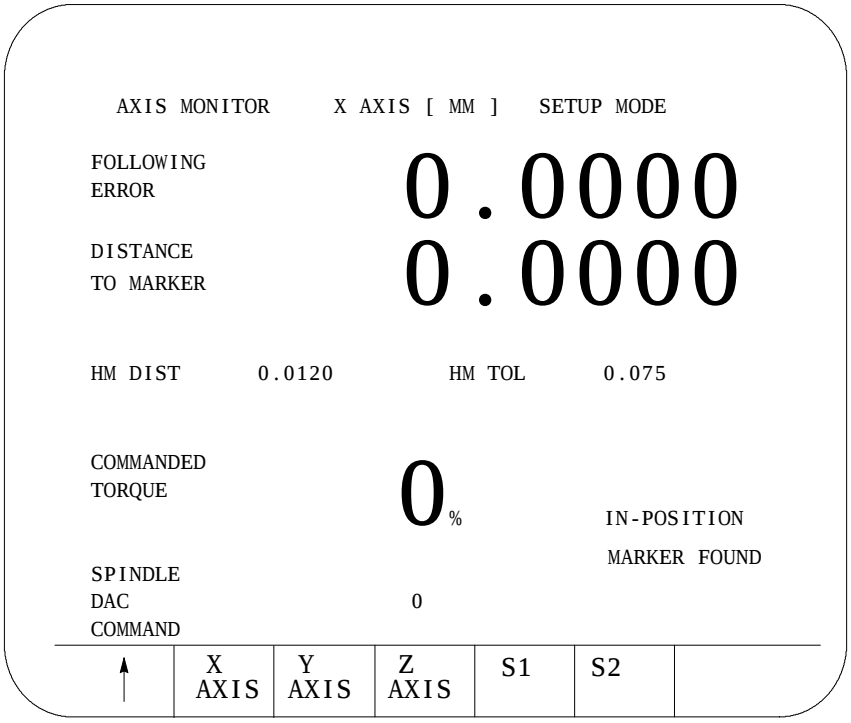
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(softkey level 3)

↑	DATA SCOPE	SEARCH MONTOR	1394 DRIVE			→

Figure 15A.16 below is an example of the Axis Monitor I/O screen. Note this screen is slightly different if you select the slave servo of a split axis.

Figure 15A.16
Axis Monitor Screen



When the Axis Monitor screen first appears, axis 1 data is displayed. Axes are displayed with the axis names assigned to them in AMP. Spindles are shown after all configured axes. Press the appropriate softkey at the bottom of the screen. Only servos that have been configured in AMP will have softkeys available.

If the axis is an adaptive depth probe, only the following error and probe position is shown. The position display for an adaptive depth probe shows the probe position relative to the zero point established either through PAL or at power up. The following error display shows following error on the adaptive depth probe.

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When the probe is not fired, the following error magnitude equals the probe deflection from the probes zero point. Once the probe is fired, the following error shows:

- the actual following error for the adaptive depth probe axis if the probe is AMPed to close the position loop for another axis.

- the probe deflection relative to the probes zero point if the probe is not AMPed to close the position loop for another axis.

Important: The following error display is invalid for the block that initially fires the adaptive depth probe, and the block that pulls out of the hole releasing the adaptive depth probe.

The distance to marker value for the spindle is updated in both open- and closed-loop spindle operation. The following error is updated only during closed-loop spindle operation. Information for spindle servos following error is valid only when the spindle is in one of these closed-loop modes:

- orient
- solid tapping
- virtual C

The control does not cancel following error when a spindle transitions from closed-loop mode to open-loop mode.

The axis units of INCH, MM or DEG are displayed after the axis name.

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Beneath the servo name are several rows of servo data. This data is displayed:

FOLLOWING ERROR	This indicates the following error in inches, millimeters or degrees.
DISTANCE TO MARKER	This indicates the distance from the current axis position to the nearest encoder marker in inches or millimeters. The display rolls over at 1/2 the distance between markers. At this rollover point, the display switches sign depending on the direction of rotation. At the actual marker, the display reads zero.
HM DIST	This value is the distance to the marker calculated when the axis stopped after the home switch went false, during the last home operation. Value is in this axis's programming units. If the axis does not requrie homing , or if a "switchless" home was executed on this axis, a value of 0.0 will be displayed. Only visable for servo AXES.
HM TOL	This is a static display of the value set in AMP to detect a home tolerence error. A value in the "HM DIST" larger than this limit indicates that an error has occured.
COMMANDED TORQUE	This is the torque output being commanded to the motor for the axis being monitored. It is expressed as a percentage of rated torque (0 to 300%) defined in AMP as the torque limit for that axis. The sign indicates the direction of commanded torque. This value is also available in PAL. Refer to $TORQ.
SPINDLE DAC COMMAND	This is an integer number reflecting the digital output to the DAC. The same value is displayed for every axis (except the split axis slave servo). Only visable for "spindls". This value is calculated as follows: $\frac{[\text{Voltage at Max for Gear n}][\text{Commanded RPM}] \times 4096}{[\text{Maximum Spindle Speed - Gear n}] \times 10}$ [Voltage at Max for Gear n] and [Maximum Spindle Speed - Gear n] are AMP parameters.
SKEW	Skew data is only displayed on the axis screen of a split axis slave servo. The value shown here as skew indicates the difference in following error between the split axis master servo and the split axis slave servo.

The status of the following error and the distance from marker/null are displayed in the lower right corner of the screen. It is displayed as one of the following:

IN-POSITION	The absolute value of the following error is less than the value of the INPOSITION BAND parameter.
< FEEDRATE SUPPRESSION	The absolute value of the following error is greater than the value of the INPOSITION BAND parameter, but is less than the value of the FEEDRATE SUPPRESSION POINT parameter.
> FEEDRATE SUPPRESSION	The absolute value of the following error is greater than the value of the FEEDRATE SUPPRESSION POINT parameter.
EXCESS ERROR	The absolute value of the following error is greater than the value of the EXCESS ERROR parameter.

The status of the distance from marker/null is displayed as either:

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MARKER NOT FOUND	The axis has not yet encountered an encoder marker/null.
MARKER FOUND	The axis has encountered an encoder marker/null since last reset or power up.

The status of the distance from marker/null is reset whenever there is a loss of feedback or power to the control.

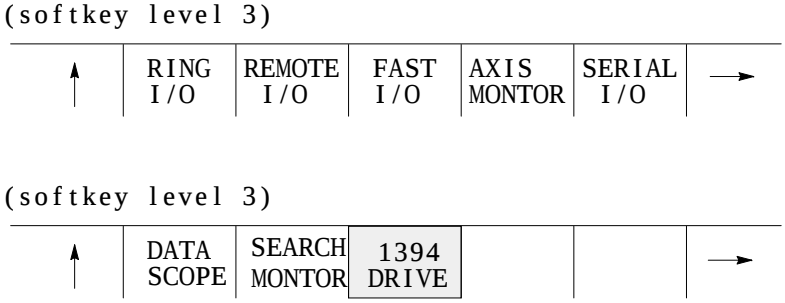
These are real time displays, response is limited only by delays in screen updates.

Pressing the exit softkey (up arrow) at any time displays the Main Diagnostics Menu screen.

When you use the Axis Monitor screen during solid tapping, the position loop type, gain, and acceleration ramp of the AMPed tapping axis matches that of the spindle. This may result in a monitored following-error magnitude for these two axes that is different while in solid-tapping mode. When they are not in solid tapping mode the monitored following-error magnitude for these axes is the same.

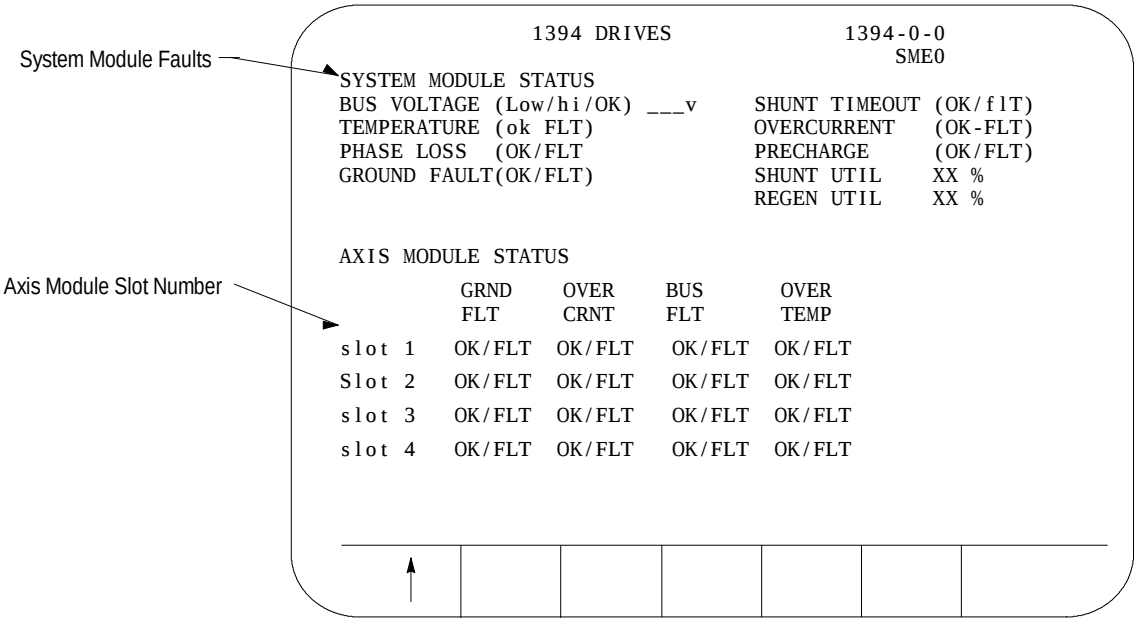
15A.7.2 1394 Drives Diagnostics Screen

If you are starting up a 9/440 system, the following screen is available to help you determine what servo faults, if any , exist on your system prior to attempting to run the machine. Select the [1394 DRIVE] softkey under the [MONITOR] section of the [SYSTEM SUPPORT] softkey.



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Figure 15A.17
1394 Drive Diagnostics Screen



The following table lists the axis module and system module faults that can be shown on this screen and gives a description of each. Note that those items designated with a "**" in this table are only shown if the smart power (or Series C) 9/440 hardware is being used in your system. On all other systems these areas of the screen are left blank.

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Faults Axis Module	**CNC display: Error Message Description**
GRND FLT	**Axix Module PowerFault (0:1,2,3,4)** The axis module hardware has faulted from a short duration over current condition. If the output current exceeds a fixed level (Over 200% of axis module rating for the 10 and 15 Kw modules and Over 300% for the 2, 3 and 5 Kw modules) this fault will appear. Typical causes are a shorted lead, motor malfunction, or malfunctioning power IGBTs.
OVER CRNT	**Axis Module OverCurrent (0:1,2,3,4)** This axis module of your 1394 system has been requested to provide too much current over an extended time period. This is typically caused by: Accel/Decel command from the CNC is requiring peak current for an excessive amount of time, the machine friction or inertial/viscous load is excessive, the motor has been improperly sized, a short circuit exists across the drive output terminals, logic supply circuits have malfunctioned, or AC input is incorrectly wired.
BUS FLT	**Axis Module Buss Voltage Loss (0:1,2,3,4)** The DC bus supply to the axis module was lost or has fallen below 275VDC. Check slider connections/termination strip or there could be a blown link fuse. This condidtion also occurs in a systemE-stop state.
OVER TEMP [1]	**Axis Module OverTemp (0:1,2,3,4)** The 1394 axis module contains a thermal sensor which senses the internal ambient temperature. Causes could be: that the cabinet ambient temperature is above the 70 degree C rating. The machine duty cycle requires an RMS current exceeding the continuous rating of the axis module. The airflow access to the 1394 is limited or blocked.

Faults System Module	**CNC Display error message Description**
BUSS VOLTAGE ____	HIGH : **System Module Over Voltage (0)** The 1394 system module bus voltage exceeds the maximum operating voltage. The DC power bus is continuously monitored. If it exceeds a preset level (810 Vdc), an over voltage fault is sensed and the axis modules are disabled. This can be caused by an under sized shunt requirement, shunt regulator fuse has blown, the shunt regulator transistor has malfunctioned, the power driver board is malfunctioning and incorrectly sensing the bus voltage, the CNC acc/dec rate is incorrectly set, the input line voltage is excessive, the system inertia is too high causing excessive energy to be returned to the power supply bus, or a vertical axis with insufficient counterbalancing is overdriving the servomotor and causing excessive energy to be returned to the power supply bus.
	LOW : **System Module Under Voltage** The 1394 system module voltage does not meet the minimum operating voltage. The DC power buss shall activate the under voltage limit when the bus drops to 275 VDC or less. It will clear at 300 Vdc. Typical causes include low voltage on the three phase input. If any Phase is missing, the "PhaseLoss" message will take priority.
BUSS VOLTAGE ____	VALUE : Displays the value of the DC buss voltage in DC volts. Nominal normal voltage is 600 V

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TEMPERATURE [1]	**System Module Over Temperature** The 1394 contains a thermal sensor which senses the internal ambient temperature. Causes could be that : The cabinet ambient temperature is above the 70 deg C rating. The machine duty cycle requires an RMS current exceeding the continuous rating of the controller. The airflow access to the 1394 is limited or blocked. An axis module or a system module FAN has failed.
PHASE LOSS	**system Module Phase Loss (0)** The 1394 system module has detected a loss of one of the input power phases. The three-phase input line is monitored and a fault will be issued when a phase loss is detected. Typical causes include, one, two or all three of the input line fuses have opened, contactor malfunction, or incorrect wiring.
GROUND FAULT	**System Module Ground Fault (0)** The 1394 system module has detected a ground fault. The system generates a ground fault when there is an imbalance in the DC bus of greater than 50 A. This drive error can be caused by incorrect wiring (verify motor and ground wiring), motor malfunction, or an axis module IGBT malfunction, or a short to ground
SHUNT TIMEOUT **	**System Module Shunt timeout (0)** The shunt resistor has timed out due to an amount of regeneration energy produced by the motor exceeding the limit of the shunt resistor by more than 5%. You may require a properly sized shunt, modification of the duty cycle of the application, or the addition of an external shunt for additional capacity.
OVER CURRENT **	**System Module Current Limit (0)** The system module has reached the limit of its current capabilities. The total motoring and regeneration current produced has exceeded the current capability of the system module by 5% or more. You may need to reduce the acc /dec profiles or increase the size of the system module.
PRE CHARGE **	**System Module Pre-Charge (0)** The DC bus voltage did not rise to operating levels (285 V) within .5 sec after 3 phase power was applied to the system. This can occur if : a short is detected on the DC bus . An axis is enabled before the pre-charge check is complete, or if torque is commanded before full bus voltage is present.
SHUNT UTIL ** value	Shunt resistor utilization percentage. This is a display of the amount of heat (current) that the shunt resistor has absorbed. A value approaching 100% indicates that the shunt resistor is saturated and will not be able to sustain further dynamic use.
REGEN UTIL ** value	Regeneration unit utilization percentage. This is a display of the amount of heat (current) dissipation that the regeneration electronics have absorbed. A value approaching 100% indicates that the regen electronics are becoming saturated and will not be able to sustain further dynamic use.

1 Over Temperature Indicators are for the system module and axis modules only. They do not reflect any motor over temperatures that may occur. Motor thermal switches (if available) should be wired into the E-STOP string.

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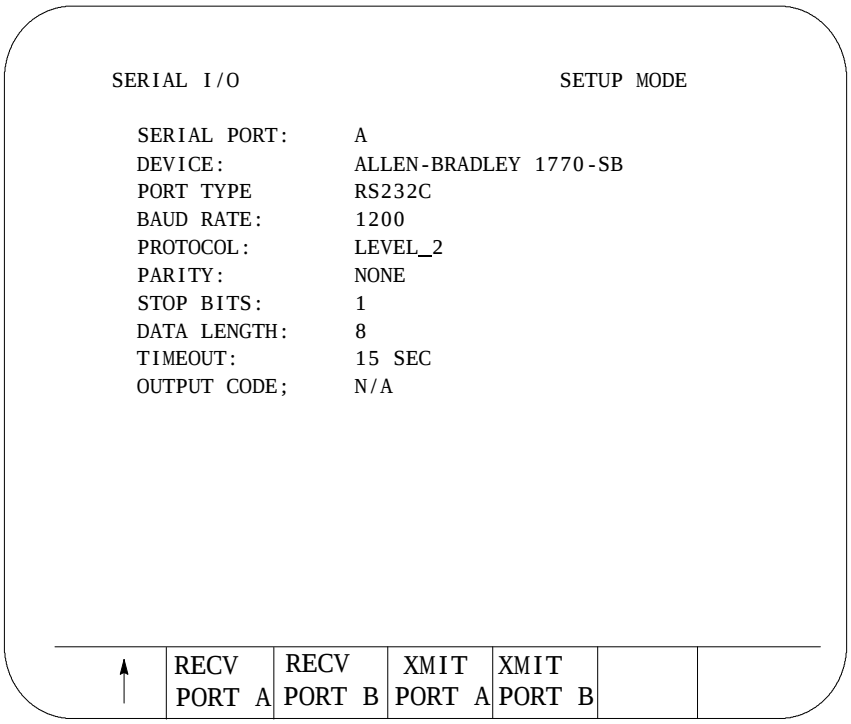
15A.8
Serial I/O Diagnostics

When the {SERIAL I/O} softkey is pressed on the Main Diagnostics Menu screen, the Serial I/O diagnostics screen appears. "SERIAL I/O" appears on the top line of the screen, along with the "SETUP MODE" message indicating that the control is in setup diagnostics mode.

Important: If ports A and B are both currently communicating with a peripheral, pressing the {SERIAL I/O} softkey displays the message "BOTH PORTS ARE BUSY" on the operator panel CRT. This softkey is disabled until the ports are no longer communicating.

Figure 15A.18 below shows a typical Serial I/O screen.

Figure 15A.18
Serial I/O Diagnostics Screen

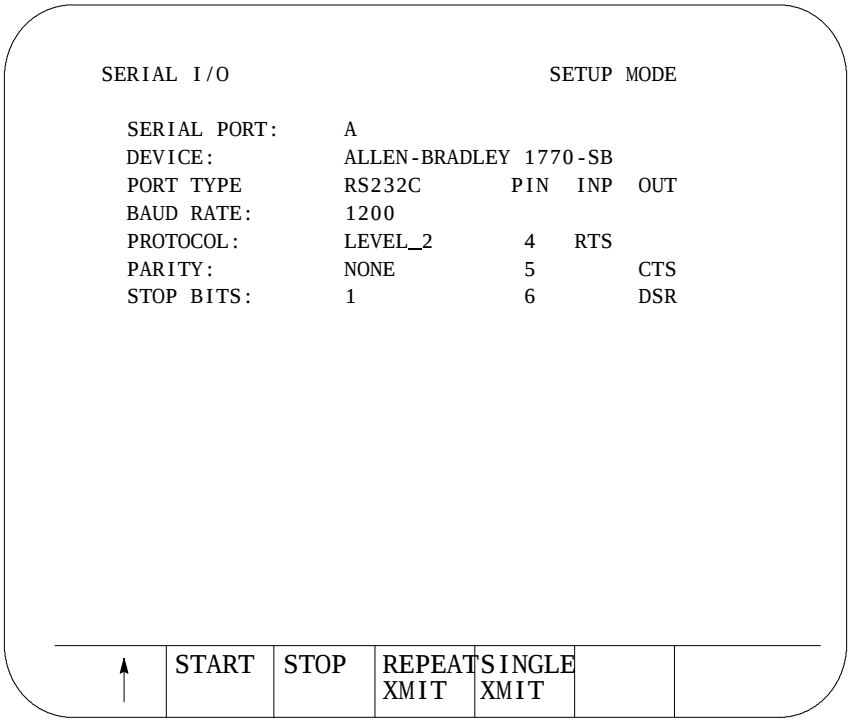


Important: If port B is configured for ODS communication, the {RECV PORT B} and {XMIT PORT B} softkeys are not be displayed. This prevents the user from using port B when the control is communicating with ODS.

When any of the 4 (or 2) softkeys displayed on the Serial I/O diagnostics screen is pressed, a screen similar to that in Figure 15A.19 is displayed:

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Figure 15A.19
Serial I/O Diagnostics Screen



The serial I/O parameters shown will vary for each peripheral device. If the parameters displayed for a specific peripheral device do not match the default parameters for that device, the message "PARAMETERS DO NOT MATCH THE DEFAULTS" are displayed on the screen.

If the protocol parameter is set to LEVEL_1, RAW, or DF1, pressing the {START} softkey will highlight the CTS output signal. Pressing the {STOP} softkey changes the CTS output signal back to normal display.

If the protocol parameter is set to LEVEL_2 and the control is receiving data, pressing the {START} softkey displays DC1 on the screen. Pressing the {STOP} softkey displays DC3.

If the protocol parameter is set to LEVEL_2 and the control is transmitting data, pressing the {START} softkey displays DC2 on the screen. Pressing the {STOP} softkey displays DC4.

Important: For more information on protocol, refer to page 8-9.

When the {REPEAT XMIT} softkey is pressed, the control highlights this softkey and transmits a string of characters that corresponds to last key pressed on the operator panel keyboard. Pressing any of the softkeys stops transmission.

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When the {SINGLE XMIT} softkey is pressed, the control highlights this softkey and transmits the character that corresponds to last key pressed on the operator panel keyboard. Pressing any of the softkeys stops transmission.

15A.9 Data Scope Monitor

Use the data scope monitor feature to debug communications. To access the data scope monitor screen, shown in Figure 15A.20:

1. Press the [SYSTEM SUPORT] softkey:

(softkey level 1)

	PRGRAM MANAGE	OFFSET	MACRO PARAM	PRGRAM CHECK	SYSTEM SUPORT	→
	FRONT PANEL	ERROR MESAGE	PASS-WORD	SWITCH LANG		→

2. Press the [MONITOR] softkey:

(softkey level 2)

↑	PRGRAM PARAM	AMP	DEVICE SETUP	MONI-TOR	TIME PARTS	→
↑	PTOM SI/OEM		SYSTEM TIMING			→

3. Press the [DATA SCOPE] softkey.

(softkey level 3)

↑	RING I/O	REMOTE I/O	FAST I/O	AXIS MONITOR	SERIAL I/O	→
↑	DATA SCOPE					→

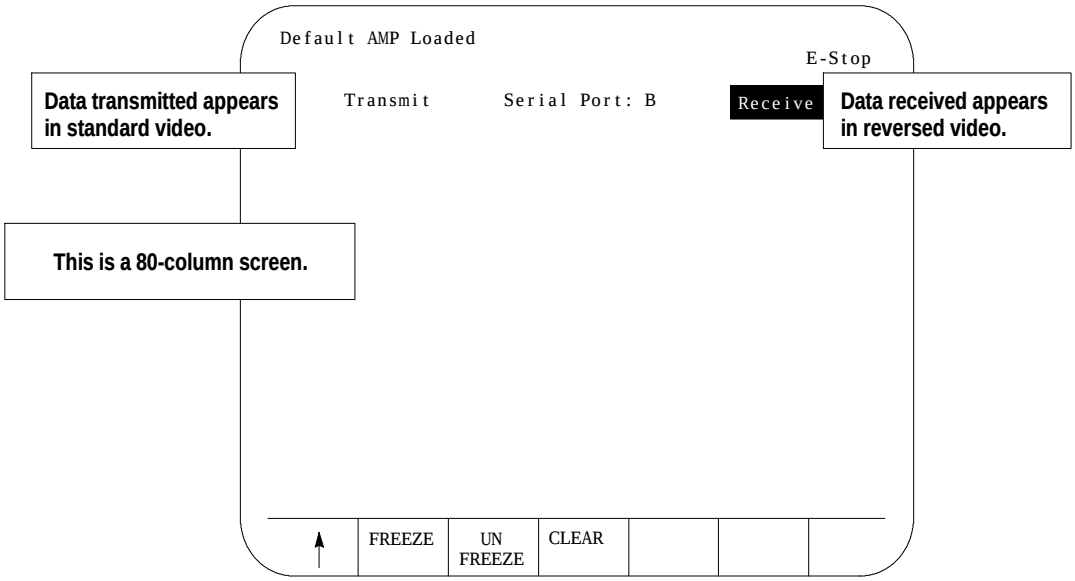
4. Press either [PORT A] or [PORT B] depending on what port your device is connected to.

(softkey level 4)

↑	PORT A	PORT B				→

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Figure 15A.20
Data Scope Monitor for Communication Diagnostics



Important: The keyboard is inactive during a PAL download; therefore, you cannot stop or freeze data on the screen while downloading PAL.

Communication data is shown in hexadecimal form with two characters used for each communication byte. Data is continually overwritten in the display area. The position on the screen where the next data byte will be written is indicated by a blinking, block cursor.

You have these softkey choices:

- FREEZE – only the data scope display is frozen; no interruption of communication occurs. This means that while the display is in "freeze," communication data is lost.
- UNFREEZE – begins display of real time communication data from the current cursor position.
- CLEAR – erases the displayed data and positions the cursor to the upper left of the display area; no data is lost.

END OF SECTION

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Section 15B

Replacement Procedures

15B.0 Section Overview

This section covers replacement procedures for the components in your system. It also contains the procedure for updating your executive software.

For Information on:	See Page:
Updating the Executive Firmware	15B-2
Replacing the Lithium Battery (8520-LIBAT)	15B-8
Replacing the CPU Board on the 9/260 and 9/290	15B-10
Replacing the Motherboard on the 9/260 and 9/290	15B-13
Replacing the Processor Board on the 9/230	15B-15
Replacing the Main Power Supply on the 9/260 and 9/290	15B-22
Replacing the Main Power Supply on the 9/230	15B-23
Replacing the Monochrome CRT	15B-25
Replacing the Color CRT	15B-25
Replacing the Keyboard Assembly for the Monochrome Operator Panel	15B-26
Replacing the Keyboard Assembly for the Color Operator Panel	15B-27
Replacing the I/O Interface for the Keyboard	15B-27
Replacing the Fuse in the Monochrome CRT	15B-29
Replacing the Fuse in the Color CRT	15B-30
Replacing the Power Supply for Monochrome Operator Panel	15B-31
Replacing the Power Supply for Color Operator Panel	15B-31
Replacing the Rotary MTB Panel	15B-32
Replacing the Push-Button MTB Panel	15B-33
Replacing the Push-Button Light Bulbs	15B-34
Replacing the Hand Pulse Generator and Interface Board	15B-36
Replacing the Battery Backup for Absolute Encoders on the Digital Servo Module	15B-37
Replacing the Digital Servo Module	15B-38
Replacing the Digital Servo Amplifier	15B-40
Replacing the Logic Board on the Digital Servo Amplifier	15B-41
Replacing the Power Section on the Digital Servo Amplifier	15B-42
Replacing the Optional Feedback Module	15B-43
Replacing the Analog Servo Module (9/260 and 9/290)	15B-44
Replacing an Analog Servo Amplifier	15B-46
Replacing the Rotary MTB Panel I/O Module	15B-47
Replacing the Push-Button MTB Panel I/O Module	15B-49
Replacing Digital I/O	15B-50
Replacing the Power Fuse on Digital I/O and Analog I/O	15B-52
Replacing the High Density I/O	15B-53
Replacing the Analog I/O	15B-54

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Replacing the Removable Operator Panel (ROP) Interface Module	15B-55
Replacing the ROP Module in the Removable Operator Panel Interface Assembly	15B-56
Replacing the Removable Operator Panel CRT or Keyboard Assemblies	15B-57
Replacing the 9/440 System Module or CNC Assembly	15B-58
Replacing the 9/440 E-Stop String Fuse	15B-60

15B.1 Updating the Executive Firmware

As we release new versions of executive software for your control, you will have to install the new software. For the 9/230, 9/260 or 9/290 the executive software updates come to you on 3 1/2-inch floppy disks. You can install the executive software update on an:

- Allen-Bradley T35, T45, T47, T50, or T60 with MS-DOS 3.3 or greater installed
- IBM XT/AT personal computer or 100% compatible with MS-DOS 3.3 or greater installed

When you install the update, it uses an external drive for the update, and an internal drive for a scratch directory. The update requires about 2 MB of disk space. In this procedure, all variables that are entered by the control during installation are in italic.

Important: Installing the executive firmware can delete all battery backed up memory, AMP, and PAL. Make sure you have all necessary information backed up before you re-install the executive software.

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To install the executive software follow this procedure:

1. At the external drive prompt, insert the disk labeled A into your external drive and type *update source: destination: <dir>*
where:
source = source drive
destination = destination drive
dir = optional directory name that will be created on destination drive:

For example when you type:
`update a:d:`

This screen appears:

```
**********************
*      Update Utility      *
*      Revision 2.0        *
*  Allen-Bradley Company, 1992  *
**********************
This utility will update the executive software
on your 9/230, 9/260 or 9/290 CNC.

It will use drive "a:" as the source of the update,
and drive "d:" for a scratch directory, "$update$", which will be removed upon
completion of the utility.

A description of the update process can be found
in the file "a:\read.me". If you have not already
reviewed this file, you should consider doing so
before proceeding.

Continue (y/n)?
```

2. If you answer the prompt with an N you return to the DOS prompt. If you answer with a Y, this screen appears:

```
2Mb bytes of disk space are needed.
Drive d: has 2736128 bytes available.

This is enough to continue...

The system will now be copied from drive a: to
the scratch directory d:\$update$.

You will periodically be requested to change
floppy disks as the entire set is copied to
the hard disk

Strike any key when ready....
```


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3. When you press a key, this screen appears:

```
Copying...


Insert backup diskette 01 in drive A:
Strike any key when ready
```

4. Insert the next disk and strike a key when the update prompts you to do so. If you have additional disks in your update package, repeat this step for those disks. The screen may display more files being read by the computer than shown here. When prompted, strike any key.

```
Copying...


Insert backup diskette 01 in drive A:
Strike any key when ready

*** Files were backed up 12-31-1999 ***

*** Resstoring file from drive A:
Diskette: 01
\SYS0201.ZIP
```

5. When you press a key, these screens appear. When decompression is complete, power down the control and connect the RS-232 cable as instructed on the screen.

PC Screen

```
Copying is complete.

The system file was compressed on floppy disk to conserve
storage space, and minimize the number of required disks.

It must now be decompressed.

Decompressing is complete

In order to download the system updates,
the CNC and PC must first be connected.

Power down the CNC.
Connect the RS-232 cable from CNC port B to PC port COM1.
Then restart the CNC.

Press a key when ready...
```

Control Screen

```
                Informative Messages

Connected to Host



                  Error Messages
```


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6. Press any key when you have connected the control to your personal computer. After a few minutes the PC displays this screen:

```
Connection established.
Device is a 9/290 CNC
Downloading required system modules...

Module:Boot DirectoryRevision 1.0  Status: downloaded
Module:XLINX Data    Revision 1.0  Status: downloaded
Module:Main CPU Exec     Revision 1.0  Status: downloaded
Module:I/O CPU Exec      Revision 1.0  Status: downloading (81%)
```

If you have a 9/230 or 9/260 a similar screen appears that does not include the last message about the I/O CPU. Also, the 9/230 downloads a servo executive. If this screen does not appear, refer to the table at the end of this section for a listing of status and error messages.

7. Once the download is complete:

Control Screen

```
Informative Messages

Host Operations Complete.
Power Down Control.
Disconnect Serial Channel Then
Restart the Control.


Error Messages
```

PC Screen

```
Connection established.
Device is a 9/290 CNC
Downloading required system modules...

Module:   Boot Directory   Revision 1.0 Status: downloaded
Module:   XLINX Data       Revision 1.0 Status: downloaded
Module:   Main CPU Exec    Revision 1.0 Status: downloaded
Module:   I/O CPU Exec     Revision 1.0 Status: downloaded
Download complete.
The CNC system is now ready to use.

Power down the CNC.
Disconnect the RS-232 cable.
Then restart the CNC and check the updated system.

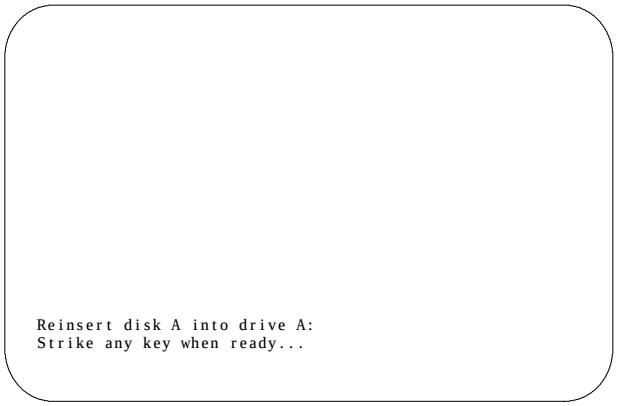
If there are problems, the update may be retried.

Retry update (y/n)?
```

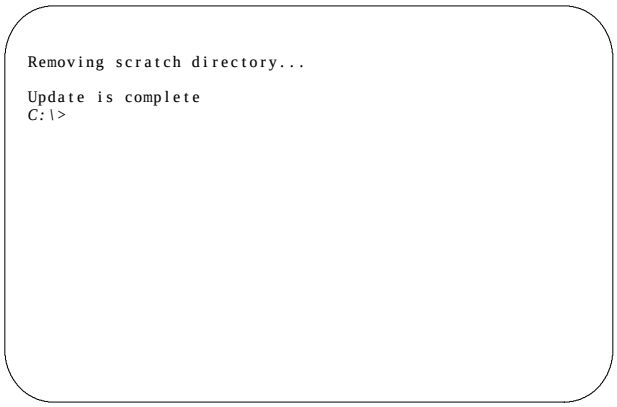

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8. If error messages appear when you restart the control, perform the appropriate recovery and then type y at the PC prompt.
Go on to step 9.

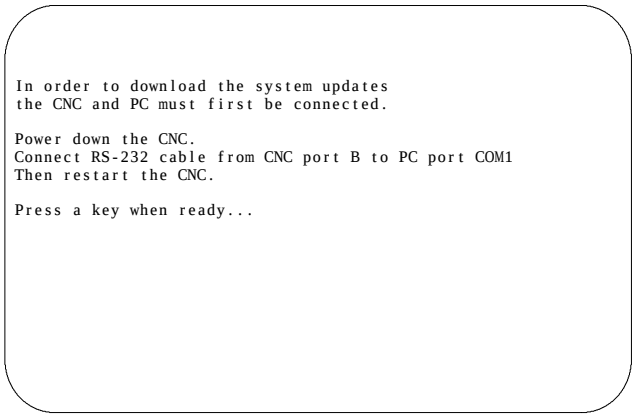
If no error messages appear, type n at the PC prompt. This screen appears:



When you strike a key, the control update deletes the directory that it created to install the update and returns to the drive prompt:



9. When you choose to retry the update, this screen appears:



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10. When you press a key, the update procedure begins again at step 6.

Error and Status Messages

As you use the update utility, the control and your PC display status and when necessary, error messages. The status messages tell you what the control is doing or what it has just done. The utility displays error messages when it cannot complete the update. Table 16.A lists the error messages and recovery steps.

Table 16.A
Error Messages and Recovery Steps for the Update Utility

Messages that Appear on the PC Screen	
Message	**Recovery**
Boot directory conflict	Call Allen-Bradley Support Services.
Communication line error detected	Retry at lower baud rate. If that does not work check communication ports and connections. Check config.sys file for proper device driver setup.
Connected to invalid device	Make sure you are connected to a 9/230, 9/260, 9/290, or 9/440, and not a 9/240.
Could not open DF1 protocol on COM1	Retry at lower baud rate. If that does not work check communication ports and connections.
I/O error on file	Check disks to make sure that they have not been damaged.
Module has an invalid checksum	Check disks, communication connections, and flash SIMMs. Retry update.
Not enough RAM available	Add memory to your PC.
System update files are corrupt	Call Allen-Bradley and request a new update utility.
Unable to connect to control	Retry at lower baud rate. If that does not work check communication ports and connections. Check config.sys file for proper device driver setup.
Unable to download	Refer to recovery for the error message on the next line of the display.
Unable to find file	Check the disk in the external drive. Make sure it is an update disk.
Unable to open file	Check the disk in the external drive. Make sure it is an update disk.
Unable to set up communications port	Retry at lower baud rate. If that does not work check communication ports and connections.
Update floppies corrupt: Inconsistent module revision	Call Allen-Bradley and request a new update utility.
Messages that Appear on the Control Screen	
Message	**Recovery**
Boot directory is missing	Retry update.
Comm error while processing host request	Retry at lower baud rate. If that does not work check communication ports and connections.
Flash SIMMs are not installed	Install the flash SIMMs onto the CPU board (for 9/260 or 9/290) processor board (9/230).
Flash SIMMs contain invalid data	Retry update.
Flash SIMMs U10 and U14 are empty or missing	Make sure your flash SIMMs are installed in the correct tracks.
Flash SIMM U10 is empty or missing	Make sure your flash SIMMs are installed in the correct tracks.

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Flash SIMM U14 is empty or missing	Make sure your flash SIMMs are installed in the correct tracks.
Low voltage on flash sticks	Call Allen-Bradley Support Services.
Module(s) with inconsistent revision level	Retry update. If this does not work, call Allen-Bradley and request a new update utility.
Module(s) with invalid checksum	Retry update.
Unable to write to flash memory	Call Allen-Bradley Support Services.
Unrecoverable error	Call Allen-Bradley Support Services.

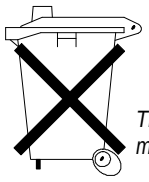
15B.2 Replacing the Lithium Battery

The RAM memory on the motherboard stores part programs and tool offsets. This stored data is kept active by battery backup while system power is off. The battery backup, which is supplied by a battery pack (8520-LIBAT) will retain data for approximately six months.

The battery backup is tested on power-up and at four-hour intervals while system power is on. If battery voltage drops below the replace-battery reference level during the battery test, the control automatically displays the warning message "REPLACE MEMORY BACKUP BATTERY" on the operator panel.

Once the "REPLACE MEMORY BACKUP BATTERY" message is displayed, it is essential that the batteries be replaced to avoid loss of data. If battery voltage drops below the battery-dead reference level during the battery test, the control displays the message "BATTERY FAILURE." Data in RAM memory will be lost if power to the control is turned "OFF" when the battery is dead.

Batteries and battery replacement instructions are included with the battery replacement kit. Before installing new batteries, use a voltmeter to make sure that new battery voltage is higher than 3.5V.



The lithium battery contains heavy metals and must be collected separately from other waste.

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To replace the main processor board battery:

1. Backup up any data (typically part programs, PAL, AMP, tool offsets, axis calibration, etc.) that is resident in RAM memory.

2. Turn **OFF** all power to the control.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

Important: To prevent static discharge, the use of a ground strap is recommended .

3. Disconnect the old battery pack from the connector on the motherboard.

4. Loosen the four screws holding the battery pack to the component enclosure.

5. Replace the old battery pack with a new one and tighten the four screws.

6. Connect the new battery pack to the connector CN10 on the motherboard.

7. Turn **ON** power to the control.

8. Download the the backed up data to RAM.

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15B.3 Replacing the CPU Board on the 9/260 and 9/290

In the case of hardware failure, you may be required to replace the CPU board. When you remove the CPU board from the enclosure, you also must remove the flash memory SIMMs and the shadow RAM SIMMs. To replace the CPU board:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

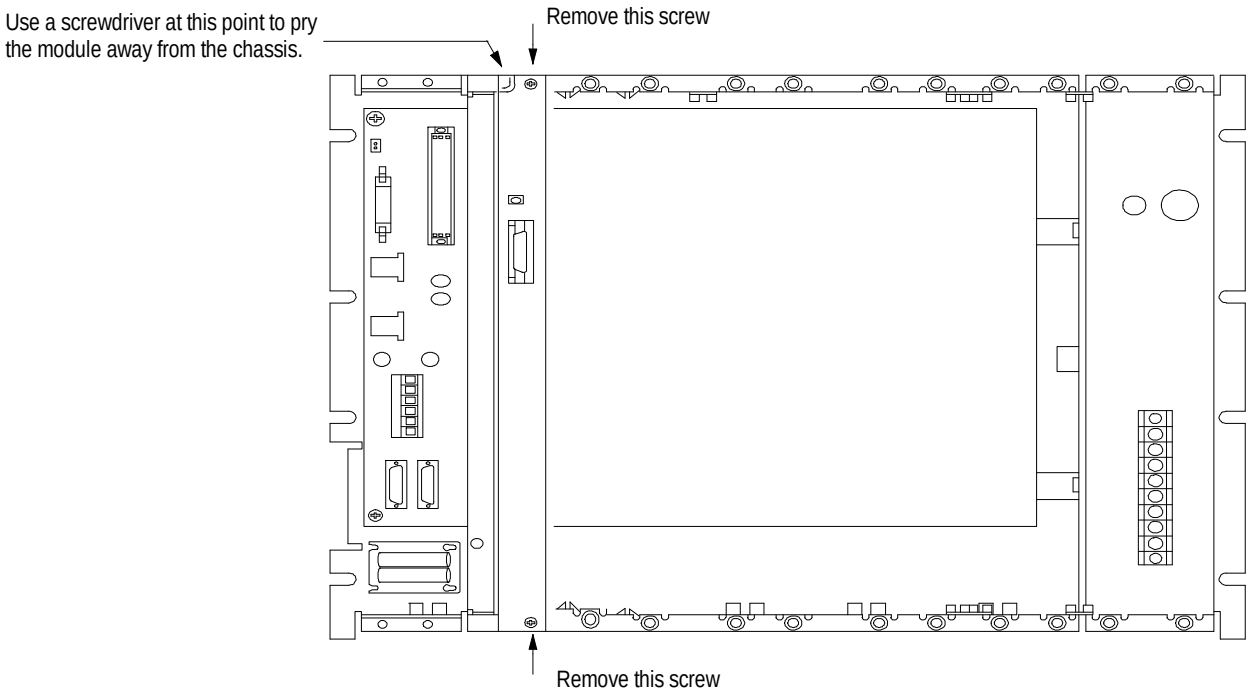
---

2. If there is a cable connected to the RS 232 port (port A) disconnect it.

3. Remove the Phillips head screws at the top and bottom of the CPU board's face panel. Use Figure 15B.1 to locate the screws.

4. Use a flathead screwdriver to pry the board's faceplate a few inches from the component enclosure. Use Figure 15B.1 to find the pry point on the faceplate.

Figure 15B.1
Removing the CPU Board from the Component Enclosure on the 9/260 and 9/290

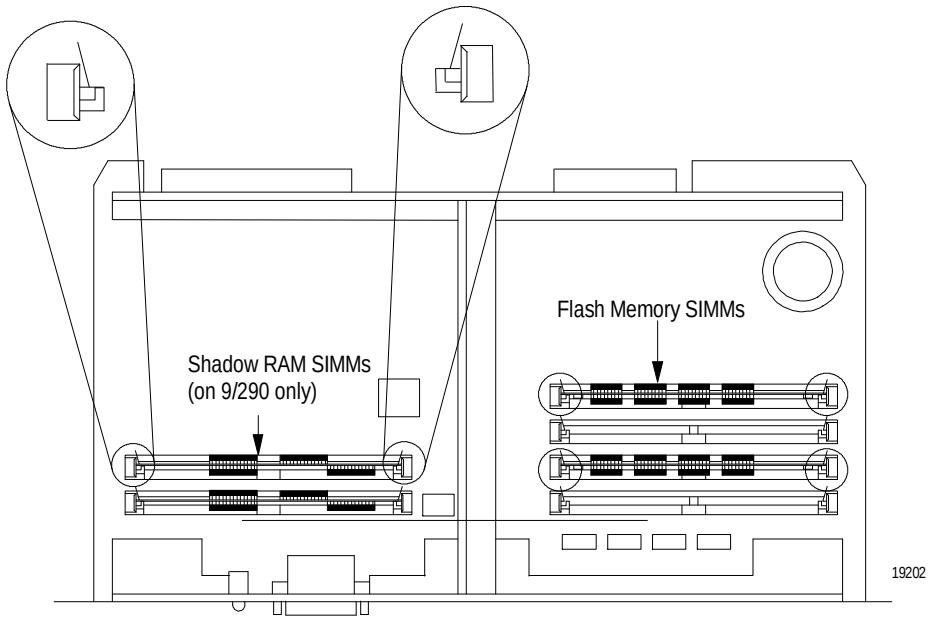


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5. With your hands pull the board away completely from the enclosure and lay the board on a clean surface with the SIMMs facing you.

6. Use Figure 15B.2 to find the release tabs for the flash memory and shadow RAM SIMMs.

Figure 15B.2
Release Tabs on the SIMM modules



7. Press the raised lever on the left and right tabs at the same time to release the SIMM module. As each SIMM is released, it turns slightly.

8. Remove all SIMM modules from the board. These modules contain the PAL and AMP information for your control. You may want to label these modules before storing them. You will need to reinstall the modules when you receive the new or repaired CPU board.

9. When you receive your replacement CPU board, install it into the component enclosure as shown in Figure 15B.3. If you have extended memory, you need to set the jumper shown in Figure 15B.4 before you install the module.

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Figure 15B.3
Replacing the CPU Module on the 9/260, and 9/290

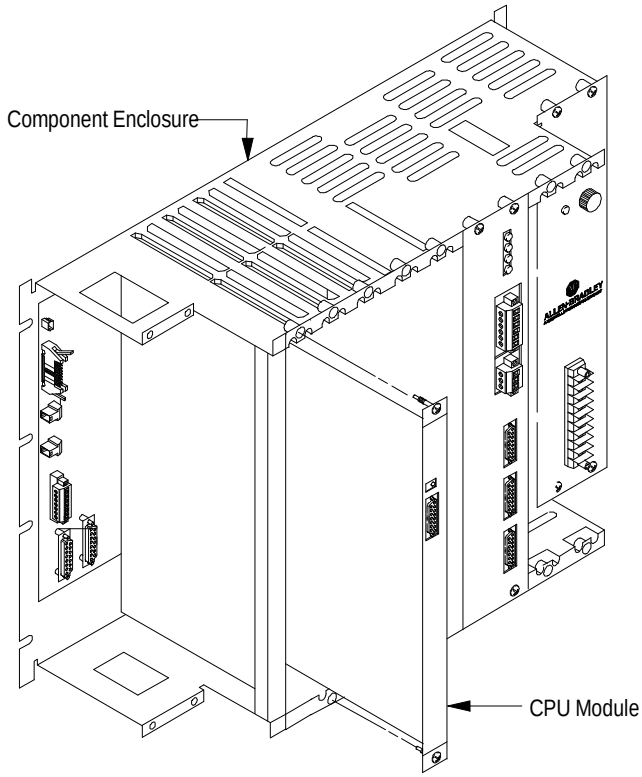
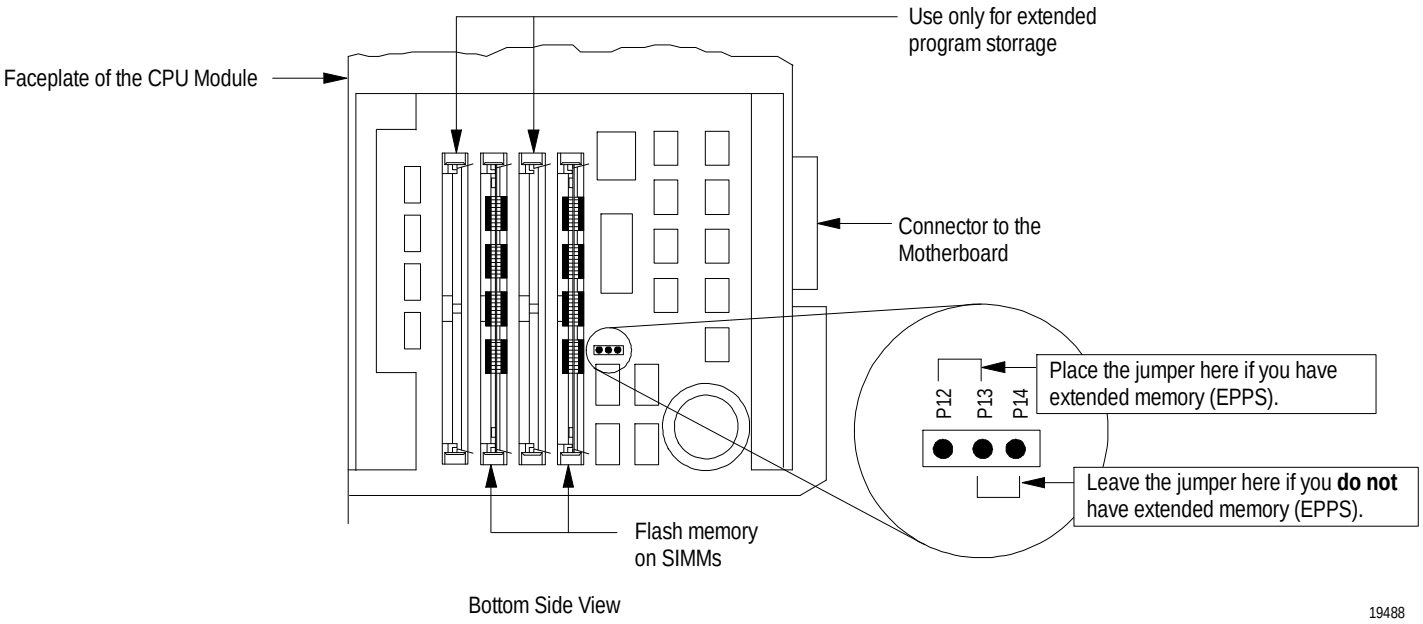


Figure 15B.4
Setting the Extended Memory (EPPS) Battery Jumper



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15B.4 Replacing the Motherboard on the 9/260 and 9/290

In the case of hardware failure,you may be required to replace the motherboard. When you remove the motherboard from the enclosure, you also must remove the software option chip. This chip turns on all the optional features that you purchased with the control. To replace the motherboard:

1. Turn **OFF** all power to the control.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

2. Remove all connections to the motherboard, including:

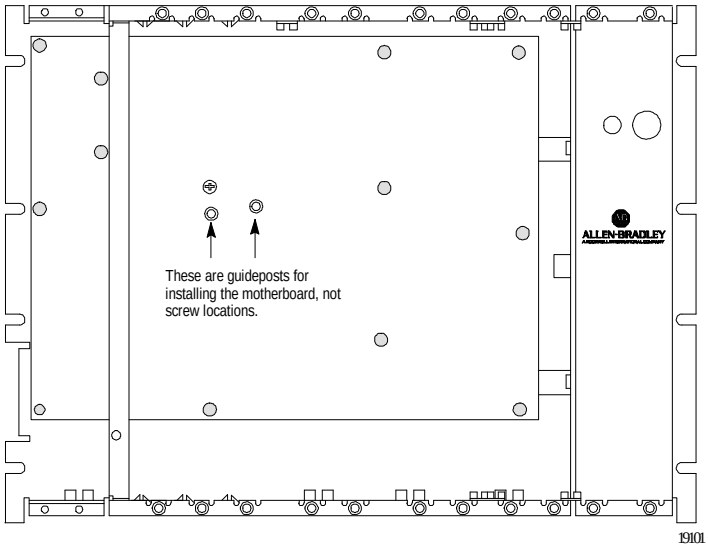
- battery
- fast I/O
- I/O ring
- E-stop wiring
- video
- RS-232/RS-422 communications

3. Remove all modules connected to the motherboard, including:

- CPU board (see the previous procedure)
- analog or digital servo modules
- optional communication modules
- remote I/O port

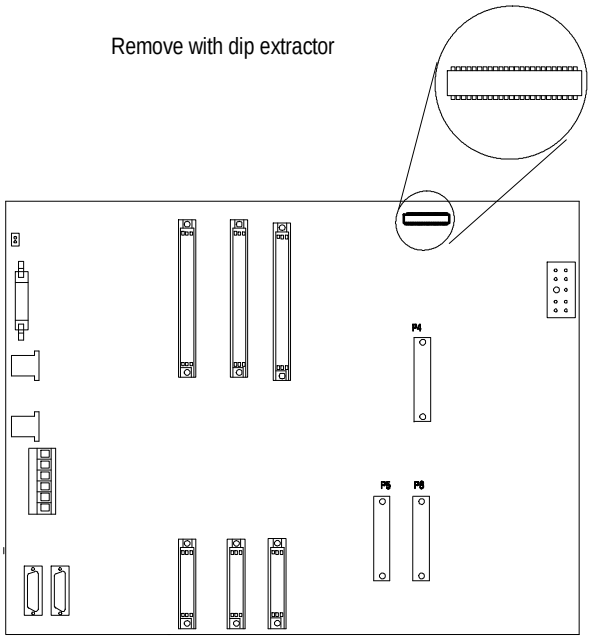
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4. Remove the 12 screws shaded in this figure.



5. Remove the motherboard from the component enclosure and lay it down on a clean surface with the connectors facing up.

6. Locate the software option chip with this figure. With a dip extractor, remove the chip from the motherboard. You may want to label it before storing it. When the new or repaired motherboard is received, replace the software option chip.



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15B.5 Replacing the Processor Board on the 9/230 Analog

You may be required in the case of hardware failure to replace the 9/230 Processor Board. When you remove the processor board from the enclosure, you also must remove the software option chip and the flash memory SIMMs. The software option chip turns on all the optional features that you purchased with the control. To replace the processor board:

1. Turn **OFF** all power to the control.



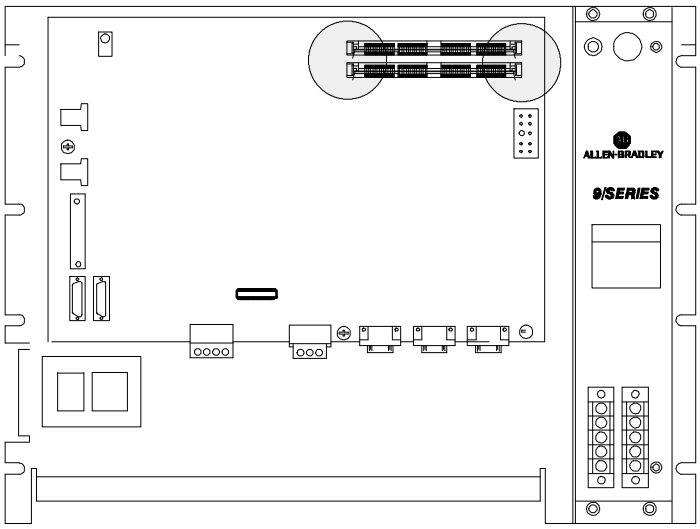
ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

2. Remove all connections to the motherboard, including:

- battery
- I/O ring
- E-stop wiring
- Video
- RS-232/422 communications
- touch probe
- auxiliary analog out
- all axis cables
- Remote I/O

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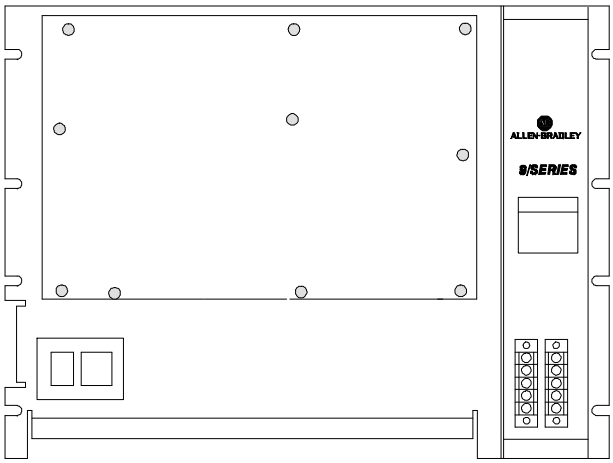
3. Use this figure to find the release tabs for the flash memory.



4. Press the raised lever on the left and right tabs at the same time to release the SIMM module. As the module is released, it turns slightly.

5. Remove all SIMM modules from the board. These modules contain the PAL and AMP information for your control. You may want to label these modules before storing them. You will need to reinstall the modules when you receive the new or repaired processor board.

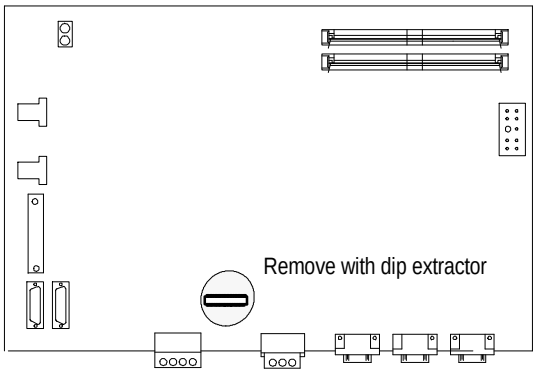
6. Remove the 10 screws indicated in this figure.



7. Remove the processor board from the component enclosure and lay it down on a clean surface with the connectors facing up.

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8. Locate the software option chip with this figure. With a dip extractor, remove the chip from the processor board. You may want to label it before storing it. When the new or repaired processor board is received, replace the software option chip.



15B.6 Replacing the Processor Board on the 9/230 Digital

You may be required in the case of hardware failure to replace the 9/230 Digital processor board. Before you remove the processor board you must first remove the front cover, the power supply, the software option chip and the flash memory SIMMs. The software option chip turns on all the optional features that you purchased with the control.

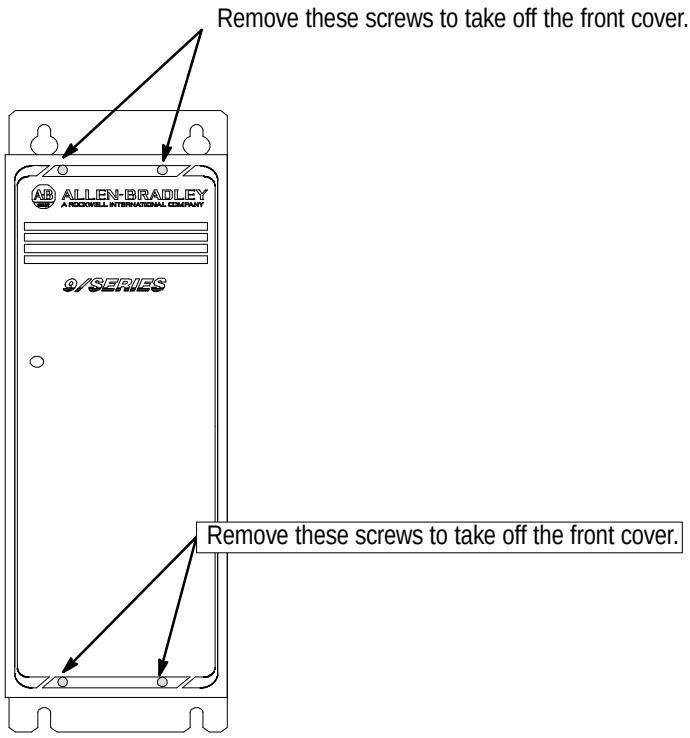
To replace the processor board:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

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2. Remove these 4 screws, and gently pull the front cover from the enclosure:



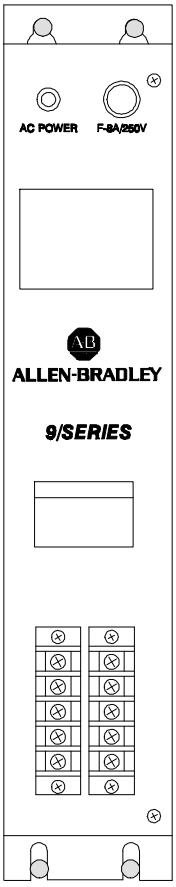
3. Remove all connections to the motherboard, including:

- power supply
- battery
- I/O ring
- E-Stop wiring
- video
- RS-232/422 communications
- touch probe
- analog out
- all axis cables

4. Disconnect all cables that are connected to the main power supply module. Label all cables so you can reconnect them correctly.

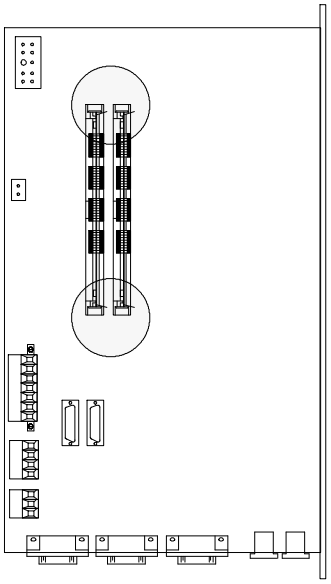
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5. Remove the screws that are shaded below and gently remove the power supply from the enclosure:



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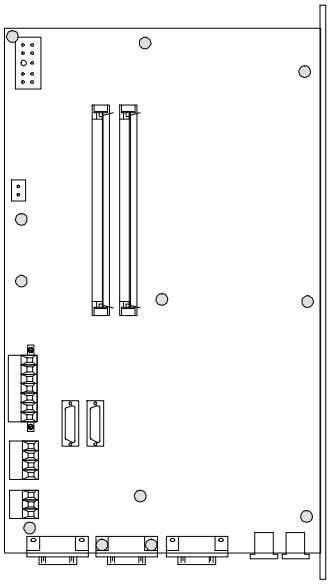
6. Use this figure to find the release tabs for the flash memory.



7. Press the raised lever on the left and right tabs at the same time to release the SIMM module. As the module is released, it turns slightly.

8. Remove all SIMM modules from the board. These modules contain the PAL and AMP information for your control. You may want to label these modules before storing them. You will need to reinstall the modules when you receive the new or repaired processor board.

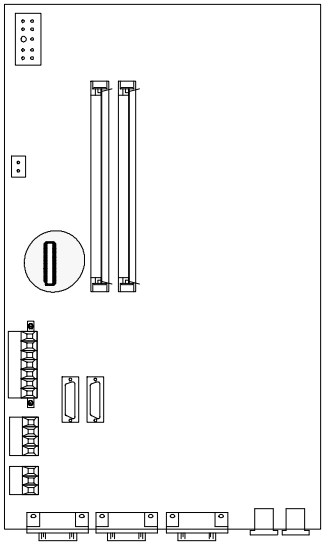
9. Remove the 12 screws shaded in this figure and gently remove the processor board from the enclosure.



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10. Locate the software option chip with this figure. With a dip extractor, remove the chip from the processor board. You may want to label it before storing it. When the new or repaired processor board is received, replace the software option chip.

Remove with dip extractor



11. When you receive the new or repaired processor board, make sure you:

- replace all 12 screws you removed
- replace your option chip
- replace your flash memory SIMMs
- reconnect all cables to the processor board.

12. Reattach the power supply to the enclosure and reconnect all cables to the power supply.

13. Turn power on to the control. If it does not power up, check all connections.

14. When the control is running, replace the front cover and attach with its four screws.

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15B.7 Replacing the Main Power Supply on the 9/260 and 9/290

To replace main power supply:

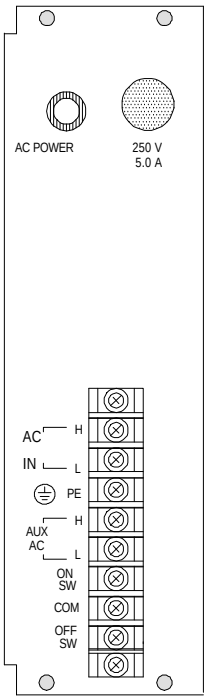
1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

2. Disconnect all cables that are connected to the main power supply module. Label all cables to simplify installation of the new main power supply module.

3. Remove the 4 mounting screws shown in Figure 15B.5 that hold the main power supply module to the component enclosure.

Figure 15B.5
Locating the Screws on the Main Power Supply



4. Replace the main power supply module with a new one.

5. Replace and tighten the 4 mounting screws then reconnect all cables that were disconnected.

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ATTENTION: Make sure that all cables are properly attached to the correct terminals. Failure to do so may result in injury to personnel, or damage to the control or machine.

6. Turn **ON** power to the control.

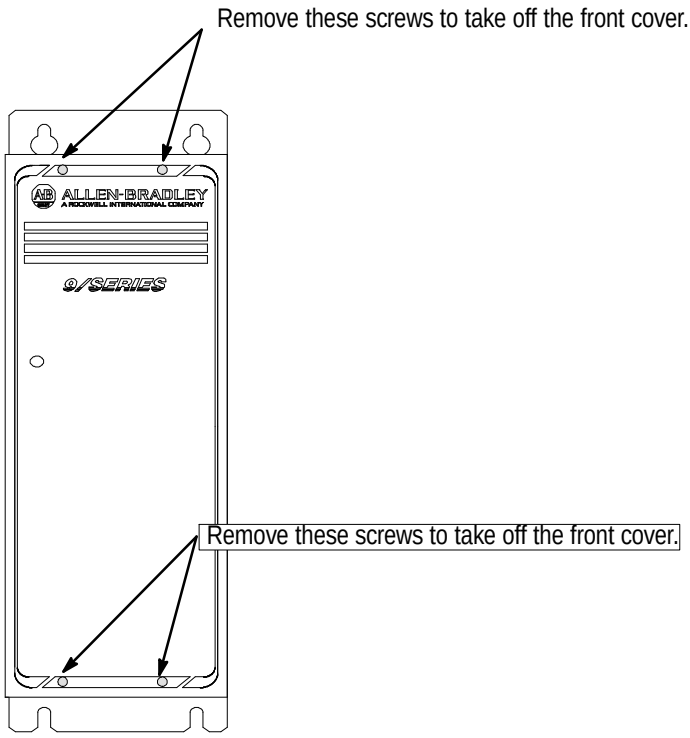
15B.8 Replacing the Main Power Supply on the 9/230

To replace main power supply:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

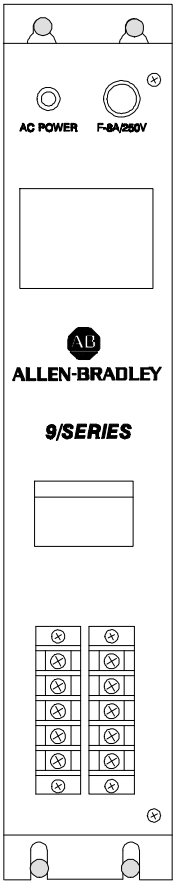
2. If you have a 9/230 Digital remove the four screws hold the front cover to the enclosure as shown. If you have a 9/230 Analog skip this step and go on to the next step.



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3. Disconnect all cables that are connected to the main power supply module. Label all cables to simplify installation of the new main power supply module.

4. Loosen the 4 mounting nuts that hold the main power supply module to the component enclosure.



5. Replace the main power supply module with a new one.

6. Tighten the 4 mounting screws then reconnect all cables.

ATTENTION: Make sure that all cables are properly attached to the correct terminals. Failure to do so may result in injury to personnel, or damage to the control or machine.

---

7. Turn **ON** power to the control.

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15B.9 Replacing the Monochrome CRT

To replace the monochrome CRT:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Remove the cover on the back of the monochrome operator panel.
3. Disconnect the cable running from the main power supply to the operator panel power supply.
4. Disconnect the cable running from the operator panel power supply to the monochrome CRT.
5. Remove the 4 screws on the sides of the monochrome CRT enclosure.
6. Slide the monochrome CRT out of the monochrome operator panel enclosure and replace it with a new monochrome CRT.
7. Replace and tighten the 4 screws, reconnect the cable running from the operator panel power supply to the monochrome CRT, replace the rear cover, then reconnect all additional cables and modules.

15B.10 Replacing the Color CRT

To replace the color CRT:

1. Turn **OFF** all power to the control.

ATTENTION: Make sure that all cables are properly attached to the correct terminals. Failure to do so may result in injury to personnel, or damage to the control or machine.

---

2. Remove the cover that covers the rear of the color operator panel.
3. Disconnect the cable running from the main power supply to the operator panel power supply.
4. Disconnect the cable running from the color CRT to the operator panel power supply at the molex connector.

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5. Remove the 4 mounting screws on the sides and the 2 mounting screws on the bottom of the color CRT enclosure.

6. Slide the color CRT out of the color operator panel enclosure and replace it with a new color CRT.

7. Replace and tighten the 6 mounting screws, replace the rear cover, then reconnect all cables and modules.

15B.11 Replacing the Keyboard Assembly for the Monochrome Operator Panel

To replace the monochrome panel keyboard assembly:

1. Turn **OFF** all power to the control.



ATTENTION: Make sure that all cables are properly attached to the correct terminals. Failure to do so may result in injury to personnel, or damage to the control or machine.

2. Disconnect the flat cable running from the keyboard I/O ring interface to the monochrome panel keyboard assembly.

3. Disconnect the keyboard ground wires, by removing the screws on the keyboard.

4. Remove the six keyboard mounting nuts on the back of the panel. Install the new keyboard.

   Important: The CRT mounting screws must be loosened to allow the CRT to be pushed up against the bezel gasket for proper seal when the new keyboard is installed.

5. Move the CRT up against the bezel and tighten the mounting screws.

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15B.12 Replacing the Keyboard Assembly for the Color Operator Panel

To replace the color panel keyboard assembly:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Disconnect the flat cable running from the keyboard I/O ring interface to the color panel keyboard assembly and ground wires by removing the screws on the keyboard.
3. Remove the 12 mounting nuts along the back edges of the color panel keyboard assembly.
4. Remove the color panel keyboard assembly and replace it with a new color panel keyboard assembly.
5. Replace and tighten the 12 mounting nuts along the back then reconnect the flat cable to the keyboard I/O ring interface and ground wire.

15B.13 Replacing the I/O Ring Interface for the Keyboard

To replace the keyboard I/O ring interface:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Disconnect the cable running from the operator panel power supply to the keyboard I/O ring interface.
3. Disconnect the flat cable running from the operator panel keyboard to the keyboard I/O ring interface.
4. Disconnect the fiber optic cables.
5. Remove the 4 mounting screws which are located at the corners of the keyboard I/O ring interface.

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6. Remove the keyboard I/O ring interface and replace it with a new keyboard I/O ring interface.

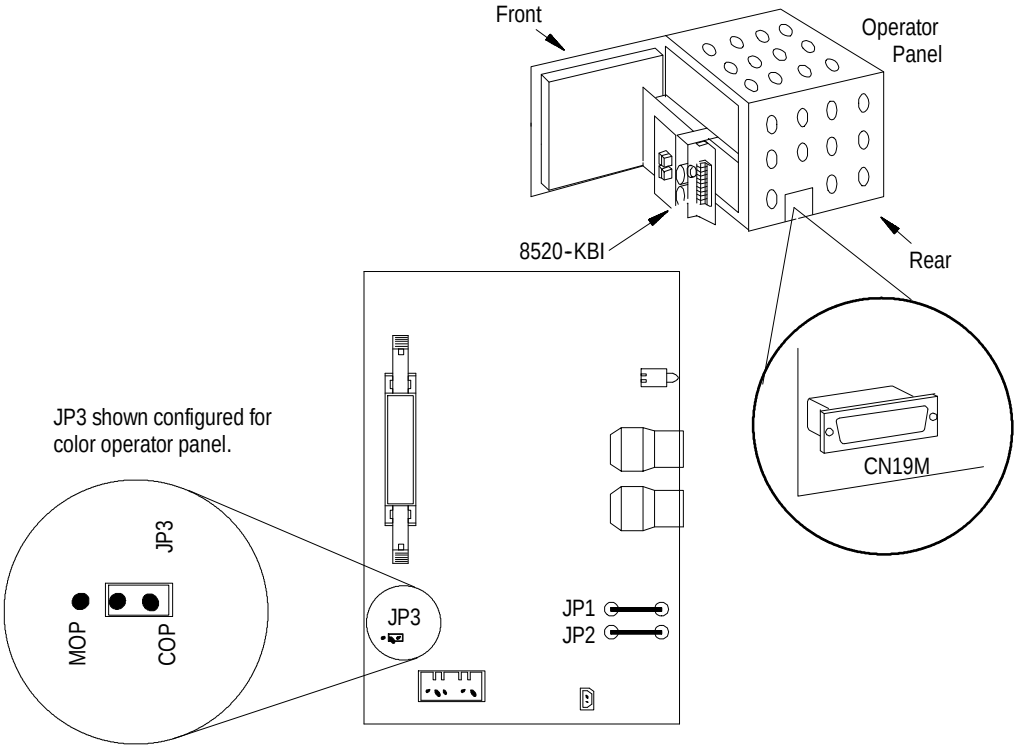
7. Replace and tighten the 4 mounting screws then reconnect all cables.

8. Set the node address (JP1 and JP2) to match the jumper settings on the old keyboard I/O ring interface.

The node address is selected by cutting the jumpers located on the operator panel keyboard I/O ring interface. Figure 15B.6 shows the location of the jumpers.

9. Set the color or monochrome operator panel jumper (JP3) to match the type of operator panel you have. The center pin of JP3 and the pin labeled COP should be shorted when installed on a color operator panel. The center pin of JP3 and the pin labeled MOP should be shorted when installed on a monochrome operator panel.

Figure 15B.6
Operator Panel Jumper Positions



The keyboard I/O ring interface board is mounted under the CRT, next to the power supply module on the color operator panel.

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15B.14 Replacing the Fuse in the Monochrome CRT

To replace the monochrome CRT fuse:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

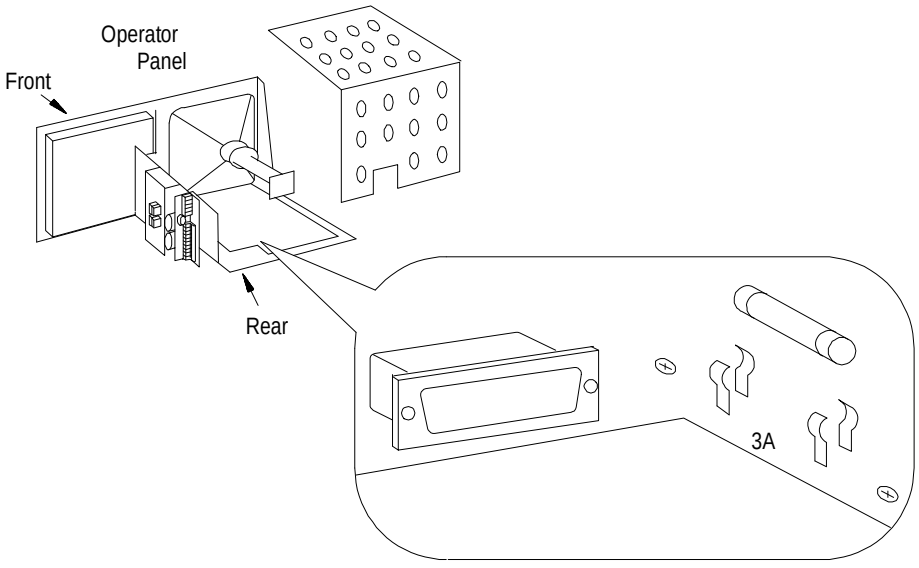
---

2. Remove the cover that covers the rear of the monochrome operator panel.

3. Remove the fuse from its holder and replace it with a recommended replacement fuse. Refer to Figure 15B.7 for the location of the monochrome CRT fuse.

ATTENTION: Use only replacement fuses of the type and rating specified for the monochrome CRT. Improper fuse selection may result in equipment damage.

Figure 15B.7
Location of Monochrome CRT Fuse



4. After replacing the fuse, replace the rear cover of the monochrome operator panel, then turn power **ON**.

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15B.15 Replacing the Fuse in the Color CRT

To replace the color CRT fuse:

1. Turn **OFF** all power to the control.

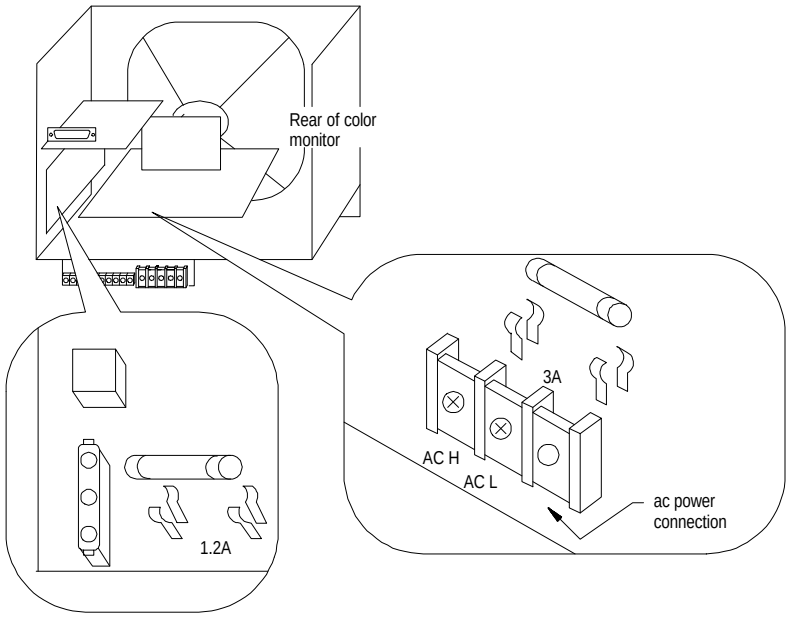
ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

2. Remove the cover that covers the rear of the color operator panel.

3. Remove the fuse(s) from its holder and replace it with a recommended replacement fuse. Refer to Figure 15B.8 for the location of the color CRT fuses.

ATTENTION: Use only replacement fuses of the type and rating specified for the color CRT. Improper fuse selection may result in equipment damage.

Figure 15B.8
Location of Color CRT Fuses



4. After replacing the fuse(s), replace the rear cover of the color operator panel, then turn power **ON**.

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15B.16 Replacing the Power Supply for Monochrome Operator Panel

To replace the operator panel power supply on a monochrome operator panel:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Disconnect the cable running from the main power supply to the operator panel power supply.
3. Disconnect the cable running from the operator panel power supply to the keyboard I/O ring interface.
4. Remove the keyboard I/O ring interface.
5. Disconnect the cables running from the operator panel power supply to the MTB panel and the HPG's.
6. Loosen the 4 mounting screws on the operator panel power supply.
7. Slide the operator panel power supply out of the mount and replace it with a new operator panel power supply.
8. Tighten the 4 mounting screws on the operator panel power supply then reconnect all cables.

15B.17 Replacing the Power Supply for the Color Operator Panel

To replace the operator panel power supply on a color operator panel:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Disconnect the cable running from the main power supply to the operator panel power supply.
3. Disconnect the cable running from the color CRT internal power supply to the operator panel power supply.

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4. Disconnect the cable running from the operator panel power supply to the keyboard I/O ring interface.

5. Disconnect the cables running from the operator panel power supply to the MTB panel and the HPG's.

6. Loosen the 4 mounting screws on the operator panel power supply.

7. Slide the operator panel power supply out of the mount and replace it with a new operator panel power supply.

8. Tighten the 4 mounting screws on the operator panel power supply then reconnect all cables.

15B.18 Replacing the Rotary MTB Panel

To replace the rotary MTB panel:

1. Turn **OFF** all power to the control.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

2. Disconnect the cable running from the operator panel power supply to the power supply terminals on the rotary MTB panel I/O module.

3. Disconnect the I/O interface cable running from the connector (CN16F) on the sub processor board to the rotary MTB panel.

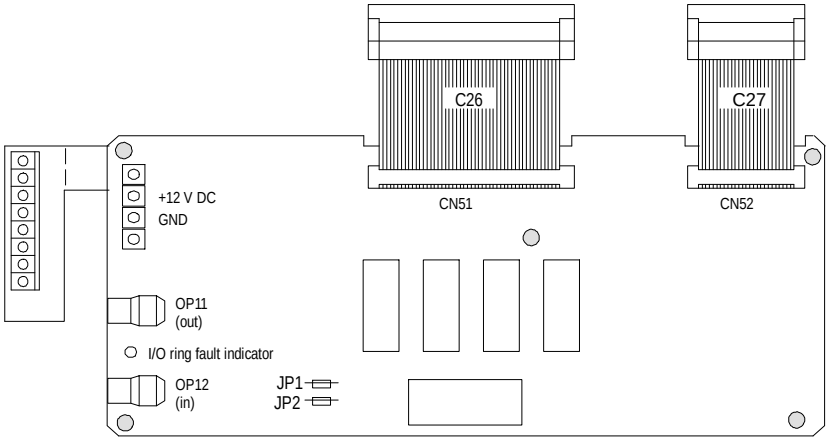
4. Disconnect the cable running from the E-Stop terminals of terminal block BT-20 to the E-Stop terminal block BT01 on the motherboard.

5. Disconnect the cable running from the power ON/OFF terminals of terminal block BT-20 to the ON SW/OFF SW terminals on the main power supply.

6. Disconnect the fiber optic cables from the MTB panel I/O module.

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7. Remove the 8 mounting screws along the top and bottom edges of the rotary MTB panel.



8. Replace the rotary MTB panel with a new rotary MTB panel.

15B.19 Replacing the Push-button MTB Panel

To replace the push-button MTB panel:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Disconnect the cable running from the operator panel power supply to the power supply terminals on the push-button MTB panel I/O module.

3. Disconnect the I/O interface cable running from the connector (CN16F) on the sub processor board to the push-button MTB panel.

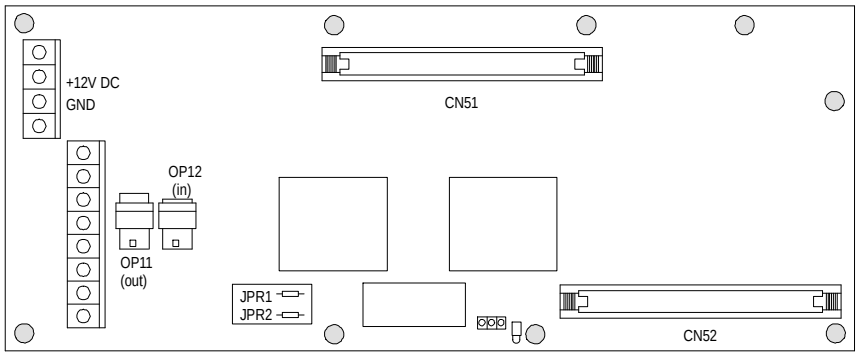
4. Disconnect the cable running from the E-Stop terminals of terminal block BT-20 to the E-Stop terminal block BT01 on the motherboard.

5. Disconnect the cable running from the power ON/OFF terminals of terminal block BT-20 to the ON SW/OFF SW terminals on the main power supply.

6. Disconnect the fiber optic cables from the MTB panel I/O module.

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7. Remove the 9 mounting screws along the top and bottom edges of the push-button MTB panel.



8. Replace the push-button MTB panel with a new MTB panel.

9. Replace and tighten the 9 mounting screws, then reconnect all cables.

15B.20 Replacing the Push-button Light Bulbs

To replace the light bulbs in the push-button MTB panel:

1. Call your A-B sales representative and have them order replacement light bulb, part number 156780 for your digital MTB panel or part number 800M–N16 for your A–B 800 push–button MTB panel from A-B field service.

2. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

3. Disconnect the cables from TB1 located on the MTB interface board.

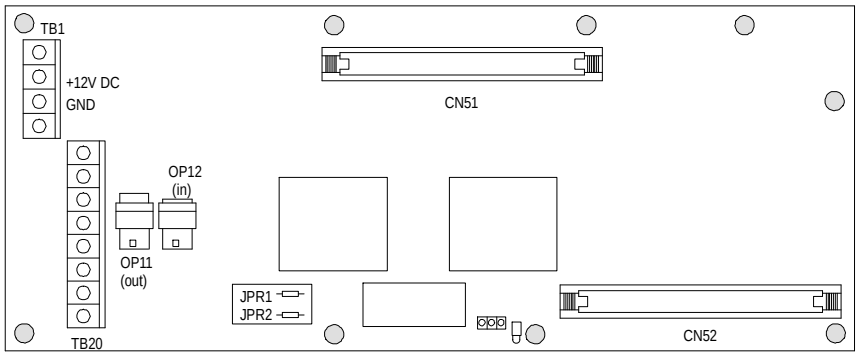
4. Disconnect the cables from TB20 located on the MTB interface board.

5. Disconnect the input interface ribbon cable from CN51 and the output interface ribbon cable from CN52.

6. Disconnect the fiber optic cables from connectors OP11 and OP12.

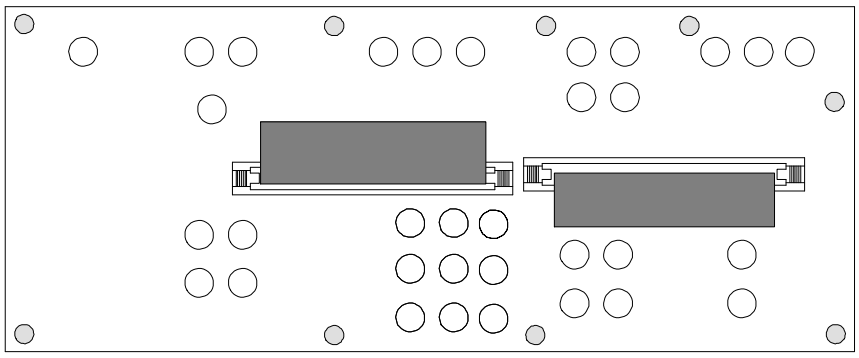
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7. Remove the 9 mounting screws along the top and bottom edges of the MTB interface board.



MTB Interface Board

8. Remove the interface board to reveal the MTB board that contains the push-buttons.



MTB Board

9. Use a flat head screwdriver to twist the bulb and its socket out of the panel.

10. Place the replacement bulb into the hole and gently twist the socket into place.

Important: Do not over-tighten the light bulbs.

11. Remount the MTB interface board and reconnect the cables and wiring you disconnected in steps 3. through 6.

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15B.21 Replacing the Hand Pulse Generator and Interface Board

To replace the Hand Pulse Generator and Interface Board

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

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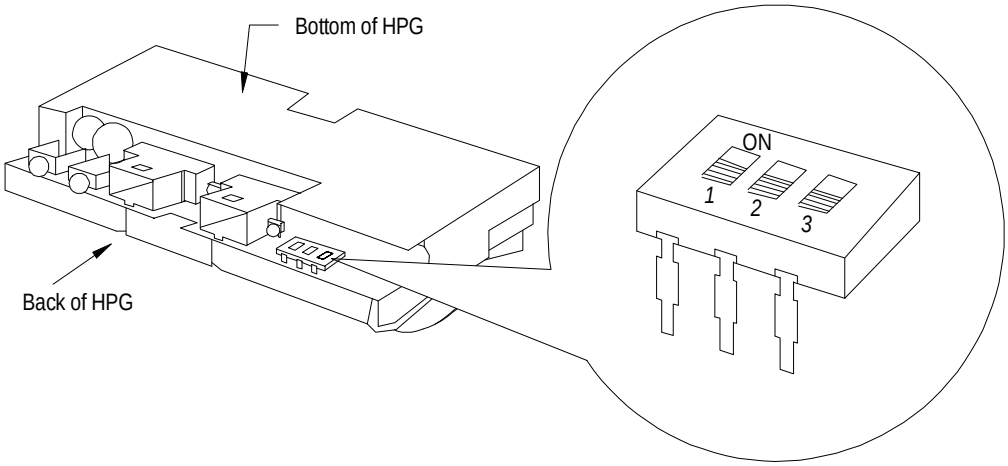
2. Disconnect the cable running from the operator panel power supply to the HPG interface board.
3. Disconnect the fiber optic cables.
4. Remove the screw holding the handle on the HPG interface board then remove the handle.
5. Disconnect the cable running from the HPG to the HPG interface board.
6. Remove the 3 nuts on the HPG mounting studs that hold the HPG to the cabinet or front panel.

Important: The HPG interface board is mounted behind the front panel using 2 of the 3 nuts that secure the HPG to the front panel. When the nuts holding the HPG to the front panel are removed, the HPG interface will come off.

7. If the HPG or HPG interface board is defective, replace it with a new HPG.
8. Match the setting of the switch assembly on the new HPG interface board to that of the one being replaced as shown below.
9. Put the HPG back onto the cabinet or front panel.
10. Place the HPG interface board onto two of the mounting studs of the HPG.
11. Tighten the 3 nuts.

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12. Reconnect all cables, then place the handle over the HPG interface board and tighten the screw that holds the handle in place.



15B.22 Replacing the Battery Backup for Absolute Encoders on the Servo Module

Important: If incremental encoders are used instead of absolute encoders, the servo module requires no batteries.

The digital servo module provides battery backup for the absolute encoder position register. The absolute encoder position register provides position data retention during power loss. The battery backup power originates from the batteries plugged into the servo board at connector CN10.

Even if battery backup fails, or the encoder cable is temporarily disconnected, the encoder will still maintain position data for up to 24 hours. This also allows for battery replacement without loss of information.

Important: On the 9/230 Digital CNC the battery backup for the absolute encoder originates from the battery on the processor board. This battery is also used for axis data backup.

To replace the servo module battery:

1. Turn **OFF** all power to the control.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

Important: Wear an ESD wristband to prevent static discharge.

2. Disconnect the old battery pack from connector CN10 on the 3-axis servo module or connector P3 on the 4-axis servo module.

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3. Loosen the four screws holding the battery pack to the control chassis.
4. Replace the old battery pack with a new one and tighten the four screws.
5. Connect the new battery pack to connector CN10 on the 3-axis servo module or connector P3 on the 4-axis servo module.
6. Turn **ON** power to the control.

Batteries and battery replacement instructions are included with the battery replacement kit. Before installing new batteries, use a voltage meter to make sure that new battery voltage is higher than 3.5V.



The lithium battery contains heavy metals and must be collected separately from other waste.

15B.23 Replacing the 3-axis Digital Servo Module

This is not available on the 9/230 control. To replace the digital servo module:

1. Turn OFF all power to the control.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

Important: The use of a ground strap is recommended to prevent static discharge.

2. Disconnect all cables that are connected to the servo module.

Important: The control must be "homed" after replacing the servo module. If the servo motors incorporate an absolute encoder, the absolute axis position will be lost. The absolute encoder must be reset after the servo module is replaced. Refer to page 13A-33 for absolute encoder reset procedures.

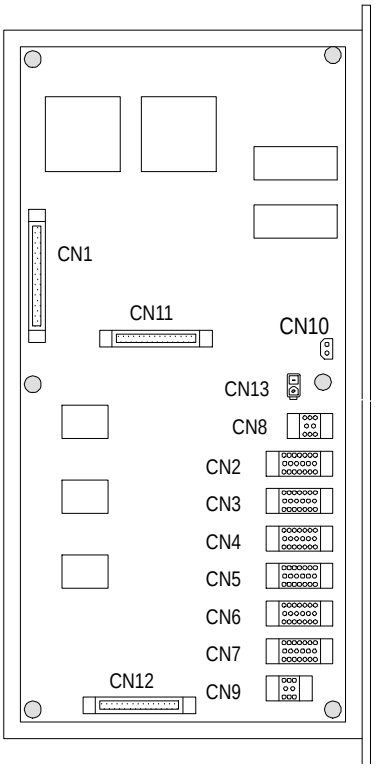
3. Remove the 4 mounting screws that hold the board rack, which holds the servo module to be replaced, in the component enclosure. Slide the board rack out of the component enclosure board slot.

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4. If your system has an optional feedback module, remove it as described on page 15B-43.

5. Remove the 6 mounting screws, shown in Figure 15B.9, which hold the servo module to the board rack.

Figure 15B.9
Servo Module Mounting Screw Locations



6. Remove the servo module being replaced and install the new servo module.

7. Replace and tighten the 6 mounting screws.

8. If you have an optional feedback module, reinstall it.

9. Slide the board rack into the the board slot of the component enclosure then replace and tighten the 4 mounting screws.

10. Replace all cables that were disconnected.

11. Turn **ON** power to the control.

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15B.24 Replacing the Digital Servo Amplifier

To replace a digital servo amplifier:

1. Turn OFF all power to the control and the servo amplifier.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

---

2. Carefully disconnect and mark all cables that are connected to the servo amplifier.

3. Loosen but do not remove the 4 mounting screws that hold the servo amplifier to the cabinet.

4. Grasp the servo amplifier firmly with one hand holding the chassis under connector TB1 and one hand holding the chassis just to the right of TB2.

5. Carefully slide the servo amplifier up (mounting holes are slotted) and then out.

6. Install the replacement amplifier by reversing the removal procedure. Grasp it as described in step 4 above and position it over the mounting screws.

7. Carefully slide it down, making sure all four screws are positioned into the screw slots.

8. Tighten the four mounting screw securely.

9. Replace all wires and connectors exactly as they were removed.

10. MATCH JUMPERS on the new servo amplifier to the settings on the amplifier being replaced. Amplifier jumper settings are listed starting on page 13A-16.

ATTENTION: Jumper settings configure the amplifier to match the specific application. Failure to match jumper settings on the new servo amplifier may result in damage to the amplifier, servomotors, or machine.

---

11. Turn **ON** power to the control and servo amplifier.

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15B.25 Replacing the Logic Board on the Digital Servo Amplifier

The logic board(s) is the circuit board(s) mounted directly to the face of the servo amplifier. Generally replacement can be accomplished without removing the servo amplifier from the cabinet.

To replace the logic board on a servo amplifier:

1. Turn OFF all power to the control and the servo amplifier.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open (off) and locked.

Important: The use of a ground strap is recommended to prevent static discharge to any of the sensitive electronic components on the servo amplifier logic board(s).

2. Carefully label and disconnect all wires and connectors to the logic board(s).

Important: Labeling is essential since some connectors are the same size and could be accidentally interchanged.

3. Disconnect the chassis ground wire from the logic board(s). If the ground wire is soldered to the logic board, it will have to be disconnected at the chassis, just to the left of TB1.

4. Remove the screws that secure the logic board(s) to the servo amplifier chassis.

5. Carefully push the wires and connectors to the side and remove the logic board(s).

6. Install the replacement board(s) by reversing the removal procedure. First position the board(s) on the chassis and verify that all wires and connectors are accessible.

7. Install and tighten the screws that secure the logic board(s) to the chassis.

8. Reconnect all wires and connectors, including the chassis ground wire.

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9. MATCH JUMPERS on the new servo amplifier logic board(s) to the settings on the board(s) being replaced. Amplifier jumper settings are listed starting on page 13A-16.

ATTENTION: Jumper settings configure the amplifier to match the specific application. Failure to match jumper settings on the new servo amplifier may result in damage to the amplifier, servomotors, or machine.

---

10. Turn **ON** power to the control and servo amplifier.

15B.26 Replacing the Power Section on the Digital Servo Amplifier

The servo amplifier power section includes the entire servo amplifier chassis and all components mounted beneath the servo amplifier logic board. Replacement requires removal of the servo amplifier from the cabinet.

To replace the servo amplifier power section on a servo amplifier:

1. Turn OFF all power to the control and the servo amplifier.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open (off) and locked.

Important: The use of a ground strap is recommended to prevent static discharge to any of the sensitive electronic components on the servo amplifier logic board(s).

2. Remove the servo amplifier from the cabinet as discussed earlier in this section.

3. Carefully label and disconnect all wires and connectors to the logic board(s).

Important: Labeling is essential since some connectors are the same size and could be accidentally interchanged.

4. Disconnect the chassis ground wire from the logic board(s). If the ground wire is soldered to the logic board, it will have to be disconnected at the chassis, just to the left of TB1.

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5. Remove the screws that secure the logic board(s) to the servo amplifier chassis.
6. Carefully push the wires and connectors to the side and remove the logic board(s).
7. Install the logic board(s) onto the new servo amplifier power section by reversing the removal procedure. First position the board(s) on the chassis and verify that all wires and connectors are accessible.
8. Install and tighten the screws that secure the logic board(s) to the chassis.
9. Reconnect all wires and connectors to the logic board(s) as labeled, including the chassis ground wire.
10. Return the servo amplifier to the cabinet and reconnect it.
11. Turn **ON** power to the control and servo amplifier.

15B.27 Replacing the Optional Feedback Module

This is not available on the 9/230 control. To replace the optional feedback module:

1. Turn **OFF** all power to the control.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

---

2. Remove the servo module next to the optional feedback module.
3. Disconnect all cables connected to the optional feedback module.
4. Disconnect the optional feedback module from the servo module.
5. Replace the optional feedback module with a new one.
6. Set jumper JP1 on the new optional feedback module to correspond to the setting of jumper JP1 on the old optional feedback module.
7. Adjust the variable resistors (pots) on the new optional feedback module so they to correspond to the settings of the variable resistors (pots) on the old optional feedback module.
8. Reconnect all cables that were disconnected.

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9. Reinstall the servo module

10. Turn **ON** power to the control.

15B.28 Replacing the 3-axis Analog Servo Module (9/260 and 9/290 only)

To replace the analog servo module:

1. Turn OFF all power to the control.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

Important: The use of a ground strap is recommended to prevent static discharge to any of the sensitive electronic components on the servo amplifier logic board(s).

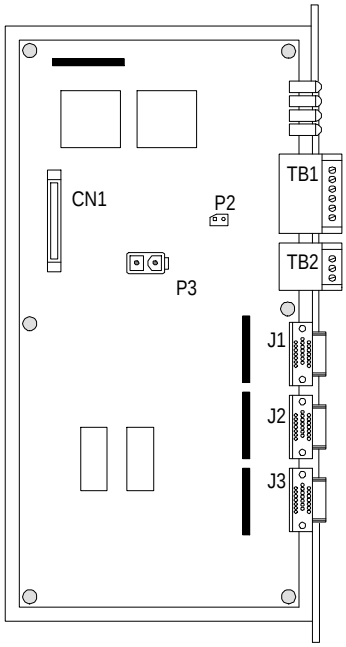
2. Disconnect all cables that are connected to the servo module.

3. Remove the 4 mounting screws that hold the board rack with the servo module to be replaced, in the component enclosure. Slide the board rack out of the component enclosure board slot.

4. Remove the 6 mounting screws, shown in Figure 15B.10, which hold the servo module to the board rack.

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Figure 15B.10
Analog Servo Module Mounting Screw Locations



5. Remove the servo module being replaced and install the new servo module.

6. Replace and tighten the 6 mounting screws.

7. Slide the board rack into the the board slot of the component enclosure then replace and tighten the 4 mounting screws.

8. Replace all cables that were disconnected.

9. Turn **ON** power to the control.

15B.29 Replacing the 4-axis Servo Module (9/260 and 9/290 only)

To replace the 4-axis servo module:

1. Turn OFF all power to the control, any peripherals, and servo devices.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open and locked.

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Important: The use of a ground strap is recommended to prevent static discharge to any of the sensitive electronic components on the servo amplifier logic board(s).

2. Disconnect all cables that are connected to the servo module.

Important: For digital systems, the control must be "homed" after replacing the servo module. If the servo motors incorporate an absolute encoder, the absolute axis position will be lost. The absolute encoder must be reset after the servo module is replaced. Refer to page 13A-33 for absolute encoder reset procedures.

3. Remove the 4 mounting screws that hold the board rack with the servo module to be replaced, in the component enclosure. Slide the board rack out of the component enclosure board slot.

4. Remove the 6 mounting screws, shown in Figure 15B.10, which hold the servo module to the board rack.

5. Remove the servo module being replaced and install the new servo module.

6. Replace and tighten the 6 mounting screws.

7. Slide the board rack into the the board slot of the component enclosure then replace and tighten the 4 mounting screws.

8. Replace all cables that were disconnected.

9. Turn **ON** power to the control.

15B.30 Replacing an Analog Servo Amplifier

To replace an analog servo amplifier, first read all documentation prepared by the analog servo amplifier's manufacturer, then:

1. Turn OFF all power to the control and the servo amplifier.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open (off) and locked.

---

2. Carefully disconnect and mark all cables that are connected to the servo amplifier.

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3. Loosen and/or remove the mounting screws that hold the servo amplifier to the cabinet.

4. Carefully remove the servo amplifier.

5. Install the replacement amplifier by reversing the removal procedure.

6. Replace all wires and connectors exactly as they were removed.

7. MATCH SETTINGS on the new servo amplifier to the settings on the amplifier being replaced. Servo amplifiers may use jumpers, DIP switches, software switches or potentiometers for amplifier configuration. Refer to the literature provided with the servo amplifier.



ATTENTION: Amplifier settings configure the amplifier to match the specific application. Failure to match settings on the new servo amplifier may result in damage to the amplifier, servo motors, or machine.

8. Turn **ON** power to the control and servo amplifier.

15B.31 Replacing the Rotary MTB Panel I/O Module

To replace the rotary MTB panel I/O module:

1. Disconnect the cable running from the operator panel power supply or external power source to the power supply terminals.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

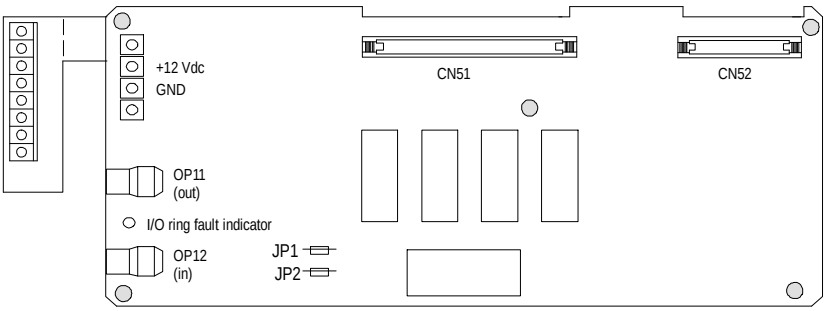
2. Disconnect the fiber optic cables.

3. Disconnect the input and output cables running from the rotary MTB panel I/O module to the rotary MTB panel.

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4. Remove the 5 mounting screws, shown in Figure 15B.11, that connect the rotary MTB panel I/O module to the stand-offs.

Figure 15B.11
Rotary MTB Panel I/O Module Mounting Screw Locations

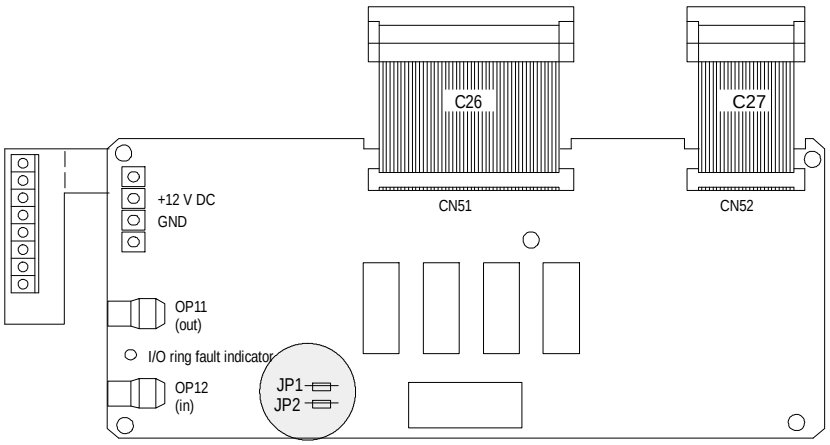


5. Replace the old rotary MTB panel I/O module with a new rotary MTB panel I/O module.

6. Replace and tighten the 5 mounting screws then reconnect all cables.

7. Set the node address to match the settings on the old rotary MTB panel by cutting the wire jumpers on the new rotary MTB panel I/O module.

Figure 15B.12
Rotary MTB Panel I/O Module Jumper Positions



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15B.32 Replacing the Push-Button MTB Panel I/O Module

To replace the push-button MTB panel I/O module:

1. Disconnect the cable running from the operator panel power supply or external power source to the power supply terminals.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

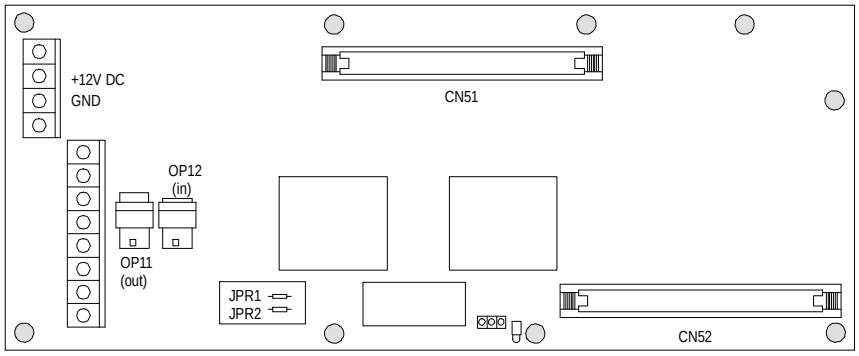
---

2. Disconnect the fiber optic cables.

3. Disconnect the input and output cables running from the push-button MTB panel I/O module to the push-button MTB panel.

4. Remove the 9 mounting screws, shown in Figure 15B.13, that connect the push-button MTB panel I/O module to the stand-offs.

Figure 15B.13
Push-Button MTB Panel I/O Module Mounting Screw Locations



5. Replace the old push-button MTB panel I/O module with a new push-button MTB panel I/O module.

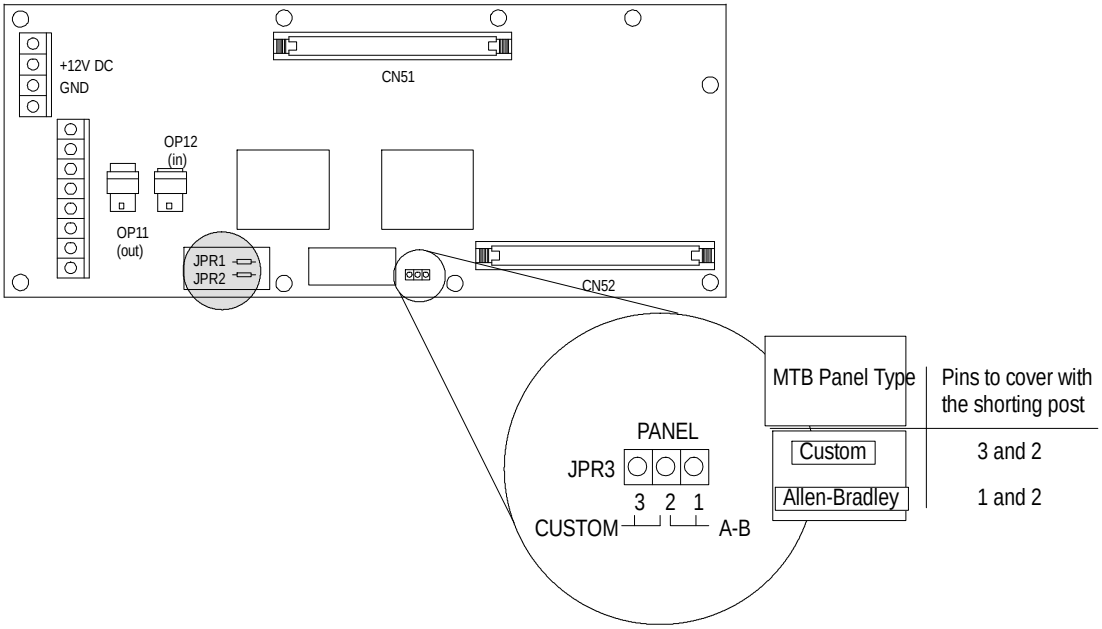
6. Replace and tighten the 9 mounting screws then reconnect all cables.

7. Set the node address to match the settings on the old push-button MTB panel by cutting the wire jumpers on the new push-button MTB panel I/O module.

8. If you are using a custom MTB panel, set the shorting post of JPR3 over pins 2 and 3.

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Figure 15B.14
Push-Button MTB Panel I/O Module Jumper Positions



15B.33 Replacing Digital I/O

To replace the digital I/O:

1. Disconnect the cable running from the external power source to the digital I/O.

ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the ac distribution network unless the main ac disconnect switch is open (off) and locked.

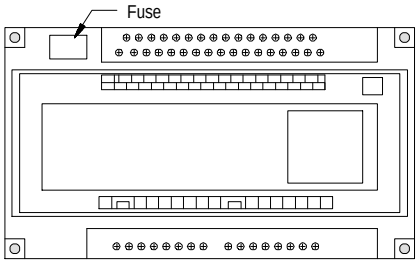
---

2. Disconnect the cables running from the external I/O devices to the digital I/O.

3. Disconnect the fiber optic cables.

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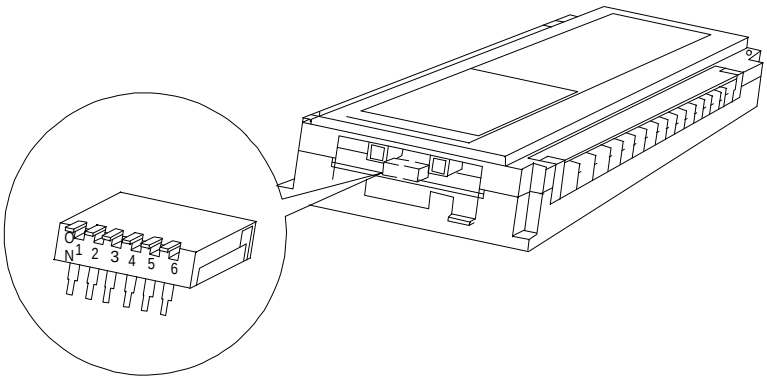
4. Remove the mounting screws, which are located at each corner of the digital I/O.



5. Replace the old digital I/O with a new digital I/O.

6. Replace and tighten the 4 mounting screws then reconnect all cables.

7. Set the node address to match that of the old digital I/O using the switch assembly located between the fiber optic connectors.



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15B.34 Replacing the Power Fuse on Digital I/O and Analog I/O

Under normal conditions the DC POWER indicator will be illuminated. If a fuse is blown, the DC POWER indicator will not be illuminated.

One of the following conditions may have caused a blown fuse:

- Excessive line voltage
- Internal power supply malfunction.

To replace a blown fuse:

1. Disconnect the cable running from the external power source to the digital I/O.



ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Remove the fuse compartment cover.

3. Remove the fuse holder; push the handle to the left, then pull outward.

4. Remove the fuse from its holder and replace it with a recommended replacement fuse.



ATTENTION: Use only replacement fuses of the type and rating specified for the unit. Improper fuse selection may result in equipment damage.

---

5. Place the fuse holder back into its compartment. Push inward until it locks into place.

6. Replace the fuse compartment cover.

7. Restore power. The DC POWER indicator should now be illuminated.

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15B.35 Replacing the High Density I/O

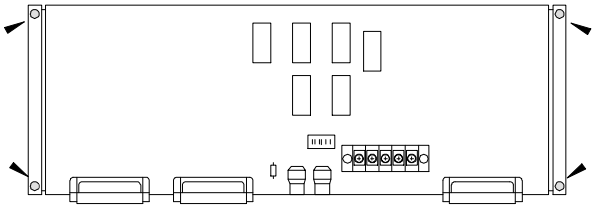
To replace the high density I/O:

1. Disconnect the cable running from the external power source to the high density I/O.

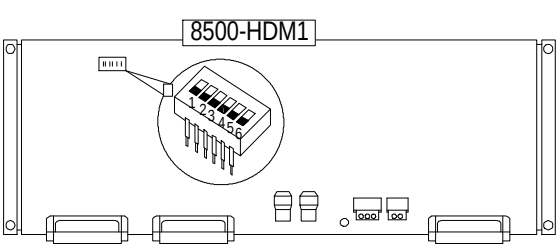
ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

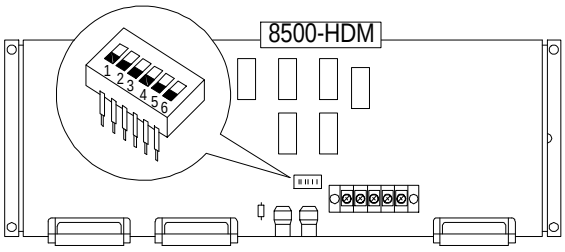
---

2. Disconnect the cables running from the external I/O devices to the high density I/O.
3. Disconnect the fiber optic cables.
4. Remove the 4 mounting screws shown in the figure below that secure the high density I/O back plate to the cabinet.



5. Replace the old high density I/O with a new high density I/O. There are two versions of the high density I/O module. If you are replacing an existing module with a different version of the high density I/O module, you will have to drill new mounting holes to secure the new module. Refer to page 2B-21 for mounting dimensions for both of these modules.
6. Replace and tighten the 4 mounting screws then reconnect all cables.
7. Set the node address to match that of the old high density I/O using the switch assembly shown in the figure below. The location of this switch is slightly different between the two available modules.





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15B.36 Replacing the Analog I/O

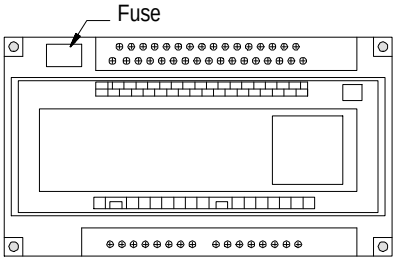
To replace the analog I/O:

1. Disconnect the cable running from the external power source to the analog I/O.

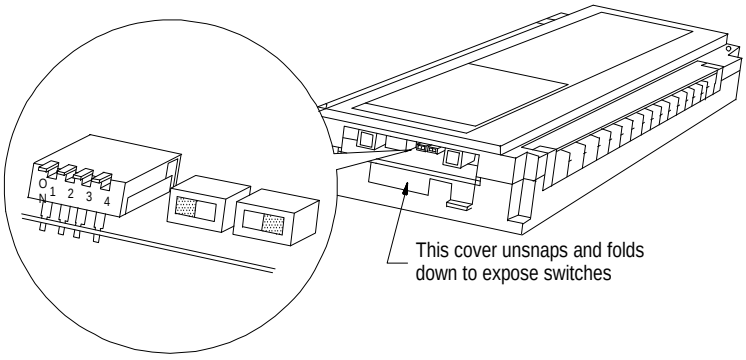
ATTENTION: To guard against electrical shock hazards, **never** make connections or disconnections at the AC distribution network unless the main AC disconnect switch is open and locked.

---

2. Disconnect the cables running from the external I/O devices to the analog I/O.
3. Disconnect the fiber optic cables.
4. Remove the mounting screws, which are located at each corner of the analog I/O.



5. Replace the old analog I/O with a new analog I/O.
6. Replace and tighten the 4 mounting screws then reconnect all cables.
7. Set the node address to match that of the old analog I/O using the switch assembly shown below.



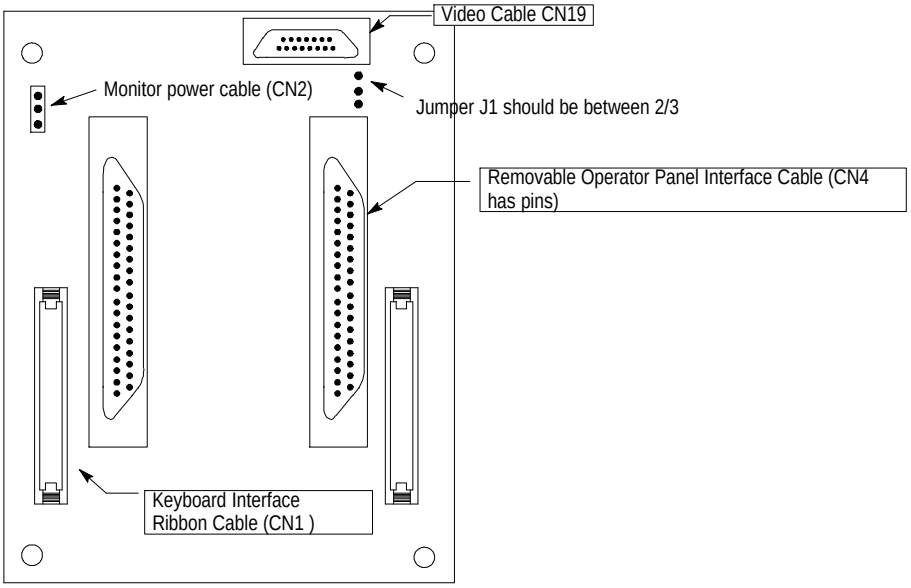
8. Set the unipolar/bipolar switches to match the settings on the replaced analog I/O module.

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15B.37 Replacing the Removable Operator Panel (ROP) Interface Module

This ROP interface module resides in the removable operator panel cabinet. To replace the ROP interface module:

1. Make sure power to the removable operator panel has been disconnected.
2. Open the back cover of the removable operator panel.
3. Remove the back cover by sliding the cover off its hinge pins. Do this by firmly pushing the cover to the left while it is open.
4. Disconnect all cables connected to the ROP module including:
   a. 37–pin D–shell removable operator panel interface cable (CN4)
   b. 15–pin D–shell video cable (CN19M)
   c. Keyboard interface ribbon cable (CN1)
   d. Monitor power cable (CN2)
5. Remove the four ROP module mounting screws.



6. Place the jumper installed on jumper J1 across pins 2 and 3.
7. Installation of the new ROP module is the reverse of steps 1 to 5.

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15B.38 Replacing the ROP Module in the Removable Operator Panel Interface Assembly

This ROP interface module resides in the removable operator panel interface assembly which resides on the 9/Series fiber optic I/O ring. To replace the ROP interface module:

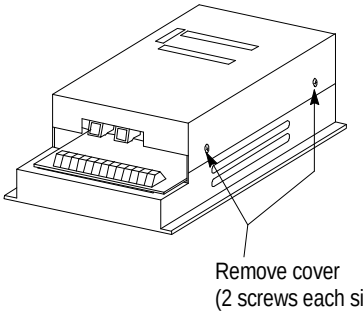
1. Make sure power to the removable operator panel interface assembly has been disconnected.

2. Disconnect all cables connected to the ROP module through the cover including:

a. 37–pin D–shell removable operator panel interface cable (CN4) if connected.

b. 15–pin D–shell video cable (CN19M)

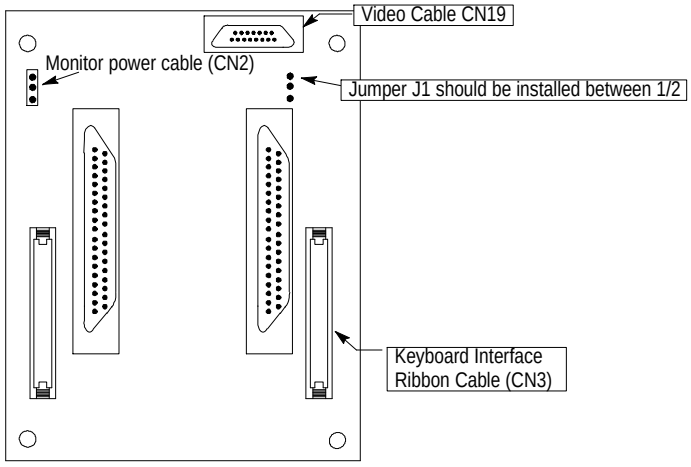
3. Remove the four screws that hold the cover on the interface assembly and remove the cover.



4. Disconnect all cables connected to the ROP module including:

a. Keyboard interface ribbon cable (CN3)

b. Monitor power cable (CN2)



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5. Remove the four ROP module mounting screws.

6. Install the jumper on jumper J1 across pins 1 and 2 on the new 8520-ROP.

7. Installation of the new ROP module is the reverse of steps 1 to 5.

15B.39 Replacing the Removable Operator Panel CRT or Keyboard Assemblies

To replace the either the CRT or the keyboard assembly in the removable operator panel follow these procedures:

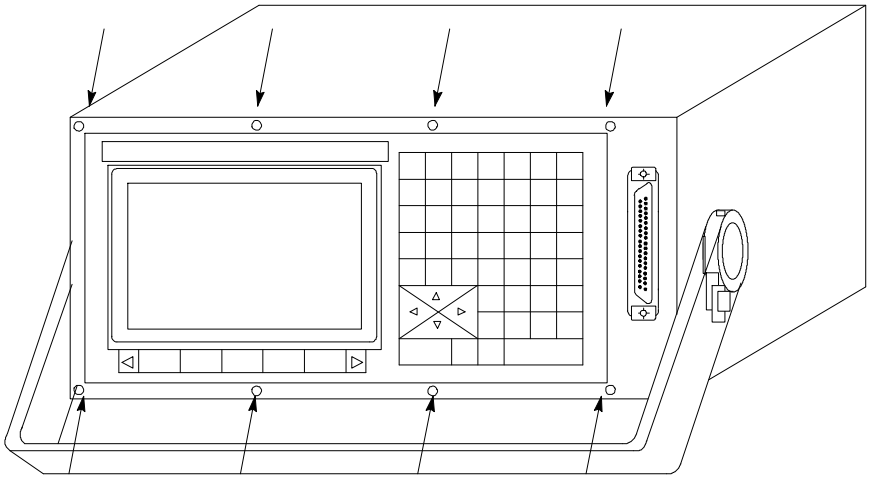
1. Make sure power to the removable operator panel has been disconnected.

2. Open the front and back cover of the removable operator panel.

3. Remove the front and back cover by sliding the cover off its hinge pins. Do this by firmly pushing the cover to the left while it is open.

4. Disconnect the 37-pin D-shell removable operator panel interface cable (CN4) from the ROP interface module.

5. Remove the eight screws that hold the operator panel in the removable panel case from the front of the unit.



6. Slide the operator panel assembly out the front of the case.

7. Follow the monochrome CRT replacement procedure from page 15B-25 or the keyboard replacement procedure from page 15B-26.

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15B.40 Replacing the 9/440 System Module or CNC Assembly

The 9/440 system module is the assembly that holds the drive power assembly as well as the 9/440 CNC assembly and wiring board. The 9/440 CNC assembly consists of the 9/440 main processor board, the feedback board, and the mounting bracket. When a repair is necessary to the 9/440 CNC assembly it must be removed from the system module and sent as a separate assembly. When a repair is necessary to the power assembly of the 9/440 system module, the 9/440 CNC assembly must be removed and the entire system module sent without the 9/440 CNC assembly, wiring board, and battery backup.

Important: Never attempt to separate the boards of the CNC assembly (processor board/feedback board). These boards must be serviced as an assembly.

Regardless of if you are sending in the system module or the 9/440 CNC assembly you must remove the 9/440 CNC assembly from the system module. This procedure covers this removal.

Important: When sending in the 9/440 CNC assembly you must remove both your FLASH and RAM SIMMs as well as your 9/Series option chip. If you send these in with your 9/440 CNC assembly they may not be returned. Removing these SIMMs and the option chip is discussed later in this procedure.

1. Make sure 3–phase drive power and 24 V logic power to the system module has its circuit breaker open.



ATTENTION: Make sure all power is off to the 9/440 before continuing with this procedure. Both three phase power and 24 volt logic power should be disabled.

Important: Follow proper electro static discharge precautions. Always wear an ESD certified wrist strap.

2. Open the system module front cover. Label and disconnect any cables going to the CNC wiring board. Label and disconnect encoder port three (if used).

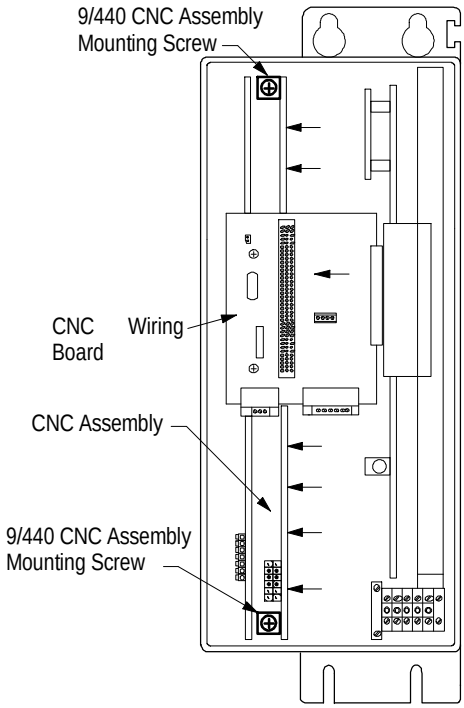
3. Label and disconnect any cables (feedback, fiber optic ring, serial port, etc...) wired through the bottom of the system module.

4. If you are sending in the 9/440 CNC assembly go to step 8.

5. Label and disconnect wires to the system module power terminal.

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Push 9/440 CNC assembly to the left to unplug the wiring board after the removing assembly mounting screws.



6. Loosen or remove the bolts that mount the axis modules to the cabinet. Disconnect axis modules from the system module by pressing down on axis module tab and sliding to the right (away from the system module).

7. Unbolt system module and remove from drive cabinet.

8. Remove the two screws holding the 9/440 CNC assembly bracket in the system module.

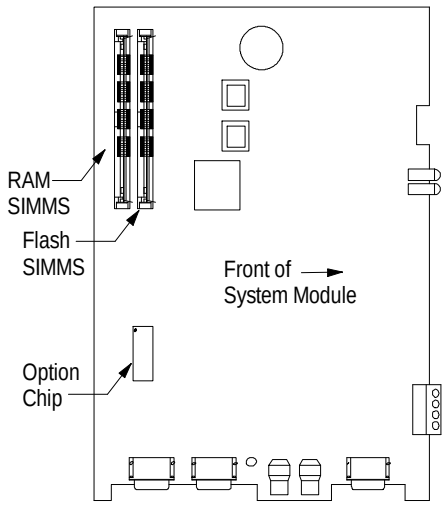
9. Push the 9/440 CNC assembly to the left (away from the axis module mounting) to unplug the wiring board from the power portion of the system module. Make sure the wiring board fully disengages from the power portion of the system module.

10. Remove the two screws holding the wiring board to the 9/440 CNC assembly and unplug the wiring board (by pulling straight out of the system module) from the 9/440 CNC assembly.

11. Carefully slide the 9/440 CNC assembly out of the system module. Be careful to not damage the flash and RAM SIMMS which are mounted on the left side of the 9/440 CNC assembly.

12. If you are sending the 9/440 CNC assembly in for repair make sure you label and **remove the flash and RAM SIMMS as well as your option chip** before sending in the assembly. Repaired or replacement units will not be shipped with these chips.

CNC Processor Board



Important: Never attempt to separate the boards of the CNC assembly (processor board/feedback board). These boards must be serviced as an assembly.

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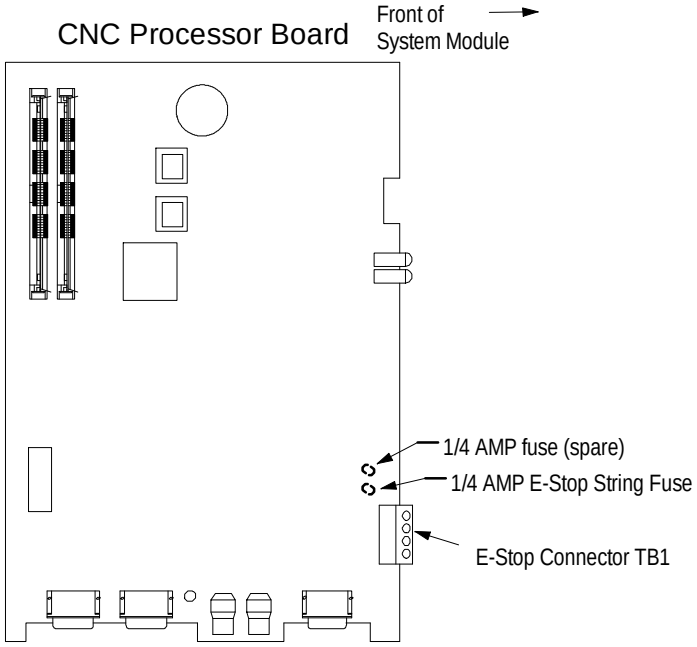
Important: Though the FLASH and RAM SIMMs can be plugged into the same sockets they are not identical or interchangeable chips. Make sure you label these SIMMs so they are returned to the correct sockets.

Important: Make sure when you re-install the 9/Series option chip that the chip is oriented properly. Pin one (marked with a dot on the option chip) is oriented towards the top left corner of the processor board.

15B.41 Replacing the 9/440 E-Stop String Fuse

The 9/440 system E-Stop String fuse is located on the 9/440 CNC processor board. You must remove the 9/440 CNC assembly to replace this fuse. Follow the procedure on page 15B-58 titled Replacing the 9/440 System Module up to and including the removal of the CNC interface assembly.

The E-Stop string is a 12V dc string protected by a .25 AMP 115 V fuse located on the 9/440 CNC processor board. A spare fuse is also included on this board. Contact your Allen-Bradley sales representative for details on purchasing additional replacement fuses.



Remove the fuse by grasping the plastic cap and pulling straight up away from the CNC processor board.

END OF SECTION

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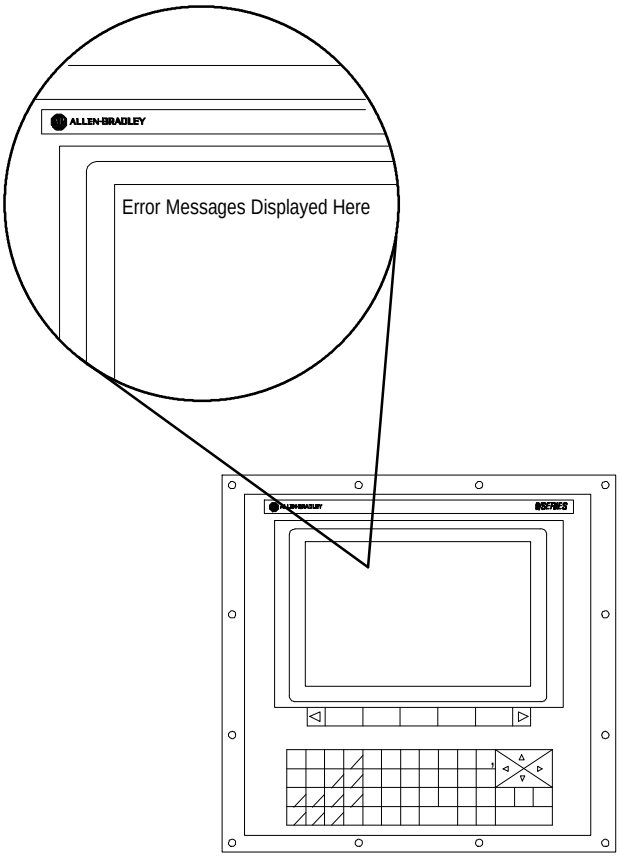
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9/Series Hardware
TAB 16

Error and System Messages



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Section 16

Error and System Messages

Overview

This section serves as a guide to error and system messages that can occur during programming and operation of the 9/Series control. We listed the messages in alphabetical order along with a brief description.

Important: To display both active and inactive messages, press the {ERROR MESAGE} softkey found on softkey level 1. For details, see Chapter 2.

Important: This appendix covers only error and system messages. PAL-generated operator messages generally appear on lines 21 and 22 of the CRT and should be described in documentation prepared by the machine tool builder.

Message	Description
Symbols	
(+) 15V SUPPLY FAILURE	+ 15 Vdc is not available at the main processor board. Check the wires from the main power supply and connector CN07 on the main processor board.
(-) 15V SUPPLY FAILURE	- 15 Vdc is not available at the main processor board. Check the wires from the main power supply and connector CN07 on the main processor board.
(+) OVERTRAVEL PROGRAM ERROR	If axis motion continues along the programmed path, the indicated axis will reach or exceed the positive software overtravel limit (runtime error).
(-) OVERTRAVEL PROGRAM ERROR	If axis motion continues along the programmed path, the indicated axis will reach or exceed the negative software overtravel limit (runtime error).
(+) OVERTRVL PRGRAM ERROR:	The end-point of the commanded move will cause the indicated axis to reach or exceed the positive software overtravel limit (pre-execution error).
(-) OVERTRVL PRGRAM ERROR:	The end-point of the commanded move will cause the indicated axis to reach or exceed the negative software overtravel limit (pre-execution error).
+/- SIGN ERROR	A + or - sign was found out of place when a numeric value was being decoded. Check the active program block for programming format errors.
1	
1394 AXIS MODULE MISMATCH	At power turn on the system identified an axis module in the 1394 rack that is misconfigured in AMP. If an extra axis module is present in the 1394 rack it should either be fully configured or not configured at all in AMP even if that axis module is not used or detached.
1394 RING COMMUNICATIONS ERROR	At power up the internal communications ring which runs through the front of the 1394 system and drive modules was either not connected, a device on the ring experienced a hardware failure, or a device on the ring was discovered to be misconfigured once a command was sent to the device. Make sure all axis modules and the end terminator are properly connected to complete the communication ring.
1746 RACK CARDS MISMATCH	The I/O configuration for the 1746 I/O rack that was downloaded from ODS, or resides in the PAL PROMs, contradicts what is actually in the rack (devices must match slot-for-slot).
1771 RACK CARDS MISMATCH	The I/O configuration for the 1771 I/O rack that was downloaded from ODS, or resides in the PAL PROMs, contradicts what is actually in the rack (devices must match slot-for-slot).

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Message	Description
2	
2MB RAM IS BAD/MISSING	The control has discovered the RAM SIMMs for the two megabyte extended storage option are either damaged or missing. The RAM SIMMs must be installed or replaced. Contact your Allen Bradley sales representative for assistance.
9	
9/SERIES LATHE - CANNOT USE MILL AMP	The control was powered up with a **lathe** software option chip installed, when the AMP file that was downloaded was configured for a mill.
9/SERIES MILL - CANNOT USE LATHE AMP	The control was powered up with a **mill** software option chip installed, when the AMP file that was downloaded was configured for a lathe.
7300	
7300 NAMES TABLE IS CORRUPTED	7300 program name doesn't match corresponding name in cross-reference table.
7300 PATTERN NAME TOO LONG	More than 5 digits have been used in the pattern name.
A	
A RETRACE BUFFER WAS DELETED	The control required one (or more) of the block retrace buffers to perform a necessary block look-ahead operation (refer to block look-ahead in the user's manual). When this occurs, less block retrace operations can be performed than AMP is configured to allow. If this error occurs, to improve control efficiency, it is recommended that the number of allowable block retrace blocks set in AMP be lowered or add additional RAM to you system.
ABS POSITION NOT INITIALIZED	This message indicates that axes with absolute encoders have not been homed. These axes require an initial homing operation to establish the absolute position.
ABSOLUTE FEEDBACK FAILURE	The control has detected a loss of feedback from the absolute encoder. The most likely cause of this error would be a broken or disconnected wire. Axis homing may be required after the error condition is corrected.
ACC/DEC CONFIGURATION ERROR	An axis configuration error was detercted by the control when manual acc/dec was requested in a program block.
ACCUM. AND EXPECTED LIFE ARE 0	No tool life data was entered for the current tool selected by the tool life management feature. Tool life management will be disabled for this tool.
ACTIVE GROUP CANNOT BE DELETED	An attempt was made to delete a tool group in the tool life management feature that contains an active tool currently in the tool holder.
ACTIVE OFFSET CANNOT CHANGE	An attempt was made to alter a tool offset value of a tool offset that is currently the active tool offset on the control. The active tool offset is indicated with an * on the tool offset table.
ACTIVE TOOL CANNOT BE CHANGED	An attempt was made to edit tool data for the currently active tool. De-activate the tool before editing.
ACTIVE TOOL CANNOT BE DELETED	An attempt was made to delete tool data for the currently active tool. De-activate the tool before editing.
ADAPTIVE FEED MAX LIMIT	The actual torque is less than the desired programmed torque and the adaptive feed axis has reached the programmed maximum feed limit. Either raise the programmed maximum feed limit, or lower the programmed desired torque.
ADAPTIVE FEED MIN LIMIT	This message indicates your are exceeding the programmed desired torque. The actual torque is greater than the desired programmed torque and the adaptive feed axis has reached the programmed minimum feed limit. Either raise the programmed desired torque or lower the minimum feed limit.
ADAPTIVE FEED PROGRAMMING ERROR	E and Q must both be programmed in every G25 block.
ALL DUAL AXES ARE PARKED	An attempt was made, while using dual axes, to move the dual group when all the axes of that group were parked.
AMP FILE SIZE ERROR	The size of the AMP file being downloaded is incorrect. The file cannot be downloaded.

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Message	Description
AMP IN BACKUP DOES NOT MATCH AMP IN RAM	This message always appears after a successful AMP download if the downloaded file is different from the one currently stored in backup memory. Its purpose is to remind the user to copy the downloaded AMP into backup memory after testing it.
AMP WAS MODIFIED BY PATCH AMP UTILITY	This message always appears after changes have been made to AMP using the patch AMP utility. Its purpose is to remind the user that the current AMP has not been verified by a cross-reference check normally performed by ODS. It is meant as a safety warning.
AMPED HOLDING OR DETECT TRQ OUT OF RANGE	This message is displayed when you have entered a value in AMP for either the holding torque or the detection torque, for the feed to hard stop feature, that is higher than the value entered for the servos available peak torque. You must change your AMP values.
ANALOG SERVO VOLTAGE FAILURE	A ± 15V to the servo cards has failed.
ANGLE WORD NOT ALLOWED	An angle word was programmed in a QPP block where it is not allowed, for example, programming an angle word in a circular QPP block.
ANGLED WHEEL AXES, JOG ONE AT A TIME	While in the angled wheel grinding mode you can not jog more than one axis in the angled wheel plane at any one time.
ANGLED WHEEL CONFIG ERROR	The angled-wheel grinder AMP downloaded to the control is not configured correctly. Make sure all necessary angled-wheel parameters are configured correctly and re-download AMP to the control.
ANGLED WHEEL NOT CONFIGURED	You have attempted to program an angled wheel grinder mode function and the angled wheel feature has not been correctly configured for your system. The angled wheel feature must be configured in AMP and is a purchased option for your 9/Series control.
ARCTAN SYNTAX ERROR	An attempt was made to calculate or execute a paramacro block that calculates the arc tangent of an invalid or improperly entered number.
ARITHMETIC OVERFLOW ERROR	An internal math error has occurred; contact Allen-Bradley customer support service.
ARITHMETIC UNDERFLOW ERROR	An internal math error has occurred; contact Allen-Bradley customer support service.
AUX FB NOT ALLOWED WITH DEPTH PROBE	Your AMP file has a depth probe configured for an axis that also is configured to use an optional feedback device. A depth probe can not be configured to use any feedback device other then its depth probe for that depth probe axis. If a second feedback device is used it is configured in AMP as a separate logical axis.
AUXILIARY FEEDBACK DISCONNECTED	The digital servo module provides the capability to use two different feedback encoders with one servo (in the case where two encoders are used, the auxiliary encoder is used for the position feedback). If the servo processor detects that the auxiliary encoder has been disconnected, this message is displayed.
AUXILIARY FEEDBACK QUADRATURE FAULT	The digital servo module provides the capability to use two different feedback encoders with one servo (in the case where two encoders are used, the auxiliary encoder is used for the position feedback). If the servo processor detects a quadrature fault on the auxiliary encoder, this message is displayed.
AUXILIARY SPINDLE 2 NOT CONFIGURED	For aux spindle 2 to be programmable, it must be configured in AMP; a decode error.
AUXILIARY SPINDLE 3 NOT AVAILABLE	AMP configuration error; aux spindle 3 can be configured only on a 9/290.
AUXILIARY SPINDLE 3 NOT CONFIGURED	For aux spindle 3 to be programmable, it must be configured in AMP; a decode error.
AXES COLLISION	Two processes have collided. Interference checking has stopped all motion.
AXES CONFIGURED ON INACTIVE PROCESS	An AMP was loaded that contains an axis that was configured for an inactive process. Set the process axis in AMP to a process that has been configured.
AXES DATA MISSING	Expected axis data is missing in a program block.
AXIS AMPED AS NON-SCALING AXIS	The user attempted to scale an axis that was AMPed as non-scaleable.
AXIS ASSIGNED TO PAL AXIS MOVER	The user attempted to move the axis configured as the PAL axis mover axis by some means other than PAL.
AXIS DISPLAY DISABLED BY PAL	The position display for a selected axis has been turned off using the $NODP flag.

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Message	Description
AXIS IN PLANE DOES NOT EXIST	At least one of the axes assigned to a plane that was defined in AMP does not exist. An example of when this error would occur is if an axis was renamed in AMP, but that new name was not entered into the AMP plane definition. Another example would be if an unfitted axis was assigned to that plane.
AXIS INVALID FOR G24/G25	The programmed axis was not AMPed for software velocity loop operation, and can not be used in a G24 or G25 block. To use these features the axis programmed must be configured for tachless operation (or be a digital servo).
AXIS IS HARD STOPPED, CANT ADJUST SERVO	The torque limit of the servo can not be adjusted because, either the axis is in a hard-stopped state, or some other axis on the same servo card is in a hard-stopped state.
AXIS MODULE POWER FAULT	The axis module hardware has faulted from a short duration over current condition. If the output current exceeds a fixed level (Over 200% of axis module rating for the 10 and 15 Kw modules and Over 300% for the 2, 3 and 5 Kw modules) this fault will appear. Typical causes are a shorted lead, motor malfunction, or malfunctioning power IGBTs.
AXIS MODULE OVER CURRENT	One of the axis modules of your 1394 drive has been requested to provide too much current over an extended time period. This is typically caused by: Accel/Decel command from the CNC is requiring peak current for an excessive amount of time, the machine friction or inertial/viscous load is excessive, the motor has been improperly sized, a short circuit exists across the drive output terminals, logic supply circuits have malfunctioned, or AC input is incorrectly wired.
AXIS MODULE BUSS VOLTAGE LOSS	The DC bus supply was lost to the axis module. Check slider connections/termination strip or there could be a blown link fuse. This condidtion also occurs in a systemE-stop state.
AXIS MODULE OVER TEMP	The 1394 contains a thermal sensor which senses the internal ambient temperature. Causes could be: that the cabinet ambient temperature is above rating. The machine duty cycle requires an RMS current exceeding the continuous rating of the controller. The airflow access to the 1394 is limited or blocked. This does not necessarily indicate a motor over temperature. Motor over temperture sensors should be wired directly into the E-Stop string.
AXIS MOVER CONFLICT WITH G16.3/G16.4	You have requested a PAL axis mover function on an angled wheel grinder. You can not use the PAL axis mover in one of the angled wheel modes unless the PAL axis mover has control of both the axial and the wheel axes.
AXIS NAME DUPLICATE	Two or more axes have been assigned the same name in AMP.
AXIS NOT IN PROCESS	You attempted to read/write a paramacro parameter for an axis that is not currently in the process requesting the data. To access paramacro parameter data for an axis, that axis must be in the process making the request.
AXIS POSITION INCORRECT	Using the mid-start program function, you have searched to a block that does not create the programmed contour if started from your current axis position. Be aware the mid-start operation may have searched thru a offset operation that is not readily apparent to determine your axis position. The mid-start operation is aborted. You must re-perform the mid-start operation and either position the axes to the correct axis position, or use the {MOVE & EXIT} softkey to find the correct axis position.
AXIS SELECT NOT ALLOWED	The {AXIS SELECT} softkey was pressed when no axis select option is available. Axis select is only available on large screens and normal character size screen for systems that contain more then 9 axes total or dual process systems with more than 8 axes in a process. It is not available when the small screen (showing all system AMPed axes) is being viewed.
AXIS TYPE-POSITION LOOP ERROR	In patch AMP, an axis was assigned a position loop type that is illegal for the axis type assigned to that axis.
B	
BACKUP VERSION OF AMP WAS COPIED TO RAM	The AMP in RAM was erased (battery backup failed) or corrupted, so the control automatically copied the version of AMP in backup memory into RAM memory. (The control stores AMP in backup, but works from the copy of AMP in RAM memory.)
BAD DAC MONITOR PATCH AMP ENTRY	An invalid value was entered into patch AMP parameter #86 or #87. Either parameter allows the axes to be monitored through the servo module (DAC) analog output. See documentation provided by Allen-Bradley on patch AMP, or contact Allen-Bradley customer support service.

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Message	Description
BAD FIRST POCKET BLOCK	When performing an irregular pocket cycle, the first pocket block should be away from the pocket start/end corner, not toward it. The move to the start/end corner is generated based on the coordinates programmed in the pocket definition block itself.
BAD PAL PROM	One of the PAL PROM chips (plugged into the main processor board) has failed or is not plugged in properly.
BAD RAM DISC SECTOR CHECKSUM ERROR	A RAM disk sector error was detected during the RAM checksum test at power-up. Attempt to power-up again. If the error remains, contact Allen-Bradley customer support services.
BAD RECORD IN PROGRAM	This indicates a serious problem with the program. Attempt to open the program a second time. If retry doesn't work, you may have to delete the program. Typically this error is not caused by a programmer or operator action. It is typically caused by an internal software error in the program.
BAD STATE/TOKEN COMBINATION (PROGRAM ERROR)	While attempting to decode the current block, a combination of characters caused a decode error to occur. Check the characters in the current block for an illegal combination.
BATTERY FAILURE	The battery that provides backup of the RAM memory is not functioning; the voltage may be low. The battery may be dead, removed, or poorly connected.
BLK DELETE CHG IGNORED ON PREPARED BLKS	A block-delete was activated while a program was executing. This change is ignored by the control for blocks that have already been read into the control's set-up buffer (see block look-ahead in user's manual).
BLOCK LENGTH ERROR	A block that exceeds the allowable maximum block length was programmed.
BLOCK RETRACE ABORTED	The block retrace operation being performed has been canceled. When <CYCLE START> is pressed, the control will return the tool along a linear path back to the start-point of the block retrace operation.
BOOT DIRECTORY IS MISSING	The update utility failed to properly create the system boot directory. Retry the update. If the error occurs again, contact your local Allen Bradley service.
BOOTSTRAP FAILED TO START	The bootstrap code did not send the "ok" signal to the main processor within the specified time.
BOTH AXES IN QPP PLANE NOT PRGMD	The second block of a currently executing QuickPath Plus two-block set does not contain both required axis words in the current plane. Both axis words are required to correctly identify the end-point of the second move.
BOTH LINES ARE PARALLEL	Both blocks of a two-block QPP sequence are parallel, and no mathematical intersection can be computed.
BOTH PORTS ARE BUSY	An attempt was made to use or monitor communication ports A or B when neither were available.
BUSY, REQUEST IGNORED	You have requested an operation while the control is currently executing some other higher priority function. The control must first complete the higher priority task before your new task can be performed.
C	
CALLED 7300 PATTERN NAME IS BAD	The 7300 pattern name that is called by a part program does not exist .
CANCEL/REMOVE OFFSET BEFORE AXIS CHANGE	You have attempted to change the active tool length axis while an length offset is currently active on that axis. You must cancel tool length offsets before you are allowed to change the active tool length axis.
CANNOT (GOTO) TO INSIDE A (DO)	A (GOTO) command cannot transfer execution to a block which is located within a (DO) loop.
CANNOT ACCESS REMOTE VARIABLE	Variable name is invalid. Check the fields for CNC name and remote name, and make sure they are in the correct format.
CANNOT ACTIVATE - OPEN PROGRAM	An attempt was made to activate a program for execution when it was still open for an editing operation. Before it can be activated for automatic execution, it is necessary to press the {EXIT EDITOR} softkey from the edit menu to close a program being edited.
CANNOT ACTIVATE RAM PARTITION	The RAM disk has been corrupted. Attempt to perform a "REFORMAT" operation. If this is unsuccessful, consult Allen-Bradley customer support services.

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Message	Description
CANNOT ASSIGN IN CURRENT MODE	An attempt was made to modify a paramacro parameter that cannot be modified when the cutter compensation or TTRC feature is active.
CANNOT CALCULATE - PROMPT PRESENT	An attempt to perform a calculate operation was made when some other prompt was present on line 2 of the CRT. Before the control will allow a calculation to be made, it is necessary to remove any prompts from line 2 .
CANNOT COPY	The requested copying task cannot be performed due to an internal problem in the file or RAM disk. Contact Allen-Bradley customer support service.
CANNOT DELETE - OPEN PROGRAM	The selected program is either active or open for editing and cannot be deleted.
CANNOT DELETE ALL PROGRAMS	An attempt was made to delete all part programs or to reformat RAM while a program was being edited or was currently selected as the active program for execution.
CANNOT DELETE PROGRAM	The file selected cannot be deleted. This is caused by a major error being detected in the actual software file of the program. It may be necessary to "REFORMAT" RAM to remove the program. If this is unsuccessful, contact Allen-Bradley customer support service.
CANNOT DIVIDE BY ZERO	An attempt was made to divide a quantity by zero, either using the CALC functions or in an executing program with a paramacro operator.
CANNOT EDIT - FILE UPLOADING	The file you've tried to open is already open and is in the middle of a part program upload or download operation with ODS.
CANNOT EDIT - MUST BE IN CYCLE OR E-STOP	An attempt was made to edit a part program while another part program was currently being executed.
CANNOT EDIT - OPEN PROGRAM	The program that you have selected for editing is currently open for another feature.
CANNOT EDIT - OTHER FILE IS BEING EDITED	An attempt was made to edit a part program while another part program was currently being edited.
CANNOT EDIT ACTIVE PROGRAM	An attempt was made to edit a program that is currently selected as the active program for execution. Before it can be edited, the program must first be disabled.
CANNOT EXIT IN CYCLE	You cannot exit in the middle of a roughing cycle because it executes at runtime, not during setup.
CANNOT FIND CORRECT POSITION	The program-restart feature cannot locate the correct program block in the program at which automatic execution was interrupted. To position the program at the correct block, it will be necessary to perform one of the other search operations. The operator must know what this correct block is as the control has failed its recover operation.
CANNOT FIND PAL PAGE	PAL requested a PAL display page to be displayed that does not exist in the display page file.
CANNOT FORMAT - OPEN PROGRAM	A program was selected for automatic execution or was still in the edit mode when a request to format memory was made. The active program must be disabled by pressing the {CANCEL PRGRAM} softkey, and any program being edited must be closed by pressing the {EXIT EDITOR} softkey before formatting memory.
CANNOT FORMAT RAM PARTITION	The control is unable to format memory due to open file conditions indicating a more serious problem. Consult Allen-Bradley customer support services.
CANNOT JOG - ALL AXES ARE PARKED	An attempt was made to jog a dual group when all the axes were parked.
CANNOT MERGE WITH SAME PROGRAM	An attempt was made to merge the same program that is being edited with itself. If this is desirable, first copy the original program, then merge the copy into the original.
CANNOT OPEN DIRECTORY	This indicates a serious RAM disk problem. If retry doesn't work, you may have to reformat.
CANNOT OPEN PROGRAM FOR READ	This indicates a serious problem with the program. If retry doesn't work, you may have to delete the program.
CANNOT OPEN PROGRAM FOR WRITE	An error occurred while attempting to open a file on the RAM disk. Either the RAM disk is full, or there is an internal problem with the file. The file may need to be deleted.
CANNOT OPEN SUBPROGRAM	An attempt to call a sub-program has failed. This is usually caused by the sub-program name (programmed in the calling block with a P-word) not existing in the current program directory.

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Message	Description
CANNOT READ A WRITE-ONLY PARAMETER	An attempt was made to use the value of a paramacro system parameter that is a write-only parameter. This parameter may have only its value written to. It cannot be read.
CANNOT READ DIRECTORY	This indicates a serious RAM disk problem. If retry doesn't work, you may have to reformat.
CANNOT READ PROGRAM	This indicates a serious problem with the program. If retry doesn't work, you may have to delete the program.
CANNOT RENAME	When performing a rename of a program name, the new program name has not been correctly entered. The format is OLD PROGRAM NAME,NEW PROGRAM NAME.
CANNOT REPLACE START POINT	An illegal attempt was made to change the axis calibration start-point using the online AMP feature.
CANNOT RESTART G24 HARD STOP	An attempt was made to restart a part program on a block which would have an axis at the hard stop. You cannot restart or mid start a part program after if (at that blocks execution) any axis would be holding against a hard stop. You must either re-start/mid-start to a block before the G24 hard stop block or to a block after the hard stop is released.
CANNOT SEND AVAILABLE COMMAND	This is displayed when a non-programmed communications command is executed from "send" softkey.
CANNOT SET DATA WHEN TOOL IS ACTIVE	An attempt was made to manually (using the softkeys) change tool management data for the currently active tool. Tool management data can be changed only for a tool that is not currently selected as the active tool.
CANNOT TAP IN CSS	You must disable the CSS feature before you begin a tapping operation. Disable CSS using a G97 command.
CANNOT TAP IN VIRTUAL-C MODE	You attempted to use the solid tapping feature while cylindrical or end-face milling was active.
CANNOT UPLOAD - PAL NOT IN PROM	PAL can be uploaded only from the PAL PROMs. PAL in RAM memory cannot be uploaded.
CANNOT UPLOAD - PAL SOURCE NOT LOADED	When the source is loaded, PAL can be uploaded in the 9/240 only . The 9/260 and 9/290 always have PAL in flash.
CANNOT USE COPY WITH ACTIVE TOOL OFFSET	An attempt was made to copy offset data from one axis to another using the {COPY OFFSET} softkey. You cannot use this softkey if the tool offsets are active.
CANNOT USE EXIT - BLOCK NOT FOUND	An attempt was made to {EXIT} while searching for a block for a mid-program start. You cannot use {EXIT} until the block has been found. To abort the search, use {QUIT}.
CANNOT WRITE A READ-ONLY PARAMETER	An attempt was made to assign a value to a PAL or system paramacro parameter that is a read-only parameter. The value of these parameters can be used only by the programmer; they cannot be altered in the program.
CANNOT WRITE TO PROGRAM	This indicates a serious problem with the program. Attempt to write to program a second time. If retry doesn't work, you may have to delete the program. Typically this error is not caused by a programmer or operator action, but rather by an internal program software error.
CAUTION! YOU ARE IN 7300 TAPE MODE TO RETURN TO STANDARD 9/240 MODE RESET THE 7300-COMPATIBILITY PAL FLAG	The operator is cautioned that the tape being copied is presumed to be a 7300 formatted tape. This message is displayed on the copy-tape set-up screen when the MCU is in 7300 compatibility mode.
CC/TTRC ON, CAN'T ASSIGN TIME DEP. PARAM	An attempt was made to assign a time-dependent paramacro system parameter while dresser/wheel radius compensation was active. Time-dependant parameters are any system parameters that record or reference a current axis position.
CHAMFER LENGTH/RADIUS TOO LARGE	A chamfer or radius value programmed with a ,C or ,R would generate a chamfer or radius that is larger than one or both of the two adjacent tool paths.
CHAMFER/RADIUS NOT ALLOWED	An attempt was made to perform a chamfer or radius cut (programmed with a ,R or ,C) in a block that does not allow these functions to be performed. For example, you cannot do a chamfer or radius cut in a non-motion block, in the last block on an MDI line, or in the last block of a part program.
CHANGE NOT MADE IN BUFFERED BLOCKS	Changes to the offset table did not affect those program blocks that were already in the control's current activation queue. Program blocks that call for offsets and which follow those already in the activation queue will call the updated offset tables.

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Message	Description
CHANNEL NAME TOO LONG	There is an error in G05 DH+ communications block.
CHAR MUST BE _, ., LETTER, DIGIT	You have used incorrect search string syntax in the PAL search monitor utility.
CHAR MUST BE LETTER,DIGIT, UNDERSCORE	You have used incorrect search string syntax in the PAL search monitor utility.
CHARACTERS MUST BE DIGIT	You have used incorrect search string syntax in the PAL search monitor utility.
CHARACTERS MUST FOLLOW WILDCARD	You have used incorrect search string syntax in the PAL search monitor utility.
CHECKSUM ERROR IN FILE	The file (AMP, PAL) being downloaded from a storage device has a checksum error. The file cannot be used.
CIRCLE MID-POINT NOT ENTERED	The center-point of an arc is not entered in a circular programming block. Circular blocks require programming either an R or an I, J, K in the block.
CIRCULAR BLOCK NOT ALLOWED	When activating cutter compensation, you cannot program a circular block as the first block or as the last block prior to deactivating cutter compensation.
CIRCULAR NOT ALLOWED AFTER SKIP	A circular move cannot immediately follow a G31 or G37 series skip block. Only linear moves are permitted as the next move following a G31 or G37 type code.
CIRCULAR PROGRAMMING ERROR	A circular motion was programmed incorrectly. Typically this occurs from incorrectly programming an R or I, J or K value.
CODING ERROR	A system software error has occurred. Consult Allen-Bradley customer support services.
COM COMMAND TABLE IS CORRUPTED	Restore the flash version of the output command table.
COM CONFIGURATION TABLE IS CORRUPTED	Restore the flash version of the communication configuration table.
COMM ERROR WHILE PROCESSING HOST REQUEST	A communication error occurred between your PC and 9/Series while performing an update utility. Retry at a lower baud rate. If that does not work check communication ports, connections and cable wiring.
COMMUNICATION TIME-OUT	The time allowed for a peripheral device to respond has elapsed. Check cable connections and device set-up.
COMMUNICATIONS DISPLAY PAGE ENABLED	When a remote host enables the 9/Series remote operator display screen, this message is displayed.
COMMUNICATIONS LINK IS DOWN	A problem was detected in the communications line. Check the cables and retry the download/upload.
COMPLETED WITH ERROR(S)	A QuickCheck syntax check operation has completed the check of the currently active program and found one or more errors. Some editing of the program is required.
COMPLETED WITH NO ERRORS	A QuickCheck syntax check operation has completed the check of the currently active program and found no syntax errors.
CONFIGURATION EXCEEDS AVAIL MEMORY	This error occurs when the amount of available control memory drops below what is required to maintain a minimum 5 block setup buffer for program execution. The system is held in E-Stop when this error occurs. You may either chose to add more memory to your system or re-configure your system by decreasing the watch list allocation (in AMP) for OCI systems.
CONTINUE NOT ALLOWED	An attempt was made to continue a program search when no character string was entered. This can occur when an error is generated by the program being searched and the control cannot continue the search of the program correctly.
CONTROL RESET NOT ALLOWED	The Control Reset Request was not honored by the control (e.g., a Control Reset Request during Cycle Suspended state).
CORRUPTED PROGRAM FOUND & DELETED	Program was found to be corrupted and not usable. This program was deleted.
CPU #2 DUALPORT RAM FAILED	The DUALPORT RAM memory shared between the 68000 main processor and the Z80 I/O ring processor has failed. (two 98030's instead of the 68000 and Z80 on 9/230, 9/260, and 9/290 controls)
CPU #2 EXEC IS BAD/MISSING	CPU #2 exec is not in flash; you must use update utility to load it (9/290 only). Consult Allen-Bradley customer support services.

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Message	Description
CPU #2 EXEC WILL NOT START	CPU #2 is halted and will not start to execute its exec (9/290 only). Consult Allen-Bradley customer support services.
CPU #2 HARDWARE ERROR #2	The 68030 main processor has detected a bus error. Consult Allen-Bradley customer support services (9/290 only).
CPU #2 HARDWARE ERROR #3	The 68030 main processor has detected a spurious interrupt. Consult Allen-Bradley customer support services (9/290 only).
CPU #2 HARDWARE ERROR #4	The 68030 main processor has detected an illegal address. Consult Allen-Bradley customer support services (9/290 only).
CPU #2 HARDWARE ERROR #6	The 68030 main processor has detected a privilege violation. Consult Allen-Bradley customer support services (9/290 only).
CPU #2 HARDWARE ERROR #8	CPU #2 has detected an unassigned vector interrupt. Consult Allen-Bradley customer support services (9/290 only).
CPU #2 HARDWARE ERROR #9	CPU #2 has detected an illegal instruction. Consult Allen-Bradley Customer Support Services (9/290 only).
CPU #2 LOCAL RAM FAILED	The RAM memory supporting the 68030 I/O ring processor has failed (Z80 I/O ring processor on 9/240 only). Consult Allen-Bradley customer support services.
CPU #2 PROM HAS FAILED	The PROM memory supporting the 68030 (Z80 9/240 only) I/O ring processor has failed its checksum test. Consult Allen-Bradley customer support services.
CPU #2 RAM HAS FAILED	The RAM memory supporting the 68030 (Z80 9/240 only) I/O ring processor has failed. Consult Allen-Bradley customer support services.
CPU #2 WATCHDOG ERROR	The 68030 (Z80 9/240 only) I/O ring processor has failed. Consult Allen-Bradley customer support services.
CREATING BACKUP FILE - PLEASE WAIT	A backup file for the current utility is being created. The message will clear when the backup is complete.
CREATING TOOL OFFSET FILE - PLEASE WAIT	The tool offset table (or tables) is currently being backed-up. The control is generating an executable G10 program and entering it into the control's program directory.
CREATING TOOL MGMT. FILE - PLEASE WAIT	The tool management tables are currently being backed-up. The control is generating an executable G10 program and entering it into the control's program directory.
CSS RPM LIMIT AUXILIARY SPINDLE 2	The aux spindle 2 RPM requested by CSS is greater than the maximum CSS RPM limit. This limit is set by the system installer in AMP or can be reduced by programming a G92 block.
CSS RPM LIMIT AUXILIARY SPINDLE 3	The aux spindle 3 RPM requested by CSS is greater than the maximum CSS RPM limit. This limit is set by the system installer in AMP or can be reduced by programming a G92 block.
CSS RPM LIMIT FIRST SPINDLE	The spindle 1 RPM requested by CSS is greater than the maximum CSS RPM limit. This limit is set by the system installer in AMP or can be reduced by programming a G92 block.
CSS RPM LIMIT PRIMARY SPINDLE	The primary spindle RPM requested by CSS is greater than the maximum CSS RPM limit. This limit is set by the system installer in AMP or can be reduced by programming a G92 block.
CSS RPM LIMIT SECOND SPINDLE	The spindle 2 RPM requested by CSS is greater than the maximum CSS RPM limit. This limit is set by the system installer in AMP or can be reduced by programming a G92 block.
CSS RPM LIMIT THIRD SPINDLE	The spindle 3 RPM requested by CSS is greater than the maximum CSS RPM limit. This limit is set by the system installer in AMP or can be reduced by programming a G92 block.
CUR LOOP G/A CLOCK LOST	This error was generated by a servo amplifier error. It can usually be corrected by turning off power to the amplifier, and then back on.
CURRENT FEEDBACK ERROR	The servo module has detected faulty or missing current feedback from the digital servo motor. The most likely cause of this error is be a broken or disconnected wire.
CURSORING NOT ALLOWED	While assigning a {CUSTOM TOOL} in {RANDOM TOOL}, you cannot cursor to select another tool position.

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Message	Description
CUTTER COMP./TTRC INTERFERENCE	The cutter radius is too large, reverse motion is required, or some other cutter compensation interference exists. Either an alternate tool or an alternate tool path must be programmed. Another option would be to disable cutter compensation error detection.
CYCLE ALREADY ACTIVE	An attempt was made to start a cycle while another cycle was currently executing.
CYLINDER RADIUS IS ZERO	The cylinder radius was not programmed in a virtual C cylindrical interpolation (G16.1) cycle.
CYLINDRICAL AXIS NOT PRESENT	Cylindrical interpolation was programmed without at least one cylindrical interpolation axes present (rotary, park, or feed axes).
CYLIND/VIRTUAL CONFIGURATION ERROR	An axis configuration error was detected by the control when cylindrical interpolation or end face milling was requested in a program block. Some examples would include: A cylindrical/virtual axis is named same as a real axis or is missing (for example on a lathe A, the cylindrical axis may have been named the same as a incremental axis name). A cylindrical/virtual axis is named the same as another programing command (for example a secondary auxiliary word, the angle word, etc...).
D	
D-WORD IS GREATER THAN TOOL DIA.	The programmed D-word value is greater than the tool diameter of the current tool.
D-WORD IS LESS THAN AMP THRESHOLD	The D-word has been programmed with a value that is too small.
D-WORD OUT OF RANGE	More than 1000 auto-dress operations were specified by the D-word in a grinder fixed cycle.
DAC MONITOR CIPC ON	This message comes up on power-up, after patch AMP has been modified to invoke DAC monitoring of the coarse incremental position command.
DAC MONITOR F. E. ON	The axis-following error is being output to the DAC output port for monitoring and debugging. Turning parameters 86 or 87 ON through patch AMP enables this output.
DAC MONITOR FV ON	This message comes up on power-up, after patch AMP has been modified to invoke DAC monitoring of the fine interpolated final velocity for each fine iteration (20ms).
DAC MONITOR INTEGRATOR ON	This message comes up on power-up, after patch AMP has been modified to invoke DAC monitoring of the velocity error integrator accum.
DAC MONITOR VEL ERROR ON	This message comes up on power-up, after patch AMP has been modified to invoke DAC monitoring of the velocity error.
DAC MONITOR VELOCITY ON	The axis velocity command is being output to the DAC output port for monitoring and debugging. Turning ON parameters 86 or 87 through patch AMP enables this output.
DATA MAY BE OUTPUT TO PRINTER ONLY	The information being output by the control is intended to go to a printer. Make sure that the output port that is **selected** is properly connected to a printer and try again.
DATA STARVED	The control is waiting for the next program block to set up. Typically, this is the result of the control executing a part program faster than it can be read from a peripheral device such as a tape reader. This error often occurs immediately after the execution of several very short, rapidly executed blocks. To prevent this error from reoccurring, it is recommended that the program be loaded into control memory or to a faster peripheral device.
DECIMAL POINT ERROR	A word or parameter has been programmed with more than one decimal point.
DECIMAL POINT NOT ALLOWED	A word or parameter has been programmed with a decimal point when it can legally exist only as an integer value . For example, the number of repetitions (L) must be an integer value programmed without a decimal point.
DEFAULT AMP LOADED	This indicates that the default AMP values stored in the control's executive memory have been activated. AMP in RAM and AMP in Backup memory were either unavailable or corrupt. This message can also occur if the battery backup fails.
DEFAULTS LOADED	The default device set-up parameters were loaded into the current device.
DEPTH > PROGRAMMED ENDPOINT	This error occurs during a threading cycle when the depth of the cut exceeds the programmed final depth of thread.

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Message	Description
DEPTH PROBE AXIS MUST BE LAST	Adaptive depth probe is not AMPed as the last axis in the system. It must be AMPed after all normal axis and after the deskew slave and before any spindles. Refer to your AMP reference manual for details.
DEPTH PROBE AXIS NOT AMPED	A G26 (adaptive depth probe) move was programmed but no adaptive depth probe axis has been specified in AMP. Refer to your 9/Series AMP reference manual.
DEPTH PROBE FB GEARING NOT 1:1	The AMP configured gear ratio for the logical axis used as a depth probe must be a one to one ratio. "Reset Teeth on Motor Gear for Pos. FB" and "Teeth on Lead Screw Gear for Pos. FB".
DEPTH PROBE TRAVEL LIMIT	The adaptive depth probe has moved to its AMPed travel limit. Note the value entered in AMP is the adaptive depth probe deflection from the PAL determined probe zero point. It may not be the actual total probe deflection.
DEPTH PROBE NOT SUPPORTED	A depth probe axis has been AMPed on an axis located on a servo card or a 9/230 that does not support the adaptive depth feature. (analog servo rev < rev 0.10 or 3 axis 9/260 9/290 digital servo cards)
DESKEW OPTION NOT INSTALLED	If the AMPed name specifying the deskew slave servo is not zero, or the AMPed name specifying the deskew master servo is not zero, and the option flag for deskew is zero, then the system is held in E-Stop.
DEVICE ALREADY OPENED	An attempt was made to open a device for download or upload from ports A or B when the device was already opened.
DEVICE NOT OPENED YET	The ready signal was not received when attempting to send data to or communicate with a peripheral device connected to communication ports A or B.
DIAMETER AXIS MISCONFIGURED	An invalid axis has been configured as the diameter axis.
DIRECTORY CHANGED TO MAIN DIRECTORY	When a password is entered that does not have access to the protectable part program directory and the protectable part program directory is currently selected, the control changes the selected directory to the main directory.
DISP SELECT NOT ALLOWED	You can not use the display select functions while the online PAL search monitor utility is active. Leave the search monitor utility before you try to select a display.
DIVIDE BY ZERO ERROR	A system software error has occurred. Consult Allen-Bradley customer support services.
(DO) NUMBER ALREADY USED	When executing a program, an attempt was made to activate a DO loop that has the same loop identifier (DO 1, 2, or 3) as an already active loop in the program. Provided they are not nested loops, the same loop identifier can be used more than once in a program .
(DO) RANGES INTERSECT	DO loops are improperly nested. A DO loop that is nested within another DO loop does not have an END command before the original DO loop END occurs.
DRESS CANCEL DEFERRED TO G40	The in-process dresser cannot be canceled (made inactive) while dresser/wheel radius compensation is active. If an attempt to cancel the in-process dresser is made, the control will postpone the request until dresser/wheel radius compensation is canceled with a G40 (note that M02, M30, and M99 can also cancel compensation).
DRESSER AXIS NOT ALLOWED	An attempt was made to program the dresser axis when the over the wheel dresser feature has been activated through PAL. You cannot program the dresser axis when the over the wheel dresser feature is active.
DRESSER FLANGE LIMIT REACHED	While dressing the grinding wheel the wheel size reached the entered flange limit. You should stop dressing the wheel before damage to the wheel flange occurs.
DRESSER MINIMUM LIMIT REACHED	The current dressing operation would dress the grinding wheel below the minimum wheel diameter as specified on the dresser status screen. This dressing operation will not be performed.
DRESSER MISCONFIGURED	One of the AMP parameters for the dresser axis has not been configured properly. Either the dresser axis, the vertical axis, or some other axis name is not a valid axis in the system. You must re-configure your AMP. Refer to your AMP manual for details.

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Message	Description
DRESSER MIS-POSITIONED	Wheel re-enable was requested with IPD active and wheel is more than 4 inch-programming counts (hard-code amount) away from its previously active absolute position. Wheel dressing does not start.
DRESSER NOT INITIALIZED	This error is generated if an attempt is made to activate the in-process dresser before the dresser has been initialized through a wheel calibration operation.
DRESSER NOT/MIS CONFIGURED	The grinder over-the-wheel dresser feature issues this message when a wheel is initialized and the dresser parameters in AMP have been misconfigured. This message is issued when the dresser axis, dresser vertical axis, or dresser other axis has not been selected, or has been AMPed to have common axes, or has been AMPed to be a non-existent axis name.
DRESSER WARNING LIMIT REACHED	The axis specified as the dresser axis has been dressed smaller than the dresser warning limit value as specified on the dresser status page.
DRILL AXIS CONFIGURATION ERROR	The drilling axis is not a currently configured machine axis. On dual processing controls this message may result when the drilling axis is in another process. The drilling axis must be a configured axis in the current process and should not be the slave of a dual axis (drill axis should be the master axis for dual group). On machines with dual axes, this message can mean the axis configured in AMP as the fixed-drilling axis is a slave axis. The drill axis should be the master axis.
DUAL AXES MASTER&SLAVE PROCESS NOT SAME	When configuring a dual axis on a dual processing system, configure AMP so all axes in the dual axis group are in the same source process even if the dual axis group is shared.
DUAL AXES PARK LOGIC CANNOT CHANGE	An attempt was made, using dual axes, to change the current park status. At this point, the request will not be allowed.
DUAL GROUP AXES MUST HAVE SAME ROLLOVER	All rotary axes in a dual axes group must have the same rollover value. These rollover values are set in AMP.
DUAL LATHE-MUST USE PROCESS 1,2	Dual lathe must have the active processes be the first 2 available in AMP; 3 or 4 should not be configured as an active process.
DUAL MASTER&SLAVE RAD/DIAM CONFIG ERR	The slave of a dual group has been defined as a diameter axis. The OEM must define the master to be a diameter axis and the system will change the slave to be a diameter axis. When the group is decoupled the slave will continue to take on the master's rad/diam traits.
DUAL PLANE CONFIGURATION ERROR	In AMP you have defined a plane with an axis and a master and a slave in the wrong order. For example: If the system has 4 axes YXZU and ZU are duals, if an AMPed plane is ZX, then UX can not be and AMPed plane. It must be XU (refer to your AMP reference manual for details).
DUAL SLAVE OR SPLIT AXIS NOT ALLOWED	Neither a dual slave, nor a split axis (deskew axis) may be programmed in a G24, G25, or G26 block.
DUALS CANNOT CHANGE OFFSETS IN CIRCULAR	An attempt was made, using dual axes, to account for an offset change in a **circular** move. Dual offset changes can only be made in **linear** blocks.
DUALS ONLY ALLOWING SINGLE AXIS HOME	An attempt was made to home multiple axes in a dual group when PAL only allows one axis at a time to be homed. PAL can be changed to allow homing of multiple axes in a dual group.
DUALPORT PTO TEST FAILED	The Dualport failed the diagnostic test and the bootstrapping operation is skipped. Consult Allen-Bradley customer support services.
DUPLICATE 1394 SLOT	The 1394 rack ID and slot number AMP entries are the same for two or more servos. Each axis module in a 1394 rack must have an individual address.
DUPLICATE 7300 PATTERN NAME	An attempt was made to enter a 7300 pattern name that already exists.
DUPLICATE DUAL MASTER NAMES	Both dual master axes names have the same letter.
DUPLICATE I/O RING DEVICE	Two or more of the same type of device on the I/O ring have the same device address switch setting.
DUPLICATE PROGRAM	An attempt was made to rename a program in control memory using the same program name (or number) of another program already in memory.
DUPLICATE PROGRAM NAME	An attempt was made to store or copy a program in control memory using the same program name (or number) of another program already in memory.

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Message	Description
DWELL VALUE NOT PROGRAMMED	A G04 Dwell or a parameter requesting a dwell at hole bottom in a fixed drilling cycle was programmed with no value assigned to the length of the dwell.
E	
(E) AND (F) IN SAME BLOCK	In a G32 block (Lathe A) or G33 block (Lathe B & C), both leads were programmed in the same block.
EMPTY PROGRAM WAS DELETED FROM DIRECTORY	The current program being edited was saved and contained no program blocks. This program was deleted from the control's program directory.
ENCODER QUADRATURE FAULT	An error has been detected in the encoder feedback signals. Likely causes are excessive noise, inadequate shielding, poor grounding, or encoder hardware failure.
END OF FILE	When transferring a file over the serial port, the control has reached the last block in the program.
END OF PROGRAM	When displaying a part program on the CRT, the control has reached the last block in the program.
END OF PROGRAM REACHED	When performing one of the program search features, the control has reached the last block in the program.
ENTER ALL REQUIRED PROMPT DATA	An attempt was made to create a transfer line part program from the quick view screen without entering all the required quick view screen prompt data. Optional data is shown in reverse video.
ENTRY OUT OF RANGE	A parameter value was entered that is larger or smaller than the usable range determined in AMP or allowed on the system.
ERASE PROMPT	The operator has data on the input line (line 2 of the CRT) that must be cleared or entered so that a new prompt can be displayed on the input line.
ERROR ACCESSING PROGRAM	A major software error was generated by the control's internal software when editing the program; the program should be deleted. If the error persists, contact Allen-Bradley customer service support.
ERROR FOUND	A QuickCheck syntax check operation has found an error in the currently displayed program block. This is the block after the block containing the block-completed symbol "@". Press <CYCLE START> to continue the program check.
ERROR IN CIRCLE DATA	This error can occur when digitizing a circular block, typically the result of entering positions that cannot be correctly connected with an arc.
ERROR LOOKING FOR (END) COMMAND	The control has found a paramacro END command that does not match one of the active paramacro DO loop ranges.
ERROR TRANSFERRING PAL TO CPU #2	An error occurred while PAL was being transferred to the I/O CPU at power-up. PAL is transferred to the I/O CPU at power-up on a 9/290. Consult Allen-Bradley customer support services.
EXACTLY 2 DIGITS MUST FOLLOW DECIMAL PT	You have used incorrect search string syntax in the PAL search monitor utility.
EXCESS FOLLOWING ERROR	The following error for an axis exceeds the allowable value as defined in AMP. Most likely cause is AMP servo related parameters are set too stringently for the hardware. Also caused by axis runaway.
EXCESS SKEW ON	The calculated skew is larger than the AMPed maximum allowable skew.
EXEC BOOTSTRAP FAILED	The bootstraper failed to respond within the specified time for any code segment. Consult Allen-Bradley customer support services.
EXPRESSION INCOMPLETE	A syntax problem has been found in a paramacro expression. The control is unable to correctly evaluate the expression as entered.
EXTRA DATA IN INTERRUPT MACRO BLK	An attempt was made to program extra data (such as a G-code) in the M-code block that activates or deactivates an interrupt program. No extra commands can be programmed in this block.

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Message	Description
EXTRA DATA IN QPP BLOCK	The QuickPath Plus block has been programmed with too many parameters. For example, you cannot program a G13 block with both axis data and an angle word or with an L or A word in the block.
EXTRA I/O RING DEVICE	An I/O device that has **not** been defined in the I/O assignment file is physically present on the I/O ring.
EXTRA KEYBOARD OR HPG ON I/O RING	The control detected a keyboard or HPG on the 9/Series fiber optic ring that was not configured as a ring device. The I/O ring will still function and the control will NOT be held in E-Stop. You may also use the keyboard or HPG by selecting it as the active device via the corresponding PAL flags. You should configure the keyboard or HPG with the I/O assigner utility (See your 9/Series PAL reference manual for details).
F	
FCM DUALPORT RAM FAILURE	The FCM detected an error in dualport RAM.
FCM FLASH RAM FAILURE	The FCM detected an error in flash RAM.
FCM LOCAL RAM FAILURE	The FCM detected an error in local RAM at power-up or during the runtime diagnostics.
FCM PLUG CONFIGURE FAILED	The FCM card failed to configure correctly.
FCM PLUG FAULT	The plug on the FCM detected an error.
FCM PLUG NEGOTIATE FAILED	The FCM firmware could not communicate with the plug.
FCM POWER UP SEQUENCE FAILURE	Power-up failed. Try again. If error appears again, contact your Allen-Bradley sales representative.
FCM REVISION CHECK FAILURE	Revision on module is out-of-date. Contact Allen-Bradley sales representative to get latest revision of the module's firmware.
FCM ROM FAILURE	The FCM detected an error in ROM during runtime diagnostics.
FCM SHADOW RAM FAILURE	The FCM detected an error in shadow RAM.
FCM SPURIOUS INTERRUPT	A spurious interrupt occurred on the FCM card.
FCM VRTX ERROR	A call from VRTX from the FCM card firmware returned an error.
FCM WATCHDOG	The watchdog on the FCM card timed out.
FDBK NOT AVAILABLE ON 4TH AXIS OF BOARD	An attempt was made to receive feedback from the axis that is configured as the fourth axis on a servo board. You can only receive feedback from the first three axes on a servo board.
FEEDBACK DISCONNECTED	The control has detected a loss of feedback from the encoder. The most likely cause of this error would be a broken or disconnected wire. Axis homing will be required after the error condition is corrected.
FEEDBACK OPTION NOT INSTALLED	A PTO check determines the legal number of axes.
FEED AXIS DATA NOT PROGRAMMED	Feed axis data required during a grinder fixed cycle was not programmed.
FEED AXIS MOTION NOT ALLOWED	During Virtual C programming, no axis motion is allowed on the axis specified as the feed axis in AMP.
FEED TO HARDSTOP PROGRAMMING ERROR	No axis, or more than one axis, was programmed in a G24 block. Or the programmed axis integrand was not programmed in the block.
FILE CANNOT BE CONVERTED TO EIA FORMAT	The file requested to be output to a device has characters that cannot be converted to EIA.
FILE DOWNLOAD COMPLETE	Status message that means the download has completed.
FILE DOWNLOAD ERROR	Check file download and file download configuration screens to make sure all fields are entered correctly.
FILE DOWNLOAD IN PROGRESS	This status message means a file is being downloaded.
FIXED CYCLE ALREADY ACTIVE	You cannot program a fixed cycle with a fixed cycle already active.
FIXED CYCLE PROGRAMMING ERROR	A fixed cycle has been programmed incorrectly. Verify that the correct parameters have been used and that parameters restricted to integer or positive values are programmed as such.

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Message	Description
FLASH IN USE - TRY AGAIN LATER	Only one task is allowed to write flash at a time. If a second task requests a flash write, you will see this message.
FLASH SIMMS ARE NOT INSTALLED	Install the flash SIMMs into the 9/Series mother board. Flash SIMMs must be installed. If a repaired system is being installed, you should have saved your flash SIMMs for re-installation before making the return.
FLASH SIMMS CONTAIN INVALID DATA	Flash SIMMs have become corrupted probably from a communication error during a system update. Retry the system executive update utility. If the situation persists, contact Allen-Bradley support.
FLASH SIMMS U10 AND U14 ARE EMPTY OR MISSING	Make sure your flash SIMMs are installed in the correct tracks. Refer to the 9/Series integration and maintenance manual section covering your processor for details on flash installation. Remove and reseat flash SIMMs.
FLASH SIMM U10 IS EMPTY OR MISSING	Make sure your flash SIMMs are installed in the correct tracks. If they appear to be installed correctly, remove and reseat SIMMs. If problem persists, contact Allen-Bradley support service.
FLASH SIMM U14 IS EMPTY OR MISSING	Make sure your flash SIMMs are installed in the correct tracks. If they appear to be installed correctly, remove and reseat SIMMs. If problem persists, contact Allen-Bradley support service.
FLASH WRITE ERROR	A problem occurred while writing to flash, for example bad flash, no flash, or no voltage.
FOREGROUND OVERLAP	The foreground tasks did not complete execution within the 20-millisecond period allocated. Foreground tasks include PAL foreground, axis interpolation, servo interface, and I/O ring scanning. Correct by reducing PAL foreground program size or removing some devices from the I/O ring.
G	
G10 NOT ALLOWED DURING CYCLE	G10 code is not allowed to be used during the cycle. Cancel the fixed cycle.
G24 NOT ALLOWED	G24 is not allowed when any automatic G coded cycle is active (such as G81).
G24 PLANE INCOMPATIBILITY	The hard stop axis may not be in the active part rotation plane.
G25 NOT ALLOWED	G25 is not allowed when any automatic G coded cycle is active (such as G81).
G25 PLANE INCOMPATIBILITY	The adaptive feed axis may not be in the active part rotation plane.
G26 NOT ALLOWED	G26 (adaptive depth probe) can not be programmed when another modal group is active (such as a G81 fixed cycle).
G26 PLANE INCOMPATIBILITY	A conflict between a plane dependent feature and a G26 (depth probe). For example if part rotation is active and a G26 is programmed on an axis in the part rotation plane this error is generated. Refer to the 9/Series users manual section on G26 for details on incompatible planar features.
G28 BLOCK DOES NOT PRECEDE G29 BLOCK	A G29 block was programmed before a G28 block. During 7300 tape compatibility mode, the first automatic threading block must contain a G28 code; the next block must contain a G29 code.
G29 BLOCK DOES NOT FOLLOW G28 BLOCK	A G28 block was programmed without a following G29 block. During 7300 tape compatibility mode, the first automatic threading block must contain a G28 code; the next block must contain a G29 code.
G40 NOT ALLOWED IN CIRCULAR	An exit move from cutter compensation or TTRC was attempted in a circular block (G02 or G03). An exit move (programmed with a G40) must generate a linear move.
G53 NOT ALLOWED IN G91 MODE	An attempt was made to make an incremental move in the machine (absolute) coordinate system. Only absolute moves (G90) are permitted in the machine coordinate system.
G53 NOT ALLOWED IN INCREMENTAL MODE	A G53 move to absolute position was requested while in incremental mode.
G53 ON AN UNHOMED AXES	An attempt to program a move in the machine (absolute) coordinate system was made before the axis was homed. It is necessary to home the axes to establish the location of the machine coordinate system.

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Message	Description
G91 MODE NOT ALLOWED IN QPP	Since QuickPath Plus is generally used to program blocks without knowing the intersection of the blocks, it is impossible to calculate a location for the end-point of the block when the move is incremental. QuickPath Plus must be programmed in absolute mode (G90).
(G-CODE) TABLE ERROR	There has been an internal software fault relative to the G-code table. Consult Allen-Bradley Customer Support Services.
(GOTO) SEQ. NUMBER NOT FOUND	The sequence number (N word) called by a GOTO command does not exist in the currently executing program.
GRAPHICS ACTIVE IN ANOTHER PROCESS	Graphics can only be active in one process at a time. You must turn graphics off in one process before you can activate them in another process.
H	
HARD STOP ACTIVATION ERROR	An attempt was made to (G24) hard stop an axis while a different axis was already holding against a hard stop.
HARD STOP AND/OR ADAPTIVE DATA CONFLICT	An attempt was made to create a transfer line part program from the quick view screen entering data for both hard stop (G24) and adaptive depth features (G26). You can select only one of these features.
HARD STOP AXIS NOT ALLOWED IN INTERRUPT	An axis which is still hard-stopped due to a previous G24 block may not be moved by any block inside an interrupt macro program.
HARD STOP DETECTION ERROR	A hard stop (G24) was detected outside of the programmed hard stop region. Or a hard stop was not detected before the hard stop axis reached its endpoint.
HARD STOP DIRECTION ERROR	The axis currently holding against a hard stop (G24) was programmed with a move further into the hard stop. You must program the move away from the hard stop in the direction opposite to the direction used to place the axis at the hard stop.
HARD STOP EXCESS ERROR	The hard stop axis (G24) was moving too fast when it encountered the hard stop. You must reduce the axis feedrate before contacting the hard stop.
HARDWARE ERROR #1	The 68030 (68000 on 9/240 only) main processor received an interrupt of unknown origin on level 6. Consult Allen-Bradley customer support services.
HARDWARE ERROR #2	The 68030 (68000 on 9/240 only) main processor has detected a bus error. Consult Allen-Bradley customer support services.
HARDWARE ERROR #3	The 68030 (68000 on 9/240 only) main processor has detected a spurious interrupt. Consult Allen-Bradley customer support services.
HARDWARE ERROR #4	The 68030 (68000 on 9/240 only) main processor has detected an illegal address. Consult Allen-Bradley customer support services.
HARDWARE ERROR #5	The PAL program residing in RAM memory has failed a checksum test. Attempt to download your PAL program to the control again. If the error remains, consult Allen-Bradley customer support services.
HARDWARE ERROR #6	The 68030 (68000 on 9/240 only) main processor has detected a privilege violation. Consult Allen-Bradley customer support services.
HARDWARE ERROR #7	The AMP data in Backup memory has failed a checksum test. Attempt to download your AMP program to the control again and again try to store it in Backup memory. If the error remains, consult Allen-Bradley customer support services.
HARDWARE ERROR #10	The servo processor RAM diagnostic test has failed. Consult Allen-Bradley customer support services.
HARDWARE ERROR #12	The servo communications timing diagnostic test between the main processor and the servo processor has failed. Consult Allen-Bradley customer support services.
HARDWARE ERROR #13	The main processor was not ready in time to send data to the servo processor. Consult Allen-Bradley customer support services.
HARDWARE ERROR #14	The servo processor sent an invalid error code to the main processor. Consult Allen-Bradley customer support services.

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Message	Description
HARDWARE ERROR #15	The servo communications data echo diagnostic test between the main processor and the servo processor has failed. Consult Allen-Bradley customer support services.
HARDWARE OVERTRAVEL (+)	The indicated axis has reached a travel limit in the positive direction.
HARDWARE OVERTRAVEL (-)	The indicated axis has reached a travel limit in the negative direction.
HIPERFACE COMMUNICATION ERROR	A serial communications error (e.g., CHECKSUM, TIMEOUT) was detected within the SINCOS device during power-up. If this error occurs at PTO, check your feedback device to make sure it is not disconnected.
HIPERFACE PASSWORD FAILURE	During the SINCOS device's alignment procedure, the logic used to set the passwords detects an incorrect password. A section of the code will repeatedly attempt various combinations of each of the passwords to correct the error condition.
HOME TOLERANCE EXCEEDED	This error condition occurs when the homing operation of the indicated axis is aborted due to the condition of the axis stopping off of the home switch in excess of 3/8 of an electrical cycle of the feedback device away from a null marker. If this problem persists you may need to adjust either the home switch position, or the home switch trip dog, or the feedback position. This may also require you to adjust the AMP Home Calibration parameter for this axis.
HOME REQUEST ON A PARKED AXIS	An attempt was made, while using dual axes, to do a homing operation on a parked axis.
HOMING NOT COMPLETED	An attempt was made to execute a programmed axis move before the axes have been homed. Axes must be homed before they can be moved through part program or MDI commands.
I	
I/O RING COMMUNICATIONS ERROR	A communication error has occurred in the fiber optic I/O ring. This is usually caused by a broken or disconnected fiber optic cable.
I/O RING NOISE WHILE IDLE	An illegal character was detected by an optical receiver while the I/O ring should have been idle. The system will try to reset itself. If it cannot reset itself, the system enters E-Stop.
I/O RING NOT CONFIGURED	The control cannot run the I/O ring if it was not configured and downloaded from ODS or resident in the PAL PROMs.
I/O RING TIME-OUT	A very large foreground PAL program, combined with a large number of I/O ring devices, has created timing problems for I/O ring communications. Reduce PAL program size by deleting unnecessary rungs and optimize the execution of others.
ILLEGAL (/) VALUE	A block delete slash value greater than /9 was programmed. There are only 9 block deletes available.
ILLEGAL (G) CODE	An illegal G-code value has been programmed.
ILLEGAL (M) CODE	An illegal M-code value has been programmed.
ILLEGAL ANGLE VALUE	A QuickPath Plus block has defined the angle of the next block incorrectly. There is no possible path that connects the two tool paths to the programmed end-point using the entered angle.
ILLEGAL APPLICATION COMMAND FROM TEACH	A non-recognized SD1-type packet was received in a CMD=61 DF1 packet from the teach pendant interface. Allowable SD1s are 1 - 5.
ILLEGAL AXIS DATA FORMAT	Digitized axis data does not fit within the allowable AMPed axis format. For example, if an axis inch format is set at 2.3 and a digitized position is recorded as 121.0, an error will be generated. The axis display will also show "__.___".
ILLEGAL CHARACTER	An undefined character was entered in a program block and could not be executed. Certain characters cannot be recognized while in certain modes. Also verify that you are using the correct axis and integrand names as assigned in AMP.
ILLEGAL CODE DURING G41/G42	An illegal code was encountered during G41/G42 programming.
ILLEGAL CODE DURING VIRTUAL C	An illegal code was encountered during Virtual C programming.
ILLEGAL CODES IN RANDOM TOOL BLOCK	An invalid parameter was entered in a G10.1L20 block that loads data into the Random Tool table. P, Q, R, and O are the allowable parameters.
ILLEGAL COMMAND FROM ODS	A command was received from ODS that was not recognized by the control.

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Message	Description
ILLEGAL COMMAND FROM TEACH PENDANT	A non-recognized CMD-type packet was received in a DF1 packet from the teach pendant interface. Allowable CMDs are 60 - 63.
ILLEGAL CONTROL TYPE	You have downloaded from a peripheral device an AMP that does not match your control hardware.
ILLEGAL CPU #2 COMMAND	The 68000 main processor sent incorrect data to the Z80 I/O ring processor. (two 98030's instead of the 68000 and Z80 on 9/230, 9/260, and 9/290 controls)
ILLEGAL CYLINDRICAL BLOCK	A G-code not allowed in a cylindrical entry block or during cylindrical programming mode was programmed.
ILLEGAL DCM FDBK ON RESOLVER SYSTEM	This message indicates that an illegal attempt has been made to configure a resolver based system with a Distance Coded Marker (DCM) A quad B device type on one or more of the feedback channels. When this error condition is encountered, the system will not be released from e-stop.
ILLEGAL DUAL CONFIGURATION	Both dual master axes names have the same letter OR when assigning dual groups in AMP, dual groups must be assigned in contiguous order, starting with group 1, 2, 3, 4, and 5. You can not assign axes to dual group 3 without axes having been assigned to dual groups 1 and 2.
ILLEGAL DUAL LINEAR/ROTARY CONFIGURATION	The dual group cannot contain a mixture of linear and rotary axes.
ILLEGAL FILENAME	An attempt was made to create a program using a program name that contains illegal characters. A different program name must be used.
ILLEGAL G40 EXIT BLOCK	An illegal sequence of exit moves was programmed in a G40 exit block.
ILLEGAL G88.5 OR G88.6 PARAMETERS	Illegal parameters were entered in a G88.5 or a G88.6 programming block.
ILLEGAL G99	An illegal G99 was entered in a programming block.
ILLEGAL G-CODE IN INTERRUPT MACRO	An illegal G-code has been programmed in a program called by a program interrupt. G24, G25, G26, G40, G41, G42, G52, G92, and G92.1 cannot be programmed in an interrupt program.
ILLEGAL G-CODE IN POCKET	An illegal G-code was entered in a G88 or G89 pocket-programming block.
ILLEGAL I/O RING DEVICE CODE	There is a device on the I/O ring that cannot be identified.
ILLEGAL I/O RING RACK SLOT CODE	There is a card in the 1771 I/O rack that the I/O ring cannot use.
ILLEGAL INPUT	A number was input from the keyboard instead of a character, or a character was input instead of a number.
ILLEGAL MACRO CMD VIA MDI	A paramacro command that cannot be used in MDI mode was programmed. This also can include an illegal sub-program return M99 code.
ILLEGAL MASTER AXIS NAME	Slave axes that do not have a master have been configured for a dual group OR you have assigned a $ axis name as a group master. Axis names beginning with a $ can not be assigned as the master axis for a dual group (first logical axis assigned to the group).
ILLEGAL PAL PRIORITY MESSAGE	This error message displays each time your PAL logic program attempts to save a machine error message that contains dynamic data in the error log. Contact your system installer for assistance with this problem.
ILLEGAL PASSWORD	A password was entered that was not assigned to one of the 8 different password levels. Make sure that no one has changed the passwords by using {ACCESS CONTRL}.
ILLEGAL PLANE - USING SLAVE AXIS	This is a power turn-on message. When using dual axes, one of the slave axes was AMPed as part of the plane configuration. Only master can be used in the plane configuration.
ILLEGAL PLANE DEFINITION	The axis plane assignment made in AMP is incorrect. It can also occur if the two axes assigned to a plane have the same axis name.
ILLEGAL PROGRAMMED RETURN GROUP	The tool group programmed in an M06 block must be the currently active tool group that is being replaced (not the tool group you are changing to). This requirement is configured in AMP by the system installer.
ILLEGAL PROGRAMMED RETURN TOOL	The tool number programmed in an M06 block must be the currently active tool number that is being replaced (not the tool number you are changing to). This requirement is configured in AMP by the system installer.

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Message	Description
ILLEGAL RANDOM TOOL TABLE ASSIGNMENT	An attempt was made to program a G10.1L20 block that would assign a tool to a tool pocket that already has a tool assigned to it.
ILLEGAL RECIPROCATION INTERVAL	The programmed reciprocating interval is greater than the total rollover distance.
ILLEGAL ROTATION PLANE SELECTED	When using the external part rotation feature, the external part rotation plane selected on the rotation parameter screen is not the currently active plane in the program block being executed.
ILLEGAL SPINDLE PROCESS NUMBER	An illegal process number was used to indicate a process that uses one of the spindles.
INCOMPATIBLE PAL SOURCE	The PAL search monitor utility can not be accessed. The PAL search monitor utility requires PAL program built with a newer version of ODS.
INCOMPATIBLE TOOL ACTIVATION MODES	This message is displayed and the control is held in E-Stop at power up when the tool geometry offset mode is "Immediate Shift/Immediate Move" and the tool wear offset mode is "Immediate Shift/Delay Move" or when the tool geometry offset mode is "Immediate Shift/Delay Move" and the tool wear offset mode is "Immediate Shift/Immediate Move". These modes are incompatible. You must correct your AMP configuration and re-download AMP.
INCORRECT NUMBER OF SYMBOLS	An error occurred in G05 DH+ communications block.
INPUT DATA TOO LONG	The data input has a number of characters exceeding the allowable number of characters.
INPUT STRING SYNTAX ERROR	An attempt was made to search for an illegal character string, or no character string was entered.
INSUFFICIENT MEMORY FOR PAL PROGRAM	An attempt was made to load a PAL program that exceeded the PAL storage space limit allotted by the flash memory.
INSUFFICIENT MEMORY FOR PART PROGRAM	There is not enough available memory for the current program to be stored. Any attempt to store the program in memory will be aborted by the control.
INTEGRANDS FOR DUALS MUST BE THE SAME	This is a power turn-on message. When using dual axes, all integrands of the dual group must use the same letter.
INTEGRANDS FOR NON-MASTER MUST BE NONE	An axis integrand name was configured in AMP that corresponds to an axis in a dual axis group that is not the master axis of that group. Only the master axis in a dual axis group can have a corresponding axis integrand name.
INTEGRANDS NOT AMPED PROPERLY	The axis integrand names were not configured properly in AMP. Refer to your AMP manual for additional details on axis integrand names.
INTERF CHECKING ZONE TABLE CORRUPTED	The zone tables used by interference checking have an invalid checksum and were cleared.
INTERNAL COMMUNICATIONS ERROR	Communication failed. Contact Allen-Bradley customer support services.
INTERRUPT NOT RECOGNIZED	An interrupt macro was not acted on for some reason. An example would be if an interrupt occurred in the middle of another interrupt.
INVAL LOOP BASE	An attempt was made to configure ports TB2 and TB3 as postion/velocity loop or digital or digital spindle.
INVALID AMP-DEFINED G CODE	An attempt was made to assign the same G-code to different macro calls. This message appears after AMP is downloaded and the control does secondary calculations.
INVALID AMP LETTER FORMAT	The programmed word or parameter has an invalid letter format defined in AMP. Since ODS AMP detects and prohibits invalid formats, this error usually indicates that an invalid format was entered through patch AMP. Refer to your AMP reference manual for details.
INVALID ARC-COSINE ARGUMENT	An attempt was made to calculate or execute a paramacro block that calculates the arc cosine of an invalid or improperly entered number.
INVALID ARC-SINE ARGUMENT	An attempt was made to calculate or execute a paramacro block that calculates the arc sine of an invalid or improperly entered number. Change cosine to sine.
INVALID ARGUMENT ASSIGNMENT	An invalid argument assignment was programmed.
INVALID AXIS	The axis programmed in the adaptive depth (G26) or adaptive feedrate (G25) block is invalid. Valid axis names for programming these features are defined in AMP.

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Message	Description
INVALID AXIS FOR CSS	The CSS axis (the axis that is perpendicular to the center-line of the rotating part) is not a valid axis on the control. This usually occurs when the CSS axis is changed from the default axis by programming a P-word in the G96 block that selects some other axis.
INVALID AXIS PROGRAMMING RESOLUTIONS	The axis resolutions set in AMP by the system installer are too far apart. The control is incapable of handling large differences in axis resolutions. For example, if the X axis has a resolution that allows .999999 and the Z axis allows a resolution of only .9, the control can have difficulty moving both axes simultaneously.
INVALID CCT INDEX	An error occurred in G05 DH+ communications block.
INVALID CHANNEL NAME	An error occurred in G05 DH+ communications block.
INVALID CHARACTER	A program name has been entered that contains an illegal special character.
INVALID CHECKSUM DETECTED	This error is common for several different situations. Most typically it results when writing or restoring invalid data to flash memory. For example if axis calibration data is being restored to flash and there was an error or invalid memory reference in the axis calibration data file. Typically this indicates a corrupt or invalid file.
INVALID CNC FILENAME	An error occurred in G05 DH+ communications block.
INVALID CODE PROGRAMMED FOR 7300	An invalid G or M code was programmed during 7300 tape compatibility mode.
INVALID COMMUNICATIONS PARAMETER	Parameters in G05 and/or G10.2 communication blocks are incorrect.
INVALID CONTROL FOR DUAL PROCESS SYS	The system executive downloaded to the control does not match the hardware configuration established by your option chip.
INVALID CUTTER COMPENSATION NUMBER	A compensation number (or TTRC number) out of the range of allowable compensation numbers (either too large or too small) was programmed.
INVALID CYCLE PROFILE	The path defining the cycle profile is not valid. This is typically caused by the cutter radius being set to the wrong sign, being set too large, or the values for U, W, I, K, and the cutter radius combined are not valid for the profile to be cut.
INVALID DATA AFTER A MACRO COMMAND	Typically caused by a non-paramacro command following a paramacro command. Macro and non-macro commands cannot exist in the same block.
INVALID DATA BEFORE A MACRO COMMAND	Typically caused by a non-paramacro command preceding a paramacro command. Macro and non-macro commands cannot exist in the same block.
INVALID DATA FORMAT MUST BE MM/DD/YY	An invalid date format was entered. The format must be Month / Day / Year (MM/DD/YY).
INVALID DEPTH PROBE CONTROLLING AXIS	The axis name which is AMPed as the controlling axis for the depth axis is not an axis that has been configured on the system or the adaptive depth controlling axis is configured as the same axis defined to have depth probe feedback. Refer to your AMP reference manual for details on axis configuration.
INVALID DESKEW MASTER	The AMPed name specifying the master deskew servo is not one of the AMPed axes.
INVALID DESKEW SLAVE	The AMPed name specifying the master deskew servo is not one of the AMPed axes, or it has already selected as a master axis.
INVALID DH COMMAND TYPE	An error occurred in G05 DH+ communications block.
INVALID (DO) COMMAND NUMBER	The specified loop number in a paramacro DO command is out of the legal range, or not found. DO commands must be followed by a 1, 2, or 3.
INVALID (END) COMMAND NUMBER	A paramacro END command has been encountered without a matching DO or WHILE, or outside the valid range. END commands must be followed by a 1, 2, or 3, as programmed with the corresponding DO command.
INVALID ENDPOINT IN G27 BLOCK	The position programmed in the G27 block is not the home position. The end-point of a G27 block must be the machine home position.
INVALID EXPECTED LIFE	The data just entered for the expected life of the cutting tool for tool management is invalid.
INVALID EXPECTED TOOL LIFE	The current program is attempting to enter an invalid value for the tool management expected life of a tool. Tool life is programmed in a G10 block with an L-word.

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Message	Description
INVALID FB COUNTS	At power up the control checks the AMP configured position and velocity feedback counts per revolution. If either of these parameters are invalid (for this hardware type) this error appears and the control is held in E-Stop.
INVALID FDBK/MTR TYPE COMBO	When changing between an executive from system 9.xx to 10.xx some major changes occurred to how a servo is configurated in AMP. When copying this AMP project from 9.xx to 10.xx you must open and reconfigure some of the AMP servo group parameters before saving and downloading to the control.
INVALID FILE TYPE	An error has occurred in a file that has been sent from the ODS workstation to the control. Typically it is the result of ODS sending the wrong file type to the control (for example, an AMP file is sent when a PAL download is taking place, etc.). Attempt to download the file again, making sure that the correct file type is selected when downloaded.
INVALID FIXED DRILLING AXIS	The axis selected as the drilling axis is an invalid axis for a drilling application.
INVALID FORMAT SPECIFIED IN B/DPRNT CMD	Improper format was used in the paramacro command (BPRNT or DPRNT) that outputs data to a peripheral device.
INVALID FUNCTION ARGUMENT	An invalid paramacro argument was used in a paramacro function. The argument contains either bad syntax or an illegal value.
INVALID G10 CODE	The format for a G10 block is not correct. Refer to your user manual for the correct format for the G10 block that is currently being programmed.
INVALID IN ANGLED WHEEL MODE	A feature that is not available in G16.3 mode, or G16.4 mode or both has been programmed. Refer to your grinder users manual angled-wheel grinder section for a description of features not available on an angled-wheel grinder.
INVALID INFEED (P WORD)	Infeed value (P-word) is not in valid range. The valid range for a P-word during a threading cycle is whole numbers 1 though 4.
INVALID INPUT VALUE	The data entered is invalid for the current operation being performed.
INVALID INTERFERENCE AREA	A G10 block has programmed a zone where the plus value is less than the minus value.
INVALID INTERFERENCE CHECK AXIS	An axis from the wrong process was AMPed. Unless a shared axis is used in the zone, the axis defined to make up an interference area must be in the process the zone is defined for.
INVALID LATHE AXIS	An illegal code was encountered during cylindrical interpolation programming.
INVALID LIFE TYPE	The current program is attempting to enter an invalid tool life type for a tool group in the tool management tables. Valid tool life types are type 0, 1, or 2. Tool life type is programmed in a G10 block following a I-word.
INVALID M99 IN MAIN PROGRAM	An M99 part program rewind and auto start was programmed in the middle of the main program. An M99 can be programmed only at the end of a part program.
INVALID MACRO COMMAND	The IS and IM commands are reserved for use by the control only for program interrupts. They cannot be entered in a part program or MDI program.
INVALID MACRO FROM TAPE	You have programmed a paramacro command that cannot be executed from tape.
INVALID NUMBER OF POCKETS	This error occurs when using G10 L20 to enter random tool data and the number of pockets needed for the tool is invalid.
INVALID OFFSET NUMBER	An offset number out of the range of allowable offset numbers (either too large or too small) was programmed.
INVALID OPERATOR IN EXPRESSION	Check expressions to make sure they are correct.
INVALID OPERATOR IN PARAMACRO EXPRESSION	The control has encountered a non-mathematical operator (character) in a paramacro expression or calculate operation.
INVALID OUTPUT FORMAT	An error occurred in G05 DH+ communications block.
INVALID PARAMACRO ARGUMENT ASSIGNMENT	An argument assignment in a block that calls a paramacro program contains either an invalid argument specification or a syntax error was made in the argument.
INVALID PARAMETER NUMBER	An attempt was made to assign or read the value of a paramacro parameter that does not exist.

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Message	Description
INVALID PARAMETER VALUE	An attempt was made to assign an invalid value (typically too large or too small of a value) to a paramacro parameter.
INVALID POCKET NUMBER	An attempt was made to enter a tool pocket number that exceeds the allowable number of tool pockets in the random tool table. This error occurs when a P-word that is too large or too small is programmed in a G10.1L20 block.
INVALID POCKET PROFILE	An invalid pocket profile was programmed in a lathe roughing or finishing cycle.
INVALID POSITION FB TYPE	System was incorrectly AMPed with a Yaskawa type encoder (absolute or incremental) on the position feedback device when separate position and velocity feedback devices are used.
INVALID PROGRAM NUMBER (P)	A program number called by a sub-program or paramacro call is invalid. A P-word that calls a sub-program or paramacro can only be an all-numeric program name as many as 5 digits long. The O-word preceding the numeric program number in control memory cannot be entered with the P-word.
INVALID REMOTE NODE NAME	An error occurred in G05 DH+ communications block.
INVALID REMOTE STATION TYPE	An error occurred in G05 DH+ communications block.
INVALID REPEAT COUNT (L)	An L parameter that programs the number of times a paramacro or other operation is to be repeated was programmed incorrectly or out of the legal range. The L-word for repeat count must be a whole, positive number. Decimal values and negative values are invalid. The maximum value of an L-word is 9999.
INVALID ROUGHING CYCLE (P/Q) WORD VALUE	When executing a roughing cycle, the starting or ending sequence number of the contour defining blocks cannot be found in the currently executing program. The sequence number of the contour blocks is programmed using the P and Q words. These blocks can be anywhere in the program provided they are resident in the same program, sub-program, or paramacro program that contains the calling block.
INVALID SCALE FACTOR (P-WORD)	An invalid scale factor has been specified. The P-word has a range of 0.0001 to 999.99999.
INVALID SERVO HARDWARE TYPE	The AMP servo parameter that selects the servo type does not match the hardware found on the control when the AMP file is downloaded. Either AMP is misconfigured or the servo hardware installed on your system is not correctly installed or not of the correct type.
INVALID SHAFT POCKET	When entering a custom tool in the random tool table, an attempt was made to assign a shaft pocket position that is not in the range of the number of pockets assigned to the tool. The shaft pocket number must be equal to or less than the number assigned for the number of pockets.
INVALID SHAFT POCKET VALUE	A program is attempting to enter a custom tool in the random tool table with a invalid shaft pocket position (not in the range of the number of pockets assigned to the tool). The shaft pocket number must be equal to or less than the number assigned for the number of pockets. The shaft pocket value is assigned in a G10.1 block following the R-word.
INVALID SPCMD VALUE	A invalid special command error typically occurs when the servo PROMs are not compatible with the main processor PROMs. Check the software version numbers and contact Allen-Bradley customer support services.
INVALID SYMBOL NAME	An error occurred in G05 DH+ communications block.
INVALID T-CODE FORMAT	This is an invalid T-Code Format
INVALID_THREAD_ANGLE	An attempt was made to program an angle that is outside the allowable range, which is 0 through 120 degrees.
INVALID THRESHOLD RATE	An invalid threshold percentage was entered for a tool group while setting tool management data. The threshold percentage must range between 0 and 100 percent. Only whole positive numbers can be entered. If using a G10 block, the threshold percentage is entered with a Q-word.
INVALID TIME FORMAT MUST BE HH:MM:SS	An invalid time format was entered. The time format must be hour / minute / second (HH/MM/SS).
INVALID TOOL AXIS	This is an invalid Tool Axis.

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Message	Description
INVALID TOOL CUTTER COMPENSATION NUMBER	An attempt was made to enter a tool radius offset number, for cutter compensation or TTRC, in the tool life management table that is larger than the maximum offset number allowed. If the tables are being loaded by a G10 program, the radius offset is entered with a D-word in the block.
INVALID TOOL DIAMETER VALUE	An invalid tool diameter value was entered in a program block.
INVALID TOOL GROUP	An attempt was made to create a tool group greater than 200 in the tool management tables. A maximum of 200 tool groups can be used. If loading the tables using a G10 program, the tool group number is entered using a P-word.
INVALID TOOL LENGTH OFFSET NUMBER	An attempt was made to enter a tool length offset number in the tool life management table that is larger than the maximum offset number allowed. If the tables are being loaded by a G10 program, the length offset number is entered with a H-word in the block.
INVALID TOOL LIFE TYPE	An attempt was made to enter an invalid tool life type for a tool group in the tool management tables. Valid tool life types are type 0, 1, or 2.
INVALID TOOL NUMBER	Either no tool or an invalid tool number was programmed in a random tool G10.1 block. Tools should be programmed with a Q-word in a G10.1 block or within a range determined by the system installer in AMP. An invalid tool number was entered into the tool management tables or was programmed in a part program block.
INVALID TOOL NUMBER FROM PAL	The PAL offset change feature specified an invalid tool number to the control.
INVALID TOOL ORIENTATION	This is an invalid tool orientation.
INVALID TOOL TABLE TYPE	This is an invalid tool table type.
INVALID VALUE ZONE 3	A zone 3 value was entered that is outside of the zone 3 limits.
INVALID VALUE ZONE 3:	The zone listed has values that are outside of the zone limits.
INVALID VELOCITY FDBK TYPE	AMP for your digital drive system has been configured for an invalid velocity loop hardware type. Valid values for digital systems are NO FEEDBACK, ABSOLUTE FEEDBACK, and INC ENCODER ON DIGITAL MODULE. Other selections are invalid on digital systems.
INVALID WHEEL ANGLE	An invalid wheel angle has been entered for the angled wheel grinder. Wheel angles must be entered between 0 and 180 degrees. Also wheel angles that approach 90 degrees are also invalid.
INVALID WORD IN G10L3 MODE	An attempt was made to assign a parameter that is not a legal parameter in the G10L3 mode. G10L3 assigns data to the tool management tables.
INVALID WORD IN G11 BLOCK	An invalid word was programmed in a G11 block that cancels the data setting mode for the tool management tables. The G11 code must be programmed in a block that contains no other data.
INVALID ZONE LIMIT	This is an invalid Zone Limit.
INVALID ','WORD	A word other than a chamfering C-word, a radius R-word, or QPP angle word was programmed in a block with a comma ",". Only the radius and chamfer words can be preceded with a ","in a block.
IPD AND G16.3/G16.4 CANNOT BE CONCURRENT	This error message is issued when in-process dressing is on and a block containing a G16.3 or G16.4 is activated on a cylindrical grinder in angled wheel configurations.
J	
JOG WILL CAUSE (+) OVERTRAVEL	An attempt was made to execute an incremental jog that would move the indicated axis beyond its positive software overtravel limit.
JOG WILL CAUSE (-) OVERTRAVEL	An attempt was made to execute an incremental jog that would move the indicated axis beyond its negative software overtravel limit.
JOGGED HOME TOO FAST:	The speed selected for the move to the home limit switch is too fast and the homing operation has failed. Move the axes back to the other side of the limit switch (the side before the homing operation began), and re-execute the homing operation, this time slowing the speed using the <SPEED/MULTIPLY> switch or the <FEEDRATE OVERRIDE> switch.
L	

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Message	Description
L VALUE OUT OF RANGE	An L-word repeat count was programmed larger than the system is capable of performing (typically a maximum L of 9999 is permitted). A second block will need to be programmed to duplicate the commands again. Enter a smaller L-word for both blocks.
L-WORD CANNOT BE GREATER THAN TOOL RADIUS	The programmed L-word value in a G88.5 or G88.6 hemispherical pocket cycle is greater than the programmed tool radius. The incremental plunge depth of a hemispherical pocket cycle cannot be greater than the tool radius.
L- WORD OUT OF RANGE	More than 1000 spark-out passes were specified by the L-word in a grinder fixed cycle.
LARGER MEMORY - REFORMAT	This message typically occurs after a new AMP or PAL has just been downloaded to the control. There is now more memory available for the RAM disk, but you need to reformat to use it. If desired, you do not have to reformat RAM and can continue to run the control with the RAM disk at its current size.
LEAD WORD FORMAT FINER THAN	The word format programmed is requesting a finer resolution than the axis word format for the corresponding axis allows. These word formats are set in AMP.
LENGTH OFFSET AXIS MISSING IN PROCESS	You have configured the tool length axis as a shared axis and it is currently not being controlled by the process requesting to activate a tool length offset. The shared length axis must be returned to the process attempting to activate the tool offset. Or tool offsets were programmed for an axis that is configured in AMP as unfitted.
LESS MEMORY - REFORMAT	This message typically occurs after a new AMP or PAL has just been downloaded to the control. There is now less memory available for the RAM disk, and you must reformat to use the RAM disk.
LETTER OR DIGIT MUST FOLLOW $, %, !, &, OR #	You have used incorrect search string syntax in the PAL search monitor utility.
LETTER OR DIGIT MUST FOLLOW $, %, ! OR #	You have used incorrect search string syntax in the PAL search monitor utility.
LETTER OR DIGIT MUST FOLLOW $, % OR !	You have used incorrect search string syntax in the PAL search monitor utility.
LETTER OR DIGIT MUST FOLLOW $, % OR !	You have used incorrect search string syntax in the PAL search monitor utility.
LETTER OR DIGIT MUST FOLLOW #	You have used incorrect search string syntax in the PAL search monitor utility.
LIMIT EXTRN DECEL SPEED ON	Dual axes have limited the external decel speed AMP value. An axis in the dual-axis group was AMPed with a lower value.
LIMIT MANUAL DLY CONSTNT ON	Dual axes have limited the manual delay constant AMP value. An axis in the dual-axis group was AMPed with a lower value.
LIMIT MAX CUTTING FEED ON	Dual axes have limited the maximum cutting feedrate AMP value. An axis in the dual-axis group was AMPed with a lower value.
LIMITED ACC/DEC RAMP ON	Dual axes have limited the acc/dec ramp AMP value. An axis in the dual-axis group was AMPed with a lower value.
LIMITED RAPID FEEDRATE ON	Dual axes have limited the rapid feedrate AMP value. An axis in the dual-axis group was AMPed with a lower value.
LIMITED VELOCITY STEP ON	If the velocity step AMP value is not the same for all axes of a dual group, the control will adjust them to the limiting axis.
LOW VOLTAGE ON FLASH STICKS	Call Allen-Bradley Support Services.
LOWER > UPPER	A value entered in the programmable zone table for zone 2 or 3 results in a lower limit value being greater than the upper limit. The upper limit must always be greater than the lower limit.
M	
M02 OR M30 FOUND - REQUEST TERMINATED	This error occurs if an M02 or M30 is found before the requested block while searching during a mid-program start. The search will be terminated at the M02/M30 block.
MACHINE HOME REQUIRED OR G28	An attempt was made to program an axis move before the axes were homed. Axes can be homed manually or by programming a G28 block.
MASTER HAS TO BE AMPED FIRST	The dual master axis has to be configured first in the AMP data base.

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Message	Description
MASTER ONLY G-CODE - MUST PARK SLAVES	An attempt was made to program a G-code that is not compatible with a dual axes. The programmed G-code can only be applied to the AMP defined master axis of the dual axis group. All other axes in the dual axis group must be parked.
MATH OVERFLOW	Your paramacro or calculator function is requiring a calculation with an excessively large or illegal value.
MAX SIZE EXCEEDED	The programmed number of symbols is too large (the communication data packet is too large).
MAX SOLID TAP RPM EXCEEDS MAX GEAR RPM	The resulting solid taping RPM exceeds the spindles current RPM Maximum for the active gear range. Either change gear ranges, or reduce the tapping speed.
MAXIMUM BLOCK NUMBER REACHED	A renumber operation was performed to renumber block sequence numbers (N-words), and the control has exceeded a block number of N99999. Either the program is too large to renumber, or the parameters for the first sequence number, or the sequence number increment, are too large. When this error occurs, the renumber operation stops renumbering at the last block within the legal range of N-words.
MAXIMUM NUMBER OF AXES EXCEEDED	If the COCOM breakout is true, a maximum of 4 concurrent interpolated axes can be used.
MAXIMUM NUMBER OF PROGRAMS	The RAM disk directory for part program storage is full. You can store only 328 files on the system even when memory is available for part program storage.
MAXIMUM RETRACE COUNT REACHED	The limit (defined in AMP) for the amount of retrace blocks allowed was reached. No further retracing will be allowed.
MAXIMUM REVERSE PLANES EXCEEDED	The order that the axes are named in AMP is important. If, for example, axis one's name is assigned as X and axis three's name is assigned as Z, a reverse plane is defined if the G18 plane is assigned in AMP as the ZX plane. The G18 plane defines a plane consisting of axis 3 followed by axis 1, making it a reverse plane (axis 1 followed by axis 3 would be a normal plane since 1 is configured before 3 from the standpoint of ODS). This also pertains to parallel axes. A maximum of four reverse planes is allowed. If your system exceeds this number of reverse planes, you must re-configure your AMP.
MAXIMUM RPM LIMIT AUXILIARY SPINDLE 2	A request was made for the aux spindle 2 speed to exceed the AMPed maximum value. Reduce the programmed aux spindle 2 speed, or use the spindle speed override switch to reduce the RPM.
MAXIMUM RPM LIMIT AUXILIARY SPINDLE 3	A request was made for the aux spindle 3 speed to exceed the AMPed maximum value. Reduce the programmed aux spindle 3 speed, or use the spindle speed override switch to reduce the RPM.
MAXIMUM RPM LIMIT FIRST SPINDLE	A request was made for the spindle 1 speed to exceed the AMPed maximum value. Reduce the programmed spindle 1 speed, or use the spindle speed override switch to reduce the RPM.
MAXIMUM RPM LIMIT PRIMARY SPINDLE	A request was made for the primary spindle speed to exceed the AMPed maximum value. Reduce the programmed primary spindle speed, or use the spindle speed override switch to reduce the RPM.
MAXIMUM RPM LIMIT SECOND SPINDLE	A request was made for the spindle 2 speed to exceed the AMPed maximum value. Reduce the programmed spindle 2 speed, or use the spindle speed override switch to reduce the RPM.
MAXIMUM RPM LIMIT THIRD SPINDLE	A request was made for the spindle 3 speed to exceed the AMPed maximum value. Reduce the programmed spindle 3 speed, or use the spindle speed override switch to reduce the RPM.
MESSAGE PENDING, PRESS A KEY TO DISPLAY	The 9/Series screen saver is engaged and a system error message, PAL error message, E-Stop condition, or PAL display page has been activated. Press any key on the keyboard to disable the screen saver and view the error or PAL display page.
MDI INPUT COMMAND TOO LONG	The MDI input command string exceeds the maximum length allowed.
MDI NOT ALLOWED DURING INTERRUPT MACRO	An attempt was made to halt the execution of a interrupt program and execute a MDI command. MDI commands cannot be executed during the execution of a interrupt program.
MDI NOT ALLOWED DURING POCKET MILLING	An MDI command cannot be programmed while a G88 or G89 pocket milling cycle is executing.
MDI NOT ALLOWED DURING RETRACE	You cannot use MDI while a retrace operation is in progress.
MEASUREMENT POINT OVERFLOW	The user tried to enter more points into online AMP for axis calibration than are permitted.

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Message	Description
MEMORY CRASH - REFORMAT	A major error has occurred within the system RAM memory. All part programs stored in memory will have to be be deleted by performing a reformat operation. This will **not** remove the current versions of AMP or PAL from the system.
MEMORY FULL	There is no more RAM memory space for part program storage. If you are in the process of editing a part program, your changes cannot be saved.
MIDSTART NOT ALLOWED FROM TAPE	You cannot perform a mid-program start on a program that is stored on tape. The program must first be transferred to RAM memory.
MINIMUM RPM LIMIT AUXILIARY SPINDLE 2	The commanded aux spindle 2 speed requested by the control is less than the AMPed minimum aux spindle 2 speed for the current gear being used. This requires a gear change operation or a change in the programmed aux spindle 2 speed. In some cases, the <SPINDLE SPEED OVERRIDE> switch may be sufficient.
MINIMUM RPM LIMIT AUXILIARY SPINDLE 3	The commanded aux spindle 3 speed requested by the control is less than the AMPed minimum aux spindle 3 speed for the current gear being used. This requires a gear change operation or a change in the programmed aux spindle 3 speed. In some cases, the <SPINDLE SPEED OVERRIDE> switch may be sufficient.
MINIMUM RPM LIMIT FIRST SPINDLE	The commanded spindle 1 speed requested by the control is less than the AMPed minimum spindle 1 speed for the current gear being used. This requires a gear change operation or a change in the programmed spindle 1 speed. In some cases, the <SPINDLE SPEED OVERRIDE> switch may be sufficient.
MINIMUM RPM LIMIT PRIMARY SPINDLE	The commanded primary spindle speed requested by the control is less than the AMPed minimum primary spindle speed for the current gear being used. This requires a gear change operation or a change in the programmed primary spindle speed. In some cases, the <SPINDLE SPEED OVERRIDE> switch may be sufficient.
MINIMUM RPM LIMIT SECOND SPINDLE	The commanded spindle 2 speed requested by the control is less than the AMPed minimum spindle 2 speed for the current gear being used. This requires a gear change operation or a change in the programmed spindle 2 speed. In some cases, the <SPINDLE SPEED OVERRIDE> switch may be sufficient.
MINIMUM RPM LIMIT THIRD SPINDLE	The commanded spindle 3 speed requested by the control is less than the AMPed minimum spindle 3 speed for the current gear being used. This requires a gear change operation or a change in the programmed spindle 3 speed. In some cases, the <SPINDLE SPEED OVERRIDE> switch may be sufficient.
MIRROR NOT ALLOWED ON ROLLOVER AXIS	You cannot perform mirrored motion using an axis with rollover.
MISSING 1394 I/O RING ADDR	This message indicates that a 1394 amplifier ID has been AMPed but not defined in I/O ring assignment from ODS. The 1394 amplifier must be a defined device on the 9/Series fiber optic I/O ring.
MISSING ([ ) AFTER FUNCTION NAME	Paramacro and calculator functions must have their values enclosed in [ ], for example, SIN[5].
MISSING ( ])	Paramacro and calculator functions must have their values enclosed in [ ], for example, SIN[5]. The control has found that a right bracket "]" is missing in the current operation.
MISSING (END) COMMAND	The control has found an end-of-program block (M02 or M30) before it has read the END command for a paramacro DO loop.
MISSING (F) IN INVERSE TIME	An F-word must be programmed in every motion block that is not rapid when in inverse time feed mode (G93). F is not modal in G93.
MISSING (GOTO) COMMAND	An IF paramacro condition does not have a GOTO with a sequence number following the condition.
MISSING A (DO) COMMAND	A WHILE paramacro condition does not have a DO with a loop identifier following the condition.
MISSING ADAPTIVE FEED DATA	An attempt was made to create a transfer line part program from the quick view screen with incomplete adaptive feedrate data.
MISSING COMMA	An error occurred in G05 DH+ communications block.
MISSING COMMA OR RIGHT PARENTHESIS	An error occurred in G05 DH+ communications block.

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Message	Description
MISSING CUTTER COMP CODE	Cutter compensation must be activated before initiating a G89 irregular pocket cycle.
MISSING DATA FROM BLOCK	G89 irregular pocket cycle parameters are missing from a the G89 programming block.
MISSING END PARENTHESIS	An error occurred in G05 DH+ communications block.
MISSING G67	An active modal macro (G66 or G66.1) was not canceled by a G67 before the control read an M02 or M30 end-of-program command.
MISSING HPG FROM I/O RING	The I/O assignment file that was compiled and downloaded with PAL defines an HPG that is not physically present in the I/O ring. Verify that the HPG address settings are correct.
MISSING I/O RING DEVICE	The I/O assignment file that was compiled and downloaded with PAL defines an I/O ring device that is not physically present in the I/O ring. Verify that all device address settings are correct.
MISSING INTEGRAND/RADIUS WORD	A circular or helical block has been programmed with axis data and no radius (R) or integrand (I, J, or K) values. A radius or integrand must be programmed in a circular or helical block to define the location of the arc center.
MISSING KEYBOARD AND HPG FROM I/O RING	The I/O assignment file that was compiled and downloaded with PAL defines a keyboard and an HPG that is not physically present in the I/O ring. Also verify that the keyboard and HPG address settings are correct.
MISSING KEYBOARD FROM I/O RING	The I/O assignment file that was compiled and downloaded with PAL defines a keyboard that is not physically present in the I/O ring. Verify that the keyboard address settings are correct.
MISSING L-WORD	The L-word parameter is missing from the G88.5 or G88.6 hemispherical pocket programming block.
MISSING M02 OR M30	The control has executed through to the last block of a program and has not read an end-of-program command (M02 or M30).
MISSING MASTER AXIS NAME	Slave axes that do not have a master have been configured for a dual group.
MISSING OR ILLEGAL L-VALUE	An attempt was made to program an irregular pocket milling cycle (G89) with a missing or illegal L-word.
MISSING PROGRAM NAME	An operation, such as a copy or rename, was performed without the proper program names being specified. The proper format consists of the program performing the operation followed by a comma and the target program (OLD PROGRAM NAME,NEW PROGRAM NAME).
MISSING PROGRAM NUMBER (P)	No sub-program name was specified in a block that calls a sub-program or paramacro. A sub-rogram name must be programmed with a P-word in the calling block.
MISSING PROMPT DATA	The control is waiting for data to be entered on the input line (line 2 of the CRT) using the keys on the operator panel.
MISSING Q-WORD	The Q-word parameter is missing from the G88 or G89 programming block.
MISSING QPP ANGLE WORD	The second block of a two block QPP set does not contain the necessary angle word to define an intersection with the first block.
MISSING ROUGHING CYCLE (P/Q) WORD	A roughing cycle block was programmed that does not contain both a starting and ending sequence number for the contour blocks as programmed with the P- and Q-words.
MISSING ROUGHING CYCLE DEPTH (D) WORD	A roughing cycle block was programmed that does not contain the D parameter for depth of cut.
MISSING SHADOW RAM	Either your 9/290 control is missing the SIMMS necessary for shadow RAM, or your 9/260 control is not equipped with enough RAM to operate properly. If your 9/260 system contains both the DH+ module and the search monitor utility, additional RAM must be installed. All 9/290 controls must have this additional RAM. Refer to your 9/Series installation and maintenance manual for details on installing SIMMS.
MISSING SLAVE INCREMENTAL AXIS NAME	When using dual axes on Lathe A, all slave axes must have incremental axis names.
MISSING START PARENTHESIS	An error occurred in G05 DH+ communications blocks.
MISSING TOOL ENTRY	This is missing a tool entry.
MODULE(S) WITH INCONSISTENT REVISION LEVEL	Retry the update utility. If this does not work, call Allen-Bradley and request a new update utility that matches your hardware revision level.

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Message	Description
MODULE(S) WITH INVALID CHECKSUM	Retry update.
MOTION IN DWELL BLOCK	An attempt was made to program axis motion in the same block that generates a dwell. No axis words can be programmed in a block that generates a dwell.
MOTION NOT ALLOWED	The block includes G-codes that must be programmed in a block without axis motion. For example, the G-codes that convert from inch to metric or metric to inch cannot have axis motion in the same block.
MOTOR SHAFT - LEAD SCREW RATIO TOO HIGH	The motor shaft to lead screw gear ratio is too high to achieve the rapid speed assigned in AMP.
MULTIPLE FUNCTIONS NOT ALLOWED	Multiple functions are not allowed.
MULTIPLE SPINDLE CONFIGURATION ERROR	Each multiple spindle must have a servo board identified in AMP to indicate to which board the spindle is connected. The spindle must be included in the number-of-motors AMP parameter for the board the spindle is on.
MUST ASSIGN TOOL NUMBER FIRST	In random tool, an attempt was made to customize a tool before the tool number was assigned.
MUST BE IN (AUTO)	It is necessary to place the control in auto mode to perform the requested operation.
MUST BE IN (AUTO) OR (MDI)	It is necessary to place the control in Auto or MDI mode to perform the requested operation.
MUST BE IN (CYCLE STOP)	It is necessary to place the control in cycle stop state to perform the requested operation. The control cannot be in cycle suspend, feed hold, or E-Stop.
MUST BE IN (CYCLE STOP) AND (EOB)	The control must be in cycle stop state and at the end-of-program block to perform the requested operation. The control cannot be executing a program, in cycle suspend, feed hold, or E-Stop.
MUST BE IN (E-STOP)	An attempt was made to perform an operation (such as, editing the reversal error parameters in online AMP) that must be performed in E-Stop. Place the control in E-Stop by pressing the <E-STOP> button.
MUST BE IN (LINEAR MODE)	An attempt was made to perform an operation (such as, exiting from cutter compensation) that must be performed in a linear block (G00 or G01).
MUST BE IN (MANUAL)	It is necessary to place the control in manual mode to perform the requested operation.
MUST BE IN (MDI)	It is necessary to place the control in MDI mode to perform the requested operation.
MUST BE IN E-STOP OR CYCLE STOPPED	It is necessary to place the control in E-Stop or cycle stop state to perform the requested operation. Place the control in E-Stop by pressing the <E-STOP> button. Place the control in cycle stop state by pressing the <SINGLE BLOCK> button. Simply pressing <CYCLE STOP> will not guarantee the control to be in cycle stop mode. Most likely a cycle stop request while executing a program will place the control in cycle suspend mode. If you get this error using the CALC function it indicates you may be asking the calculator function to access a paramacro variable (using the # sign) when a program is executing. You can not use a paramacro variable # sign in a calculator function when any part program is executing or suspended.
MUST BE IN MANUAL MODE TO HOME	To do a jog home operation (from jog retract) the control must be in manual mode.
MUST COMPLETE ACTIVE HOME OPERATION	An attempt was made to jog a dual group when one of the axes of the dual was homing.
MUST DISABLE RUN-TIME GRAPHICS	An attempt was made to call up one of the QuickView prompting options while the active graphics option was currently executing. Active graphics must be disabled before QuickView prompting can be performed.
MUST HOME ANGLE SOURCE AXIS FIRST	Before you can enter angled wheel grinding mode both the axial and wheel axes must be homed.
MUST HOME AXIS	An attempt was made to perform axis calibration before the axes were homed. Axes can be homed manually or by programming a G28 block.
MUST SETUP THE ENCRYPTION ARRAY	An attempt was made to encrypt a part program while uploading it to ODS or the mini-DNC package. The encryption array must be set up before you can encrypt a part program.
MUST START WITH $, %, !, #, +, -, LTR, DIGIT	You have used incorrect search string syntax in the PAL search monitor utility.
MUST START WITH $, %, !, #, OR LETTER	You have used incorrect search string syntax in the PAL search monitor utility.

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Message	Description
MUST START WITH $, %, !, OR LETTER	You have used incorrect search string syntax in the PAL search monitor utility.
MUST START WITH $, !, OR LETTER	You have used incorrect search string syntax in the PAL search monitor utility.
MUST START WITH A LETTER	You have used incorrect search string syntax in the PAL search monitor utility.
MUST SWITCH PROCESS FOR SCREEN RESTORE	An attempt was made to 'restore screen' while the system was in Digitize, Graphics, Search, or while PAL was selecting a process. Any attempt to switch processes results in this message.
N	
NEED SHADOW RAM FOR ONLINE SEARCH	Your system contains the DH+ module and you have not installed the extra RAM SIMMS that are required to run the PAL online search monitor with the DH+ module installed. You must buy additional RAM for a system equipped with both of these features. Contact your Allen-Bradley Sales representative to purchase these SIMMS. Refer to your 9/Series integration manual for details on installing additional SIMMS.
NEED SPINDLE FEEDBACK	You attempted to use the solid-tapping feature or synchronization feature with a spindle that does not have feedback.
NEGATIVE DWELL VALUE	An attempt was made to execute a dwell with a negative value. Dwell values must be positive values.
NEGATIVE F-WORD PROGRAMMED	A negative feedrate was programmed in a program block. Negative feedrates are illegal.
NEGATIVE TO UNSIGNED LONG ERROR	Internal math error has occurred; contact Allen-Bradley customer support services.
NEGATIVE VALUE NOT ALLOWED	The minus (-) sign was used for an address which cannot be programmed with a negative value.
NET CORRECTION IS NOT ZERO	For a rotary axis, the net amount of correction for axis calibration should be zero for one complete revolution.
NET PICK/PLUNGE AWAY FROM ENDPOINT	The primary and secondary pick/plunge amounts, when added together, are in the direction away from the programmed endpoint.
NETWORK COMMUNICATION DISABLED	When editing or restoring communications configuration data, this message is displayed.
NETWORK PASSTHRU COMMUNICATIONS FAULT	A communication error has occurred between the controls ethernet module and the ODS passthrough device (typically a PLC).
NEVER OPENED THE PROGRAM	An attempt was made to edit a program that was not currently open.
NEW TOOL OFFSET SETUP BUT NOT ACTIVATED	The tool offsets for the active tool were changed, but not activated in the current block. These new tool offsets will not be activated until the set-up blocks are cleared of the old tool offsets and refilled with the new tool offsets.
NO ACTIVE PROCESS CONFIGURED	The AMP has been loaded into a multi-processing system that has no processes configured as active.
NO ACTIVE PROGRAM	An attempt was made to do a search when no part program is active.
NO AXIS CONFIGURED	The current active version of AMP does not have any axes configured as usable. All axes are configured as unfitted.
NO CHARACTERS ENTERED FOR SYMBOL	You have used incorrect search string syntax in the PAL search monitor utility.
NO DEPTH PROBE TRIP	A G26 block reached its programmed endpoint without the adaptive depth probe being tripped. The part surface was not detected by the adaptive depth probe before the G26 block completed.
NO FEEDRATE PROGRAMMED	A command for axis motion was executed when there was no active feedrate. Applies to non-rapid moves (G01, G02, or G03).
NO FURTHER RETRACE ALLOWED	The control has reached a block during retrace from which no further retrace is permitted.
NO INTERSECTION EXISTS	There is no mathematical intersection for the QPP blocks as programmed.
NO MARKER FOUND ON :	The encoder marker was not detected when homing the indicated axis. Homing was unsuccessful.
NO MORE MDI BLOCKS	Cycle start was requested during MDI mode when there were no MDI blocks present to be executed.

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Message	Description
NO MORE MDI BLOCKS TO RESET	A reset was requested during MDI mode when there were no incomplete or unexecuted MDI blocks reset.
NO OFFSET ACTIVE	An offset must be active before the control will allow the offset to be changed. This check is used so that the control will no the method and direction of the offset will be the same as the previous offset.
NO OPTIONAL FB PORT ON ANALOG SERVO	The system was incorrectly AMPed with optional feedback module on an analog servo module.
NO PROGRAM TO RESTART	There is no program to restart. The previous program was either completed or cancelled.
NO RECIPROCATION DISTANCE	A reciprocation interval of zero (0) was programmed for a grinder reciprocation fixed cycle.
NO RECIPROCATION FEEDRATE	The reciprocation feedrate, E-word, required during a grinder reciprocation fixed cycle was not programmed.
NO SPINDLE ASSIGNED TO THIS PROCESS	A process attempted to activate virtual or cylindrical mode and that process has no spindle assigned to it via AMP.
NO STRING INPUT	A program search operation was requested and no string to search for has been entered. Key in the required search string, and press the [TRANSMIT] key to enter a search string.
NO TOOL GROUP PROGRAMMED	A block that loads data into the tool management table does not contain the parameter that determines the tool group number corresponding to the other data in the block. The group number is programmed using the P-word.
NO TOOL NUMBER PROGRAMMED	A block that loads data into the tool management table does not contain the parameter that determines the tool number corresponding to the other data in the block. The tool number is programmed using the T-word.
NO UNEXPIRED TOOL AVAILABLE	A request for a tool group was made, and all of the tools in that tool management group have expired their tool lives. Either reset the tool life for the tools, or install new tooling.
NON_CONSECUTIVE/TOO MANY FITTED AXES	More than the allowable number of axes may have been assigned in AMP or an unfitted axis was assigned between two fitted axes. You can assign only fitted axes consecutively in AMP.
NON-LINEAR AXIS IN PLANE DEFINITION	The current axis plane is illegal because a non-linear axis (rotary) has been assigned to the plane in AMP.
NOT ALIGNED	During the power-up alignment procedure, either the 1326 motor (connected to a 9/440HR) is misaligned or the SINCOS device's memory is corrupt.
NOT ALLOWED IN ANGLED WHEEL MODE	The axes can not be moving when you change to angled wheel mode. Also the axes involved in angled wheel motion must be homed before you can enter angled wheel mode. Other features, such as block retrace or jog retract also must not be active when changing mode.
NOT ALLOWED - G41/G42 ACTIVE	An attempt was made to perform some operation or program some feature that cannot be performed when cutter compensation or TTRC is active (G41 or G42). Cancel compensation by programming a G40 block before performing the operation.
NOT ALLOWED FROM MDI	Certain programming commands are not allowed from MDI (GOTO, WHILE, etc.).
NOT ALLOWED ON DUAL/SLAVE AXIS	A G26 was programmed on a dueled axis. The G26 feature is incompatible with the dual axis feature.
NOT ALLOWED - THREADING ACTIVE	An attempt was made to perform some operation (typically a spindle speed adjustment) that is not allowed when cutting a thread. This includes all forms of threading, including single pass or multiple pass threads.
NOT IN G10L3 MODE	A G11 block was programmed that cancels G10L3 data setting when the control is not in the G10L3 data setting mode. G10L3 is used to set the tool management table data.
NUMBER IS OUT OF RANGE	An attempt was made to perform a calculation using the paramacro features or the calculator features that contains a number longer than 11 characters.

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Message	Description
NUMBER OF MOTORS/SPINDLE CONFIG ERROR	This is error indicates AMP is incorrectly configured for the 9/Series hardware. Typical AMP configuration errors that generate this error include: You have AMPed more motors than the current hardware supports. You have indicated there are servo motors attached to servo boards that don t exist (the 9/230 and 9/440 are configured as if they have only one servo card). You have configured too many spindles (1 on 9/230, 2 on 9/260 and 9/440, 3 on 9/290). Too few axes were configured for the indicated number of motors on the boards or too few servos were configured for indicated number of motors on the boards.
NUMERIC VALUE MISSING	The numeric value associated with the programmed word is missing. There is an AMP parameter that determines whether a missing numeric is assumed to be zero or if it will generate this error.
O	
OBJECT NOT FOUND IN PROGRAM	The object you are searching for in the search monitor utility does not exist in the current module, or does not exist in the program in the direction you are searching.
OCI ETHERNET CARD NOT INSTALLED	An OCI dual-process system has a standard CRT installed. The OCI Ethernet card has not been installed. This may happen if a dual-process OCI executive is loaded into a non-OCI system.
OCI SYSTEM ERROR	VRTX error. Contact Allen Bradley Support.
OCI PROCESSING TASK OVERLAP	The amount of time to process a new OCI request is taking longer than expected. This is an informational warning only. It i s not critical to the CNC.
OCI WATCH LIST TASK OVERLAP	This message indicates that the watch list task was not running to completion in the AMPed allotted amount of time. This typically occurs when a large task is requested by an OCI station and the CNC takes longer than expected to complete.
ODS & 9/SERIES REVISIONS DIFFER	The version of AMP or PAL on the peripheral device does not match the control version.
ODS RUNG MONITOR ACTIVE	The online PAL search monitor utility can not be accessed. The online PAL search monitor utility requires the offline ODS PAL search monitor utility to not be running.
OFFSET EXCEEDS MAX CHANGE	You have attempted to modify an offset table by an amount that is larger than the allowable change to an offset table. Refer to your AMP reference manual for details on Maximum wear and geometry offset change.
OFFSET EXCEEDS MAX VALUE	You have attempted to modify an offset table by entering an offset amount that is larger than the allowable maximum offset selected in AMP. Refer to your AMP reference manual for details on Maximum offset table values.
OFFSET MOTION PENDING ON CYCLE START	After changing the active offset this message identifies that the control will move the axis to the new offset location the next time cycle start is pressed (this may or may not occur on a non-motion block depending on the AMP offset configuration).
OFFSET TABLE(S) CORRUPT/CLEARED	A bad offset table checksum value was detected by the control during PTO.
ONLY ONE DEPTH PROBE PER SERVO BOARD	The 9/Series servo card firmware only supports one adaptive depth probe on each servo card. If your system requires more than one adaptive depth probe they must be attached to different servo cards (9/230 and 9/440 controls can only have one adaptive depth probe). AMP must be configured to indicate which port the adaptive depth probe is attached to.
ONLY ONE M19 ALLOWED PER BLOCK	For system configured with multiple spindles, only one spindle orient M-code (M19) is allowed per block.
ONLY REQUEST THE DUAL MASTER FOR JOGS	An attempt was made to jog a slave axis; you can jog a slave axis only when the master axis is parked.
OPTION NOT INSTALLED	An attempt was made to program an optional feature that has not been purchased from Allen-Bradley.
OPTION NOT INSTALLED (PAL DISPLAY PAGE)	The PAL display page option is not installed on your control.
OPTIONAL FEATURE IS NOT PROVIDED	An attempt was made to program an optional feature that has not been purchased from Allen-Bradley.

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Message	Description
OPTIONAL RAM SIMM BAD/MISSING	The control has discovered the RAM SIMMs for the extended storage option are either damaged or missing. The RAM SIMMs must be installed or replaced. Contact your Allen Bradley sales representative for assistance.
OTHER PROCESS G CODE CONFLICT	On a dual processing system, one process has a conflicting G code active when you attempted to activate a G26 depth probe cycle. For example, process one executes a G26 while process two has an axis in feed to hard stop which is on the same servo card as the depth probe.
OVER SPEED	A servo motor is turning at an RPM that is greater than the maximum RPM allowed for that servo as defined in AMP by the system installer. For digital spindles this error can result from maximum RPM gear range 1 being set higher than your AMPed allowed Maximum Motor Speed.
OVER SPEED IN POCKET CYCLE	The programmed feedrate for an irregular pocket cycle (G89) was too high for the cycle to keep up. The part program stops at the endpoint of the block in which the error occurred. The cycle must be executed with a lower feedrate.
OVERTRAVEL (+)	The indicated axis has reached the positive software overtravel limit during an axis jog. This message can appear prior to reaching the overtravel limit in certain instances. For example, if a single pulse from the handwheel will result in a large incremental move beyond the overtravel limit, this error message will appear before the axis moves up to the limit.
OVERTRAVEL (-)	The indicated axis has reached the negative software overtravel limit during an axis jog. See OVERTRAVEL (+) for details.
P	
P VALUE OUT OF RANGE	An attempt was made to call a macro or sub-program using a program number, following the P-word, that is out of the valid range. Valid range for a P-word is 1 to 99999.
PAL & 9/SERIES REVISIONS DIFFER	Either the overall revision number of PAL does not match the software revision on the control, or the revision number of system symbols in PAL and the revision number of those on the control do not match.
PAL ANALOG PORT ILLEGAL CONFIGURATION	This is a power turn-on error that occurs when an AMP configuration error exists in the PAL analog port configuration.
PAL ANALOG PORT/SERVO F-W INCOMPATIBLE	PAL-controlled analog output port feature requires the servo firmware (f-w) revisions: Analog servo f-w rev 0.06 or greater Digital servo f-w re. 2.03 or greater Consult Allen-Bradley customer support services about servo firmware updates.
PAL AXIS STATUS CANNOT CHANGE	You attempted to change the status of a PAL axis (either to PAL axis or to a system axis) when it is not allowed. Examples of when the transition is not allowed are when the axis is jogging, performing jog retract, performing block retrace, etc...
PAL BACKGROUND TOOK TOO LONG	Background PAL was not completed in the time allocated to it in AMP. Background PAL will continue on to completion before restarting. If and when background PAL does complete in the allocated time, this message will disappear. If this message appears continuously, the PAL program should be rewritten, or else the AMP defined background PAL execution time should be increased. Refer to the AMP and PAL reference manuals for more details.
PAL DIVIDE BY ZERO ERROR	The PAL program tried to divide a value by zero. Check the PAL program for errors.
PAL DOES NOT EXIST	There is no PAL program in the system, either on EPROM or in RAM memory. EPROMs must be installed, or else PAL must be downloaded to RAM from ODS.
PAL INITIATED MOTION POSSIBLE	While in QuickCheck mode it is possible for PAL to physically move axes. This includes any motion generated by PAL including the PAL axis mover, or jogs that can occur in automatic mode such as jog on the fly or manual gap elimination. This message is cleared after the first block is executed in QuickCheck mode.
PAL OVERWRITING G54 ® G59.3	PAL is overwriting the current G54 - G59.3 offset through PAL offsets.
PAL PAGE WAITING - EXIT DISPLAY SELECT	A PAL display page is being overwritten by the current screen. Pressing the {DISPLY SELECT} softkey will display the display page.

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Message	Description
PAL PAGE WAITING - EXIT MONITOR	A PAL display page is being overwritten by the current screen. Exit the search monitor utility to see the screen PAL is attempting to display.
PAL PAGE WAITING - SCREEN HAS PROMPT	A PAL display page is being overwritten by the current screen.
PAL PROM CHECKSUM ERROR	Checksum error in the PAL PROM memory. This indicates PAL has been loaded successfully however it has failed to pass verification. Check if your flash sticks are installed properly and are not damaged. Attempt to download a copy of the same PAL image from another project.
PAL SOURCE NOT DOWNLOADED TO CNC	The PAL search monitor utility can not be accessed. The PAL search monitor utility requires the PAL source code be downloaded with the built PAL program.
PAL SOURCE NOT LOADED	The copy of PAL in flash does not contain source programs.
PAL SOURCE REV. MISMATCH - CAN'T MONITOR	PAL source code in the control does not match the revision of the CNC executive. The PAL code may execute if all of the PAL system flags exist but the monitor cannot be used.
PAL USING MEMORY - REFORMAT	The AMP parameter allowing PAL to be stored in RAM memory has been enabled. This changes the amount of RAM memory available for part program storage, requiring the RAM disk to be reformatted. Part programs should have been backed up prior to this.
PARAMETER ASSIGNMENT SYNTAX ERROR	A block that assigns Paramacro parameters has been entered incorrectly.
PARAMETER NUMBER NOT FOUND	The AMP parameter number being searched for through the control's patch AMP utility does not exist in the system.
PARAMETER VALUE OUT OF RANGE	The value entered for the selected AMP parameter or paramacro parameter is less than or greater than the allowed legal value.
PARENTHESIS INPUT ERROR	Parentheses have been entered incorrectly in a program block or calculation operation. Correct the use of the parenthesis; verify they are in matched pairs.
PARITY ERROR IN PROGRAM	A serial communications error has occurred. A data parity error occurred while sending or receiving data. This can result in a corrupted file, or the entire date transfer operation may be aborted by the control.
PARK AXIS MOTION NOT ALLOWED	Axis motion was programmed for a parked axis in a dual axis group. When both master and slave axes are parked, no axis motion is allowed on a parked axis in a dual group.
PART PROGRAM NOT SELECTED	An attempt was made to execute a program or check a program before a program was selected for execution.
PART ROTATION FORMAT ERROR	In part rotation blocks (G68, G69), only plane changes and mode changes including inch/metric and absolute/incremental are permitted. Any commands other than normal motion commands and the motion G-codes (G00, G01, G02, and G03) are not permitted.
PASSWORD PROTECTED	When assigning password protectable features to an access level, an attempt was made to assign a feature to a different access level when the currently active password does not have access to the feature. You can assign features to other access levels only when you have access to that feature yourself.
PEAK CURRENT NOT 300%	The axis for a 1394 or 9/440 is not AMPed to have the PEAK CURRENT set to 300%. This misconfiguration forces the control into E-Stop.
PERIPHERAL DEVICE ERROR	An illegal communication attempt was made with a peripheral device, for example, attempting to **output** to a tape reader or **input** from a tape punch.
PLANE SELECT ERROR	An attempt was made to change planes during cutter compensation (TTRC), between QPP blocks, or between chamfer and corner rounding blocks. This error also will occur if G17 or G19 planes are selected on a lathe.
PLEASE WAIT FOR CLEARING OF PAL MEMORY	PAL is being erased in preparation for a PAL download.
PLUNGE MOTION NOT ALLOWED	The final plunge position must be different from the start point of the cycle. This message can occur if the plunge axis is not programmed in the entry block to G89 mode, or if the plunge axis increment is zero, or if the final plunge axis position is the same as the start point of the cycle block during G89 mode.

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Message	Description
PLUNGE MOTION NOT PROGRAMMED	In your pocket cycle you have either not programmed a final depth, or the final depth you have programmed is equal to the depth of the cutting tool at the starting point of the cycle. The location of the cutting tool when the pocket cycle is programmed must be at a different depth than the final programmed depth of the cycle.
PLUNGE NOT ALLOWED	A plunge that will cut into the pocket wall was requested in a G89 irregular pocket cycle.
PLUNGE STEPS MIS-PROGRAMMED	The rough, medium, and fine-feed depths in the cycle block are not programmed correctly. This is possible if the data in the block is incorrect or if the data in the modal values of the parameter not programmed in the block are incorrect.
POCKET END NOT SAME AS START	A pocket end-point that is not the same as the pocket start-point was programmed in a G89 irregular pocket cycle.
POCKET IS PART OF CUSTOM TOOL	An attempt was made to assign a tool to a tool pocket that is already used by a custom tool. Custom tools are assigned to tool pockets that are shown with an XXXX next to the pocket number on the random tool table.
POCKET MILLING SHAPE IS INVALID	A parameter is missing in the G88 programming block.
POINT ALREADY EXISTS	The point that you are trying to enter is already in the axis calibration table.
PORT B IS BUSY	This message appears when you press {SYSTEM SUPORT}, {MONITOR}, or {SERIAL I/O} and port B is busy.
PORT IS BUSY - REQUEST DENIED	An attempt was made to output or input information to or from a serial communications port that is already being used by some other device or is selected as the port that an active program is coming from.
POWER DOWN ERROR, POSSIBLE PAL DATA LOSS	This message can be displayed on power up of the contol. When it occurs, it indicates that the control was shut doen abnormally , possible from a control "watch-dog time out". You must take appropriate steps to insure that the PAL program can still function properly with loss of temporary data.
PREVIOUS ABORT COMMAND NOT COMPLETE	This message is displayed when the communications "abort" key is entered before the last abort requested has completed.
PROBE/CONTROLLING AXIS CARD DIFFERENT	Both the adaptive depth probe and the adaptive depth probe controlling axis (typically the axis that positions the probe) must be attached to the same servo card. You must re-AMP your system and re-arrange your servo wiring so that the adaptive depth probe and it's corresponding servo are on the same servo card.
PROBE CYCLES CALCULATION ERROR	The servo module was unable to compute the probe position when the probe is fired. Make sure that all measurement points are within the programmed range entered for the probe cycle. Lower the feedrate during the probing operation and try again.
PROBE CYCLES PROGRAMMING ERROR	Either not enough or too many axes are programmed in a probing cycle block.
PROBE ERROR	A probing cycle has reached the outer limits of the tolerance band without firing the probe, or the probe has fired before entering the tolerance band.
PROBE IN USE BY OTHER PROCESS	On a dual processing control only one probing function is allowed at any one time. Probing can not be performed by both processes simultaneously. You must wait for probing to complete in one process before probing in the other process.
PROBE IS ARMED, CAN'T ADJUST SERVOS	With the probe armed through a probing operation, until the probe fires or the probe is disarmed, other online AMP servo parameters like torque, feedforward percentage, gain, etc., are not allowed to be changed.
PROBE TRIP DURING DECEL	An adaptive depth probe trip occurred after the program block reached endpoint. The trip was made while the control was waiting for the following error to collapse after interpolation is complete. Avoid this error by reducing axis speed (thus reducing following error) or by moving the adaptive depth block endpoint further into the part.
PROCESS SWITCH NOT CURRENTLY ALLOWED	On a dual-processing system, you cannot switch processes while in graphics or in digitize.

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Message	Description
PROGRAM ACTIVE	An attempt has been made to delete or perform some other operation to a program that was activated for automatic execution. The program must be deactivated using the {CANCEL PRGRAM} softkey.
PROGRAM ACTIVE IN ANOTHER PROCESS	This dual lathe error appears when one process attempts to open a file for edit, deletion, etc., while that file is active in another process.
PROGRAM BEING EDITED	An attempt has been made to copy, verify, or perform some other operation on a program that is still in the edit mode. It is necessary to press the {EXIT EDITOR} softkey from the edit menu to properly end an editing operation.
PROGRAM BLOCK TOO LONG	More than 128 characters were entered into a single block.
PROGRAM CURRENTLY IN USE	A subprogram or paramacro program was called that is currently being used to perform some other operation (such as editing or copying). Typically, this message is the result of attempting to edit a program that was not properly closed. A program remains in the edit mode until the {EXIT EDITOR} softkey is pressed from the program edit menu.
PROGRAM NAME TOO LONG	An attempt was made to create a program with a program name longer than 8 alphanumeric characters. If a large, descriptive program name is desired, a comment may be added to the right of the program name using the {PRGRAM COMENT} feature.
PROGRAM NOT FOUND	The program cannot be located in memory. Check to make sure the program name was correctly entered.
PROGRAM OPEN FOR EDIT IN ANOTHER PROCESS	On a dual-processing system, you cannot edit a program that is active in another process. You will need to switch processes if you want to edit the other program.
PROGRAM REWIND ERROR	An attempt to rewind the tape was not successful. Check to be sure that the tape reader is functioning properly and the tape is on the drive sprockets.
PROGRAM SHOULD START HERE	When performing a {MID ST PRGRAM} operation to restart a program, the control has found the block that the program execution should begin at, and selected that block as the next block to be executed. That block is the block immediately following the one containing an @.
PROGRAMMED AXIS IS OFF OR DETACHED	Part program blocks are attempting to program motions on an axis that has its servos either off or configured as detached in AMP.
PROGRAMMED G26 DEPTH < TRIGGER TOLERANCE	A G26 block is programmed with an integrand less than or equal to the AMPed Adaptive Depth Trigger Tolerance amount. A block decode error is given and the block will not execute until the integrand in the block is made larger or AMP is modified to reduce the trigger tolerance.
PROGRAMMED SPINDLE UNAVAILABLE	The programmer attempted to program the follower spindle independently (M03, M04, M05, or M19) while spindle synchronization was active.
PROGRAMS ARE DIFFERENT	A program verify operation has determined that the two selected programs are not identical.
PROGRAMS ARE IDENTICAL	A program verify operation has determined that the two selected programs are identical matches.
PROGRMABLE ZONE 2 VIOLATION	An attempt was made to move the indicated axis into the area defined by programmable zone 2.
PROGRMABLE ZONE 3 VIOLATION	An attempt was made to move the indicated axis into (or out of) the area defined by programmable zone 3.
PROGRMD G26 DEPTH < TRIGGER TOLERANCE	The programmed adaptive depth deflection (hole depth) is less than the probe tolerance value. You must either increase the programmed block depth, or decrease the AMPed probe tolerance value.
Q	
QPP ANGLE WORD SAME AS AXIS NAME	AMP has downloaded an angle word for QuickPath Plus that is the same as an axis name. AMP must be reconfigured; the angle word cannot be the same as an axis name.
QPP BLOCK FORMAT ERROR	Data is incorrectly entered or insufficient data is entered for the control to correctly execute a QuickPath Plus block or pair of QuickPath Plus blocks.

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Message	Description
QPP MDI BLOCK LOOKAHEAD ERROR	Only one of two necessary blocks was programmed in MDI using QuickPath Plus commands that require two blocks for proper execution.
QPP NOT ALLOWED DURING POLAR MODE	With polar coordinate programming active, you cannot use QPP.
R	
R WORD FORMAT FINER THAN	The word format programmed is requesting a finer resolution than the axis word format for the corresponding axis allows. These word formats are set in AMP.
RAPID SPEED TOO HIGH FOR AMPED CONFIG	AMP configuration error. The axis resolutions and feedback device resolutions will not permit the rapid and maximum feedrates assigned in AMP.
RADIUS TOO SMALL	An arc (or helix) was programmed (G02 or G03) that defines a radius that is too small to connect the start-point of the arc to the end-point. The value of R is too small.
RAPID TOO HIGH FOR AMPED CONFIG	AMP configuration error. The axis and feedback device resolutions will not permit the rapid feedrates assigned in AMP.
RAPID TRAVERSE ERROR :	An attempt was made to jog an axis using rapid traverse when it is not permitted. Typically, to use the TRVRS function while jogging, the control must be in manual mode; continuous jog must be selected; and, if the axis being jogged has an overtravel value, that axis must first have been homed.
READ ERROR	An attempt to read a program from a tape or disk drive has failed.
RECIP AXIS IN WRONG PLANE	The reciprocation axis specified in a G81 or a G81.1 programming block is not in the currently selected plane.
RECIP AXIS NOT PROGRAMMED	No reciprocation axis was specified in a G81 or a G81.1 programming block.
RECIPROCATION NOT STOPPED	An attempt was made to deactivate the current part program while reciprocation is still active. You must deactivate reciprocation before deactivating the current part program.
REMOTE I/O COMMON RAM FAULT ON RESET	The RIO module tests the common RAM after reset and detects an error. The Interboard Communications Fault LED is turned ON.
REMOTE I/O CTC CHIP TEST FAULT	The RIO module tests the CTC chip after reset and detects a fault. The Processor Fault LED is turned ON.
REMOTE I/O DENIED COMMON ACCESS ON RESET	The RIO module was denied access to CRAM for more than 1 second after reset. The Interboard Communications Fault LED is turned ON.
REMOTE I/O EPROM INTEGRITY FAULT	The checksum test over the RIO program area in the EPROM chip found a fault. The Processor Fault LED is turned ON.
REMOTE I/O INCORRECT USER BT DATA AMOUNT	The RIO module attempted to read a block of data from one of the user output block transfer data buffers in common RAM and found the word count of the data to be outside of the range of 1 to 64. The Interboard Communications Fault LED is turned ON.
REMOTE I/O INITIALIZATION ERROR	Remote I/O hardware or network has failed to initialize. Cycle power to try to restart or check remote I/O hardware (9/290 only).
REMOTE I/O INTERNAL RAM FAULT	The RIO module tests its internal RAM chip after reset and during operation. A fault has been detected. The Processor Fault LED is turned ON.
REMOTE I/O INTERRUPT HARDWARE FAULT	The RIO module detects that its CPU was not interrupted by any expected external interrupts. This condition indicates a problem in recognizing interrupts. The Processor Fault LED is turned ON.
REMOTE I/O INVALID RACK ADDRESS SET UP	The RIO module's rack address is illegal. This fault is the result of the user setting the rack address, via the dip switches, to an invalid rack size and/or starting module group number.
REMOTE I/O INVALID USER BT DATA CHECKSUM	The 16-bit 2's complement checksum calculated by the RIO module using data from a user output block transfer data buffer does not match the checksum placed in the buffer by the user device. The Interboard Communications Fault LED is turned ON.
REMOTE I/O INVALID USER DATA CHECKSUM	The 16-bit 2's complement checksum calculated by the RIO module using data from the user output data table in common RAM does not match the checksum placed by the user in the user output data table in common RAM. The Interboard Communications Fault LED is turned ON.

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Message	Description
REMOTE I/O MISSING USER OPERATIONAL CODE	The RIO module did not detect the user operational code after reset. This fault is displayed when the RIO module does not detect the user operational code in the user status register in common RAM within 100ms after the RIO module has set its operational code and released control of common RAM back to the user device. The Interboard Communications Fault LED is turned ON.
REMOTE I/O RIO DENIED COMMON RAM ACCESS	The RIO module was denied access to CRAM for longer than the specified interval. The RIO module failed to gain access to common RAM after attempting for the Accessing Time-out time period. The time-out is due to either the user device maintaining access for more than the Accessing Time-out interval. or to a hardware failure. The Interboard Communications Fault LED is turned ON.
REMOTE I/O SERIAL COMMUNICATIONS FAULT	The RIO module cannot communicate with the PLC processor. Either the PLC processor's power is OFF, the blue hose is not connected, or the PLC processor is in Edit mode.
REMOTE I/O SIO CHIP TEST FAULT	The RIO module tests the SIO chip after reset and detects a fault. The processor fault LED is turned ON.
REMOTE I/O UNABLE TO FIND BT DATA BUFFER	The RIO module was unable to detect the user block transfer data buffer. The interboard communications fault LED is turned ON.
REMOTE I/O UNRECOVERABLE ERROR	Remote I/O hardware or network has catastrophic failure. Cycle power to try to restart or check remote I/O hardware (9/920 only).
REMOTE I/O USER FAULT OCCURRED	The RIO module detected that the user fault bit was set. The interboard communications fault LED is flashing.
REMOTE I/O WATCHDOG TIMEOUT	The watchdog mechanism on the RIO module timed out, indicating that the RIO module has not operated in an expected manner for possibly 17ms. The processor fault LED is turned ON.
REMOTE IO INTERPROCESSOR HANDSHAKE FAULT	The RIO module failed to detect the complement of the user-handshake word, in the complement user-handshake word in common RAM, within the handshake interval. The user device has not shook hands with the RIO module. The interboard communications fault LED is flashing.
REPLACE ABSOLUTE FB BATTERY	The battery that attaches to the servo module and supplies power for the absolute encoders is under-voltage and must be replaced.
REPLACE MEMORY BACKUP BATTERY	The battery that attaches to the main processor board and supplies power for the control's RAM memory is under-voltage and must be replaced. If not replaced, AMP data cannot be copied to backup memory and part program data may be lost.
REQUESTED DATA TOO LARGE	The data you are trying to send or receive is too large.
REQUIRES AT LEAST TWO AXES	A transfer line quick view prompt was selected for a cycle which requires two or more axes. Your system is currently configured as a single axis system.
RESETTING E-STOP	Once you push the E-Stop Reset button to clear the E-Stop state, the Resetting E-Stop message displays to alert you that the control is attempting to come out of E-Stop. After the system is out of E-Stop and the drives are enabled, the control clears this message. If the error condition is not cleared, this message clears, but the "E-STOP" message continues to flash as the control remains in E-Stop state.
RETRACE NOT ALLOWED	A retrace is not allowed from the point in program execution.
RIGHT OPERAND MUST BE POSITIVE	The right operand of a logical operator must be a positive value. Negative values are illegal; for example, 1AND-2 is illegal because of the -2.
RING I/O RECOVERY DISABLED	This message is activated when the {RECVRY DISABL} softkey is pressed on the I/O RING MONITOR page. It is a visual indicator that the operator has disabled the I/O Ring retry functionality.
RIO COMMON RAM ACCESS NOT ACKNOWLEDGED	The control's request to use the RIO module was denied. The RIO module lost power, or the control was restarted, but the RIO module was not.
ROLLOVER/OVERTRAVEL INCOMPATIBLE	Overtravel limits were specified in AMP for an axis that is configured as a rollover axis. Rollover axes do not have overtravel limits.
ROTARY AXIS CANNOT BE SCALED	A rotary axis cannot be scaled.

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Message	Description
ROTARY WORD OUT OF RANGE	A rotary axis was programmed to move to an absolute position that is greater than or equal to 360 degrees. In absolute mode, a rotary word must range between 0 and 360 degrees.
ROUGHING CYCLE NESTING ERROR	The contour blocks called by a roughing cycle to define the finished contour of a part contain a block that likewise calls for a roughing cycle. Contour blocks for a roughing cycle cannot contain a block that likewise calls for a roughing cycle.
ROUGHING CYCLE PROGRAMMING ERROR	A syntax error has been found in a roughing routine block (G72, G73, G74, or G75).
RUNG NUMBER NOT FOUND	The rung number you are searching for in the search monitor utility does not exist in the current module, or does not exist in the program in the direction you are searching.
S	
S-CURVE ACC/DEC CONFIGURATION ERROR	An axis configuration error was detected by the control when the programmed acc/dec ramp was out of range. An attempt to program an acceleration ramp value of 0 in a G48.3 or G48.4 block. An attempt was made to program another G-code in a block with a G48.x.
S-CURVE MIN PROG JERK TOO SMALL	An attempt was made to select a jerk value below the allowable AMPed value.
S-CURVE MODE NOT ALLOWED	This message displays when an attempt was made to use a feature that is illegal in S-Curve Acc/Dec mode. The following can not be used with S-Curve Acc/Dec: 7300 Series Tape Compatibility, PAL Axis Mover, Circular Interpolation Mode (G02, G03), Feed to Hard Stop (G24), jogging, threading, and solid tapping.
S-CURVE OPTION NOT INSTALLED	An attempt was made to select S-Curve Acc/Dec (G47.1) when the S-Curve option bit was set to false. Make sure your system includes the S-Curve option.
S NOT LEGAL PROGRAMMING AXIS NAME	This is displayed at power-up when the letter "S" is assigned to linear or rotary axis. Only the spindle(s) can be AMPed with "S" as the name; it cannot be assigned to a programmable axis.
S OVER SPEED	A servo motor is turning at an RPM that is greater than the maximum RPM allowed for that servo as defined in AMP by the system installer. For digital spindles this error can result from maximum RPM gear range 1 being set higher than your AMPed allowed Maximum Motor Speed.
SAVE COMPLETED	The changes made to the current device set-up have been saved.
SCALE FACTORS MUST BE EQUAL FOR PLANE	When performing circular motion or motion in certain cycles, keep the scale factors for the axes of the active plane equal.
SCALING INVALID DURING POLAR	Scaling cannot be used during polar programming.
SEARCH ALREADY IN PROGRESS	You cannot request a search operation while one is currently running. Complete or abort the current search before attempting another search.
SEARCH MONITOR SELECT NOT ALLOWED	You can not use the online PAL search monitor utility while the display select function softkeys are active. Leave the display select screens (press DISP SELECT) before you try to access the search monitor utility.
SEARCH REQUIRES AN ACTIVE PROGRAM	An attempt has been made to perform a search operation when no program was selected for execution. A program must be selected for automatic execution before a program search can be performed.
SEARCH STRING NOT FOUND	The character or character string designated in the search operation was not found.
SECOND SPINDLE NOT CONFIGURED	For spindle 2 to be programmable, it must be configured in AMP; a decode error.
SECONDARY AUX. WORD SAME AS AXIS NAME	The secondary auxiliary word (usually B) is the same as an axis name, causing an interpretation conflict for the control. This word and all axis names are assigned in AMP.
SEE (MESSAGE) IN PROGRAM BLOCK	The programmer has assigned a system parameter that generates this message, telling the operator to read the comment in the current part program block. Program execution will resume when cycle start is pressed.
SEQUENCE NUMBER OUT OF RANGE	A sequence number beyond the range of 1 - 99999 was programmed.

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Message	Description
SEQUENCE STOP NUMBER FOUND	A sequence stop number has been activated, and that sequence number has been found in the currently executing program. Execution will stop after the block containing the sequence number corresponding to the sequence stop number is executed. Execution will resume when cycle start is pressed.
SERIAL COMMUNICATIONS BUFFER OVERFLOW	A peripheral device communication error (such as a tape reader). The 512 character input (receive) buffer has overflowed. Data may have been lost. Check your configured communications protocol (flow control) and check for proper cabling/pin connections.
SERIAL COMMUNICATIONS ERROR #1	This is an internal software error. The control is unable to access DF1 Driver.
SERIAL COMMUNICATIONS ERROR #2	This is an internal software error. Check cables and try again.
SERIAL COMMUNICATIONS ERROR #3	This is an internal software error. This is an unknown DF1 Driver error.
SERIAL COMMUNICATIONS ERROR #4	This is an internal software error. The control is unable to access the serial communications port.; check cables and try again.
SERIAL COMMUNICATIONS ERROR #5	Serial communications port has not received the expected response in the time allowed.
SERIAL COMMUNICATIONS FRAMING ERROR	An incorrect number of bits was encountered during a read operation. Check your device setup.
SERIAL COMMUNICATIONS PARITY ERROR	Incorrect parity of data was received. Check your device setup.
SERIAL PORT IN USE	This message will appear if a serial communications port is busy when checked prior to transmission.
SERIAL UART BUFFER OVERFLOW	The 2 character buffer on the UART receiver has overflowed. A character has been lost. Check communications setup.
SERVO AMP C LOOP GAIN ERROR	One of the following AMP parameter errors exist:: Current Prop. Gain + Current Integral Gain < 4096 or Current Prop. Gain - Current Integral Gain > 0.
SERVO AMP ERROR	There is an error in one or more of the AMP parameters relative to servo control or an absolute feedback encoder failed to initialize.
SERVO AMP FDBK PORT ERROR	The feedback port assignments in AMP are wrong; for example, two servos are using the same feedback port on the same servo module.
SERVO AMP FE LIMITS CORRECT	One or more of the following AMP parameters were changed to satisfy the following equation: Inposition Band £ Gain Break Point £ Feedrate Suppression £ Excess Error The servo module would have disabled control operation if these parameters were not changed.
SERVO AMP ID SPEED CORRECT	One or more of the following AMP parameters were changed to satisfy the following equation: o/ ≤ Motor speed at starting Id ≤ Motor speed at Id Break Point ≤ Max. Motor Speed The servo module would have disabled control operation if these parameters were not changed.
SERVO AMP OUTPUT PORT ERROR	The output ports as assigned in AMP are wrong; for example, two servos on the same board are assigned to the same output port.
SERVO AMP V LOOP GAIN ERROR	One of the following AMP parameter errors exist: Velocity Prop. Gain + Velocity Integral Gain < 65536 or Velocity Prop. Gain - Velocity Integral Gain > 0
SERVO AMP, AMP TYPE ERROR	The AMP parameters specifying amplifier types and connectors are contradictory.
SERVO AMPLIFIER FAULT	This indicates that a fault signal has been received from a servo amplifier. It can usually be corrected by turning off power to the amplifier, and then back on.

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Message	Description
SERVO BUSY DURING HOMING OPERATION	This error indicates that the servo processor was unable to respond during a homing operation. It can occur under the unusual condition resulting from two or more servo axes reaching their home point simultaneously. Generally, the axes can be re-homed with no problems.
SERVO CONFIGURATION ERROR	The AMP servo configuration is inconsistent. An example of this error would be if the downloaded AMP file were configured for only two axes, when the AMP parameter "Number of Motors on First Board" was set for three.
SERVO COMMUNICATIONS ERROR	A communications error occurred between the control and the servo module.
SERVO CURRENT LOOP ERROR	While running an axis, the allowable current loop proportional error or current loop integral error has gone out of range.
SERVO INTERFACE FAILURE	The servo interface diagnostics performed on power-up have failed. Attempt to power up again. If the error remains, contact Allen-Bradley customer support services.
SERVO POS & VEL FB SIGN ERR	This is a power turn-on error which occurs when the signs of the position and velocity feedback devices do not match when a common feedback port is used for both.
SERVO POWER UP SEQUENCE ERROR	The servo processor diagnostics performed on power-up have failed. Attempt to power up again. If the error remains, contact Allen-Bradley customer support services.
SERVO POWERUP DIAGNOSTICS FAILURE	The servo module diagnostics performed on power-up have failed. Possible causes include incorrect servo AMP parameters being downloaded. An example would be configuring AMP for five axes when there is only one servo module installed.
SERVO PROCESSOR ASSIGNMENT ERROR	Too many servos were AMPed or a servo was assigned to a non-existent servo processor. The system is held in E-Stop. The message indicates an error in the total number of fitted axes and spindles, or in the AMPed values of: Number of Motors on 1st board Number of Motors on 2nd board.
SERVO PROCESSOR OVERLAP	The analog version of the servo sub-system provides fine iteration overlap detection. This message is displayed if the fine iteration software on the DSP does not execute to completion in one fine iteration.
SERVO PROM CHECKSUM ERROR	The checksum test on the servo processor software stored in PROM memory has failed. This test is performed on power-up and periodically while the system is running. Contact Allen-Bradley customer support services.
SERVO PTO DIAGNOSTICS FAIL	The servo card has failed its power-up diagnostics. Consult Allen-Bradley customer support services.
SERVO PTO SEQUENCE ERROR	The servo card has failed its power-up diagnostics. Consult Allen-Bradley customer support services.
SERVO TIME-OUT READING ABSOLUTE ENCODER	During power-up initialization of the position registers or during a homing operation, the servo processor has failed to return a read within the required time after the absolute position has been requested by the main processor. Consult Allen-Bradley customer support services.
SERVO TIME-OUT READING FEEDBACK	During a homing operation, if there is an error reading feedback from the servo module, this message appears. This usually occurs when the system scan time is close to the threshold at which PAL execution can just complete and when homing more than 3 axes at a time. This error can be avoided by homing axes individually or increasing the system scan time in AMP.
SET ZERO NOT ALLOWED ON:	A set zero operation on the specified axis is not permitted. Typically this is because either the control is not in manual mode, or the selected axis is in the process of being jogged.
SHAFT VALUE > NUMBER OF POCKETS	An attempt was made to assign a shaft pocket that is greater than the number of pockets assigned for that custom tool. The shaft pocket number must be a value between 1 and the number of pockets assigned to that tool.
SHARED AXIS CONFIGURATION ERROR	Either there are too many shared axes configured, a shared axis has the same name as some other axis in the system, the diameter axes on a lathe are shared axes, or some other miscellaneous configuration error occurred.

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Message	Description
SHARED AXIS NOT IN PROCESS	You have attempted to position a shared axis (or recouple a shared dual axis) not currently available to the requesting process. A shared axis can only be positioned by the process currently controlling the shared axis.
SHARED SPINDLE CONTENTION	This is a run-time decode error. A process attempted to activate an exclusive-use spindle mode or change the spindle speed when another process was using it. The process goes into cycle stop.
SHIFT AWAY FROM ENDPOINT	When a cylindrical grinder cycle (G84 or G85) is programmed with a shift and plunge, and the shift increment does not move towards the cycle endpoint, this message is generated. The shift increment must move towards the cycle endpoint.
SHIFT VALUE HAS TOO MANY DIGITS	You have used incorrect search string syntax in the PAL search monitor utility.
SKIPPING SOURCE NOT INCLUDED MODULE(S)	When you downloaded your PAL program the source code for some modules was not included. The ODS software can decide to not include the source on selected modules when it determines their is not sufficient memory on the control to hold both the PAL image and the source code. The PAL search monitor utility will not monitor any PAL modules that do not have their source code downloaded.
SLASH NOT ALLOWED	An error occurred in G05 DH+ communications block.
SLAVE AXIS LETTER CANNOT BE PROGRAMMED	An attempt was made, when using dual axes, to program the slave's axis letter.
SPINDLE CONFIGURATION ERROR	An attempt was made to configure a spindle that did not have a servo board identified in AMP to indicate to which board the spindle is connected. The spindle must be included in the number-of-motors AMP parameter for the board the spindle is on.
SPINDLE ERROR, AMP FIRST SPINDLE 1ST	AMP order of spindles must be spindle 1, spindle 2, spindle 3.
SPINDLE ERROR, AMP SECOND SPINDLE 2ND	AMP order of spindles must be spindle 1, spindle 2, spindle 3.
SPINDLE ERROR, AMP THIRD SPINDLE 3RD	AMP order of spindles must be spindle 1, spindle 2, spindle 3.
SPINDLE IS CLAMPED	An attempt was made to program a block containing a spindle code other than an M05 while the PAL servo clamp request flag for the spindle was set.
SPINDLE MODES INCOMPATIBLE	An attempt was made to enter virtual mode when the spindle that is used for this mode is synchronized as the follower spindle or an attempt was made to perform end face milling during synchronization.
SPINDLE MOTOR SPEED TOO HIGH	When using a 1326 motor as a spindle, feedback resolution combined with your configured maximum spindle speed would return feedback counts faster than the control can reliably decode. Either reduce the maximum configured spindle speed, or reduce the configured feedback counts for the spindle in AMP.
SPINDLE MUST BE THE LAST SERVO	When the system is AMPed, the spindle must be assigned to the first available port after all axes have been assigned.
SPINDLE NOT ASSIGNED	A spindle axis was AMPed, but not assigned to any process.
SPINDLE ORDER ERROR, AMP AUX. 2 SECOND	AMP order of spindles must be primary spindle, aux. spindle 2, aux. spindle 3.
SPINDLE ORDER ERROR, AMP AUX. 3 THIRD	AMP order of spindles must be primary spindle, aux. spindle 2, aux. spindle 3.
SPINDLE ORDER ERROR, AMP PRIMARY 1ST	AMP order of spindles must be primary spindle, aux. spindle 2, aux. spindle 3.
SPINDLE SYNC NOT CONFIGURED	The programmer attempted to enter synchronized spindle mode before it was configured in AMP.
SPINDLE SYNC UNAVAILABLE THIS PROCESS	An attempt was made to enter synchronized spindle mode on a dual-process control when the process was not yet configured for both spindles in the synchronized pair.
SQUARE ROOT OF NEGATIVE ERROR	Internal math error has occurred; contact Allen-Bradley customer support services.
SQUARE ROOT OF NEGATIVE INVALID	An attempt was made to determine the square root of a negative number using the calculator or through a paramacro SQRT command.
STORED PASSWORD LIST TO BACKUP	This message appears after the password list has been successfully stored to the control's backup memory.

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Message	Description
STORING TO BACKUP - PLEASE WAIT	This message appears whenever AMP or axis calibration data in RAM is being stored in backup memory.
SYMBOL NAME FORMAT ERROR	Check the remote symbol and CNC symbol to make sure they exist on both remote and CNC. Check the table of the read only or write only variables.
SYMBOL NOT FOUND	Check the remote symbol and CNC symbol to make sure they exist on both remote and CNC. Check the table of the read only or write only variables.
SYNCHRONIZATION DEADLOCK	A synchronization code is activated and caused the activating process to wait on a process that is already waiting.
SYNCH SPINDLES MISCONFIGURED	Causes for this could be: only one spindle (either controlling or follower) was defined in the synchronized spindle pair, you exceeded the simple feedback ratio limitation of 10 (e.g., 11:1 or 2:13), or on a multiprocess system, one (or both) of the spindles in the synch pair is currently not available to the process making the synchronization request.
SYNCH SPINDLES REQUIRE FEEDBACK	One or both of the spindles, configured in AMP as a member of a synchronized pair, did not have feedback. Both spindles in a synchronized pair must be equipped with an AMP configured feedback device.
SYNTAX ERROR (COMMA)	A missing comma or an extra comma was found in the program block.
SYSTEM DIAGNOSTIC #1	An illegal parameter was passed into a switch statement (mid-program start) in the control software. Contact Allen-Bradley customer support services.
SYSTEM DIAGNOSTIC #2	An illegal parameter was passed into a switch statement (ASCII buffer task) in the control software. Contact Allen-Bradley customer support services.
SYSTEM DIAGNOSTIC #3	An illegal parameter was passed into a switch statement (ASCII buffer task) in the control software. Contact Allen-Bradley customer support services.
SYSTEM MODULE CONFIG ERROR	In the "Smart "1394 power supplies, the CNC sends configuration data to the power supply. These values are read back by the CNC for verification. This fault message indicates a mismatch between the two values. This mandates that the system module power supply be replaced.
SYSTEM MODULE GROUND FAULT	The 1394 system module has detected a ground fault. The system generates a ground fault when there is an imbalance in the DC bus of greater than 50 A. This drive error can be caused by incorrect wiring (verify motor and ground wiring), motor malfunction, or an axis module IGBT malfunction.
SYSTEM MODULE CURRENT LIMIT WARNING	The system module has reached 80% of it's RMS Bus current capabilities. You may need to reduce the acc /dec profiles or increase the size of the system module. The CNC system will not take action based on this fault, However the machine logic (PAL) can take action based on this status.
SYSTEM MODULE MIS MATCH	This error indicates an AMP value is set in error on a 1394 "smart" power system module. You may have set some of the "system wide" parameters differently between two axes that exist on a single 1394 platform.
SYSTEM MODULE OVER CURRENT	The system module has reached the limit of its current capabilities. The total motoring and regeneration current produced has exceeded the current capability of the system module by 5% or more. You may need to reduce the acc /dec profiles or increase the size of the system module.
SYSTEM MODULE OVER TEMP	The 1394 contains a thermal sensor which senses the internal ambient temperature. Causes could be that : The cabinet ambient temperature is above the 70 deg C rating. The machine duty cycle requires an RMS current exceeding the continuous rating of the controller. The airflow access to the 1394 is limited or blocked. An axis module or a system module FAN has failed. This does not necessarily indicate a motor over temperature. Motor over temperture sensors should be wired directly into the E-Stop string.

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Message	Description
SYSTEM MODULE OVER VOLTAGE	The 1394 system module buss voltage exceeds the maximum operating voltage. The DC power bus is continuously monitored. If it exceeds a preset level (810V DC), a fault is sensed and the power supply is disabled. There are several possible causes for this error. ·an undersized shunt requirement ·a blown shunt regulator fuse ·a malfunctioning shunt regulator transistor ·the power driver board is malfunctioning and incorrectly sensing the bus voltage ·an incorrectly set CNC acc/dec rate ·an excessive input line voltage ·the system inertia is too high causing excessive energy to be returned to the power supply bus ·a vertical axis with insufficient counterbalancing is overdriving the servomotor and causing excessive energy to be returned to the power supply bus ·an incorrect power supply is installed in your system. Make sure you are using a CNC power supply
SYSTEM MODULE PHASE LOSS	The 1394 system module has detected a loss of one of the input power phases. The three-phase input line is monitored and a fault will be issued when a phase loss is detected. Typical causes include, One, two , or all three input line fuses opened, contactor malfunction, or incorrect wiring.
SYSTEM MODULE PRE-CHARGE	The DC bus voltage did not rise to operating levels (285 V) within .5 sec after 3 phase power was applied to the system. This can occur if : a short is detected on the DC bus . An axis is enabled before the pre-charge check is complete, or if torque is commanded before full bus voltage is present.
SYSTEM MODULE SHUNT TIMEOUT WARNING	The shunt resistor has absorbed 80% of the rated regeneration energy produced by the motor. In general this warning message will not cause any action to be taken by the CNC system, however the logic program can take action based on this status.
SYSTEM MODULE SHUNT TIMEOUT	The shunt resistor has timed out due to an amount of regeneration energy produced by the motor exceeding the limit of the shunt resistor by more than 5%. You may require a properly sized shunt, modification of the duty cycle of the application, or the addition of an external shunt for additional capacity.
SYSTEM MODULE UNDER VOLTAGE	The 1394 system module voltage does not meet the minimum operating voltage. The DC power buss shall activate the under voltage limit when the bus drops to 275 VDC or less. It will clear at 300 Vdc. Typical causes include low voltage on the three phase input.
T	
(T) WORD IN CIRCULAR MODE	An attempt was made to activate a tool length offset in a block that generates a circular move. Tool length offsets can be activated only in linear blocks (or in non-motion blocks if AMP is so configured).
T-WORD NOT ALLOWED WITH M06	NEXT TOOL IN T WORD was selected as the tool-change type in AMP while a T-word is programmed in an M06 block.
TAN CIRCLE NOT IN 1ST BLOCK	When editing a program, an attempt was made to digitize an arc using {CIRCLE TANGNT} as the first block in the program. To use this digitizing format, the control must first have a tool path programmed to make the arc tangent.
TEMPLATE PROGRAM NOT FOUND	A transfer line quick view item was selected without the correct part program template present in the protected directory. There are 19 transfer line cycles and there must be part program templates QV01 thru QV19 present in the protected directory. Refer to your T-LINE-9 Quick Start guide for details on replacing/restoring these part program templates.
THIRD SPINDLE NOT AVAILABLE	AMP configuration error; spindle 3 can be configured only on a 9/290.
THIRD SPINDLE NOT CONFIGURED	For spindle 3 to be programmable, it must be configured in AMP; a decode error.
THRDS/IN WORD FORMAT FINER THAN	The word format programmed is requesting a finer resolution than the axis word format for the corresponding axis allows. These word formats are set in AMP.
THREAD FEEDRATE TOO LARGE	The lead is too large in threading mode. Program slower spindle speed.

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Message	Description
THREAD LEAD ERROR	The thread lead was too large or too small. This commonly occurs when cutting a variable thread lead and before the end of the threading pass is reached. Either the lead goes to zero for a decreasing lead thread, or an axis speed would exceed its maximum allowable cutting feedrate when cutting an increasing lead thread.
THREAD LEAD IS ZERO	No thread lead has been programmed in a block that calls for thread cutting. Thread lead is programmed with either an F- or an E-word.
THREAD PULLOUT DISTANCE TOO LARGE	The programmed threading pullout distance is larger than the programmed distance of the thread departure.
THREAD PULLOUT STOPPED AT I-PLANE	The chamfer block of a threading cycle is shortened so that the combination of pullout angle and pullout distance does not cause the retract in axis 1 to go beyond the I-plane. The AMP pullout angle is still used for the chamfer.
THREADING DISTANCE IS ZERO	A threading cycle has been programmed with no thread. Program an end-point or an end-point different from the start-point.
TIME-OUT OCCURRED WHILE WAITING FOR INPUT	When downloading AMP or PAL from the ODS workstation to the control, the message OKAY TO DOWNLOAD? (Y/N): appears on the control screen. If you do not respond within an allowed time, this error will appear.
TIMER MUST START WITH #	You have used incorrect search string syntax in the PAL search monitor utility.
TOO MANY ([ ) IN EXPRESSION	The control has found an unmatched number of [] in a program block or calculator operation. All left brackets "[" must have a corresponding right bracket "]".
TOO MANY ( ]) IN EXPRESSION	The control has found an unmatched number of [] in a program block or calculator operation. All right brackets "]" must have a corresponding left bracket "[".
TOO MANY 7300 PATTERNS IN MEMORY	An attempt was made to enter a 7300 pattern into the control's memory when the internal cross-reference table of pattern repeat names was full. The internal cross-reference table of pattern repeat names can only hold 20 pattern repeat names.
TOO MANY ACTIVE PROCESSES CONFIGURED	An AMP has been loaded that has too many actively configured processes for this controller model. The 260 series and the dual lathe can have only 2 active processes.
TOO MANY AXES AMPED FOR HARDWARE	An AMP has been loaded that has too many configured axes for this controller model. The 9/440 series can have only up to 6 axes.
TOO MANY AXES PROGRAMMED	Too many axis letters were programmed in a fixed cycle block.
TOO MANY AXES SELECTED FOR DISPLAY	When using the {AXIS SELECT} softkey, you can display only 6 axes. If you attempt to display more than 6 axes, this message is displayed.
TOO MANY CODES IN SYNCH BLOCK	Synch codes must be in a block by themselves, except for an N- or O-word. (9/260-9/290 dual lathe only)
TOO MANY DECIMAL POINTS	A word or parameter value has been programmed with two or more decimal points.
TOO MANY DEVICES ON I/O RING	The I/O ring cannot support the number of devices that has been connected.
TOO MANY EXPRESSION NESTS	The maximum number of nested expressions is 25; for example, [P3+[P4+[P5]]] has 3 expressions nests.
TOO MANY G67'S	A G67 cancel modal paramacro code was executed when no modal paramacro was active. This is typically caused when there are fewer nested modal paramacros than the programmer expected.
TOO MANY I-J-K SETS	An attempt was made to define a local paramacro parameter that is greater than #33 using I,J,K, argument sets. A maximum of 10 different I, J, K, sets may be programmed for each set of local parameters.
TOO MANY MACRO CALLS	The maximum number of nested paramacros was reached. Only 4 paramacros can be active at any one time.
TOO MANY MOTORS AMPED ON 1ST BOARD	The AMP parameter for the number of motors on the first servo board is larger than the number of axes in the system.

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Message	Description
TOO MANY NESTED (DO) COMMANDS	More than the allowable number paramacro DO loops are active at one time. A maximum of 3 nested DO loops are allowed.
TOO MANY NONMOTION BLOCKS-DEADLOCK	There were too many non-motion blocks encountered during the look-ahead for cutter compensation or QPP. Consult Allen-Bradley customer support services.
TOO MANY NONMOTION CHAMFER/RADIUS BLOCKS	Too many non-motion blocks separate the first tool path that determines the chamfer or radius size (programmed with a ,R or ,C) from the second tool path. A maximum number of non-motion blocks is set in AMP by the system installer. A non-motion block is defined as any block that does not generate axis motion in the current plane.
TOO MANY POCKETS IN ROUGHING CYCLE	A maximum of 2 pockets can exist in a roughing cycle.
TOO MANY QPP NONMOTION BLOCKS	Too many non-motion blocks separate the first and second tool paths with unknown intersections in QuickPath Plus. A maximum number of non-motion blocks is set in AMP by the system installer. A non-motion block is defined as any block that does not generate axis motion in the current plane.
TOO MANY SHARED SPINDLES	Too many spindles were specified as being shared by two or more processes.
TOO MANY SPINDLES	More than one spindle is configured on the control.
TOO MANY SUBPROGRAM CALLS	The maximum number of nested sub-programs was reached. Only 4 sub-programs may be active at any one time.
TOOL CONFIGURATION WILL NOT FIT	When assigning a custom tool in the random tool table, the number of pockets assigned to the tool relative to the position of the selected shaft pocket will conflict with a different tool already assigned to a pocket. If the custom tool is to be assigned as entered, it must be assigned to a different shaft pocket, or the tool that conflicts with the custom tools location must be moved.
TOOL ENTRY EXCEEDS LIMIT	The selected tool number entered is greater than the AMP'ed maximum tool number entered by the system installer.
TOOL GROUP DOES NOT EXIST	An attempt was made to edit a tool group in the tool life management tables that does not yet exist in the tool directory. A group must be created by using the {TOOL DIR} softkey options.
TOOL OFFSET CHANGES NOT ALLOWED	During certain cycles, G10 tool change operations are not allowed.
TOOL OFFSET REQUIRES MOTION BLOCK	A tool offset cannot be changed in a non-motion block. A non-motion block is any block that does not generate axis motion in the current plane.
TOOL RADIUS TOO LARGE	The programmed tool radius in a G88 or G89 pocket cycle is too large for the pocket contour. A smaller radius tool must be used to machine out the current pocket contour.
TOOL RADIUS TOO SMALL FOR POCKET SIZE	The programmed tool radius in a G88 or G89 pocket cycle is too small for the pocket contour. Either select a larger tool for the pocket contour or reduce the amount of material to be removed each rough cut of the cycle.
TOP OF PROGRAM REACHED	When performing one of the program search operations, the first block in the program has been reached.
TRAVERSE NOT ALLOWED ON :	An attempt was made to move an axis at rapid traverse before it was been homed. This only applies to axes that have software overtravel limits.
TYPE 1 INTERRUPT INCOMPATIBLE WITH G24	This message occurs when returning from a type 1 program interrupt that previously interrupted a G24 block. The interrupt is allowed however the return move is invalid since the axis was previously in the G24 mode. You must manually intervene to continue program execution. We recommend switching to a type 2 program interrupt.
U	
UART PORT IS ALREADY OPEN	The requested serial communications port has already been opened. This message will appear if an attempt is made to send data to a port that is currently being used.
UNABLE TO OPEN PROGRAM	The control cannot find the program that is requested. Make sure the program name is entered correctly or the peripheral device has the correct programs loaded in it.

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Message	Description
UNABLE TO OPEN THE UART PORT	A serial communication port error has occurred; retry. The conditions that can lead to this error are unusual and generally will not exist when a second attempt is made to open the port. If this error is generated continuously, it indicates that there may be a communications port hardware failure.
UNABLE TO SYNCH IN CURRENT MODE	The control can not perform the request to synchronize spindles. Possible causes are: synchronization is already active; virtual/cylindrical programming or a threading operation is active on the primary or follower spindle when the synchronization request is made; or on a dual-process system, one of the requesting processes cannot gain control over both spindles.
UNABLE TO WRITE TO FLASH MEMORY	If flash SIMMs appear to be installed correctly, remove and reseat SIMMs. If problem persists, contact Allen-Bradley support service.
UNDEFINED INTERRUPT MACRO/SUBPROG	An interrupt program request was received by the control, but it cannot find the paramacro or sub-program with the corresponding program name in the program directory. The program name is defined in the enable block (M96) with a P-word.
UNEXPECTED DEPTH PROBE TRIP	G26 adaptive depth probe has fired unexpectedly. Either it has fired in a non-G26 block or it has fired before the programmed G26 contact range.
UNSPECIFIED NETWORK ERROR	An error is being sent from another device that the module cannot interpret.
UNUSABLE WORDS IN ZONE BLOCK	An axis word or other data was programmed in a programmable zone block (G22, G22.1 G23, G23.1). These G-codes must be programmed in blocks containing no other data except a block delete /, N word, or comments.
UNRECOVERABLE ERROR	Can occur when updating flash SIMMs with new 9/Series firmware. Retry the update utility. If problem persists, call Allen-Bradley Support Services.
V	
VEL LOOP INVALID WITH DAC OUT	An attempt was made to select the position/velocity servo loop type on a 9/440HR system.
VIRTUAL AXIS NOT ALLOWED	The virtual axis can only be programmed when the control is in a virtual axis mode. You must place the control in G16.3 mode to program a virtual axis.
VIRTUAL C NEEDS SPINDLE WITH FDBK	When the spindle is the virtual C axis in a virtual C application, it must be configured to provide feedback to the servo module.
VIRTUAL/REAL AXIS NAME CONFLICT	The axis configured in AMP as the Virtual C axis was previously configured as a linear machine axis.
W	
WARNING - G10 OFFSETS ALTERED	This message warns that the offsets were changed by a G10 block during execution from a mid-program start.
WARNING - PROGRAM STARTING AT BEGINNING	An active program was edited and then the editor exited. This causes the active program to restart at the beginning of the program.
WARNING - VERIFY MODAL CODES	The MID START PROGRAM feature that activates modal codes for mid-program execution is requesting that these generated modal codes be checked before program execution is started. These modal codes can be checked on the G- and M-code status screens.
WARNING - WATCHDOG JUMPER IS INSTALLED	This error indicates that the watchdog has been bypassed on the 9/Series hardware and your system will not report watchdog errors. Call Allen-Bradley field service.
WHEEL AXIS MOTION INVALID IN G16.3/G16.4	While in the angled wheel grinding mode you have attempted to program the wheel axis directly. Only the virtual axis and the axial axis can be programmed in angled wheel mode.
WILDCARD MUST BE AT START/END OF SYMBOL	You have used incorrect search string syntax in the PAL search monitor utility.
WORK CO-ORD CHANGES NOT ALLOWED	You have attempted to make a change to the work coordinate system at an invalid time. Changes to the work coordinate system can not be performed when some features are active. Disable the offending feature before attempting to change coordinate systems.

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Message	Description
Z	
Z-WORD CANNOT BE GREATER THAN R-WORD	The depth (Z-word) of a pocket formed using a G88.5 and G88.6 hemispherical pocket cycle cannot be greater than the radius (R-word) of that pocket.
ZONE 2 PROGRAM ERROR	The next block in the program or MDI entry would cause the specified axis to enter the restricted area of programmable zone 2.
ZONE 2 PROGRAM ERROR:	The current block in the program or MDI entry caused the specified axis to enter the restricted area of programmable zone 2.
ZONE 3 PROGRAM ERROR	The next block in the program or MDI entry would cause the specified axis to enter or exit the area defined as programmable zone 3.
ZONE 3 PROGRAM ERROR:	The current block in the program or MDI entry caused the specified axis to enter the restricted area of programmable zone 3.

END OF APPENDIX

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9/Series Hardware
TAB 17

Installing 9/Series Hardware for CE Compliance



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Section 17

Installing 9/Series Hardware for CE Compliance

17.0 Complying with European Union Directives

If your system is installed within the European Union, EEA regions, or has the CE mark, the following regulations apply:

EMC Directive

This device is tested to meet Council Directive 89/336 Electromagnetic Compatibility (EMC) using a technical construction file and the following standards, in whole or in part:

- EN 50081–2 EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082–2 EMC – Generic Immunity Standard, Part 2 – Industrial Environment

The products described in this manual are intended for industrial use in an industrial environment. Use this table as a guide to determine what you need to know about your CE compliant Allen-Bradley product.

Low- voltage Directive

This device is tested to meet Council Directive 73/23/EEC Low–voltage, by applying the safety requirements of EN 61131–2 Programmable Controllers, Part 2 – Equipment Requirements of Tests.

For specific information required by EN–61131–2, refer to the following Allen–Bradley publications:

- Industrial Automation Wiring and Grounding Guidelines for Noise Immunity, publication 1770–4.1
- Guidelines for Handling Lithium Batteries, publication AG–5.4
- Automation Systems Catalog, publication B111

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17.1 Wiring AC Power for a CE Compliant System

If you are integrating a 9/Series that has a final destination within Europe you must attach a metal oxide varistor (MOV) to all connections that carry AC power to the system.

If you have this control:	then you need to connect a varistor to:
9/230, 9/260 or 9/290	the incoming AC connection on the power supply
9/440	the incoming AC connection on the ON/OFF module

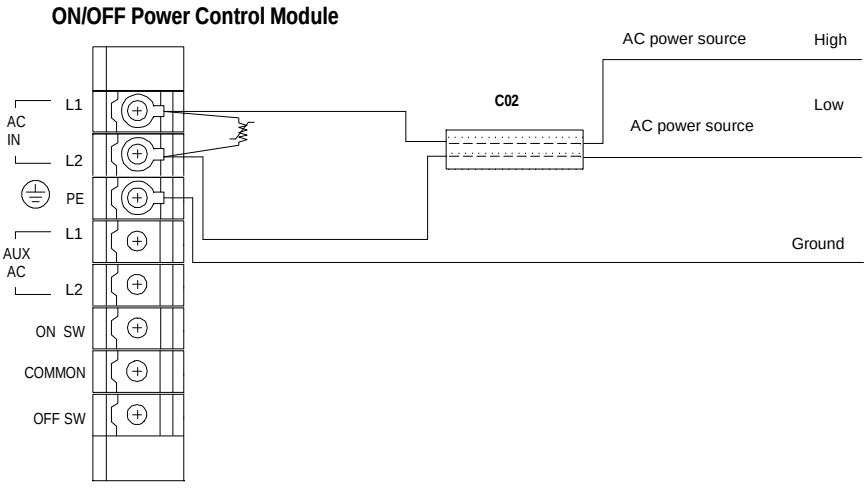
The types of MOV that you need are:

AC Power Voltage	Manufacturer	Part Number
90-130 V AC	Harris	V130LA20B
130-265V AC		V275LA40B

These devices are available through several vendors, including Newark Electronics. They can be contacted at:

Country	Phone Number
United Kingdom	(0420) 5433333
France	(1) 30-90-59-90
Germany	02 15 4-9 59 60
USA	312-784-5100

Here is an example of a typical MOV varistor connector on the 9/440 ON/OFF Control Module:



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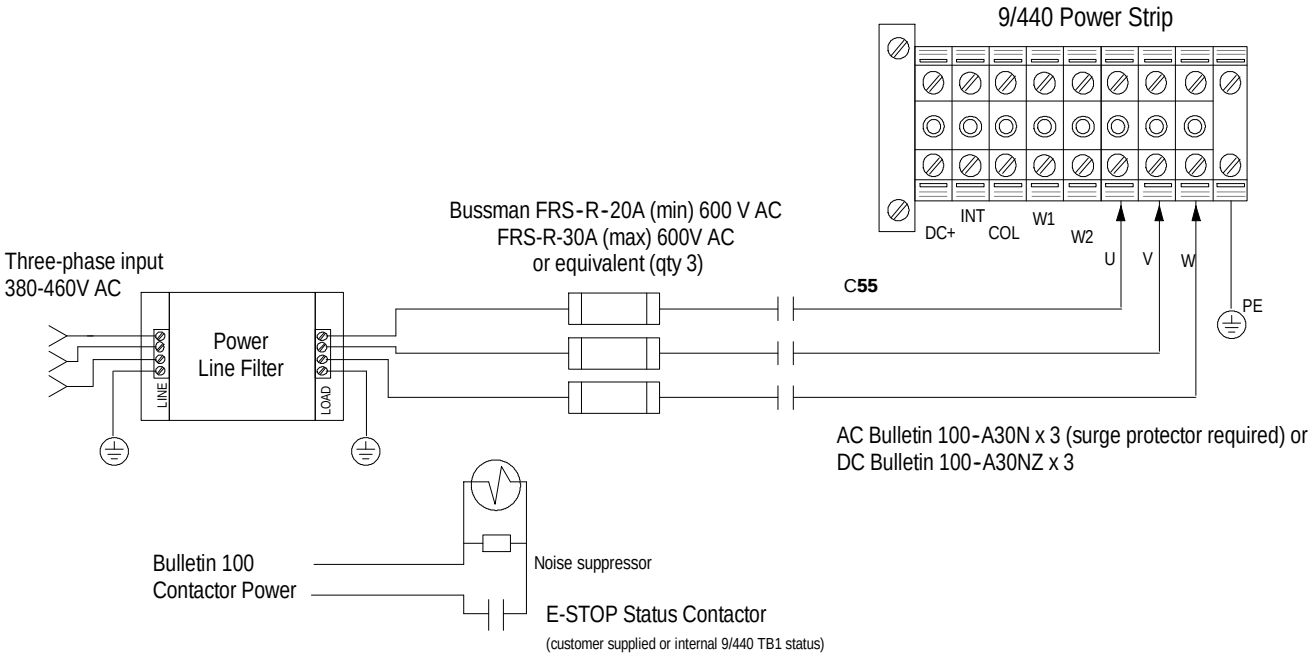
Filtering Power for a 9/440 System

To comply with CE guidelines you need to connect a power line filter to cable C55. The type of filter you need is:

Product	Part Number	Manufacturer	Phone Number
Power Line Filter	MIF323-GS	Roxburgh Electronics LTD Foxhills Industrial Park Scuntharpe South Humberside, DN158Q5 United Kingdom	011-44-017-242-81770

Connect the power line filter to C55 as shown:

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C55	9/440	External 380/460V Three Phase	Drive Power	9/440 System Module Power Terminal Block	Prepared by Customer



Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
Miscellaneous	See Local Codes (12Awg max)	Clamped by terminal screws	Line Drop Limitation

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17.2 Wiring a High-Density I/O Module for CE Compliance

If you are using a High Density I/O module, you must wire all inputs and all outputs on the module with MOV varistors for surge protection. Here's the type of MOV you need:

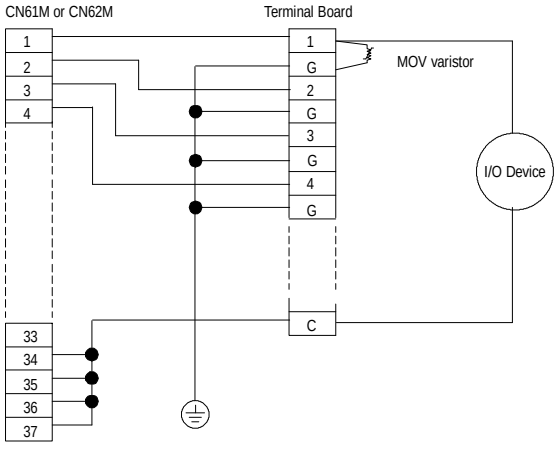
DC Power Voltage	Manufacturer	Part Number
24 V DC	Harris	V392A6

This device is available through several vendors, including Newark Electronics. They can be contacted at:

Country	Phone Number
United Kingdom	(0420) 5433333
France	(1) 30-90-59-90
Germany	02 15 4-9 59 60
USA	312-784-5100

Here is an example of a typical input and output connection on the high density I/O module that uses MOV varistors:

Typical Input or Output



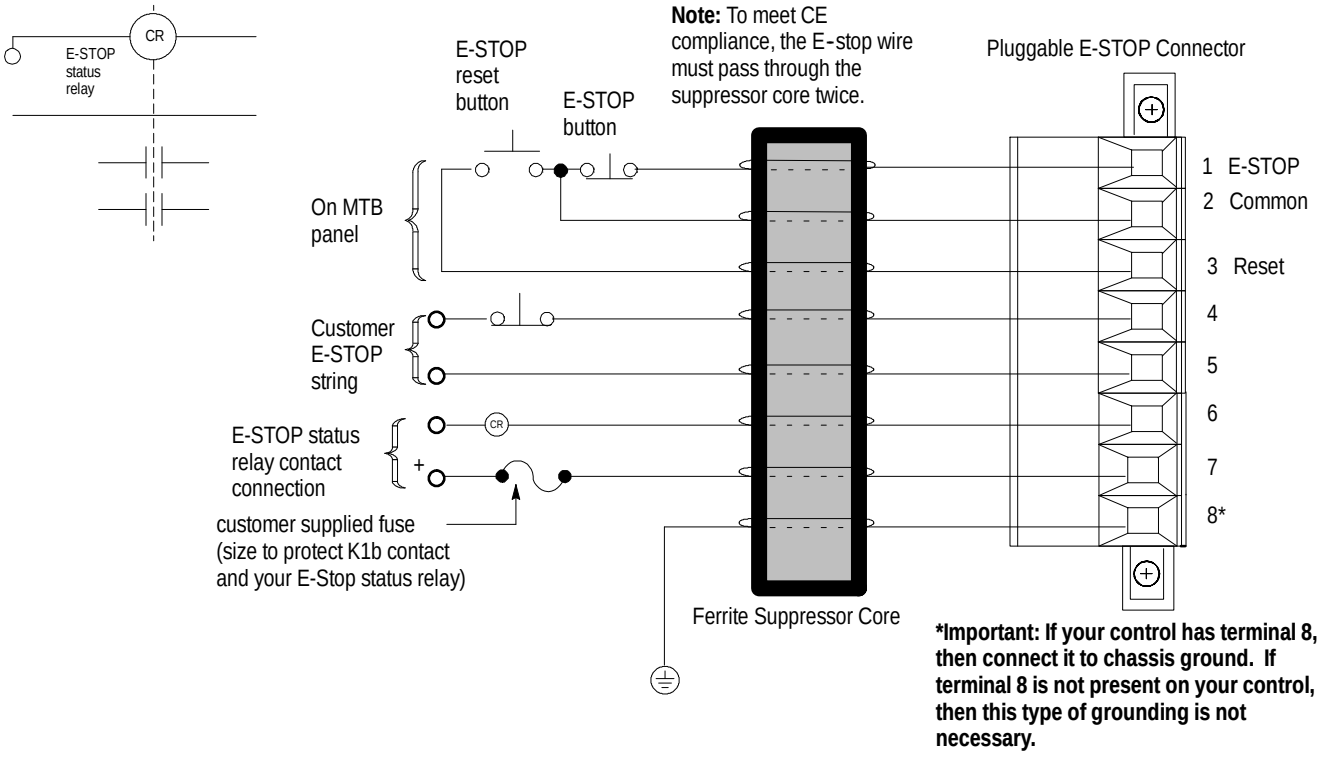
Share current between the four "common" pins

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17.3 Wiring E-stop for CE Compliance

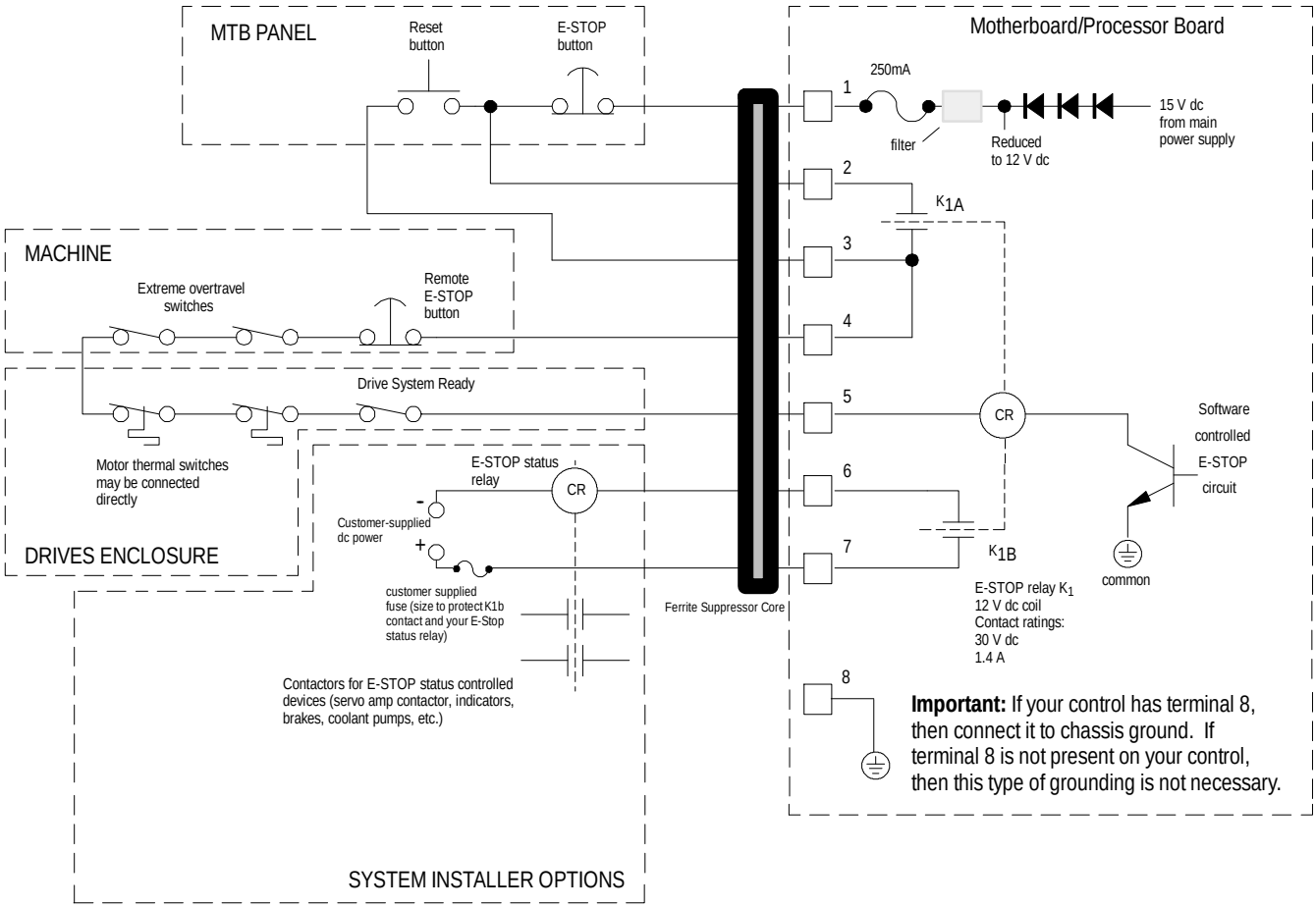
A CE compliant system must have noise-reducing components as part of its emergency stop wiring. When connecting E-stop to a 9/Series, place the ferrite suppressor core as close to the control as possible, as shown in these drawings:

Figure 17.1
E-STOP Component Connection



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Figure 17.2
Typical Emergency Stop Circuit



Ferrite suppression cores can be aquired through several vendors, including Dexter Magnetic Materials Division (DMMD):

Country	Phone
Germany	089-857-3071
United Kingdom	0753-680011
United States	1-800-345-4082

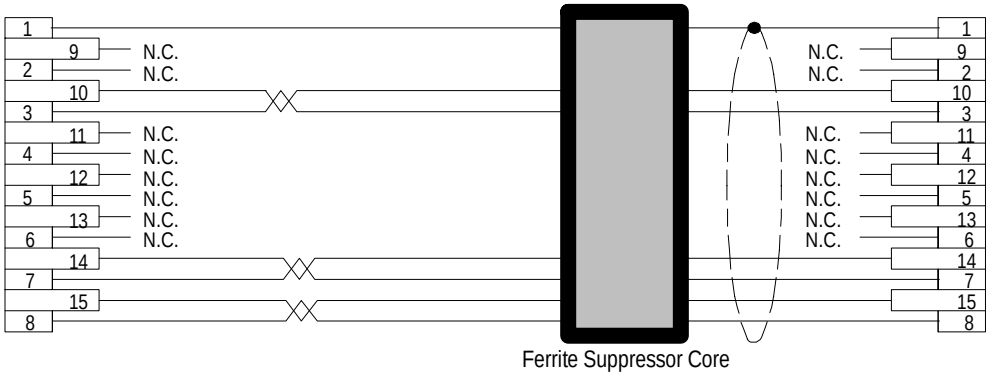
Ferrite Suppression Core Specification	Manufacturer	Part Number
250W @ 100 MHz	Fair-Rite Corporation Newark	0443164151 95F 762

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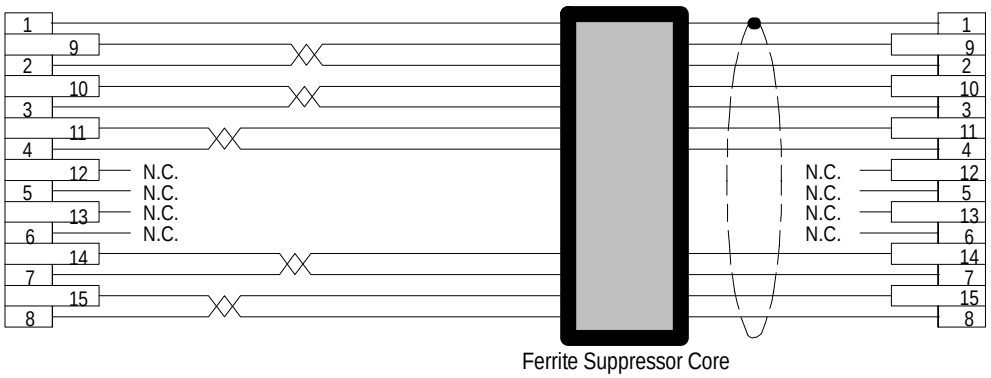
17.4 Modifying the Video Cable for CE Compliance

To meet CE compliance, a ferrite suppression core has to be installed around the video cable. Place the ferrite suppression core as close to the monitor as possible, as shown in this drawing:

Cable No.	Control	From Module and Connector	Cable Name	To Module and Connector	Cat. No.
C09	9/260 or 9/290	Motherboard J8	Video Signal Cable	CN19M on Operator Panel or on Portable Operator Panel Interface Assembly	Prepared by Customer
	9/260 or 9/290	Processor Board J8			
	9/440	System Module J8			



Monochrome monitor



Color monitor

Connector On End of Cable	Cable Type	Connector On End of Cable	Max. Cable Length
15 Pin D-Shell (has pins) 8520-D15M	Belden 9503 (monochrome) Belden 9505 (color)	15 Pin D-Shell (has sockets) 8520-D15F	15m (50 ft)

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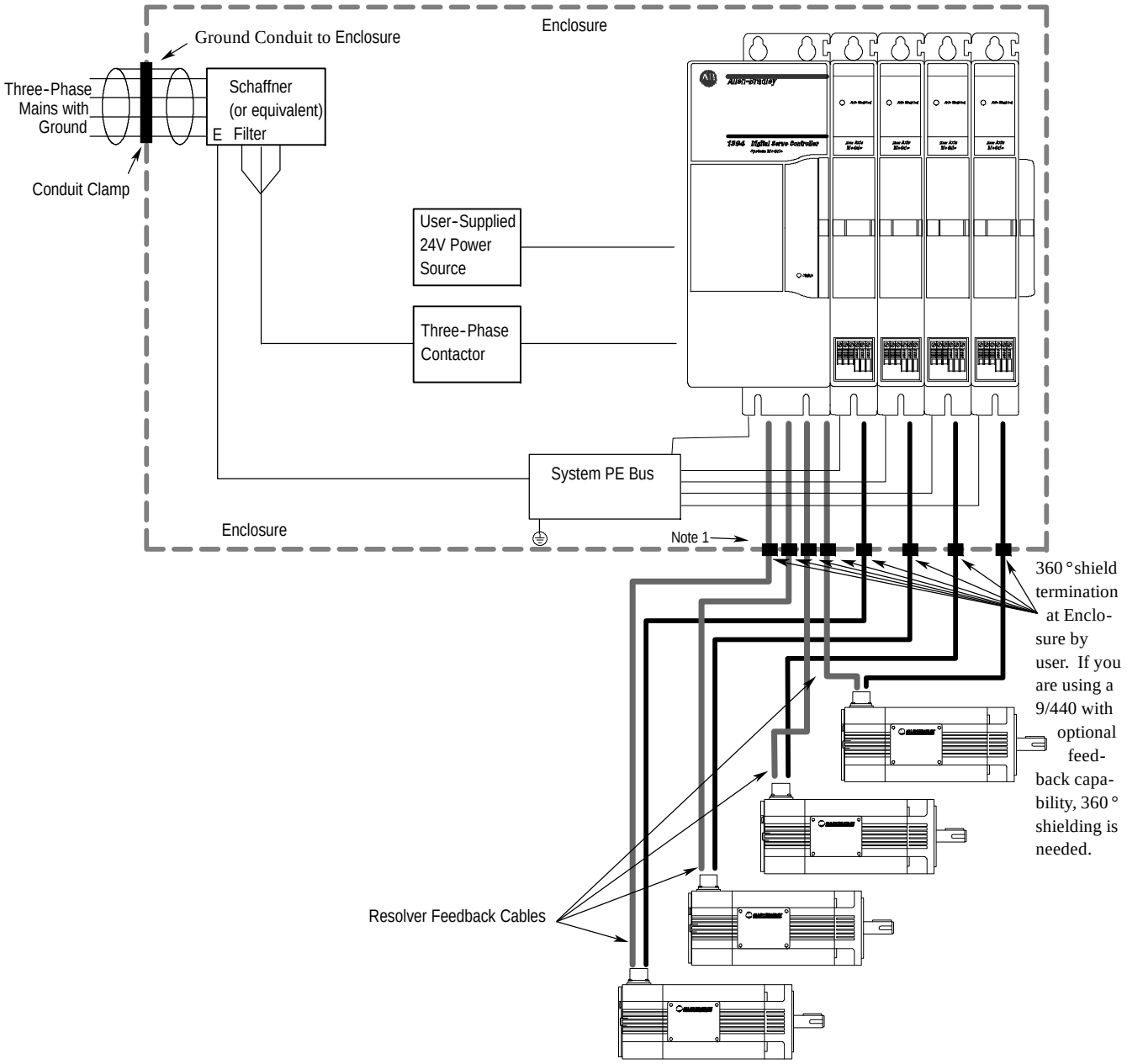
Ferrite suppression cores can be aquired through several vendors, including Dexter Magnetic Materials Division (DMMD):

Country	Phone
Germany	089-857-3071
United Kingdom	0753-680011
United States	1-800-345-4082

Ferrite Suppression Core	Manufacturer	Part Number
250W @ 100 MHz	Fair-Rite Corporation Newark	0443164151 95F 762

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17.5
1394 and 9/440 CE Requirements



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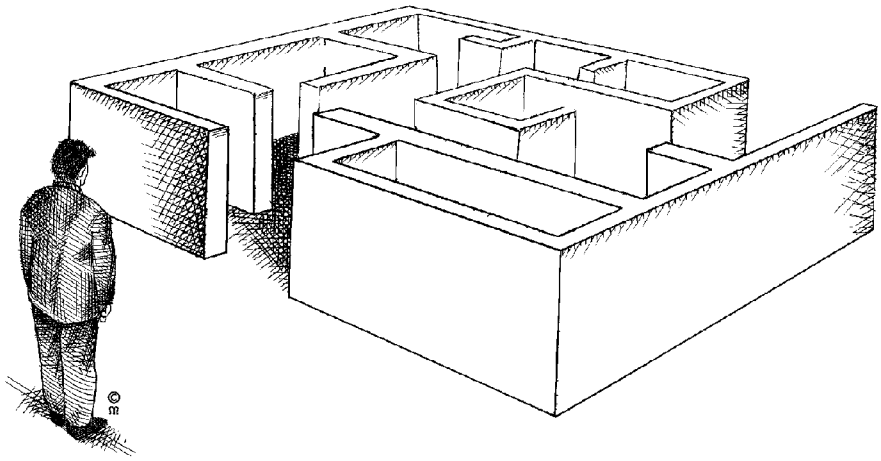
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9/Series Hardware
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Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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