Rockwell Automation
Allen-Bradley

# 9/Series Hardware
# TAB 5

9/440 CNC Systems


852062–RM005A–EN–P – June 2001 PN–198126

Section **5A**

# The 9/440 Resolver–based CNC/Drive System

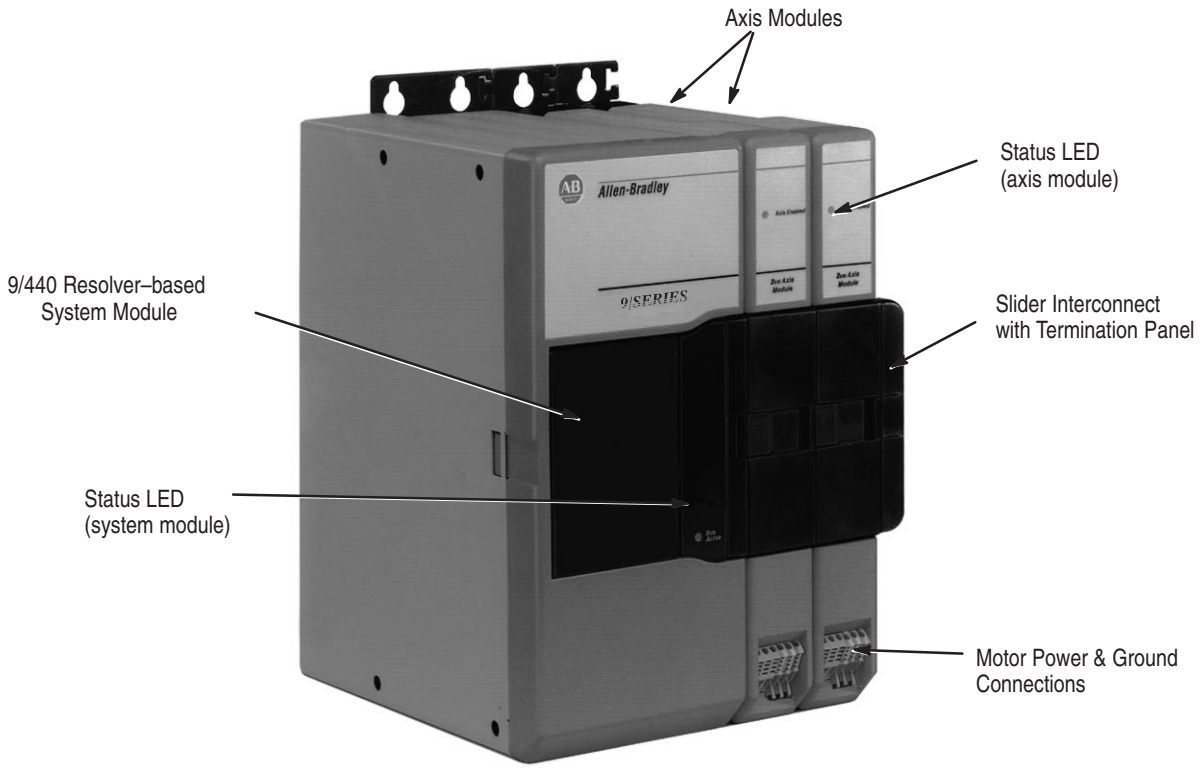
## 5A.0 Section Overview

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:



- 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. The wiring board is available in Series A/B and Series C versions.

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.

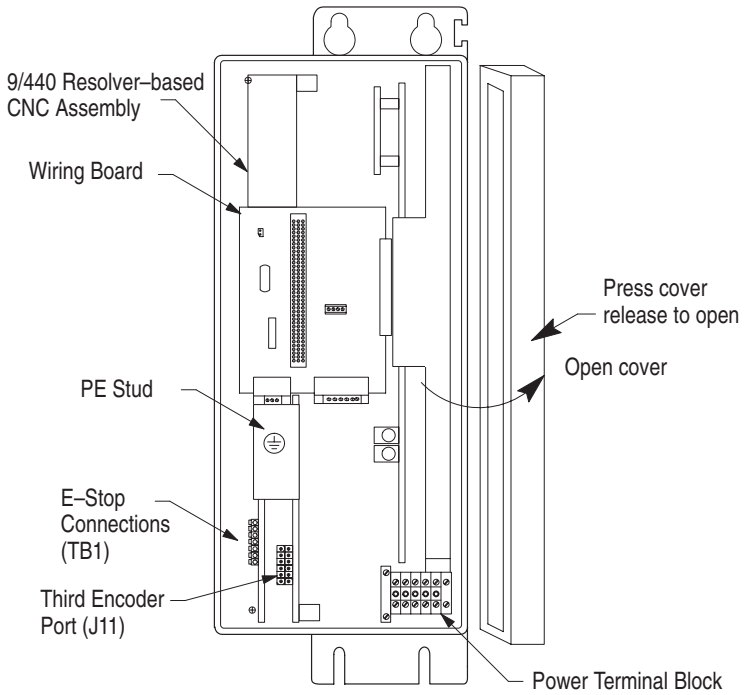
The number of axes supported and the feedback available for these systems is as follows:

| **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 |

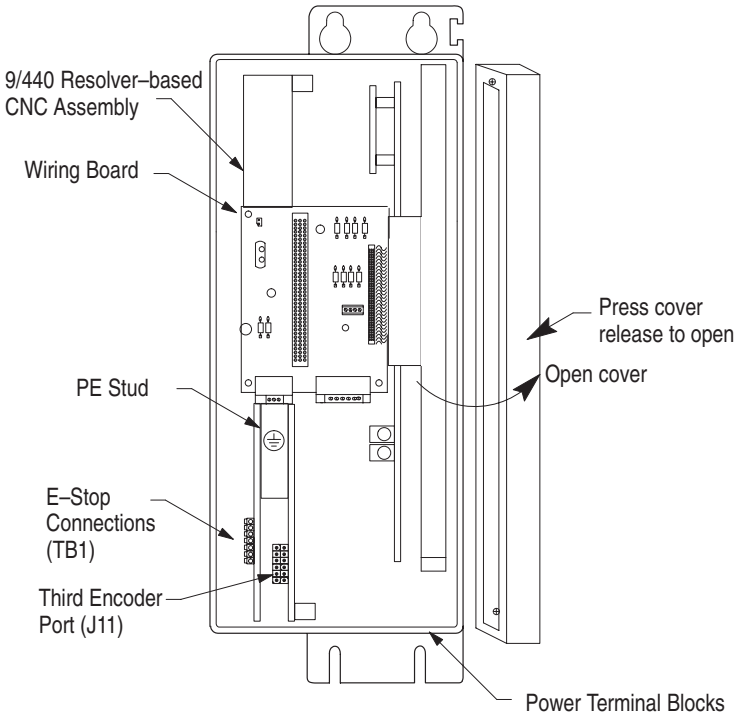
❶ A total of three feedback devices can be connected. If three resolvers are used, then the encoder port (J11) is not available. If the encoder feedback port (J11) is used, then the third resolver feedback (J3) is disabled.

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.

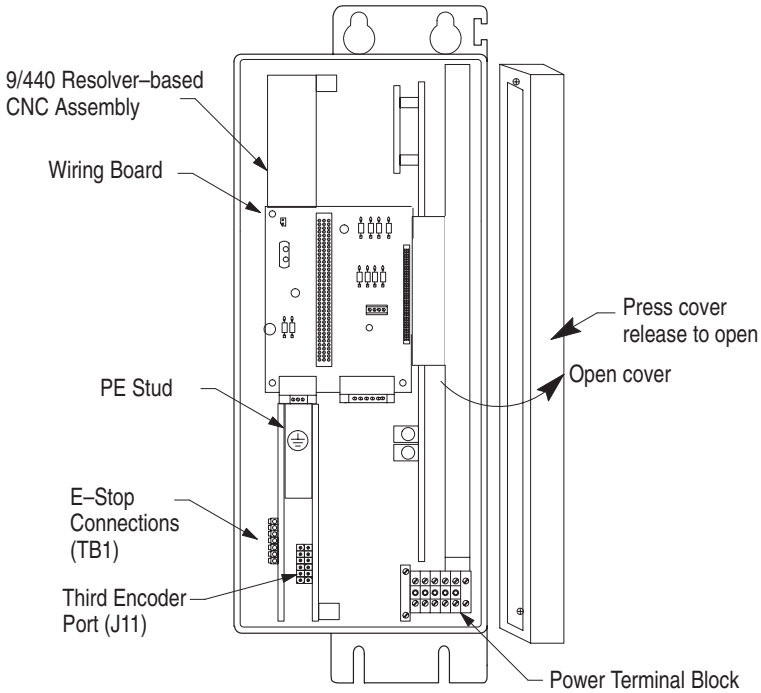
Series A/B 9/440 Resolver–based System Module



Series C 9/440 Resolver–based System Module (5 and 10 kW)




Series C 9/440 Resolver–based System Module (22 kW)




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).

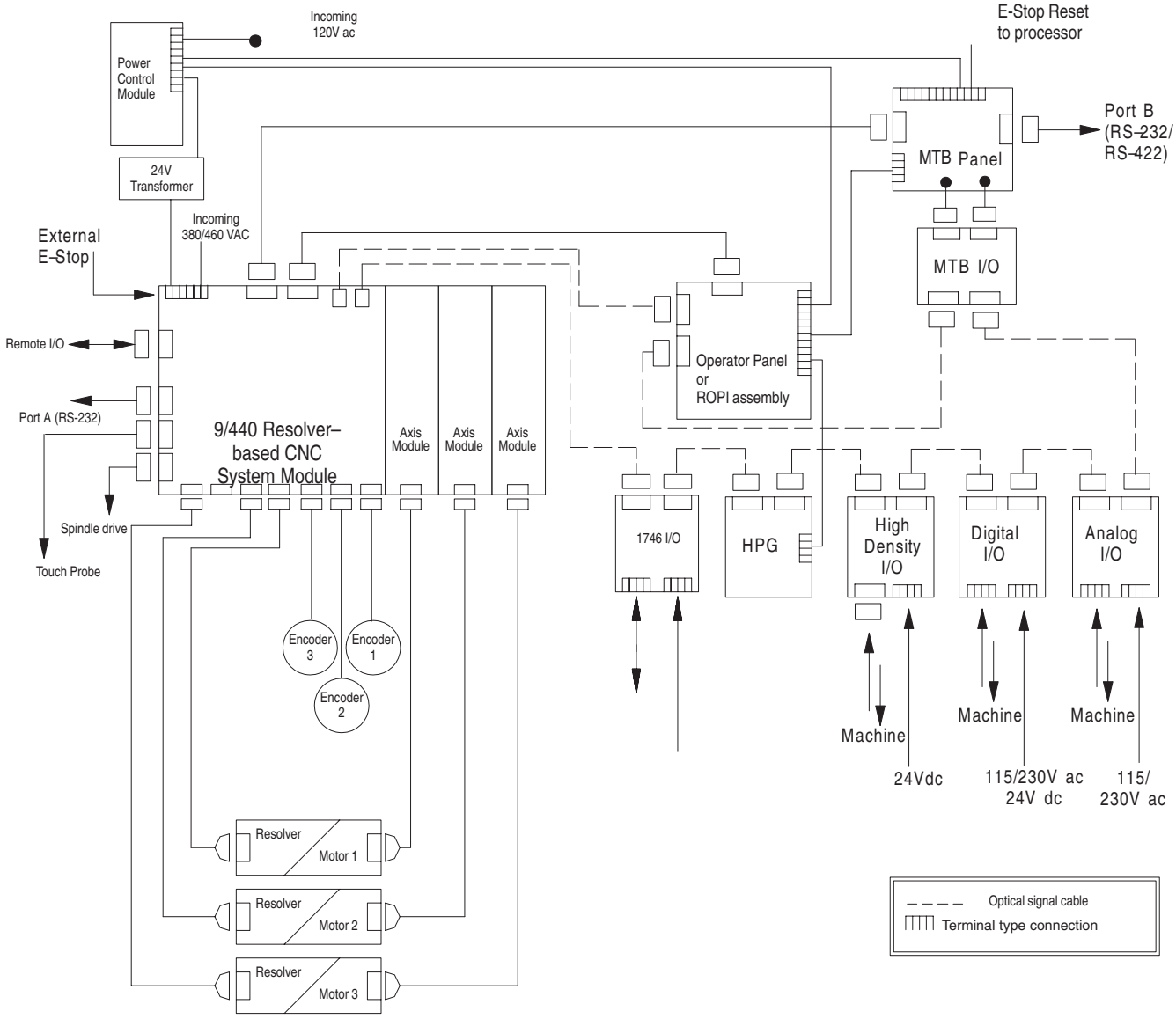
- Axis Module - Connect up to four axis modules to the 9/440 Resolver–based CNC/Drive system (depending on your system module selection). Axis modules convert the dc power supplied by the system module to a variable AC voltage (460V ac input provides 460 AC out, derated 380V ac input provides 380V ac 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.

**Figure 5A.1**
**9/440 Resolver–based System Overview**

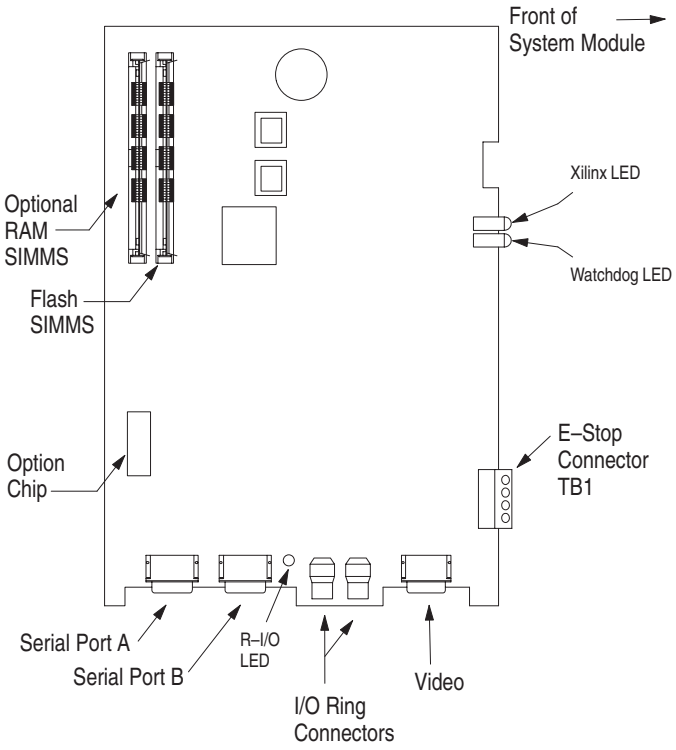


## 5A.2
## CNC Processor Board

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

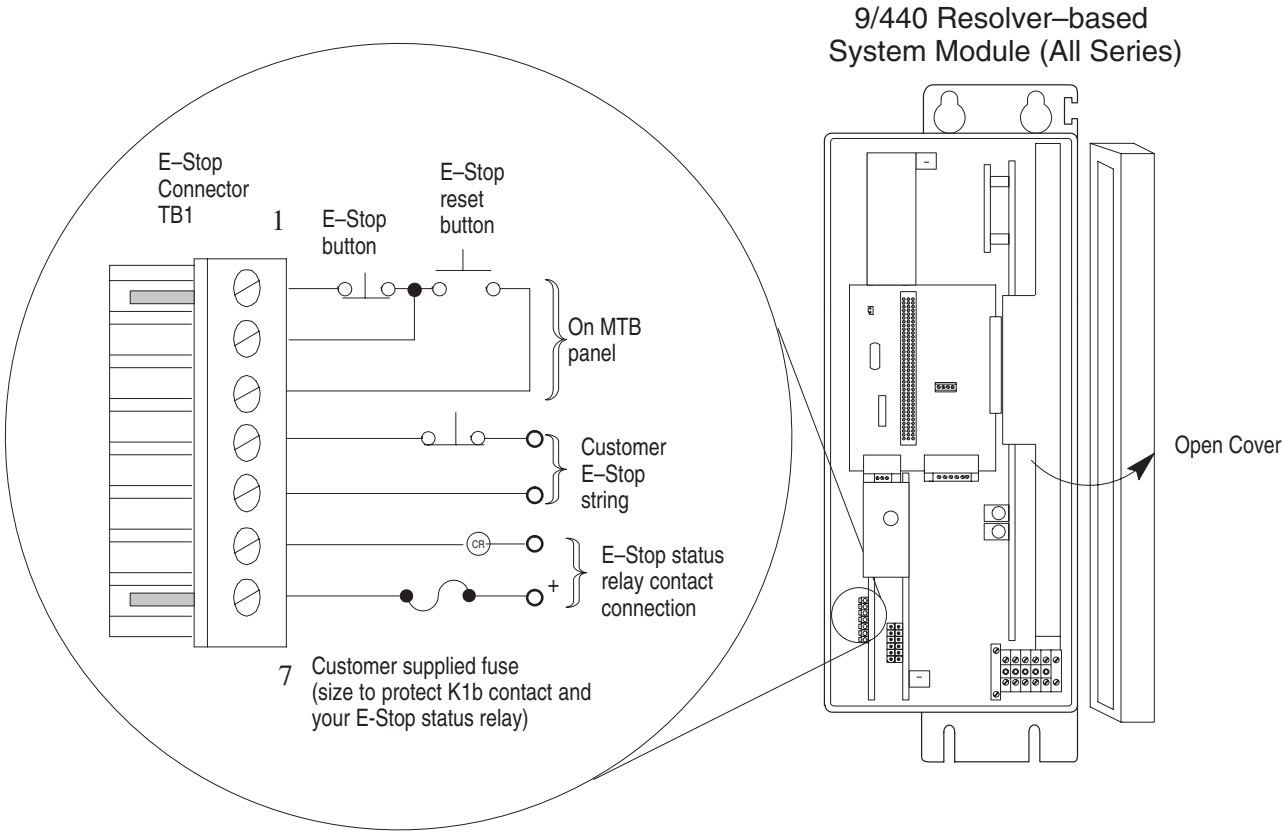
**Figure 5A.2**
**CNC Processor Board**



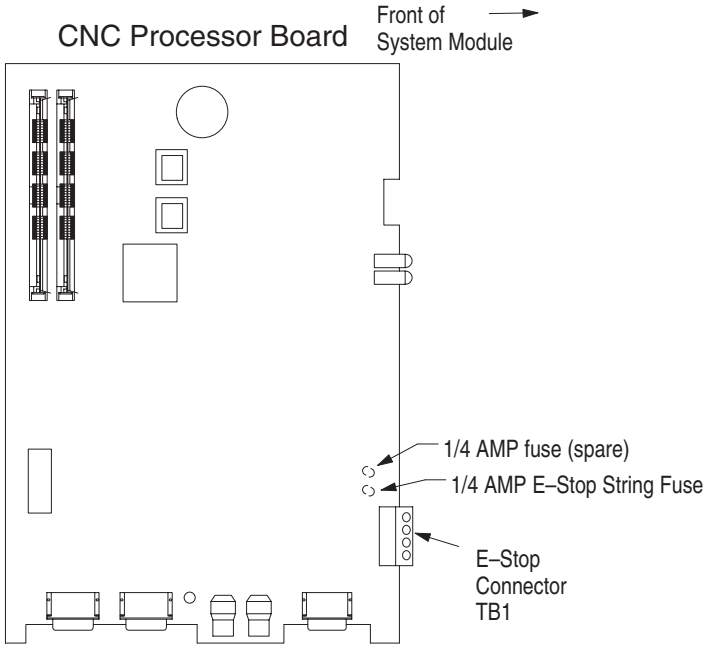
## E–Stop Plug

Connection of the E-Stop string appears in the same location for all series system modules. The following example figure indicates this location. More details on E–Stop connections to the 9/Series are given on page 6-1.

**Figure 5A.1**
**Location of E–Stop Plug (All Series Modules)**



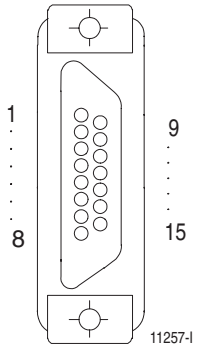
The E–Stop string is a 12V dc string protected by a .25 AMP 115 V fuse located on the 9/440 Resolver–based CNC processor board. You must remove the CNC assembly from the system module to replace this fuse (see page 15B-58 for details).




## 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**

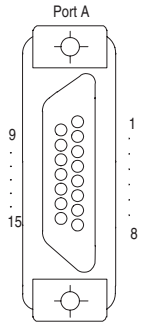



| Pin No. | Signal Name | Pin No. | Signal Name |
|---|---|---|---|
| 1 | GND (SHIELD) | 9 | RED (L) |
| 2 | RED (H) | 10 | GREEN (L) |
| 3 | GREEN (H) | 11 | BLUE (L) |
| 4 | BLUE (H) | 12 | NC |
| 5 | NC | 13 | CLOCK (L) |
| 6 | CLOCK (H) | 14 | H-SYNC (L) |
| 7 | H-SYNC (H) | 15 | V-SYNC (L) |
| 8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

## 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**



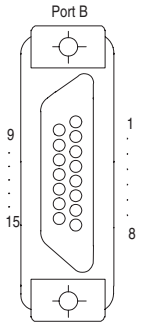

| Pin | Assignment |
|---|---|
| 1 | Chassis GND |
| 2 | Send Data |
| 3 | Receive Data |
| 4 | Request to Send |
| 5 | Clear to send |
| 6 | No connection |
| 7 | Signal GND |
| 8-15 | Not Used |

## 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.

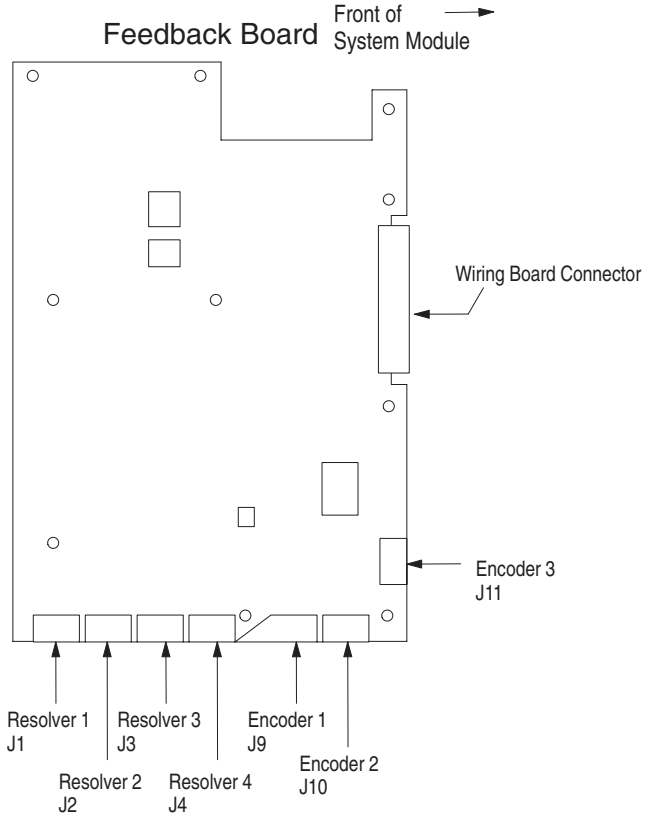
**Figure 5A.3**
**Port B-J7 (has pin sockets) and Pin Assignments**




| 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 | | |

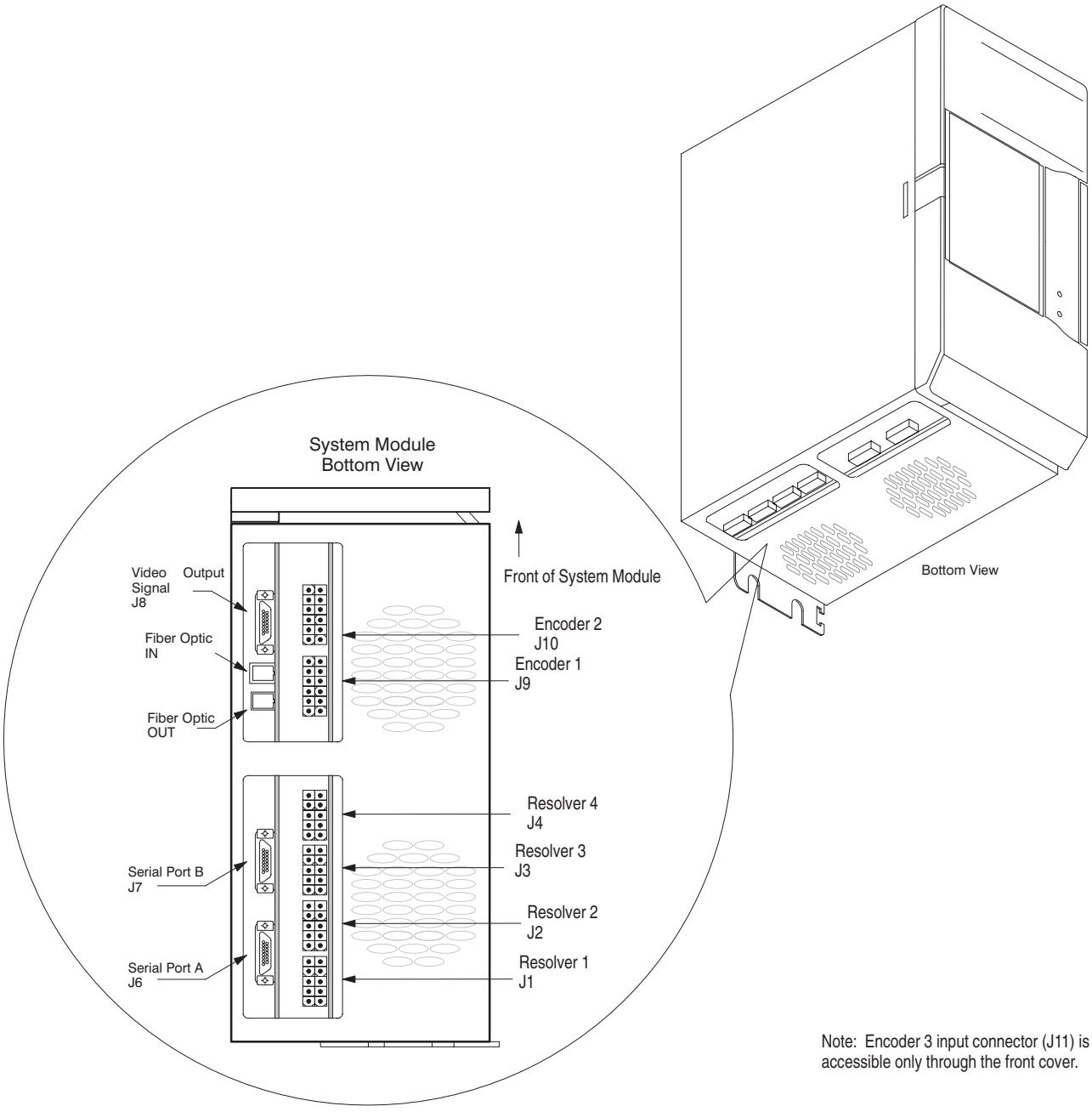
## 5A.3 Connecting Feedback

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.



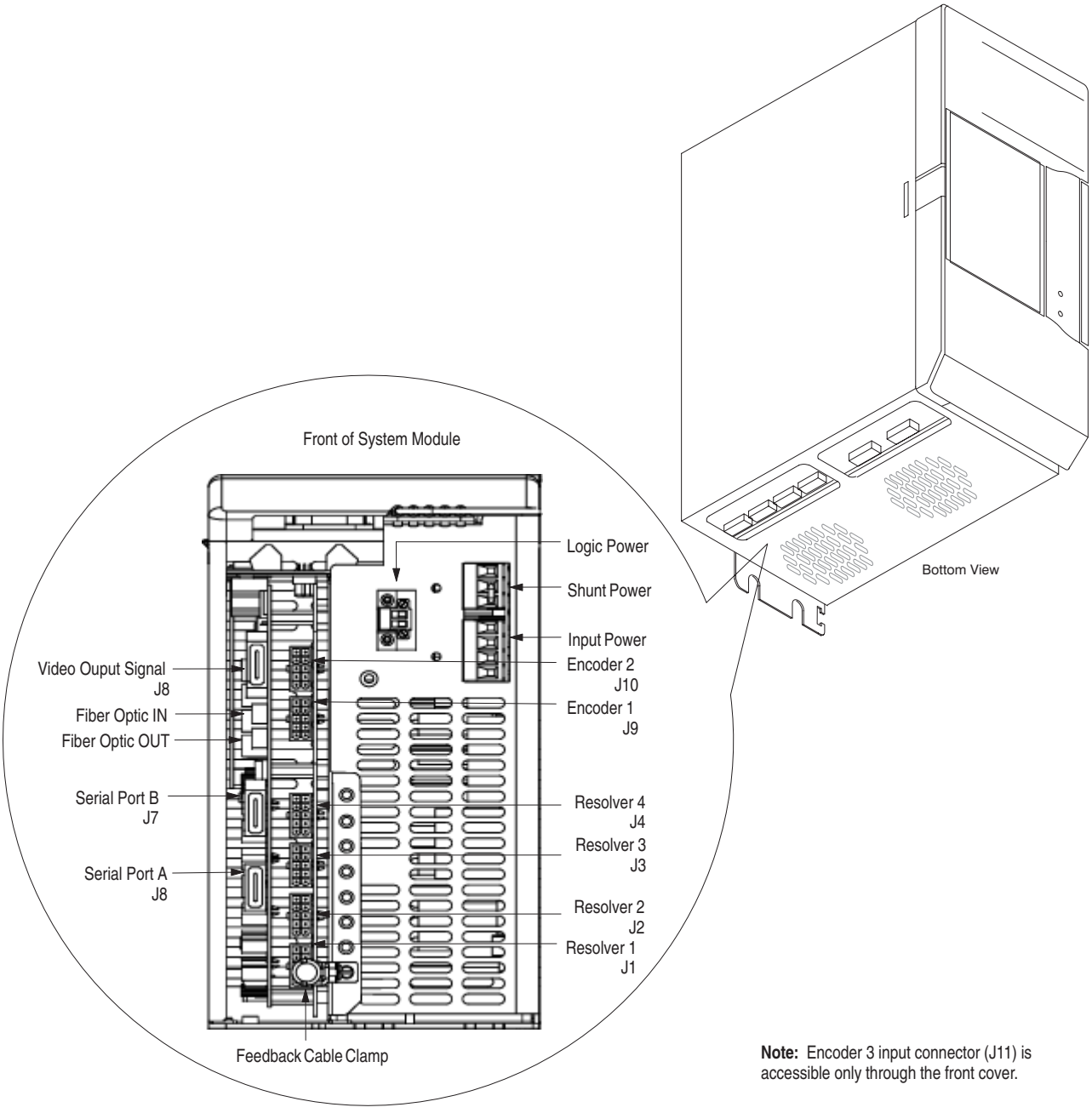
**Important:** Each feedback port must be configured in AMP to identify which motor the feedback is from as well as the type, direction, and resolution of the feedback. Refer to your *9/Series CNC AMP Reference Manual* for details.

**Figure 5A.4**
**Bottom View of System Module (Series A/B)**



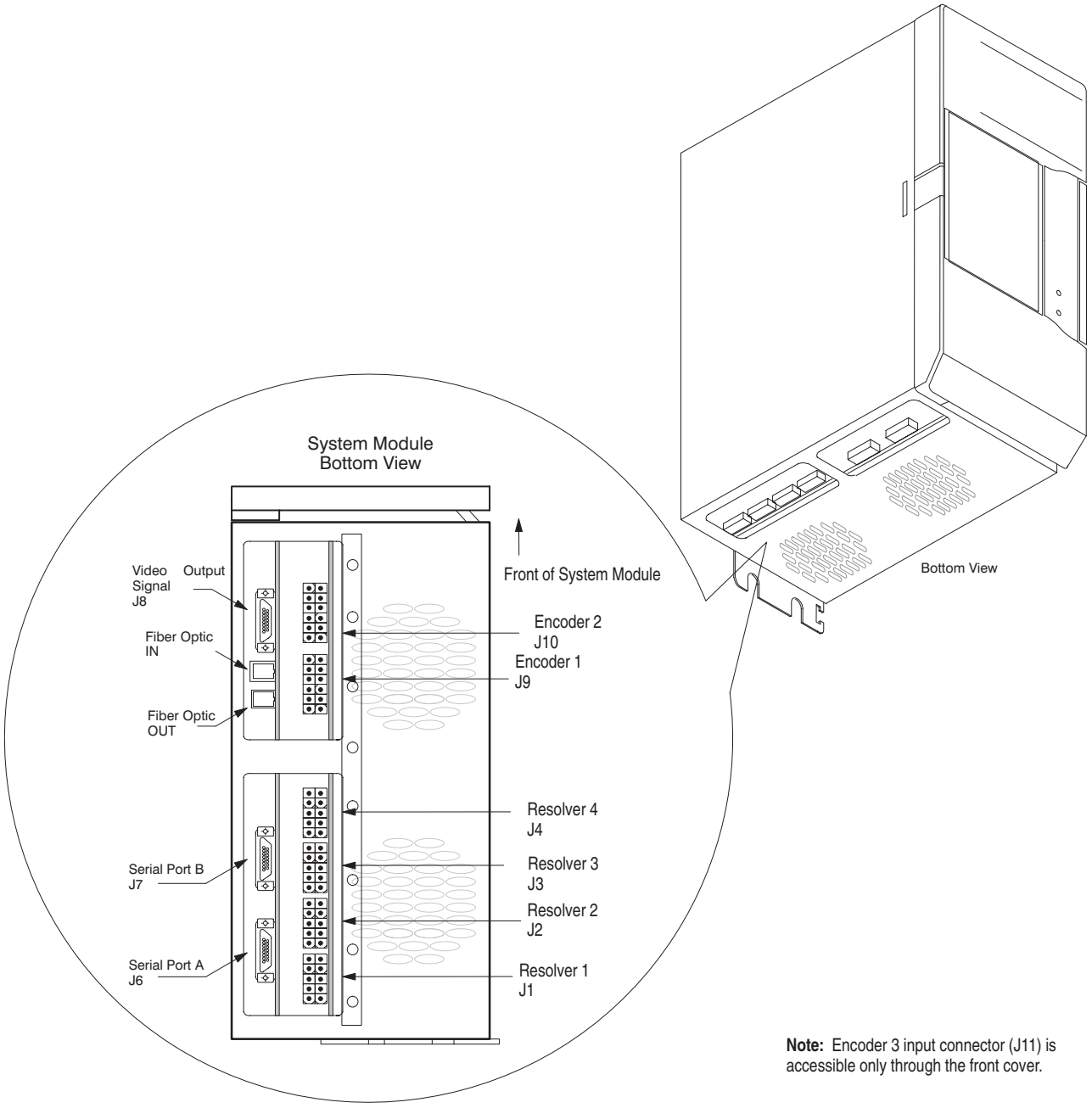

Note: Encoder 3 input connector (J11) is accessible only through the front cover.

**Figure 5A.5**
**Bottom View of System Module (5 and 10 kW Series C)**




**Note:** Encoder 3 input connector (J11) is accessible only through the front cover.

**Figure 5A.6**
**Bottom View of System Module (22 kW Series C)**




**Note:** Encoder 3 input connector (J11) is accessible only through the front cover.

### Maximum Axis Speeds

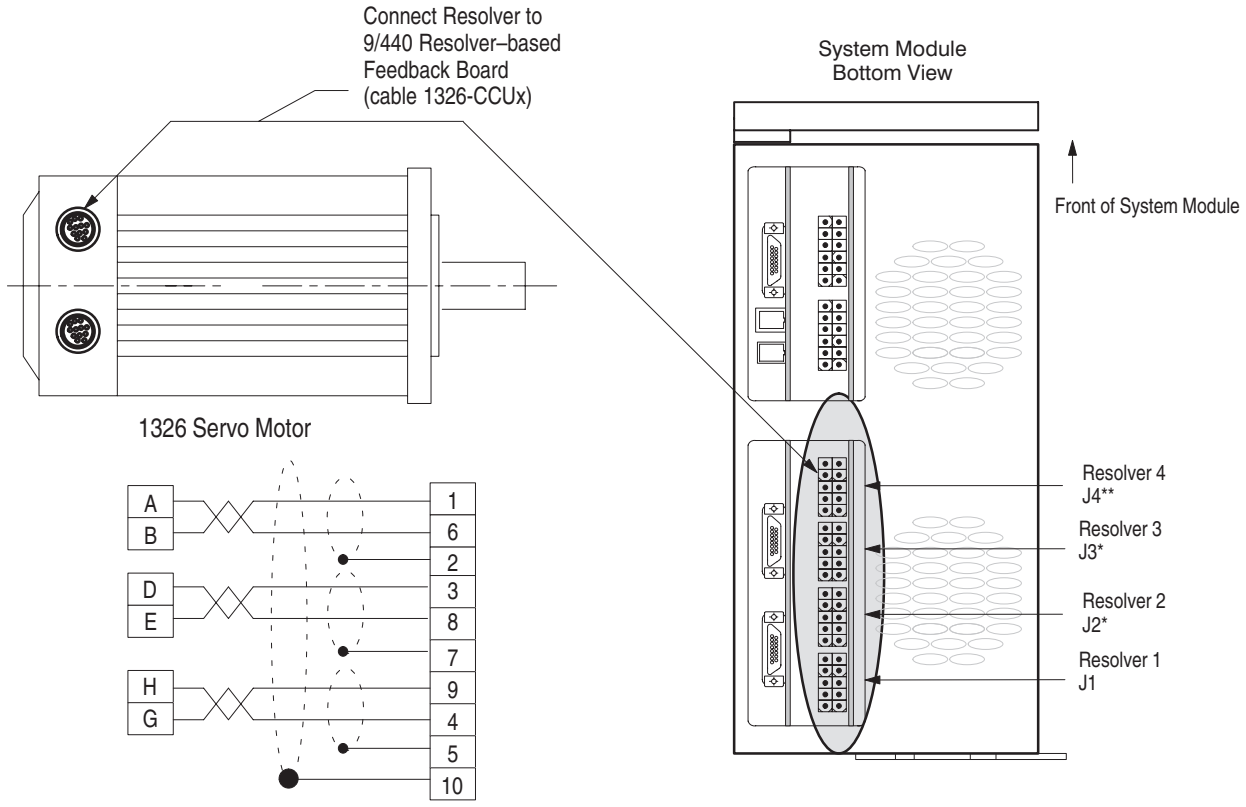
Axis feedback resolution (for 1326 motor resolvers) is selected in AMP to be either 8192 counts/rev or 32768 counts/rev. The maximum motor RPM when set for 8192 counts/rev is 6000 RPM. The maximum motor RPM when set for 32768 counts/rev is 3000 RPM. Actual final axis speed is based on gearing and lead 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).

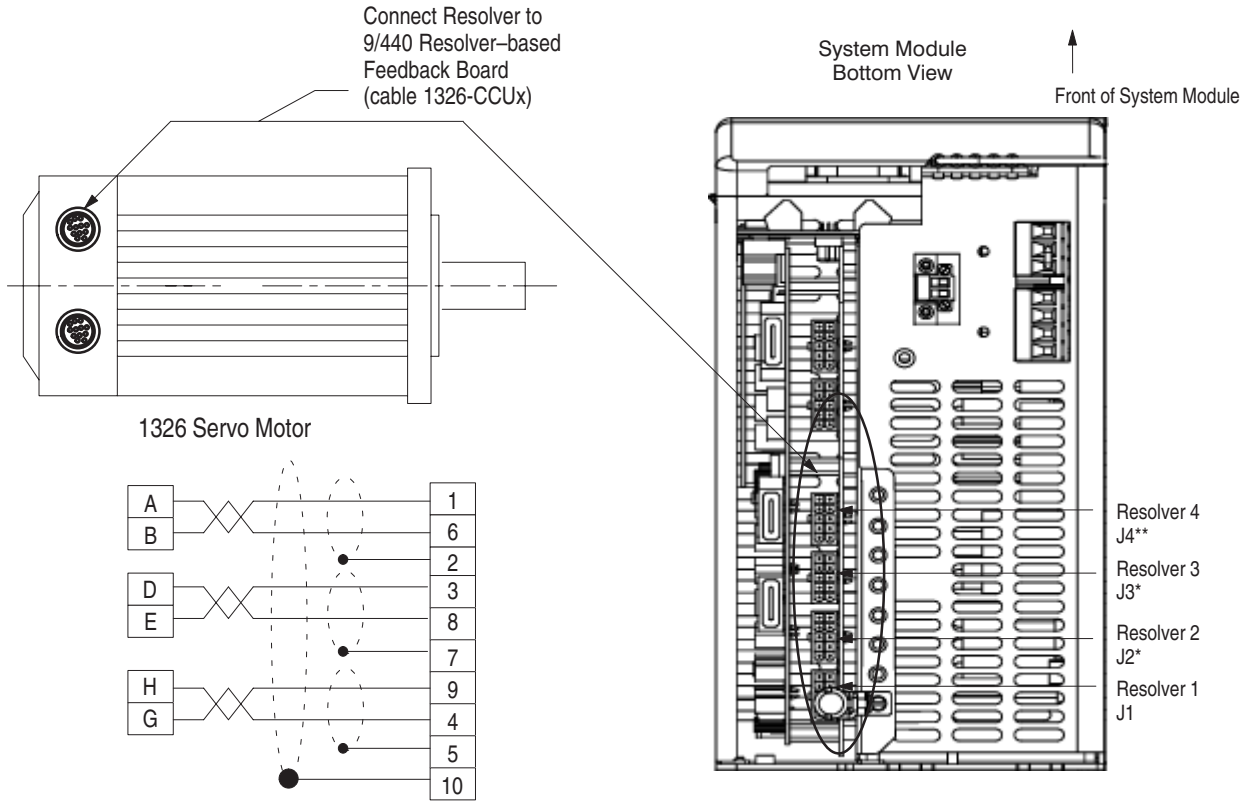
**Figure 5A.7**
**Connecting Resolver Feedback (Series A/B)**




* not available on 1–axis 9/440 Resolver–based (cat 8520-1Sx) system

** not available on 1–axis 9/440 Resolver–based (cat 8520-1Sx) and 3–axis 9/440 Resolver–based (cat 8520-3Sx) systems

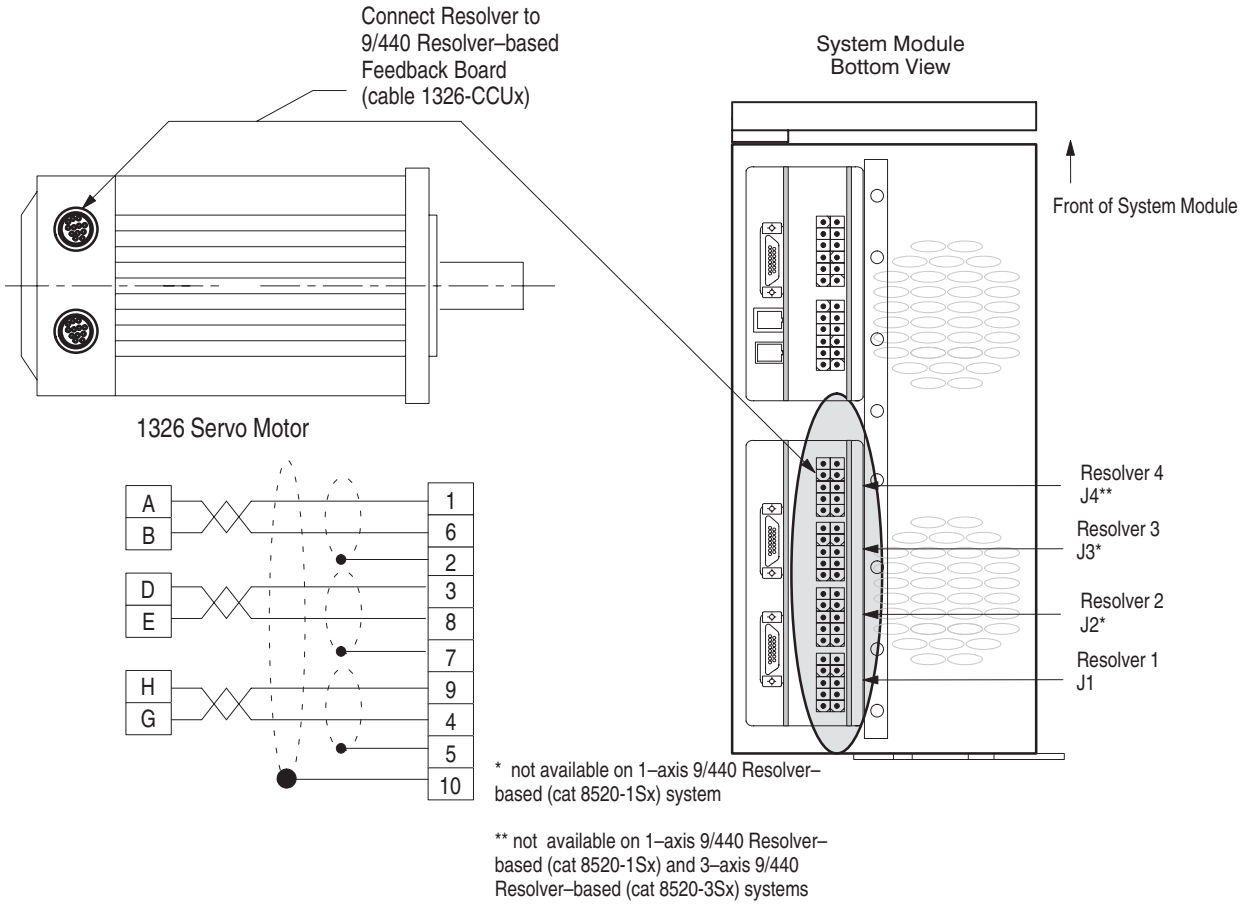
**Figure 5A.8**
**Connecting Resolver Feedback (5 and 10 kWSeries C)**




* not available on 1–axis 9/440 Resolver–based (cat 8520-1Sx) system

** not available on 1–axis 9/440 Resolver–based (cat 8520-1Sx) and 3–axis 9/440 Resolver–based (cat 8520-3Sx) systems

**Figure 5A.9**
**Connecting Resolver Feedback (22 kWSeries C)**




**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-21 for details.

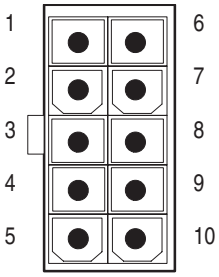



**Figure 5A.10**
**Pin Configuration for the Resolver Connectors on the 9/440 Resolver–based CNC/Drive**

| 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 | |

## Wiring Motor Power, Thermals, and Brakes

The procedures in this section assume that your system and axis modules are already mounted. We recommend that you start at either the first or last axis module, wire it completely, and then wire the module next to it completely, and so on until they are all wired.

To wire your 1394 axis:

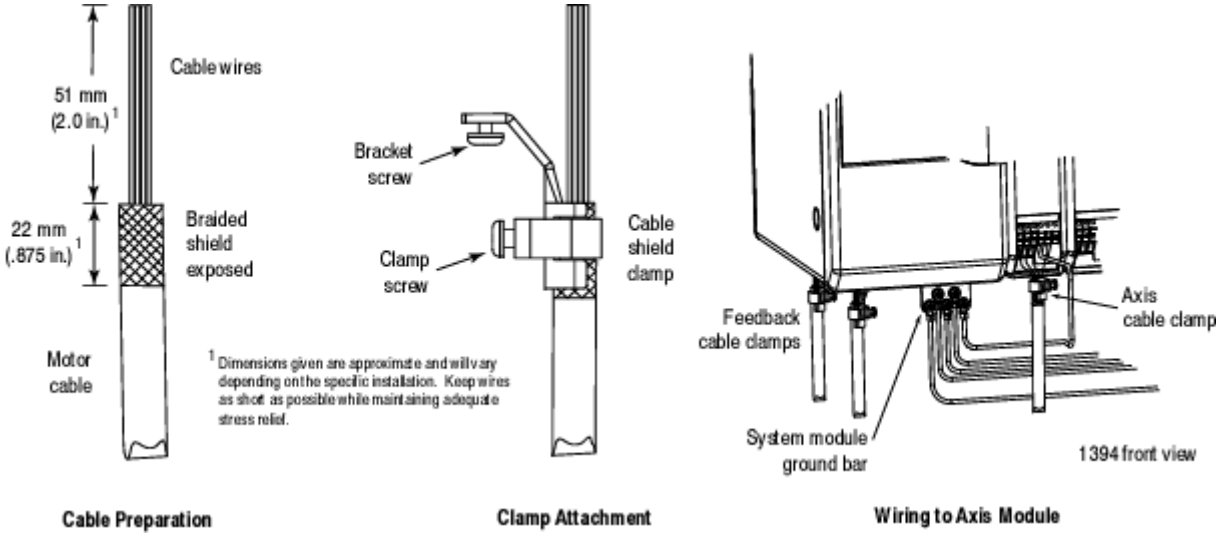
**1.**

| If you have this type of system module: | then: |
|---|---|
| Series A or B | 1. Bond one end of the axis module ground wire to the subpanel.<br>2. Connect the other end of the ground wire to terminal block PE1.<br>3. Go to main step 7. |
| Series C | 1. Connect one end of the axis module ground wire to the system module ground bar.<br>2. Connect the other end of the ground wire to terminal block PE1.<br>3. Go to main step 2. Refer to Figure 5A.11 for main steps 2 – 6. |

**Important:** For more information about bonding, refer to your 1394 documentation.

**Important:** To improve the bond between the motor cable shield and the axis module PE ground, a cable shield clamp is included with the Series C axis modules.

**Figure 5A.11**
**Series C Axis Module Cable Clamp**




**Cable Preparation** **Clamp Attachment** **Wiring to Axis Module**

**2.** Prepare one end of the motor cable for attachment to the cable shield clamp by removing the outer installation and braided shield from the motor cable. Ensure approximately 51 mm (2.0 in.) of the insulated cable wires are exposed (see Figure 5A.11).

**3.** Remove another 22 mm (0.875 in.) of insulation to expose the braided shield underneath for clamp attachment.

**Important:** When cutting into the insulation, use care not to cut into the braided shield underneath.

**4.** Position the cable shield clamp over the exposed braided shield (ensure clamp screw is behind clamp and not braided shield).

**5.** Tighten the clamp screw.

**Important:** Do not overtighten the clamp screw or damage to the braided shield may result.

**6.** Thread the bracket screw into the bottom of the axis module and tighten.

**7.** Connect an axis module connector kit (catalog number 1394–199) to each motor cable that you will use. Refer to the instructions included with the kit for the specific connections.

**8.** On one axis, connect the wires as follows:

| Insert the wire labeled: | into terminal block: |
|---|---|
| 1 | U1 |
| 2 | V1 |
| 3 | W1 |
| 8 | PE2 |
| bare wire (no label) | PE3[1] |
| [1]Applicable to Series A and B only. For Series C modules, the bare wire is replaced by the cable shield clamp on the motor cable. | |

**9.** Tighten and torque all five screw terminals to the values in the following table.

| Axis Module (kW) | Terminal Block Designator | Terminal Block Torque |
|---|---|---|
| 2, 3, and 5 | All | 0.56 – 0.62 N–m<br>(5.0 – 5.6 lb–in.) |
| 10 and 15 | All | 1.55 – 2.0 N–m<br>(14.0 – 18.0 lb–in.) |

**10.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten each loose wire.

**11.** Connect the brake and terminal switch connector to the front–most mating half (TB1) under its axis module. Refer to your 1394 documentation for information about thermal switch interconnections.

**12.**

| If your motor... | then do the following... |
|---|---|
| has the brake option | 1. Connect the appropriate control wires to the second connector in the axis module connector kit to the appropriate cable.<br>2. Insert the connector in the rear–most mating half (TB2) for its axis.<br>3. Go to main step 13. |
| does not have the brake option | Go to main step 13. |

**13.** Wire your thermal switch into the appropriate control circuitry for monitoring purposes. Refer to your 1394 documentation for information about thermal switch interconnections.

**ATTENTION:** To avoid damage to your motor, monitor the thermal switch for overheat conditions.

**14.**

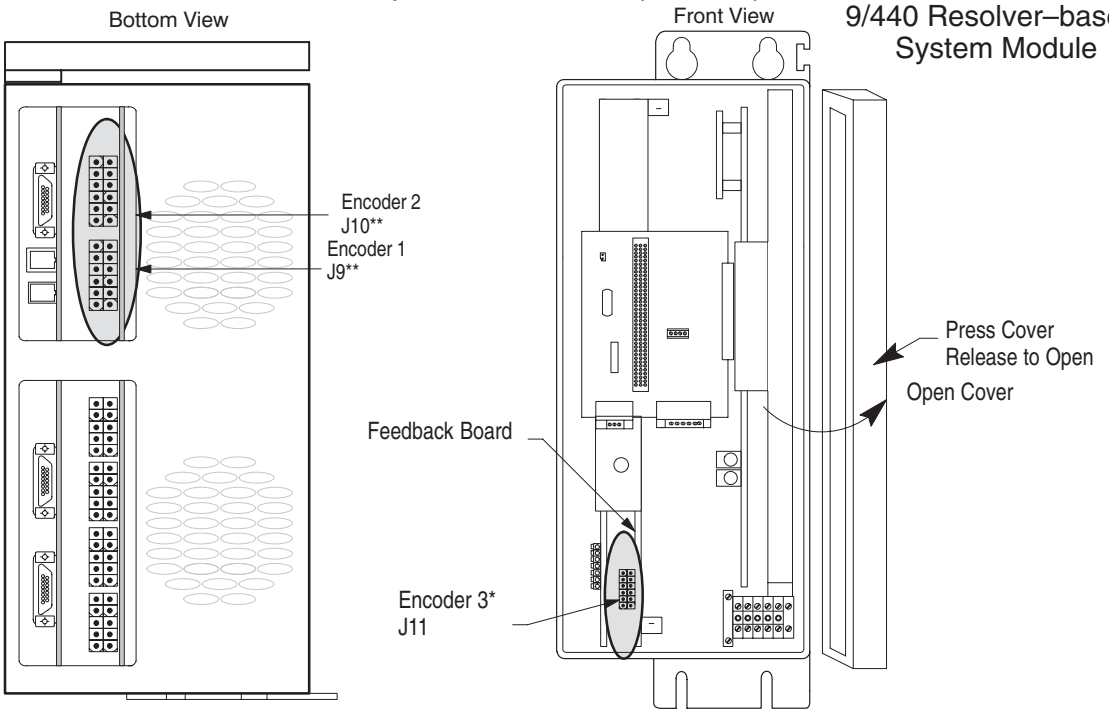
| If you have: | then: |
|---|---|
| more axis modules to wire | move to the next axis module and move to main step 2. |
| wired all of your axis modules | refer to your 1394 system documentation. |

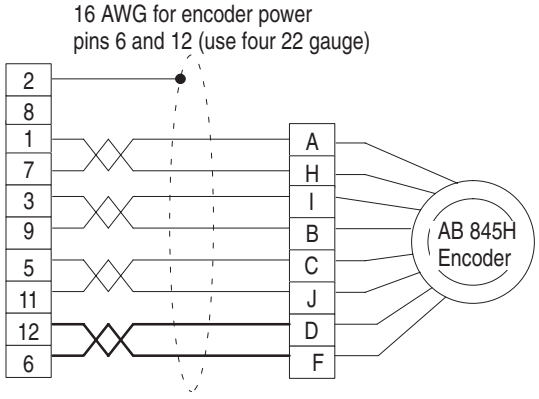
## 5A.3.2 Encoder Feedback (Optional Feedback)

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.

**Figure 5A.12**
**Optional Feedback Ports (Series A/B)**



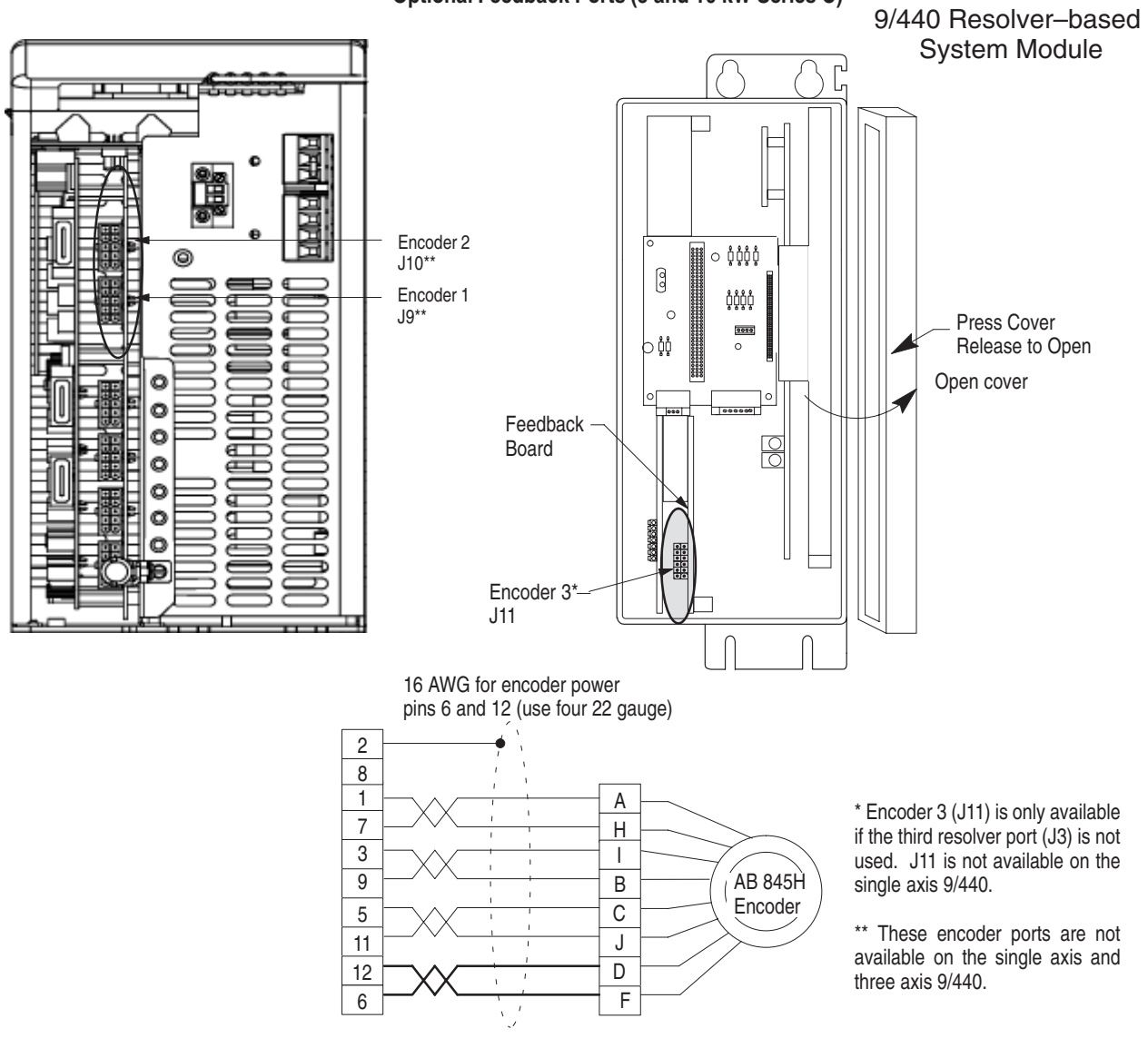




Refer to page 7A–60 for details on making this cable.

* 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.

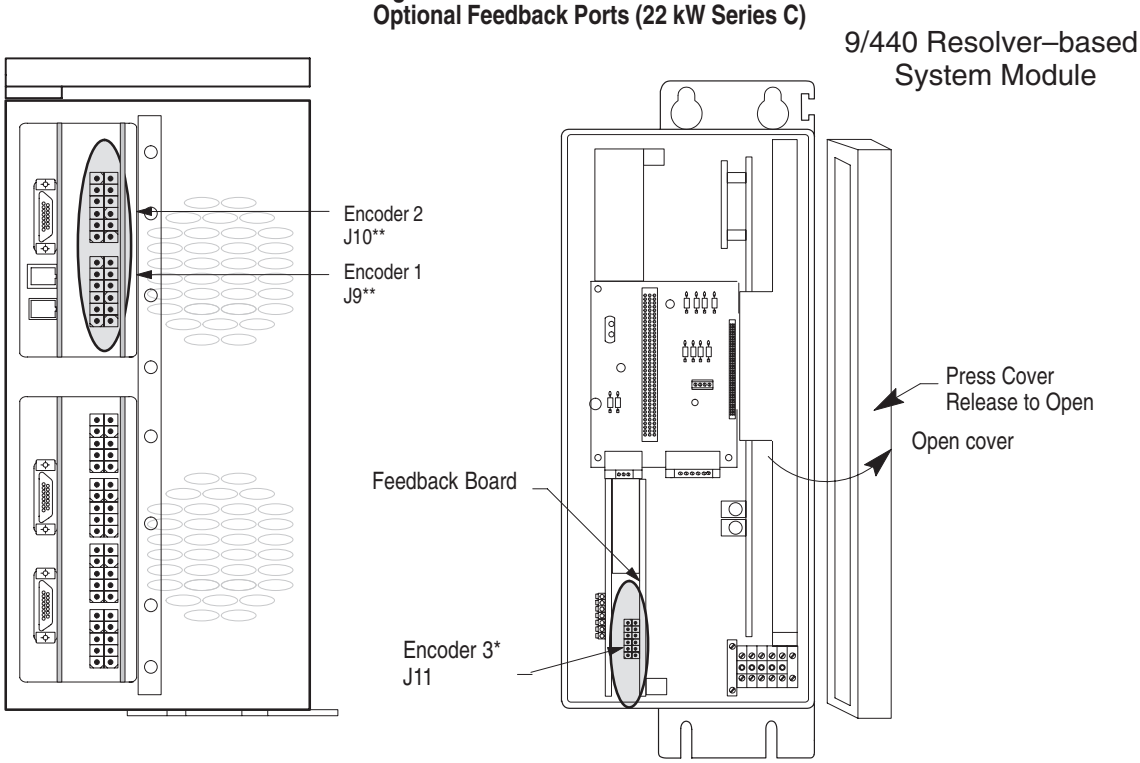
**Figure 5A.13**
**Optional Feedback Ports (5 and 10 kW Series C)**

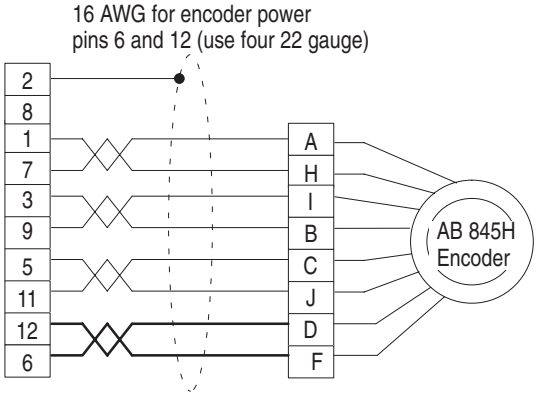



* Encoder 3 (J11) is only available if the third resolver port (J3) is not used. J11 is not available on the single axis 9/440.

** These encoder ports are not available on the single axis and three axis 9/440.

**Figure 5A.14**
**Optional Feedback Ports (22 kW Series C)**



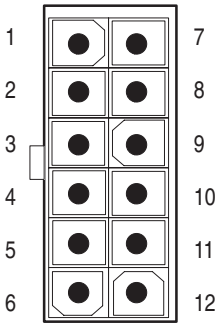




* Encoder 3 (J11) is only available if the third resolver port (J3) is not used. J11 is not available on the single axis 9/440.

** 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.

**Figure 5A.15**
**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.

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.A. Refer to the *9/Series CNC AMP Reference Manual* 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.

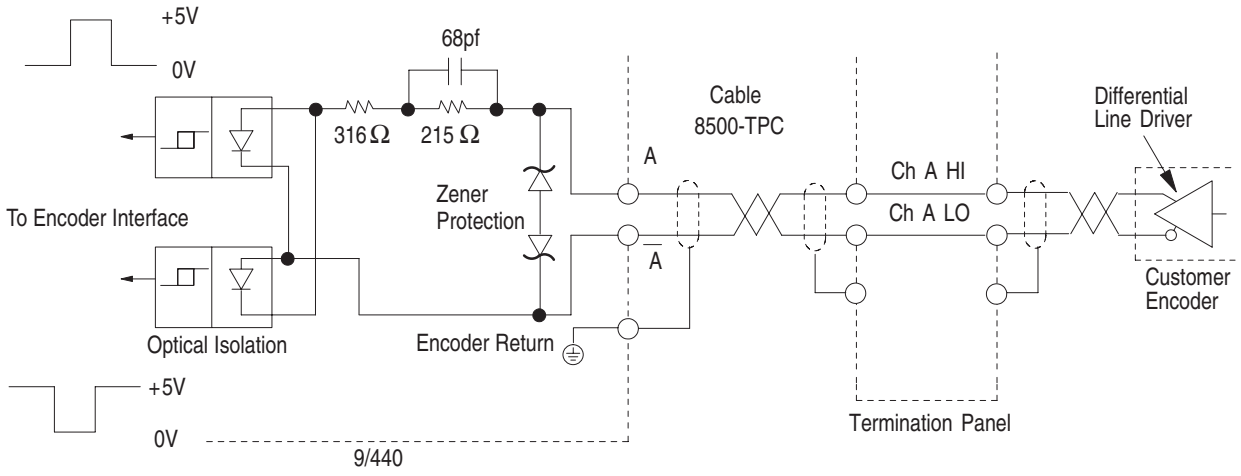
**Table 5A.A**
**Encoder Specifications**

| Item | Specification |
|---|---|
| Maximum Encoder Channel Frequency (ECF) | Use the following equation to determine the maximum channel frequency<br><br>$\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90-Eq}\right)} \times 1.15$<br><br>Where:<br><br>Clock – is the Control's Feedback Clock Frequency:<br>$5 \times 10^6$ – for 9/230, 9/440, and three axis servo cards.<br>$2.3 \times 10^7$ – for 9/260 or 9/290 systems using a four axis servo card<br><br>$E_Q$ = Quadrature Error in Degrees<br><br>1.15 = Our minimum recommended safety factor<br><br>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.<br><br>$\frac{(ECF \times 60)}{(E)(N)(P)} = \text{Maximum Axis Speed}$<br><br>Where:<br><br>Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute)<br><br>ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec.<br><br>E = the number of encoder lines between markers for your encoder<br><br>N = the ratio of encoder turns to ballscrew turns<br><br>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.<br><br>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 |

## Wiring an Incremental Feedback Device

Figure 5A.16 shows an incremental feedback device equivalent circuit for feedback channel A.

**Figure 5A.16**
**Incremental Feedback Device Equivalent Circuit**

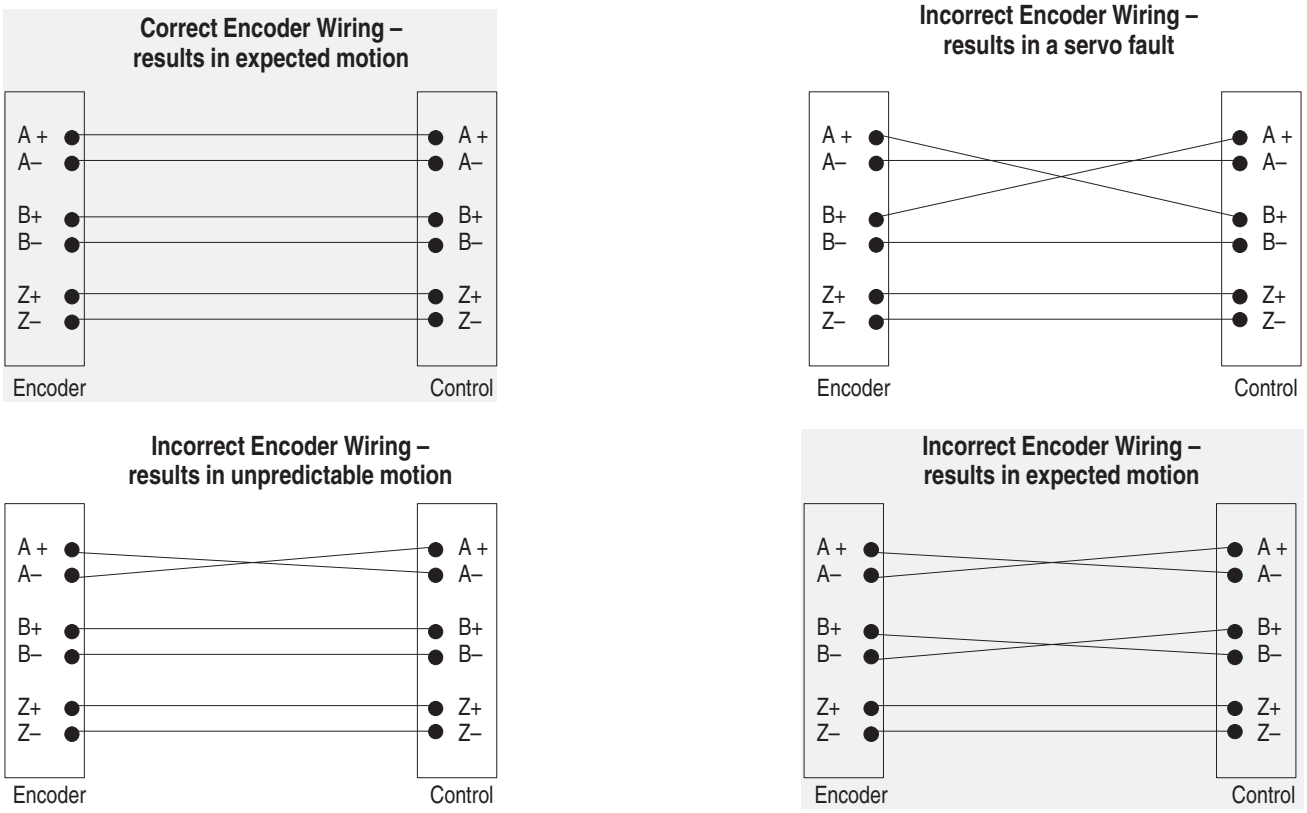



## Wiring Position Feedback

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:

**Figure 5A.17**
**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.

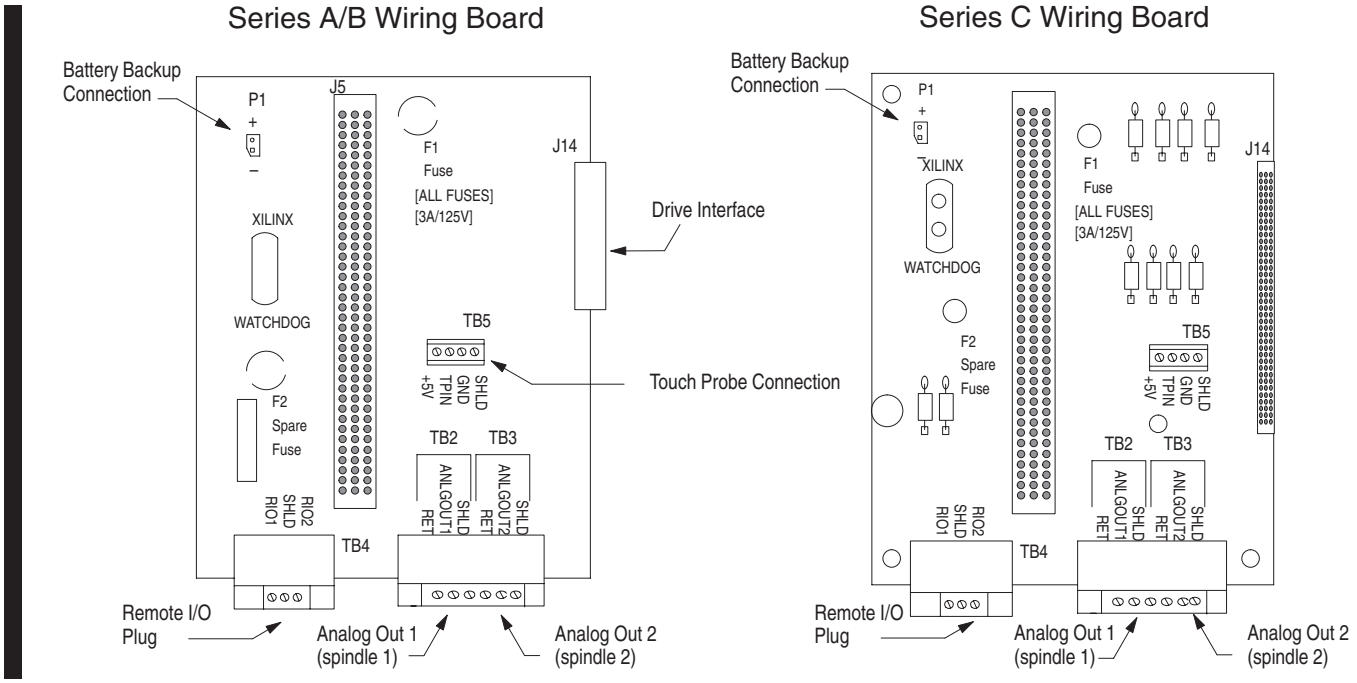
## 5A.4 9/440 Resolver–based CNC Wiring Board

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.

**Figure 5A.18**
**Wiring Board Detail**




## 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.

Location of TB5 on Wiring Board

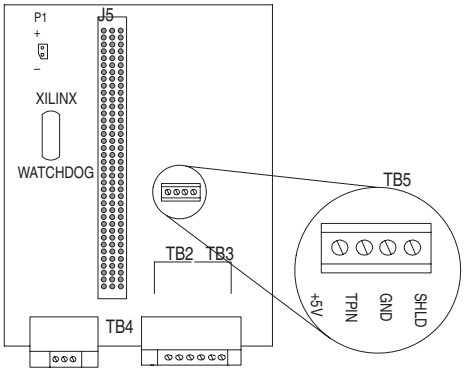



**Table 5A.A**
**TB5 Connector, 4 Plug-type Terminal Block Connections**

| 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.

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.19). Other configurations can be supported as long as the user operates within the published electrical specifications.

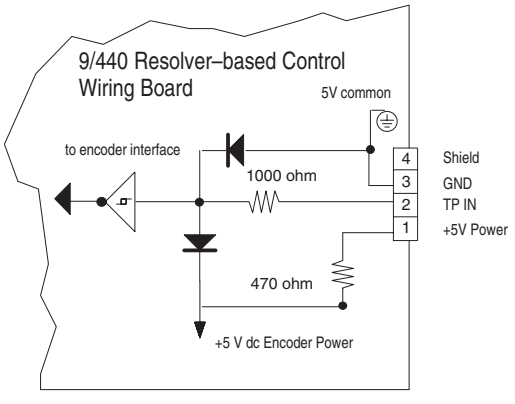
The touch probe circuitry resident on the 9/440 resolver–based control only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the 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* 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 5A.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 5A.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

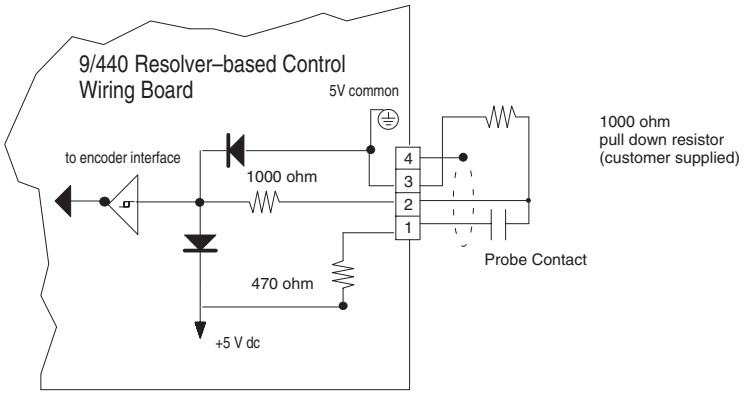
| Probe Thresholds | Voltage at Threshold |
|---|---|
| Minimum Input Threshold (probe circuit) | 3.06 (min) |
| Maximum Input Threshold (probe circuit) | 2.18V dc (max) |

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.20 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

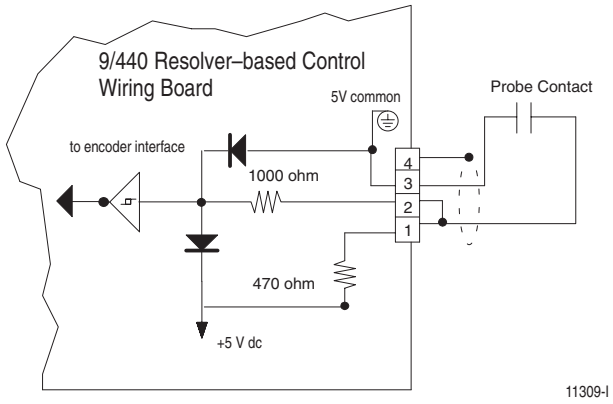
**Figure 5A.20**
**Typical Wiring of a Touch Probe Configured for Rising Edge Trigger**




## Wiring a Probe for Falling Edge Configuration

Figure 5A.21 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

**Figure 5A.21**
**Typical Wiring of a Touch Probe Configured for Falling Edge Trigger**

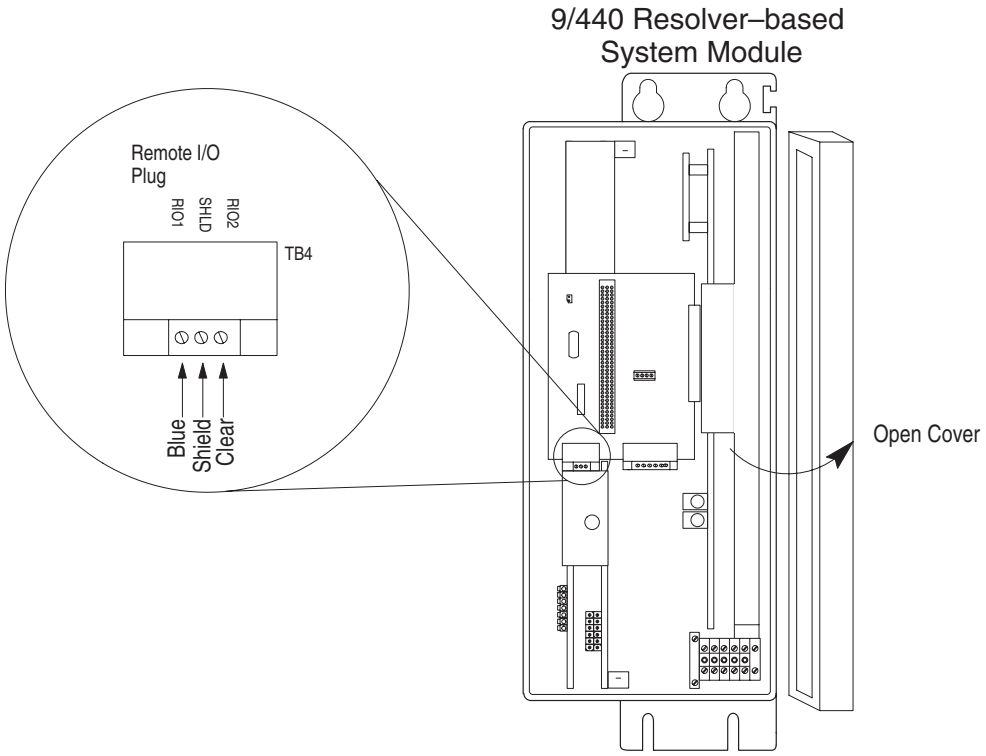


## 5A.4.2 9/440 Resolver–based Control Remote I/O Connection

The remote I/O circuitry and connector are integral parts of the wiring board in the 9/440 resolver–based system module. In all Series, the remote I/O connector is mounted on the 9/440 resolver–based control wiring board. Figure 5A.22 shows this location.

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.

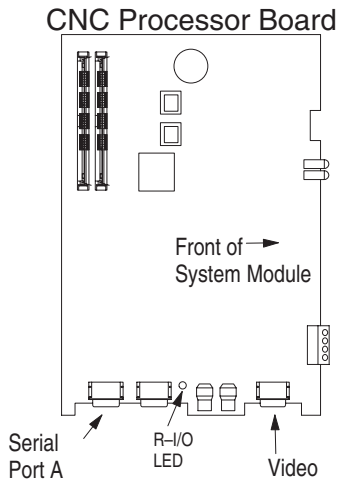
**Figure 5A.22**
**Remote I/O Connector in System Module (All Series)**




### 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.)




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:

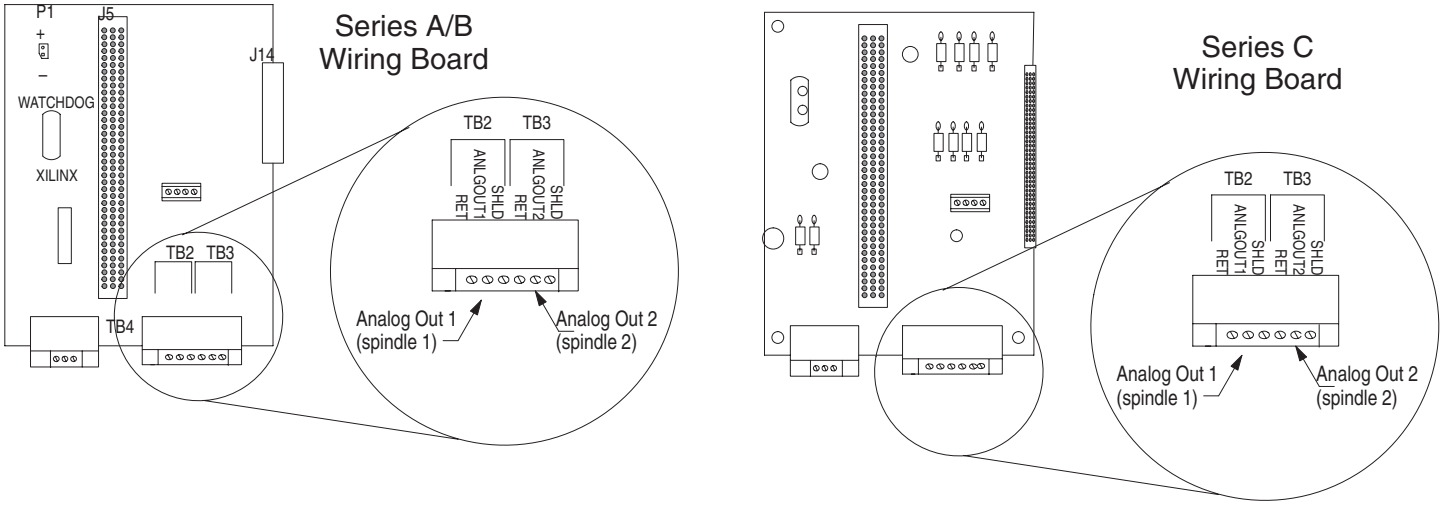
| LED | Status | Description |
|---|---|---|
| **Green R–I/O LED** | ON | Active Link to PLC. This is the normal state when the RIO link is active. |
| | FLASHING | The remote I/O link is active but the PLC is currently in program mode. |
| | OFF | Remote I/O link is offline. The port is not being used, 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.23 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.23**
**Terminal Block TB2 and TB3, Plug-type Terminal Block Connections**



| 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 |

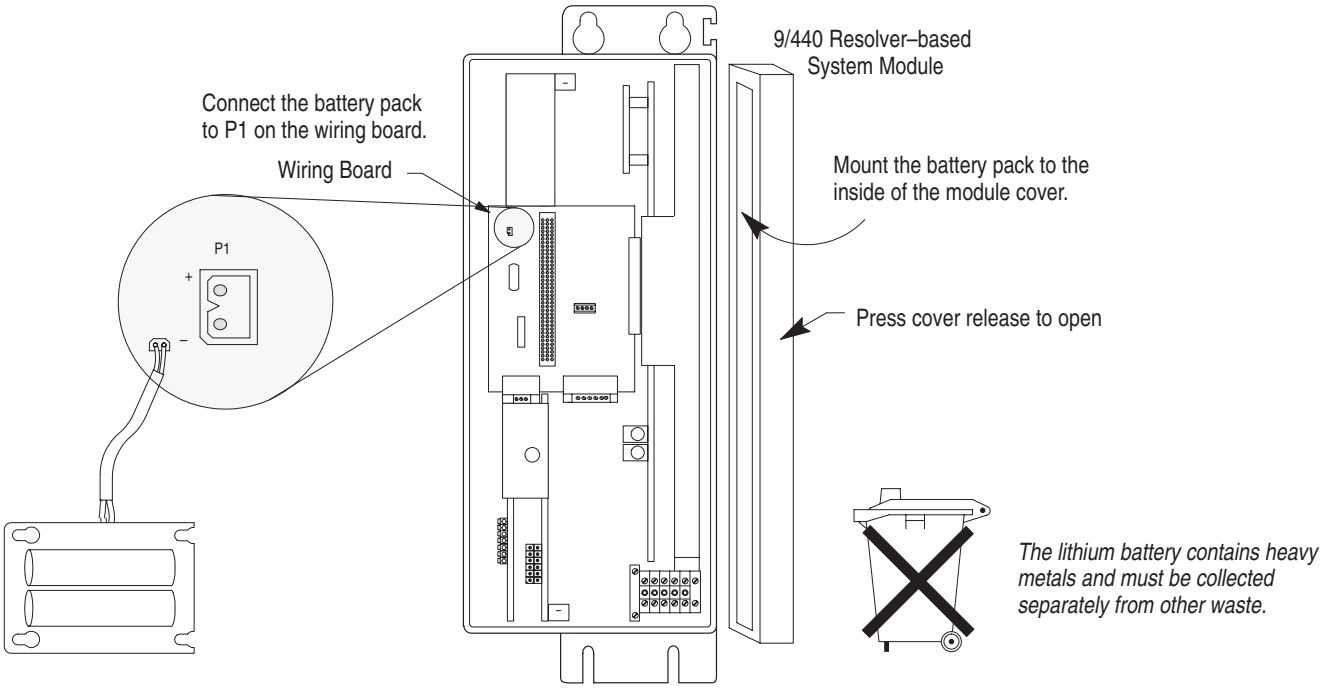
## 5A.4.4 Battery Backup

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 |

For all Series, this battery pack is connected to the lithium battery connector (P1) on the wiring board. See Figure 5A.24 for an example of this location. Batteries and the battery cable are included with the battery replacement kit.

**Figure 5A.24**
**Lithium Battery (All Series)**



## 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 24V ac or 24V 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 324-528V 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. | |

**Figure 5A.25**
**Power Terminal Block (Series A/B)**

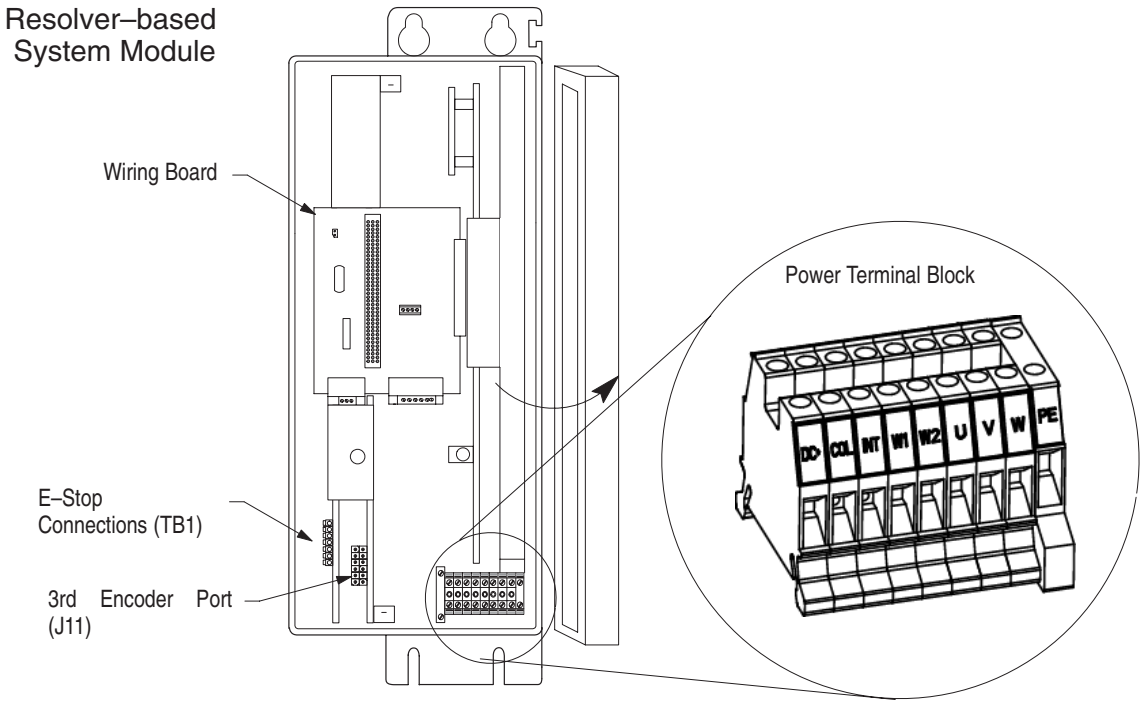
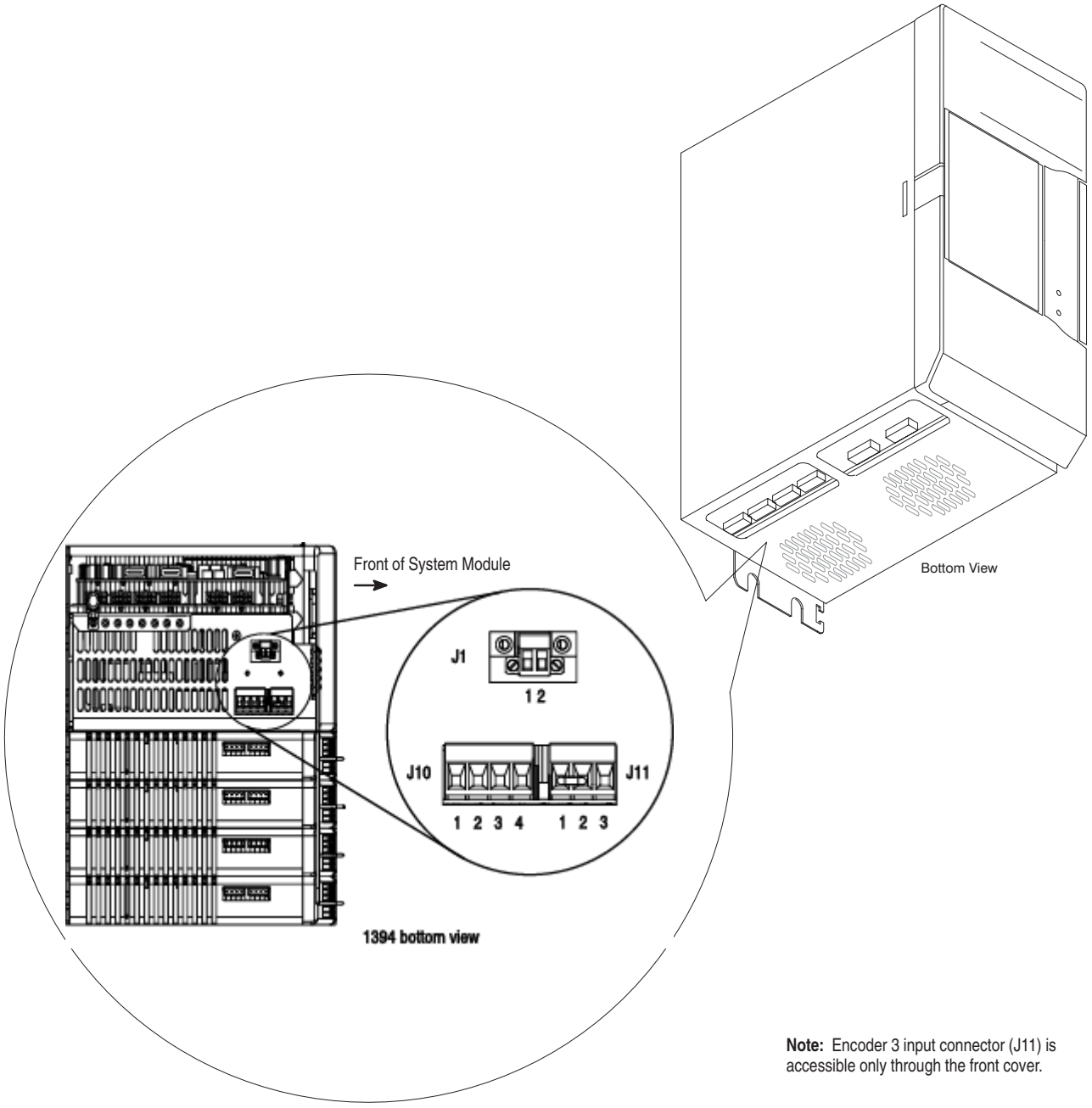
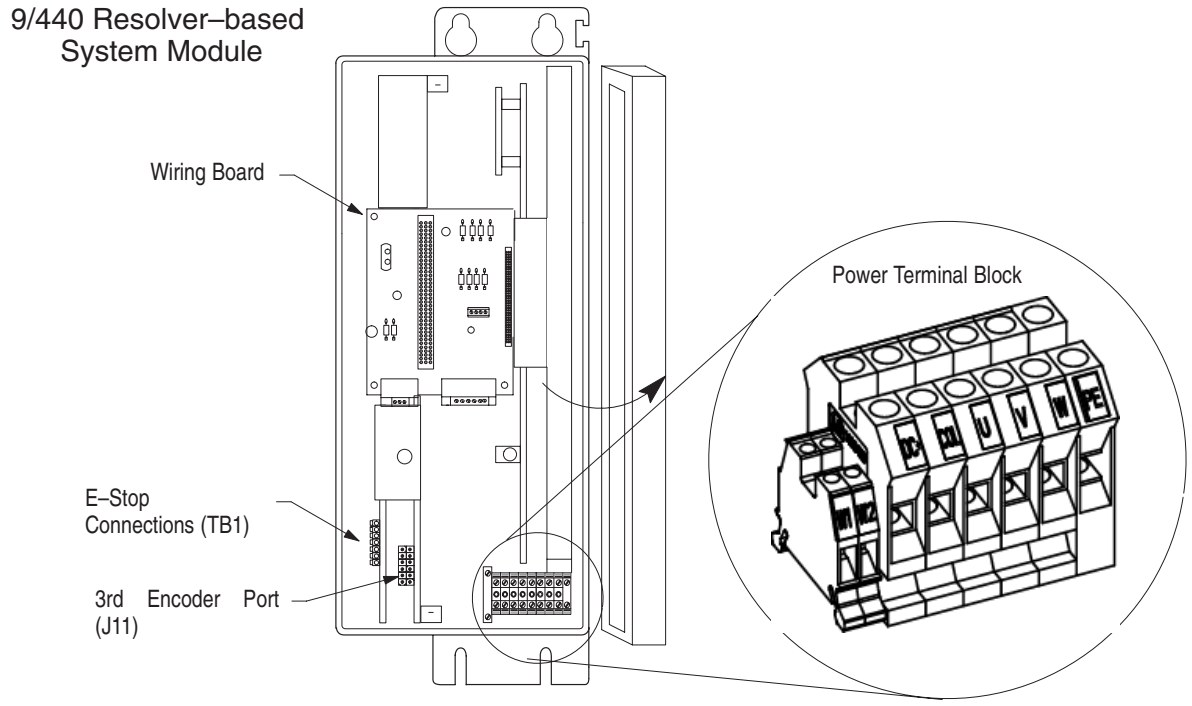


**Figure 5A.26**
**Power Terminal Blocks (5 and 10 kW Series C)**




**Note:** Encoder 3 input connector (J11) is accessible only through the front cover.

**Figure 5A.27**
**Power Terminal Block (22 kW Series C)**



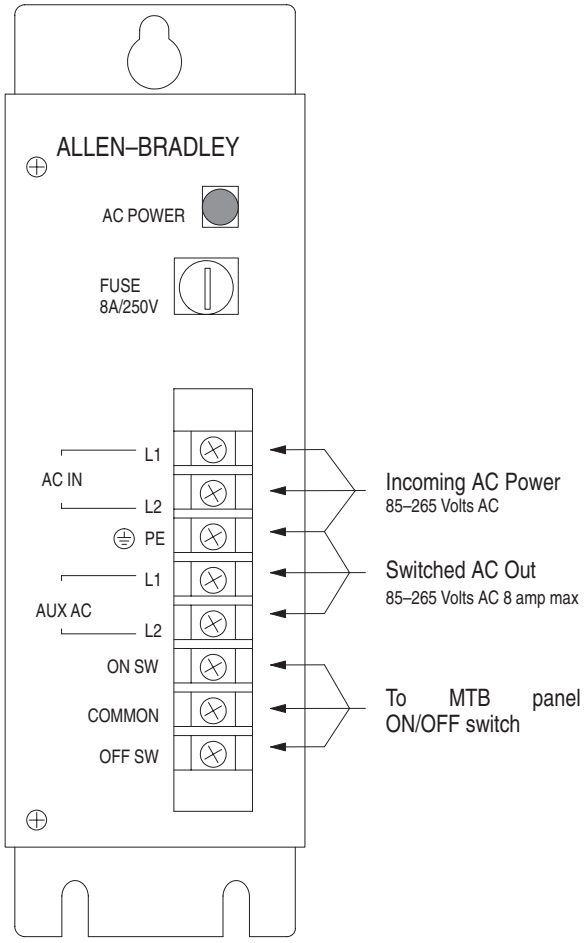

## 5A.5.1 On/Off Control and 24V Logic Power

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 | | | |
|---|---|---|---|---|---|
| 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) | 1 | 2 | 3 | 4 |
| | | 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 5A.28**
**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.39).

**Figure 5A.29**
**Connecting On/Off Power Control Assembly and 24V Transformer (Series A/B)**

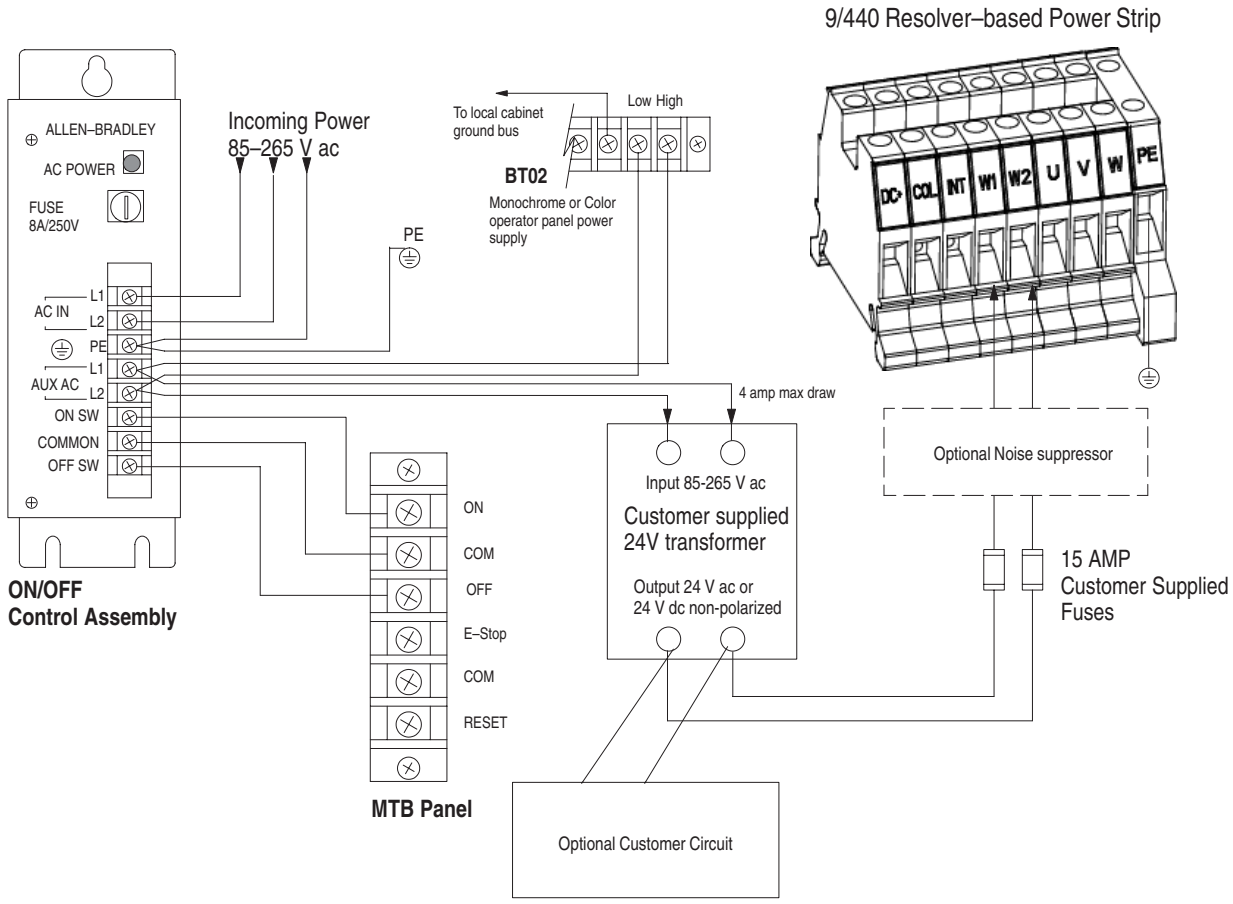


**Figure 5A.30**
**Connecting On/Off Power Control Assembly and 24V Transformer (5 and 10 kW Series C)**

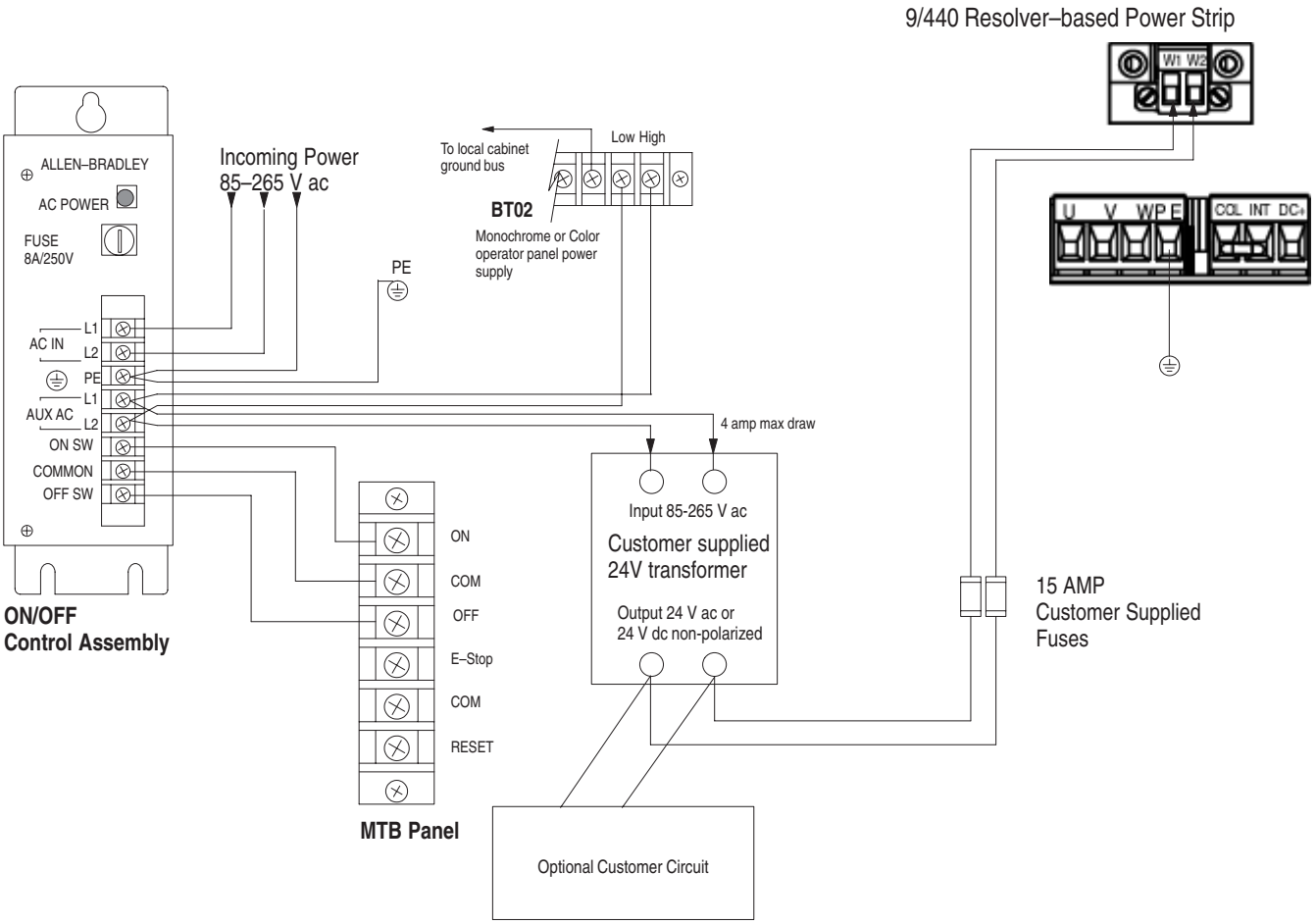
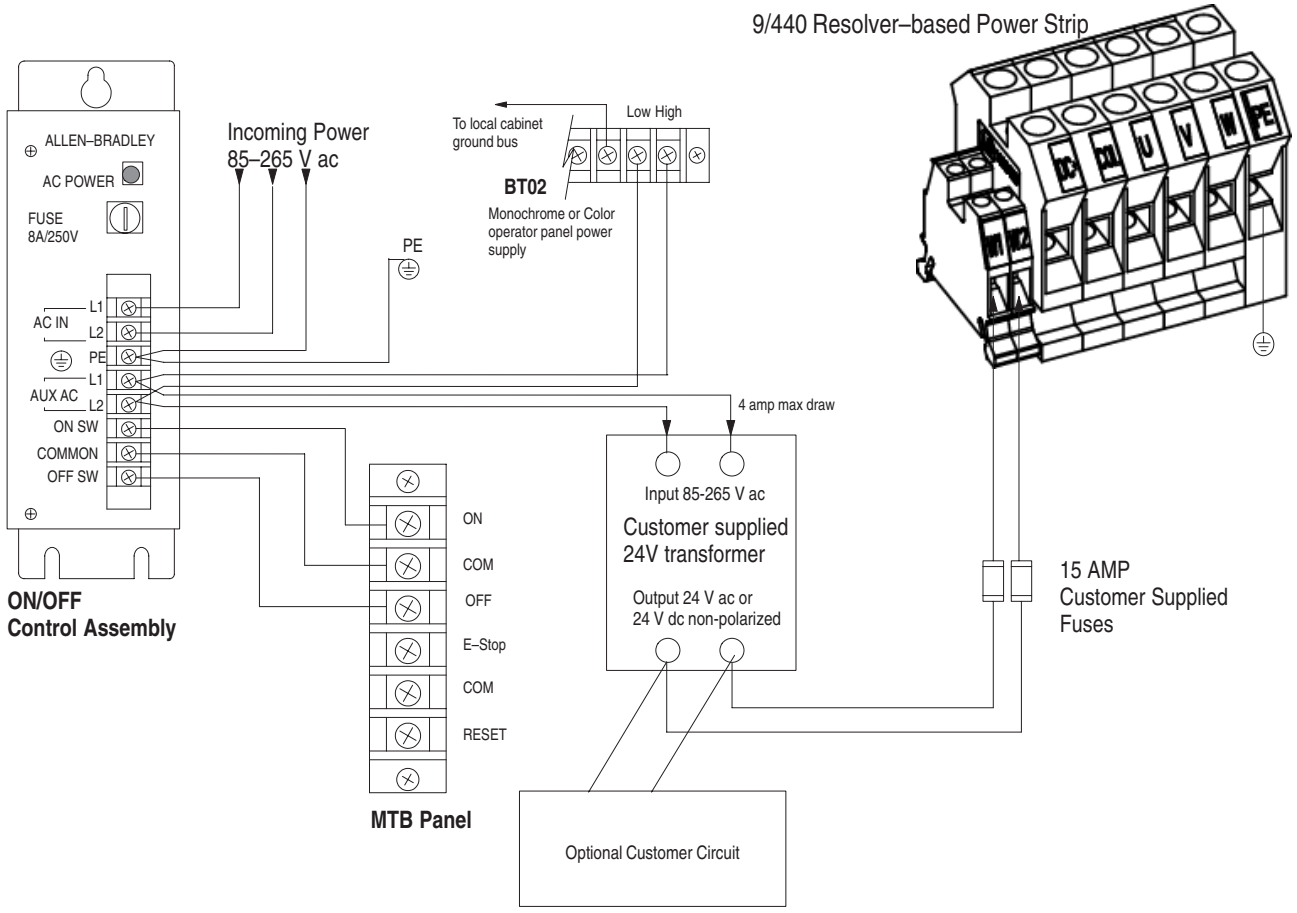


**Figure 5A.31**
**Connecting On/Off Power Control Assembly and 24V Transformer (22 kW Series C)**




**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.

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.32.

**Figure 5A.32**
**Connecting On/Off Power Control Assembly and 24V Power Supply (Series A/B)**

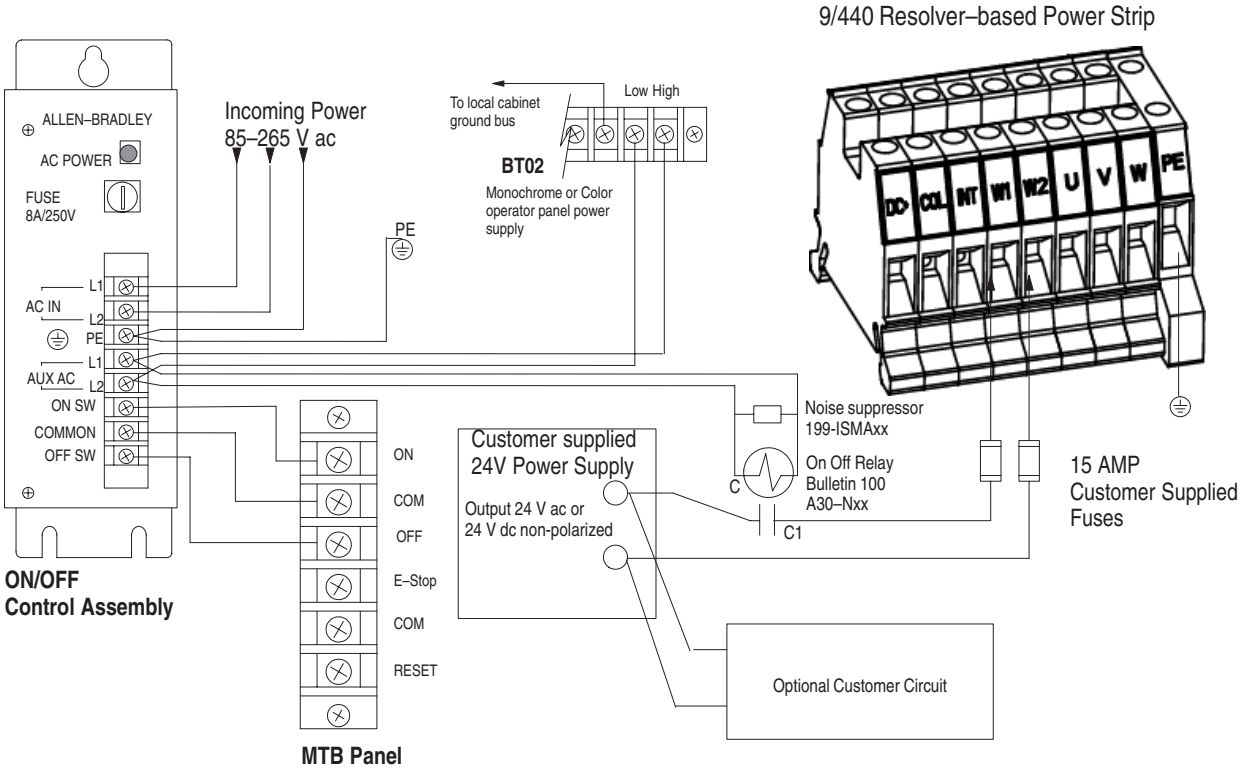


**Figure 5A.33**
**Connecting On/Off Power Control Assembly and 24V Power Supply (5 and 10 kW Series C)**

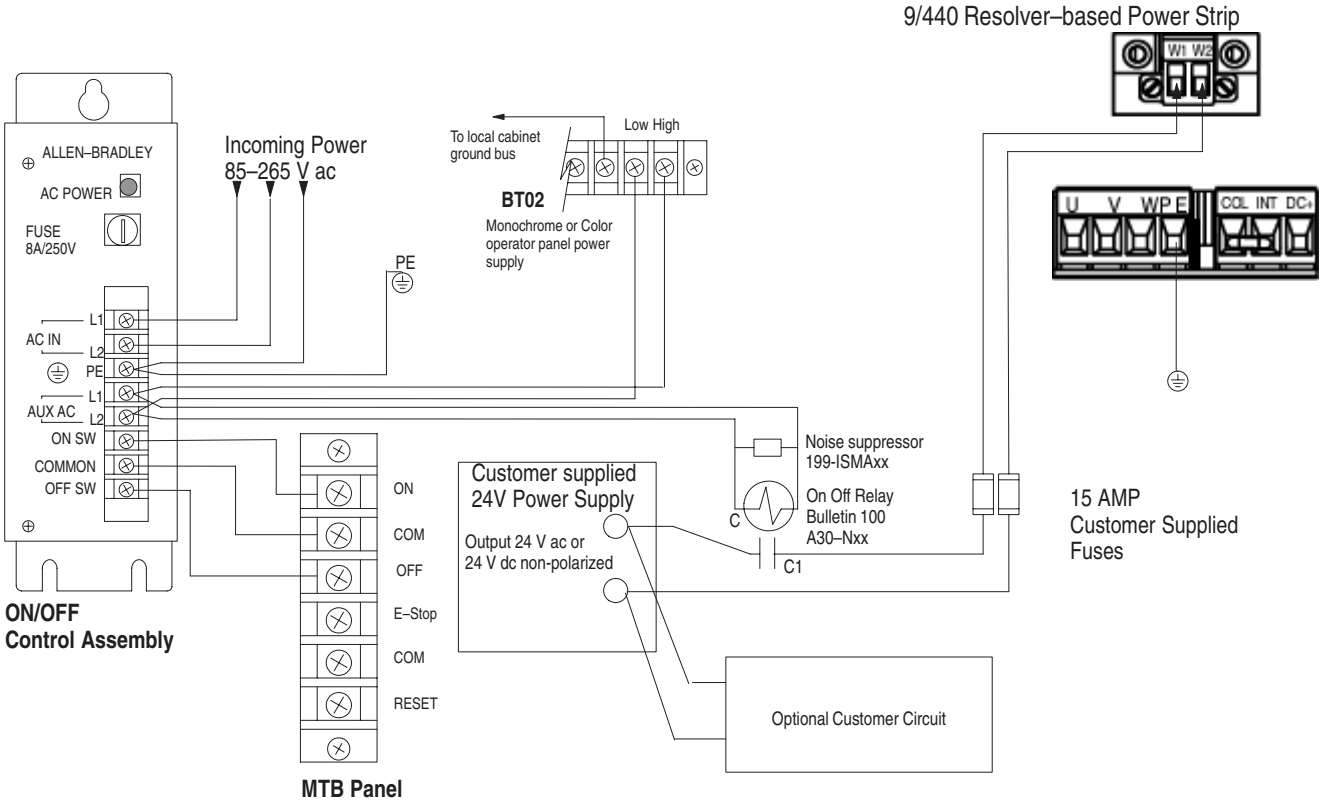
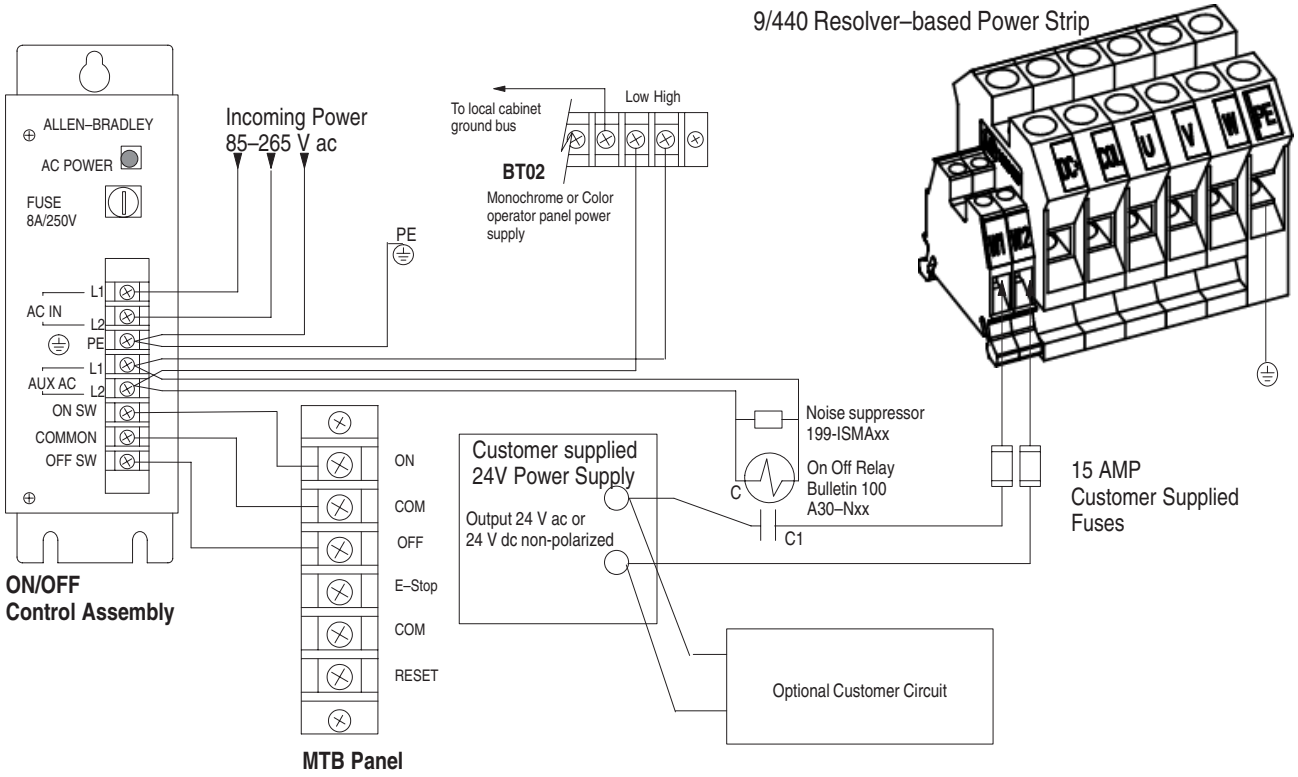


**Figure 5A.34**
**Connecting On/Off Power Control Assembly and 24V Power Supply (22 kW Series C)**




## 5A.5.2 Drive Power Three–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.

## 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.35**
**Three–phase Jumper (Series A and B)**

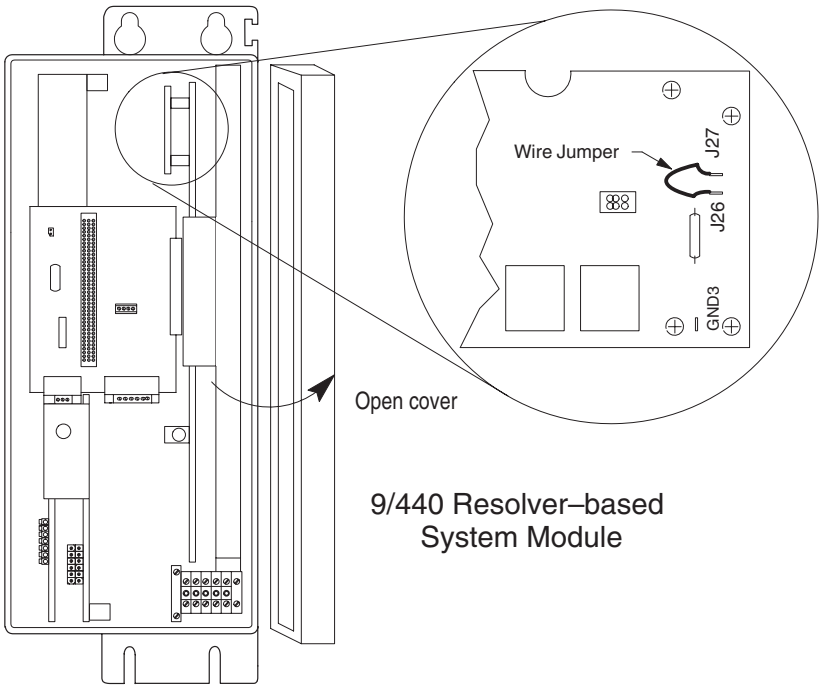


**Figure 5A.36**
**Three–phase Jumper (5 and 10 kW Series C)**

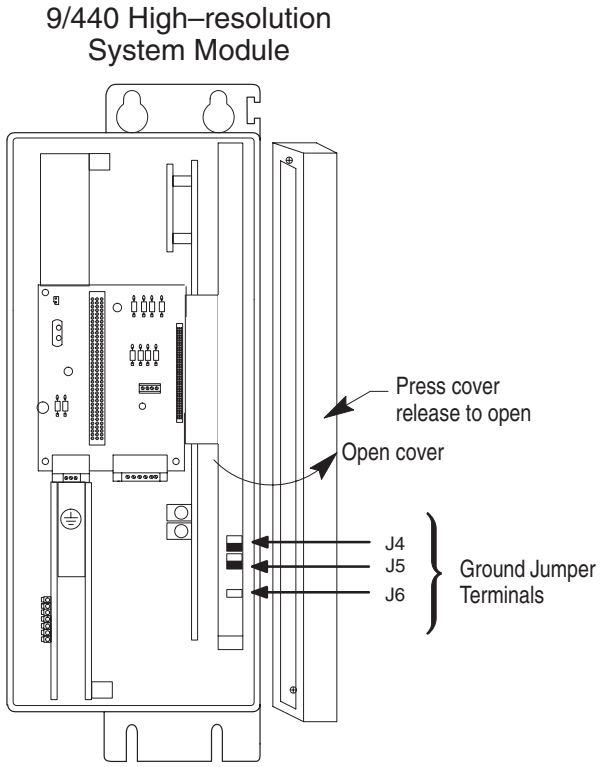


**Figure 5A.37**
**Three–phase Jumper (22 kW Series C)**

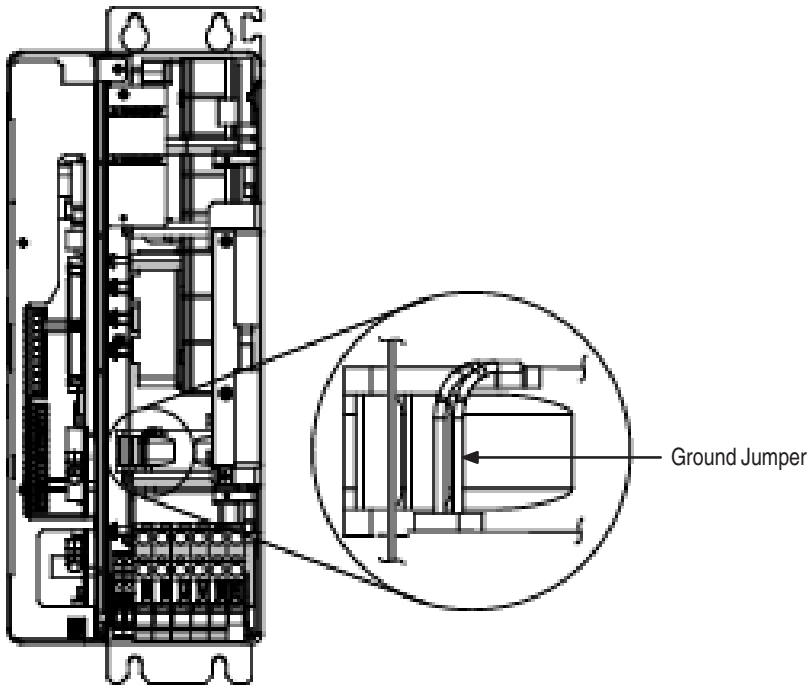


**Figure 5A.38**
**System Module Jumper Positions (22 kW Series C)**

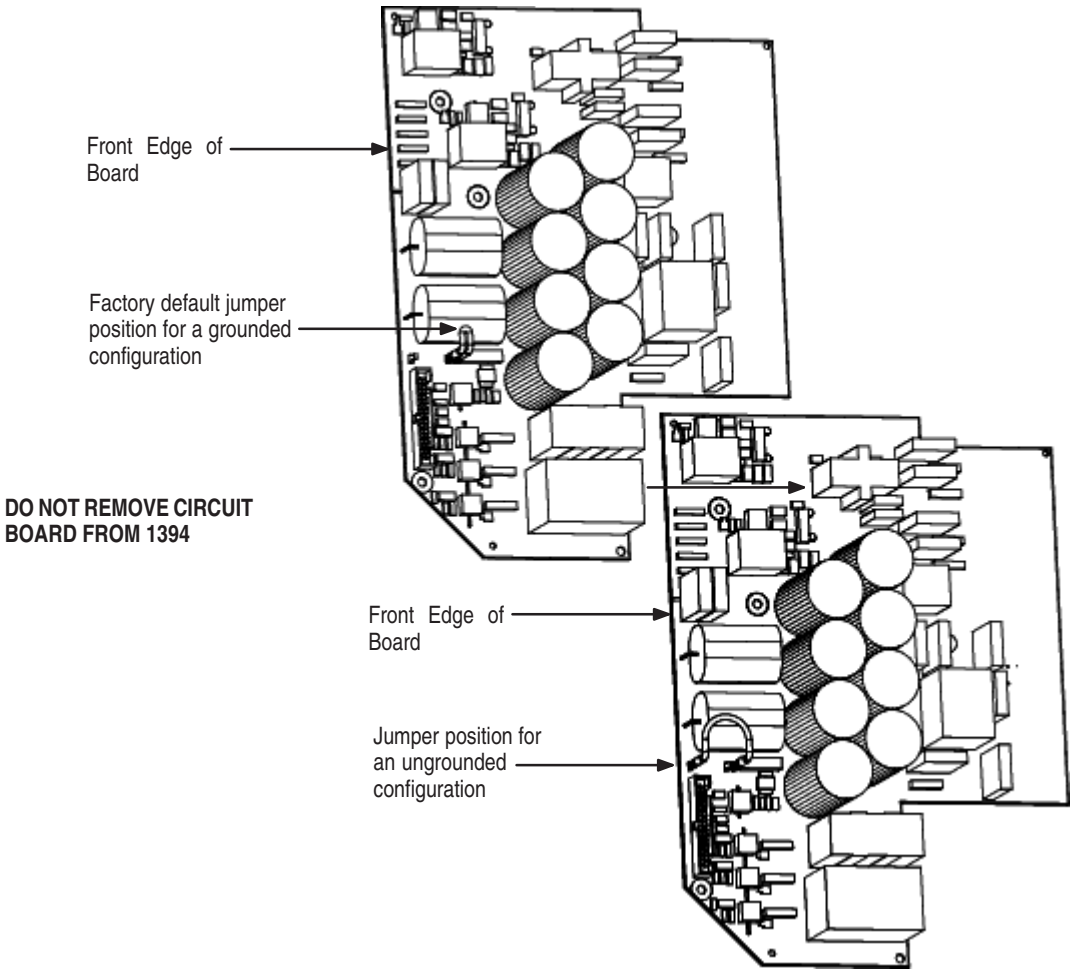


**Figure 5A.39**
**Recommended Connection of 3–phase Drive Power (Series A/B)**

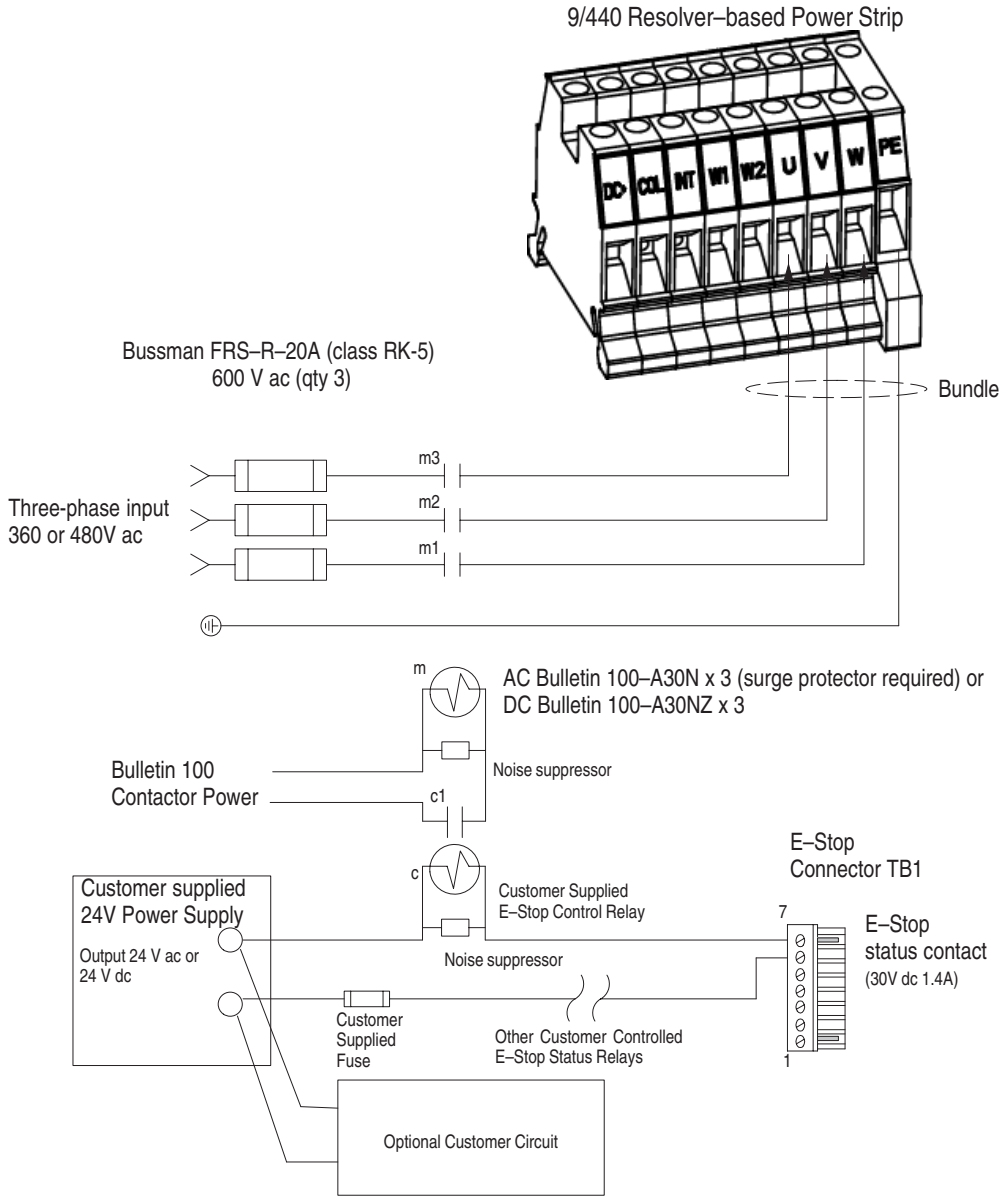


**Figure 5A.40**
**Recommended Connection of 3–phase Drive Power**
**(5 and 10 kW Series C)**

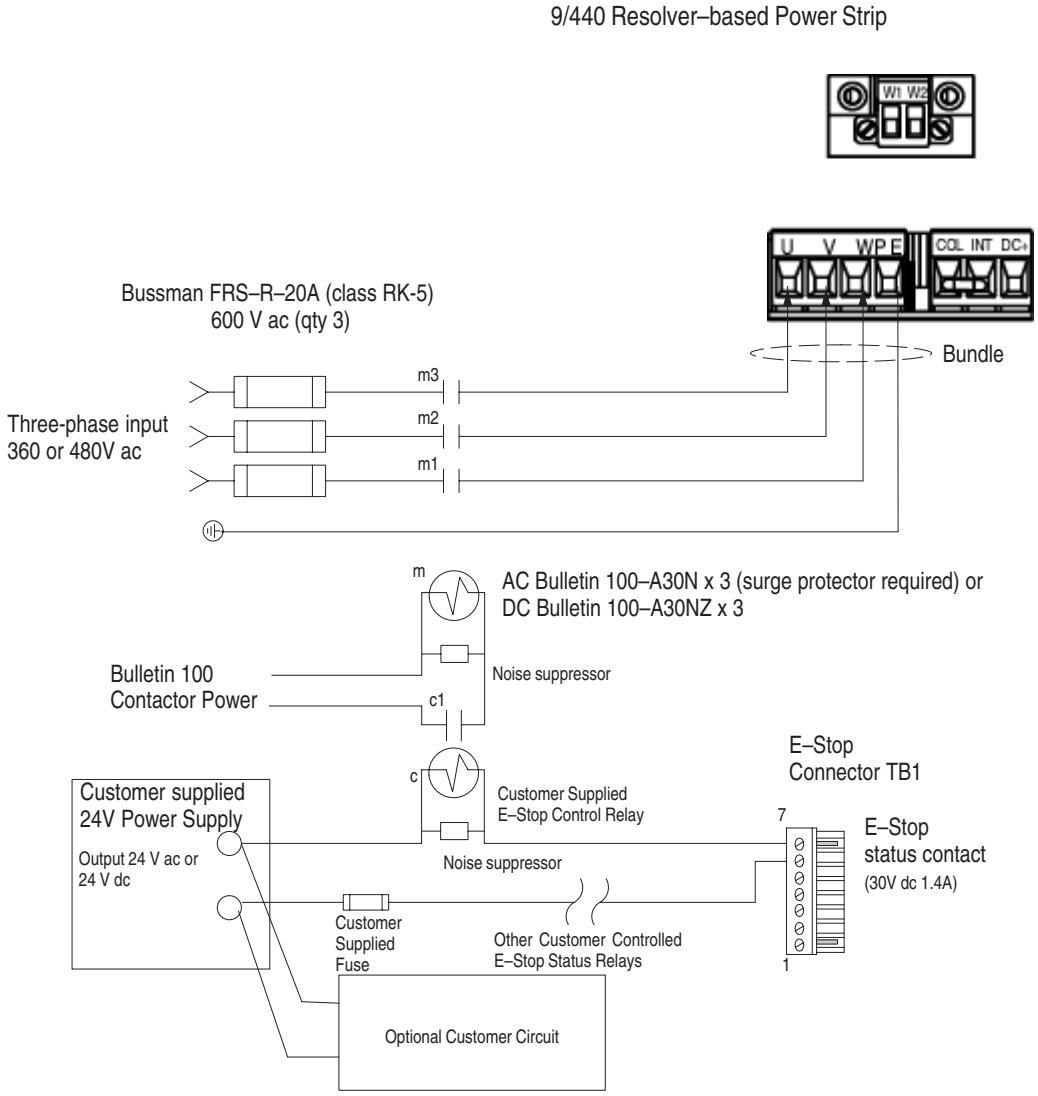
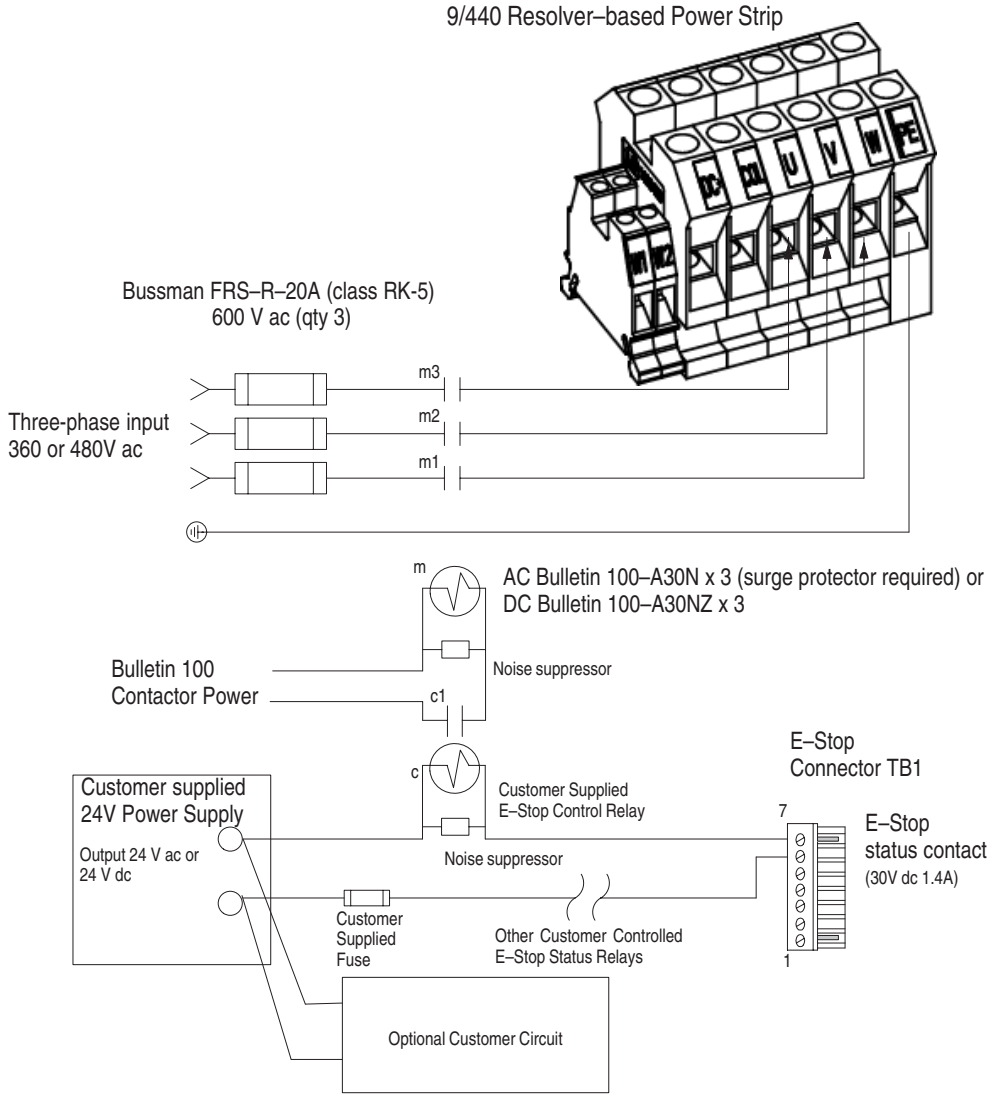
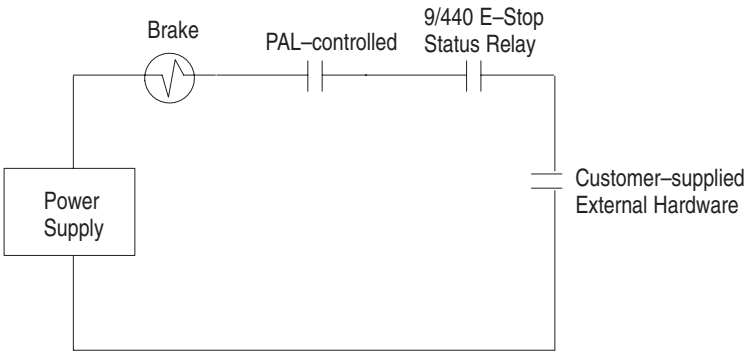


**Figure 5A.41**
**Recommended Connection of 3–phase Drive Power**
**(22 kW Series C)**




**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.




## 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.42 and the paragraphs that follow for detailed information.

**Figure 5A.42**
**Axis Module Connections (Series A/B)**

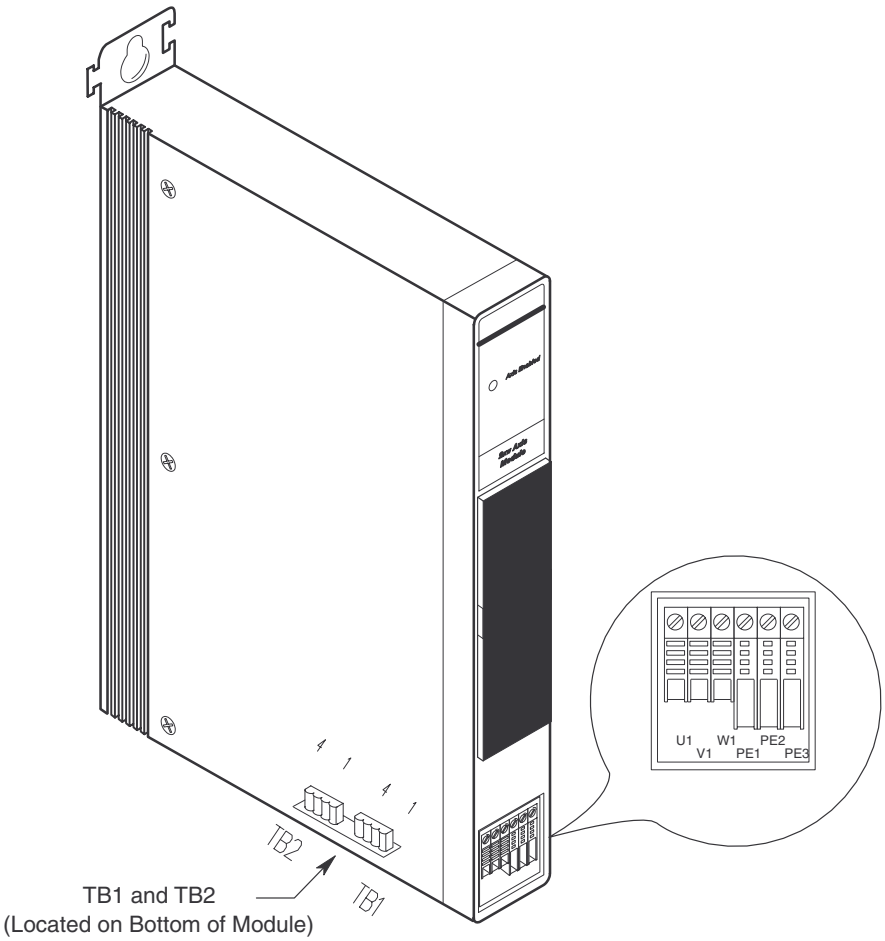
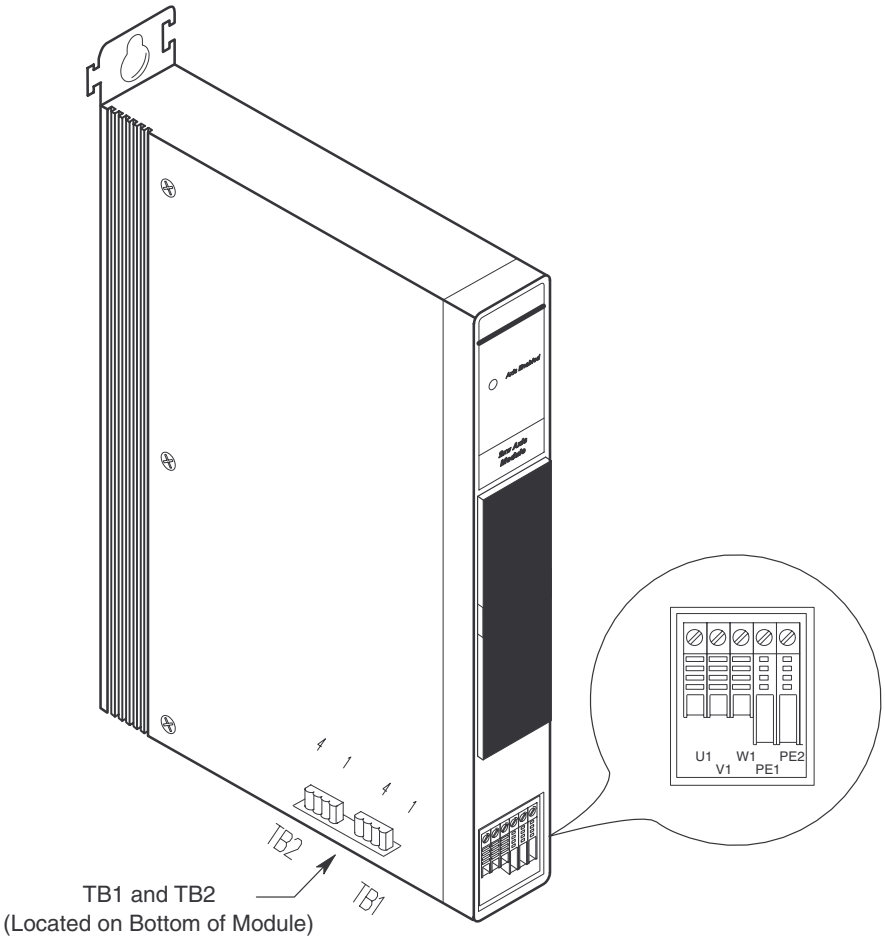


**Figure 5A.43**
**Axis Module Connections (All Series C)**




## 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).

See page 5A-14 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.42. Refer to the information below and the Interconnect Drawings on page 5A-67 for further information.

**Table 5A.B**
**Motor Power Terminations**

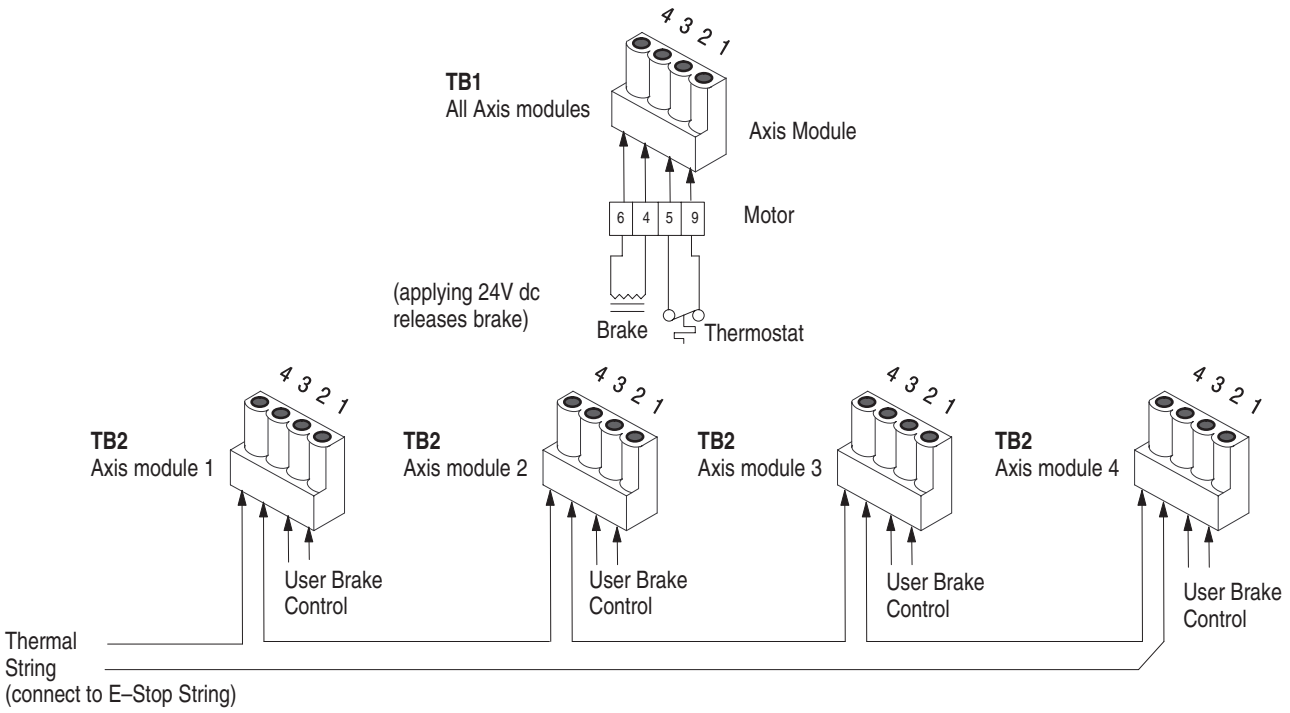
| Terminal | Description | Wire/Pin Number |
|---|---|---|
| U1 | Motor Power A | 1 |
| V1 | Motor Power B | 2 |
| W1 | Motor Power C | 3 |
| PE1 | Axis Ground | Ground Bar |
| PE2 | Motor Ground | 8 |
| PE3 | Overall Shield | 7 |

### 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.42 for location and Table 5A.C for terminations.

**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.

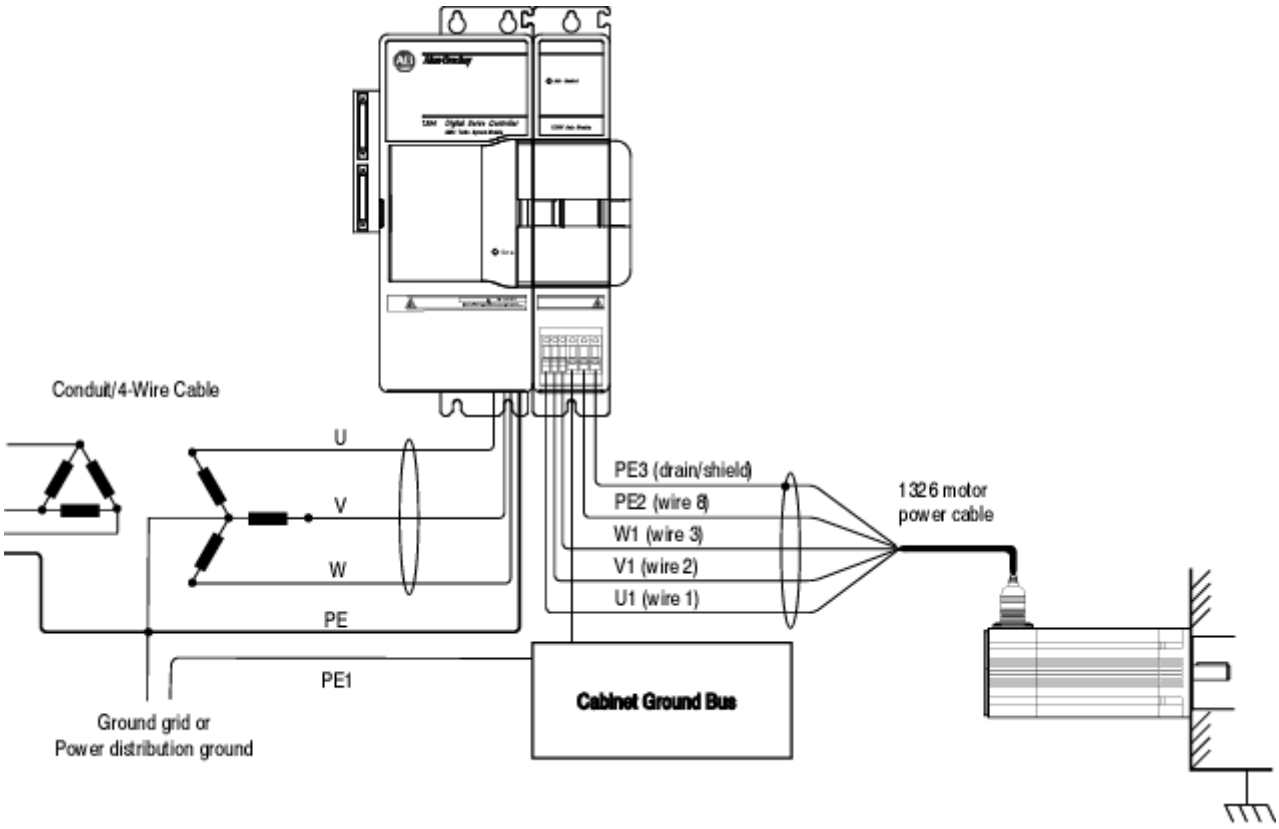
## Determining Your Type of Input

Before you ground or wire your 1394 system, you must determine the type of 360/480V input power you will be connecting to. The 1394 system is designed to operate in both grounded and ungrounded environments.

### Grounded Power Configuration

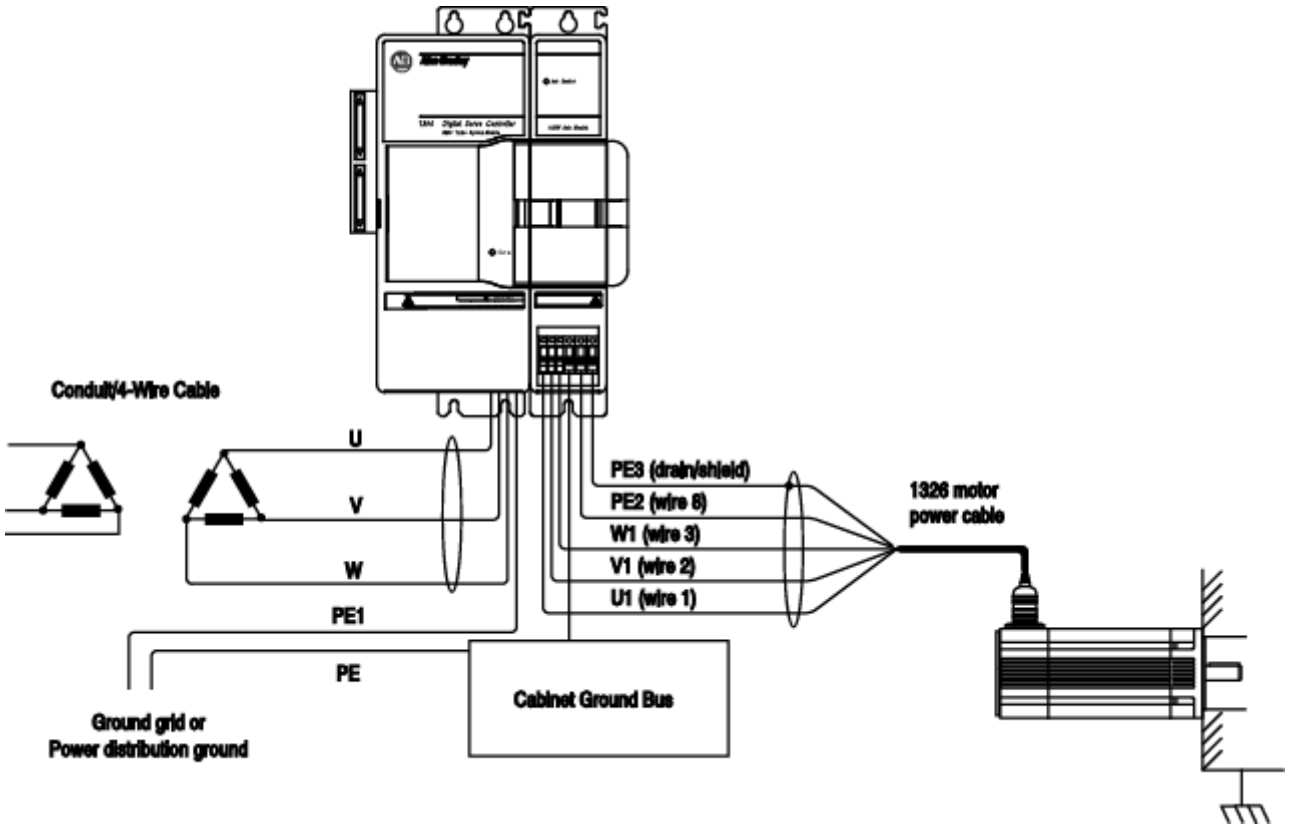
As shown in Figure 5A.44, the grounded power configuration allows you to ground your 3–phase power at a neutral point. Each 1394 system module has a factory–installed jumper configured for grounded power distribution. If you determine that you have grounded power distribution in your plant you do not need to modify your system. For detailed information about 1394 grounded power configuration, refer to your *1394 Digital AC Multi-Axis Motion Control System Users Manual* (publication 1394-5.0).

**Figure 5A.44**
**Grounded Power Configuration**




As shown in Figure 5A.45, the ungrounded power configuration does not allow for a neutral ground point. If you determine that you have ungrounded power distribution in your plant, you need to move the factory–installed jumper to the ungrounded power distribution position to prevent electrostatic buildup inside the 1394. Refer to the ground jumper procedures for the system module you need to configure. For detailed information about 1394 ungrounded power configuration, refer to your 1394 users manual.

**Figure 5A.45**
**Ungrounded Power Configuration**



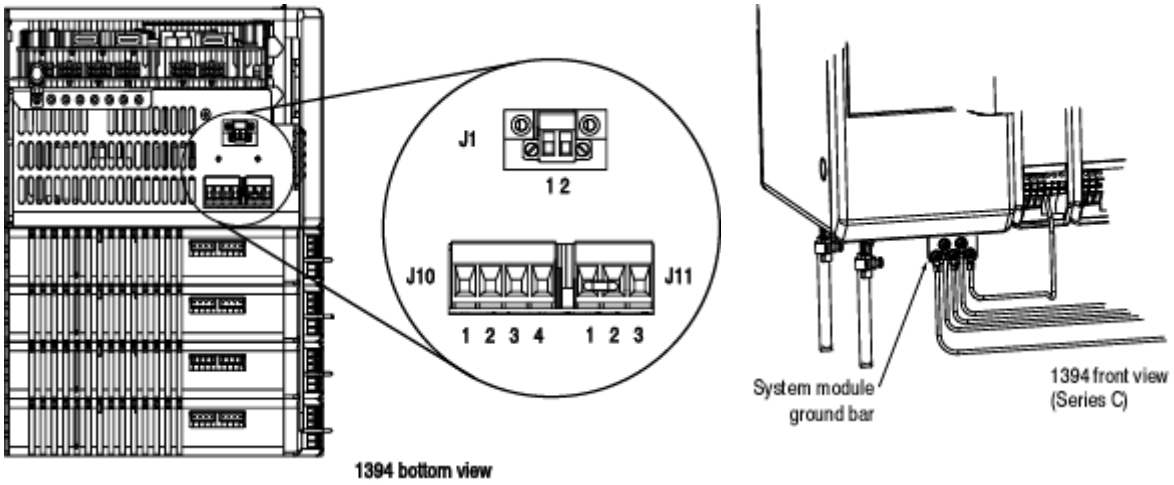

**ATTENTION:** Ungrounded systems do not reference each phase potential to a power distribution ground. This can result in an unknown potential to earth ground.

## Connector Locations for 5 and 10 kW System Module (Series C)

The 5 and 10 kW system module (Series C) uses connectors instead of IEC terminals for connecting power. Wire the system using power connectors J1, J10, and J11 that mate with plugs P1, P10, and P11 conveniently located on the bottom of the system module.

**ATTENTION:** To avoid personal injury and/or equipment damage, ensure installation complies with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment.

**Figure 5A.46**
**Connectors for 5 and 10 kW System Module (Series C)**




| Wire | Description | Maximum Wire Size | Connects to Terminal(s) | Required (Y/N) |
|---|---|---|---|---|
| 24V Logic | A user–supplied 24V ac rms or 24V dc power source. Refer to your 1394 documentation for 24V input power specifications. | 3.3 $mm^2$ (12 AWG) | J1–1 and J1–2 | Y |
| 360/480V ac Input Power | 360/480V ac, three–phase power input. Make sure to bundle your three–phase power leads and neutral together as much as possible. Refer to your 1394 documentation for system specifications for rated ac input voltage, tolerance, and source impedance. | 5.3 $mm^2$ (10 AWG) | J10–1 (U), J10–2 (V), and J10–3 (W) | Y |
| Input Power Neutral | Three–phase input neutral (present only on grounded power configurations) | 5.3 $mm^2$ (10 AWG) | J10–4 | N |
| PE Ground | The 1394's ground connection to the bonded system ground bar on the subpanel. | 8.4 $mm^2$ (8 AWG) | System Module Ground Bar | Y |
| External Shunt Resistor | Optional 1400W external shunt resistor used to dissipate excess regenerative energy from the system module | 5.3 $mm^2$ (10 AWG) | J11–3 and J11–1 | N |

**Important:** Refer to your 1394 documentation for information about three–phase input fusing and circuit breaker information as related to the power input. Refer to the same documentation for information about wiring the optional shunt resistor to the 5 and 10 kW system modules.

### Required Tools and Equipment

Before you begin connecting power wiring, be sure to have the following:

- A small, flathead screwdriver
- User–supplied contactor
- User–supplied wiring for input power

### Connecting Power Wiring for 5 and 10 kW (Series A/B) and 22 kW System Modules

To connect power wiring:

**1.** Connect the ground wire for the system module to the bonded ground bus bar on the subpanel. For more information about bonding, refer to the documentation that accompanied your 1394 system.

**2.** Open the front door of the system module.

**3.** Connect the system ground bar wire as follows:

| If you have this type of system module: | then: |
|---|---|
| 5 and 10 kW or 22 kW (Series A or B) | Insert the system ground bar wire in the terminal block labeled PE. |
| 22 kW Series C | Connect the system ground bar wire to the system module ground bar. |

**4.** Connect the three–phase incoming power wires by inserting the wire into its namesake terminal block (i.e., wire U into terminal block U, V into V, and W into W). Make sure to bundle your three–phase power leads and neutral together as much as possible.

**5.** Connect the three–phase neutral wire as follows:

| If you have this type of system module: | then: |
|---|---|
| 5 and 10 kW or 22 kW (Series A or B) | Connect the three–phase input neutral wire to the bonded system ground bar. For more information about bonding, refer to your accompanying 1394 system documentation. |
| 22 kW Series C | Insert the three–phase input neutral wire in the terminal block labeled PE. |

**Important:** The three–phase input neutral connection is present only on grounded power configurations.

**6.** Insert one of the 24V control power wires into the terminal block labeled W1.

**7.** Insert the other 24V control power wire into the terminal block labeled W2.

**8.** Tighten and torque all six screw terminals to the values in the following table:

| System Module | Terminal Block Designator | Terminal Block Torque |
|---|---|---|
| 5 and 10 kW | All | 0.56 – 0.62 N–m (5.0 – 5.6 lb–in.) |
| 22 kW | W1, W2 | 0.56 – 0.62 N–m (5.0 – 5.6 lb–in.) |
| | DC+, COL, U, V, W, PE | 2.21 – 2.66 N–m (20.0 – 24.0 lb–in.) |

**9.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

For more information about connecting motor power to axis modules, refer to your accompanying 1394 system documentation.

### Connecting Power Wiring for 5 and 10 kW (Series C) System Modules

To connect power wiring:

**1.** Connect the system module ground wire from the system module ground bar to the bonded ground bus bar on the subpanel. For more information about bonding, refer to the documentation that accompanied your 1394 system.

**2.** Insert the three–phase input neutral wire into connector terminal J10–4 and tighten the J10–4 connector screw (torque value = 0.56 – 0.62 N–m, 5.0 – 5.6 lb–in.). Make sure to bundle your three–phase power leads and neutral together as much as possible.

**Important:** The three–phase input neutral connection is present only on grounded power configurations.

**3.** Insert the three–phase incoming power wires as follows and tighten the three J10 connector screws.

| Insert this wire: | into this connector terminal: | and tighten to this torque value: |
|---|---|---|
| U | J10–1 | 0.56 – 0.62 N–m (5.0 – 5.6 lb–in.) |
| V | J10–2 | |
| W | J10–3 | |

**4.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

**5.** Plug J10 into P10.

**6.** Insert one of the 24V control power wires into connector terminal J1–1 and tighten its connector screw (torque value = 0.56 – 0.62 N–m, 5.0 – 5.6 lb–in.).

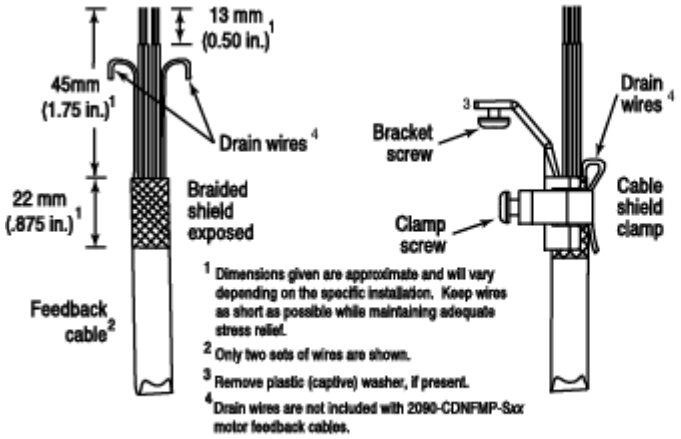
**7.** Insert the other 24V control power wire into connector terminal J1–2 and tighten its connector screw (torque value = 0.56 – 0.62 N–m, 5.0 – 5.6 lb–in.).

**8.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

**9.** Plug J1 into P1

**10.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

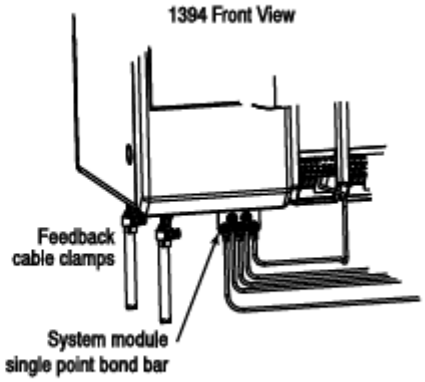
For more information about connecting motor power to axis modules, refer to your accompanying 1394 system documentation.




Cable Preparation




Clamp Attachment




Attaching Feedback to System Module

## 5A.7
## 9/440 Resolver–based LEDs

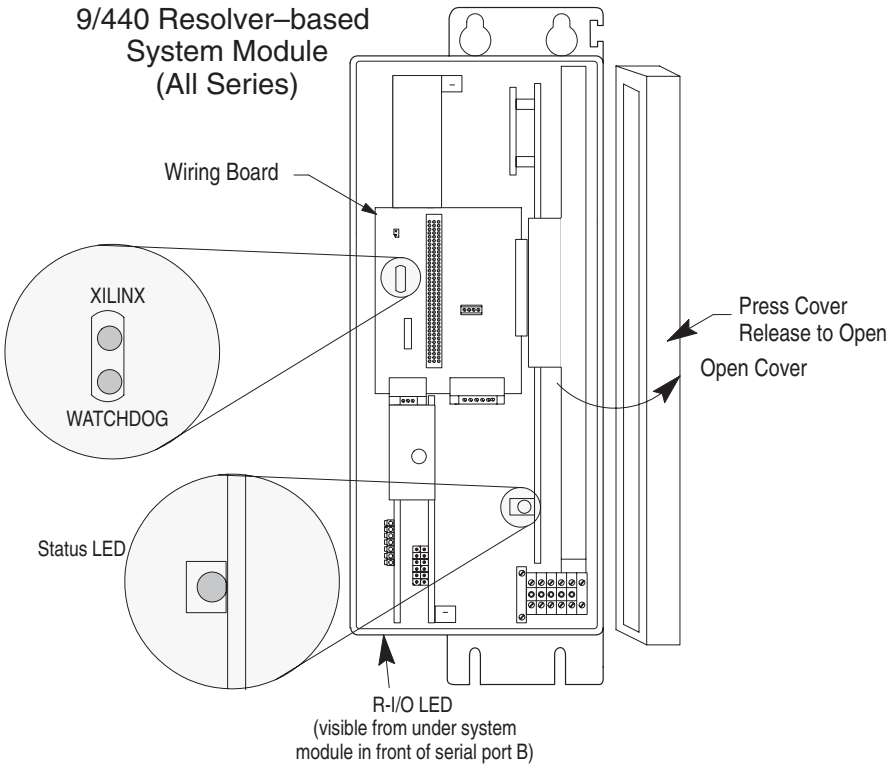
All 9/440 Resolver–based CNC/Drives have four LEDs on the system module and one LED on each axis module in the system. The LEDs operate as follows.

### System Module LEDs

The system module has four 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-35. |
| STATUS | This is identical to the Watchdog LED but is visible through the system modules front cover. |

**Figure 5A.47**
**System Module LED Locations (All Series)**



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:

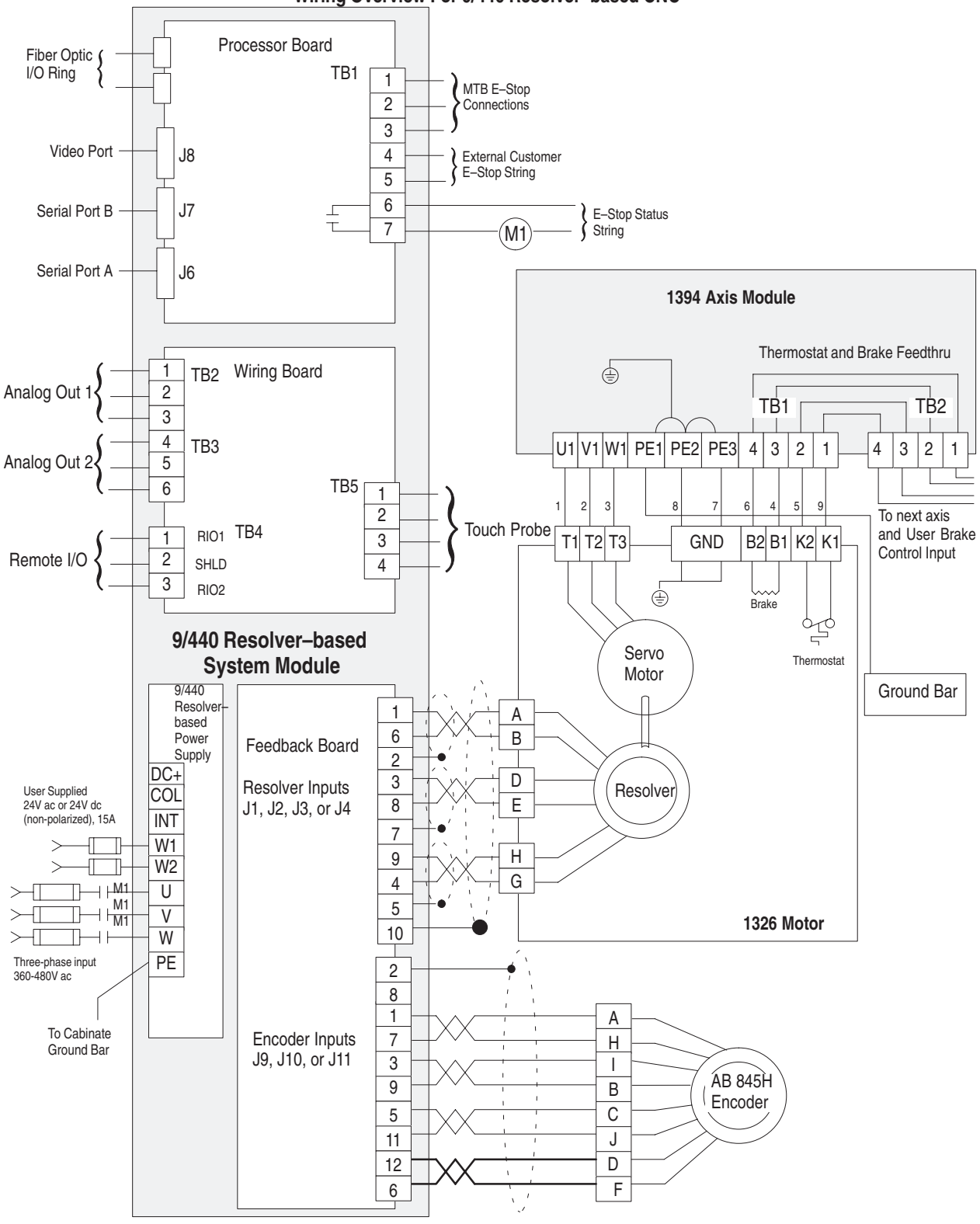
| LED | Indicates | |
|---|---|---|
| STATUS | Steady Green | bus up, axis enabled |
| | Flashing Green | bus up, axis not enabled |
| | Flashing Red/Green | ready, bus not up |
| | Flashing Red | fault present |
| | Steady Red | hardware malfunction |

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.

**Figure 5A.48**
**Wiring Overview For 9/440 Resolver–based CNC**



## System Grounding

Figure 5A.49 and Figure 5A.50 illustrate 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.

**Figure 5A.49**
**Recommended Resolver–based Grounding Scheme (Series A/B)**

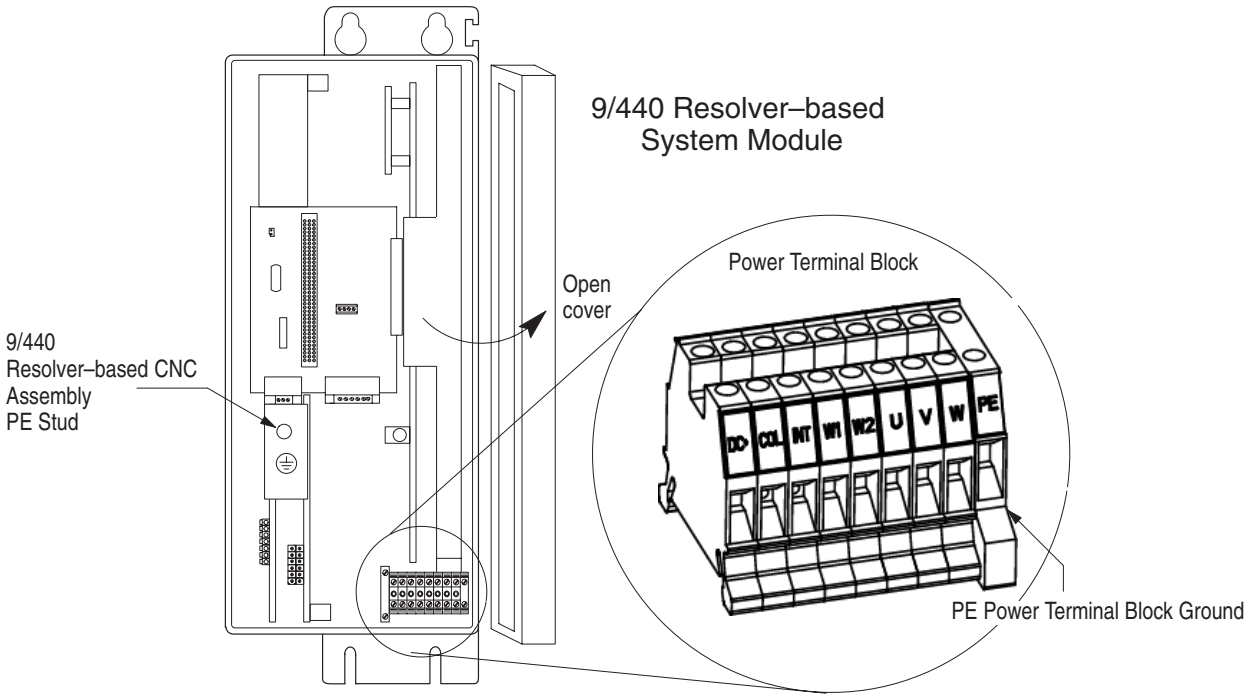


**Figure 5A.50**
**Recommended Resolver–based Grounding Scheme**
**(5 and 10 kW Series C)**

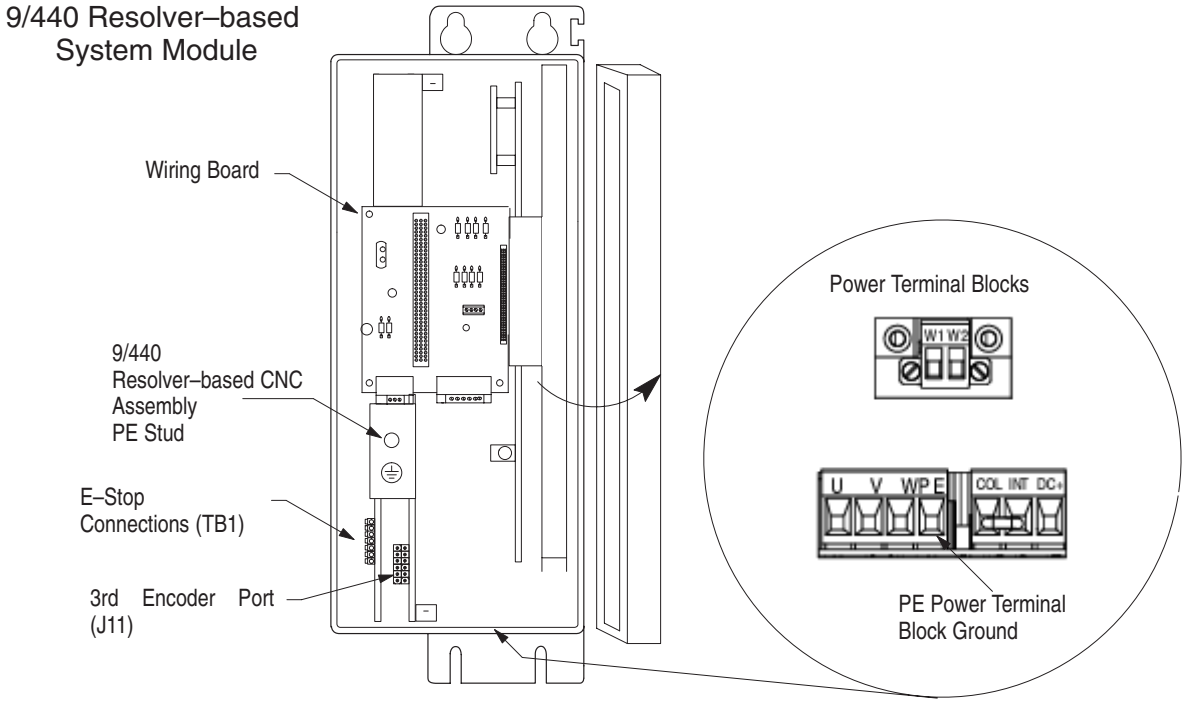


**Figure 5A.51**
**Recommended Resolver–based Grounding Scheme**
**(22 kW Series C)**

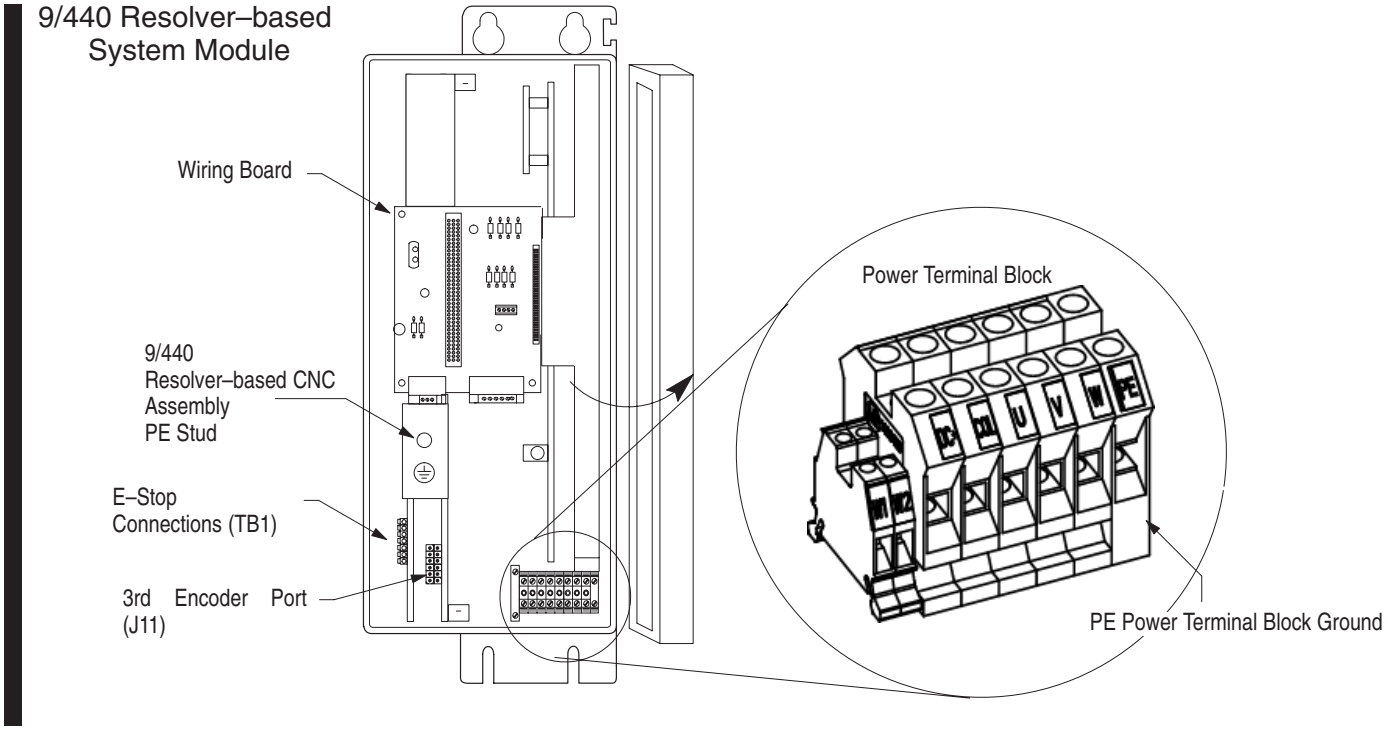


**Figure 5A.52**
**System Grounding Diagram for 9/440 Resolver–based Control (Series A and B)**

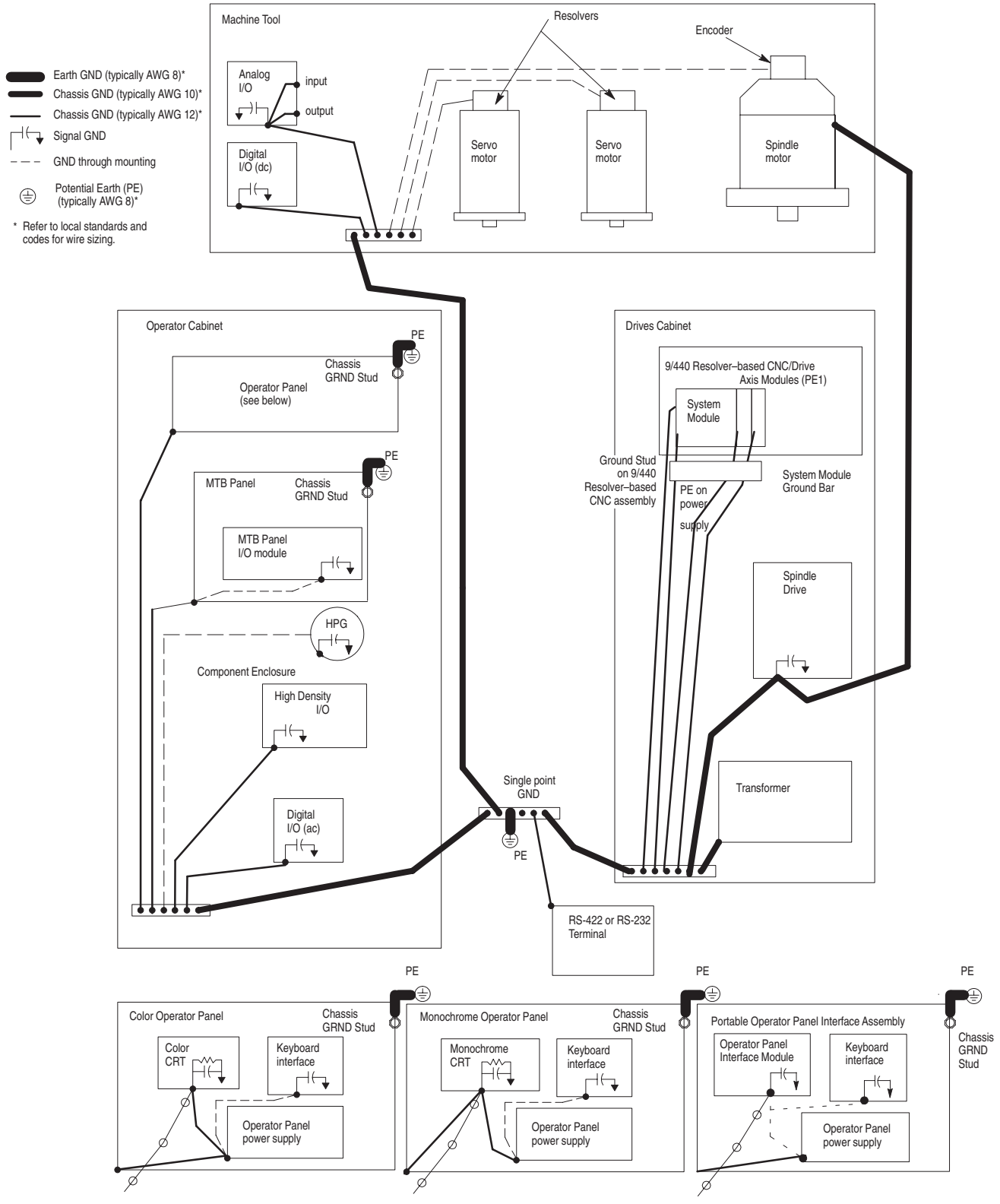
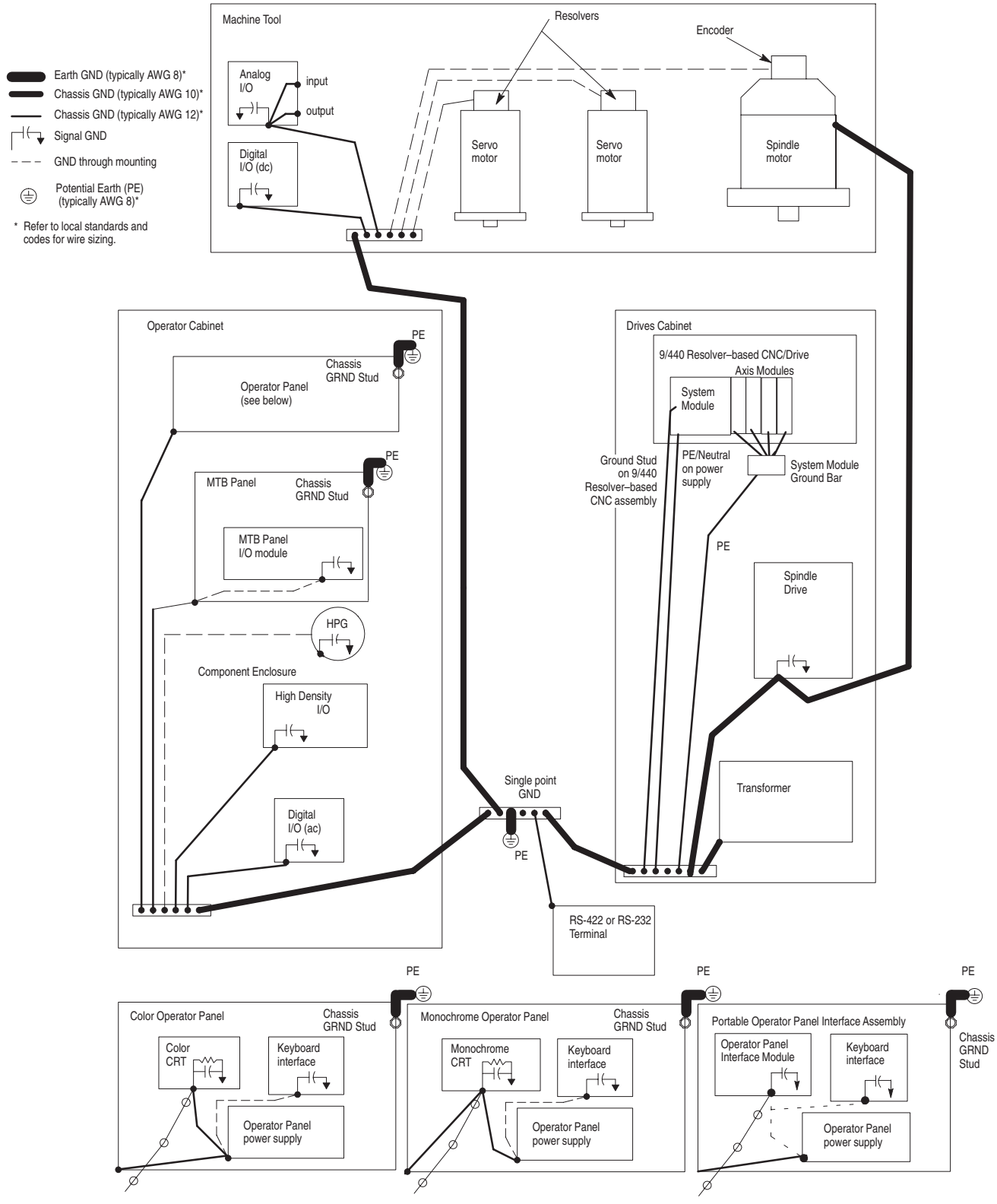


**Figure 5A.53**
**System Grounding Diagram for 9/440 Resolver–based Control (Series C)**



Section **5B**

# The 9/440HR CNC/Drive System

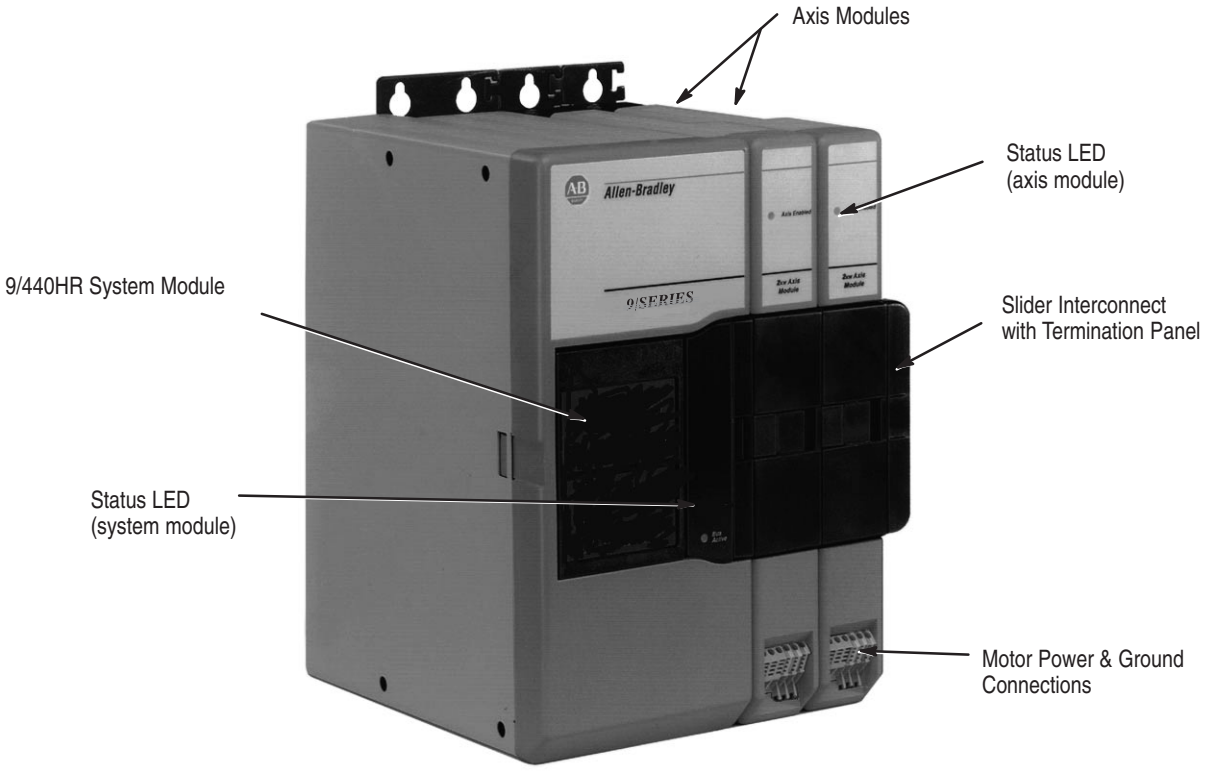
## 5B.0 Section Overview

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 an absolute (1 million counts/rev) high–resolution feedback device.

## 5B.1 Hardware Overview

The following figure shows some of the key features of the 9/440HR CNC/Drive:



- 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.

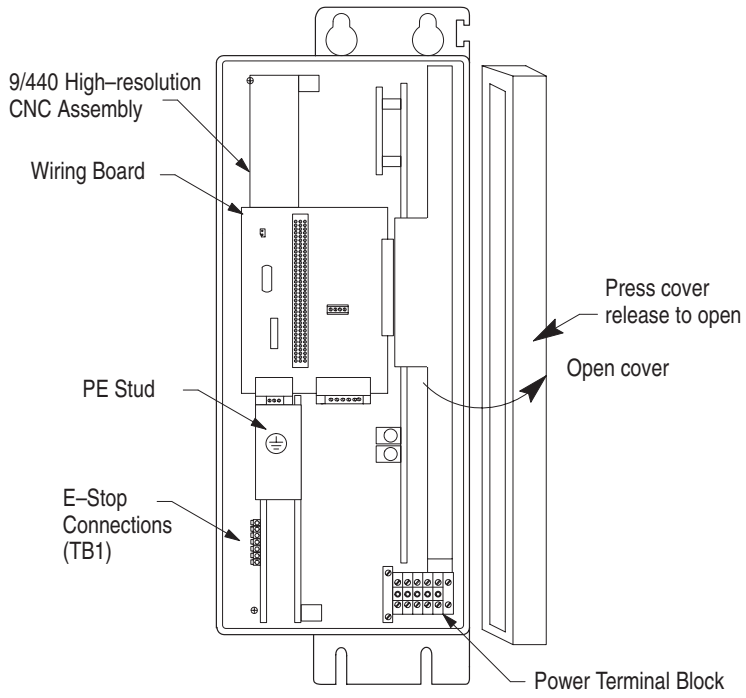
  **Interconnecting Power and 9/440HR CNC Assembly Section**

  - 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.

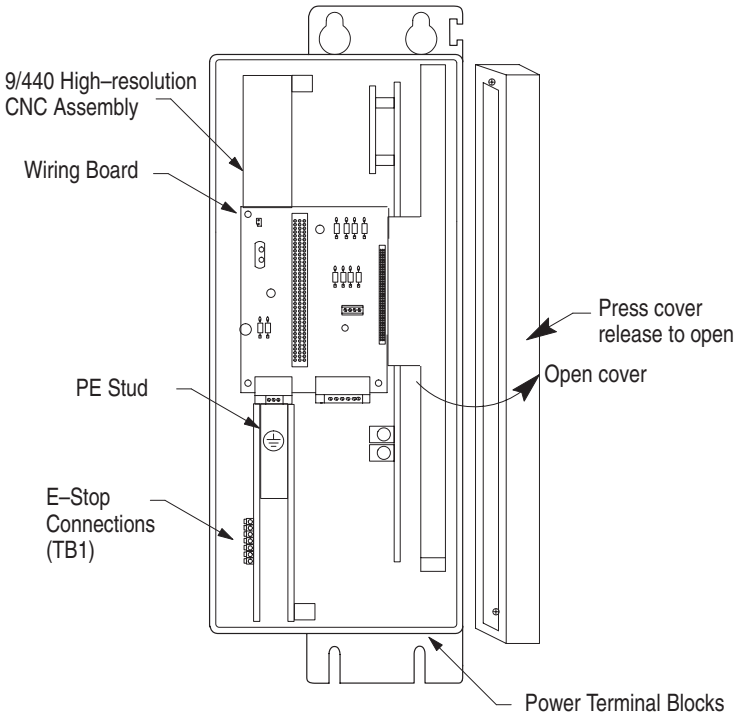
The number and type of available feedback ports supported on your 9/440HR system are defined by options installed at the factory. Some ports may not be enabled. To determine what ports are operational on your system, refer to the system configuration label located on the outer left side of your system 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) | J1 | J2 | J3 | J4 | — | — |
| A quad B (with single or distance–coded marker) | — | — | — | — | J9, J10 | J11, J12 |

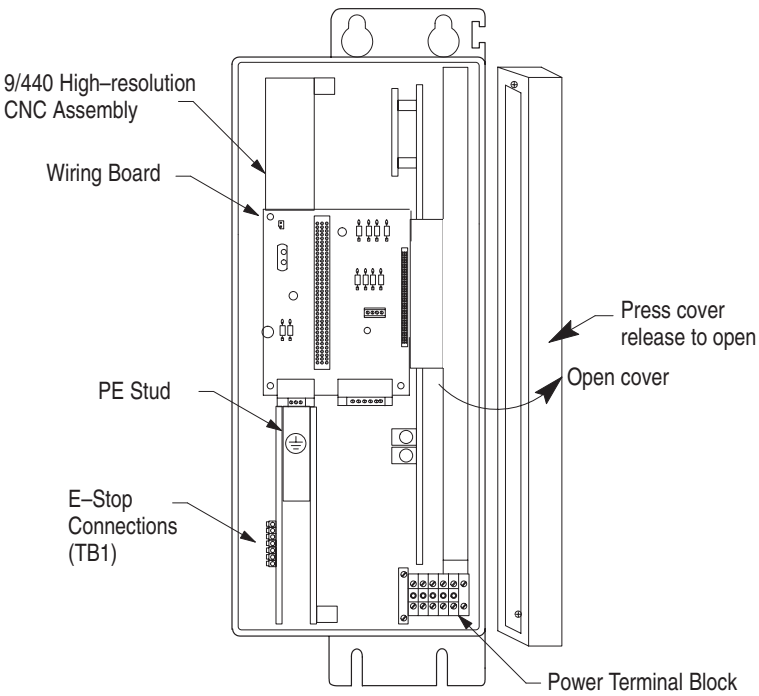
## Series A/B 9/440 High–resolution System Module




## Series C 9/440 High–resolution System Module (5 and 10 kW)




## Series C 9/440 High–resolution System Module (22 kW)



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.

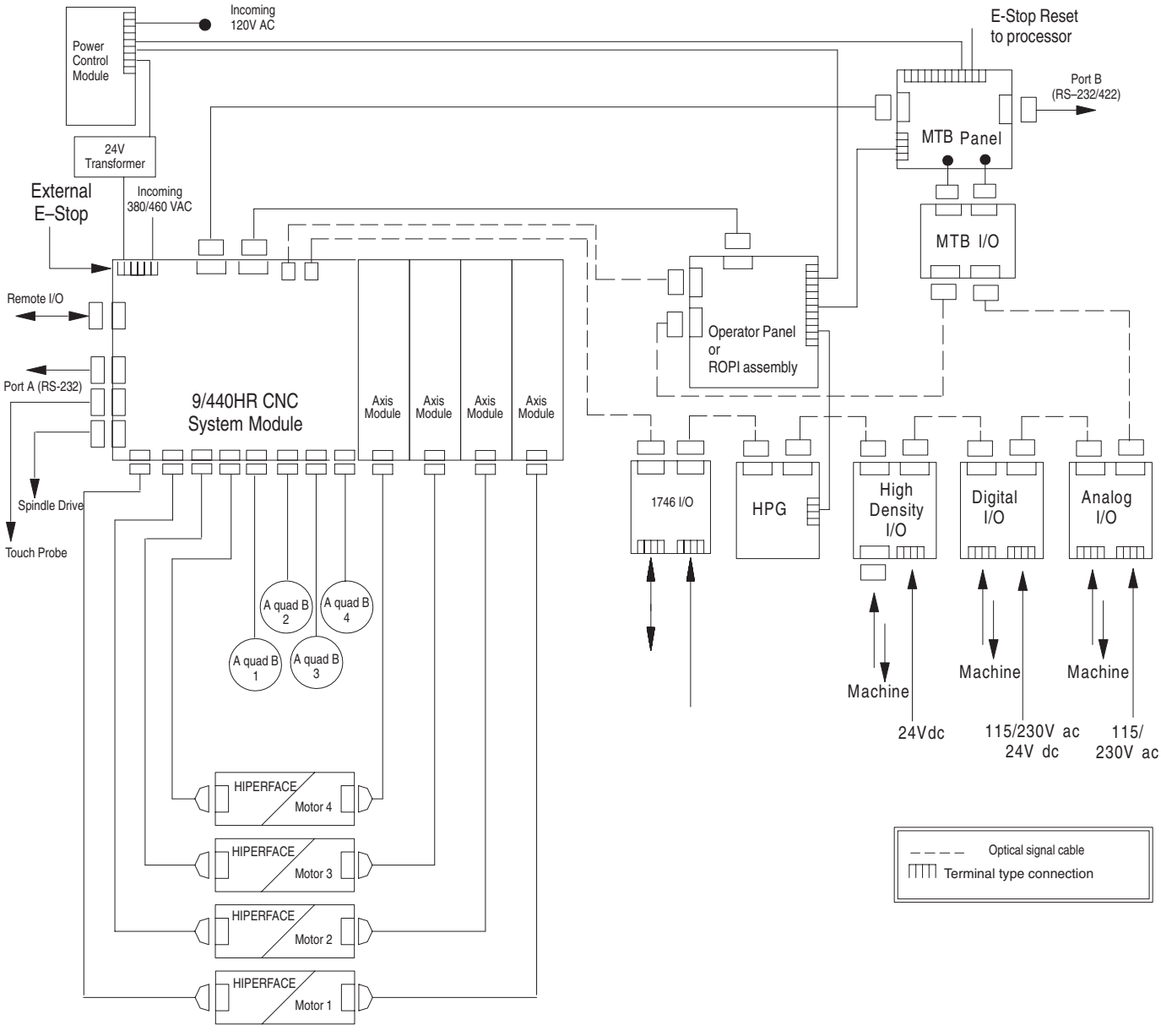
- Axis Module - Connect up to four axis modules to the 9/440HR CNC/Drive system (depending on your system module selection). Axis modules convert the dc power supplied by the system module to a variable ac voltage (460V ac input provides 460 ac out, derated 380V ac input provides 380V ac out). This voltage 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 HIPERFACE® 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.

**Figure 5B.1**
**9/440HR System Overview**

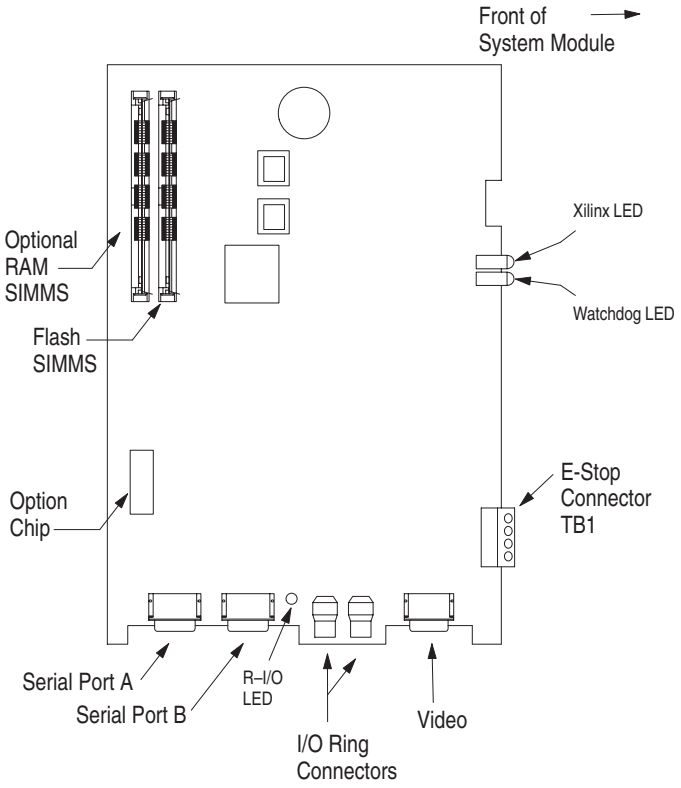


## 5B.2
## CNC Processor Board

The CNC processor board contains the main CPU. It provides connection for the 9/Series:

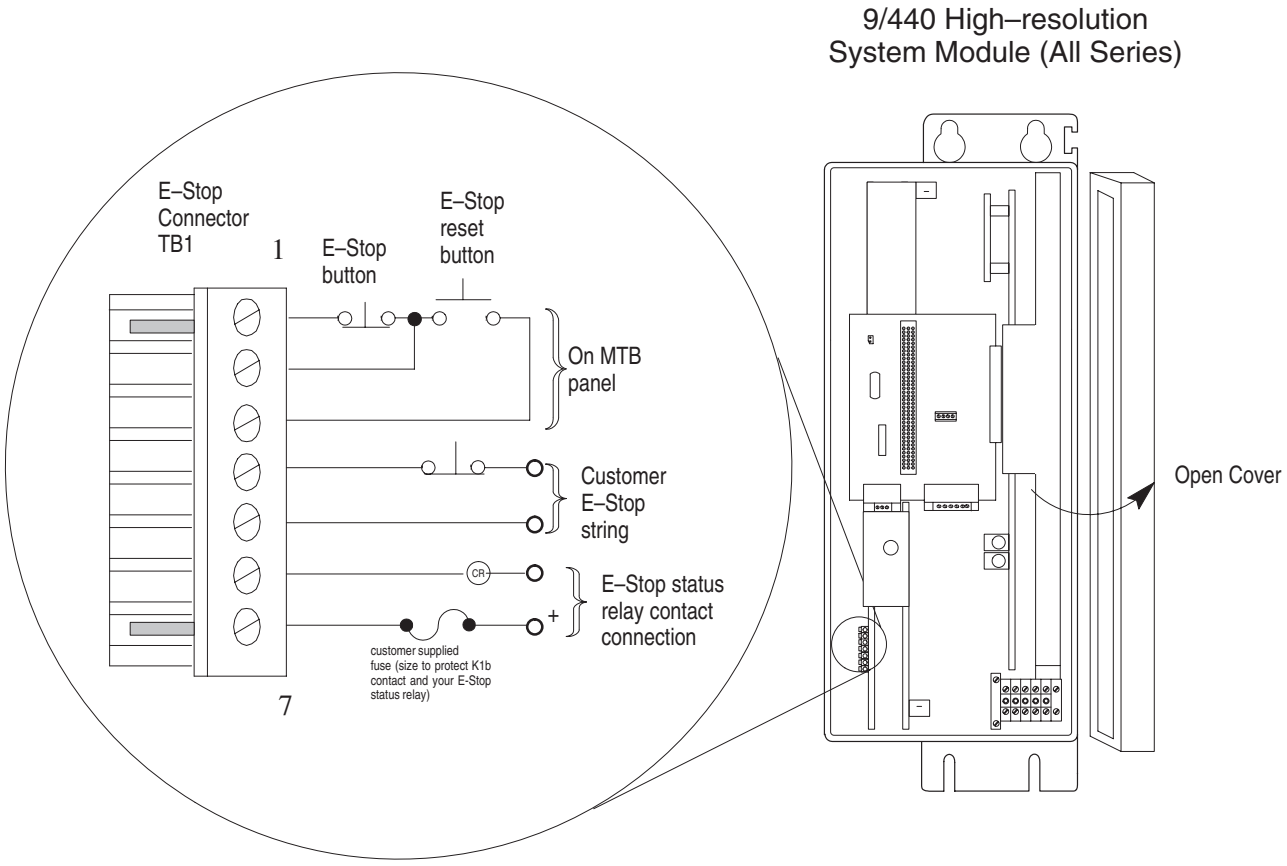
- fiber optic I/O ring
- E-Stop string
- connection to peripheral devices (two serial ports: A and B)
- video connection

**Figure 5B.2**
**CNC Processor Board**

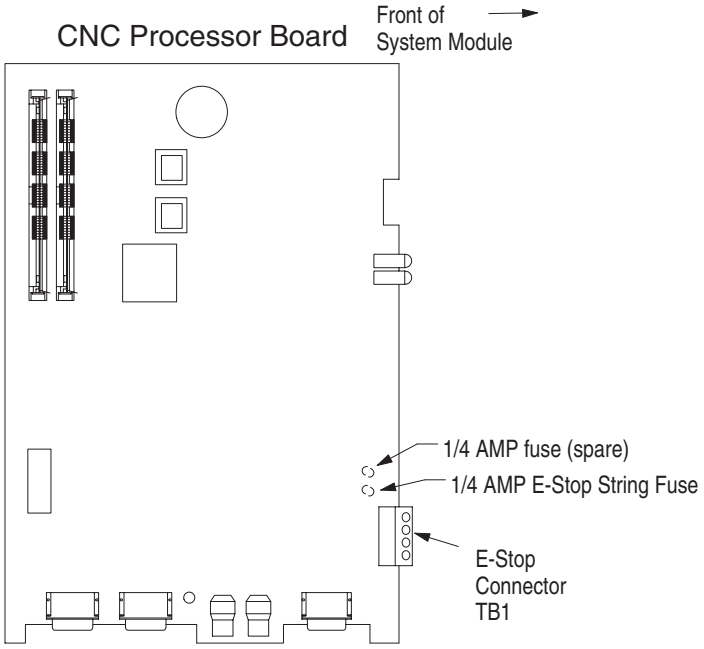


## E-Stop Plug

Connection of the E-Stop string appears in the same location for all series system modules. The following example figure indicates this location. More details on E-Stop connections to the 9/Series are given on page 6-1.



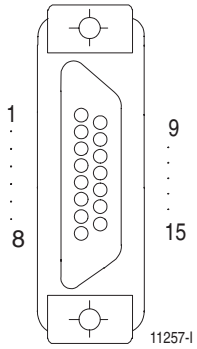
The E-Stop string is a 12V dc string protected by a .25 AMP 115 V fuse located on the 9/440HR CNC processor board. You must remove the CNC assembly from the system module to replace this fuse (see page 15B-58 for details).




## Video Monitor Connector

The video monitor connector is used to interface the video monitor with the control. Figure 5B.3 shows this connector and lists the pin assignments.

**Figure 5B.3**
**Video Monitor Connector-J8 (has pin sockets) and Pin Assignments**

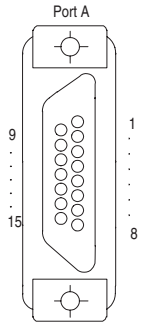



| Pin No. | Signal Name | Pin No. | Signal Name |
|---|---|---|---|
| 1 | GND (SHIELD) | 9 | RED (L) |
| 2 | RED (H) | 10 | GREEN (L) |
| 3 | GREEN (H) | 11 | BLUE (L) |
| 4 | BLUE (H) | 12 | NC |
| 5 | NC | 13 | CLOCK (L) |
| 6 | CLOCK (H) | 14 | H-SYNC (L) |
| 7 | H-SYNC (H) | 15 | V-SYNC (L) |
| 8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

## 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.4 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.4**
**Port A-J6 (has pin sockets) and Pin Assignments**



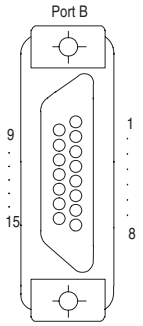

| Pin | Assignment |
|---|---|
| 1 | Chassis GND |
| 2 | Send Data |
| 3 | Receive Data |
| 4 | Request to Send |
| 5 | Clear to send |
| 6 | No connection |
| 7 | Signal GND |
| 8-15 | Not Used |

## 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.5 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.

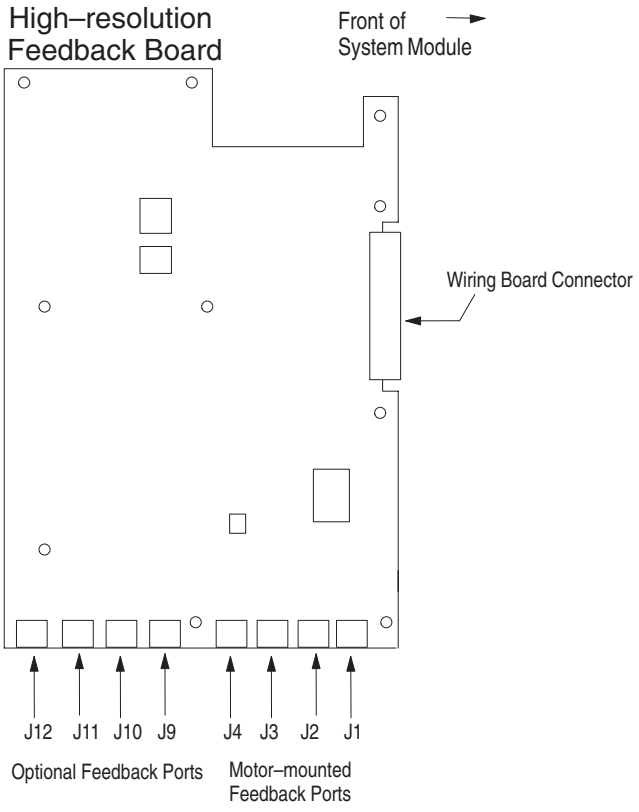
**Figure 5B.5**
**Port B-J7 (has pin sockets) and Pin Assignments**




| 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 | | |

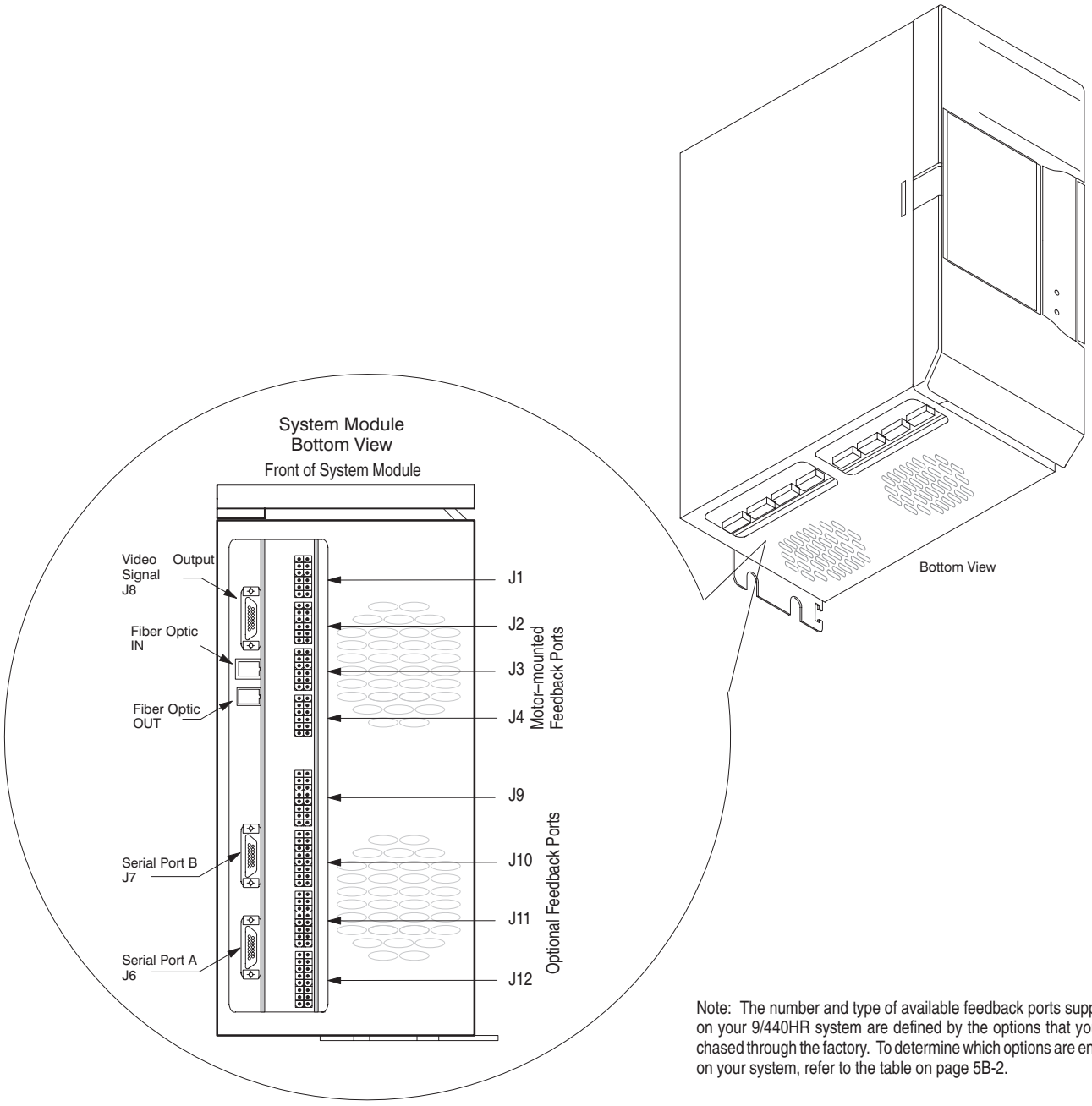
## 5B.3
## Connecting Feedback

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.



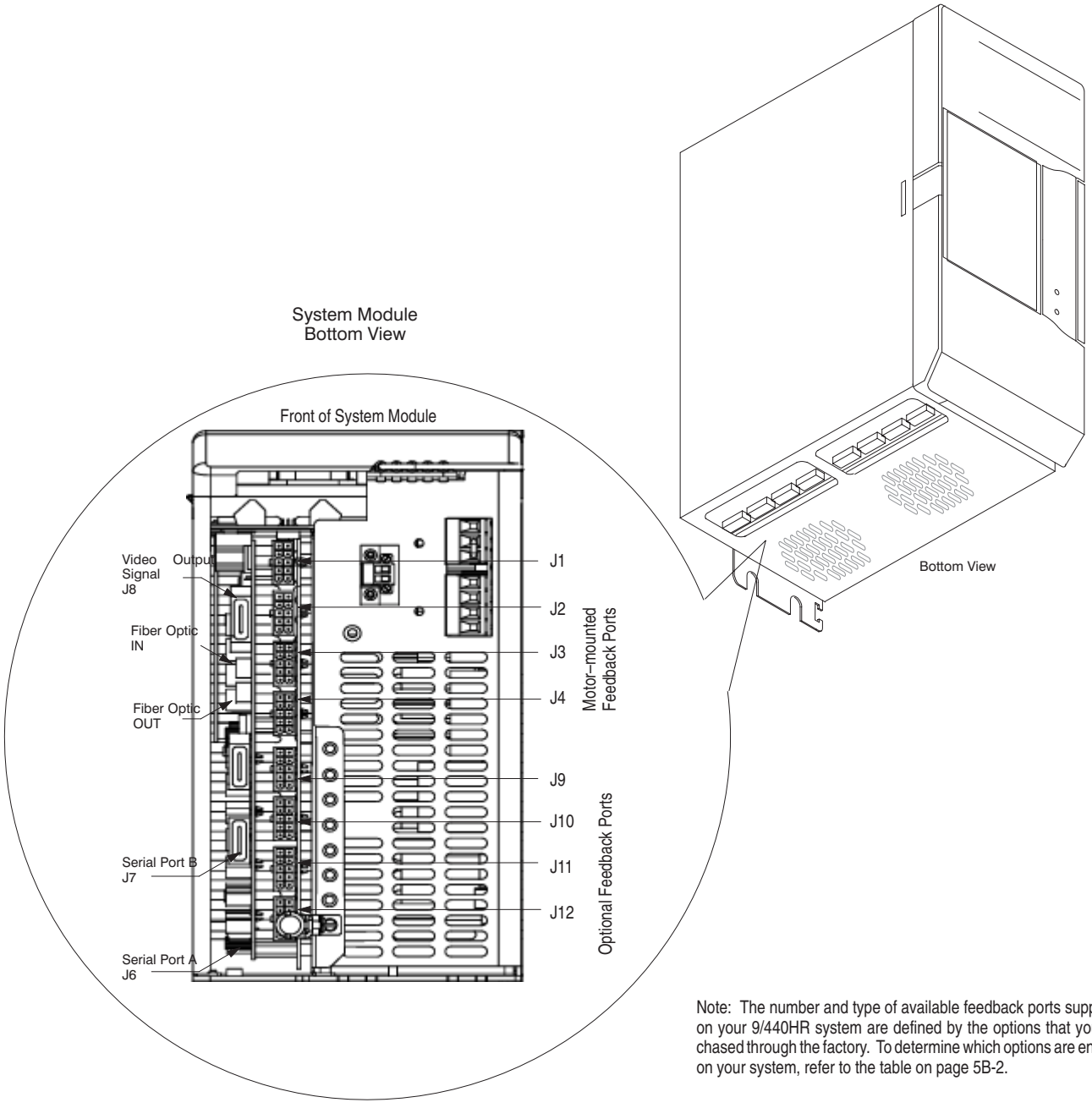
**Important:** Each feedback port must be configured in AMP to identify which axis the feedback is from as well as the type, direction, and resolution of the feedback. Refer to your 9/Series AMP Reference Manual for details.

**Figure 5B.6**
**Bottom View of System Module (Series A/B)**



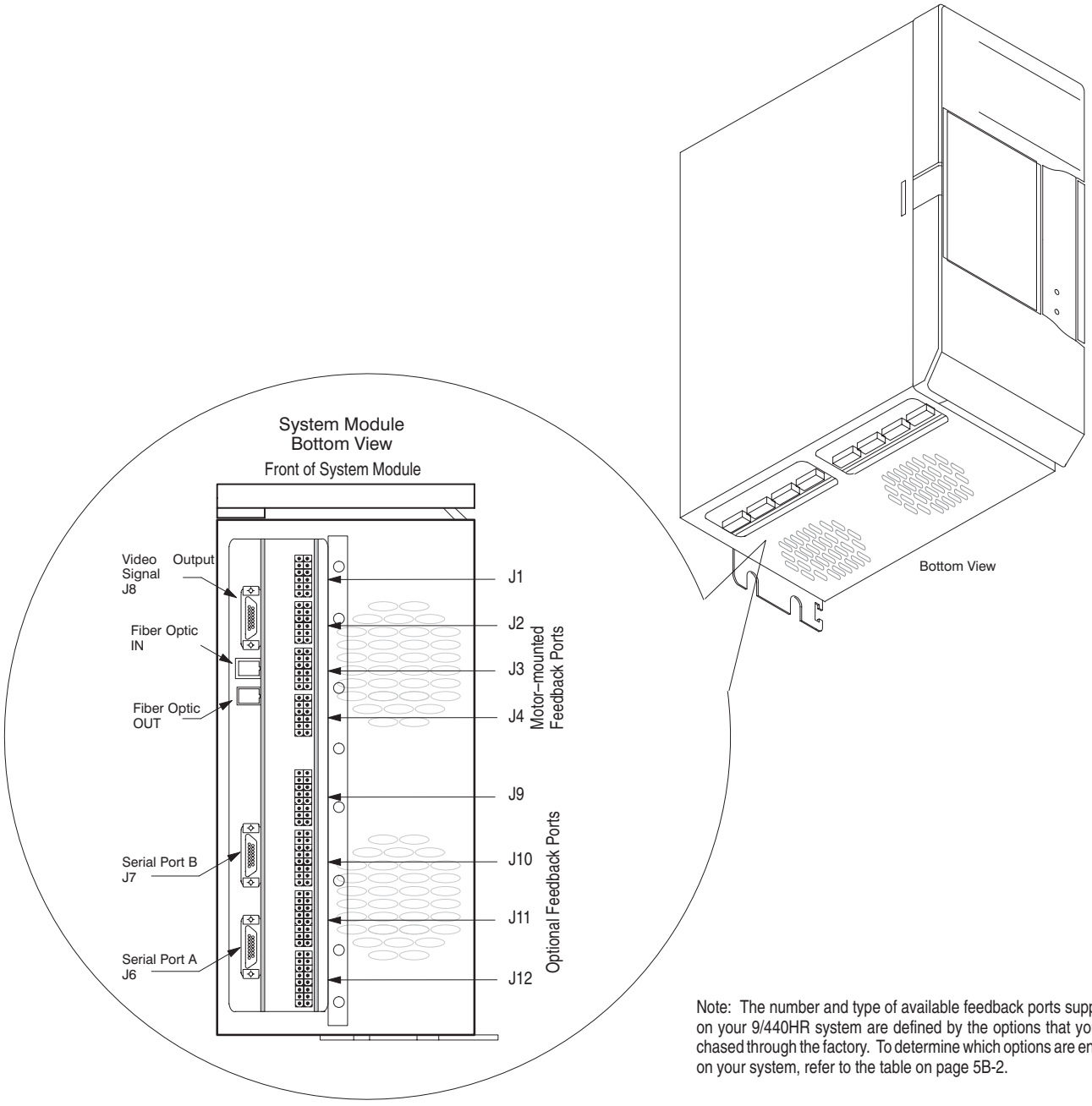

Note: The number and type of available feedback ports supported on your 9/440HR system are defined by the options that you purchased through the factory. To determine which options are enabled on your system, refer to the table on page 5B-2.

**Figure 5B.7**
**Bottom View of System Module (5 and 10 kW Series C)**




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.

**Figure 5B.8**
**Bottom View of System Module (22 kW Series C)**




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.


## Maximum Axis Speeds

Axis feedback resolution (for 1326AB motors with high–resolution feedback devices) for multiturn (SinCos) absolute high–resolution feedback devices is selected in AMP. The axis feedback resolution is 1,048,576 counts/rev. 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.

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).

**Figure 5B.9**
**Connecting High–resolution Feedback (Series A/B)**

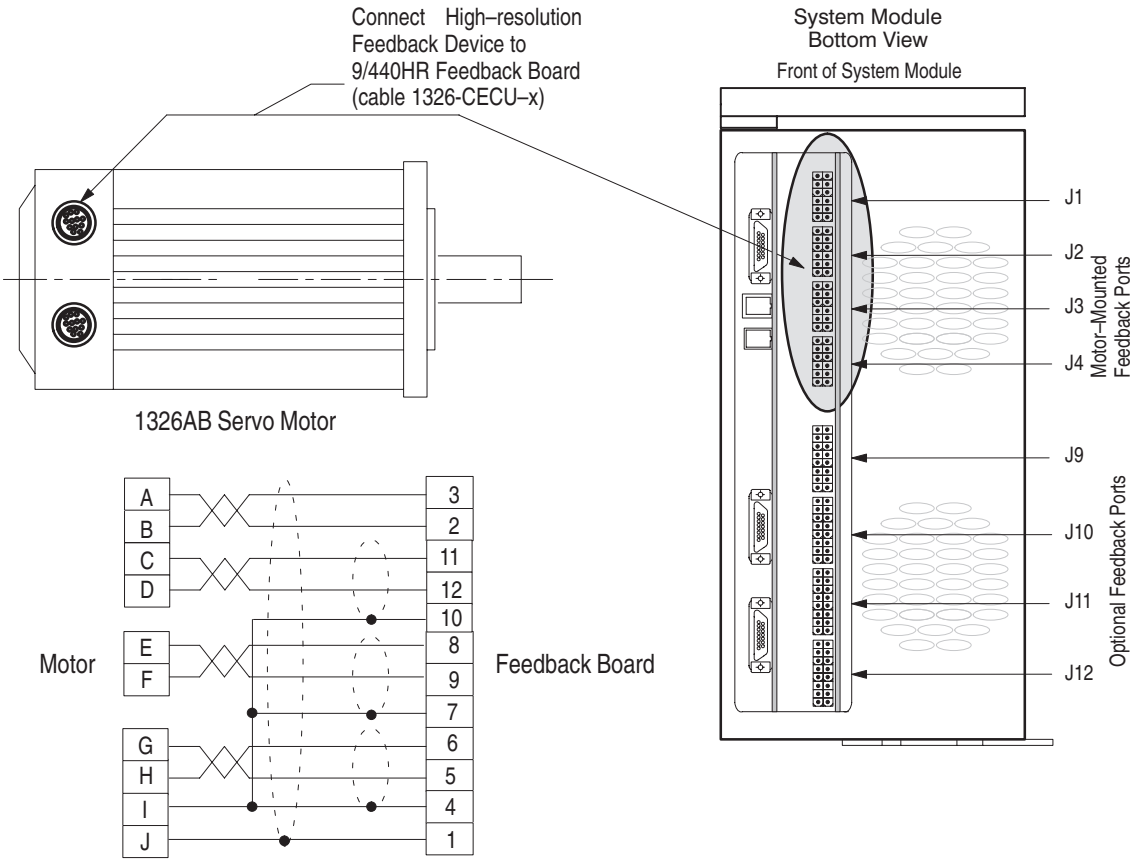


**Figure 5B.10**
**Connecting High–resolution Feedback (5 and 10 kW Series C)**

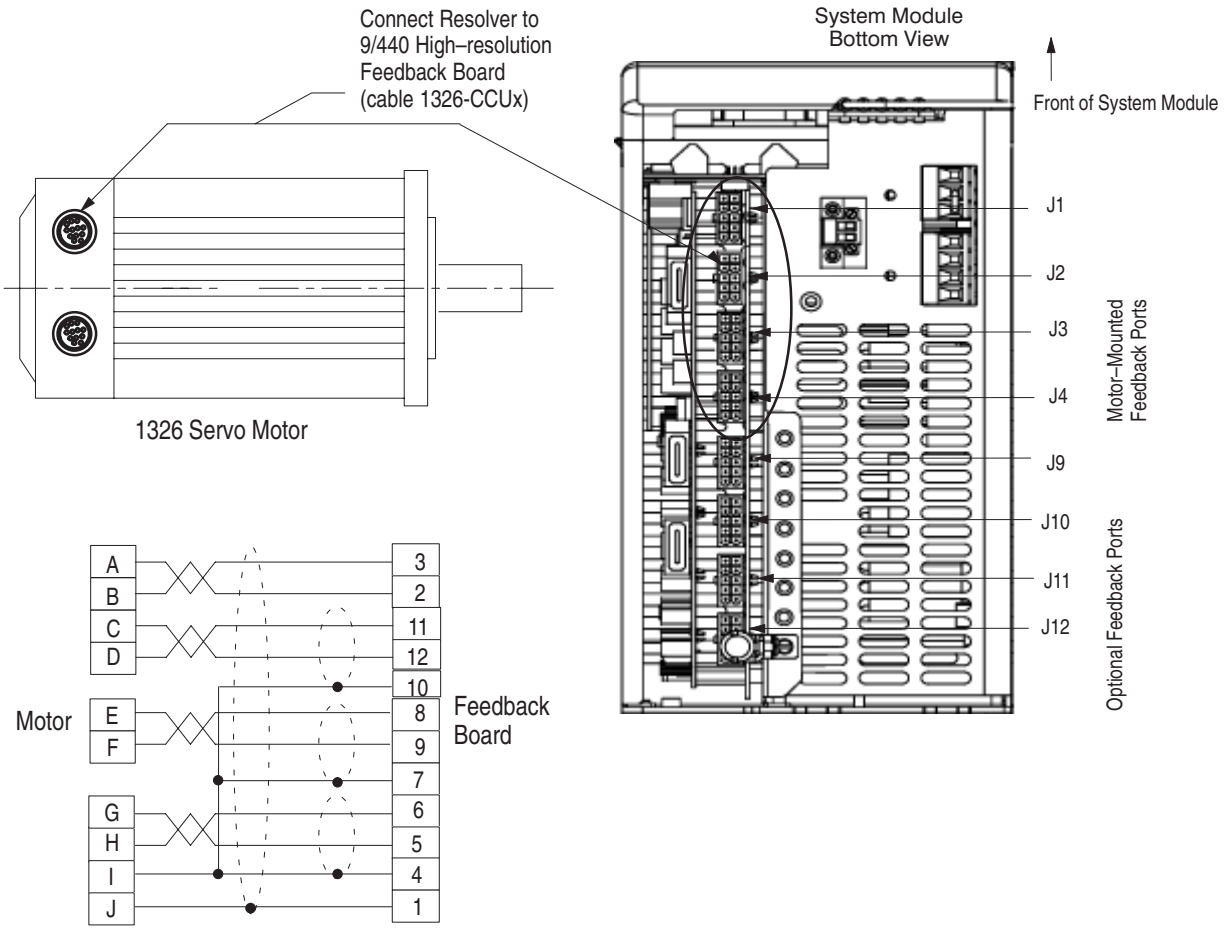
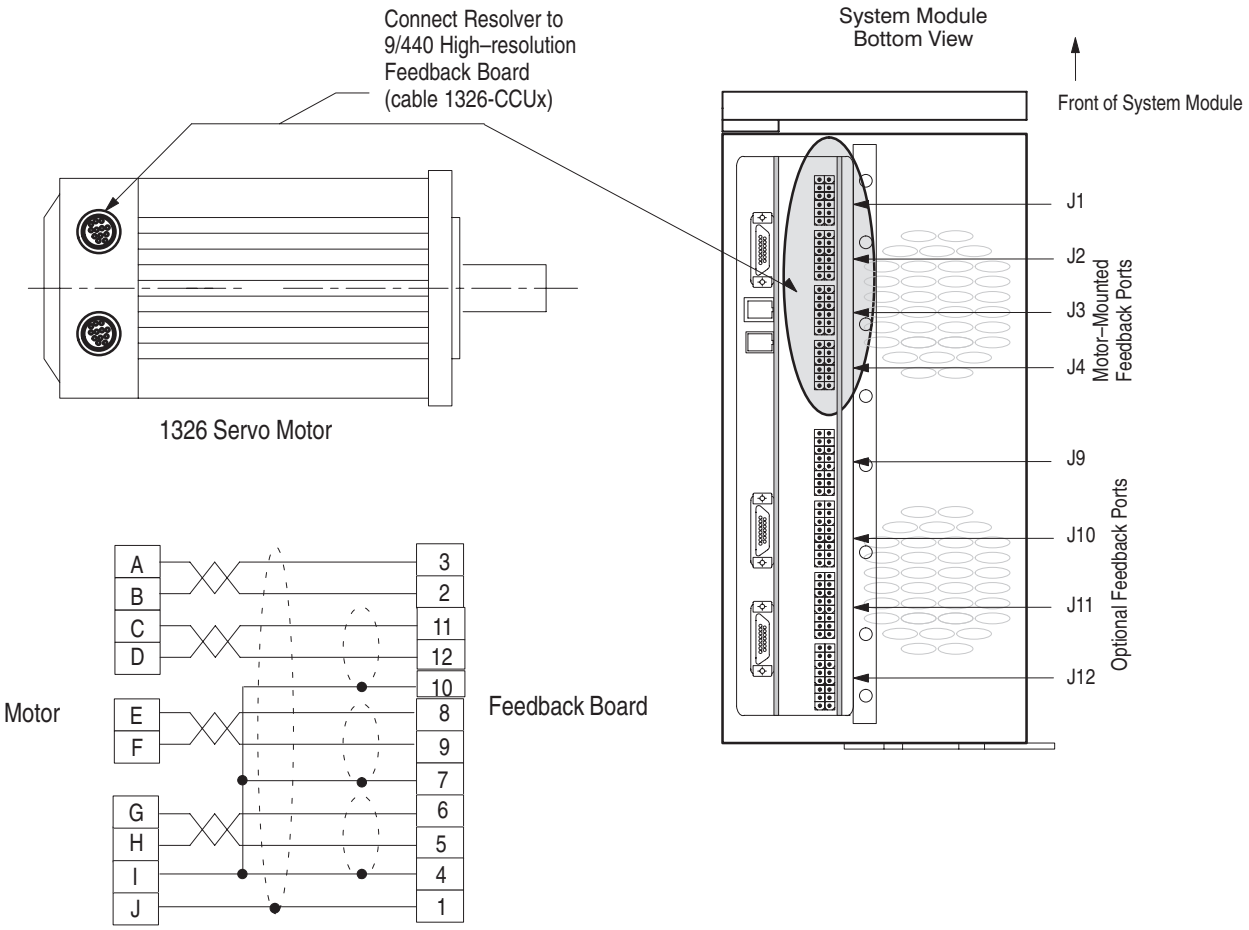


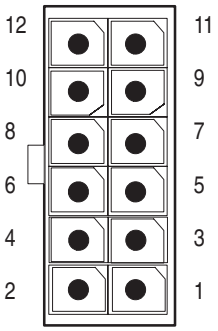
**Figure 5B.11**
**Connecting High–resolution Feedback (22 kW Series C)**




**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.12**
**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 5V dc.

## Wiring Motor Power, Thermals, and Brakes

The procedures in this section assume that your system and axis modules are already mounted. We recommend that you start at either the first or last axis module, wire it completely, and then wire the module next to it completely, and so on until they are all wired.

To wire your 1394 axis:

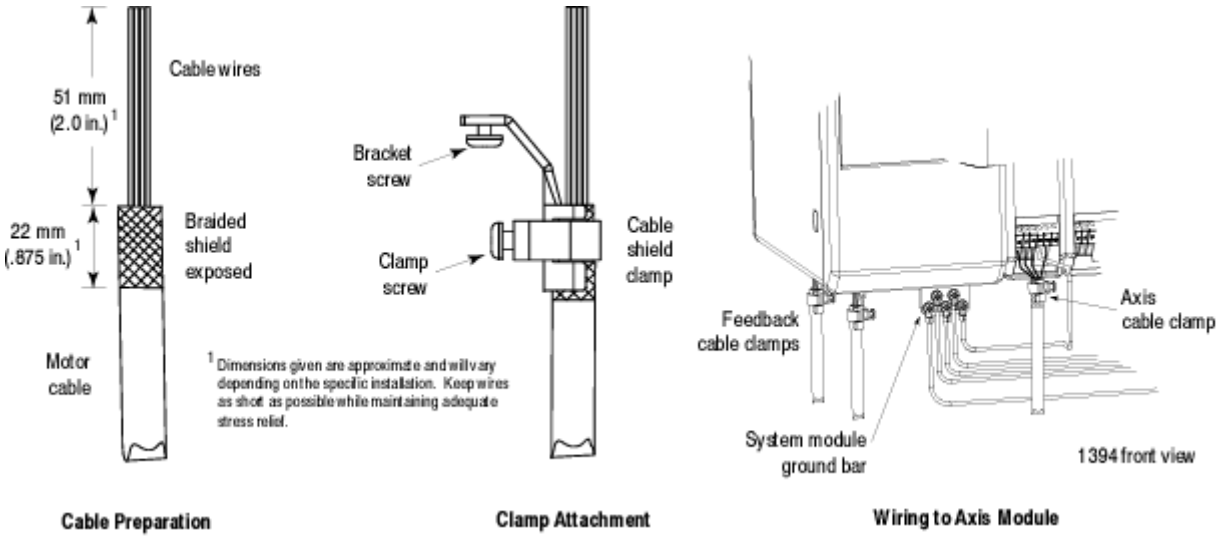
**1.**

| If you have this type of system module: | then: |
|---|---|
| Series A or B | 1. Bond one end of the axis module ground wire to the subpanel.<br>2. Connect the other end of the ground wire to terminal block PE1.<br>3. Go to main step 7. |
| Series C | 1. Connect one end of the axis module ground wire to the system module ground bar.<br>2. Connect the other end of the ground wire to terminal block PE1.<br>3. Go to main step 2. Refer to Figure 5B.13 for main steps 2 – 6. |

**Important:** For more information about bonding, refer to your 1394 documentation.

**Important:** To improve the bond between the motor cable shield and the axis module PE ground, a cable shield clamp is included with the Series C axis modules.

**Figure 5B.13**
**Series C Axis Module Cable Clamp**




**Cable Preparation** **Clamp Attachment** **Wiring to Axis Module**

**2.** Prepare one end of the motor cable for attachment to the cable shield clamp by removing the outer installation and braided shield from the motor cable. Ensure approximately 51 mm (2.0 in.) of the insulated cable wires are exposed (see Figure 5B.13).

**3.** Remove another 22 mm (0.875 in.) of insulation to expose the braided shield underneath for clamp attachment.

**Important:** When cutting into the insulation, use care not to cut into the braided shield underneath.

**4.** Position the cable shield clamp over the exposed braided shield (ensure clamp screw is behind clamp and not braided shield).

**5.** Tighten the clamp screw.

**Important:** Do not overtighten the clamp screw or damage to the braided shield may result.

**6.** Thread the bracket screw into the bottom of the axis module and tighten.

**7.** Connect an axis module connector kit (catalog number 1394–199) to each motor cable that you will use. Refer to the instructions included with the kit for the specific connections.

**8.** On one axis, connect the wires as follows:

| Insert the wire labeled: | into terminal block: |
|---|---|
| 1 | U1 |
| 2 | V1 |
| 3 | W1 |
| 8 | PE2 |
| bare wire (no label) | PE3[1] |
| [1]Applicable to Series A and B only. For Series C modules, the bare wire is replaced by the cable shield clamp on the motor cable. | |

**9.** Tighten and torque all five screw terminals to the values in the following table.

| Axis Module (kW) | Terminal Block Designator | Terminal Block Torque |
|---|---|---|
| 2, 3, and 5 | All | 0.56 – 0.62 N–m<br>(5.0 – 5.6 lb–in.) |
| 10 and 15 | All | 1.55 – 2.0 N–m<br>(14.0 – 18.0 lb–in.) |

**10.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten each loose wire.

**11.** Connect the brake and terminal switch connector to the front–most mating half (TB1) under its axis module. Refer to your 1394 documentation for information about thermal switch interconnections.

**12.**

| If your motor... | then do the following... |
|---|---|
| has the brake option | 1. Connect the appropriate control wires to the second connector in the axis module connector kit to the appropriate cable.<br>2. Insert the connector in the rear–most mating half (TB2) for its axis.<br>3. Go to main step 13. |
| does not have the brake option | Go to main step 13. |

**13.** Wire your thermal switch into the appropriate control circuitry for monitoring purposes. Refer to your 1394 documentation for information about thermal switch interconnections.

**ATTENTION:** To avoid damage to your motor, monitor the thermal switch for overheat conditions.

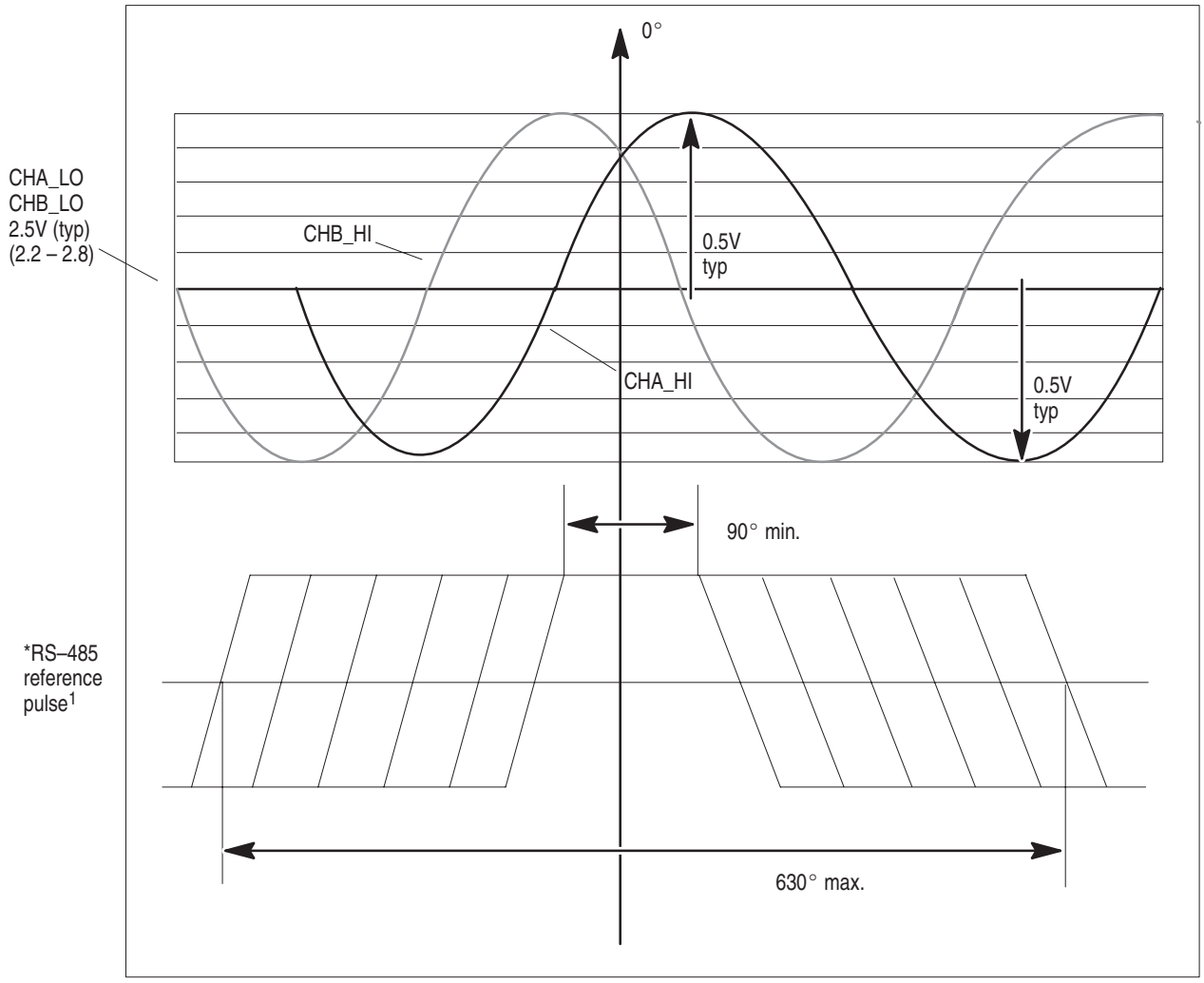
**14.**

| If you have: | then: |
|---|---|
| more axis modules to wire | move to the next axis module and move to main step 2. |
| wired all of your axis modules | refer to your 1394 system documentation. |

**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.

**Figure 5B.14**
**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:

- absolute position and rotational position for absolute HIPERFACE devices

## 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.

**Figure 5B.15**
**Connecting A quad B Optional Feedback Ports (Series A/B)**

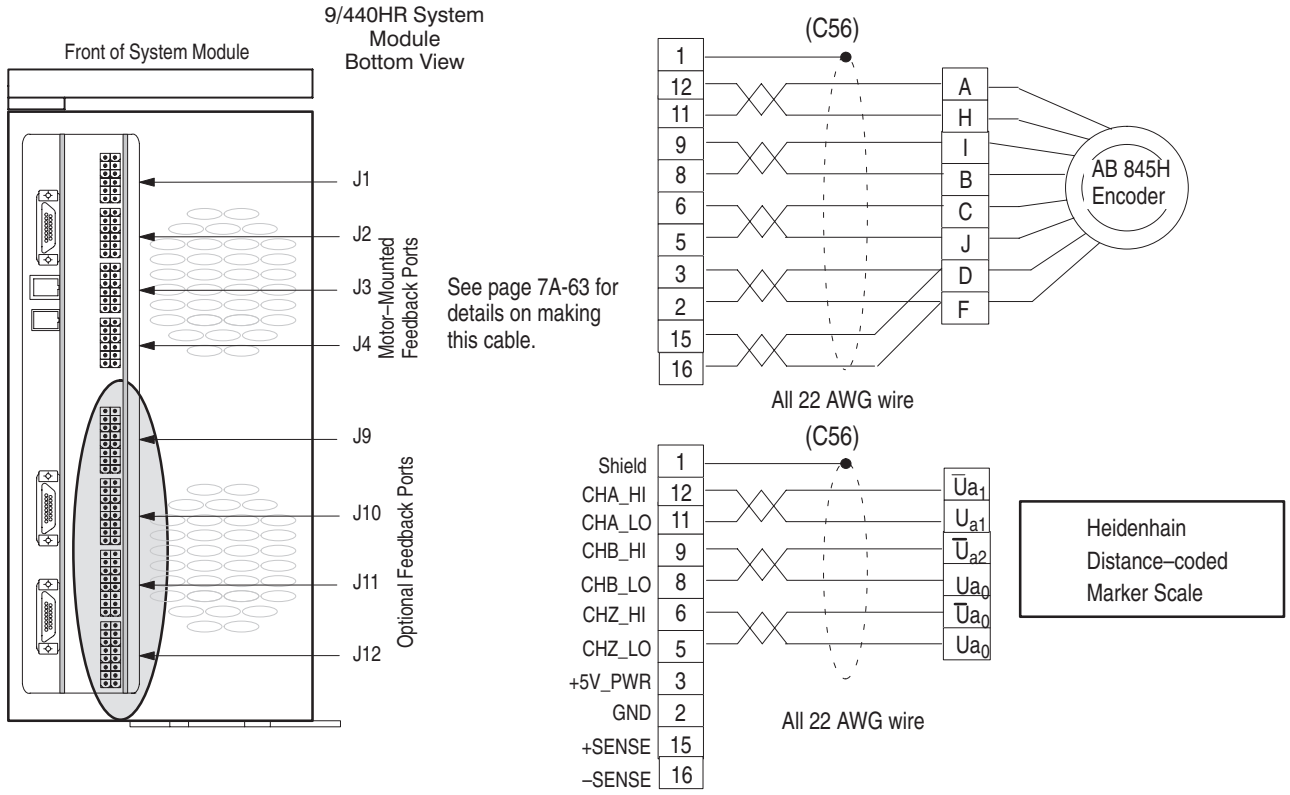


**Figure 5B.16**
**Connecting A quad B Optional Feedback Ports (5 and 10 kW Series C)**

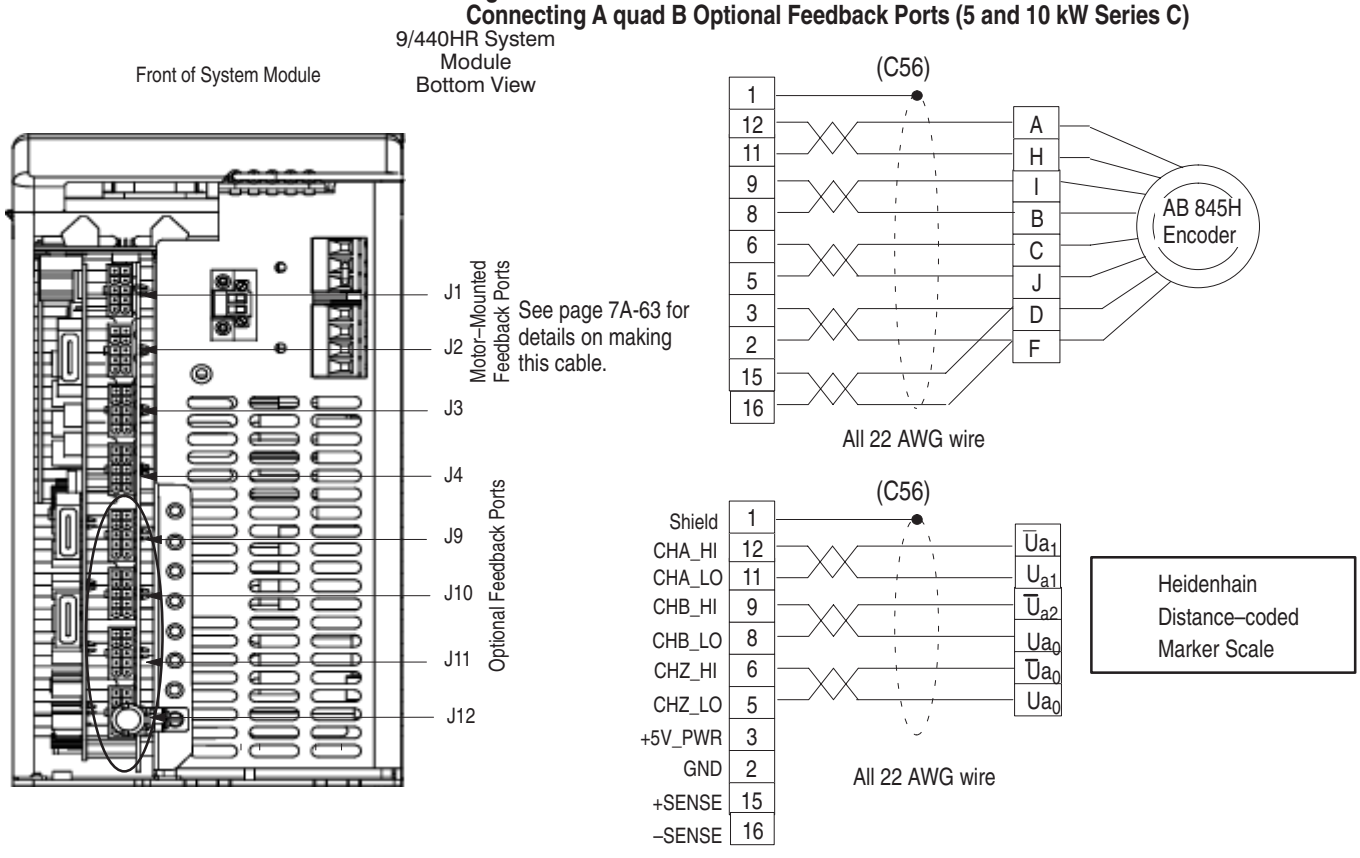


**Figure 5B.17**
**Connecting A quad B Optional Feedback Ports (22 kW Series C)**

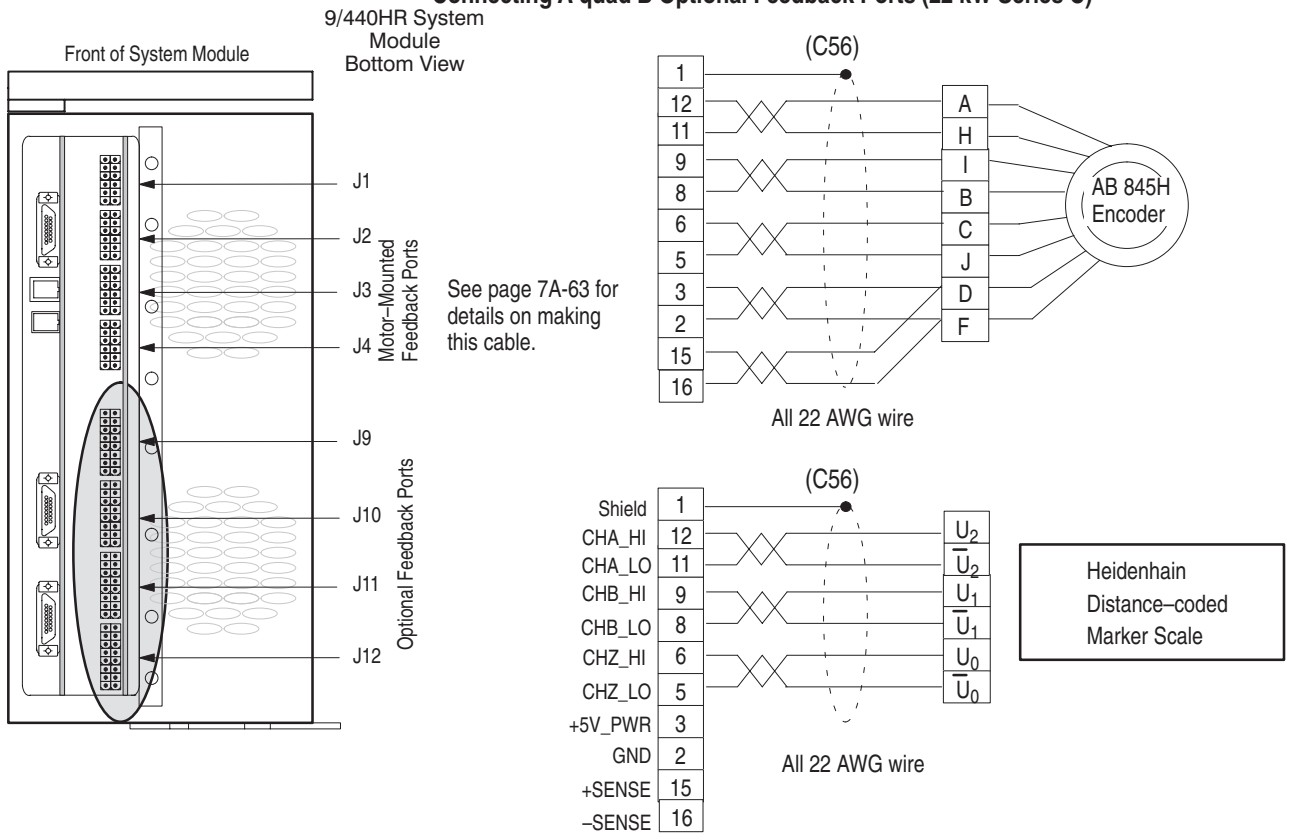
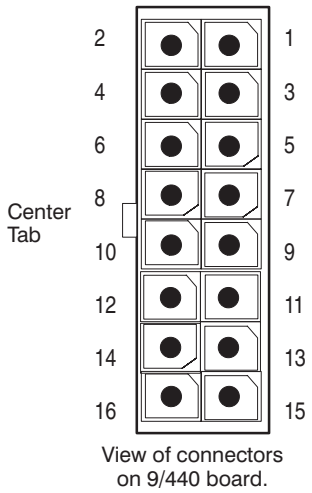


**Figure 5B.18**
**Pin Configuration for the Encoder Connectors on the 9/440HR CNC/Drive**




| 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. For information about wiring motor power, thermals, and brakes, refer to page 5B-17.

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.

- 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], LS486, LS704 |
| Newall Spherosyn | — |

[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* 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<br><br>$\text{Maximum Encoder Channel Frequency} = \frac{\text{Clock}}{\left(\frac{360}{90-Eq}\right) \times 1.15}$<br><br>Where:<br><br>Clock – is the Control's Feedback Clock Frequency:<br>$5 \times 10^6$ – for 9/230, 9/440, and three–axis servo cards.<br>$2.3 \times 10^7$ – for 9/260 or 9/290 systems using a four–axis servo card<br><br>$E_Q$ = Quadrature Error in Degrees<br><br>1.15 = Our minimum recommended safety factor<br><br>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. |

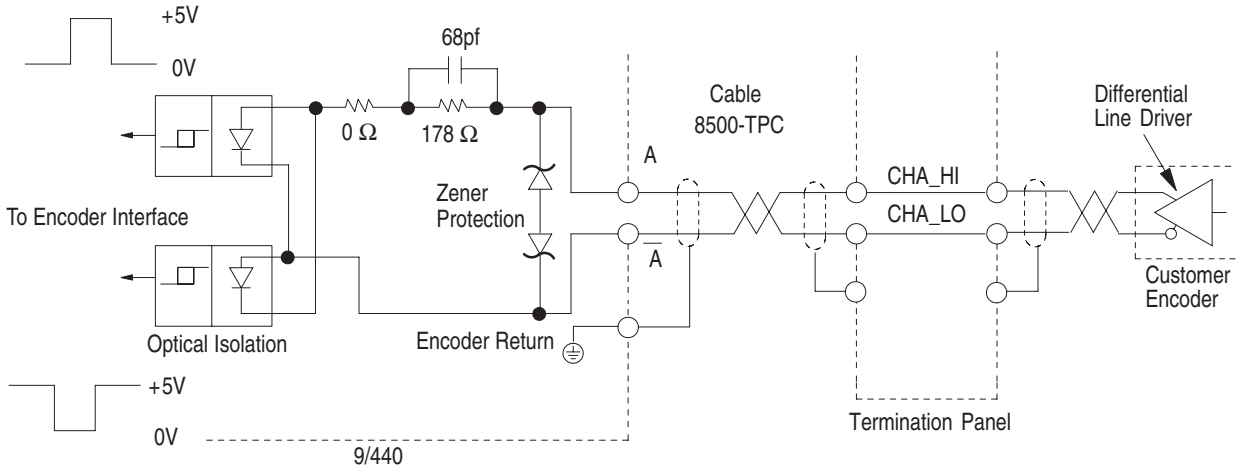
| | |
|---|---|
| Maximum Axis Speed | Use the following equation to determine the maximum axis speed. Note that this equation does not take into consideration any mechanical deficiencies in the encoder or motor. It is only concerned with the 9/Series capability of receiving feedback. Refer to the manufactures specs for encoder and motor hardware RPM limitations.<br><br>$\frac{(ECF \times 60)}{(E)\ (N)\ (P)} = \text{Maximum Axis Speed}$<br><br>Where:<br><br>Max Axis Speed = Maximum Axis Speed based on encoder feedback (inches or millimeters per minute)<br><br>ECF = Maximum encoder channel frequency the control may receive in units of cycles/sec.<br><br>E = the number of encoder lines between markers for your encoder<br>E = 1024 sin/cos cycles per revolution for HR Single–turn Absolute (SinCoder)<br>E = 512 sin/cos cycles per revolution for HR Multiturn Absolute (SinCos)<br><br>N = the ratio of encoder turns to ballscrew turns<br><br>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.<br><br>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.

## Wiring an Incremental Feedback Device

Figure 5B.19 shows an incremental feedback device equivalent circuit for feedback channel A.

**Figure 5B.19**
**Incremental Feedback Device Equivalent Circuit for**
**A Quad B High–resolution Feedback Devices (J9 – J12)**

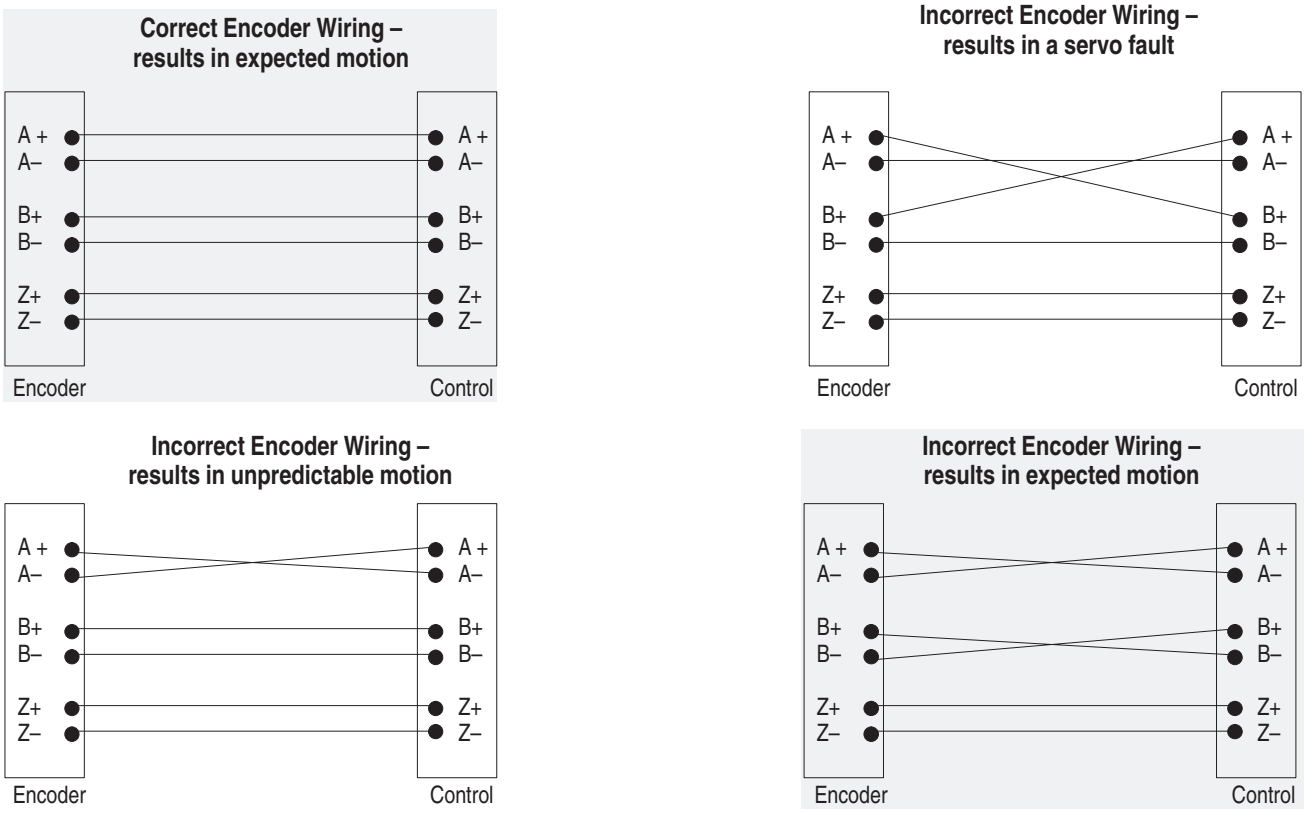



## Wiring Position Feedback

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:

**Figure 5B.20**
**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.

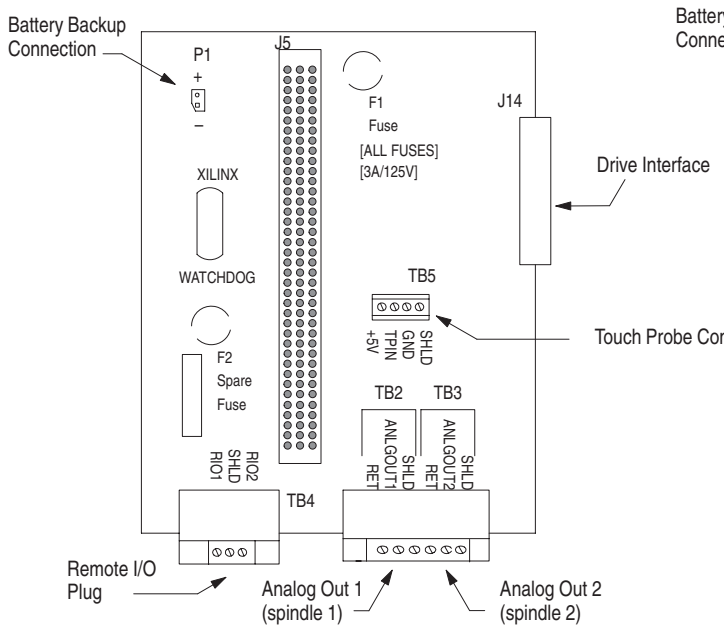
## 5B.4
## 9/440HR CNC Wiring Board

The CNC wiring board provides an easy location to wire additional hardware. It provides connection for:

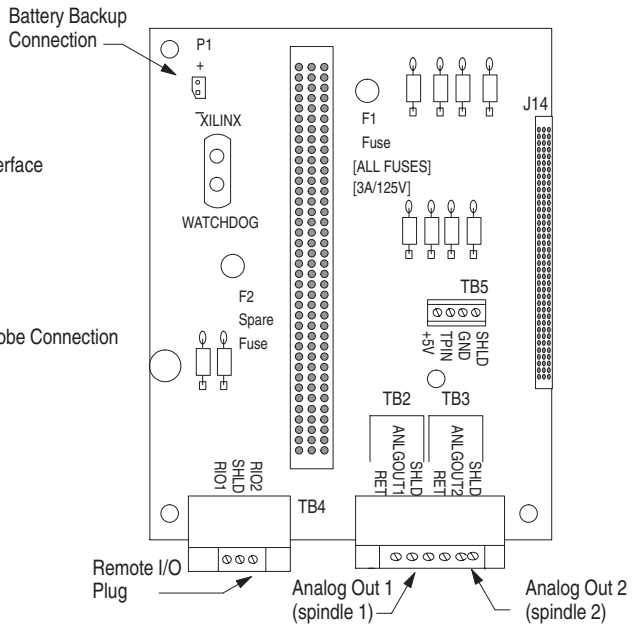
- analog outputs (typically for spindles)
- touch probe
- remote I/O
- interface between the CNC assembly and power assembly

The main fuse for the 9/440HR CNC assembly is also located on this board.

Series A/B Wiring Board




Series C 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.

Location of TB5 on Wiring Board

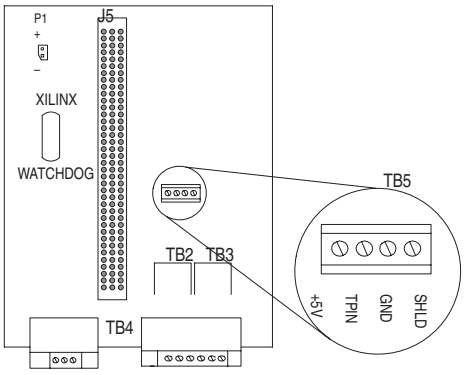



**Table 5B.A**
**TB5 Connector, 4 Plug-type Terminal Block Connections**

| 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.

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.21). Other configurations can be supported as long as the user operates within the published electrical specifications.

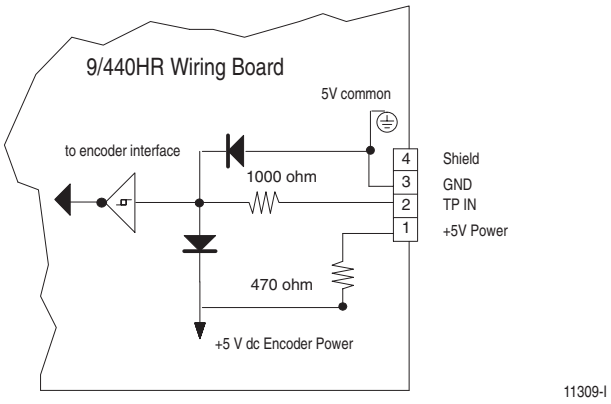
The touch probe circuitry resident on the 9/440HR only responds to the trigger probe edge changes. Polarity transition (high to low or low to high) is selectable through the AMP parameter Probe Transition. Specify the probe transition in AMP as rising edge or falling edge. Once the active edge occurs, 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* 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.

Figure 5B.21 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.21**
**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

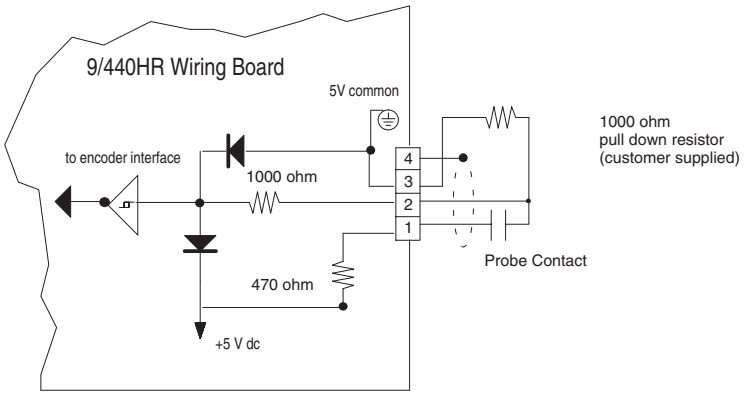
| Probe Thresholds | Voltage at Threshold |
|---|---|
| Minimum Input Threshold (probe circuit) | 3.06 (min) |
| Maximum Input Threshold (probe circuit) | 2.18V dc (max) |

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 5B.22 shows a typical wiring diagram compatible with most probe designs configured to trigger on the rising edge of the probes signal.

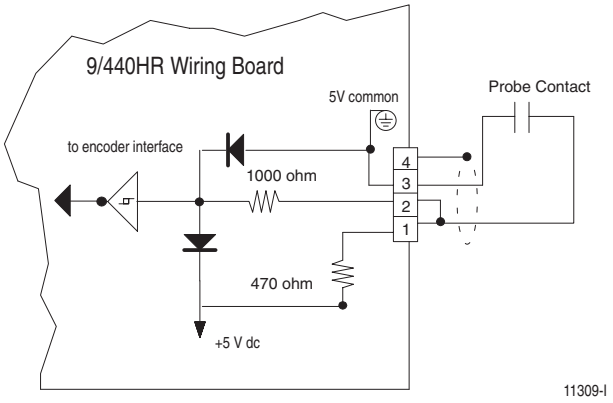
**Figure 5B.22**
**Typical Wiring of a Touch Probe Configured for Rising Edge Trigger**



## Wiring a Probe for Falling Edge Configuration

Figure 5B.23 shows a typical wiring diagram compatible with most probe designs configured to trigger on the falling edge of the probe signal.

**Figure 5B.23**
**Typical Wiring of a Touch Probe Configured for Falling Edge Trigger**

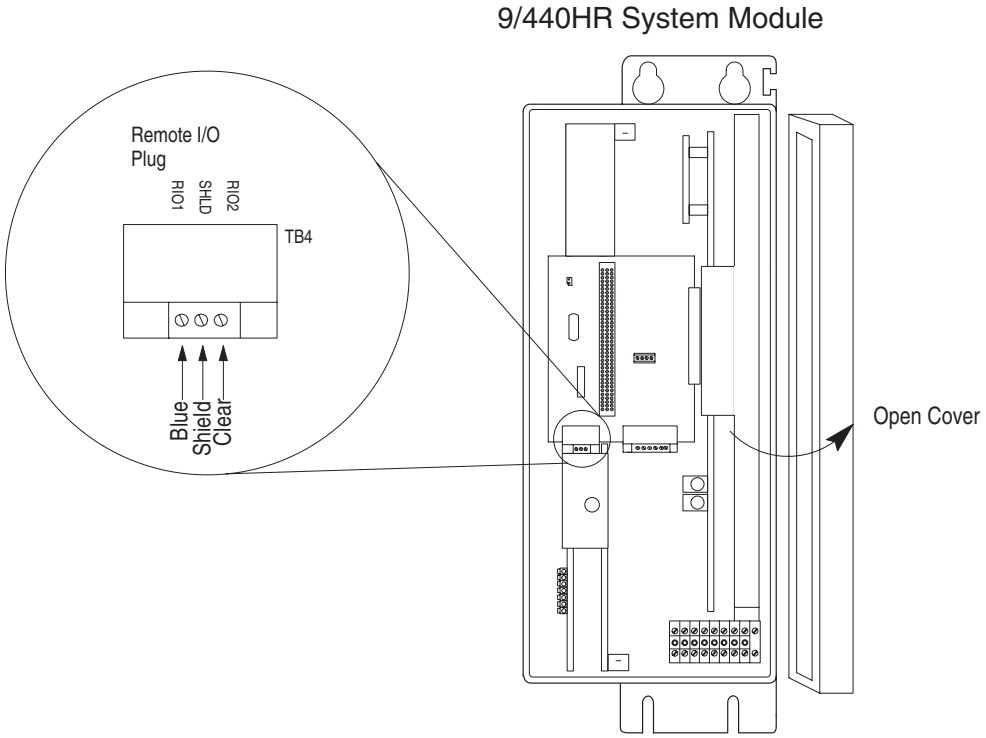


## 5B.4.2 9/440HR Remote I/O Connection

The remote I/O circuitry and connector are integral parts of the wiring board in the 9/440HR system module. Figure 5A.22 shows the location of the remote I/O connector. This connector is mounted in the same location on all Series 9/440HR wiring boards.

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.

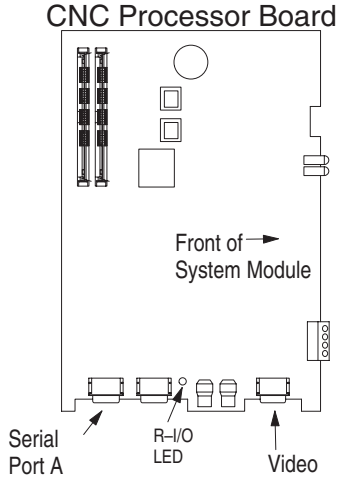
**Figure 5B.24**
**Remote I/O Connector in System Module (All Series)**




### 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.)




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:

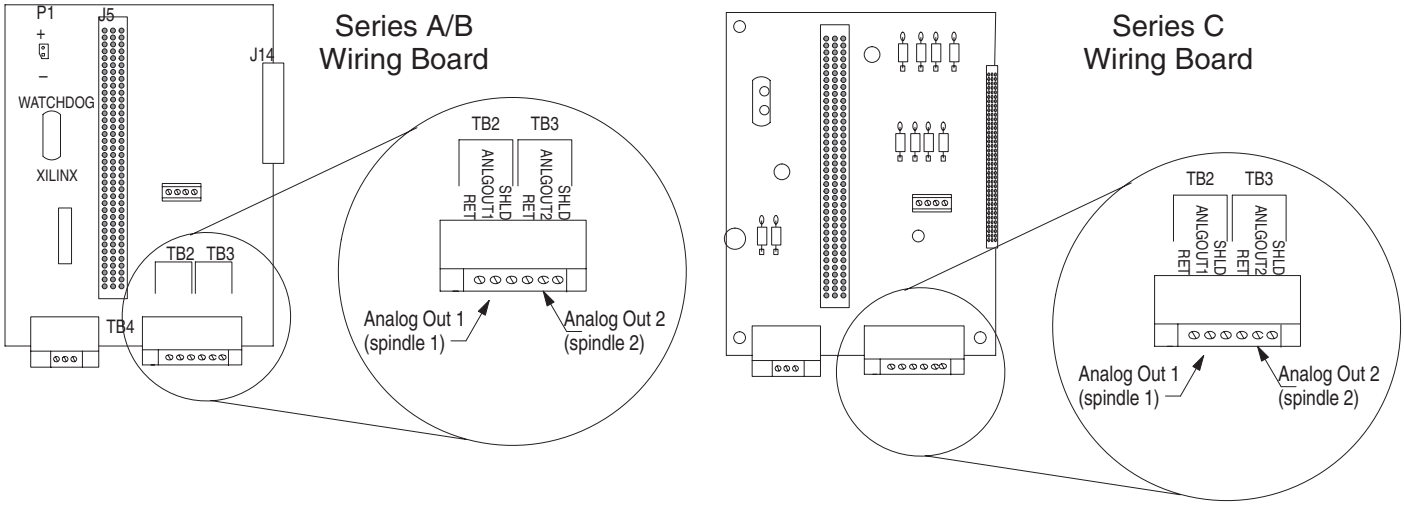
| LED | Status | Description |
|---|---|---|
| **Green R–I/O LED** | ON | Active Link to PLC. This is the normal state when the RIO link is active. |
| | FLASHING | The remote I/O link is active but the PLC is currently in program mode. |
| | OFF | Remote I/O link is offline. The port is not being used, 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.25 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.25**
**Terminal Block TB2 and TB3, Plug-type Terminal Block Connections.**



| 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 |

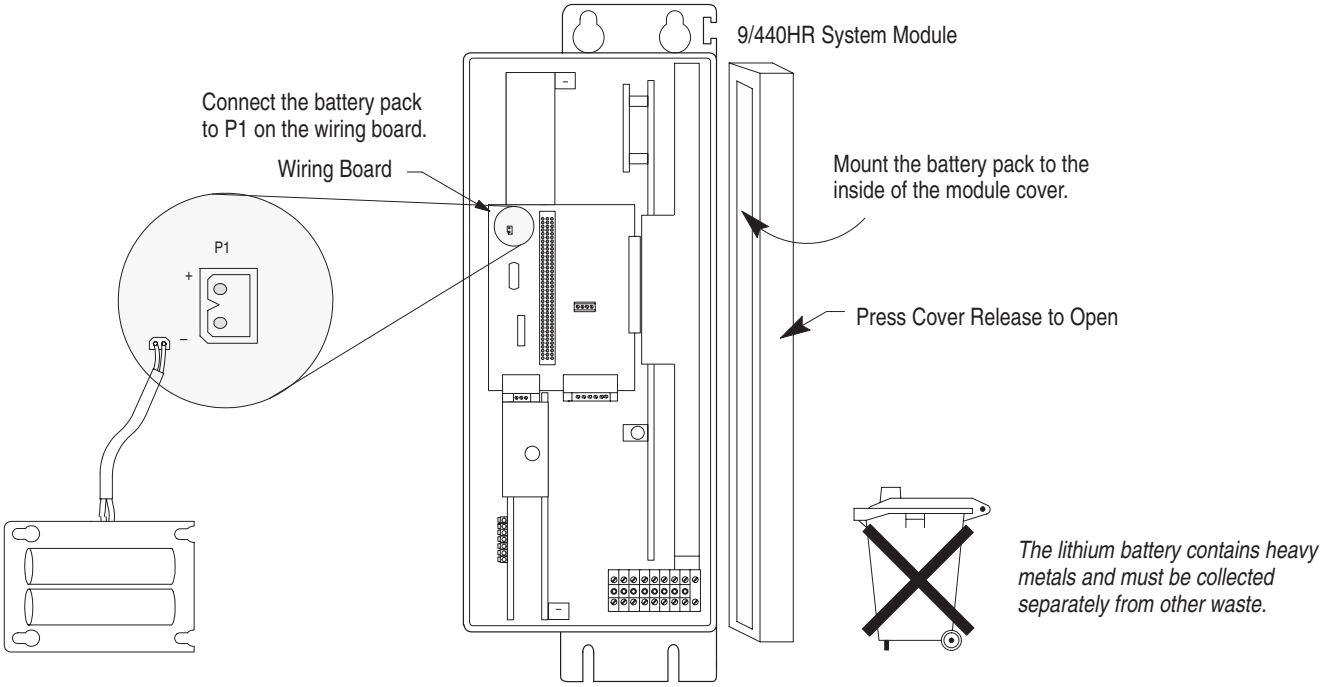
## 5B.4.4 Battery Backup

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 |

For all Series, this battery pack is connected to the lithium battery connector (P1) on the wiring board. See Figure 5A.24 for an example of this location. Batteries and the battery cable are included with the battery replacement kit.

**Figure 5B.26**
**Lithium Battery (All Series)**



## 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 24V ac or 24V 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 324-528V 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. | |

**Figure 5B.27**
**Power Terminal Block (Series A/B)**

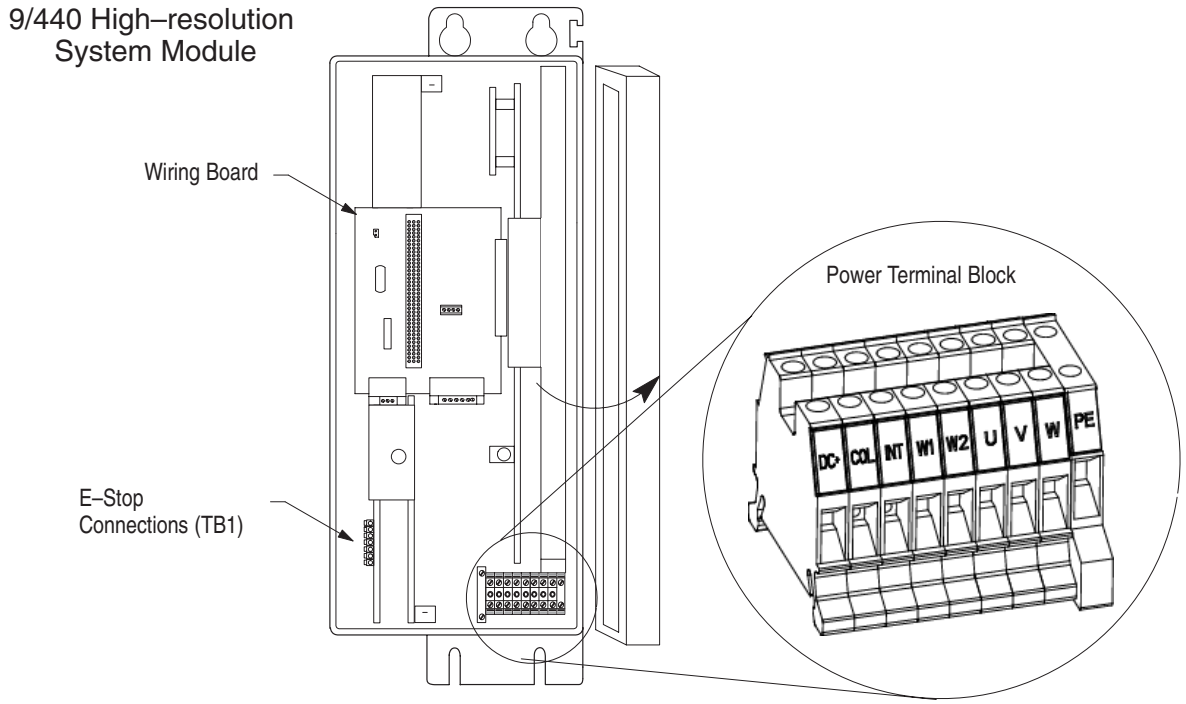


**Figure 5B.28**
**Power Terminal Block (5 and 10 kW Series C)**

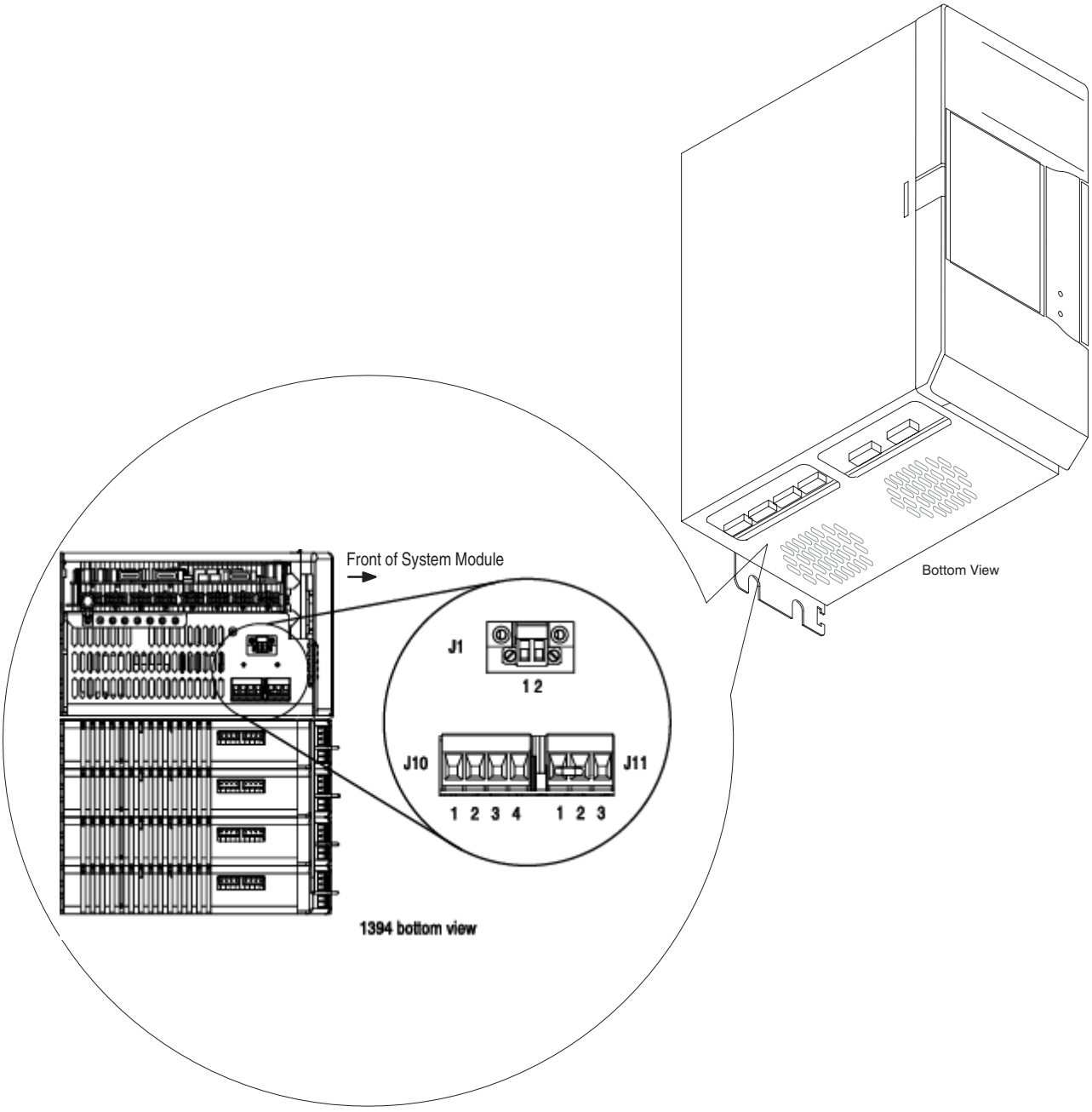
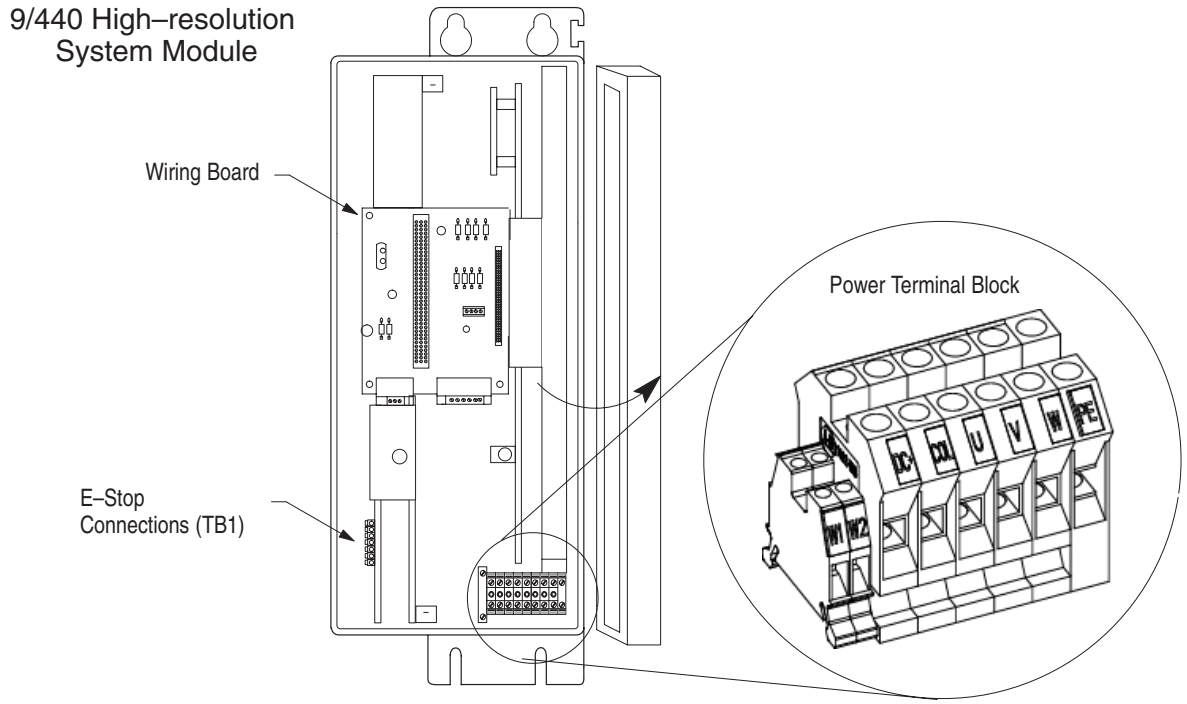


**Figure 5B.29**
**Power Terminal Block (22 kW Series C)**



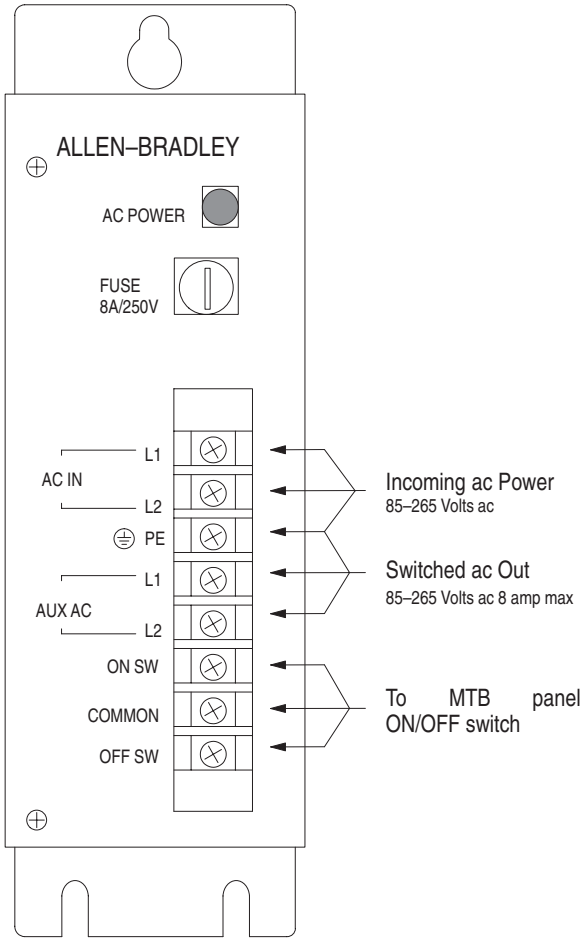

## 5B.5.1 On/Off Control and 24V Logic Power

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 | | | |
|---|---|---|---|---|---|
| 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) | 1 | 2 | 3 | 4 |
| | | 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.30**
**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.39).

**Figure 5B.31**
**Connecting On/Off Power Control Assembly and 24V Transformer (Series A/B)**

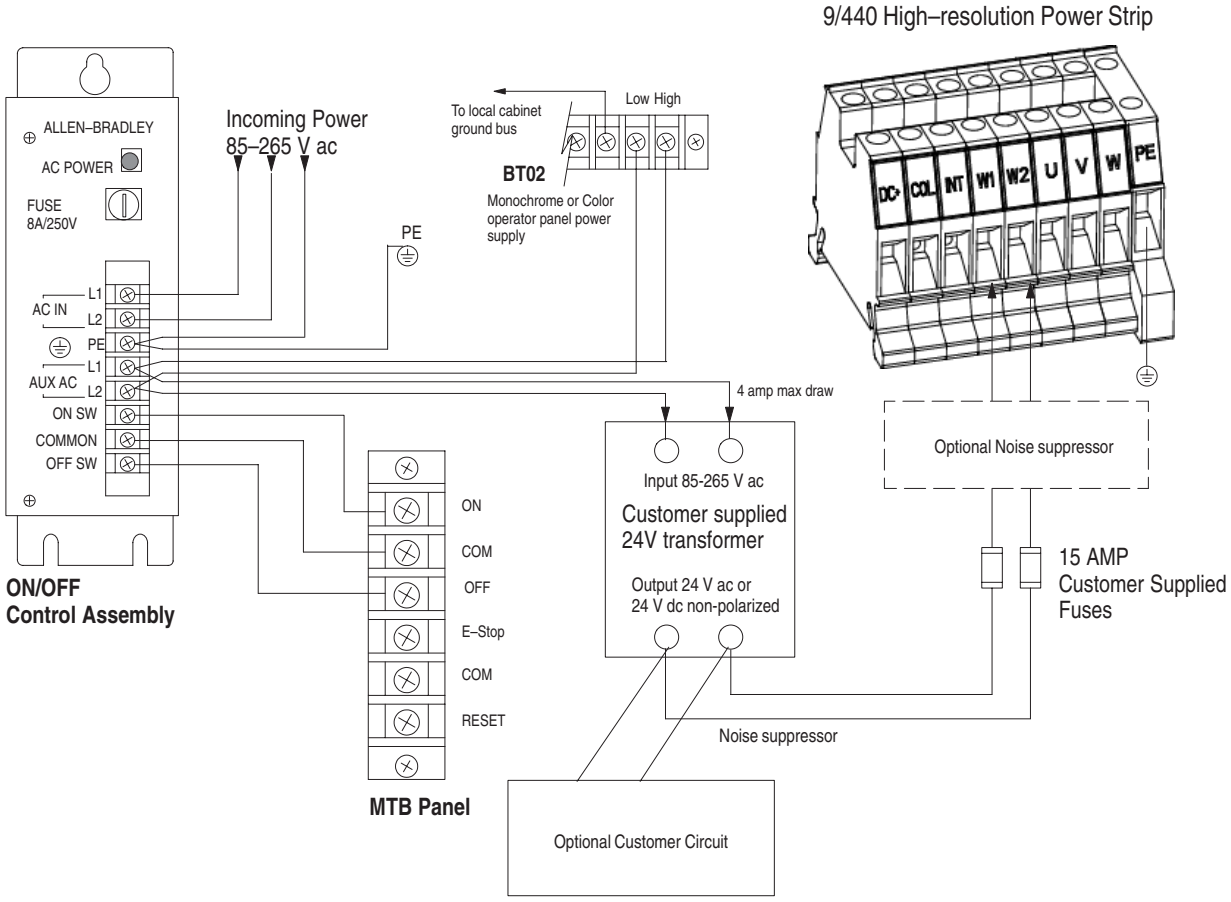


**Figure 5B.32**
**Connecting On/Off Power Control Assembly and 24V Transformer**
**(5 and 10 kW Series C)**

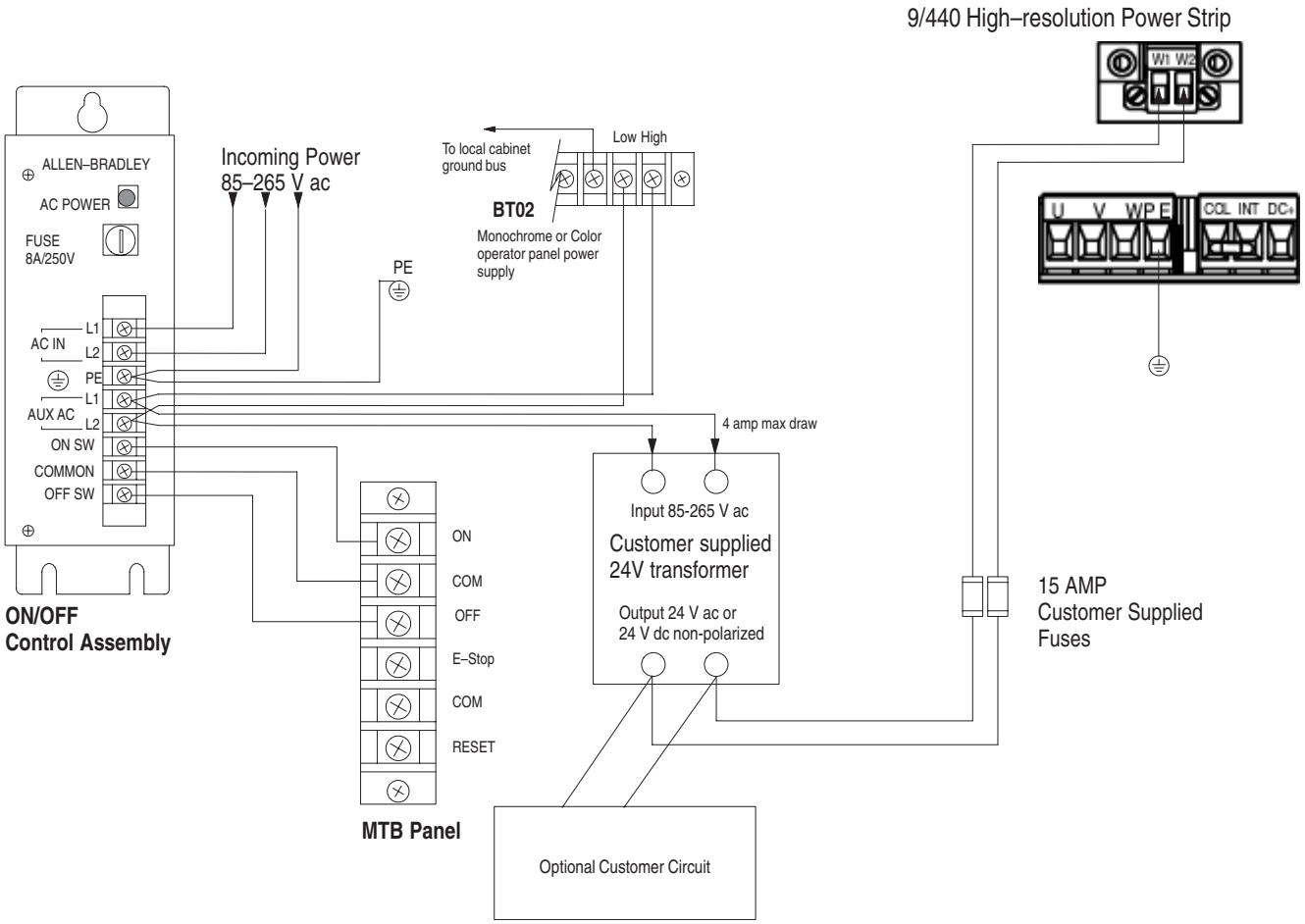
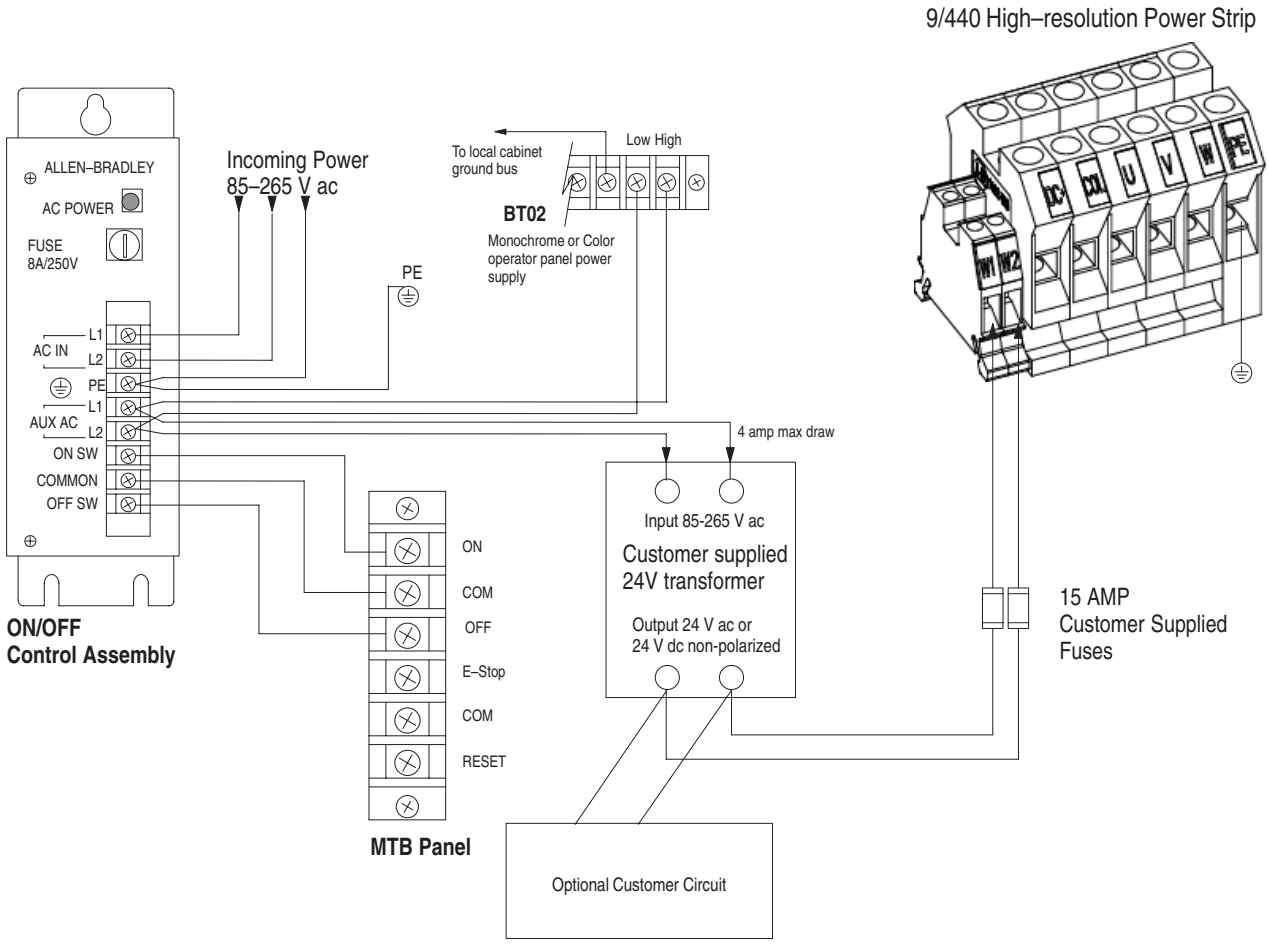


**Figure 5B.33**
**Connecting On/Off Power Control Assembly and 24V Transformer (22 kW Series C)**




**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.

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.32.

**Figure 5B.34**
**Connecting On/Off Power Control Assembly and 24V Power Supply (Series A/B)**

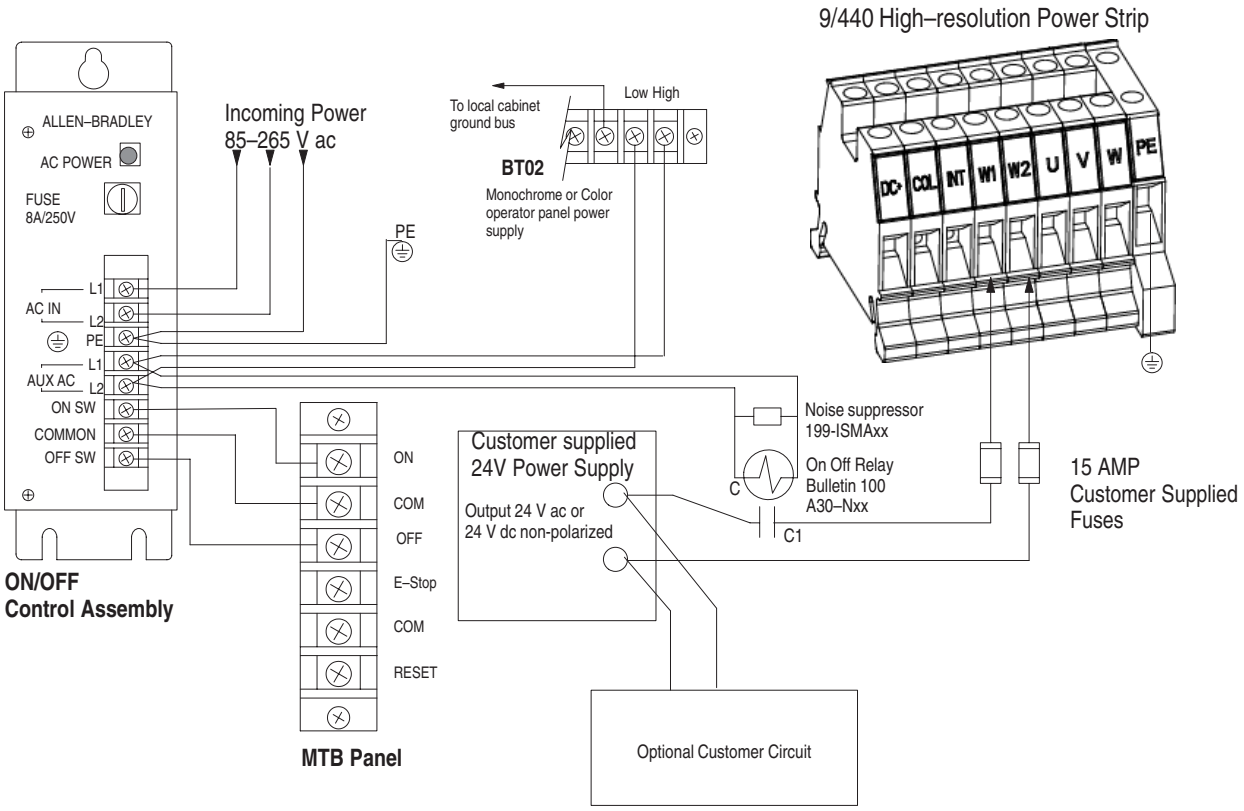


**Figure 5B.35**
**Connecting On/Off Power Control Assembly and 24V Power Supply (5 and 10 kW Series C)**

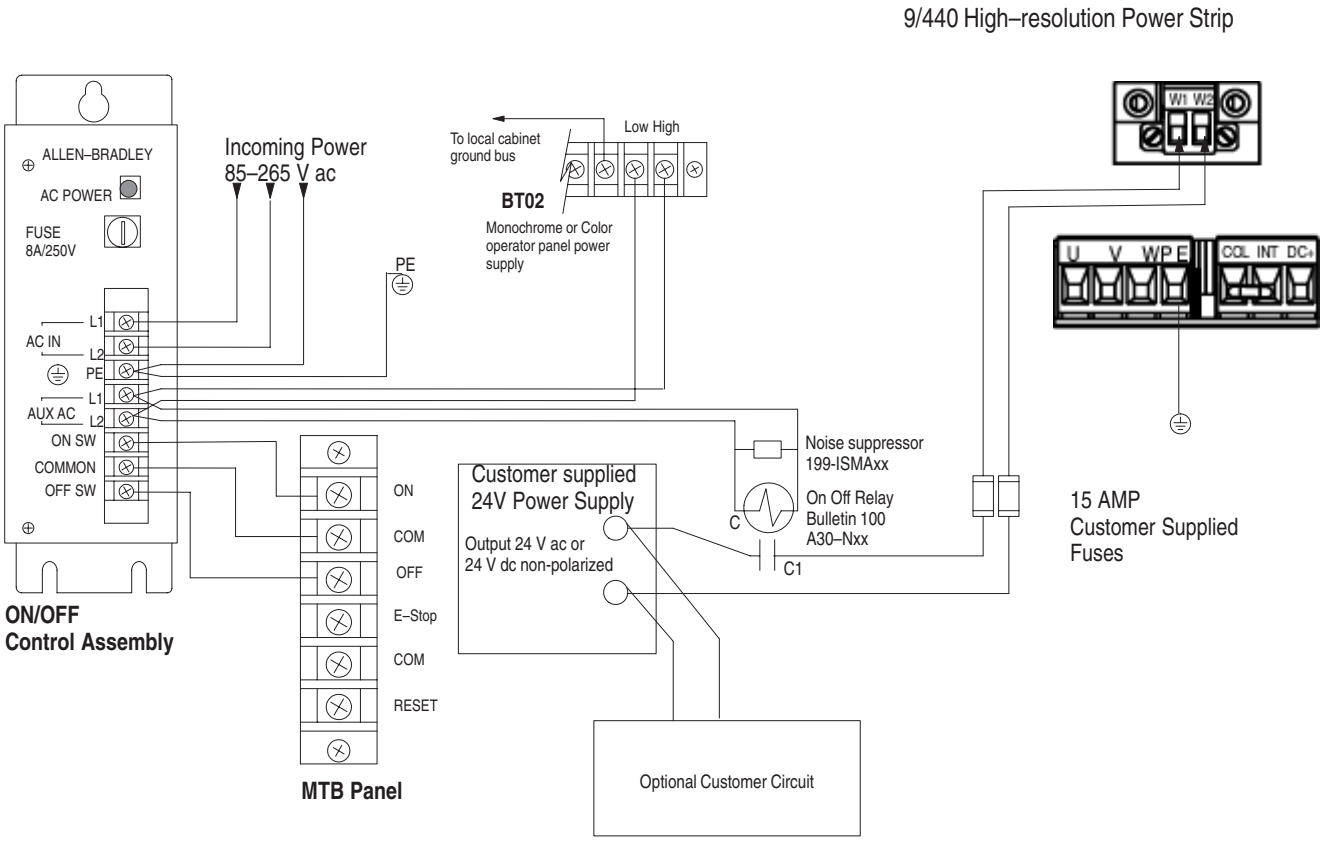
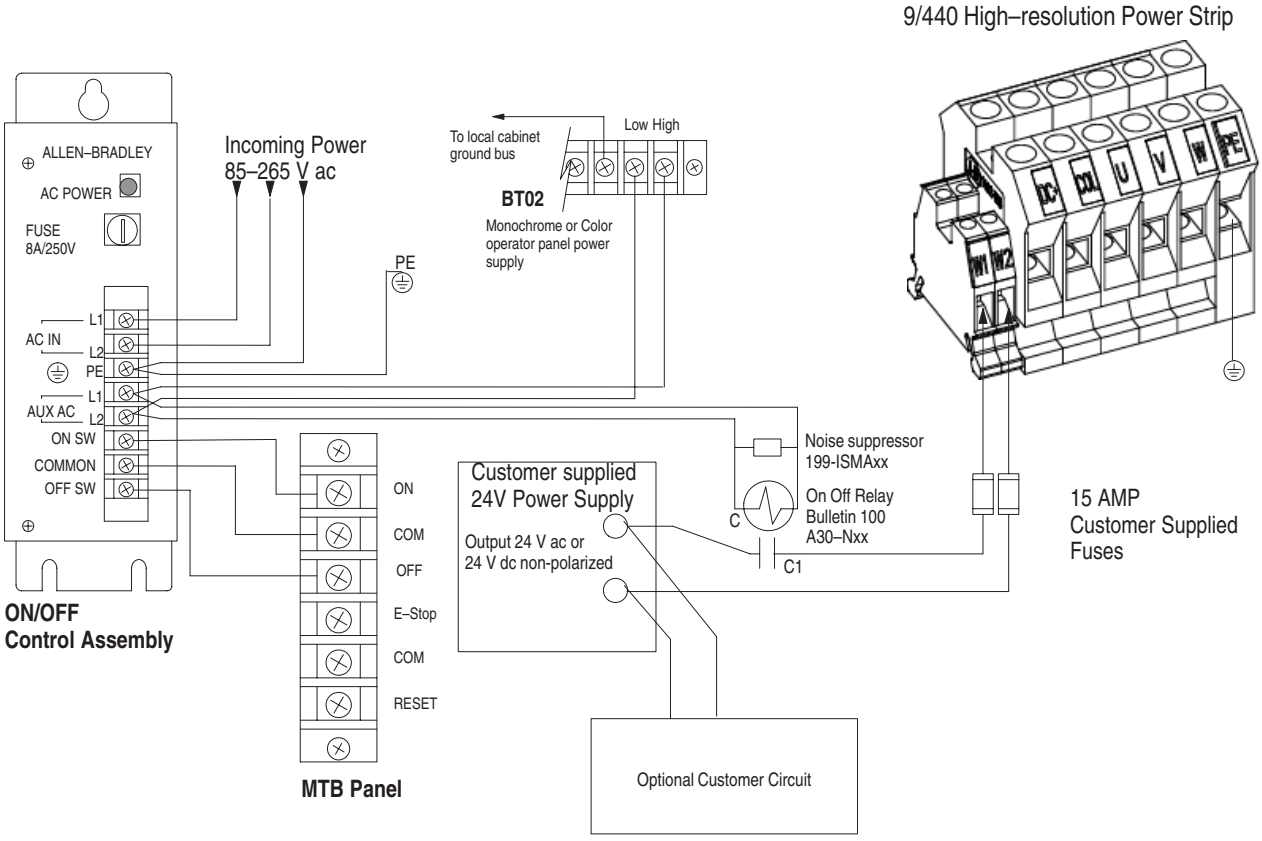


**Figure 5B.36**
**Connecting On/Off Power Control Assembly and 24V Power Supply (22 kW Series C)**




## 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.

### 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.37**
**Three–phase Jumper (Series A and B)**

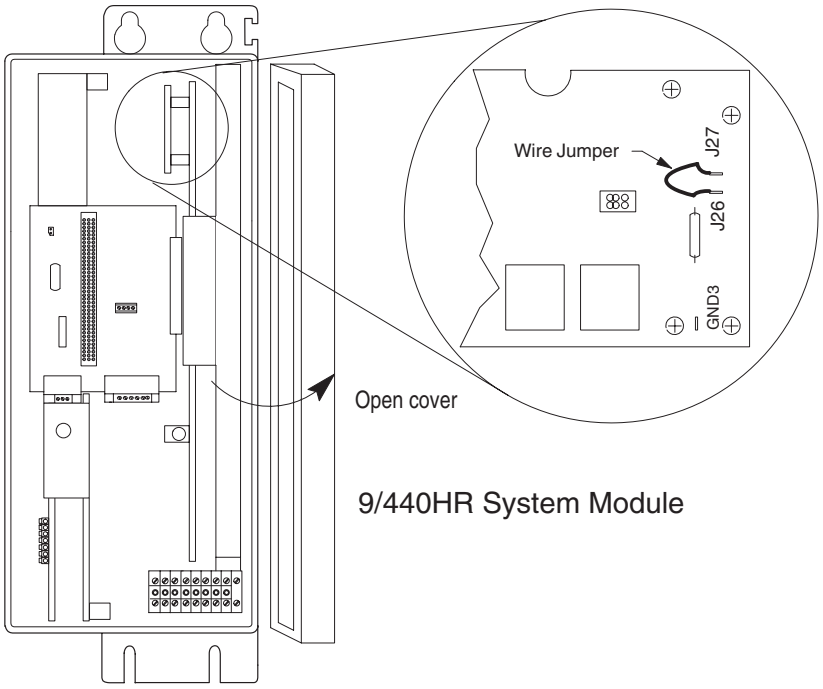


**Figure 5B.38**
**Three–phase Jumper (5 and 10 kW Series C)**

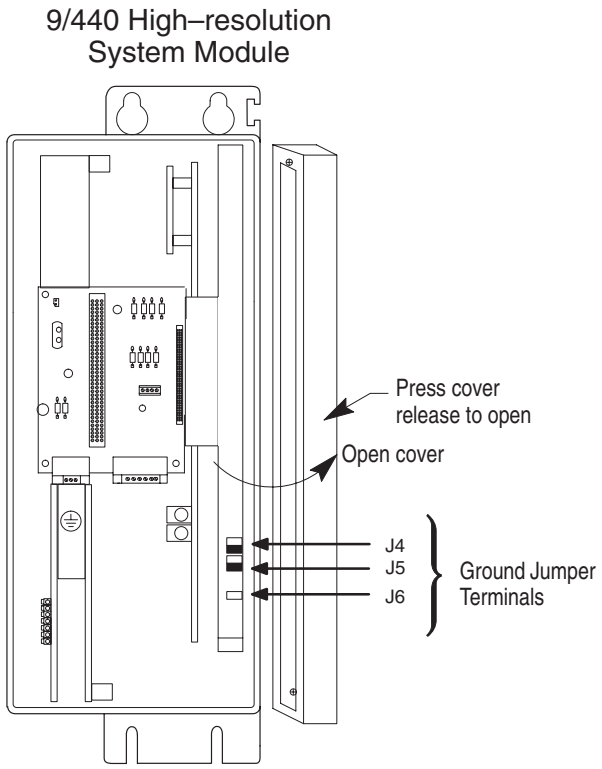


**Figure 5B.39**
**Three–phase Jumper (22 kW Series C)**

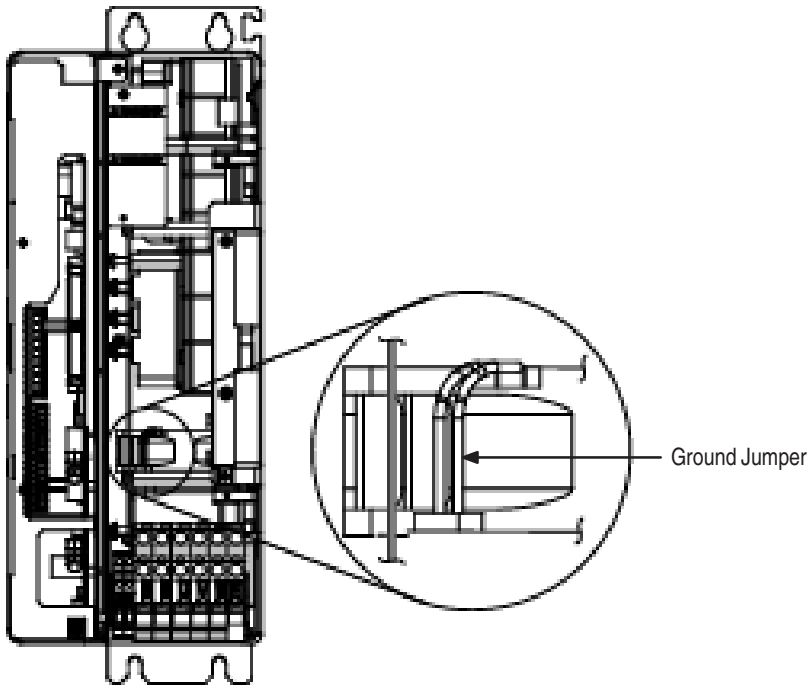


**Figure 5B.40**
**System Module Jumper Positions (22 kW Series C)**

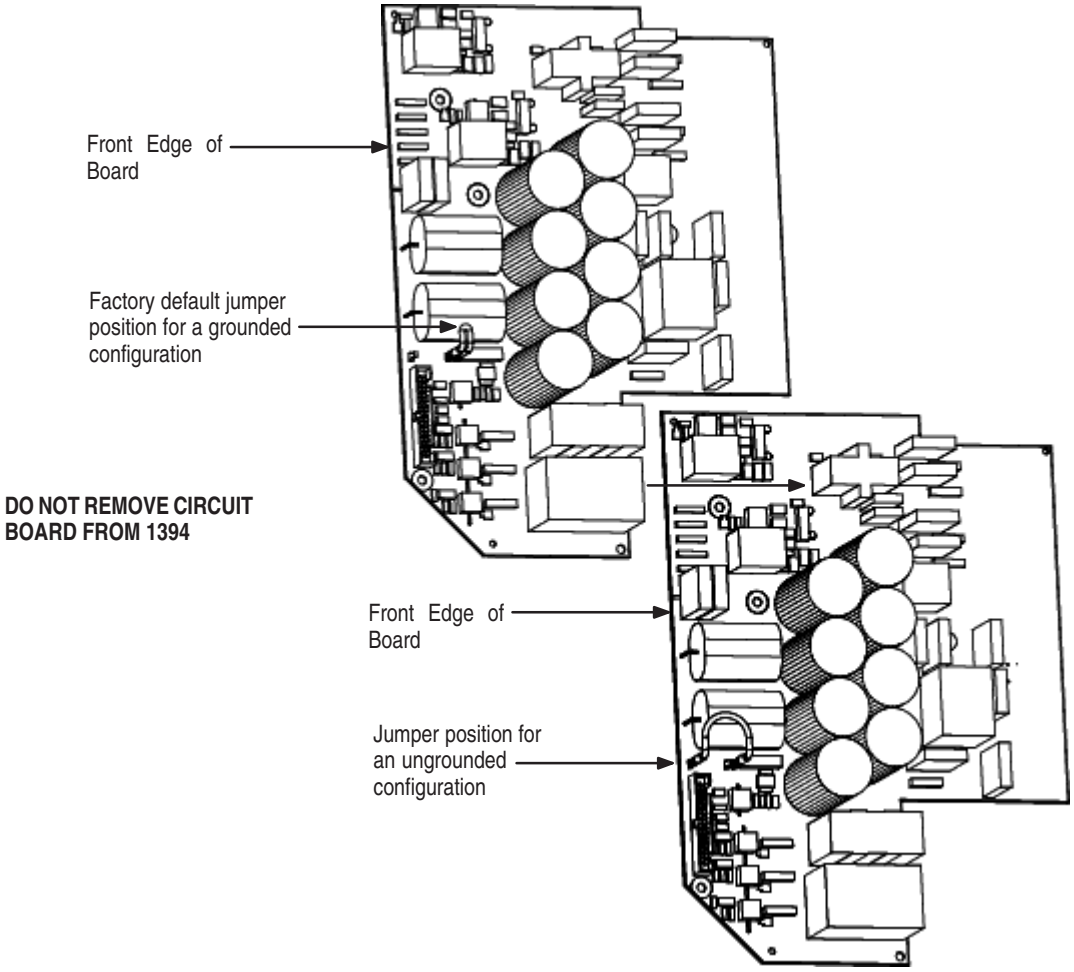


**Figure 5B.41**
**Recommended Connection of 3–phase Drive Power (Series A/B)**

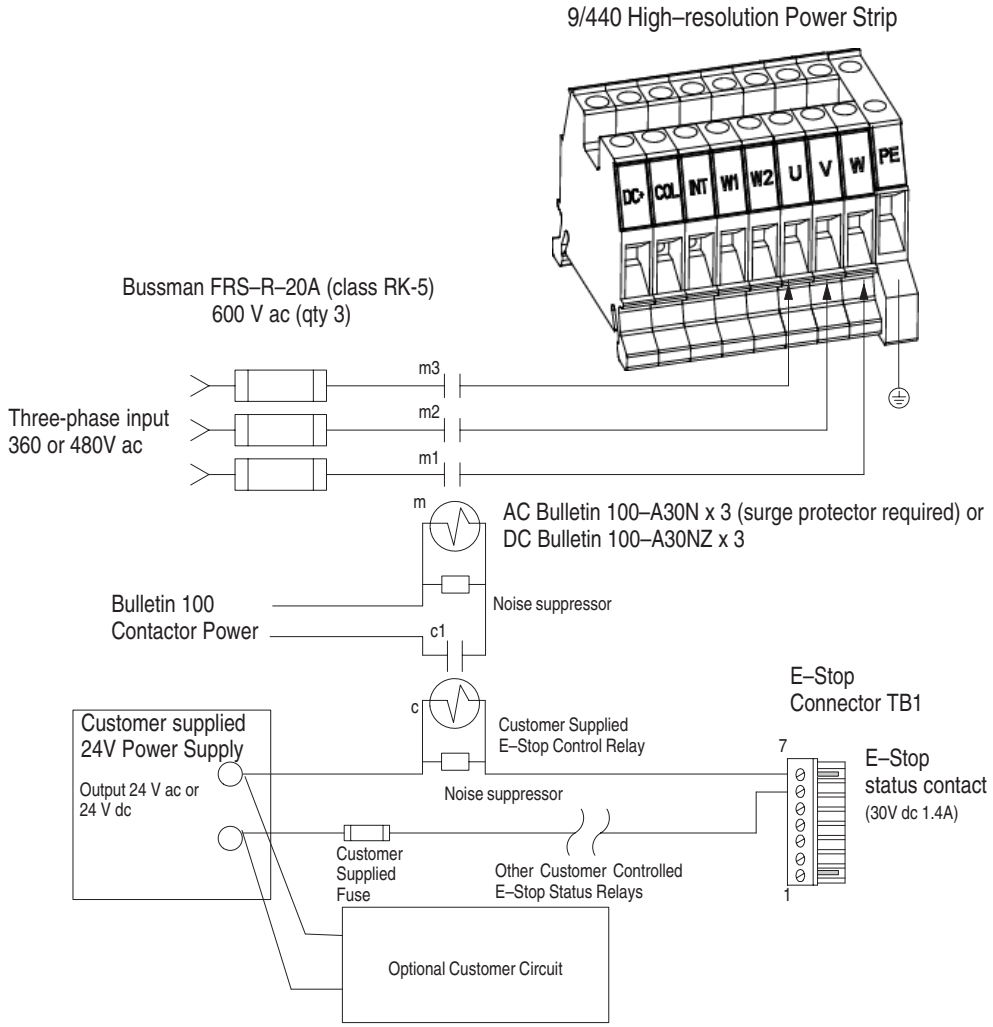


**Figure 5B.42**
**Recommended Connection of 3–phase Drive Power**
**(5 and 10 kW Series C)**

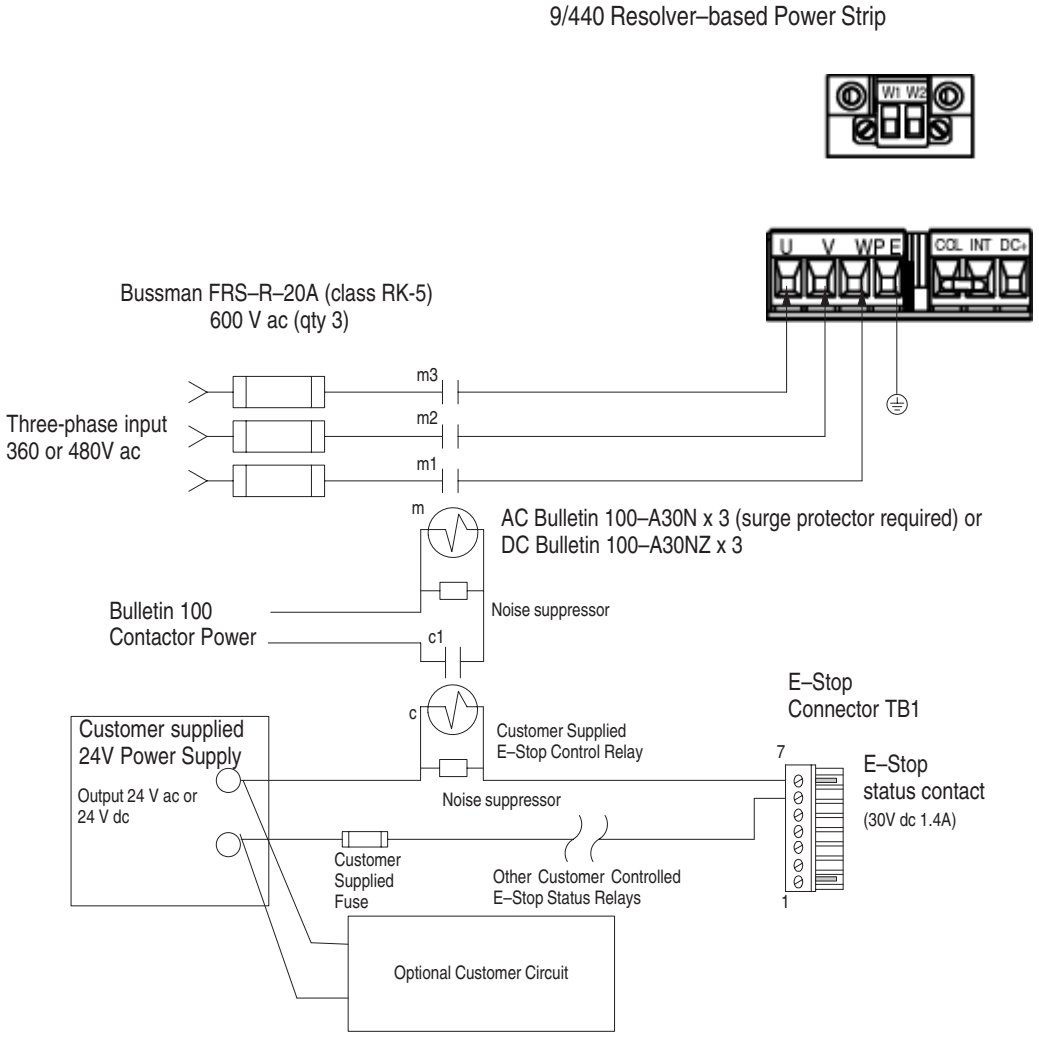
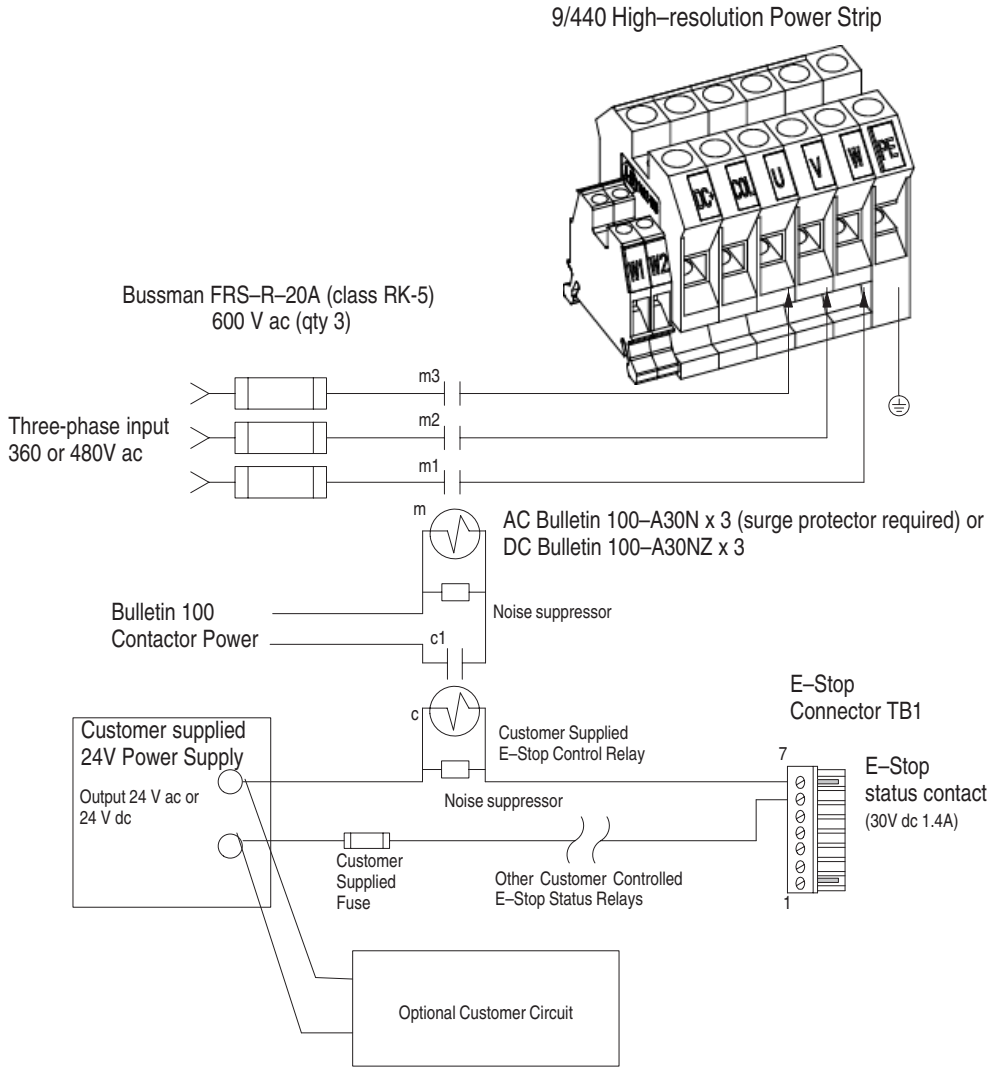


**Figure 5B.43**
**Recommended Connection of 3–phase Drive Power (22 kW Series C)**




**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.

## 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 5A.42 and the paragraphs that follow for detailed information.

**Figure 5B.44**
**Axis Module Connections (Series A/B)**

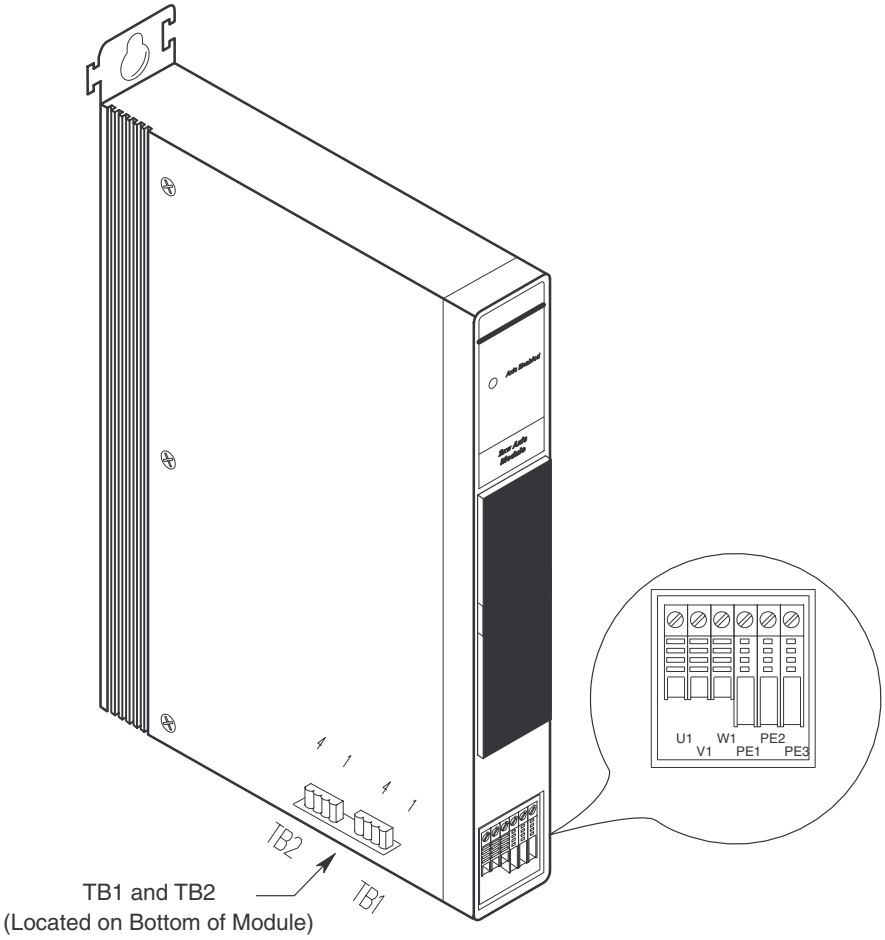
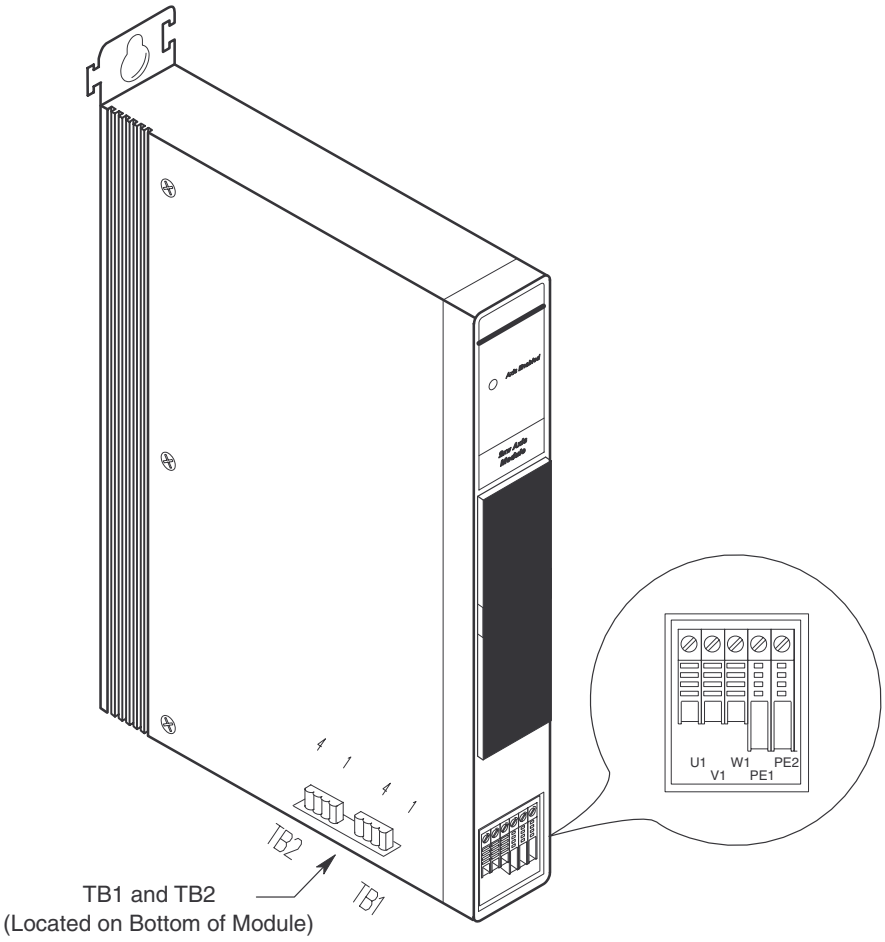


**Figure 5B.45**
**Axis Module Connections (22 kW Series C)**




## 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).

See page 5B-14 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 5A.42. Refer to the information below and the Interconnect Drawings on page 5B-68 for further information.

**Table 5B.B**
**Motor Power Terminations**

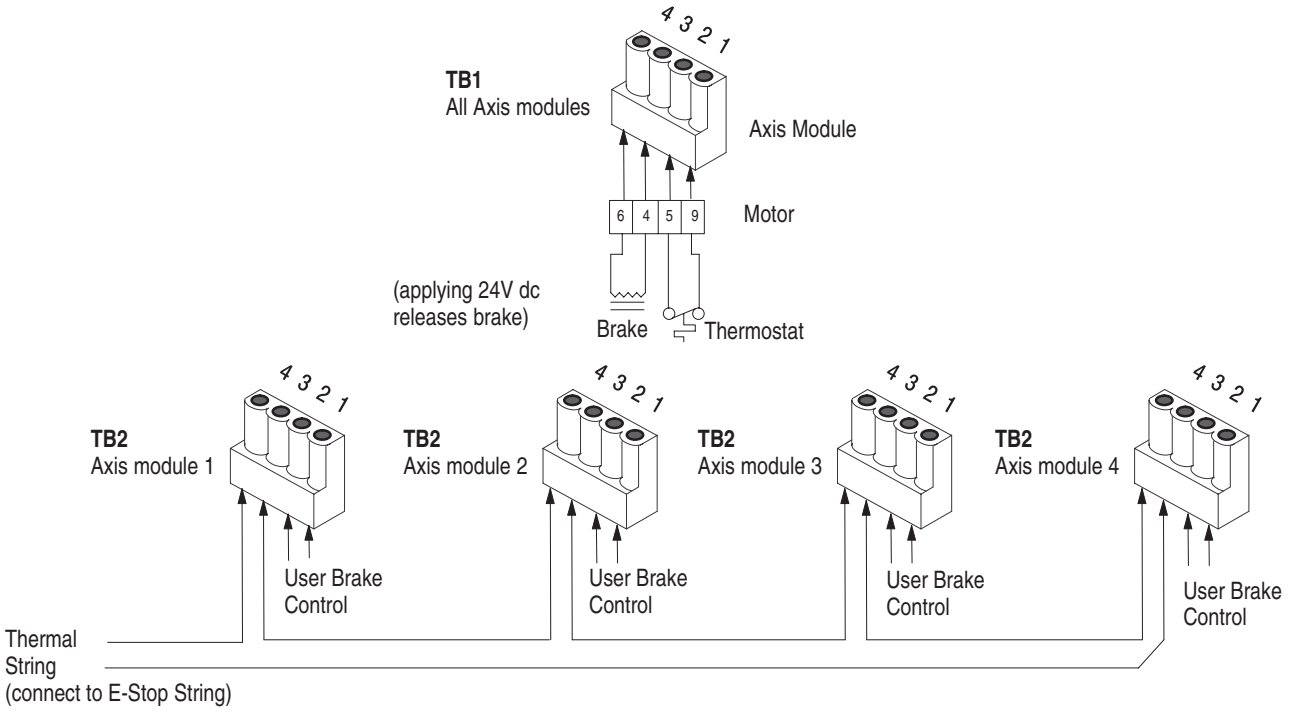
| Terminal | Description | Wire/Pin Number |
|---|---|---|
| U1 | Motor Power A | 1 |
| V1 | Motor Power B | 2 |
| W1 | Motor Power C | 3 |
| PE1 | Axis Ground | Ground Bar |
| PE2 | Motor Ground | 8 |
| PE3 | Overall Shield | 7 |

### Thermal and Brake Leads

The motor thermal sensor and brake leads (if used) are connected to the Axis Module at TB1 & TB2. See Figure 5A.42 for location and Table 5B.C for terminations.

**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.

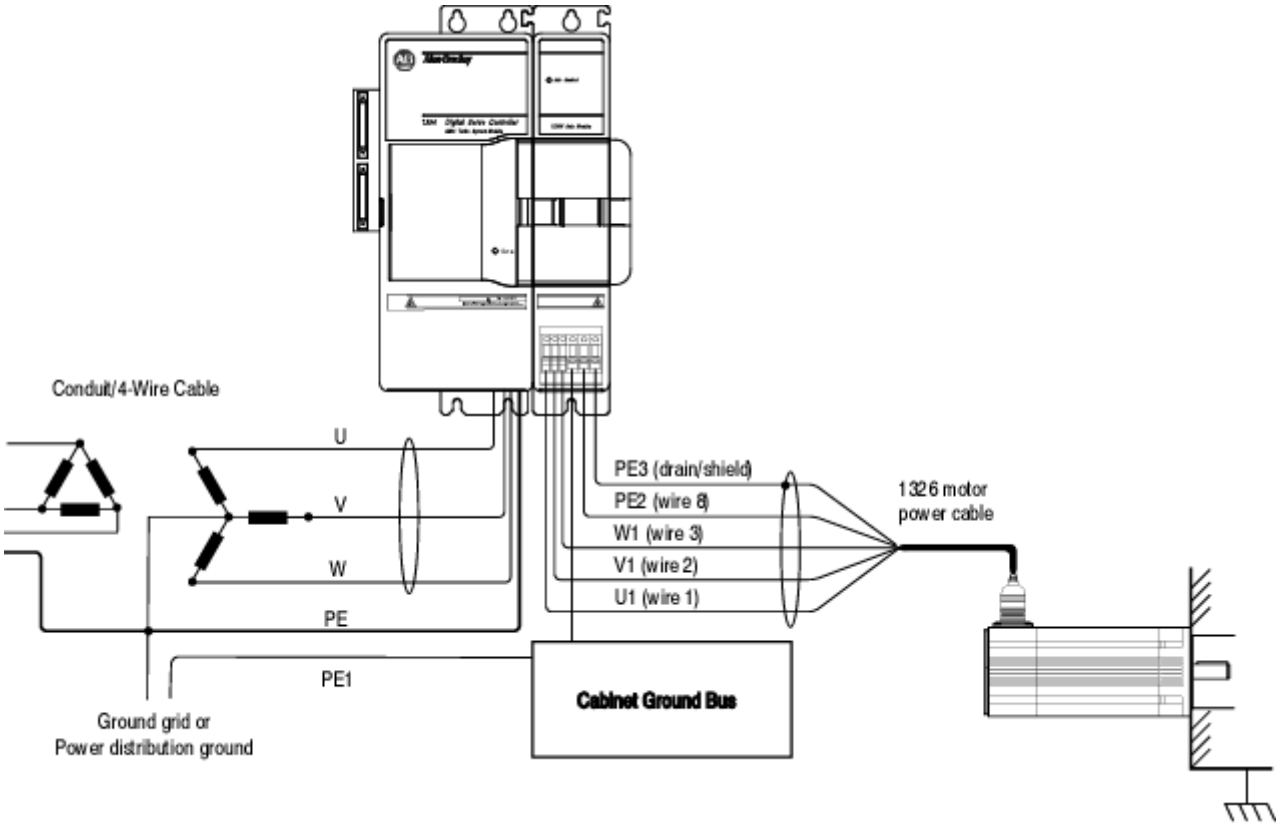
## Determining Your Type of Input

Before you ground or wire your 1394 system, you must determine the type of 360/480V input power you will be connecting to. The 1394 system is designed to operate in both grounded and ungrounded environments.

### Grounded Power Configuration

As shown in Figure 5B.46, the grounded power configuration allows you to ground your 3–phase power at a neutral point. Each 1394 system module has a factory–installed jumper configured for grounded power distribution. If you determine that you have grounded power distribution in your plant you do not need to modify your system. For detailed information about 1394 grounded power configuration, refer to your *1394 Digital AC Multi-Axis Motion Control System Users Manual* (publication 1394-5.0).

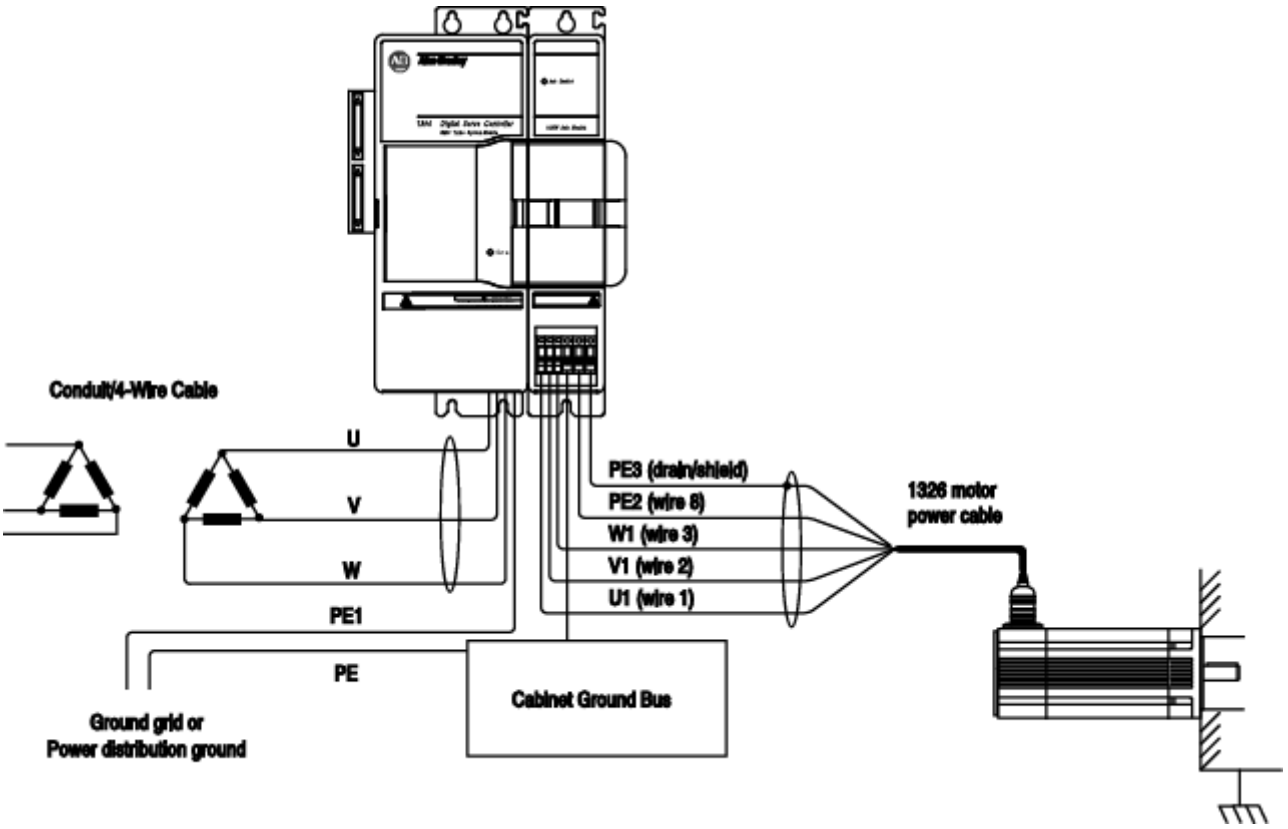
**Figure 5B.46**
**Grounded Power Configuration**




### Ungrounded Power Configuration

As shown in Figure 5B.47, the ungrounded power configuration does not allow for a neutral ground point. If you determine that you have ungrounded power distribution in your plant, you need to move the factory–installed jumper to the ungrounded power distribution position to prevent electrostatic buildup inside the 1394. Refer to the ground jumper procedures for the system module you need to configure.

**Figure 5B.47**
**Ungrounded Power Configuration**



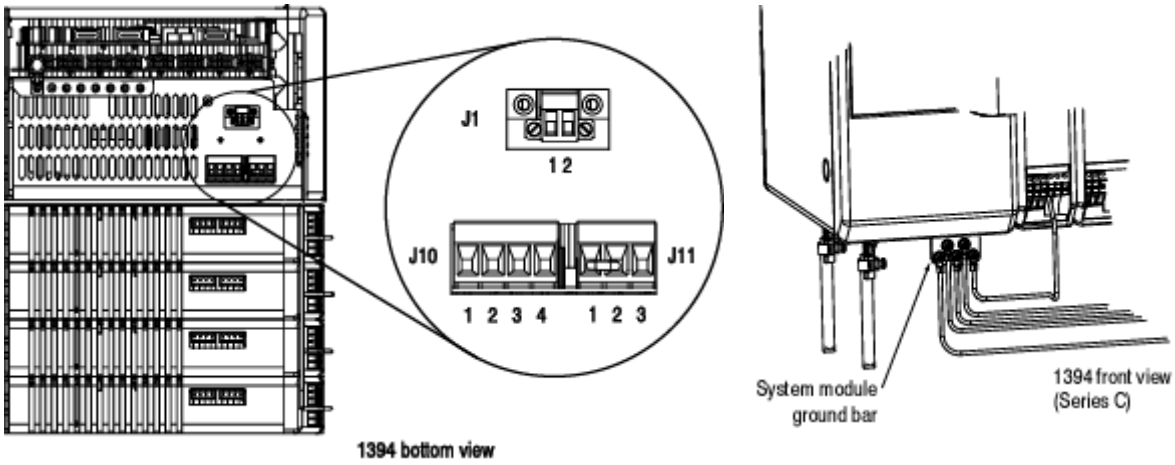

**ATTENTION:** Ungrounded systems do not reference each phase potential to a power distribution ground. This can result in an unknown potential to earth ground.

## Connector Locations for 5 and 10 kW System Module (Series C)

The 5 and 10 kW system module (Series C) uses connectors instead of IEC terminals for connecting power. Wire the system using power connectors J1, J10, and J11 that mate with plugs P1, P10, and P11 conveniently located on the bottom of the system module.

**ATTENTION:** To avoid personal injury and/or equipment damage, ensure installation complies with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment.

**Figure 5B.48**
**Connectors for 5 and 10 kW Series C System Module**




| Wire | Description | Maximum Wire Size | Connects to Terminal(s) | Required (Y/N) |
|---|---|---|---|---|
| 24V Logic | A user–supplied 24V ac rms or 24V dc power source. Refer to your 1394 documentation for 24V input power specifications. | 3.3 $mm^2$ (12 AWG) | J1–1 and J1–2 | Y |
| 360/480V ac Input Power | 360/480V ac, three–phase power input. Make sure to bundle your three–phase power together with neutral as much as possible. Refer to your 1394 documentation for system specifications for rated ac input voltage, tolerance, and source impedance. | 5.3 $mm^2$ (10 AWG) | J10–1 (U), J10–2 (V), and J10–3 (W) | Y |
| Input Power Neutral | Three–phase input neutral (present only on grounded power configurations) | 5.3 $mm^2$ (10 AWG) | J10–4 | N |
| PE Ground | The 1394's ground connection to the bonded system ground bar on the subpanel. | 8.4 $mm^2$ (8 AWG) | System Module Ground Bar | Y |
| External Shunt Resistor | Optional 1400W external shunt resistor used to dissipate excess regenerative energy from the system module | 5.3 $mm^2$ (10 AWG) | J11–3 and J11–1 | N |

**Important:** Refer to your 1394 documentation for information about three–phase input fusing and circuit breaker information as related to the power input. Refer to the same documentation for information about wiring the optional shunt resistor to the 5 and 10 kW system modules.

### Required Tools and Equipment

Before you begin connecting power wiring, be sure to have the following:

- A small, flathead screwdriver
- User–supplied contactor
- User–supplied wiring for input power

### Connecting Power Wiring for 5 and 10 kW (Series A/B) and 22 kW System Modules

To connect power wiring:

**1.** Connect the ground wire for the system module to the bonded ground bus bar on the subpanel. For more information about bonding, refer to the documentation that accompanied your 1394 system.

**2.** Open the front door of the system module.

**3.** Connect the system ground bar wire as follows:

| If you have this type of system module: | then: |
|---|---|
| 5 and 10 kW or 22 kW (Series A or B) | Insert the system ground bar wire in the terminal block labeled PE. |
| 22 kW Series C | Connect the system ground bar wire to the system module ground bar. |

**4.** Connect the three–phase incoming power wires by inserting the wire into its namesake terminal block (i.e., wire U into terminal block U, V into V, and W into W). Make sure to bundle three phase power toehter with neutral as much as possible.

**5.** Connect the three–phase neutral wire as follows:

| If you have this type of system module: | then: |
|---|---|
| 5 and 10 kW or 22 kW (Series A or B) | Connect the three–phase input neutral wire to the bonded system ground bar. For more information about bonding, refer to your accompanying 1394 system documentation. |
| 22 kW Series C | Insert the three–phase input neutral wire in the terminal block labeled PE. |

**Important:** The three–phase input neutral connection is present only on grounded power configurations.

**6.** Insert one of the 24V control power wires into the terminal block labeled W1.

**7.** Insert the other 24V control power wire into the terminal block labeled W2.

**8.** Tighten and torque all six screw terminals to the values in the following table:

| System Module | Terminal Block Designator | Terminal Block Torque |
|---|---|---|
| 5 and 10 kW | All | 0.56 – 0.62 N–m (5.0 – 5.6 lb–in.) |
| 22 kW | W1, W2 | 0.56 – 0.62 N–m (5.0 – 5.6 lb–in.) |
| | DC+, COL, U, V, W, PE | 2.21 – 2.66 N–m (20.0 – 24.0 lb–in.) |

**9.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

For more information about connecting motor power to axis modules, refer to your accompanying 1394 system documentation.

### Connecting Power Wiring for 5 and 10 kW (Series C) System Modules

To connect power wiring:

**1.** Connect the system module ground wire from the system module ground bar to the bonded ground bus bar on the subpanel. For more information about bonding, refer to the documentation that accompanied your 1394 system.

**2.** Insert the three–phase input neutral wire into connector terminal J10–4 and tighten the J10–4 connector screw (torque value = 0.56 – 0.62 N–m, 5.0 – 5.6 lb–in.). Make sure to bundle three phase power toehter with neutral as much as possible.

**Important:** The three–phase input neutral connection is present only on grounded power configurations.

**3.** Insert the three–phase incoming power wires as follows and tighten the three J10 connector screws.

| Insert this wire: | into this connector terminal: | and tighten to this torque value: |
|---|---|---|
| U | J10–1 | 0.56 – 0.62 N–m (5.0 – 5.6 lb–in.) |
| V | J10–2 | |
| W | J10–3 | |

**4.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

**5.** Plug J10 into P10.

**6.** Insert one of the 24V control power wires into connector terminal J1–1 and tighten its connector screw (torque value = 0.56 – 0.62 N–m, 5.0 – 5.6 lb–in.).

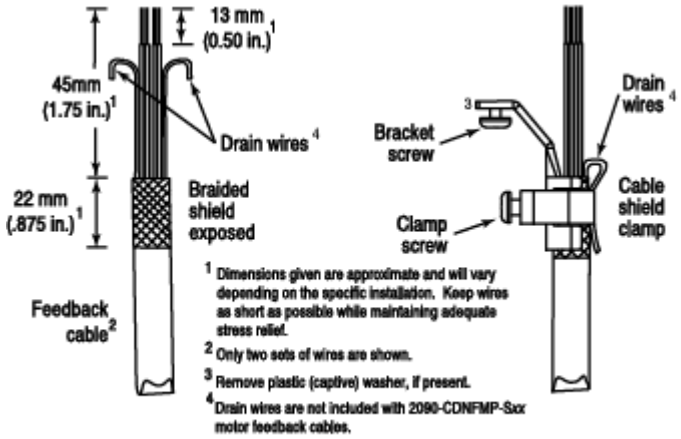
**7.** Insert the other 24V control power wire into connector terminal J1–2 and tighten its connector screw (torque value = 0.56 – 0.62 N–m, 5.0 – 5.6 lb–in.).

**8.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

**9.** Plug J1 into P1

**10.** Gently pull on each wire to make sure it does not come out of its terminal. Reinsert and tighten any loose wires.

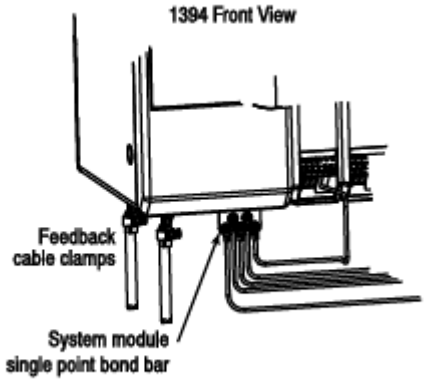
For more information about connecting motor power to axis modules, refer to your accompanying 1394 system documentation.




Cable Preparation




Clamp Attachment



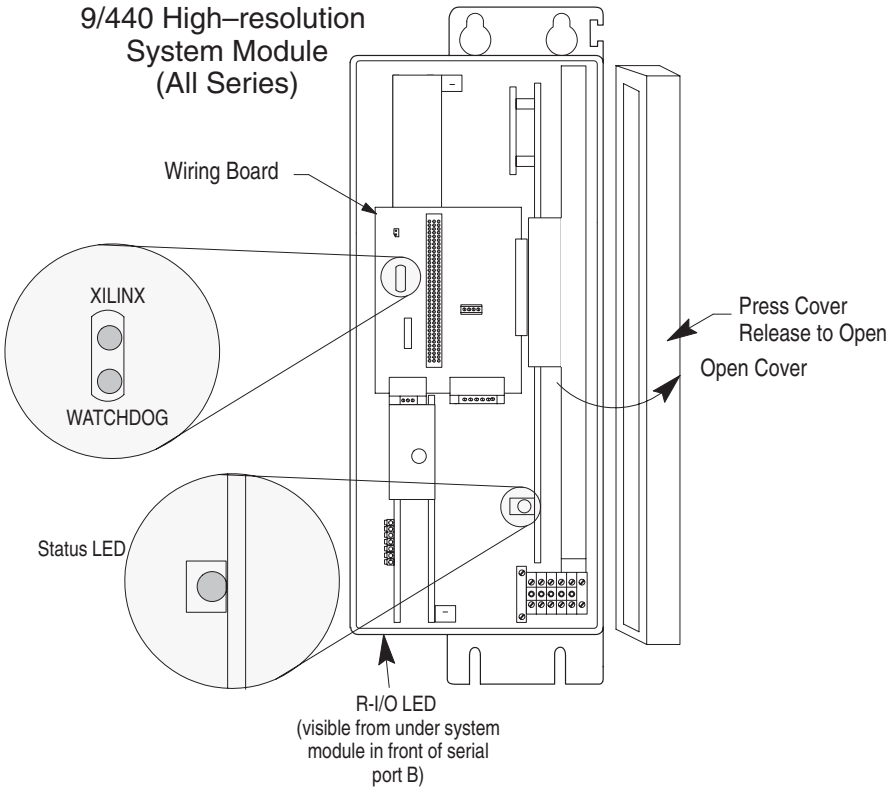

Attaching Feedback to System Module

## 5B.7
## 9/440HR LEDs

All 9/440HR CNC/Drives have four 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-36. |
| 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.

**Axis Module LEDs**

The Axis module has a Status LED visible thru the front cover. It is:

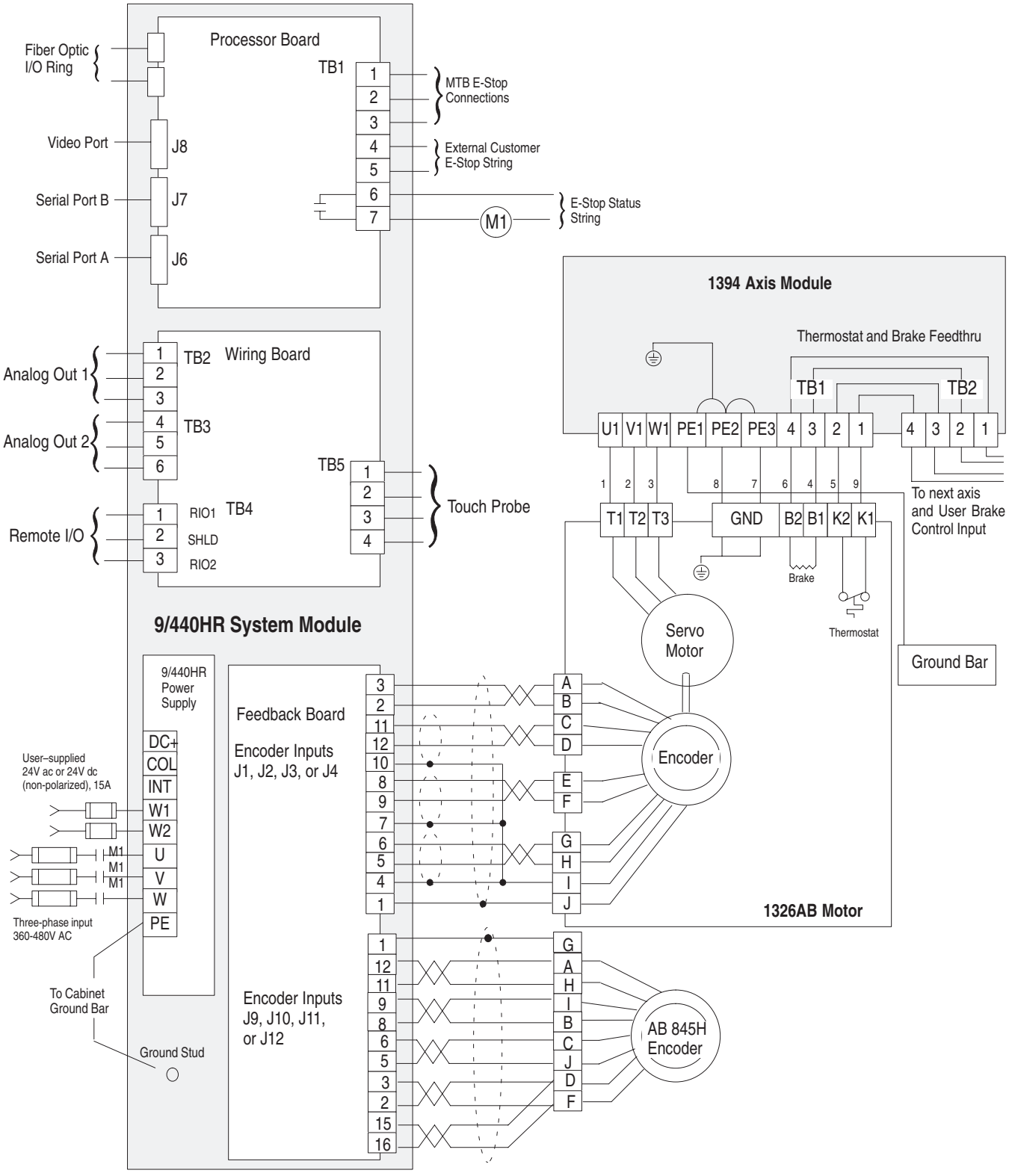
| LED | Indicates | |
|---|---|---|
| STATUS | Steady Green | bus up, axis enabled |
| | Flashing Green | bus up, axis not enabled |
| | Flashing Red/Green | ready, bus not up |
| | Flashing Red | fault present |
| | Steady Red | hardware malfunction |

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.

**Figure 5B.49**
**Wiring Overview For 9/440HR CNC**



## System Grounding

Figure 5B.53 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.

**Figure 5B.50**
**Recommended High–resolution Grounding Scheme (Series A/B)**

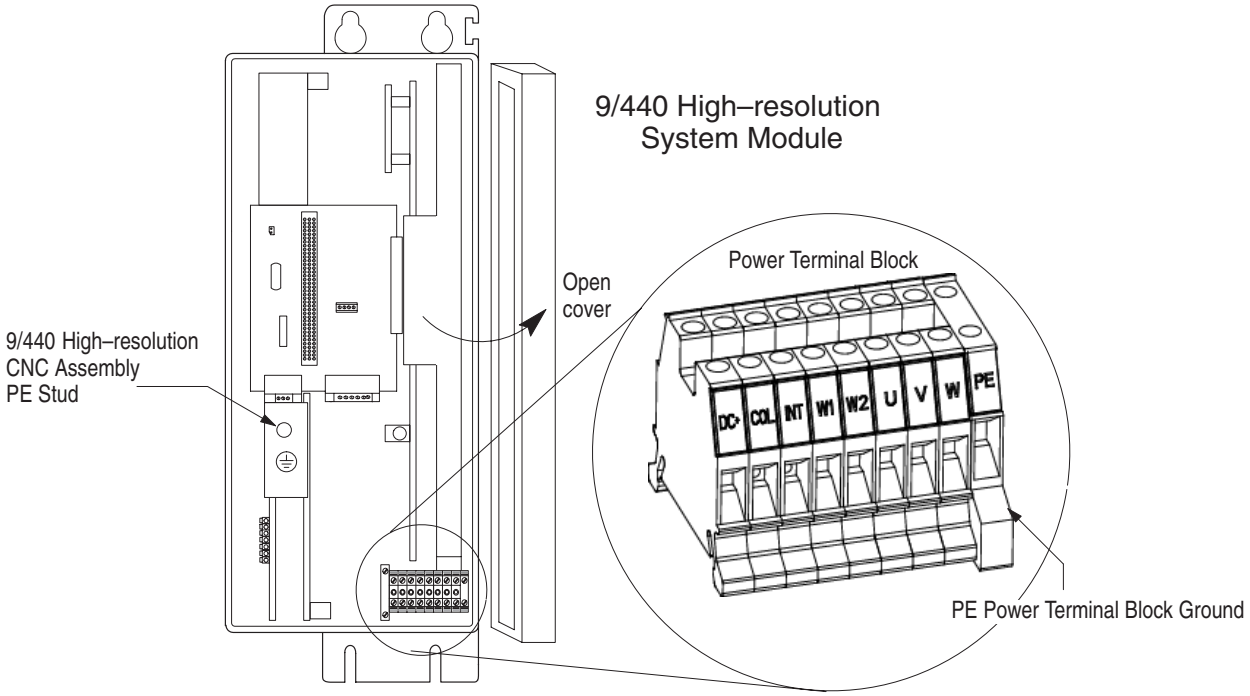


**Figure 5B.51**
**Recommended High–resolution Grounding Scheme**
**(5 and 10 kW Series C)**

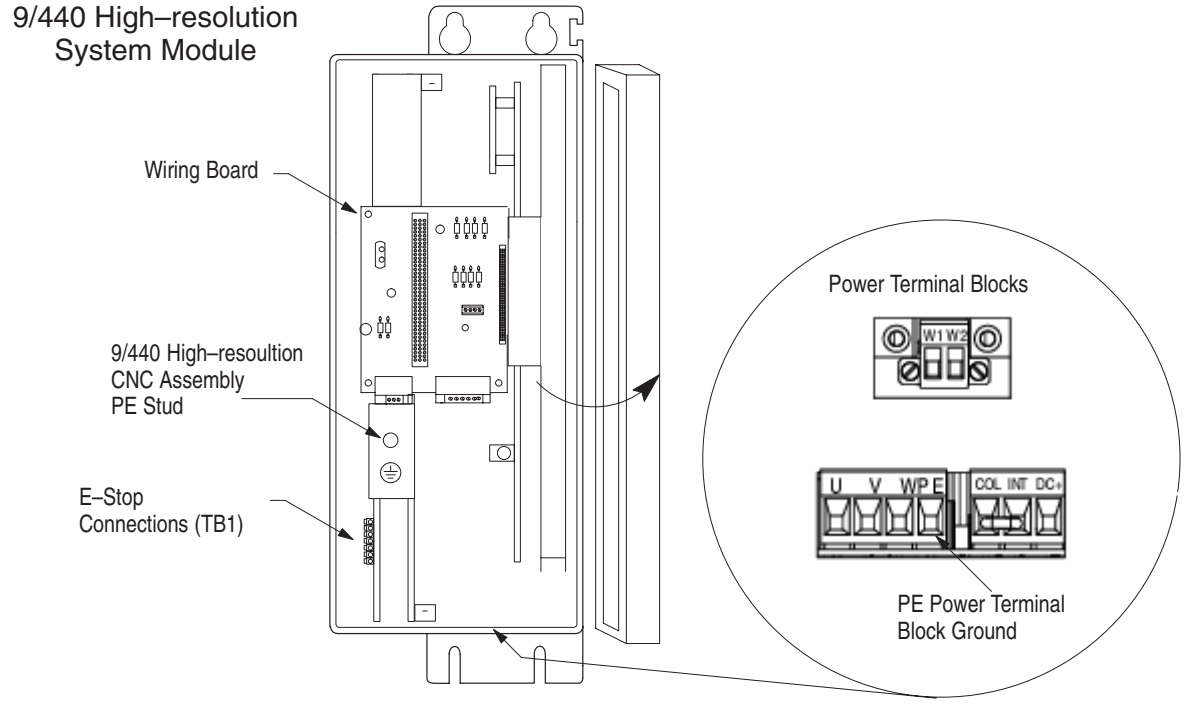


**Figure 5B.52**
**Recommended High–resolution Grounding Scheme (22 kW Series C)**

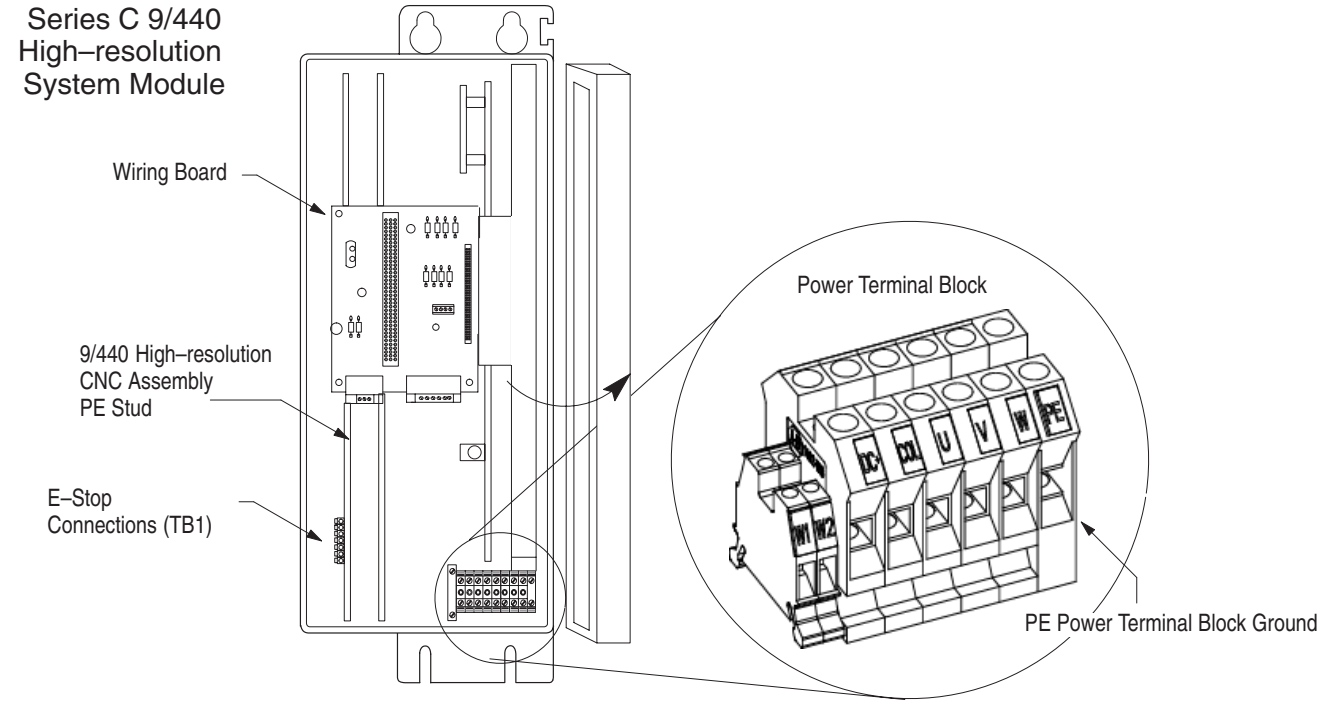


**Figure 5B.53**
**System Grounding Diagram for 9/440HR Control (Series A and B)**

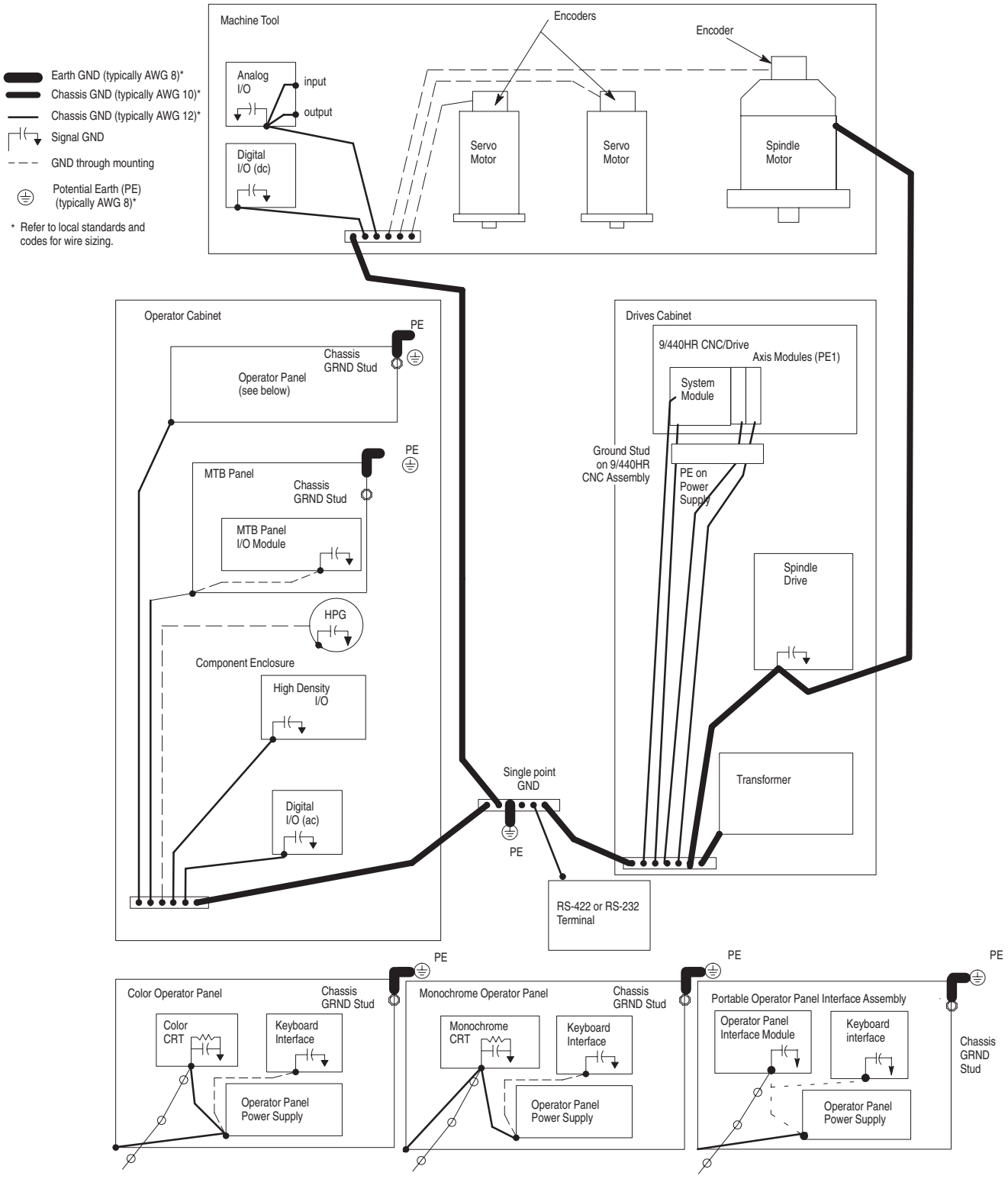
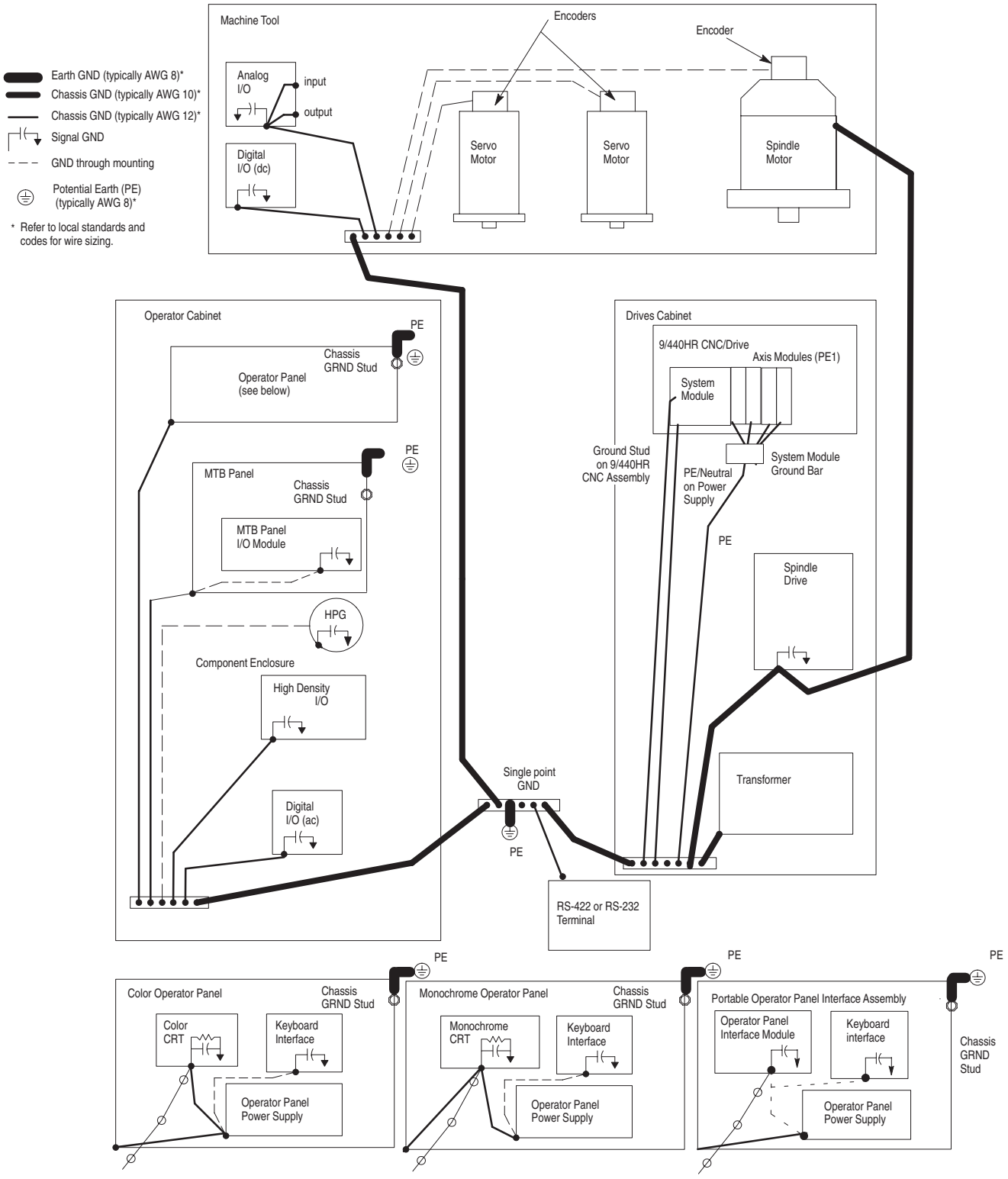


**Figure 5B.54**
**System Grounding Diagram for 9/440HR Control (Series C)**




**END OF SECTION**

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