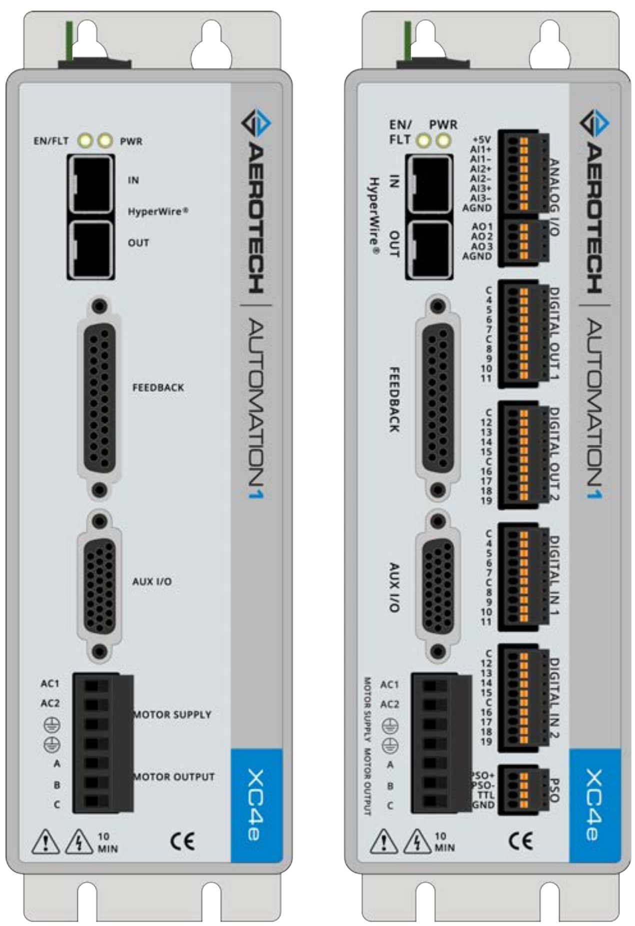
# Automation1 XC4e High-Performance PWM Digital Drive

## HARDWARE MANUAL

Revision 2.01



# GLOBAL TECHNICAL SUPPORT

Go to the Global Technical Support Portal for information and support about your Aerotech, Inc. products. The website supplies software, product manuals, Help files, training schedules, and PC-to-PC remote technical support. If necessary, you can complete Product Return (RMA) forms and get information about repairs and spare or replacement parts. To get help immediately, contact a service office or your sales representative. Include your customer order number in your email or have it available before you call.



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## EU Declaration of Conformity

| | |
|---|---|
| ***Manufacturer*** | Aerotech, Inc. |
| ***Address*** | 101 Zeta Drive<br>Pittsburgh, PA 15238-2811<br>USA |
| ***Product*** | XC4e |
| ***Model/Types*** | All |

This is to certify that the aforementioned product is in accordance with the applicable requirements of the following Directive(s):

| | |
|---|---|
| 2014/30/EU | Electromagnetic Compatibility (EMC) |
| 2014/35/EU | Low Voltage Directive |
| 2006/42/EC | Machinery Directive |
| EU 2015/863 | Directive, Restricted Substances (RoHS 3) |

*and has been designed to be in conformity with the applicable requirements of the following Standard(s) when installed and used in accordance with the manufacturer's supplied installation instructions.*

| | |
|---|---|
| EN 61326-1:2013 | EMC Requirements for Electrical Equipment |
| EN 61010-1:2010/A1:2019 | Safety Requirements for Electrical Equipment |
| EN ISO 13849-1:2015 | Safety Related Parts of Control Systems |

| | |
|---|---|
| ***Authorized Representative:*** | Simon Smith, European Director |
| ***Address:*** | Aerotech Ltd<br>The Old Brick Kiln, Ramsdell, Tadley<br>Hampshire RG26 5PR<br>UK |

| | |
|---|---|
| ***Name*** | / Alex Weibel |
| ***Position*** | Engineer Verifying Compliance |
| ***Location*** | Pittsburgh, PA |
| ***Date*** | 3/24/2021 |

CE

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## Agency Approvals

Aerotech tested its XC4e drives and found that they obey the standards that follow:

| | |
|---|---|
| ***Approval:*** | CUS NRTL |
| ***Approving Agency:*** | TUV SUD America Inc. |
| ***Certificate #:*** | U8V 068995 0028 Rev. 02 |
| ***Standards:*** | CAN/CSA-C22.2 No. 61010-1:2012/U2:2016-04; EN 61010-1:2010/A1:2019; UL 61010-1:2012/R:2016-04 |

| | |
|---|---|
| ***Approval:*** | Safety Components (STO) |
| ***Approving Agency:*** | TUV SUD |
| ***Certificate #:*** | Z10 068995 0030 Rev. 00 |
| ***Standards:*** | IEC 61508-1:2010 (up to SIL 3) |

Visit https://www.tuev-sued.de/product-testing/certificates to view Aerotech's TÜV SÜD certificates. Type the certificate number listed above in the search bar or type "Aerotech" for a list of all Aerotech certificates.

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## Safety Procedures and Warnings

**IMPORTANT**: This manual tells you how to carefully and correctly use and operate the XC4e drive.

- Read all parts of this manual before you install or operate the XC4e drive or before you do maintenance to your system.
- To prevent injury to you and damage to the equipment, obey the precautions in this manual.
- All specifications and illustrations are for reference only and were complete and accurate as of the release of this manual. To find the newest information about this product, refer to www.aerotech.com.

If you do not understand the information in this manual, contact Aerotech Global Technical Support.

**IMPORTANT**: This product has been designed for light industrial manufacturing or laboratory environments. If the product is used in a manner not specified by the manufacturer:

- The protection provided by the equipment could be impaired.
- The life expectancy of the product could be decreased.

**DANGER**: To decrease the risk of electrical shock, injury, death, and damage to the equipment, obey the precautions that follow.

1. Before you do maintenance to the equipment, disconnect the electrical power.
2. Restrict access to the XC4e when it is connected to a power source.
3. Do not connect or disconnect electrical components, wires, and cables while this product is connected to a power source.
4. Wait at least ten (10) minutes after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.
5. Supply each operator with the necessary protection from live electrical circuits.
6. Make sure that all components are grounded correctly and that they obey the local electrical safety requirements.
7. Install the necessary precautions to supply safety and protection to the operator.

**DANGER**: System travel can cause crush, shear, or pinch injuries. Restrict access to all motor and stage parts while your system is connected to a power source.

**WARNING**: To prevent damage to the equipment and decrease the risk of electrical shock and injury, obey the precautions that follow.

1. Make sure that all system cables are correctly attached and positioned.
2. Do not use the cables or the connectors to lift or move this product.
3. Use this product only in environments and operating conditions that are approved in this manual.
4. Only trained operators should operate this equipment.

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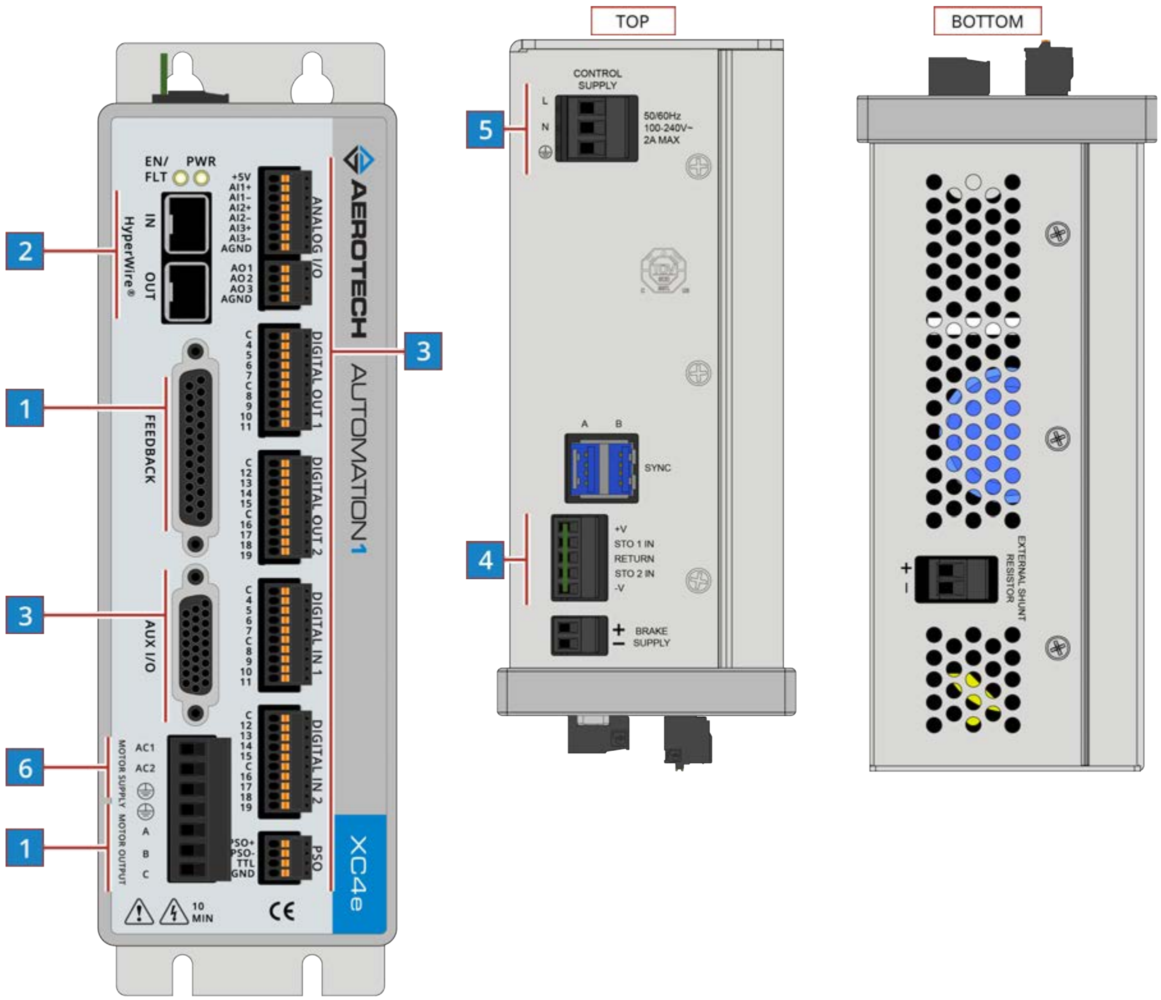
## Installation Overview

This image shows the order in which to make connections and settings that are typical to the XC4e. If a custom interconnect drawing was supplied with your system, that drawing is on your Storage Device and shows as a line item on your Sales Order in the Integration section.




| | | |
|---|---|---|
| **1** | Connect the motor to the amplifier Motor Output connector. | Section 2.2. |
| | Connect the motor to the amplifier Feedback connector. | Section 2.3. |
| **2** | Connect a PC HyperWire port to the HyperWire In port. | Section 2.7. |
| **3** | Connect additional I/O as required by your application (if you purchased the I/O option). | Section 2.5./ Chapter 3 |
| **4** | Connect the Safe Torque Off (STO). | Section 2.4. |
| **5** | Connect the power supply to the Control Supply connector. | Section 2.1.1. |
| **6** | Connect the motor power to the Motor Supply connector. | Section 2.1.2. |

**Figure 1: Installation Connection Overview**

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# Chapter 1: Introduction

The XC4e is a high performance digital drive based on the HyperWire communication protocol. The drive provides deterministic behavior, auto-identification, is fully software configurable. A double precision floating point DSP controls the digital PID and current loops in the XC4e.

The XC4e offers standard Safe Torque Off (STO) inputs and optional Position Synchronized Output (PSO) outputs. The XC4e is offered with optional encoder interpolation features (-MX2/-MX3), an auxiliary encoder input for dual loop control, dedicated analog and digital I/O (expandable with the -EB1 option), and separate power connections for motor and control supply voltages.

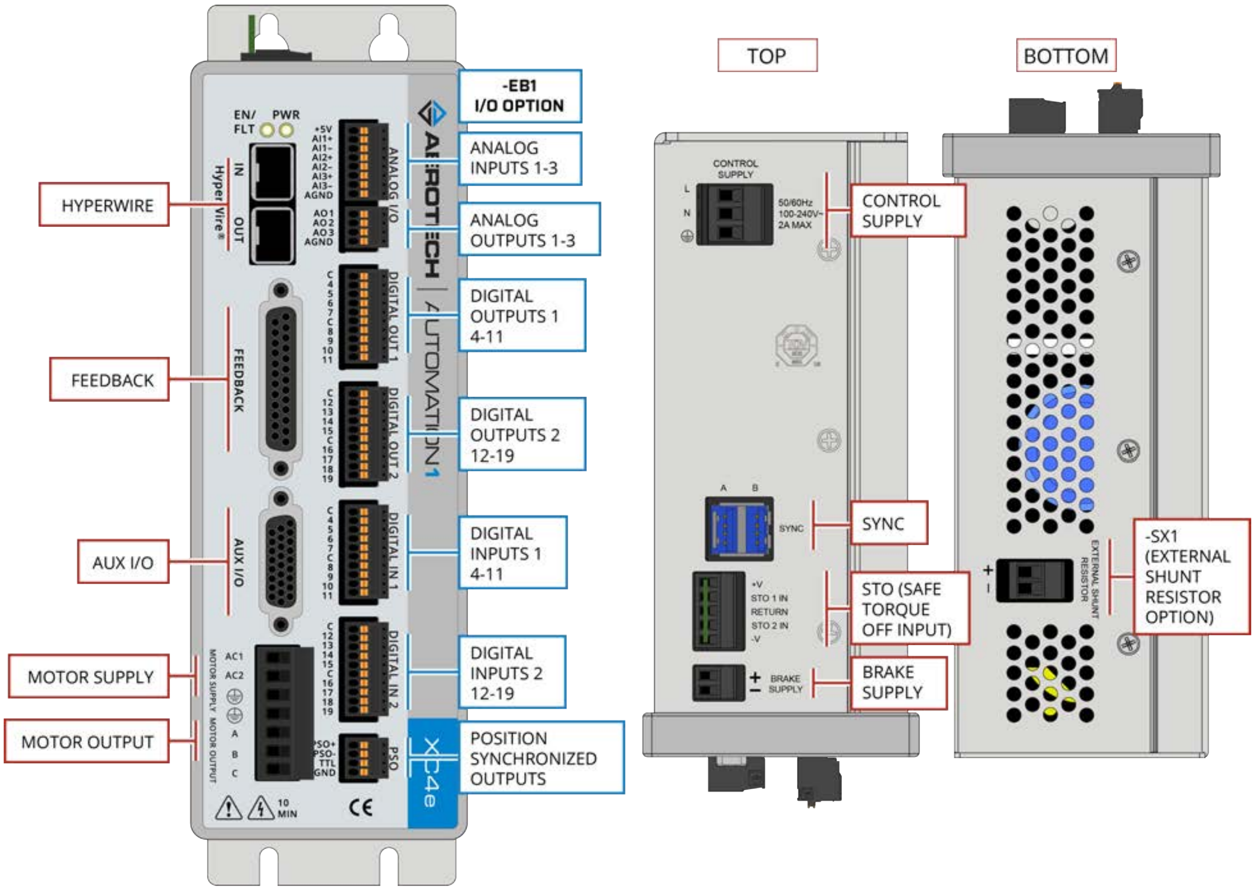



**Figure 1-1: XC4e Digital Drive**

**Table 1-1: Features and Options**

| Standard Features | | |
|---|---|---|
| • 100-240 VAC control supply inputs | | Section 2.1.1. |
| • 0-240 VAC motor supply inputs (producing 340 VDC) | | Section 2.1.2. |
| • Line driver square wave quadrature encoder input for position and velocity feedback | | Section 2.3.1. |
| • Absolute Encoder support on the Feedback Connector | | Section 2.3.1.2. |
| • One fail-safe brake output | | Section 2.3.6. |
| • Two STO sense inputs | | Section 2.4. |
| • Line driver square wave auxiliary quadrature encoder input or output for PSO | | Section 2.5.1. |
| • Absolute Encoder support on the Auxiliary I/O Connector | | Section 2.5.1.2. |
| • Four digital user outputs | | Section 2.5.3. |
| • Six digital user inputs | | |
| ▪ Four Digital Inputs | | Section 2.5.4. |
| ▪ Two High-Speed Inputs | | Section 2.5.5. |
| • One 16-bit analog output (±10 V) | | Section 2.5.6. |
| • One 16-bit differential analog input (± 10 V) | | Section 2.5.7. |
| **Options** | | |
| **Peak Current** | | Section 1.1. |
| -10 | 10 A Peak, 5 A Continuous Current | |
| -20 | 20 A Peak, 10 A Continuous Current | |
| -30 | 30 A Peak, 10 A Continuous Current | |
| **Expansion Board** | | Chapter 3 |
| -EB0 | No expansion board | |
| -EB1 | I/O expansion board<br>• Three 16-bit analog outputs (±10 V)<br>• Three 16-bit differential analog inputs (±10 V)<br>• 16 digital logic inputs (5 - 24 VDC); connect to current sourcing or sinking devices<br>• 16 digital logic outputs (5 - 24 VDC); user defined as current sourcing or sinking<br>• Digital logic laser firing (PSO) output | |
| **Multiplier** | | Section 2.3.1.3. |
| -MX0 | No encoder multiplier | |
| -MX2 | Interpolation circuit allowing for analog sine wave input on the primary encoder channel with an interpolation factor of 65,536. | |
| -MX3 | Interpolation circuit allowing for analog sine wave input on the primary encoder channel with an interpolation factor of 65,536 and an auxiliary encoder channel with an interpolation factor of 16,384. | |
| **PSO** | | Section 2.5.2. |
| -PSO1 | One-axis PSO firing (includes One-axis Part-Speed PSO) | |
| -PSO2 | Two-axis PSO firing (includes Two-axis Part-Speed PSO) | |
| -PSO3 | Three-axis PSO firing (includes Three-axis Part-Speed PSO) | |
| -PSO5 | Two-axis Part-Speed PSO firing, which uses the PSO firing circuit based off of the commanded vector velocity of up to 2 axes (includes One-Axis PSO). | |
| -PSO6 | Three-axis Part-Speed PSO firing, which uses the PSO firing circuit based off of the commanded vector velocity of 3 or more axes (includes One-Axis PSO). | |
| **External Shunt** | | Section 2.8. |
| -SX0 | No connector for the External Shunt | |
| -SX1 | Connection provided for an external shunt resistor network | |
| **Version** | | |
| -DEFAULT | Firmware Matches Software Line | |
| -LEGACY | Legacy Firmware Version X.XX.XXX | |

The block diagram that follows shows a summary of the connector signals.

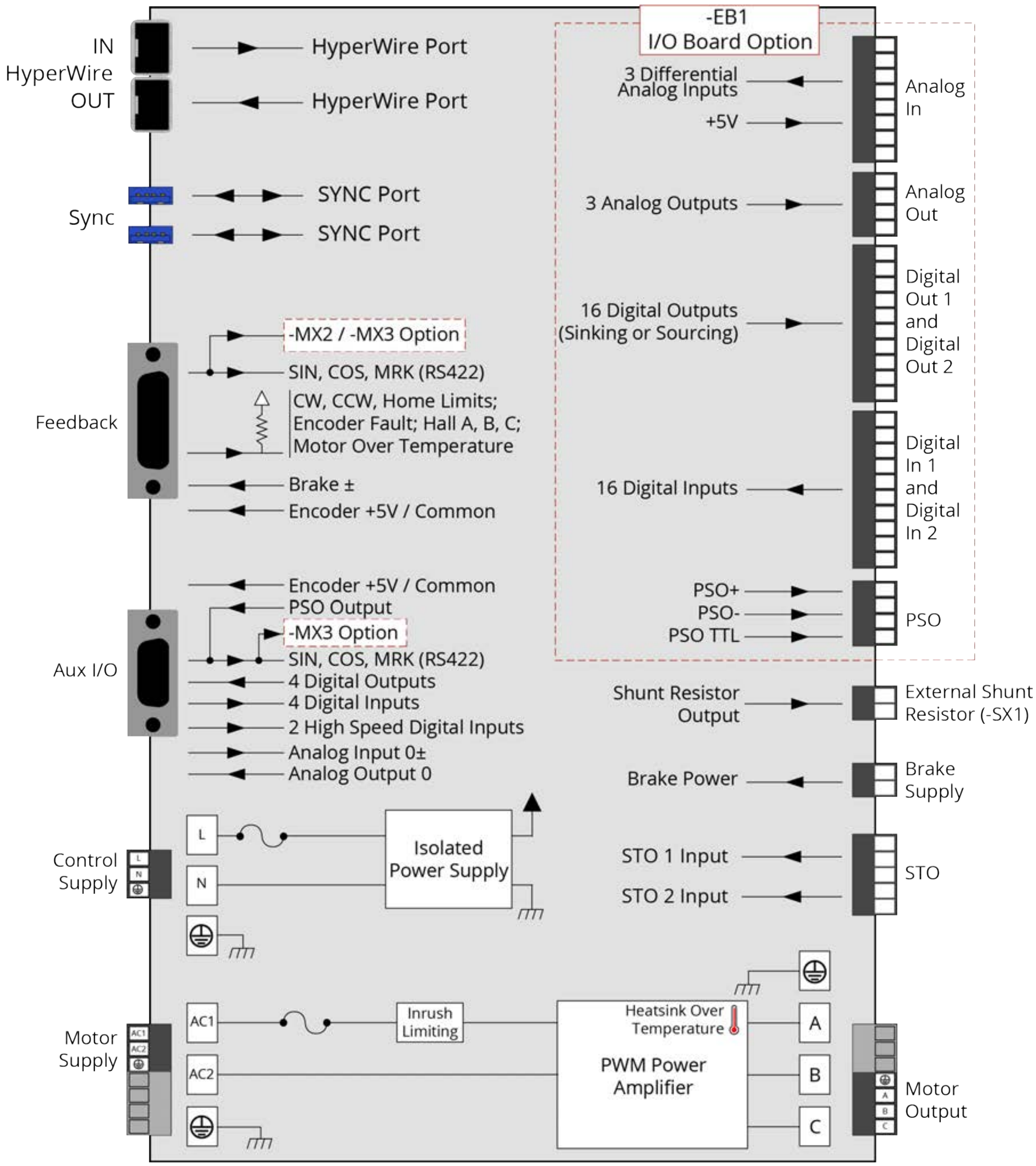



**Figure 1-2: Functional Diagram**

## 1.1. Electrical Specifications

**Table 1-2: Electrical Specifications**

| Description | | -10 Option | -20 Option | -30 Option |
|---|---|---|---|---|
| Motor Supply | Input Voltage | 0-240 VAC | | |
| | Input Frequency | 50-60 Hz | | |
| | Inrush Current | 34 $A_{pk}$ @ 240 V | | |
| | Max Continuous Input Current | 5 $A_{rms}$ | 10 $A_{rms}$ | 10 $A_{rms}$ |
| | Input Current | Refer to Section 1.1.1. System Power Requirements | | |
| Control Supply | Input Voltage | 100-240 VAC | | |
| | Input Frequency | 50-60 Hz | | |
| | Inrush Current | 68 $A_{pk}$ @ 240 V | | |
| | Input Power | 10 W | | |
| Output Voltage (1) | | 340 VDC | | |
| Peak Output Current (1 second) (3) | | 10 A | 20 A | 30 A |
| Continuous Output Current (3) | | 5 A | 10 A | 10 A |
| Power Amplifier Bandwidth | | 2500 Hz maximum (software selectable) | | |
| Power Amplifier Efficiency | | 85% - 95% (2) | | |
| PWM Switching Frequency | | 20 kHz | | |
| Minimum Load Inductance | | 0.1 mH @ 160 VDC (1 mH @ 320 VDC) | | |
| User Power Supply Output | | 5 VDC (@ 500 mA) | | |
| Modes of Operation | | Brushless; Brush; Stepper | | |
| Protective Features | | Output short circuit; Peak over current; DC bus over voltage; RMS over current; Over temperature; Control power supply under voltage; Power stage bias supply under voltage | | |
| Isolation | | Optical and transformer isolation between control and power stages. | | |

(1) AC input voltage and load dependent.
(2) Dependent on total output power: efficiency increases with increasing output power.
(3) Current is measured as the peak amplitude in any motor phase

### 1.1.1. System Power Requirements

The following equations can be used to determine total system power requirements. The actual power required from the mains supply will be the combination of actual motor power (work), motor resistance losses, and efficiency losses in the power electronics or power transformer.

Use an EfficiencyFactor of approximately 90% in the following equations.

**Brushless Motor**

Output Power

| | |
|---|---|
| Rotary Motors | Power Output [W] = Torque [N·m] * Angular velocity[rad/sec] |
| Linear Motors | Power Output [W] = Force [N] * Linear velocity[m/sec] |
| Rotary or Linear Motors | Power Output [W] = Bemf [V] * I(rms) * 3 |

Power Loss = 3 * I(rms)^2 * R(line-line)/2
Power Input = (Power Output + Power Loss) / EfficiencyFactor

**DC Brush Motor**

Power Output [W] = Torque [N·m] * Angular velocity[rad/sec]
Power Loss = I(rms)^2 * R
Power Input = (Pout + Ploss) / EfficiencyFactor

## 1.2. Mechanical Specifications

### 1.2.1. Mounting and Cooling

Install the drive in an IP54 compliant enclosure to comply with safety standards. Make sure that there is sufficient clearance surrounding the drive for free airflow and for the cables and connections.

**Table 1-3: Mounting Specifications**

| | | XC4e |
|---|---|---|
| Customer-Supplied Enclosure | | IP54 Compliant |
| Weight | | ~2.36 kg |
| Mounting Hardware | | M4 [#8] screws (four locations, not included) |
| Mounting Orientation | | Vertical (typical) |
| Dimensions | | Refer to Section 1.2.2. Dimensions |
| Minimum Clearance | Airflow | ~25 mm |
| | Connectors | ~100 mm |
| Operating Temperature | | Refer to Section 1.3. Environmental Specifications |

### 1.2.2. Dimensions

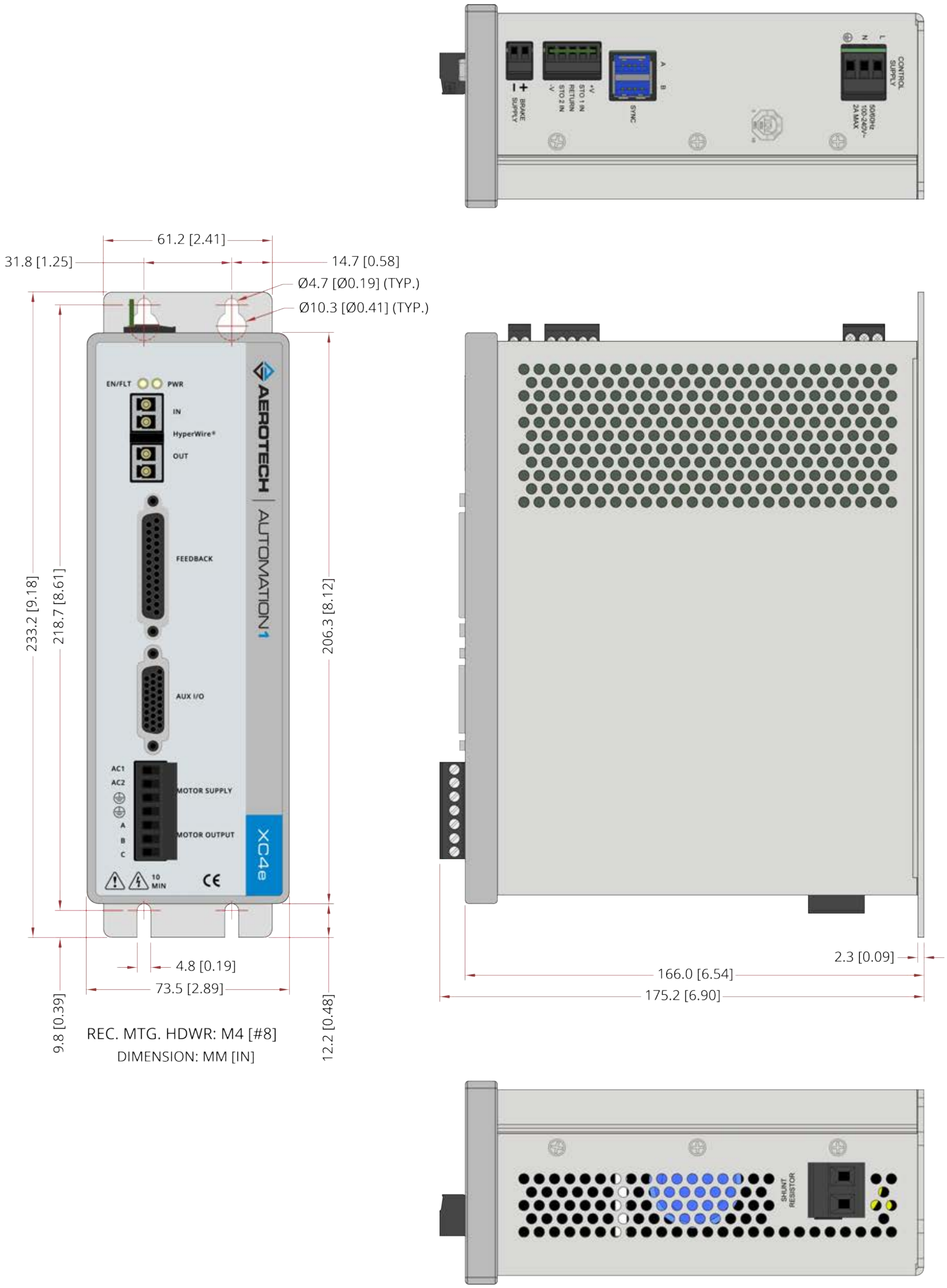



**Figure 1-3: Dimensions**

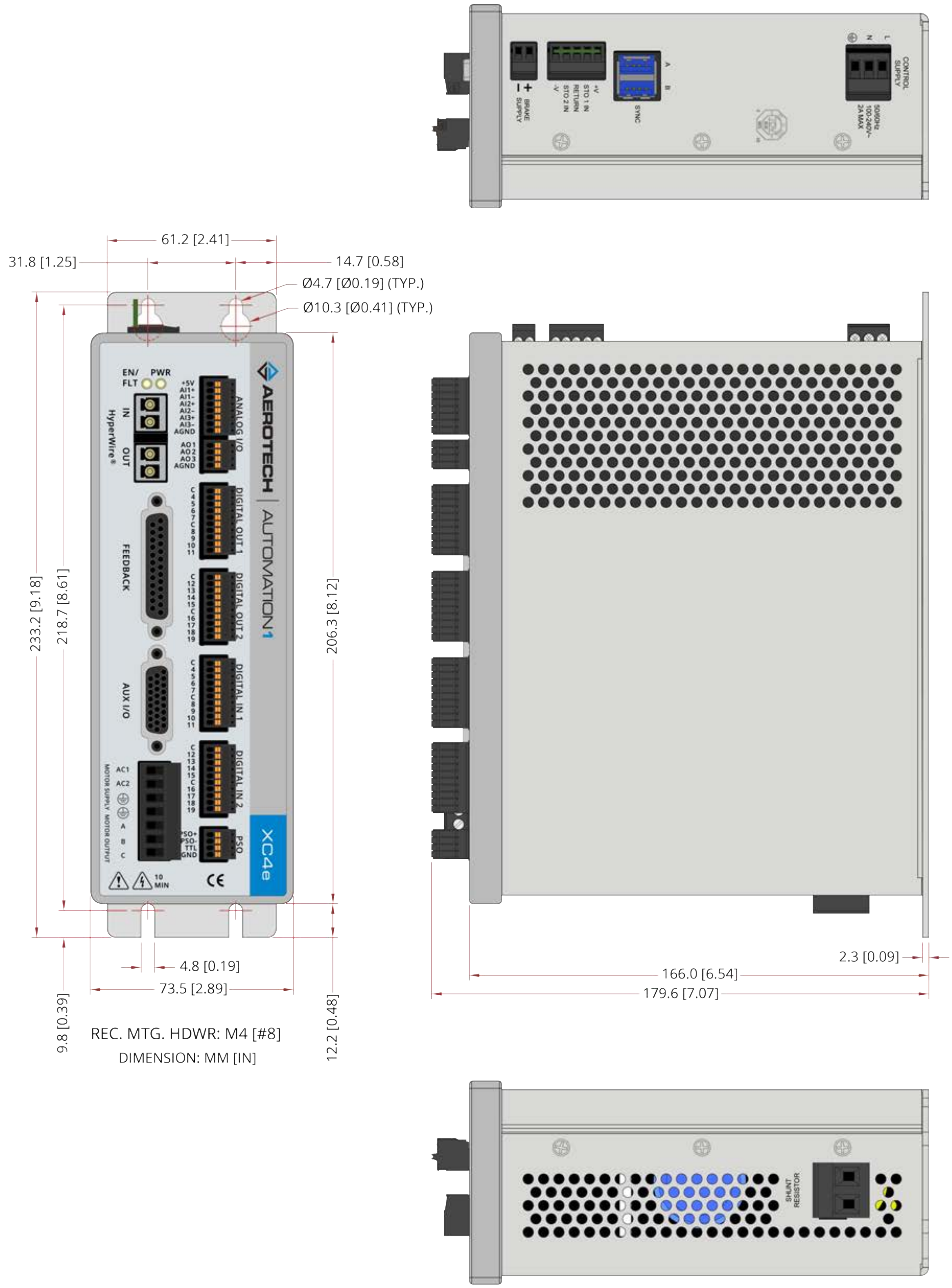



**Figure 1-4: Dimensions [-EB1]**

## 1.3. Environmental Specifications

**Table 1-4: Environmental Specifications**

| | |
|---|---|
| **Ambient Temperature** | Operating: 0° to 40°C (32° to 104° F) |
| | Storage: -30° to 85°C (-22° to 185° F) |
| **Humidity Non-condensing** | The maximum relative humidity is 80% for temperatures that are less than 31°C and decreases linearly to 50% relative humidity at 40°C. |
| **Operating Altitude** | 0 m to 2,000 m (0 ft to 6,562 ft) above sea level.<br>If you must operate this product above 2,000 m or below sea level, contact Aerotech, Inc. |
| **Pollution** | Pollution Degree 2<br>Typically only nonconductive pollution occurs. |
| **Operation** | Use only indoors |

## 1.4. Drive and Software Compatibility

This table shows the available drives and which version of the software first supported each drive. In the **Last Software Version** column, drives that show a specific version number are not supported after that version.

**Table 1-5: Drive and Software Compatibility**

| Drive Type | Software | First Software Version | Last Software Version |
|---|---|---|---|
| Automation1 XC4e | Automation1 | 1.0 | Current |
| | A3200 | 6.04 | Current |

# Chapter 2: Installation and Configuration

### Unpacking the Chassis

**IMPORTANT**: All electronic equipment and instrumentation is wrapped in antistatic material and packaged with desiccant. Ensure that the antistatic material is not damaged during unpacking.

Inspect the container of the XC4e for any evidence of shipping damage. If any damage exists, notify the shipping carrier immediately.

Remove the packing list from the XC4e container. Make sure that all the items specified on the packing list are contained within the package.

The documentation for the XC4e is on the included installation device. The documents include manuals, interconnection drawings, and other documentation pertaining to the system. Save this information for future reference. Additional information about the system is provided on the Serial and Power labels that are placed on the XC4e chassis.

The system serial number label contains important information such as the:

- Customer order number (please provide this number when requesting product support)
- Drawing number
- System part number

## 2.1. Input Power Connections

The XC4e has two AC input power connectors. One connector is for control power and the other connector is for motor power. For a full list of electrical specifications, refer to Section 1.1. Refer to Section 2.10. for a System Interconnection Drawing.

### 2.1.1. Control Supply Connector

The Control Supply input supplies power to the communications and logic circuitry of the XC4e . The **L** input is connected to an internal fuse. Refer to Table 5-4 for the internal fuse value and part number. The **N** input is not connected to an internal fuse. An external fuse will be required if **N** is not connected to Neutral.

The Control Supply contains an internal filter but you could be required to add an external filter for CE compliance. Install the external filter as close as possible to the XC4e. Use a Schaffner FN2080 filter, an Aerotech UFM-ST noise filter module, or equivalent device.

**IMPORTANT**: Refer to local electrical safety requirements to correctly size external system wires.

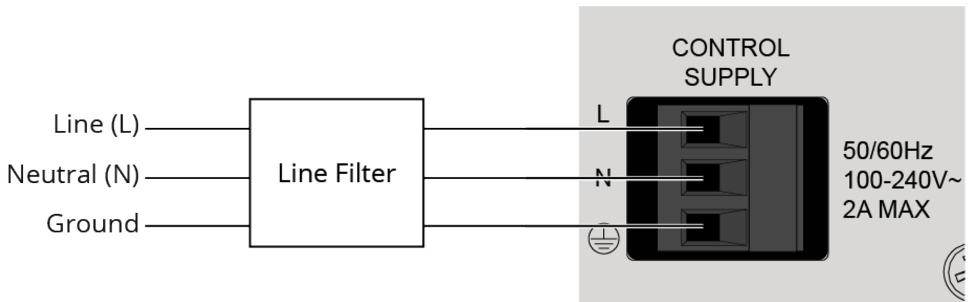



**Figure 2-1: Control Supply Connections**

**Table 2-1: Control Supply Wiring Specifications**

| Pin | Description | Recommended Wire Size |
|---|---|---|
| L | Line (L): 100-240 VAC Control Power Input | 0.8 $mm^2$ (#18 AWG) |
| N | Neutral (N) or 100-240 VAC Control Power Input with external fuse | 0.8 $mm^2$ (#18 AWG) |
| ⏚ | Protective Ground | 0.8 $mm^2$ (#18 AWG) |

**Table 2-2: Mating Connector Part Numbers for the Control Supply Connector**

| Type | Aerotech P/N | Third Party P/N | Screw Torque: N·m | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 3-Pin Terminal Block | ECK00213 | Phoenix 1754465 | 0.5 - 0.6 | 3.3 - 0.516 [12-30] |

### 2.1.2. Motor Supply Connector

Motor power is applied to the **AC1** and **AC2** terminals of the XC4e Motor Supply connector. The XC4e10 **AC1** input is internally connected to a 5 A fuse. The XC4e20/30 **AC1** input is internally connected to a 10 A fuse. Refer to Table 5-4 for the internal fuse part numbers. The **AC2** input is not internally fused. An external fuse is required if **AC2** is not connected to Neutral.

**IMPORTANT**: Before you operate the XC4e, install a ground connection for your safety and to prevent damage to the equipment.

For CE compliance, Aerotech recommends that you use an AC line filter. Connect the filter as close as possible to the drive. For more information about the AC line filter, refer to Section 2.1.4.

**IMPORTANT**: Refer to local electrical safety requirements to correctly size external system wires.

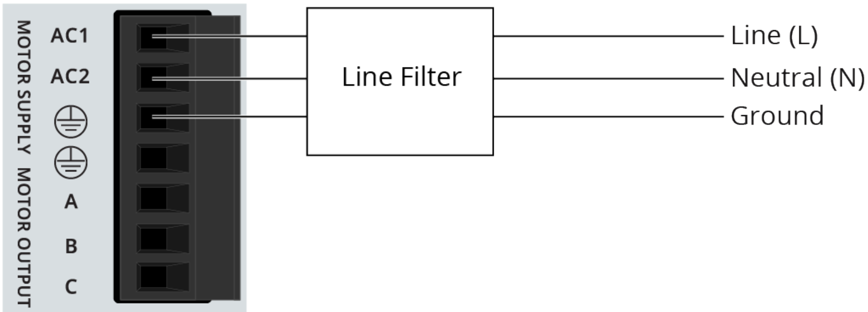



**Figure 2-2: Motor Supply Connections**

**Table 2-3: Motor Supply Connector Wiring Specifications**

| Pin | Description | Recommended Wire Size |
|---|---|---|
| AC1 | 0-240 VAC Motor Power Input | 0.5 mm$^2$ (#20 AWG) |
| AC2 | Neutral (N) or 240 VAC Motor Power Input with external fuse | 0.5 mm$^2$ (#20 AWG) |
| ⏚ | Protective Ground | 0.5 mm$^2$ (#20 AWG) |

**Table 2-4: Mating Connector Part Numbers for the Motor Supply Connector**

| Type | Aerotech P/N | Third Part P/N | Screw Torque: Nm | Wire Size: mm$^2$[AWG] |
|---|---|---|---|---|
| 7-Pin Terminal Block | ECK02387 | Phoenix 1756353 | 0.5 - 0.6 | 3.3 - 0.0516 [12-30] |

### 2.1.3. Transformer Options

You can connect an external isolation transformer to the Motor Supply AC Input to reduce the operating voltage of the motor. Using a transformer can also reduce electrical noise.

**Table 2-5: Nominal Motor Operating Voltages / Required AC Voltages**

| AC Voltage | DC Voltage |
|---|---|
| 28 | 40 |
| 56 | 80 |
| 115 | 160 |
| 230 | 320 |

**Table 2-6: Transformer Options**

| Transformer | Description |
|---|---|
| TV0.3-28-56-ST | Generate 28 or 56 VAC from 115 VAC or 230 VAC input source voltage. When rectified by the drive, it produces a 40 or 80 VDC power bus. |
| TM3 | Power up to 4 drives, providing 300 watts of power |
| TM5 | Power up to 4 drives providing 500 watts of power |
| TV0.3-28 | Generate 28 VAC from 115 VAC or 230 VAC input source voltage. When rectified by the drive, it produces a 40 VDC power bus. |
| TV0.3-56 | Generate 56 VAC from 115 VAC or 230 VAC input source voltage. When rectified by the drive, it produces an 80 VDC power bus. |
| TV1.5, TV2.5, or TV5 | 1.5 kVA, 2.5 kVA, or 5 kVA isolation transformer; 115/230 VAC input; 28, 43, 56, 70, 115 VAC output |

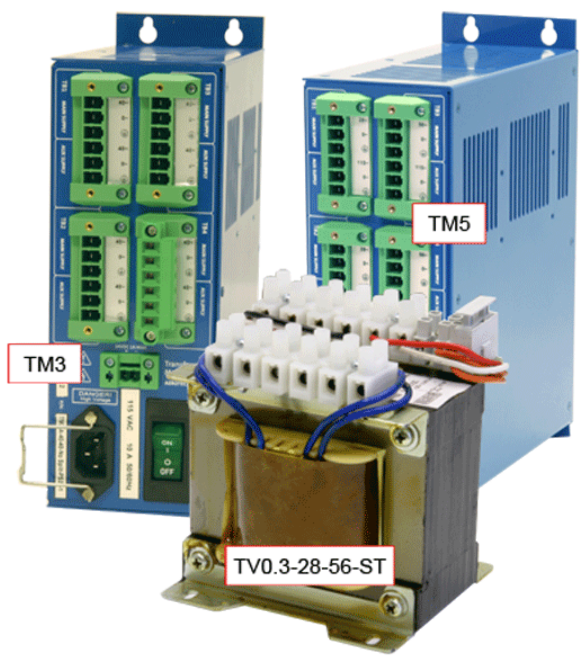
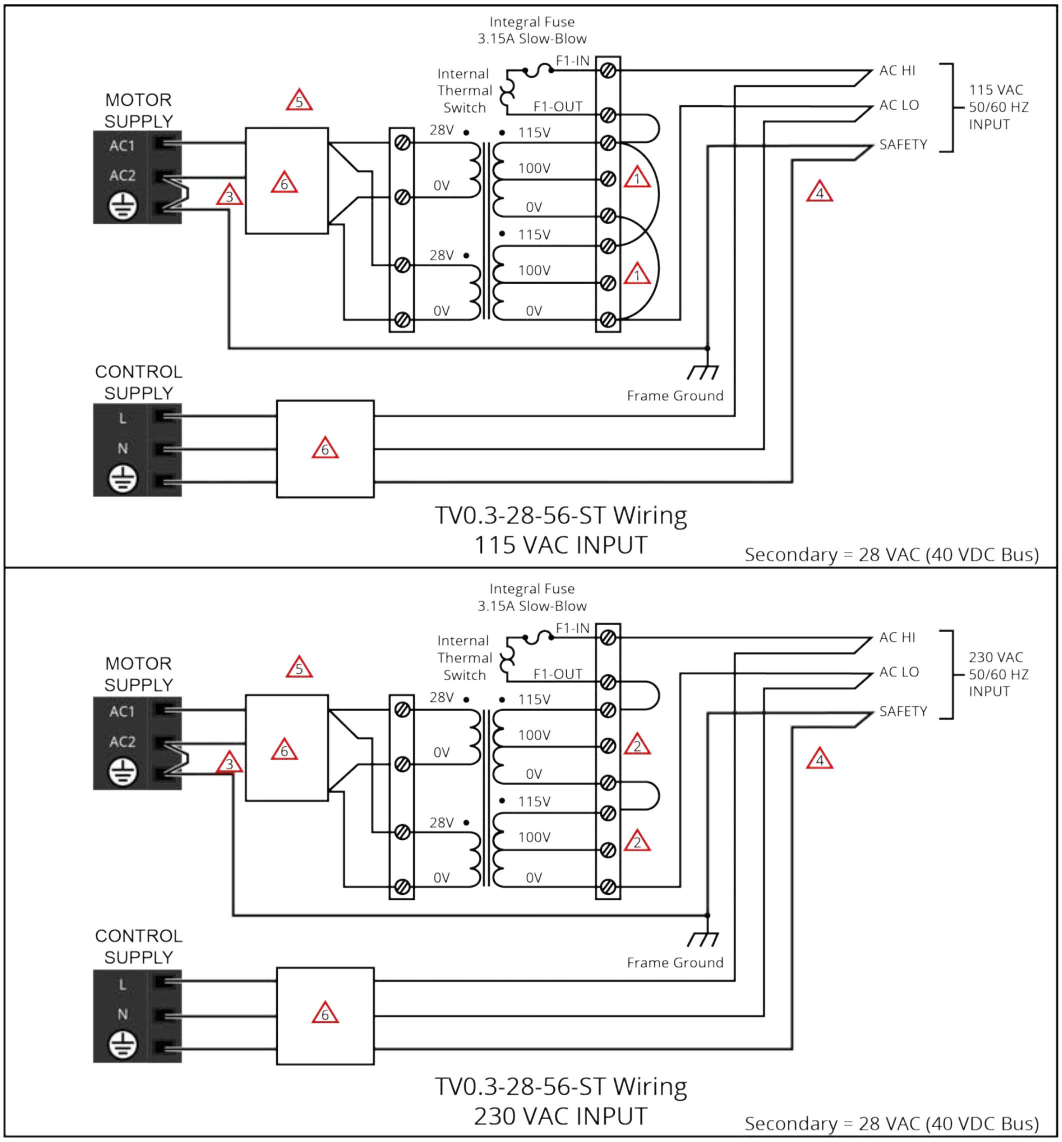



**Figure 2-3: Transformer Examples**




HAZARDOUS VOLTAGES PRESENT | CONNECT ALL WIRING BEFORE POWERING TRANSFORMER | FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES.

1. For 100 VAC primary input, parallel the 100 VAC taps and leave the 115 VAC taps unterminated.

2. For 200 VAC primary input, series the 100 VAC taps and leave the 115 VAC taps unterminated.

3. When using an isolation transformer, earth grounding of the AC2 input tap reduces electrical and audible noise emissions and provides increased servo performance.

4. Transformer Primary Wiring: 0.8 $mm^2$ (#18 AWG) 300 V wire.

5. Transformer Secondary Wiring: 1.3 $mm^2$ (#16 AWG) 300 V wire.

6. AC line filters are for CE compliance. Filters may also be located on the primary side of the transformer.

Drawing: 620B1346-8, Rev. -

**Figure 2-4: TV0.3-28-56-ST Transformer Control and Motor Power Wiring (40 VDC Bus)**

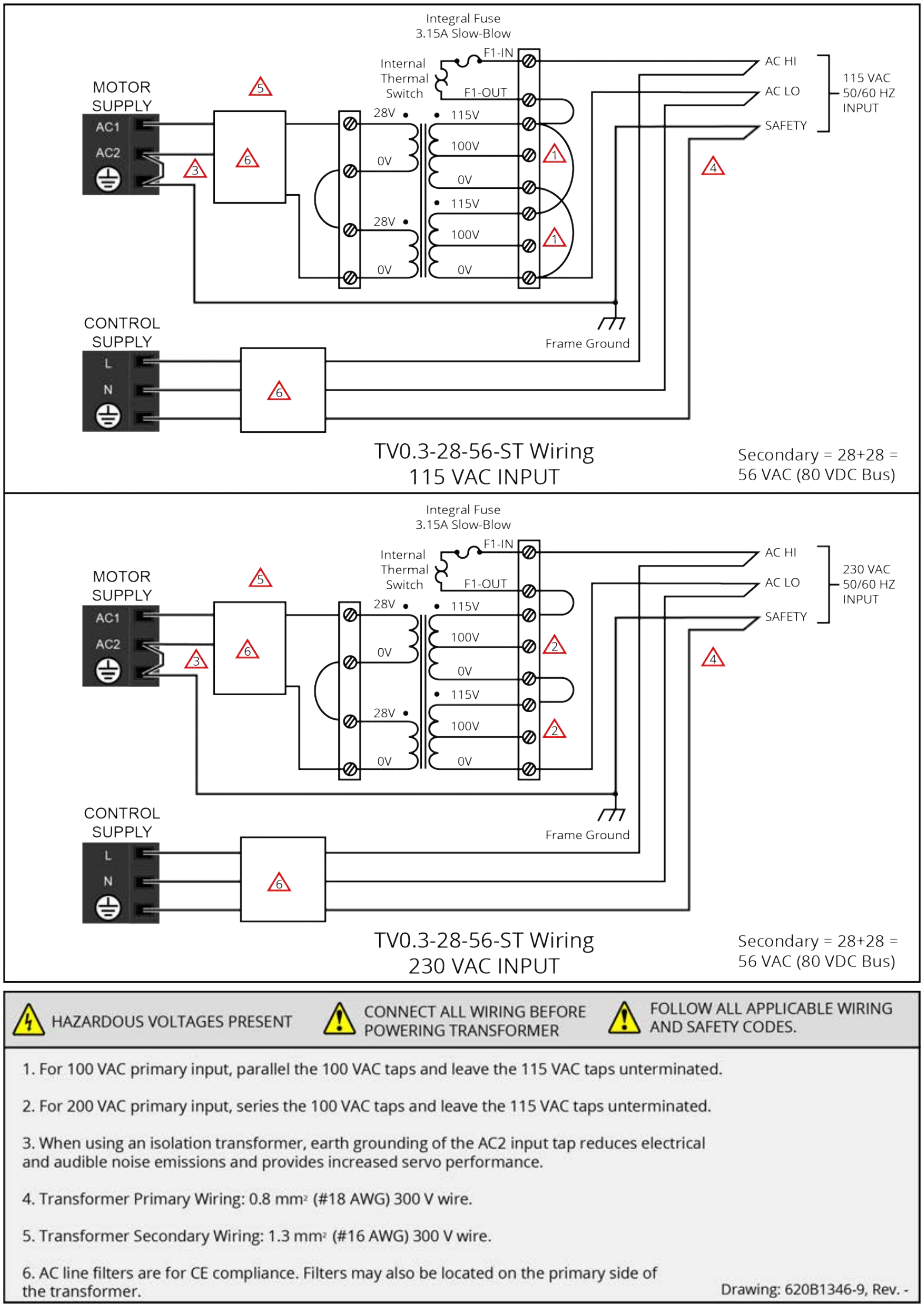
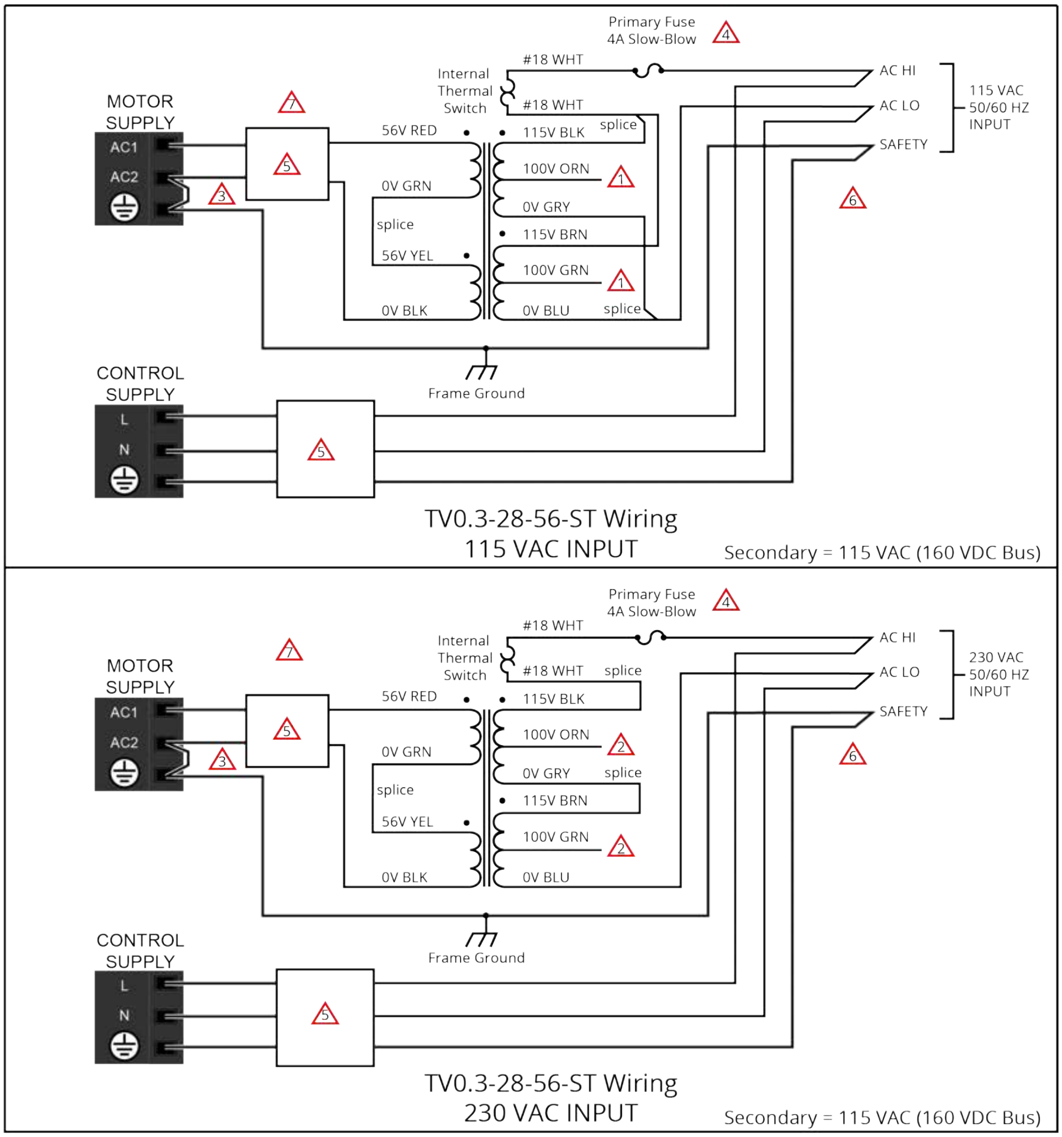



**Figure 2-5:** **TV0.3-28-56-ST Transformer Control and Motor Power Wiring (80 VDC Bus)**




HAZARDOUS VOLTAGES PRESENT | CONNECT ALL WIRING BEFORE POWERING TRANSFORMER | FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES

1. For 100 VAC primary input, parallel the 100 VAC taps and leave the 115 VAC taps unterminated.

2. For 200 VAC primary input, series the 100 VAC taps and leave the 115 VAC taps unterminated.

3. When using an isolation transformer, earth grounding of the AC2 input tap reduces electrical and audible noise emissions and provides increased servo performance.

4. Additional or alternative fusing may be required for optimum protection

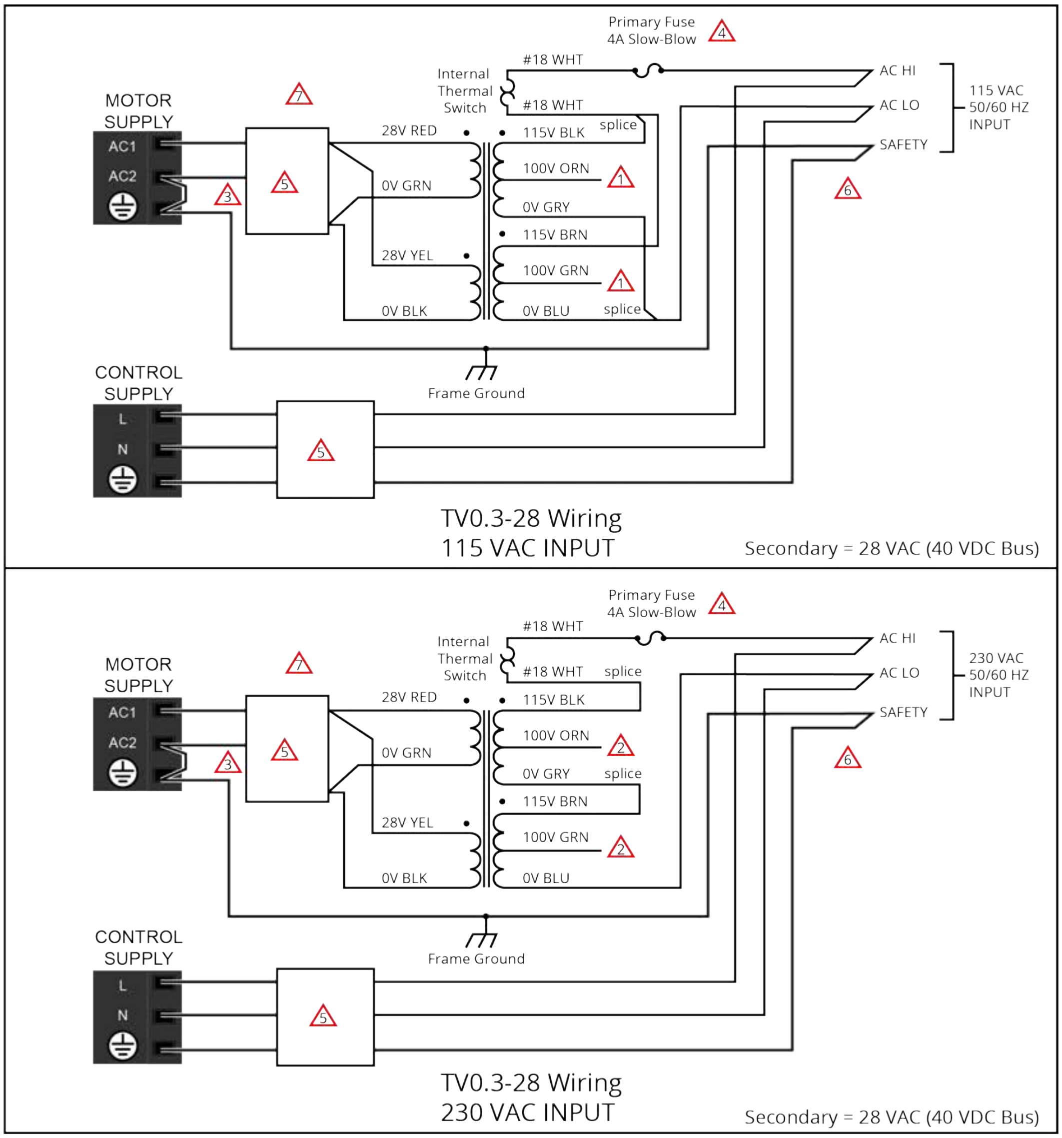
5. AC line filters are for CE compliance. Filters may also be located on the primary side of the transformer.

6. Transformer Primary Wiring: 0.8 $mm^2$ (#18 AWG) 300 V wire.

7. Transformer Secondary Wiring: 1.3 $mm^2$ (#16 AWG) 300 V wire.

Drawing: 620B1346-3

**Figure 2-6: TV0.3-28-56-ST Transformer Control and Motor Power Wiring (160 VDC Bus)**

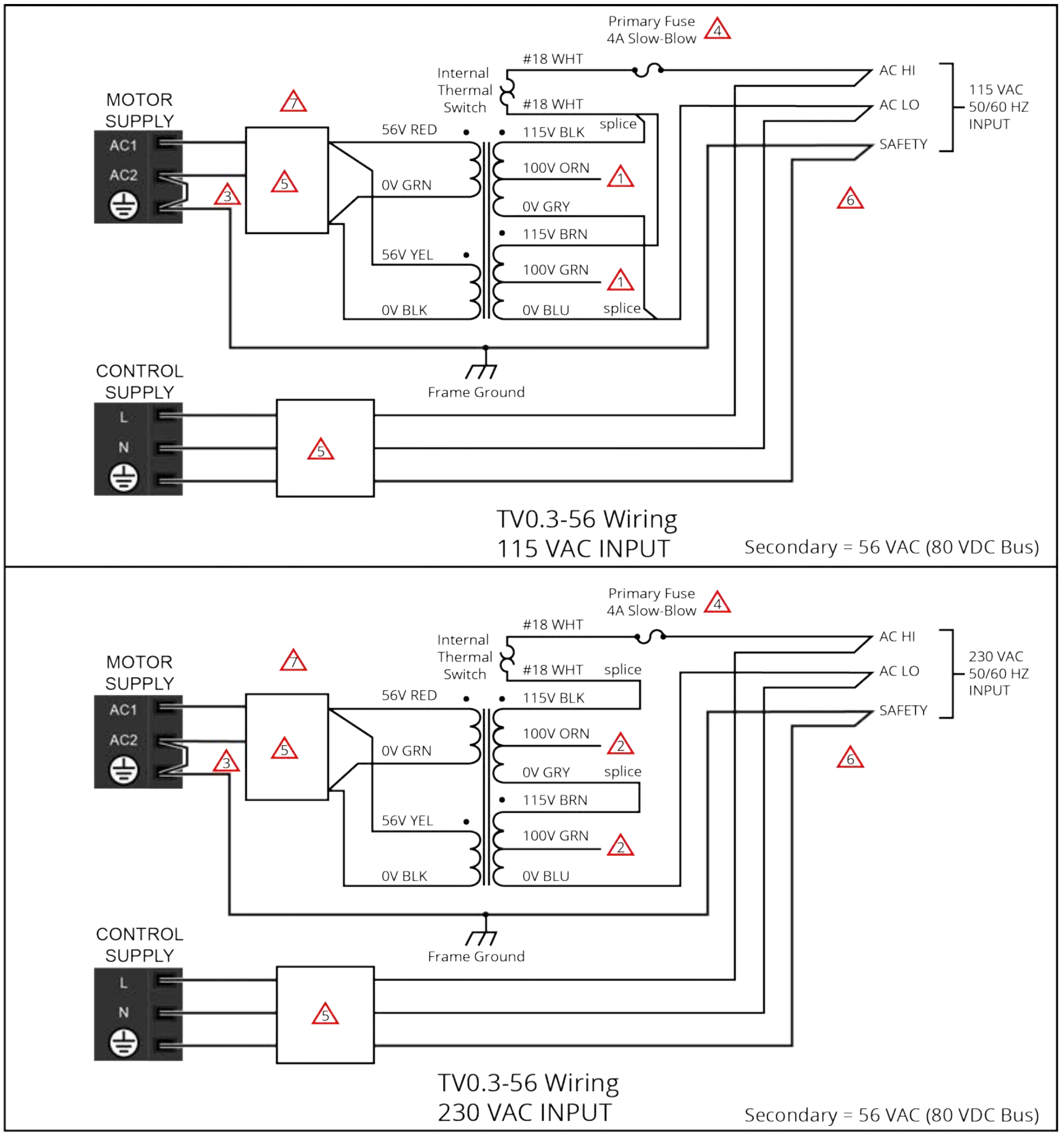



HAZARDOUS VOLTAGES PRESENT | CONNECT ALL WIRING BEFORE POWERING TRANSFORMER | FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES.

1. For 100 VAC primary input, parallel the 100 VAC taps and leave the 115 VAC taps unterminated.
2. For 200 VAC primary input, series the 100 VAC taps and leave the 115 VAC taps unterminated.
3. When using an isolation transformer, earth grounding of the AC2 input tap reduces electrical and audible noise emissions and provides increased servo performance.
4. Additional or alternative fusing may be required for optimum protection
5. AC line filters are required for CE compliance. Filters may also be located on the primary side of the transformer.
6. Transformer Primary Wiring: 0.8 $mm^2$ (#18 AWG) 300 V wire.
7. Transformer Secondary Wiring: 1.3 $mm^2$ (#16 AWG) 300 V wire.

Drawing: 620B1346-1

**Figure 2-7: TV0.3-28 Transformer Control and Motor Power Wiring (40 VDC Bus)**




HAZARDOUS VOLTAGES PRESENT | CONNECT ALL WIRING BEFORE POWERING TRANSFORMER | FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES

1. For 100 VAC primary input, parallel the 100 VAC taps and leave the 115 VAC taps unterminated.

2. For 200 VAC primary input, series the 100 VAC taps and leave the 115 VAC taps unterminated.

3. When using an isolation transformer, earth grounding of the AC2 input tap reduces electrical and audible noise emissions and provides increased servo performance.

4. Additional or alternative fusing may be required for optimum protection

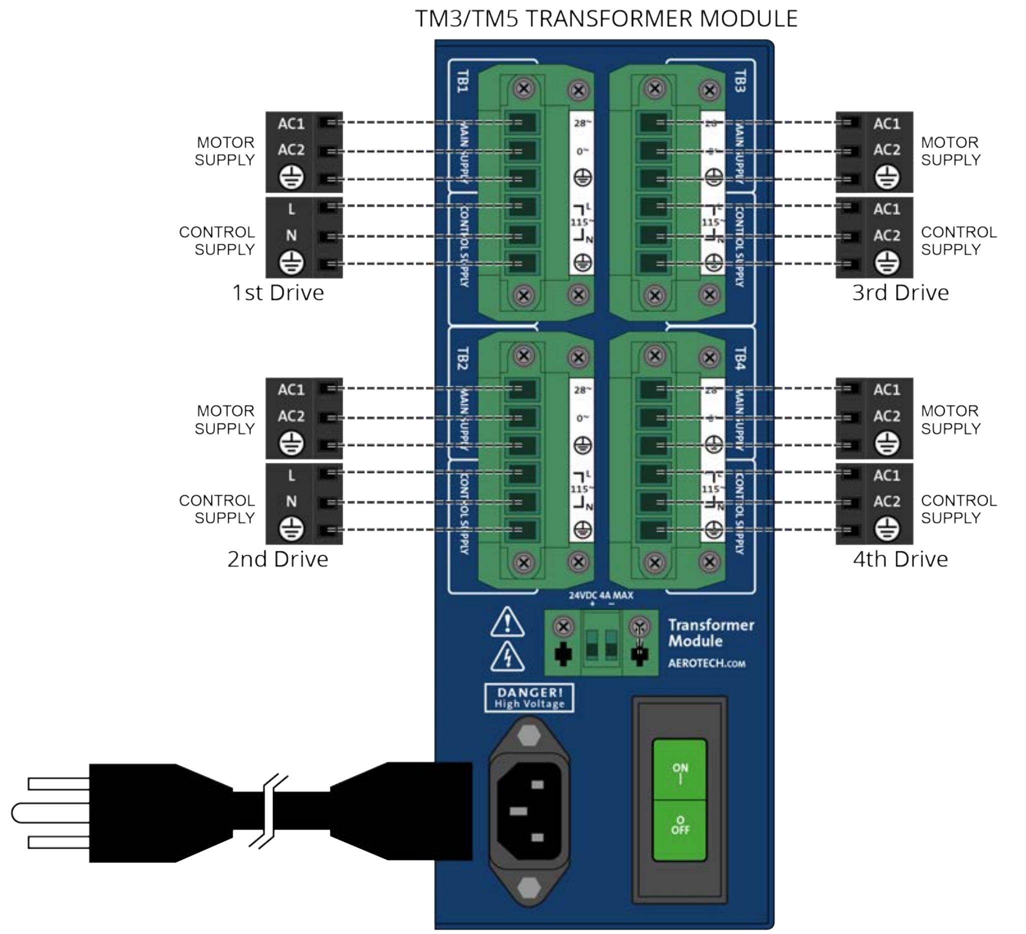
5. AC line filters are required for CE compliance. Filters may also be located on the primary side of the transformer.

6. Transformer Primary Wiring: 0.8 mm$^2$ (#18 AWG) 300 V wire.

7. Transformer Secondary Wiring: 1.3 mm$^2$ (#16 AWG) 300 V wire.

Drawing: 620B1346-2

**Figure 2-8: TV0.3-56 Transformer Control and Motor Power Wiring (80 VDC Bus)**




| | | |
|---|---|---|
| HAZARDOUS VOLTAGES PRESENT | CONNECT ALL WIRING BEFORE POWERING TRANSFORMER | FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES. |

1. See the TM3 or TM5 manual for input voltage configuration
2. Wiring Specifications: 1.3 $mm^2$ (#16 AWG) 300 V wire.
3. Control Supply output voltage (115 VAC in this example) is always the same as the AC Input Voltage to the unit.

**Figure 2-9: TM3/TM5 Transformer Control and Motor Power Wiring**

### 2.1.4. Minimizing Noise for EMC/CE Compliance

**IMPORTANT**: The XC4e is a component designed to be integrated with other electronics. EMC testing must be conducted on the final product configuration.

To reduce electrical noise, observe the following motor feedback and input power wiring techniques.

1. Use shielded cable for motor and feedback connectors. Connect the shield to the backshell at each end of the cable.
2. Separate motor and power wiring from encoder and I/O wiring.
3. Mount drives, power supplies, and filter components on a conductive panel.Mount line filters close to the drive to keep the wire length between the drive and filter to a minimum. Use a line filter, such as Aerotech's UFM-ST, on the Motor Supply and Control Supply AC inputs.
4. Use the lowest motor voltage required by the application to reduce radiated emission.
5. Use an isolation transformer with grounded secondary to keep the effects of high frequency PWM amplifier currents to a minimum.
6. Use a separate wire for each ground connection to the drive. Use the shortest possible wire length.

The following additional changes could be required for EMC compliance and are recommended during initial EMC system evaluation.

1. Add a clamp-on ferrite to the feedback cable close to the drive.
   [Aerotech PN ECZ02348, Fair-rite PN 0446167281]
2. Add a clamp-on ferrite to the Motor Supply and Control Supply wires, including the ground wire, close to the drive.
   [Aerotech PN ECZ02347, Fair-rite PN 0446164281]
3. Add a ferrite core to the UFM-ST AC input wires. Wrap the AC wires and ground wire around the core one time.
   [Ferrite core: Aerotech PN ECZ02350, Fair-rite PN 2646102002]
4. Add a ferrite core to the motor phase and ground wires close to the drive. Wrap all four wires around the ferrite core once. Remove ferrite beads from Aerotech supplied cables if installed.
   [Ferrite core: Aerotech PN ECZ02349, Fair-rite PN 2646626402]
5. Install a motor filter module MFM10-1 close to the drive. The ferrite core that you added to the motor phase and ground wires should be located between the drive and the MFM10-1.

## 2.2. Motor Power Output Connector

**DANGER**: Before you do maintenance to the equipment, disconnect the electrical power. Wait at least ten (10) minutes after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.

The XC4e can be used to drive the following motor types:

- Brushless (refer to Section 2.2.1.)
- DC Brush (refer to Section 2.2.2.)
- Stepper (refer to Section 2.2.3.)

For a complete list of electrical specifications, refer to Section 1.1.

**IMPORTANT**: Refer to local electrical safety requirements to correctly size external system wires.

The 7-pin terminal block style motor output connector is located on the front panel. The pinout for this connector is shown in Table 2-7.

**Table 2-7: Motor Power Output Connector Pinout**

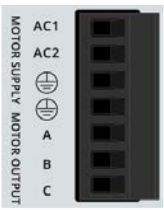
| Pin | Description | Recommended Wire Size | Connector |
|---|---|---|---|
| ⏚ | Earth Ground to Motor | 1.3 mm² (#16 AWG) |  |
| A | Brushless Phase A Motor Lead<br>DC Brush +<br>Stepper | 1.3 mm² (#16 AWG) | |
| B | Brushless Phase B Motor Lead<br>Stepper | 1.3 mm² (#16 AWG) | |
| C | Brushless Phase C Motor Lead<br>DC Brush -<br>Stepper Return | 1.3 mm² (#16 AWG) | |

**Table 2-8: Mating Connector Part Numbers for the Motor Power Output Connector**

| Type | Aerotech P/N | Third Part P/N | Screw Torque: Nm | Wire Size: mm²[AWG] |
|---|---|---|---|---|
| 7-Pin Terminal Block | ECK02387 | Phoenix 1756353 | 0.5 - 0.6 | 3.3 - 0.0516 [12-30] |

### 2.2.1. Brushless Motor Connections

The configuration shown in Figure 2-10 is an example of a typical brushless motor connection.

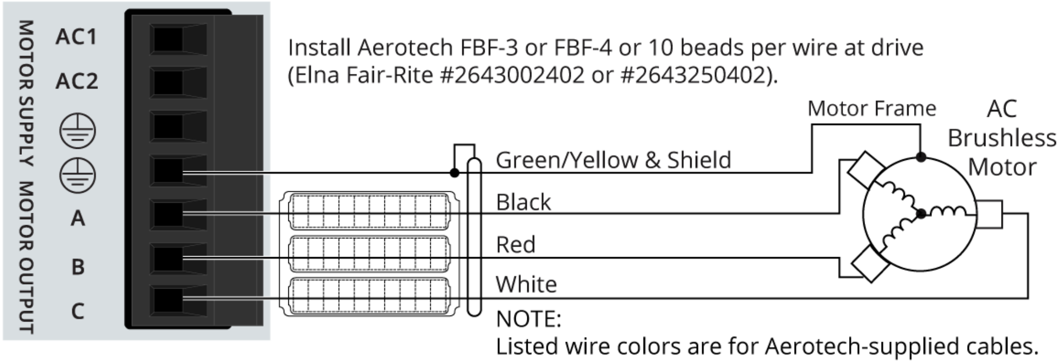



**Figure 2-10: Brushless Motor Configuration**

**Table 2-9: Wire Colors for Aerotech-Supplied Brushless Motor Cables**

| Pin | Wire Color Set 1 (1) | Wire Color Set 2 | Wire Color Set 3 | Wire Color Set 4 |
|---|---|---|---|---|
| ⏚ | Green/Yellow & Shield (2) | Green/Yellow & Shield | Green/Yellow & Shield | Green/Yellow & Shield |
| A | Black | Blue & Yellow | Black #1 | Black & Brown |
| B | Red | Red & Orange | Black #2 | Red & Orange |
| C | White | White & Brown | Black #3 | Violet & Blue |
| (1) Wire Color Set #1 is the wire set typically used by Aerotech. | | | | |
| (2) "&" indicates two wires (Red & Orange); " / " indicates a single wire (Green/White). | | | | |

Brushless motors are commutated electronically by the controller. The use of Hall effect devices for commutation is recommended.

The controller requires that the Back-EMF of each motor phase be aligned with the corresponding Hall-effect signal. To ensure proper alignment, motor, Hall, and encoder connections should be verified using one of the following methods: *powered*, through the use of a test program; or *unpowered* using an oscilloscope. Both methods will identify the A, B, and C Hall/motor lead sets and indicate the correct connections to the controller. Refer to Section 2.2.1.1. for powered motor phasing or Section 2.2.1.2. for unpowered motor and feedback phasing.

For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

A motor filter module can be installed between the drive and the motor to reduce the effects on PWM generated noise currents.

### 2.2.1.1. Brushless Motor Powered Motor and Feedback Phasing

Observe the state of the encoder and Hall-effect device signals in the Diagnostics section of the Status Utility.

**Table 2-10: Hall Signal Diagnostics**

| Hall-Signal Status | Definition |
|---|---|
| -- | 0 V or logic low |
| ON | 5 V or logic high |

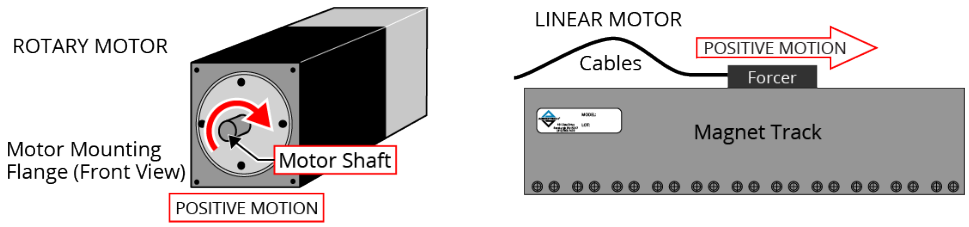



**Figure 2-11: Positive Motor Direction**

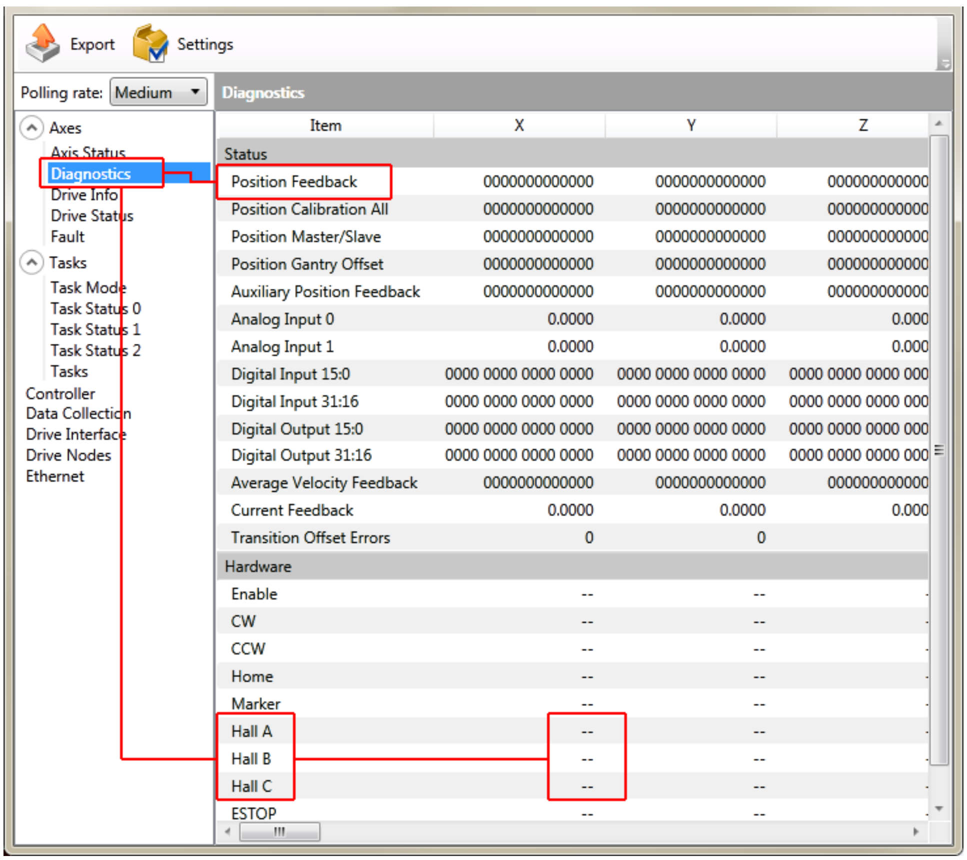


**Figure 2-12: Encoder and Hall Signal Diagnostics**

### 2.2.1.2. Brushless Motor Unpowered Motor and Feedback Phasing

Disconnect the motor from the controller and connect the motor in the test configuration shown in Figure 2-13. This method will require a two-channel oscilloscope, a 5V power supply, and six resistors (10,000 ohm, 1/4 watt). All measurements should be made with the probe common of each channel of the oscilloscope connected to a neutral reference test point (TP4, shown in Figure 2-13). Wave forms are shown while moving the motor in the positive direction.

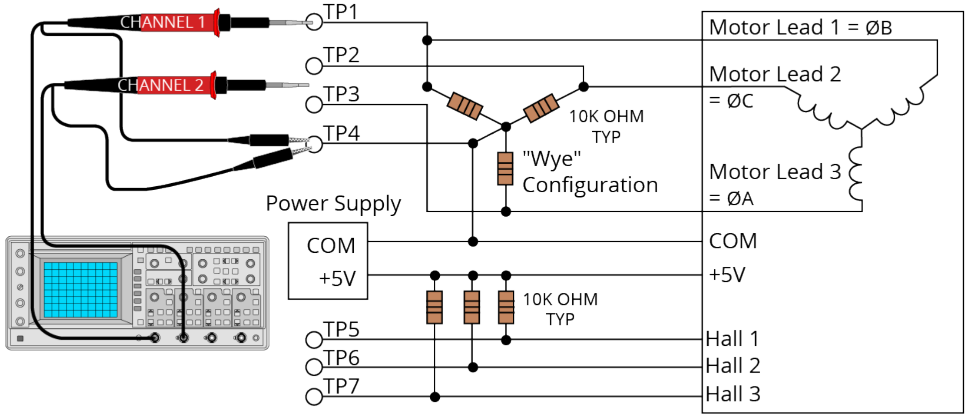



**Figure 2-13: Brushless Motor Phasing Oscilloscope Example**

With the designations of the motor and Hall leads of a third party motor determined, the motor can now be connected to an Aerotech system. Connect motor lead A to motor connector A, motor lead B to motor connector B, and motor lead C to motor connector C. Hall leads should also be connected to their respective feedback connector pins (Hall A lead to the Hall A feedback pin, Hall B to Hall B, and Hall C to Hall C). The motor is correctly phased when the Hall states align with the Back EMF as shown in (Figure 2-14). Use the CommutationOffset parameter to correct for Hall signal misalignment.

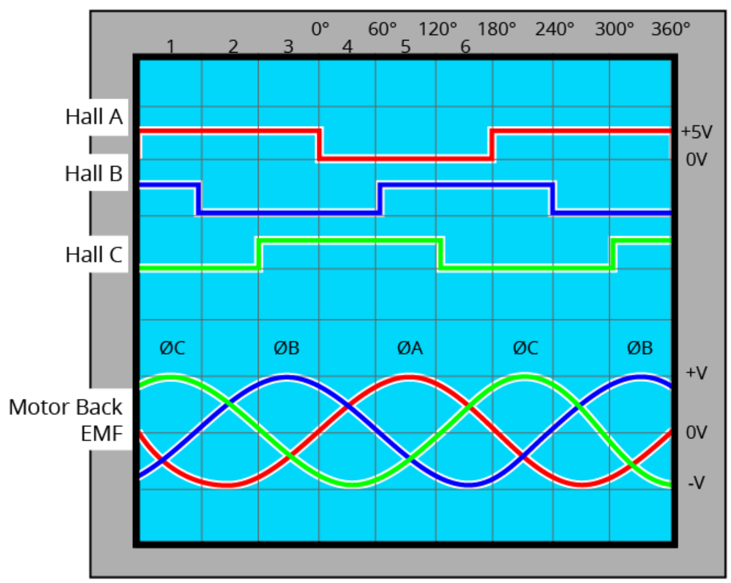



**Figure 2-14: Brushless Motor Phasing Goal**

### 2.2.2. DC Brush Motor Connections

The configuration shown in Figure 2-15 is an example of a typical DC brush motor connection. Refer to Section 2.2.2.1. for information on motor phasing.

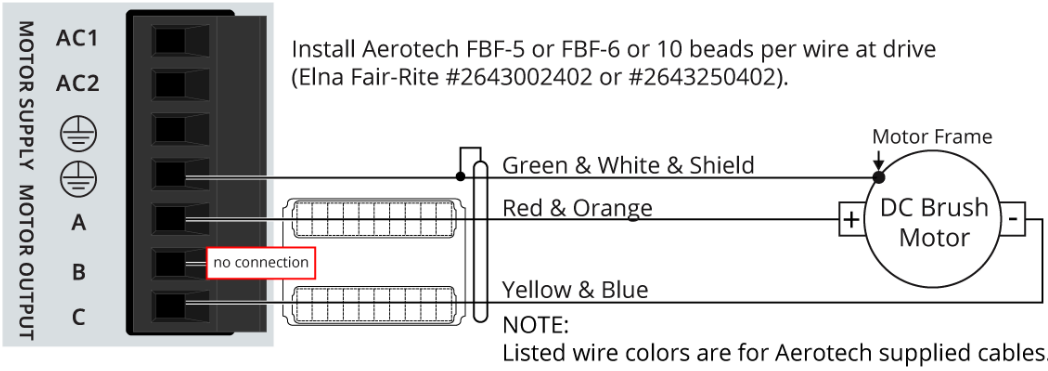



**Figure 2-15: DC Brush Motor Configuration**

**Table 2-11: Wire Colors for Aerotech-Supplied DC Brush Motor Cables**

| Pin | Wire Color Set 1(1) | Wire Color Set 2 | Wire Color Set 3 |
|---|---|---|---|
| ⏚ | Green & White & Shield (2) | Green/Yellow & Shield | Green/Yellow & Shield |
| A | Red & Orange | Red | Red & Orange |
| C | Yellow & Blue | Black | Yellow & Blue |
| (1) Wire Color Set #1 is the typical wire set used by Aerotech.<br>(2) "&" (Red & Orange) indicates two wires; " / " (Green/White) indicates a single wire. | | | |

#### 2.2.2.1. DC Brush Motor Phasing

A properly phased motor means that the positive motor lead should be connected to the ØA motor terminal and the negative motor lead should be connected to the ØC motor terminal. To determine if the motor is properly phased, connect a voltmeter to the motor leads of an un-powered motor:

1. Connect the positive lead of the voltmeter to the one of the motor terminals.
2. Connect the negative lead of the voltmeter to the other motor terminal.
3. Move or rotate the motor in the positive or clockwise (CW) direction by hand.

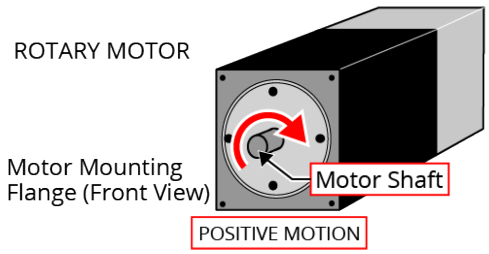



**Figure 2-16: Positive Motor Direction**

4. If the voltmeter indicates a negative value, swap the motor leads and move the motor by hand in the positive direction, again. When the voltmeter indicates a positive value, the motor leads have been identified.
5. Connect the motor lead from the positive lead of the voltmeter to the ØA motor terminal on the XC4e. Connect the motor lead from the negative lead of the voltmeter to the ØC motor terminal on the XC4e.

For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

## 2.2.3. Stepper Motor Connections

The configuration shown in Figure 2-17 is an example of a typical stepper motor connection. Refer to Section 2.2.3.1. for information on motor phasing.

In this case, the effective motor voltage is half of the applied bus voltage. For example, an 80V motor bus supply is needed to get 40V across the motor.

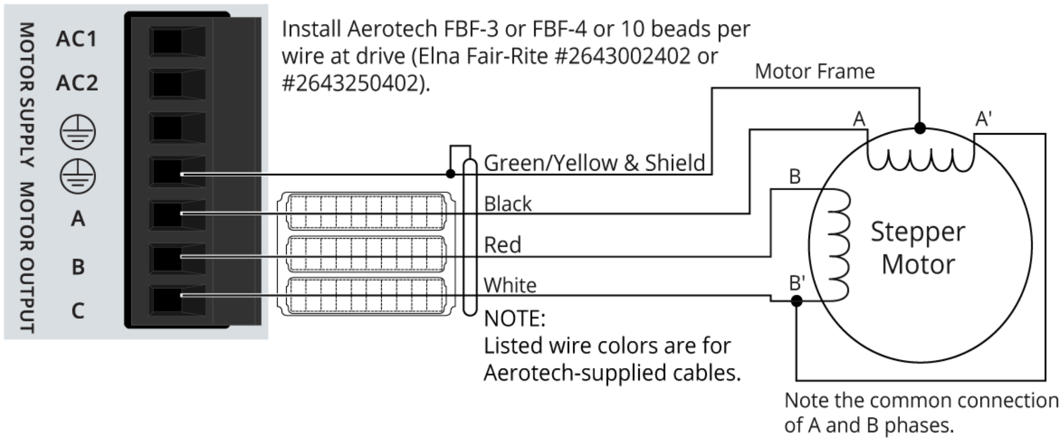



**Figure 2-17: Stepper Motor Configuration**

**Table 2-12: Wire Colors for Aerotech-Supplied Stepper Motor Cables**

| Pin | Wire Color Set 1 (1) | Wire Color Set 2 |
|---|---|---|
| ⏚ | Green/Yellow & Shield (2) | Green/Yellow & Shield |
| A | Black | Brown |
| B | Red | Yellow |
| C | White | White & Red |

(1) Wire Color Set #1 is the typical wire set used by Aerotech.
(2) “&” (Red & Orange) indicates two wires; “ / ” (Green/White) indicates a single wire.

#### 2.2.3.1. Stepper Motor Phasing

A stepper motor can be run with or without an encoder.

**Without an Encoder:** You do not need to phase the motor.

**With an Encoder:** Because the end of travel (EOT) limit inputs are relative to motor rotation, it is important to phase the motor.

Run a positive motion command. The motor is phased correctly if there is a positive scaling factor (determined by the CountsPerUnit parameters) and the motor moves in a clockwise direction when you view the motor from the front mounting flange (Figure 2-18). If the motor moves in a counterclockwise direction, swap the motor leads and re-run the command. After the motor has been phased, if you want to change the direction of positive motion, use the ReverseMotionDirection parameter.

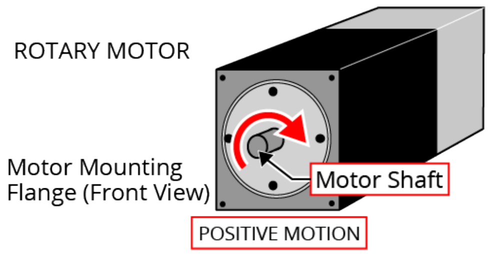



**Figure 2-18: Positive Motor Direction**

For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

## 2.3. Feedback Connector

The connector pin assignment is shown in Table 2-13 with detailed connection information in the following sections.

**Table 2-13: Feedback Connector Pinout**

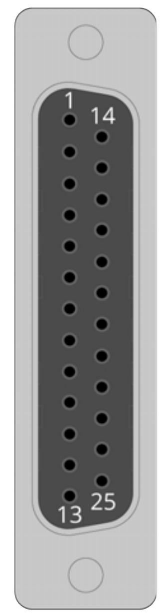
| Pin # | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Reserved | N/A |  |
| 2 | Motor Over Temperature Thermistor | Input | |
| 3 | +5V Power (1) | N/A | |
| 4 | Plug and Play Serial Data (for Aerotech stages only) | Bidirectional | |
| 5 | Hall-Effect Sensor B (brushless motors only) | Input | |
| 6 | Encoder Marker Reference Pulse - | Input | |
| | Absolute Encoder Clock - | Output | |
| 7 | Encoder Marker Reference Pulse + | Input | |
| | Absolute Encoder Clock + | Output | |
| 8 | Absolute Encoder Data - | Bidirectional | |
| 9 | Reserved | N/A | |
| 10 | Hall-Effect Sensor A (brushless motors only) | Input | |
| 11 | Hall-Effect Sensor C (brushless motors only) | Input | |
| 12 | Clockwise End of Travel Limit | Input | |
| 13 | Brake Output - | Output | |
| 14 | Encoder Cosine + | Input | |
| 15 | Encoder Cosine - | Input | |
| 16 | +5V Power (1) | N/A | |
| 17 | Encoder Sine + | Input | |
| 18 | Encoder Sine - | Input | |
| 19 | Absolute Encoder Data+ | Bidirectional | |
| 20 | Signal Common | N/A | |
| 21 | Signal Common | N/A | |
| 22 | Home Switch Input | Input | |
| 23 | Encoder Fault Input | Input | |
| 24 | Counterclockwise End of Travel Limit | Input | |
| 25 | Brake Output + | Output | |
| (1) The maximum combined current output is 500 mA. | | | |



**Table 2-14: Mating Connector Part Numbers for the Feedback Connector**

| Mating Connector | Aerotech P/N | Third Party P/N |
|---|---|---|
| 25-Pin D-Connector | ECK00101 | FCI DB25P064TXLF |
| Backshell | ECK00656 | Amphenol 17E-1726-2 |

### 2.3.1. Primary Encoder Inputs

The primary encoder inputs are accessible through the Feedback connector. Use the PrimaryFeedbackType [A3200: PositionFeedbackType or VelocityFeedbackType] parameter to configure the XC4e to accept an encoder signal type.

Square Wave encoder signals: Section 2.3.1.1.

Absolute encoder signals: Section 2.3.1.2.

Sine Wave encoder signals (as permitted by the multiplier option): Section 2.3.1.3.

Refer to Section 2.3.1.4. for encoder feedback phasing.

Refer to Section 2.5. for the auxiliary encoder input on the Aux I/O connector.

**Table 2-15: Multiplier Options**

| Option | Primary Encoder Accepts... | Auxiliary Encoder Accepts... |
|---|---|---|
| -MX0 | Square Wave or Absolute encoders | Square Wave or Absolute encoders |
| -MX2 | Sine Wave (high performance), Square Wave, or Absolute encoders | Square Wave or Absolute encoders |
| -MX3 | Sine Wave (high performance), Square Wave, or Absolute encoders | Sine Wave (standard performance), Square Wave, or Absolute encoders |

**IMPORTANT**: Physically isolate the encoder wiring from motor, AC power, and all other power wiring

**Table 2-16: Primary Encoder Input Pins on the Feedback Connector**

| Pin # | Description | In/Out/Bi |
|---|---|---|
| 3 | +5V Power (1) | N/A |
| 6 | Encoder Marker Reference Pulse - | Input |
| | Absolute Encoder Clock - | Output |
| 7 | Encoder Marker Reference Pulse + | Input |
| | Absolute Encoder Clock + | Output |
| 8 | Absolute Encoder Data - | Bidirectional |
| 14 | Encoder Cosine + | Input |
| 15 | Encoder Cosine - | Input |
| 16 | +5V Power (1) | N/A |
| 17 | Encoder Sine + | Input |
| 18 | Encoder Sine - | Input |
| 19 | Absolute Encoder Data+ | Bidirectional |
| 20 | Signal Common | N/A |
| 21 | Signal Common | N/A |

(1) The maximum combined current output is 500 mA.

### 2.3.1.1. Square Wave Encoder

The XC4e accepts RS-422 square wave encoder signals. The XC4e will generate a feedback fault if it detects an invalid signal state caused by an open or shorted signal connection. Use twisted-pair wiring for the highest performance and noise immunity.

**Table 2-17: Square Wave Encoder Specifications**

| Specification | Value |
|---|---|
| Encoder Frequency | 10 MHz maximum (25 ns minimum edge separation) |
| x4 Quadrature Decoding | 40 million counts/sec |

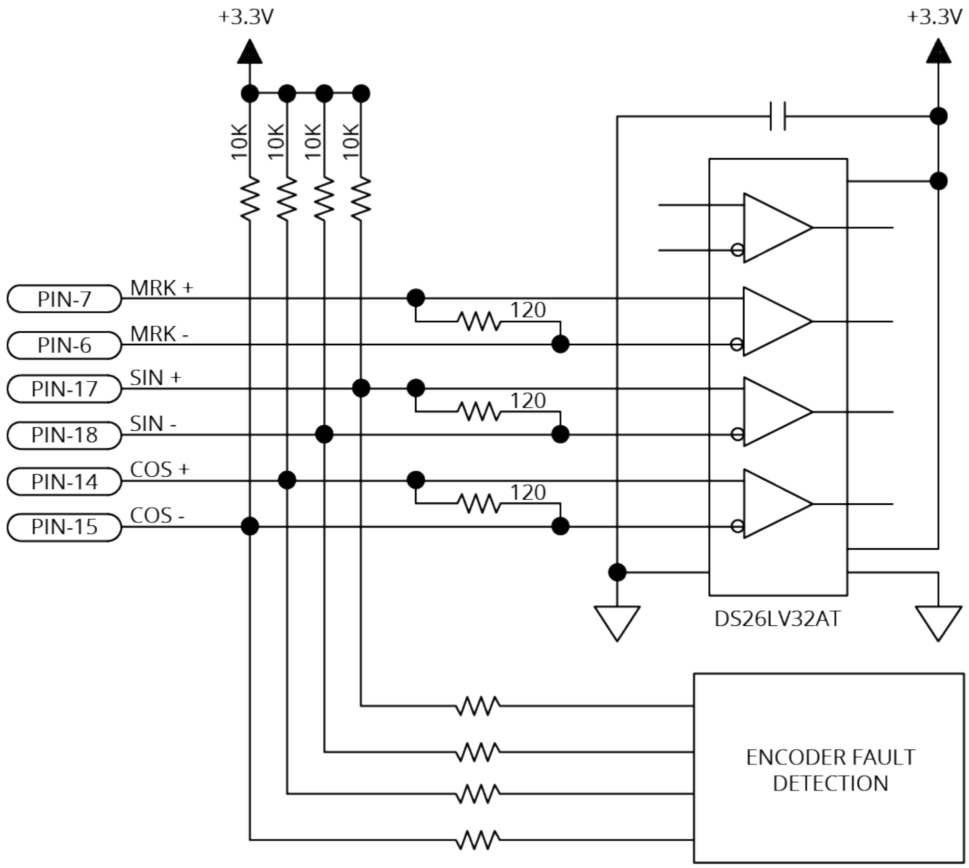



**Figure 2-19: Square Wave Encoder Schematic (Feedback Connector)**

#### 2.3.1.2. Absolute Encoder

The XC4e retrieves absolute position data along with encoder fault information through a serial data stream from the absolute encoder. Use twisted-pair wiring for the highest performance and noise immunity. You cannot echo an absolute encoder signal.

Refer to Figure 2-20 for the serial data stream interface.

Refer to the Help file for information on how to set up your EnDat or BiSS absolute encoder parameters.

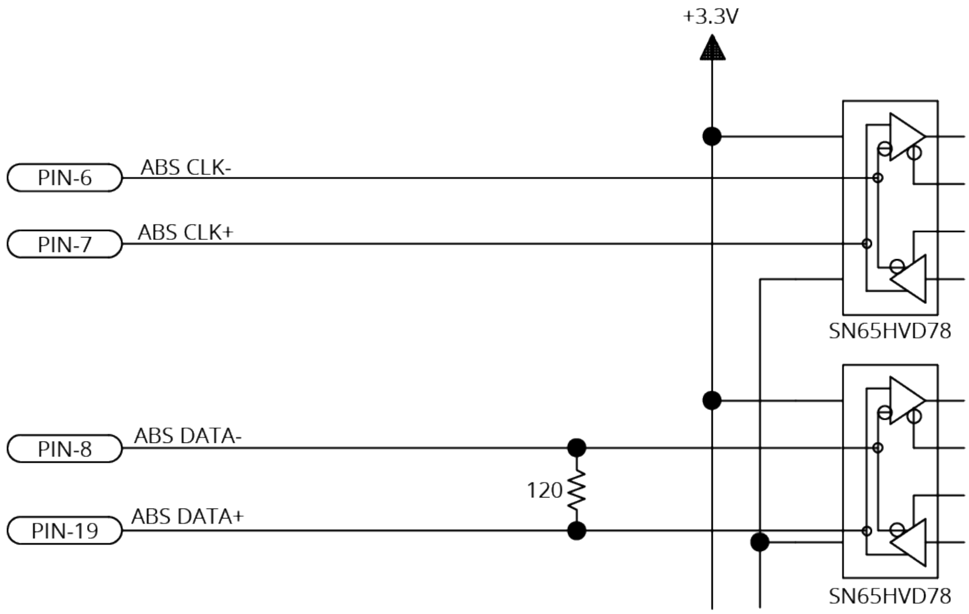



**Figure 2-20: Absolute Encoder Schematic (Feedback Connector)**

#### 2.3.1.3. Sine Wave Encoder [-MX2/-MX3 Option]

The Sine Wave Encoder option provides higher positioning resolution by subdividing the fundamental output period of the encoder into smaller increments. The amount of subdivision is specified by the PrimaryEncoderMultiplicationFactor [A3200: EncoderMultiplicationFactor] parameter. Use Encoder Tuning [A3200: Feedback Tuning] to adjust the value of the gain, offset, and phase balance controller parameters to get the best performance. For more information, refer to the Help file.

High resolution or high-speed encoders can require increased bandwidth for correct operation. Use the High Speed Mode of the PrimaryEncoderMultiplierSetup [A3200: EncoderMultiplierSetup] parameter to enable the high bandwidth mode. Because this mode increases sensitivity to system noise, use it only if necessary.

The XC4e can generate emulated encoder signals. These signals can be output on the Auxiliary Encoder (AUX) connector, SYNC port connector, or used internally by the PSO. Refer to the EncoderDivider and PrimaryEmulatedQuadratureDivider [A3200: EmulatedQuadratureDivider] parameters and the encoder output functions [A3200: ENCODER OUT command] in the Help file for more information.

For the highest performance, use twisted pair double-shielded cable with the inner shield connected to signal common and the outer shield connected to frame ground. Do not join the inner and outer shields in the cable.

**Table 2-18: Sine Wave Encoder Specifications**

| Specification | | Value | |
|---|---|---|---|
| | | Primary | Auxiliary |
| Input Frequency (max) | | 450 kHz, 2 MHz | 450 kHz |
| Input Amplitude (1) | | 0.6 to 1.75 Vpk-pk | |
| Interpolation Factor (max) | -MX2 | 65,536 | N/A |
| | -MX3 | 65,536 | 16,384 |
| -MX2/-MX3 Primary Encoder Channel Interpolation Latency | | 800 nsec (analog input to quadrature output) | |
| Input Common Mode | | 1.5 to 3.5 VDC | |
| (1) Measured as SIN(+) - SIN(-) or COS(+) - COS(-) | | | |

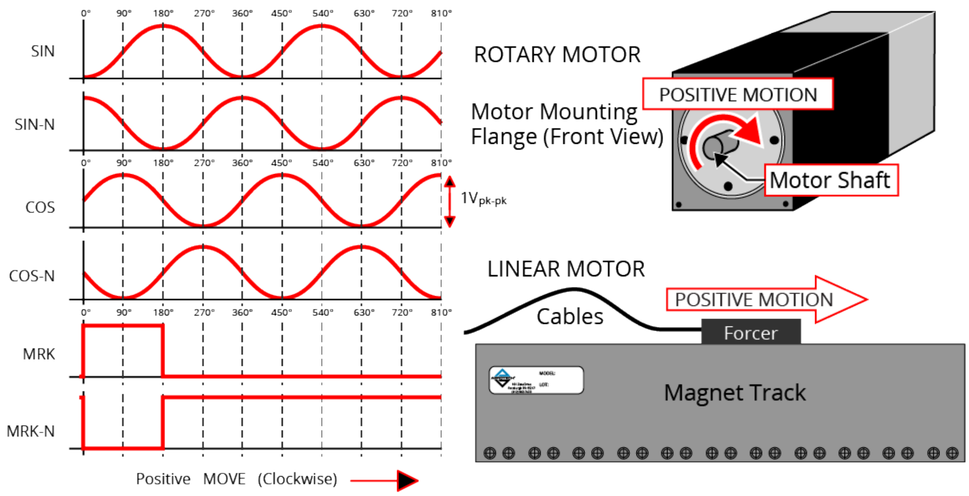



**Figure 2-21: Sine Wave Encoder Phasing Reference Diagram**

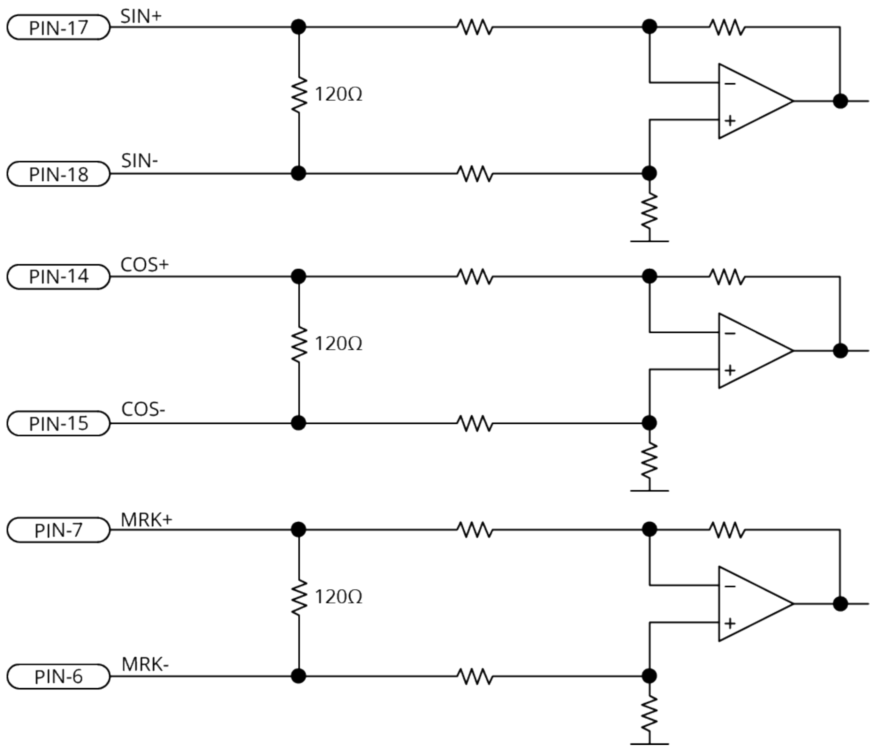



**Figure 2-22: Sine Wave Encoder Schematic (Feedback Connector)**

### 2.3.1.4. Encoder Phasing

Incorrect encoder polarity will cause the system to fault when enabled or when a move command is issued. Figure 2-23 illustrates the proper encoder phasing for clockwise motor rotation (or positive forcer movement for linear motors). To verify, move the motor by hand in the CW (positive) direction while observing the position of the encoder in the diagnostics display (see Figure 2-24).

For dual loop systems, the velocity feedback encoder is displayed in the diagnostic display (Figure 2-24).

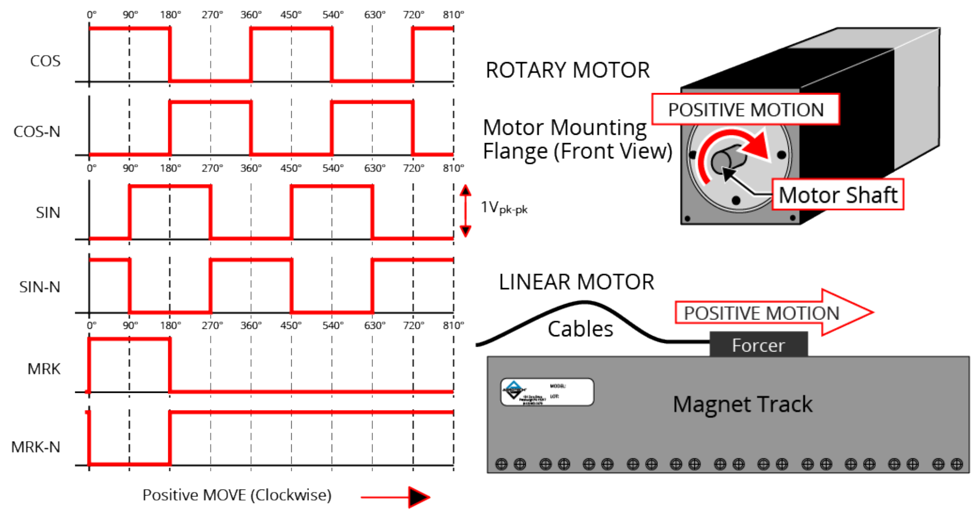



**Figure 2-23: Encoder Phasing Reference Diagram (Standard)**

**IMPORTANT**: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-23.

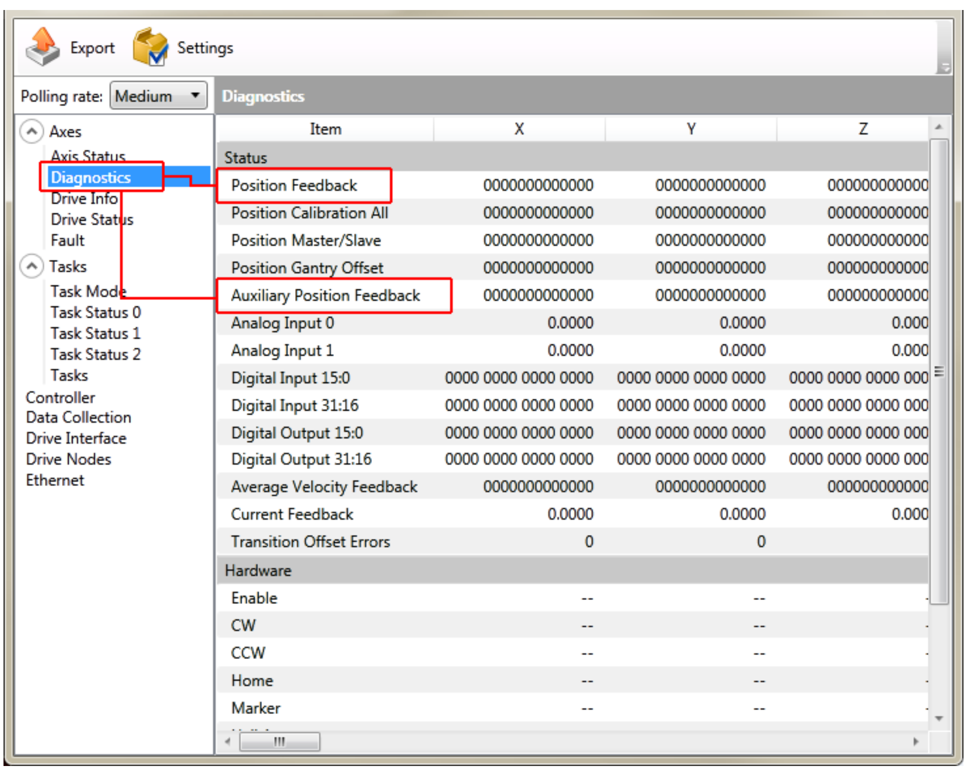



**Figure 2-24: Position Feedback in the Diagnostic Display**

### 2.3.2. Hall-Effect Inputs

The Hall-effect switch inputs are recommended for AC brushless motor commutation but not absolutely required. The Hall-effect inputs accept 5 VDC level signals. Hall states (0,0,0) or (1,1,1) are invalid and will generate a "Hall Fault" axis fault.

Refer to Section 2.2.1.1. for Hall-effect device phasing.

**Table 2-19: Hall-Effect Feedback Pins on the Feedback Connector**

| Pin # | Description | In/Out/Bi |
|---|---|---|
| 3 | +5V Power (1) | N/A |
| 5 | Hall-Effect Sensor B (brushless motors only) | Input |
| 10 | Hall-Effect Sensor A (brushless motors only) | Input |
| 11 | Hall-Effect Sensor C (brushless motors only) | Input |
| 16 | +5V Power (1) | N/A |
| 20 | Signal Common | N/A |
| 21 | Signal Common | N/A |

(1) The maximum combined current output is 500 mA.

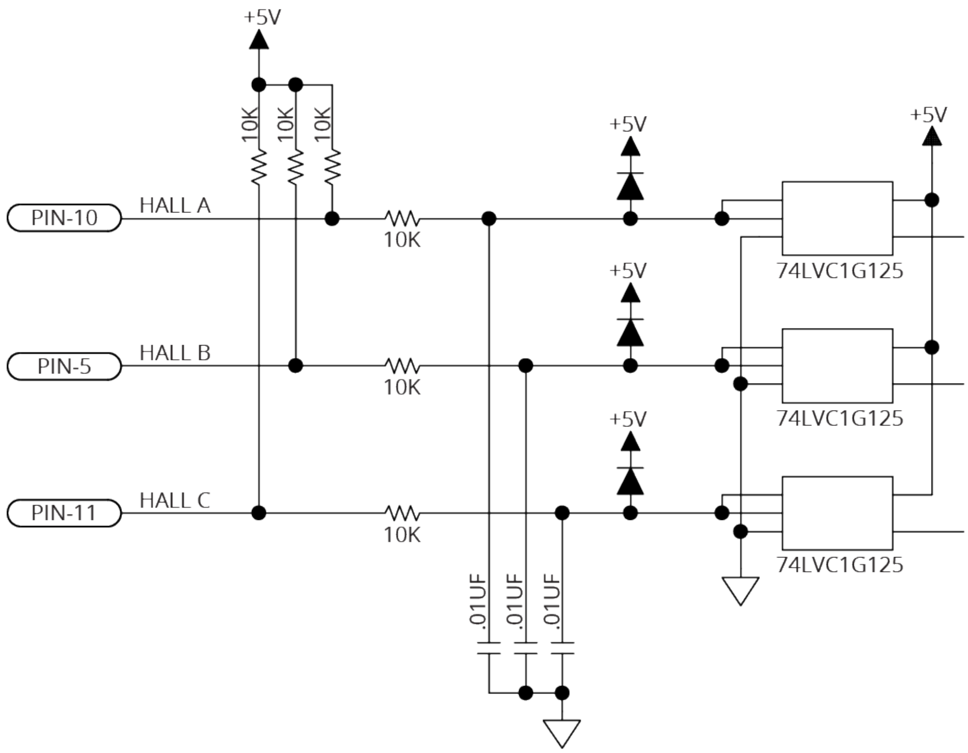



**Figure 2-25: Hall-Effect Inputs Schematic (Feedback Connector)**

### 2.3.3. Thermistor Input

The thermistor input is used to detect a motor over temperature condition by using a positive temperature coefficient sensor. As the temperature of the sensor increases, so does the resistance. Under normal operating conditions, the resistance of the thermistor is low which will result in a low input signal. As the increasing temperature causes the thermistor's resistance to increase, the sensor will trigger an over temperature fault.

The thermistor is connected between Pin 2 and Signal Common. The nominal trip value of the sensor is 1.385 kΩ. The circuit includes a 12 kΩ internal pull-up resistor which corresponds to a trip voltage of +0.52 V.

**Table 2-20: Thermistor Input Pin on the Feedback Connector**

| Pin # | Description | In/Out/Bi |
|---|---|---|
| 2 | Motor Over Temperature Thermistor | Input |

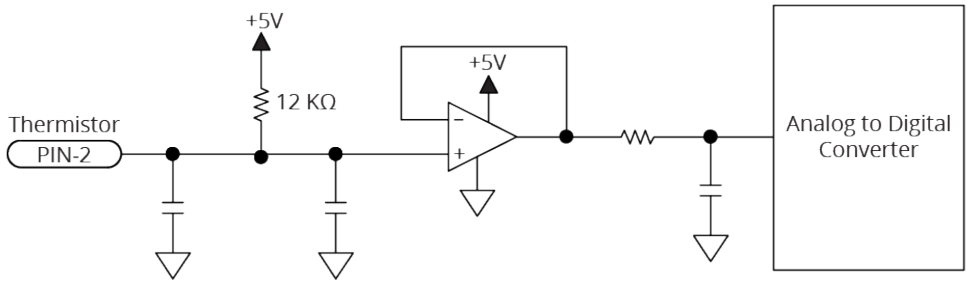



**Figure 2-26: Thermistor Input Schematic (Feedback Connector)**

### 2.3.4. Encoder Fault Input

The encoder fault input is for use with encoders that have a fault output. This is provided by some manufactures and indicates a loss of encoder function. The active state of this input is parameter configurable and the controller should be configured to disable the axis when the fault level is active. The nominal trip voltage of the encoder fault input is +2.5 V.

**Table 2-21: Encoder Fault Input Pin on the Feedback Connector**

| Pin # | Description | In/Out/Bi |
|---|---|---|
| 23 | Encoder Fault Input | Input |

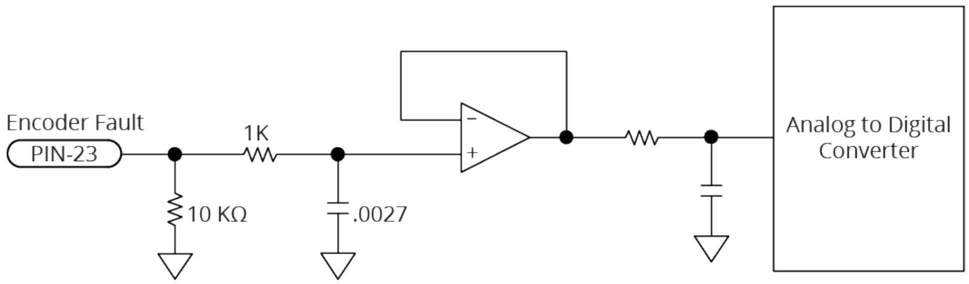



**Figure 2-27: Encoder Fault Input Schematic (Feedback Connector)**

### 2.3.5. End of Travel and Home Limit Inputs

End of Travel (EOT) limits are required to define the end of the physical travel on linear axes. Positive or clockwise motion is stopped by the clockwise (CW) end of travel limit input. Negative or counterclockwise motion is stopped by the counterclockwise (CCW) end of travel limit input. The Home Limit switch can be parameter configured for use during the home cycle, however, the CW or CCW EOT limit is typically used instead. All of the end-of-travel limit inputs accept 0-5 VDC level signals. Limit directions are relative to the encoder polarity in the diagnostics display (refer to Figure 2-30).

**Table 2-22: End of Travel and Home Limit Pins on the Feedback Connector**

| Pin # | Description | In/Out/Bi |
|---|---|---|
| 12 | Clockwise End of Travel Limit | Input |
| 16 | +5V Power | N/A |
| 20 | Signal Common | N/A |
| 21 | Signal Common | N/A |
| 22 | Home Switch Input | Input |
| 24 | Counterclockwise End of Travel Limit | Input |

The active state (High/Low) of the EOT limits is software selectable (by the EndOfTravelLimitSetup axis parameter). Figure 2-28 shows the possible wiring configurations for normally-open and normally-closed switches and the parameter setting to use for each configuration.

**IMPORTANT**: Use NPN-type normally-closed limit switches (Active High) to provide fail-safe behavior in the event of an open circuit.

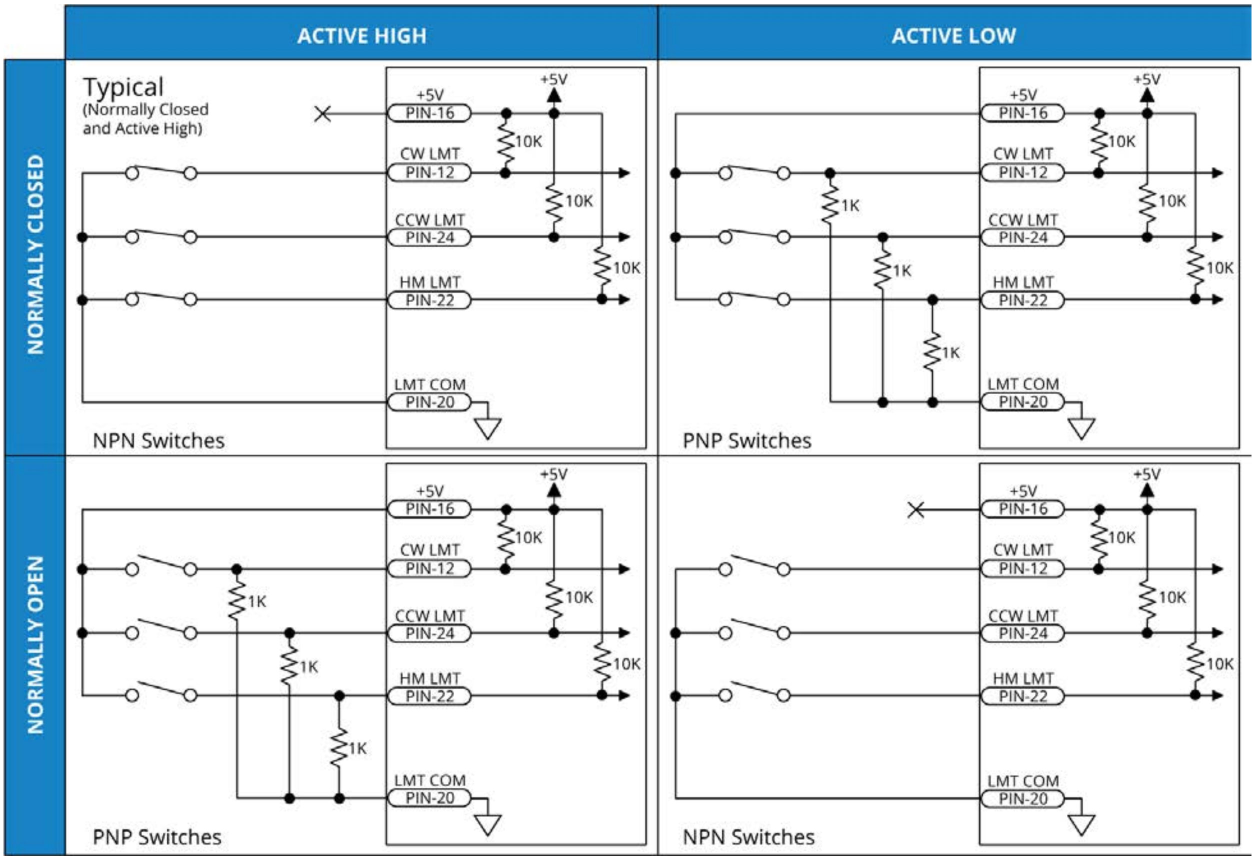



**Figure 2-28: End of Travel and Home Limit Input Connections**

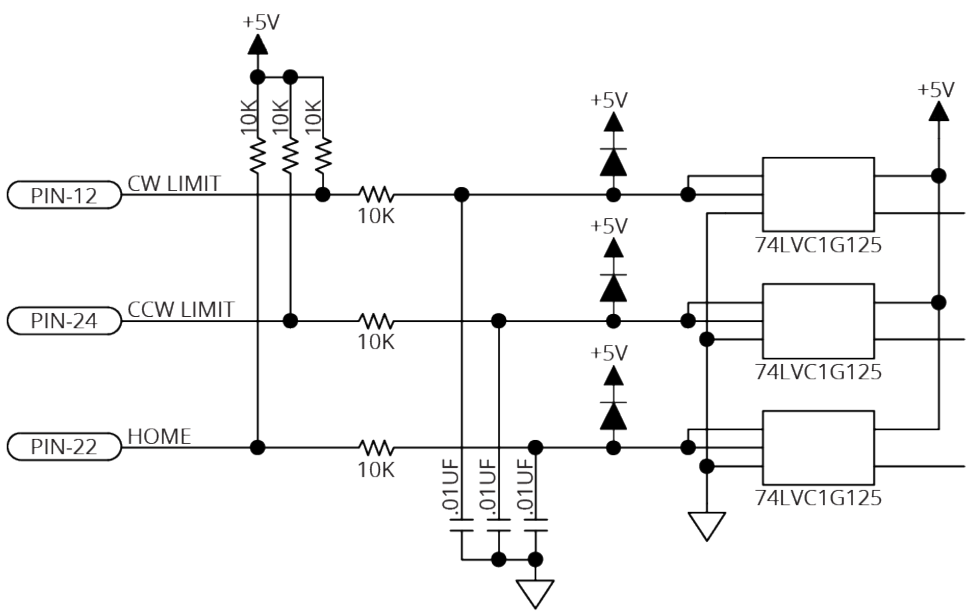



**Figure 2-29: End of Travel and Home Limit Input Schematic (Feedback Connector)**

### 2.3.5.1. End of Travel and Home Limit Phasing

If the EOT limits are reversed, you will be able to move further into a limit but be unable to move out. To correct this, swap the connections to the CW and CCW inputs at the Feedback connector or swap the CW and CCW limit functionality in the software using the EndOfTravelLimitSetup parameter. View the logic level of the EOT limit inputs in the Diagnostics display (shown in Figure 2-30).

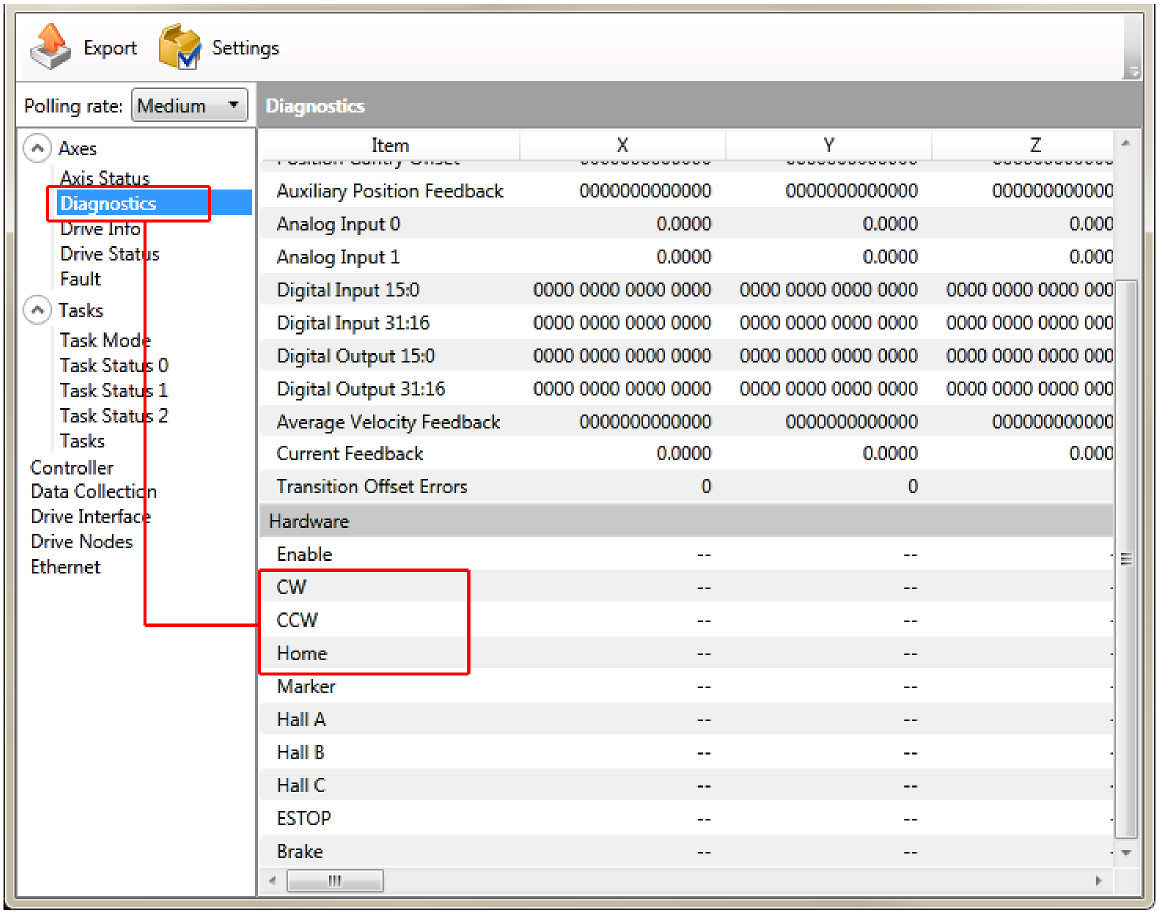



**Figure 2-30: End of Travel and Home Limit Input Diagnostic Display**

### 2.3.6. Brake Outputs

The XC4e has a dedicated brake control circuit. Configure the brake with the BrakeSetup [A3200: EnableBrakeControl] parameter for automatic control (typical). You can also use software commands to directly control the brake output.

Refer to Section 2.6. for more information on powering the brake circuit.

**Table 2-23: Brake Output Pins on the Feedback Connector**

| Pin # | Description | In/Out/Bi |
|---|---|---|
| 13 | Brake Output - | Output |
| 25 | Brake Output + | Output |

**Table 2-24: Brake Control Specifications**

| Specification | Value |
|---|---|
| Maximum Voltage | 24 VDC |
| Maximum Current | 1 A |

A varistor must be connected across the brake to minimize voltage transients.

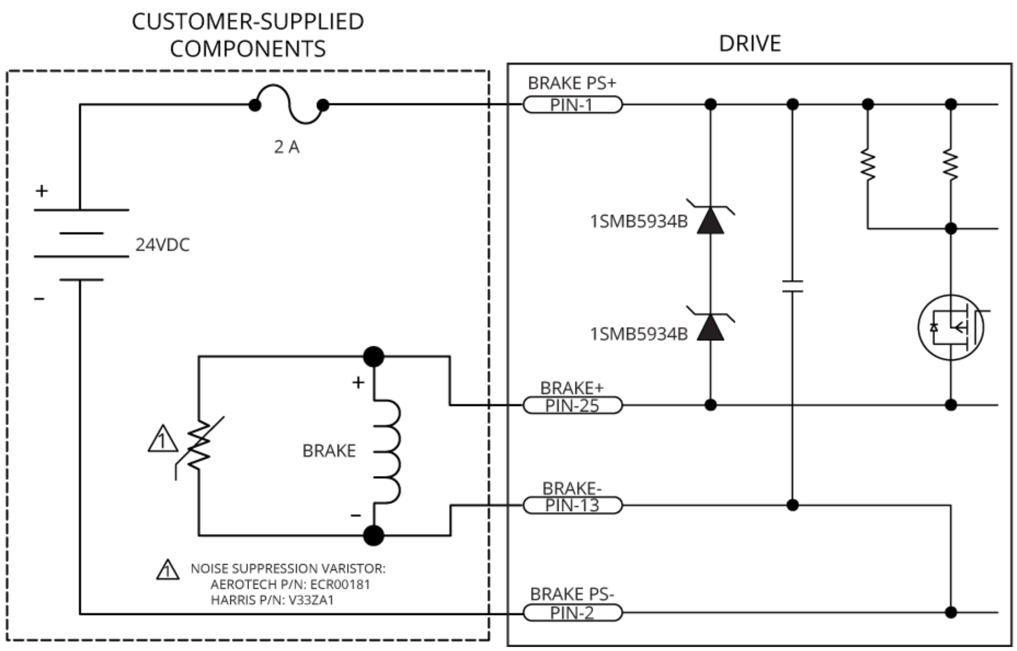



**Figure 2-31: Brake Connected to the 25-Pin Feedback Connector (Typical)**

## 2.4. Safe Torque Off Input (STO)

The STO circuit is comprised of two identical channels, each of which must be energized in order for the XC4e to produce motion. Each STO input is opto-isolated and accepts 24V levels directly without the need for external current limiting resistors.

**IMPORTANT**: The XC4e might be equipped with an STO bypass circuit board. The bypass circuit board defeats the STO safety circuit and allows the system to run at all times. To use the STO safety functionality, remove the circuit board and make connections as outlined in this section.

**IMPORTANT**: The application circuit and its suitability for the desired safety level is the sole responsibility of the user of the XC4e.

**WARNING**: STO wires must be insulated to prevent short circuits between connector pins. The primary concern is a short circuit between STO 1 IN and STO 2 IN wire strands.

**Table 2-25: STO Connector Pinout**

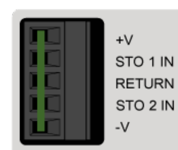
| Pin # | Signal | Description | In/Out/Bi | Connector |
|---|---|---|---|---|
| 1 | Power Supply + | Used to defeat STO by connecting to STO 1 IN and STO 2 IN | N/A |  |
| 2 | STO 1 IN | STO Channel 1 Positive Input | Input | |
| 3 | RETURN | STO Negative Input | Input | |
| 4 | STO 2 IN | STO Channel 2 Positive Input | Input | |
| 5 | Power Supply - | Used to defeat STO by connecting to RETURN | N/A | |

**Table 2-26: Mating Connector Part Numbers for the STO Connector**

| Description | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: AWG [mm²] |
|---|---|---|---|---|
| 5-Pin Terminal Block | ECK02393 | 1827622 | 0.22 - 0.25 | 2.5 - 0.05 [14-30] |

**Table 2-27: STO Electrical Specifications**

| Status | Value |
|---|---|
| STO off (motion allowed) | 18-24 V, 7 ma |
| STO on (safe state entered, no motion) | 0-6 V |
| Recommended Wire Gauge | 22-26 AWG (0.5 - 0.14 $mm^2$) |
| STO System Power Supply | PELV |
| STO Wire Length (maximum) | 50 m |

Figure 2-32 shows one safety device connected to multiple XC4es in parallel.

**WARNING**: The XC4e does not check for short circuits on the external STO wiring. If this is not done by the external safety device, short circuits on the wiring must be excluded. Refer to EN ISO 13849-2. For Category 4 systems, the exclusion of short circuits is mandatory.

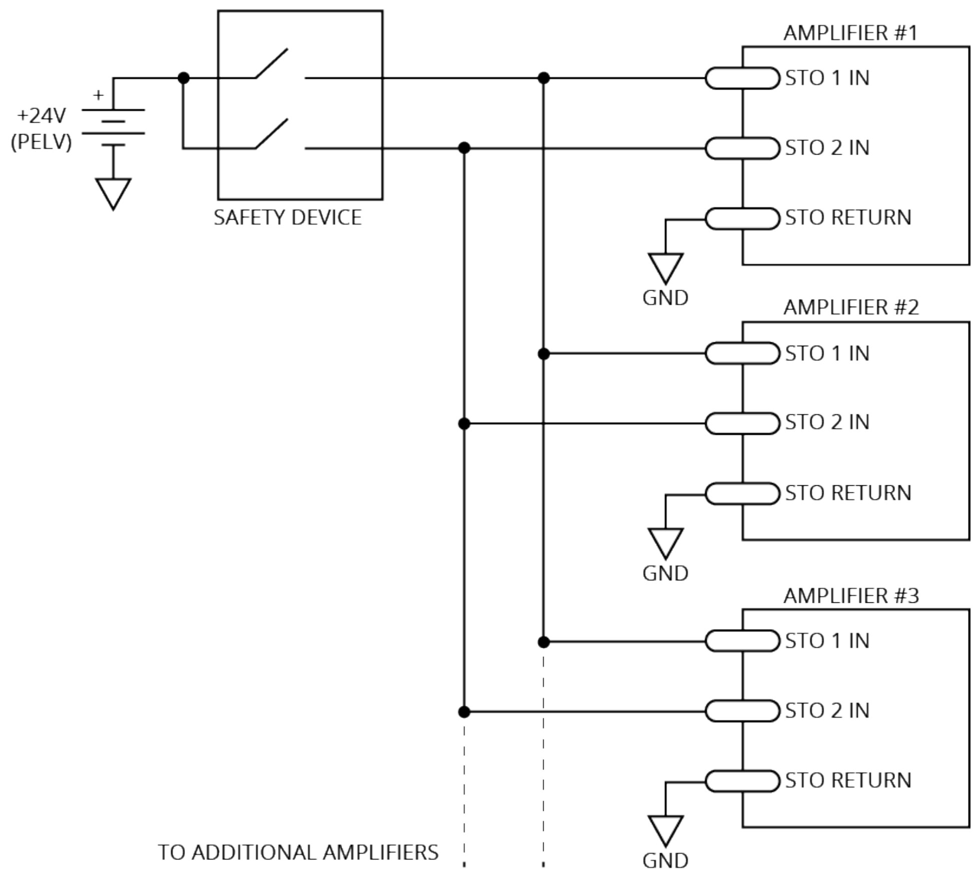



**Figure 2-32: Typical Configuration**

### 2.4.1. STO Standards

Table 2-28 describes and specifies the safety requirements at the system level for the Safe Torque Off (STO) feature of the XC4e. This assumes that diagnostic testing is performed according to Section 2.4.4. and Table 2-29.

**Table 2-28: STO Standards**

| Standard | Maximum Achievable Safety |
|---|---|
| EN/IEC 61800-5- 2:2016 | SIL 3 |
| EN/IEC 61508-1:2010 | SIL 3 |
| EN/IEC 61508-2:2010 | SIL 3 |
| EN ISO 13849-1:2015 | Category 4, PL e |
| EN/IEC 62061:2005 with Amendments | SIL 3 |

**Table 2-29: STO Standards Data**

| Standard | Value |
|---|---|
| EN ISO 13849-1:2015 | $MTTF_D$ > 1000 years,<br>$DC_{AVG}$ 99%<br>Maximum PL e, Category 4 |
| EN ISO 13849-1:2015<br>EN/IEC 61508 | Lifetime = 20 years<br>No proof test required<br>Interval for manual STO test:<br>• Once per year for SIL2/PL d/category 3<br>• Once per three months for SIL3/PL e/category 3<br>• Once per day for SIL3/PL e/category 4 |
| EN/IEC 61508 | SIL3<br>PFH < 3 FIT<br>SFF > 99% |

### 2.4.2. STO Functional Description

The motor can only be activated when voltage is applied to both STO 1 and STO 2 inputs. The STO state will be entered if power is removed from either the STO 1 or the STO 2 inputs. When the STO state is entered, the motor cannot generate torque or force and is therefore considered safe.

The STO function is implemented with two redundant channels in order to meet stated performance and SIL levels. STO 1 disconnects the high side power amplifier transistors and STO 2 disconnects the low side power amplifier transistors. Disconnecting either set of transistors effectively prevents the XC4e from being able to produce motion.

The XC4e software monitors each STO channel and will generate an Emergency Stop software fault when either channel signals the stop state. Each STO channel contains a fixed delay which allows the XC4e to perform a controlled stop before the power amplifier transistors are turned off.

A typical configuration requiring a controlled stop has the Emergency Stop Fault mask bit set in the FaultMask, FaultMaskDecel, and FaultMaskDisable parameters. This stops the axis using the rate specified by the AbortDecelRate parameter. The software will disable the axis as soon as the deceleration ramp is complete. This is typically configured to occur before the STO channel turns off the power amplifier transistors.

The software controlled stop functionality must be excluded when considering overall system safety. This is because the software is not safety rated and cannot be included as part of the safety function.

The XC4e will tolerate short diagnostic pulses on the STO 1+ and STO 2+ inputs. The parameter "STOPulseFilter" specifies the maximum pulse width that the XC4e will ignore.

To resume normal operation, apply power to both STO 1 and STO 2 inputs and use the *Acknowledge All* button or the AcknowledgeAll() or FaultAcknowledge() function to clear the Emergency Stop software fault. The recommended use of the Emergency Stop Fault fault mask bits prevent the system from automatically restarting.

You can achieve longer delay times through the use of an external delay timer, such as the Omron G9SA-321 Safety Relay Unit. Place this device between the system ESTOP wiring and the XC4e's STO inputs. Connect the ESTOP signal directly to a digital input, in addition to the external timer, to allow the XC4e to begin a software-controlled stop as soon as the ESTOP signal becomes active. Use the EmergencyStopFaultInput [A3200: ESTOPFaultInput] parameter to configure a digital input as an ESTOP input.

Non-standard STO delay times are provided by special factory order. In this case, the non-standard STO delay time is indicated by a label placed on the slice amplifier's main connector (STO DELAY = xx sec).

**Table 2-30: STO Signal Delay**

| | Value |
|---|---|
| STO Time Delay | 450-550 msec |

**Table 2-31: Motor Function Relative to STO Input State**

| STO 1 | STO 2 | Motor Function |
|---|---|---|
| Unpowered | Unpowered | No force/torque |
| Unpowered (1) | Powered (1) | No force/torque |
| Powered (1) | Unpowered (1) | No force/torque |
| Powered | Powered | Normal Operation |
| 1. This is considered a Fault Condition since STO 1 and STO 2 do not match. Refer to Section 2.4.4. | | |

### 2.4.3. STO Startup Validation Testing

Verify the state of the STO 1 and STO 2 channels by manually activating the external STO hardware. Each STO channel must be tested separately in order to detect potential short circuits between the channels. The current state of the STO 1 and STO 2 inputs is shown in the Status Utility. A "–" indicates that the STO input is powered by a high voltage level (24 V). An "ON" indicates that the voltage source has been removed from the input (open circuit or 0 V), and that the STO channel is in the safe state.

**DANGER**: The STO circuit does not remove lethal voltage from the motor terminals. AC mains power must be removed before servicing.

### 2.4.4. STO Diagnostics

Activation of STO means removing power from the XC4e's STO inputs. This is typically done by pressing the emergency stop switch. The XC4e initiates a diagnostic check every time the STO is activated after the Diagnostic Test Delay Time has elapsed. The diagnostic check verifies that each channel has entered the safe state. The XC4e is held in the safe state if it determines that one of the channels has not properly entered the safe state. An open circuit or short to 24 V in either STO channel will result in this condition (refer to Section 2.4.3.). The Status Utility screen can be used to verify the levels of the STO input signals while trouble shooting.

In order to meet the listed SIL level, the STO circuit must be activated (power removed from both inputs) according to the interval specified in Table 2-29.

**Table 2-32: STO Timing**

| Time | Description | Value |
|---|---|---|
| T1 | STO Delay Time (STO input active to motor power off) | 450-550 msec |
| T2 | STO deactivated to motor power on (the software is typically configured so that the motor does not automatically re-energize). | < 1 msec |
| T3 | Diagnostic Test Delay Time | 550-610 msec |

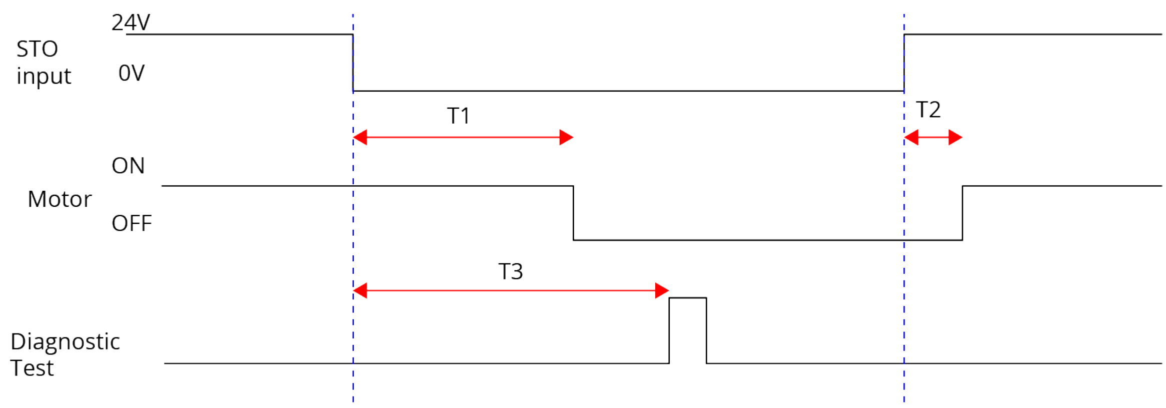


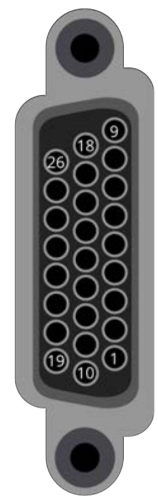

**Figure 2-33: STO Timing**

The software is typically configured to execute a controlled stop when the STO state is first detected. If power is reapplied to the STO inputs before the STO Delay Time, an STO hardware shutdown will not occur but a software stop may, depending on the width of the STO pulse. The controller will ignore STO active pulses shorter in length than the STOPulseFilter parameter setting.

## 2.5. Auxiliary I/O Connector

The Auxiliary I/O connector has 1 analog input, 6 digital inputs, 1 analog output, 4 digital outputs, a secondary line driver encoder input, and a secondary absolute encoder interface.

**Table 2-33: Auxiliary I/O Connector Pinout**

| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Auxiliary Sine + | Bidirectional |  |
| | Absolute Encoder Data + | Bidirectional | |
| 2 | Auxiliary Sine - | Bidirectional | |
| | Absolute Encoder Data - | Bidirectional | |
| 3 | High-Speed Input 20 + / PSO External Sync. + | Input | |
| 4 | High-Speed Input 20 - / PSO External Sync. - | Input | |
| 5 | High-Speed Input 21 + | Input | |
| 6 | High-Speed Input 21 - | Input | |
| 7 | Digital Output 0 | Output | |
| 8 | Digital Output 1 | Output | |
| 9 | Digital Output 2 | Output | |
| 10 | Auxiliary Cosine + | Bidirectional | |
| | Absolute Encoder Clock + | Output | |
| 11 | Auxiliary Cosine- | Bidirectional | |
| | Absolute Encoder Clock - | Output | |
| 12 | +5 Volt (500 mA max) | N/A | |
| 13 | Analog Input 0+ (Differential) | Input | |
| 14 | Analog Input 0- (Differential) | Input | |
| 15 | Digital Output Common | N/A | |
| 16 | Digital Output 3 | Output | |
| 17 | Digital Input 0 / CCW EOT Input (1) | Input | |
| 18 | Digital Input 1 / CW EOT Input (1) | Input | |
| 19 | Auxiliary Marker- / PSO output (2) / TTL Output | Bidirectional | |
| 20 | Auxiliary Marker+ / PSO output (2) | Bidirectional | |
| 21 | Common | N/A | |
| 22 | Analog Output 0 | Output | |
| 23 | Analog Common | N/A | |
| 24 | Digital Input Common | N/A | |
| 25 | Digital Input 2 / Home Input (1) | Input | |
| 26 | Digital Input 3 | Input | |

(1) Software configured option

(2) For PSO, refer to Section 2.5.2.

**Table 2-34: Mating Connector Part Numbers for the Auxiliary I/O Connector**

| Mating Connector | Aerotech P/N | Third Party P/N |
|---|---|---|
| Connector | ECK01259 | Kycon K86-AA-26P |
| Backshell | ECK01022 | Amphenol 17-1725-2 |

NOTE: These items are provided as a set under the Aerotech P/N: MCK-26HDD.

### 2.5.1. Auxiliary Encoder Inputs

The Auxiliary Encoder connector gives you a second encoder input channel. This channel is typically used for dual loop applications.

Use the AuxiliaryFeedbackType [A3200: PositionFeedbackType or VelocityFeedbackType] parameter to configure the XC4e to accept an encoder signal type.

Square Wave encoder signals: Section 2.5.1.1.

Absolute encoder signals: Section 2.5.1.2.

Sine Wave encoder signals (with the -MX3 option): Section 2.5.1.3.

You can configure the Auxiliary Encoder interface as an output that will transmit encoder signals for external use. Use the DriveEncoderOutputConfigureInput() function [A3200: EncoderDivider parameter] to configure the Sine ± and Cosine ± connector pins as RS-422 outputs. You can only echo incremental square wave primary encoder inputs or, with the -MX2 or -MX3 option, incremental sine wave primary encoder inputs. You cannot use the absolute encoder interface when you echo incremental signals.

**Table 2-35: Auxiliary Encoder Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 1 | Auxiliary Sine + | Bidirectional |
| | Absolute Encoder Data + | Bidirectional |
| 2 | Auxiliary Sine - | Bidirectional |
| | Absolute Encoder Data - | Bidirectional |
| 10 | Auxiliary Cosine + | Bidirectional |
| | Absolute Encoder Clock + | Output |
| 11 | Auxiliary Cosine- | Bidirectional |
| | Absolute Encoder Clock - | Output |
| 12 | +5 Volt (500 mA max) | N/A |
| 19 | Auxiliary Marker- / PSO output (2) / TTL Output | Bidirectional |
| 20 | Auxiliary Marker+ / PSO output (2) | Bidirectional |
| 21 | Common | N/A |
| (2) For PSO, refer to Section 2.5.2. | | |

### 2.5.1.1. Square Wave Encoder

The XC4e accepts RS-422 square wave encoder signals. The XC4e will generate a feedback fault if it detects an invalid signal state caused by an open or shorted signal connection. Use twisted-pair wiring for the highest performance and noise immunity.

**Table 2-36: Square Wave Encoder Specifications**

| Specification | Value |
|---|---|
| Encoder Frequency | 10 MHz maximum (25 ns minimum edge separation) |
| x4 Quadrature Decoding | 40 million counts/sec |

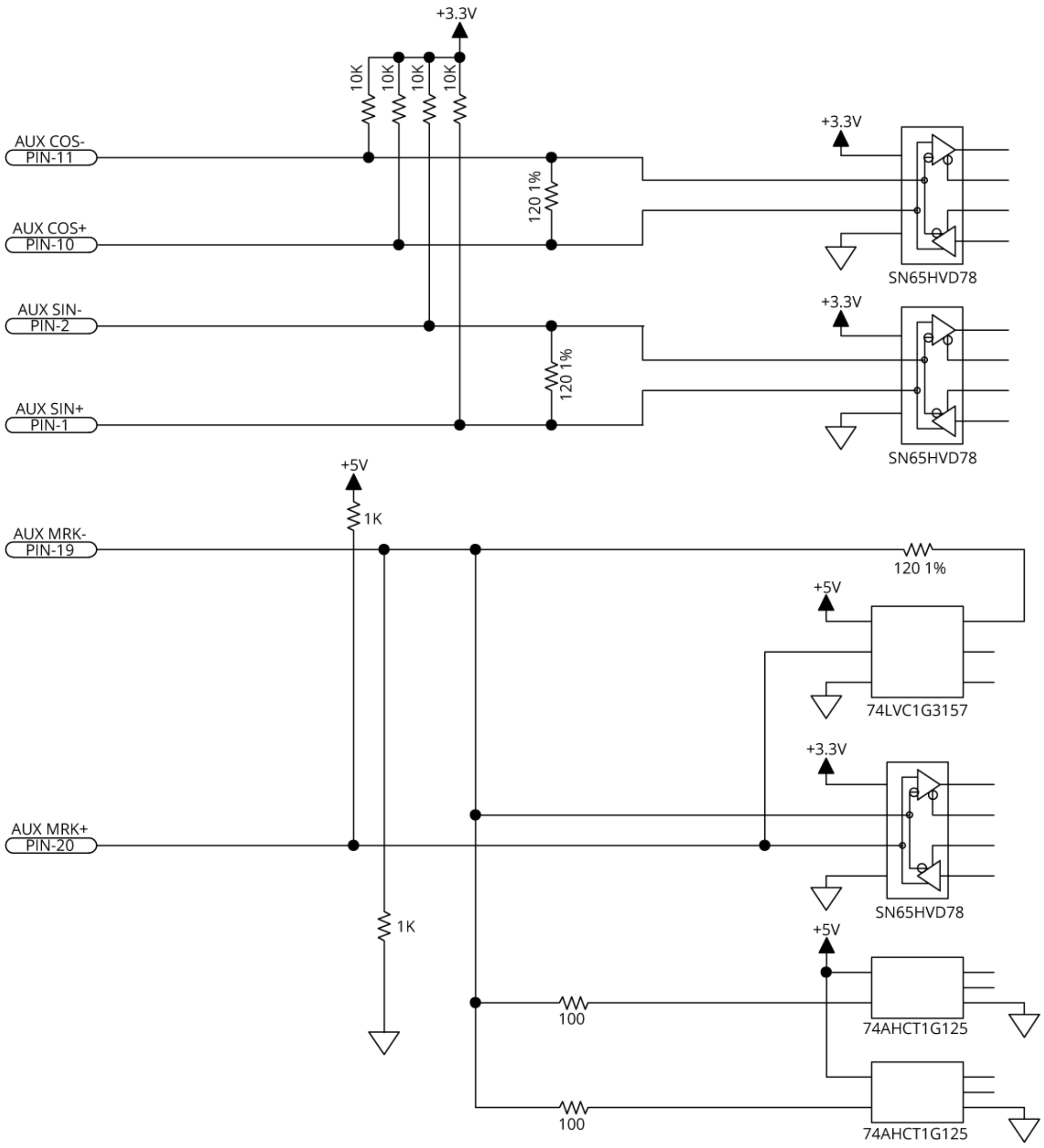



**Figure 2-34: Square Wave Encoder Interface (Aux I/O Connector)**

#### 2.5.1.2. Absolute Encoder

The XC4e retrieves absolute position data along with encoder fault information through a serial data stream from the absolute encoder. Use twisted-pair wiring for the highest performance and noise immunity. You cannot use an absolute encoder with incremental signals on the Auxiliary I/O Connector.

Refer to Figure 2-35 for the serial data stream interface.

Refer to the Help file for information on how to set up your EnDat or BiSS absolute encoder parameters.

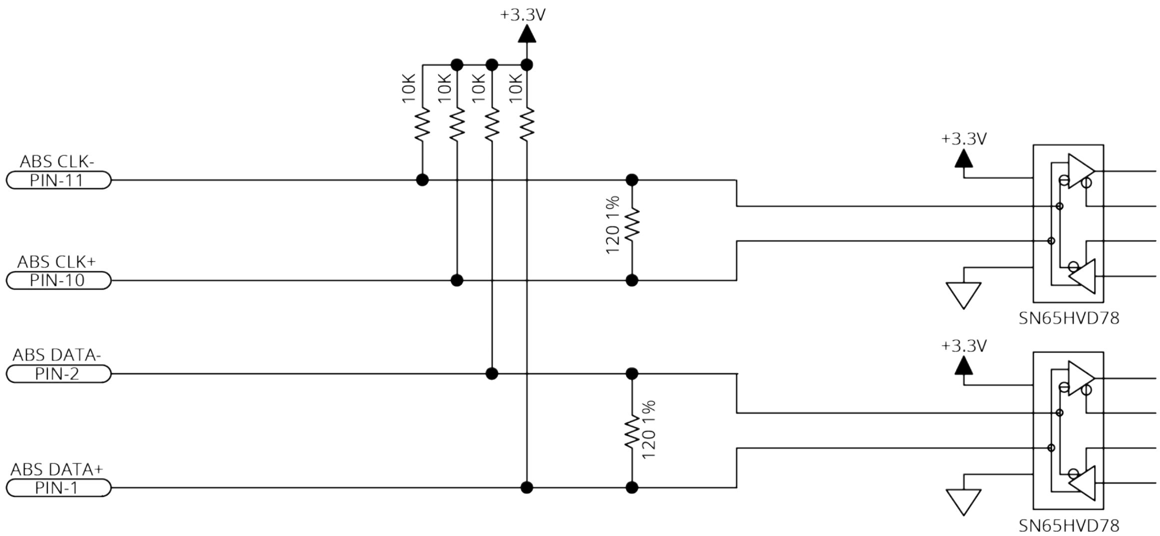



**Figure 2-35: Absolute Encoder Schematic (Auxiliary I/O Connector)**

#### 2.5.1.3. Sine Wave Encoder [-MX3 Option]

The Sine Wave Encoder option provides higher positioning resolution by subdividing the fundamental output period of the encoder into smaller increments. The amount of subdivision is specified by the AuxiliaryEncoderMultiplicationFactor parameter. Use Encoder Tuning [A3200: Feedback Tuning] to adjust the value of the gain, offset, and phase balance controller parameters to get the best performance. For more information, refer to the Help file.

You cannot use the sine wave encoder on the auxiliary connector with the -MX3 multiplier option as an input to the PSO. The -MX3 option does not generate emulated quadrature signals from the auxiliary connector.

For the highest performance, use twisted pair double-shielded cable with the inner shield connected to signal common and the outer shield connected to frame ground. Do not join the inner and outer shields in the cable.

**Table 2-37: Sine Wave Encoder Specifications**

| Specification | | Value | |
|---|---|---|---|
| | | Primary | Auxiliary |
| Input Frequency (max) | | 450 kHz, 2 MHz | 450 kHz |
| Input Amplitude (1) | | 0.6 to 1.75 Vpk-pk | |
| Interpolation Factor (max) | -MX2 | 65,536 | N/A |
| | -MX3 | 65,536 | 16,384 |
| -MX2/-MX3 Primary Encoder Channel Interpolation Latency | | 800 nsec (analog input to quadrature output) | |
| Input Common Mode | | 1.5 to 3.5 VDC | |
| (1) Measured as SIN(+) - SIN(-) or COS(+) - COS(-) | | | |

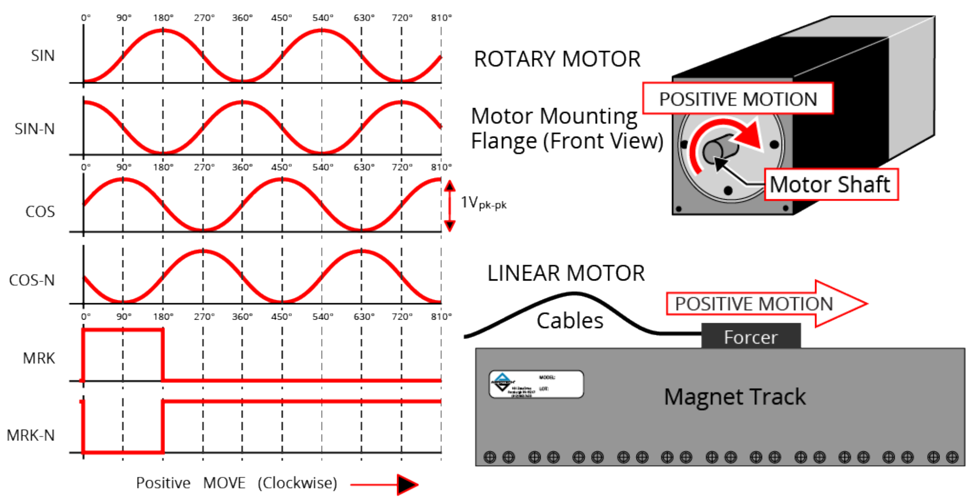



**Figure 2-36: Sine Wave Encoder Phasing Reference Diagram**

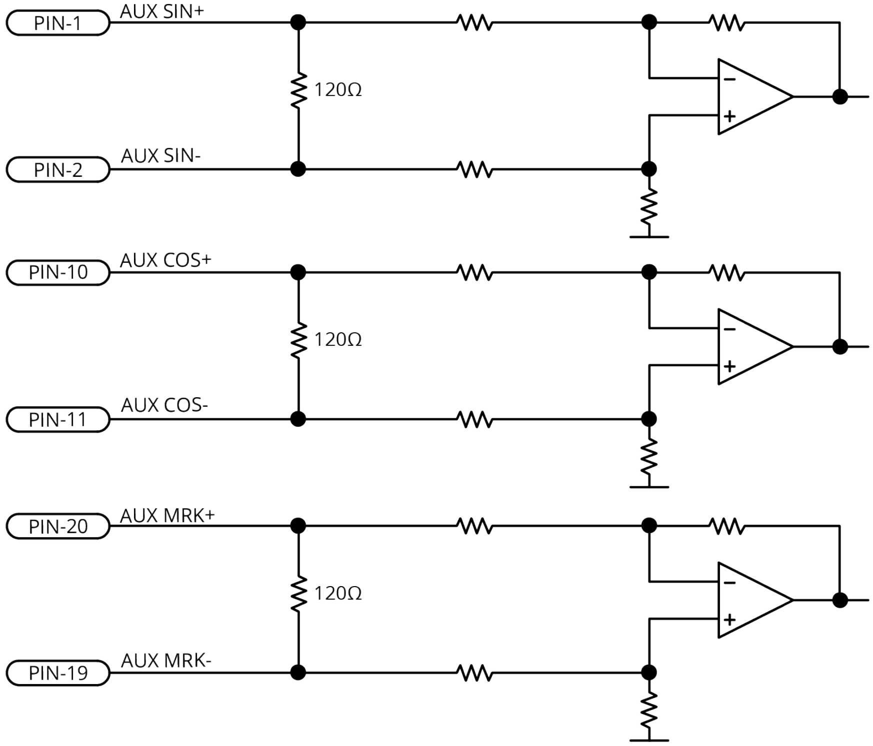



**Figure 2-37: Sine Wave Encoder Schematic (Auxiliary I/O Connector)**

### 2.5.2. Position Synchronized Output (PSO)

The PSO signal is available on the dual-function AUX Marker/PSO signal lines. Use the PSO pulse external sync functions [A3200: PSOOUTPUT PULSE EXTSYNC command] to configure the auxiliary marker as an output. Refer to the Help file for more information.

Use the PsoOutputConfigureOutput() function [A3200: PSOOUTPUT CONTROL command] to transmit the PSO output signal on the Marker ± pins differentially. Or, use the PsoOutputConfigureOutput() function [A3200: PSOOUTPUT CONTROL command] to configure the Marker - pin as a 5V TTL PSO output.

The differential signal format is recommended when using long cable lengths in noisy environments or when high frequency pulse transmission is required. It is best to locate the line receiver close to the receiving electronics. A 5 V TTL signal is used to drive an opto coupler or general purpose TTL input. This signal is active high and is driven to 5 V when a PSO fire event occurs. When the drive is reset or after initial power up, the PSO pins (refer to Table 2-39), are not actively driven and the fail safe state is defined by pull-up and pull-down resistors as shown in Figure 2-38.

The -EB1 I/O option board has additional PSO signal formats. Refer to Section 3.5. for more information.

**Table 2-38: PSO Specifications**

| Specification | | Value |
|---|---|---|
| Output | TTL | 5 V, 16 mA (max) |
| Maximum PSO Output (Fire) Frequency | TTL | 12.5 MHz |
| | RS-422 | 12.5 MHz |
| Output Latency [Fire event to output change] | TTL | 15 ns |
| | RS-422 | 15 ns |

**Table 2-39: PSO Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 19 | Auxiliary Marker- / PSO output / TTL Output | Bidirectional |
| 20 | Auxiliary Marker+ / PSO output | Bidirectional |
| 21 | Common | N/A |

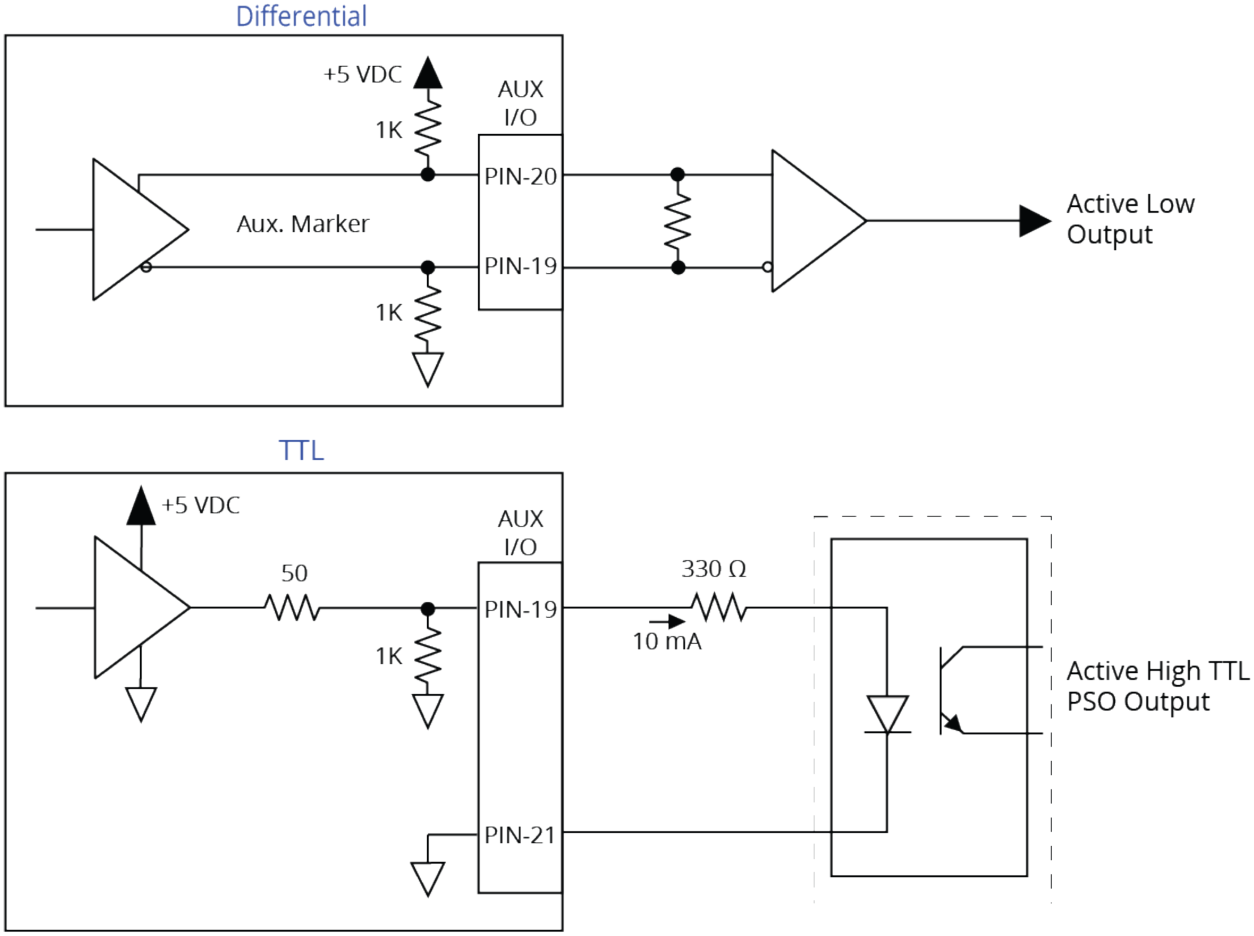



**Figure 2-38: PSO Interface**

### 2.5.3. Digital Outputs

Optically-isolated solid-state relays drive the digital outputs. You can connect the digital outputs in current sourcing or current sinking mode but you must connect all four outputs in the same configuration. Refer to Figure 2-40 and Figure 2-41.

You must install suppression diodes on digital outputs that drive relays or other inductive devices. To see an example of a current sourcing output that has diode suppression, refer to Figure 2-40. To see an example of a current sinking output that has diode suppression, refer to Figure 2-41

The digital outputs are not designed for high-voltage isolation applications and they should only be used with ground-referenced circuits.

The digital outputs have overload protection. They will resume normal operation when the overload is removed.

**Table 2-40: Digital Output Specifications**

| Digital Output Specifications | Value |
|---|---|
| Maximum Voltage | 24 V (26 V Maximum) |
| Maximum Sink/Source Current | 250 mA/output |
| Output Saturation Voltage | 0.9 V at maximum current |
| Output Resistance | 3.7 Ω |
| Rise / Fall Time | 250 µs (2K pull up to 24V) |
| Reset State | Output Off (High Impedance State) |

**Table 2-41: Digital Output Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 7 | Digital Output 0 | Output |
| 8 | Digital Output 1 | Output |
| 9 | Digital Output 2 | Output |
| 15 | Digital Output Common | N/A |
| 16 | Digital Output 3 | Output |

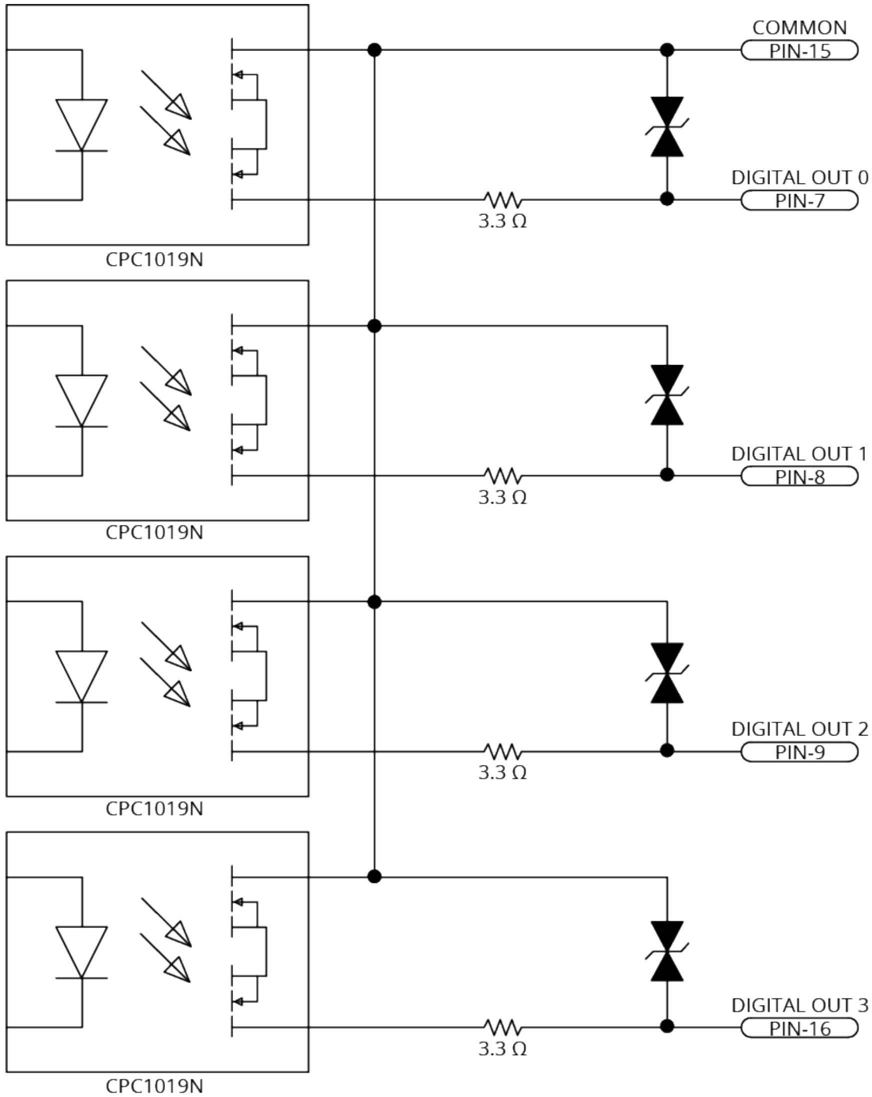



**Figure 2-39: Digital Output Schematic (Aux I/O Connector)**

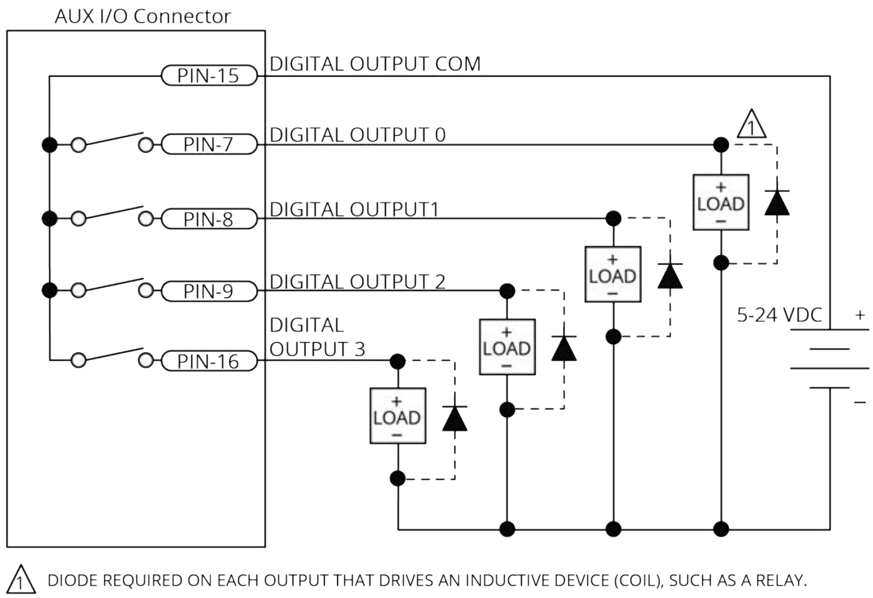



**Figure 2-40: Digital Outputs Connected in Current Sourcing Mode**

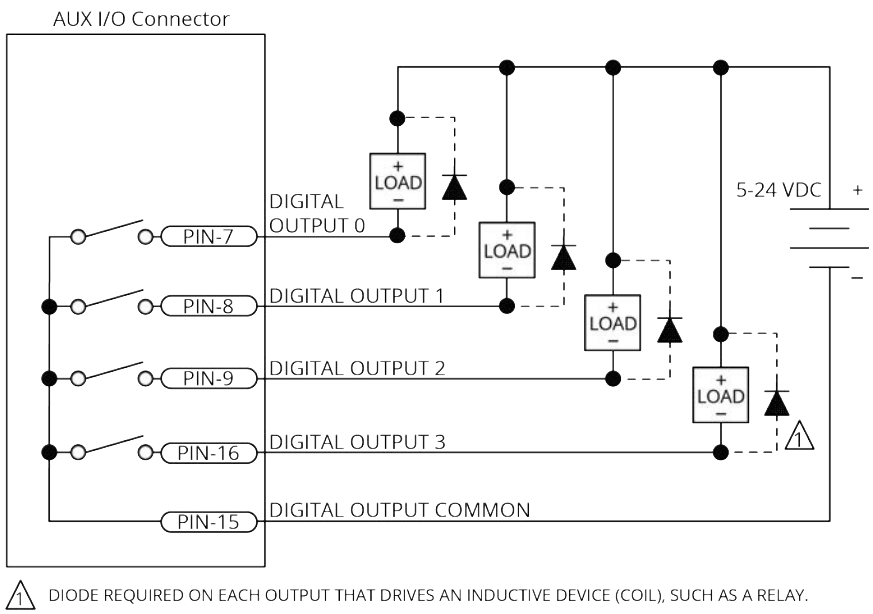



**Figure 2-41: Digital Outputs Connected in Current Sinking Mode**

### 2.5.4. Digital Inputs

You can connect the digital inputs to current sourcing or current sinking devices but you must connect all four inputs in the same configuration. Refer to Figure 2-44 and Figure 2-43. The digital inputs are not designed for high-voltage isolation applications. They should only be used with ground-referenced circuits.

**Table 2-42: Digital Input Specifications**

| Input Voltage | Approximate Input Current | Turn On Time | Turn Off Time |
|---|---|---|---|
| +5 V to +24 V | 6 mA | 10 µs | 43 µs |

**Table 2-43: Digital Input Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 17 | Digital Input 0 / CCW EOT Input (1) | Input |
| 18 | Digital Input 1 / CW EOT Input (1) | Input |
| 24 | Digital Input Common | N/A |
| 25 | Digital Input 2 / Home Input (1) | Input |
| 26 | Digital Input 3 | Input |
| (1) Software configured option | | |

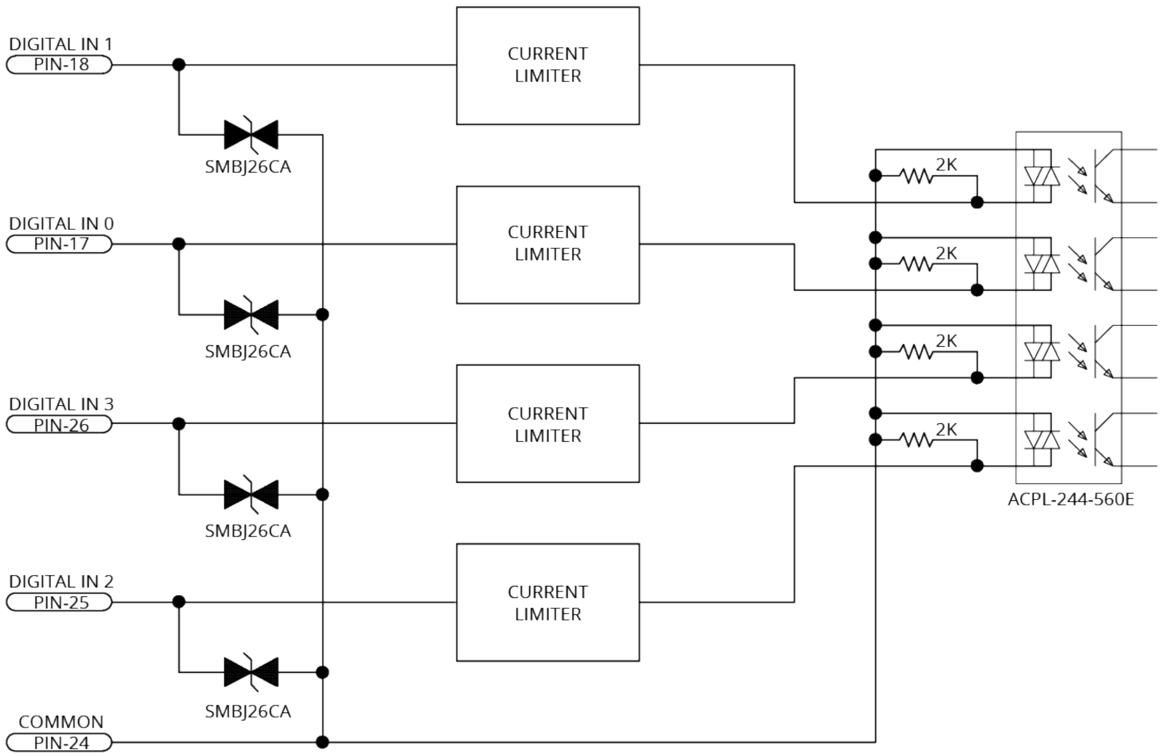



**Figure 2-42: Digital Inputs Schematic (Aux I/O Connector)**

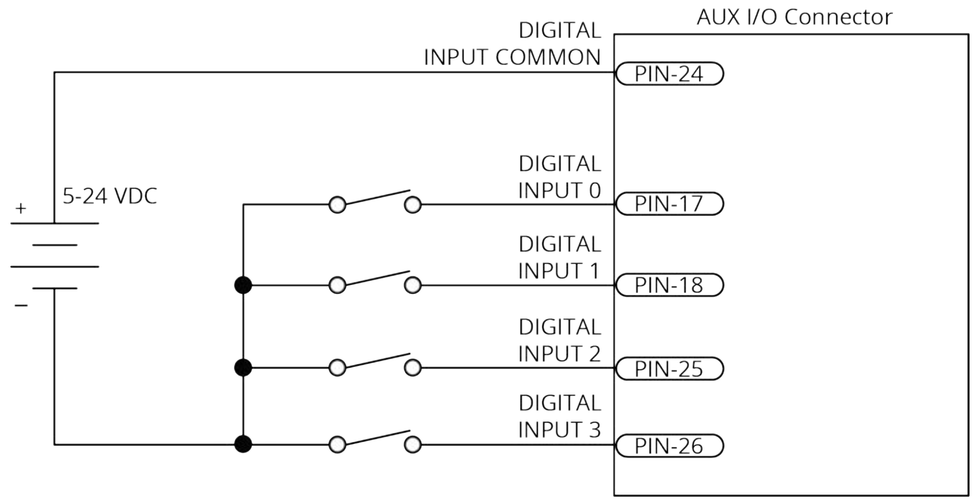



**Figure 2-43: Digital Inputs Connected to Current Sinking Devices**

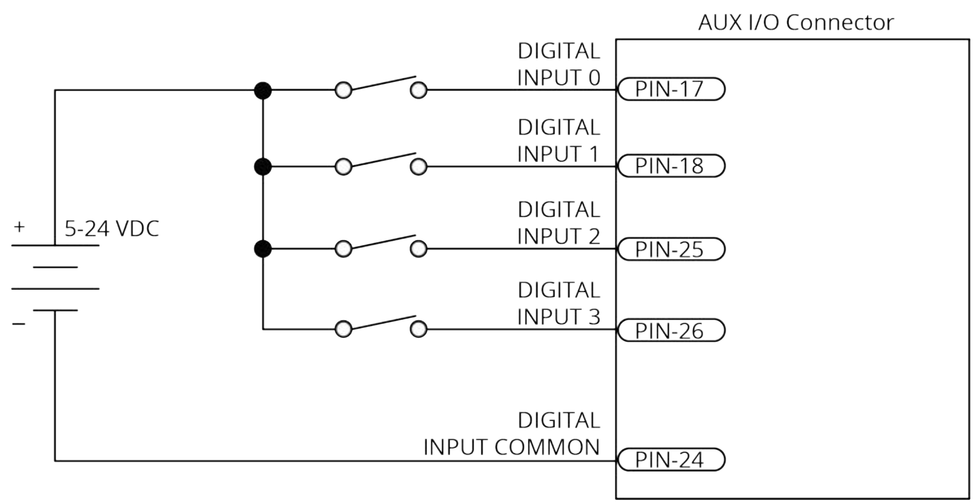



**Figure 2-44: Digital Inputs Connected to Current Sourcing Devices**

### 2.5.5. High-Speed Inputs

High-speed inputs 20 and 21 can be used as general purpose inputs or as the trigger signal for high speed data collection. Refer to the DriveDataCaptureConfigureTrigger() function [A3200: DATAACQ TRIGGER command] topic in the Help file for more information.

You can use the external PSO synchronization functions [A3200: PSOOUTPUT PULSE EXTSYNC command] to synchronize waveform generation with an external synchronization signal. When you activate this feature, the PSO Waveform module will not generate the configured waveform when an output event is received until the rising edge of the synchronization signal occurs.

**Table 2-44: High-Speed Input Specifications**

| Specification | Value |
|---|---|
| Input Voltage | 5V - 24 V input voltages |
| Input Current | 10 mA |
| Input Device | HCPL-0630 |
| Delay | 50 nsec |

**Table 2-45: High-Speed Input Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 3 | High-Speed Input 20 + / PSO External Sync. + | Input |
| 4 | High-Speed Input 20 - / PSO External Sync. - | Input |
| 5 | High-Speed Input 21 + | Input |
| 6 | High-Speed Input 21 - | Input |

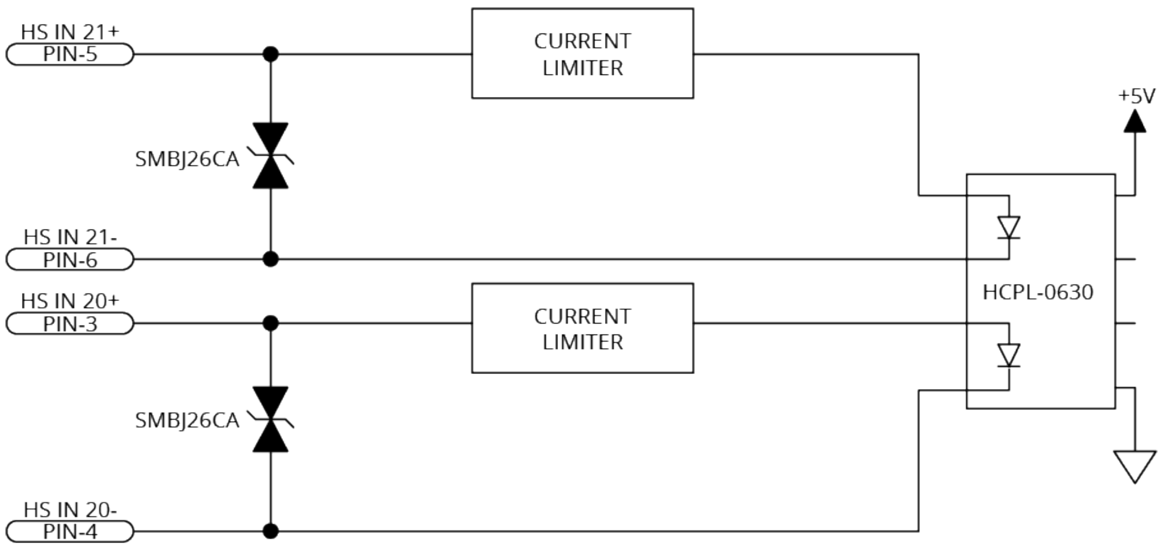



**Figure 2-45: High-Speed Inputs**

### 2.5.6. Analog Output 0

The analog output can be set from within a program or it can be configured to echo the state of select servo loop nodes.

The analog output is set to zero when you power on the system or reset the drive.

**Table 2-46: Analog Output Specifications**

| Specification | Value |
|---|---|
| Output Voltage | -10 V to +10 V |
| Output Current | 5 mA |
| Resolution (bits) | 16 bits |

**Table 2-47: Analog Output Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 22 | Analog Output 0 | Output |
| 23 | Analog Common | N/A |

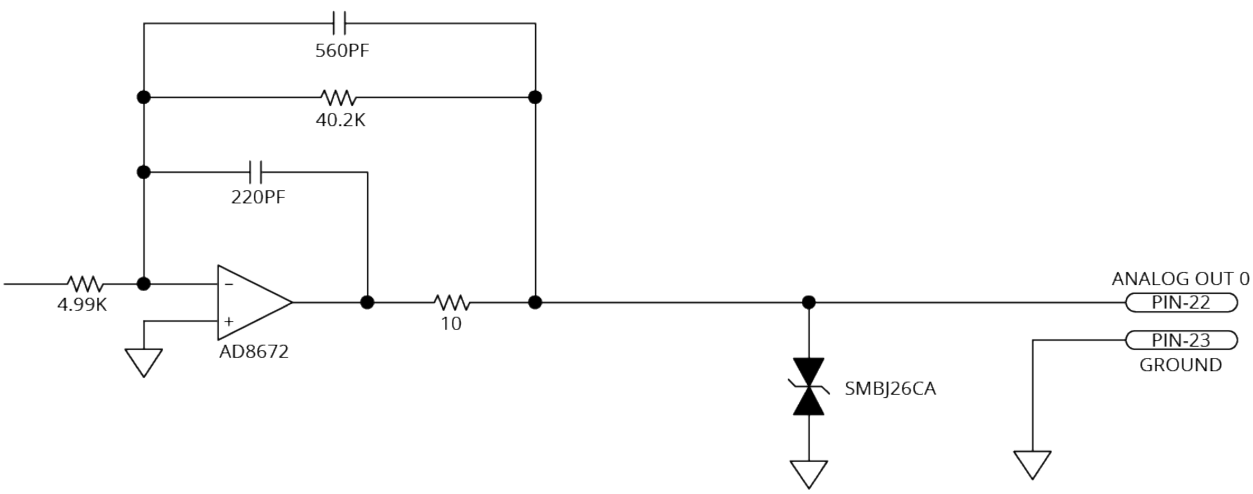



**Figure 2-46: Analog Output 0 Schematic**

### 2.5.7. Analog Input 0 (Differential)

To interface to a single-ended, non-differential voltage source, connect the signal common of the source to the negative input and connect the analog source signal to the positive input. A floating signal source must be referenced to the analog common. Refer to Figure 2-47.

**Table 2-48: Analog Input Specifications**

| Specification | Value |
|---|---|
| (AI+) - (AI-) | +10 V to -10 V (1) |
| Resolution (bits) | 16 bits |
| Input Impedance | 1 MΩ |
| 1. Signals outside of this range may damage the input | |

**Table 2-49: Analog Input Pins on the Auxiliary I/O Connector**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 13 | Analog Input 0+ (Differential) | Input |
| 14 | Analog Input 0- (Differential) | Input |
| 23 | Analog Common | N/A |

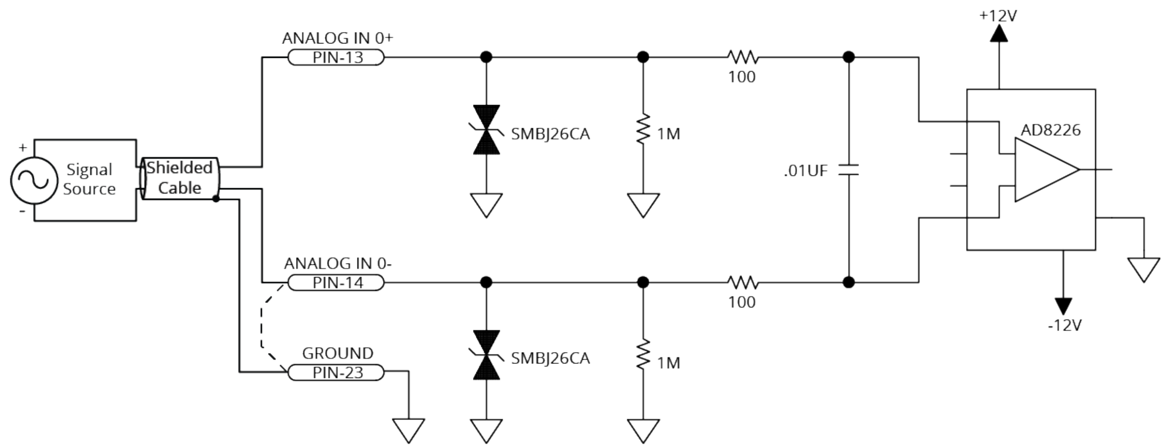



**Figure 2-47: Analog Input 0 Schematic**

## 2.6. Brake Power Supply Connector

This port is the power supply connection to the on-board brake control circuit. Refer to Section 2.3.6. for more information about the brake output interface.

**Table 2-50: Brake Power Supply Connector Pinout**

| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Brake Power Supply (+) | Input |  |
| 2 | Brake Power Supply (-) | Input | |

**Table 2-51: Mating Connector Part Numbers for the Brake Power Supply Connector**

| Description | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: AWG [mm²] |
|---|---|---|---|---|
| 2-Pin Terminal Block | ECK02390 | 1827616 | 0.22 - 0.25 | 0.14 - 1.5 [26-16] |

## 2.7. HyperWire Interface

The HyperWire bus is the high-speed communications connection from the controller. It operates at 2 gigabits per second. The controller sends all command and configuration information through the HyperWire bus.

HyperWire cables can be safely connected to or disconnected from a HyperWire port while the PC and/or drive is powered on. However, any changes to the HyperWire network topology will disrupt communication and you must reset the controller to re-establish communication.

**WARNING**: Do not connect or disconnect HyperWire cables while you are loading firmware or damage to the drives may occur.

**Table 2-52: HyperWire Card Part Number**

| Part Number | Description |
|---|---|
| HYPERWIRE-PCIE | HyperWire adapter, PCIe x4 interface |

**Table 2-53: HyperWire Cable Part Numbers**

| Part Number | Description |
|---|---|
| HYPERWIRE-AO10-5 | HyperWire cable, active optical, 0.5 m |
| HYPERWIRE-AO10-10 | HyperWire cable, active optical, 1.0 m |
| HYPERWIRE-AO10-30 | HyperWire cable, active optical, 3.0 m |
| HYPERWIRE-AO10-50 | HyperWire cable, active optical, 5.0 m |
| HYPERWIRE-AO10-200 | HyperWire cable, active optical, 20.0 m |

## 2.8. External Shunt Option [-SX1]

**DANGER**: The shunt resistor dissipates a high quantity of power. To prevent the danger of electric shock or fire, you must obey the precautions that follow:

- Correctly size, mount, and protect the external shunt resistor.
- Do not touch the shunt resistor terminals. There are lethal voltages on the terminals.
- Do not touch the surface of the drive or the external shunt resistor. The temperature can exceed 70°C.
- Restrict access to the shunt resistor while it is connected to a power source.

The -SX1 option provides a connection for a user-provided shunt resistor to dissipate excess energy and keep the internal drive voltage within safe levels. The drive switches this resistor "ON" when the internal bus voltage reaches approximately 380 VDC. This option is generally required for systems that have a large amount of stored mechanical energy that must be dissipated during deceleration.

**Table 2-54: -SX1 Component Information**

| Component | Description | Aerotech P/N |
|---|---|---|
| Recommended Shunt Resistor | 50 Ω (min), 300 W<br>Vishay/Dale: RBEF030050R00KFBVT | ECR01039 |
| 1-Pin Mating Connector [QTY. 2] | **Screw Torque Value**: 0.6 - 0.8 N·m<br>**Wire Size**: 0.2 - 6 mm$^2$ [24-10 AWG]<br>Phoenix: 0708250 | ECK02452 |
| F101 Fuse on the Control Board | 8 A S.B. | EIF01022 |
| Recommended Wire Size | 16 AWG (1.3 mm$^2$) High Temperature | -- |

**Equation 1:**

Calculate the kinetic energy of the system. Any energy that is not lost to the system could be regenerated to the DC bus.

$$E_M = \left[\frac{1}{2}\right]\left[J_M + J_L\right]\omega_M^2$$

(for rotary motors)

or

$$E_M = \left[\frac{1}{2}\right]\left[M_M + M_L\right]v_M^2$$

(for linear motors)

| | |
|---|---|
| $J_M$ | rotor inertia (kg·m$^2$) |
| $J_L$ | load inertia (kg·m$^2$) |
| $\omega_m$ | motor speed before deceleration (rad/s) |
| $M_M$ | forcer mass (kg) |
| $M_L$ | load mass (kg) |
| $v_m$ | velocity (m/s) |

**Equation 2:**

You will need a shunt resistor if the regenerated energy is greater than the Maximum Additional Storage Energy that the internal bus capacitor can store (Table 2-55).

$$E_{Ca} = \frac{1}{2}C\left(V_M^2 - V_{NOM}^2\right)$$

| | |
|---|---|
| C | bus capacitor (F) [1,200 µF] |
| $V_M$ | turn on voltage for shunt circuit (V) [380 V] |
| $V_{NOM}$ | nominal bus voltage (V) [160 V or 320 V, Typical]<br>[160 V or 320 V, Typical] |

**Table 2-55: Maximum Additional Storage Energy for a Standard XC4e**

| Bus Voltage | Maximum Additional Energy |
|---|---|
| 160 V | 71.3 J |
| 320 V | 25.2 J |

If a shunt resistor is required, calculate the value of resistance necessary to dissipate the energy.

**Equations 3**, **4**, and **5**:

Calculate the parameters of the shunt resistor.

**Equation 3:**

$$P_{PEAK} = \frac{E_M - E_{Ca}}{t_D}$$

$P_{PEAK}$ peak power that the regeneration circuit must accommodate (W)
$t_D$ deceleration time (s)

**Equation 4:**

$$P_{AV} = \frac{E_M - E_{Ca}}{t_{CYCLE}}$$

$P_{AV}$ average power dissipated on shunt resistor (W)
$t_{CYCLE}$ time between deceleration events (s)

**Equation 5:**

$$R = \frac{(2V_M - V_{HYS})^2}{4P_{PEAK}}$$

$V_{HYS}$ hysteresis voltage of regeneration circuit (V) [10 V, Typical]

**Additional useful equations:**

1 lb·ft = 1.356 N·m
1 rad/s = 9.55 rpm

## 2.9. Sync Port

The Sync port is a bi-directional high speed proprietary interface that lets you transmit encoder signals between drives. This is typically used for multi-axis PSO applications where one or two drives send their encoder signals to a main drive that has the PSO logic and PSO output signal. The XC4e contains two Sync ports, labeled A and B.

To avoid signal contention, all Sync ports default to the input state during reset and immediately after power is applied to the drive.

**Table 2-56: Sync-Related Functions**

<table>
<tr><th>Function</th><th>Description</th></tr>
<tr><td>DriveEncoderOutputConfigureDivider(),<br>DriveEncoderOutputConfigureInput(),<br>DriveEncoderOutputOn(),<br>DriveEncoderOutputOff()<br>[A3200: ENCODER OUT command]</td><td>Configure each Sync port as an input or an output</td></tr>
<tr><td>PsoDistanceConfigureInputs()<br>[A3200: PSOTRACK INPUT command]</td><td rowspan="2">Let the PSO to track the SYNC A or SYNC B port.</td></tr>
<tr><td>PsoWindowConfigureInput()<br>[A3200: PSOWINDOW INPUT command]</td></tr>
</table>

The Sync port uses low-voltage differential signaling (LVDS) and standard USB 3.0 type A (cross over) cables.

**Table 2-57: Sync Port Cables**

| Part Number | Desciption |
|---|---|
| CBL-SYNC-3 | Length 3 dm; Connectors: USB Type A to USB Type A |
| CBL-SYNC-5 | Length 5 dm; Connectors: USB Type A to USB Type A |
| CBL-SYNC-7 | Length 7 dm; Connectors: USB Type A to USB Type A |
| CBL-SYNC-10 | Length 10 dm; Connectors: USB Type A to USB Type A |

## 2.10. System Interconnection

Click on the image below to open a separate pdf window with a larger view of the drawing.

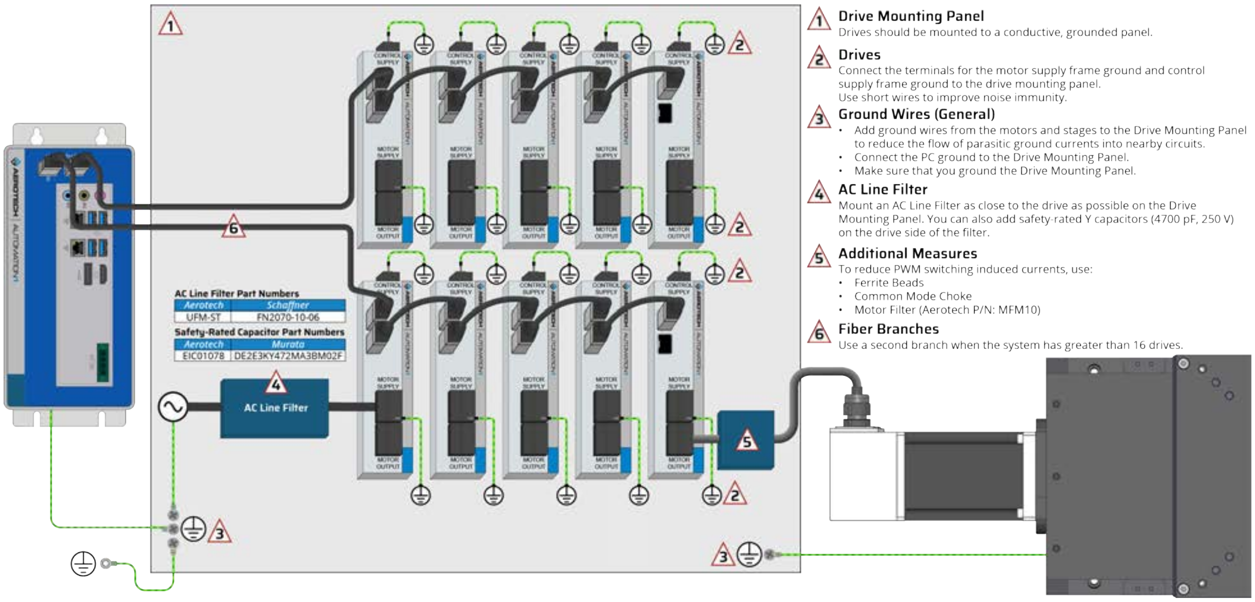



**Figure 2-48: System Wiring Drawing (Best Practice)**

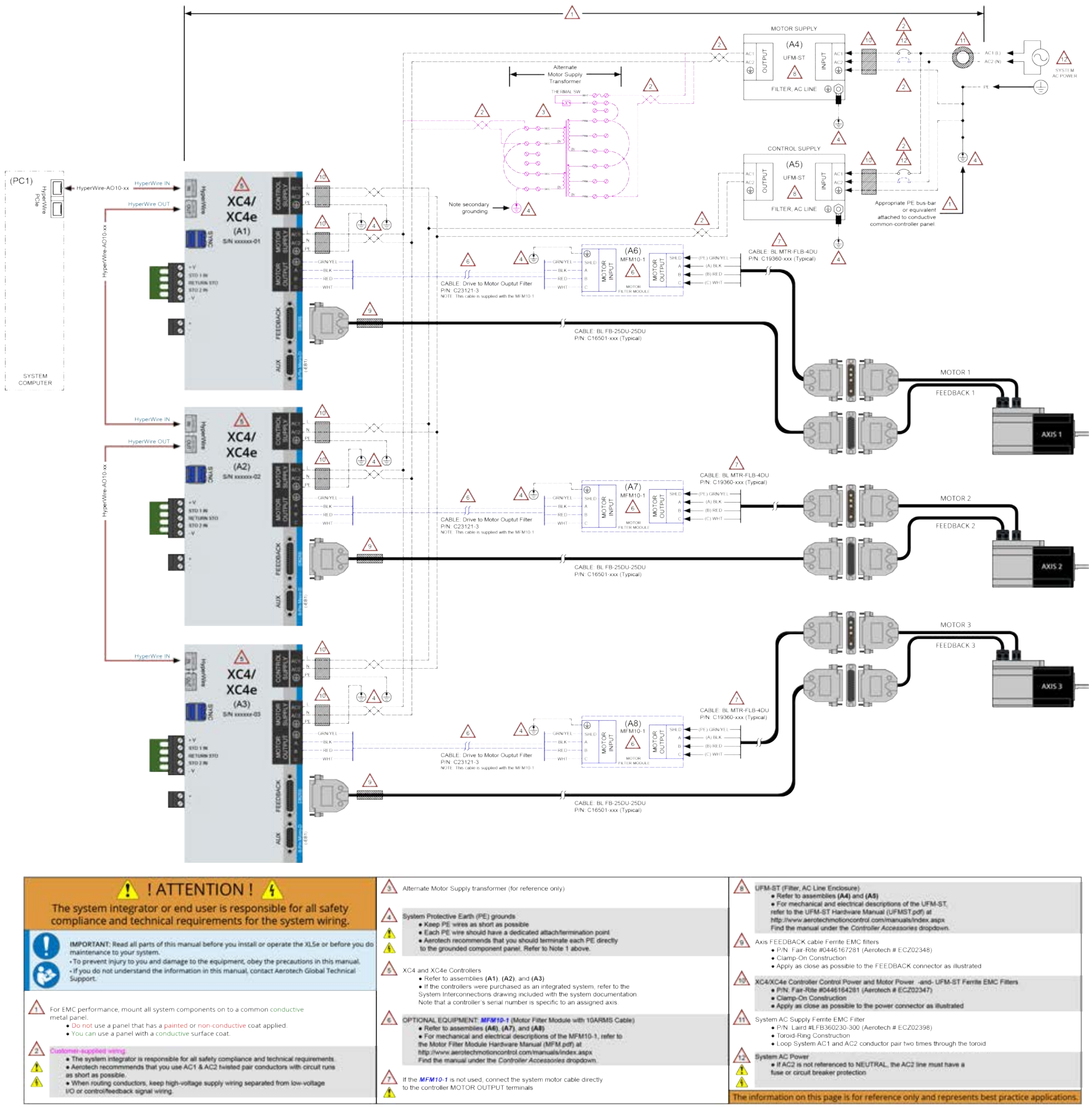



**Figure 2-49: PC-Based Controller System Interconnection (Best Practice)**

## 2.11. PC Configuration and Operation Information

For more information about hardware requirements, PC configuration, programming, system operation, and utilities, refer to the Help file.

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# Chapter 3: -EB1 I/O Option Board

The -EB1 I/O option board has 16 digital inputs, 16 digital outputs, 3 analog inputs, 3 analog outputs, and PSO outputs.

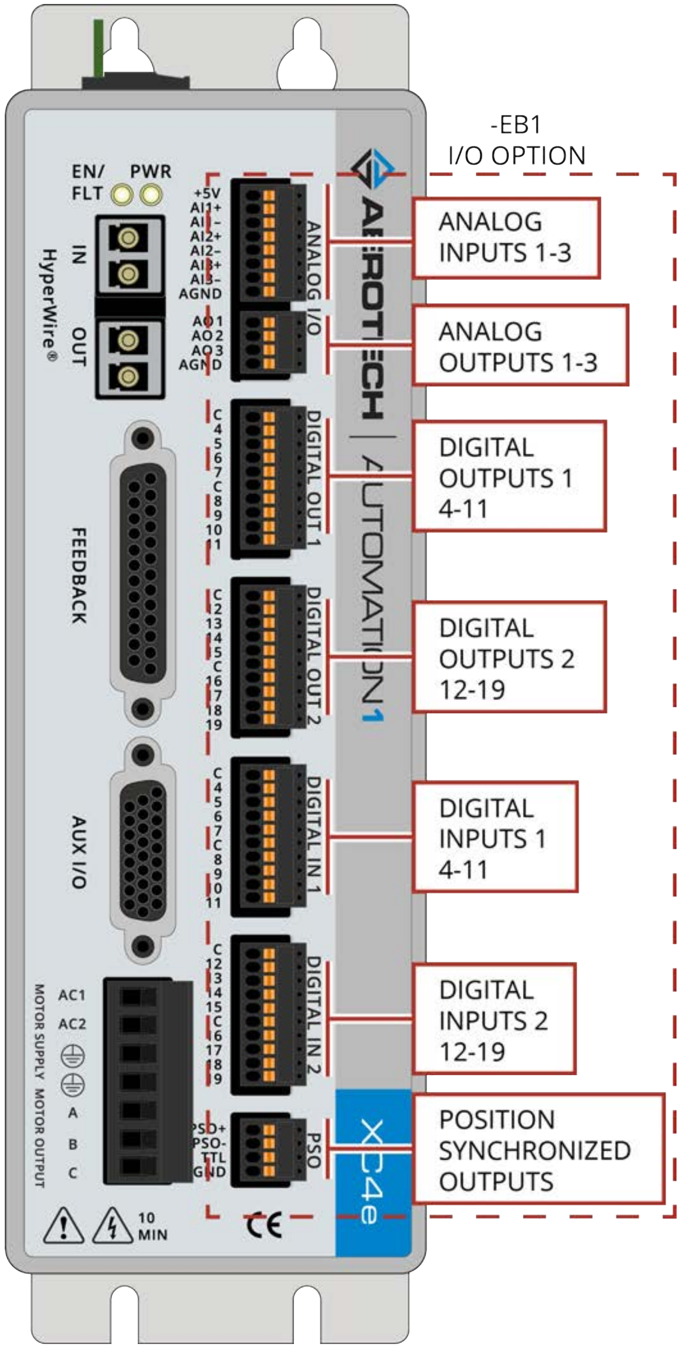



**Figure 3-1: XC4e with -EB1 I/O Option Board Connectors**

## 3.1. Digital Outputs [-EB1]

Optically-isolated solid-state relays drive the digital outputs. You can connect the digital outputs in current sourcing or current sinking mode but you must connect all four outputs in a port in the same configuration. Refer to Figure 3-3 and Figure 3-4.

The digital outputs are not designed for high-voltage isolation applications and they should only be used with ground-referenced circuits.

You must install suppression diodes on digital outputs that drive relays or other inductive devices. To see an example of a current sourcing output that has diode suppression, refer to Figure 3-3. To see an example of a current sinking output that has diode suppression, refer to Figure 3-4

The digital outputs have overload protection. They will resume normal operation when the overload is removed.

**Table 3-1: Digital Output Specifications [-EB1]**

| Digital Output Specifications | Value |
|---|---|
| Maximum Voltage | 24 V (26 V Maximum) |
| Maximum Sink/Source Current | 250 mA/output |
| Output Saturation Voltage | 0.9 V at maximum current |
| Output Resistance | 3.7 Ω |
| Rise / Fall Time | 250 µs (2K pull up to 24V) |
| Reset State | Output Off (High Impedance State) |

**Table 3-2: Digital Output 1 Connector Pinout [-EB1]**

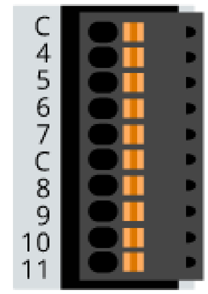
| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Output Common for Outputs 4-7 | N/A |  |
| 2 | Output 4 (Optically-Isolated) | Output | |
| 3 | Output 5 (Optically-Isolated) | Output | |
| 4 | Output 6 (Optically-Isolated) | Output | |
| 5 | Output 7 (Optically-Isolated) | Output | |
| 6 | Output Common for Outputs 8-11 | N/A | |
| 7 | Output 8 (Optically-Isolated) | Output | |
| 8 | Output 9 (Optically-Isolated) | Output | |
| 9 | Output 10 (Optically-Isolated) | Output | |
| 10 | Output 11 (Optically-Isolated) | Output | |

**Table 3-3: Mating Connector Part Numbers for the Digital Output 1 Connector [-EB1]**

| Mating Connector | Aerotech P/N | Third Party P/N | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|
| 10-Pin Terminal Block | ECK02395 | Phoenix 1700841 | 0.5 - 0.14 [20-26] |

**Table 3-4: Digital Output 2 Connector Pinout [-EB1]**

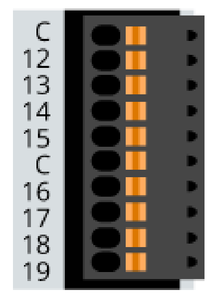
| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Output Common for Outputs 12-15 | N/A |  |
| 2 | Output 12 (Optically-Isolated) | Output | |
| 3 | Output 13 (Optically-Isolated) | Output | |
| 4 | Output 14 (Optically-Isolated) | Output | |
| 5 | Output 15 (Optically-Isolated) | Output | |
| 6 | Output Common for Outputs 16-19 | N/A | |
| 7 | Output 16 (Optically-Isolated) | Output | |
| 8 | Output 17 (Optically-Isolated) | Output | |
| 9 | Output 18 (Optically-Isolated) | Output | |
| 10 | Output 19 (Optically-Isolated) | Output | |

**Table 3-5: Mating Connector Part Numbers for the Digital Output 2 Connector [-EB1]**

| Mating Connector | Aerotech P/N | Third Party P/N | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|
| 10-Pin Terminal Block | ECK02395 | Phoenix 1700841 | 0.5 - 0.14 [20-26] |

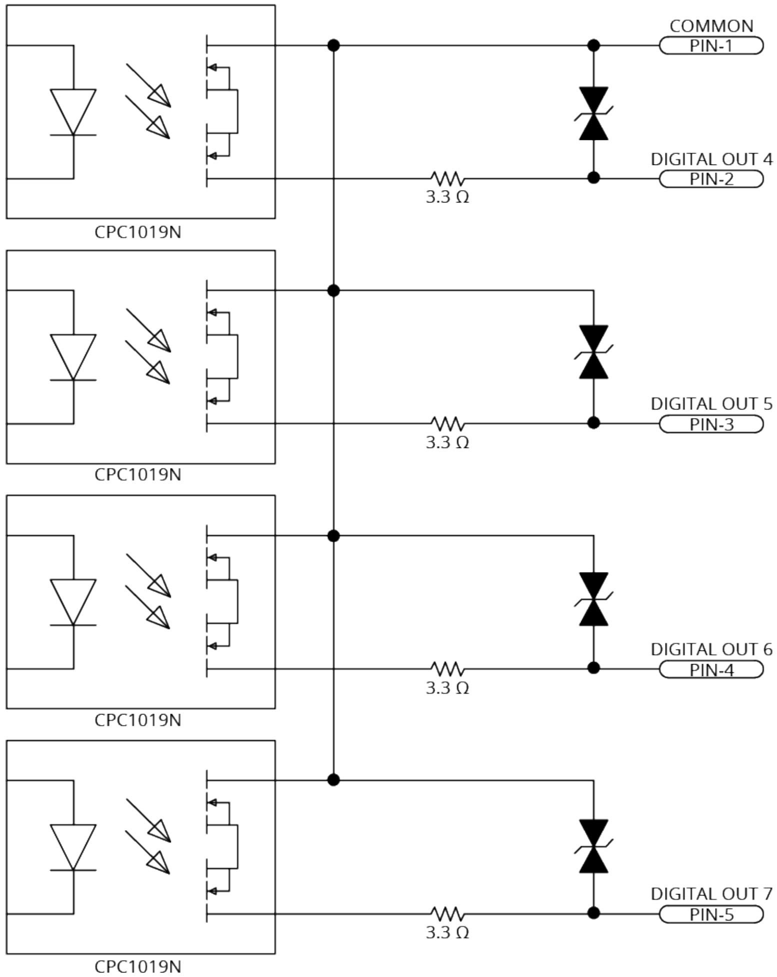



**Figure 3-2: Digital Outputs Schematic [-EB1]**

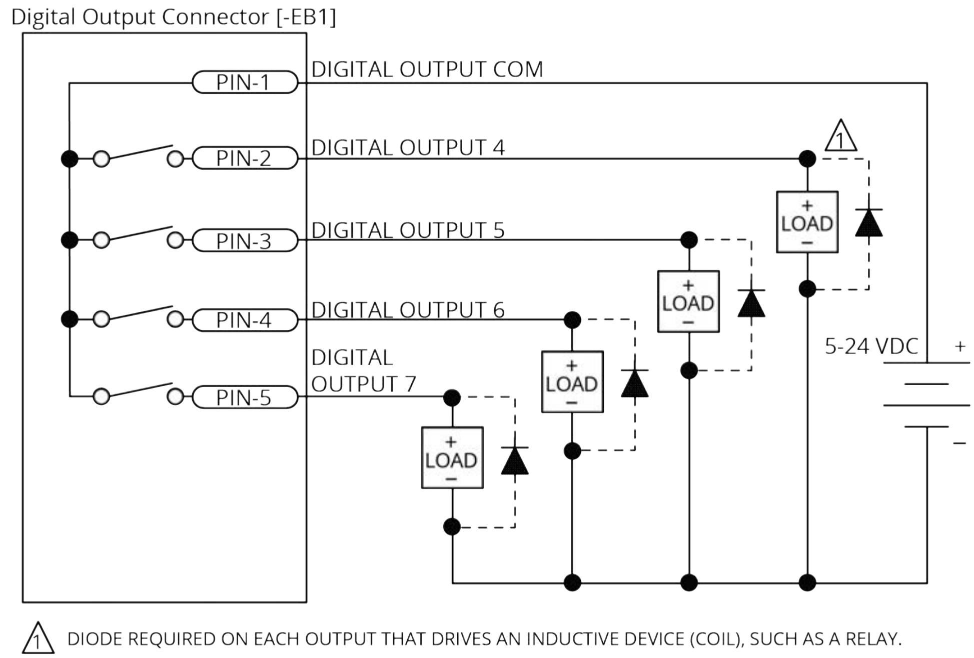



**Figure 3-3: Digital Outputs Connected in Current Sourcing Mode [-EB1]**

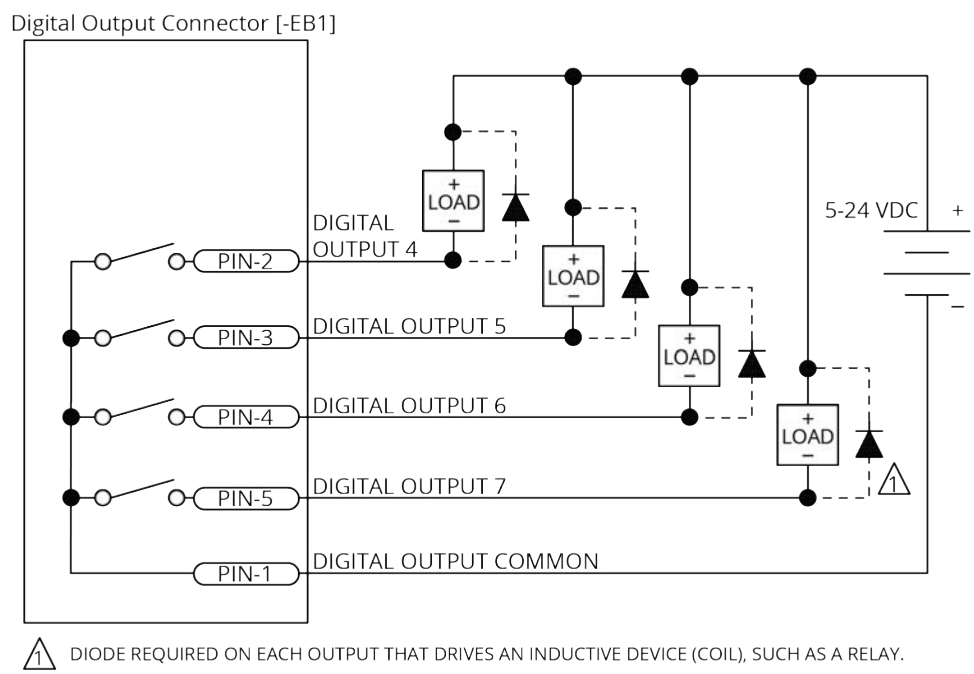



**Figure 3-4: Digital Outputs Connected in Current Sinking Mode [-EB1]**

## 3.2. Digital Inputs [-EB1]

Input bits are arranged in groups of 4 and each group shares a common pin. This lets a group be connected to current sourcing or current sinking devices, based on the connection of the common pin in that group.

To be able to connect an input group to current sourcing devices, connect the input group's common pin to the power supply return (-). Refer to Figure 3-6.

To be able to connect an input group to current sinking devices, connect the input group's common pin to the power supply source (+). Refer to Figure 3-7.

The digital inputs are not designed for high-voltage isolation applications. They should only be used with ground-referenced circuits.

**Table 3-6: Digital Input Specifications [-EB1]**

| Input Voltage | Approximate Input Current | Turn On Time | Turn Off Time |
|---|---|---|---|
| +5 V to +24 V | 6 mA | 10 µs | 43 µs |

**Table 3-7: Digital Input 1 Connector Pinout [-EB1]**

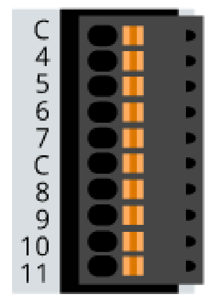
| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Input Common for Inputs 4-7 | N/A |  |
| 2 | Input 4 (Optically-Isolated) | Input | |
| 3 | Input 5 (Optically-Isolated) | Input | |
| 4 | Input 6 (Optically-Isolated) | Input | |
| 5 | Input 7 (Optically-Isolated) | Input | |
| 6 | Input Common for Inputs 8-11 | N/A | |
| 7 | Input 8 (Optically-Isolated) | Input | |
| 8 | Input 9 (Optically-Isolated) | Input | |
| 9 | Input 10 (Optically-Isolated) | Input | |
| 10 | Input 11 (Optically-Isolated) | Input | |

**Table 3-8: Mating Connector Part Numbers for the Digital Input 1 Connector [-EB1]**

| Mating Connector | Aerotech P/N | Third Party P/N | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|
| 10-Pin Terminal Block | ECK02395 | Phoenix 1700841 | 0.5 - 0.14 [20-26] |

**Table 3-9: Digital Input 2 Connector Pinout [-EB1]**

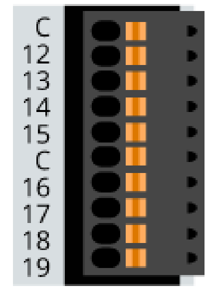
| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Input Common for Inputs 12-15 | N/A |  |
| 2 | Input 12 (Optically-Isolated) | Input | |
| 3 | Input 13 (Optically-Isolated) | Input | |
| 4 | Input 14 (Optically-Isolated) | Input | |
| 5 | Input 15 (Optically-Isolated) | Input | |
| 6 | Input Common for Inputs 16-19 | N/A | |
| 7 | Input 16 (Optically-Isolated) | Input | |
| 8 | Input 17 (Optically-Isolated) | Input | |
| 9 | Input 18 (Optically-Isolated) | Input | |
| 10 | Input 19 (Optically-Isolated) | Input | |

**Table 3-10: Mating Connector Part Numbers for the Digital Input 2 Connector [-EB1]**

| Mating Connector | Aerotech P/N | Third Party P/N | Wire Size: mm² [AWG] |
|---|---|---|---|
| 10-Pin Terminal Block | ECK02395 | Phoenix 1700841 | 0.5 - 0.14 [20-26] |

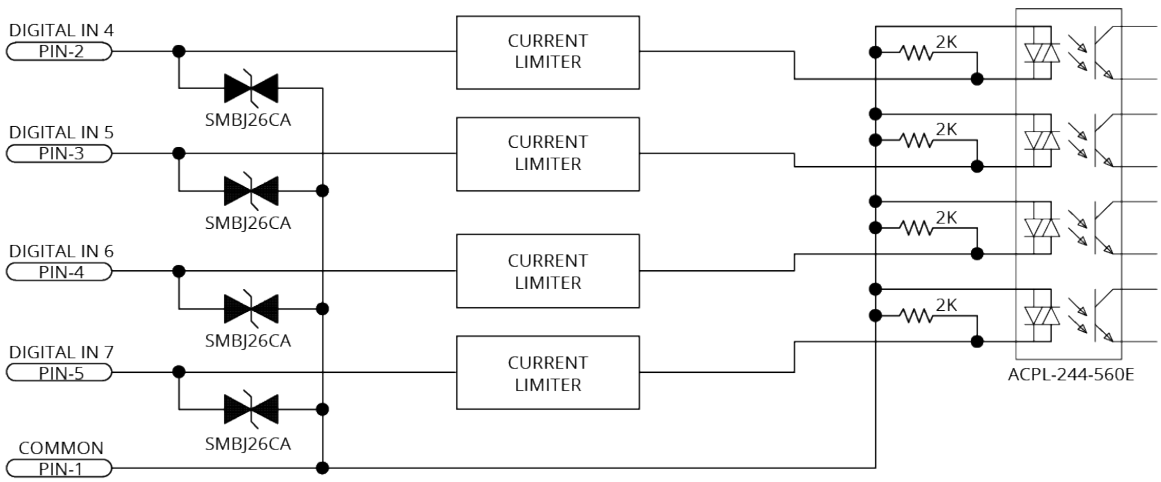



**Figure 3-5: Digital Inputs Schematic [-EB1]**

**IMPORTANT**: Each bank of four inputs must be connected in an all sourcing or all sinking configuration.

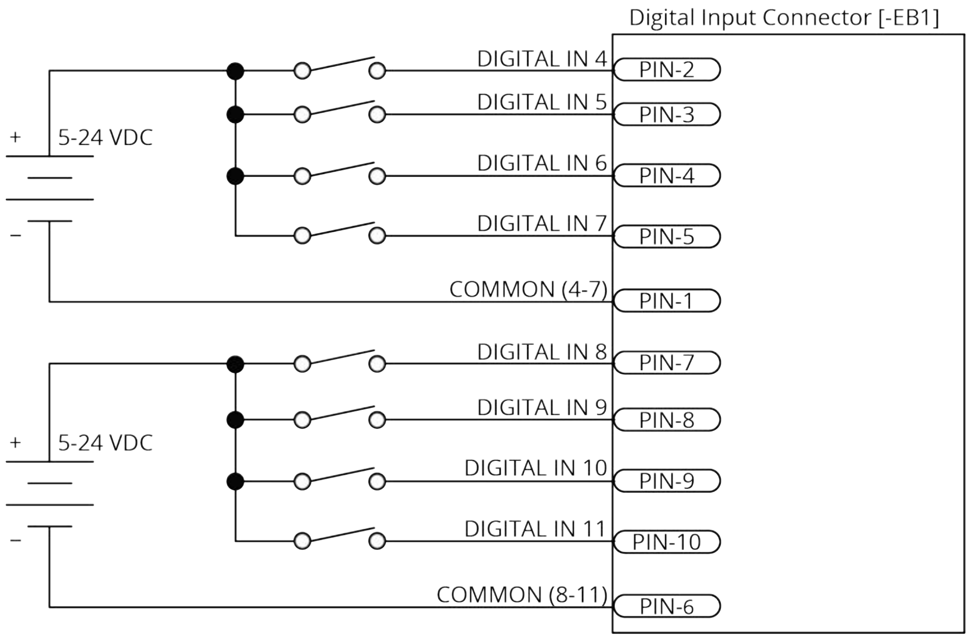



**Figure 3-6: Digital Inputs Connected to Current Sourcing (PNP) Devices [-EB1]**

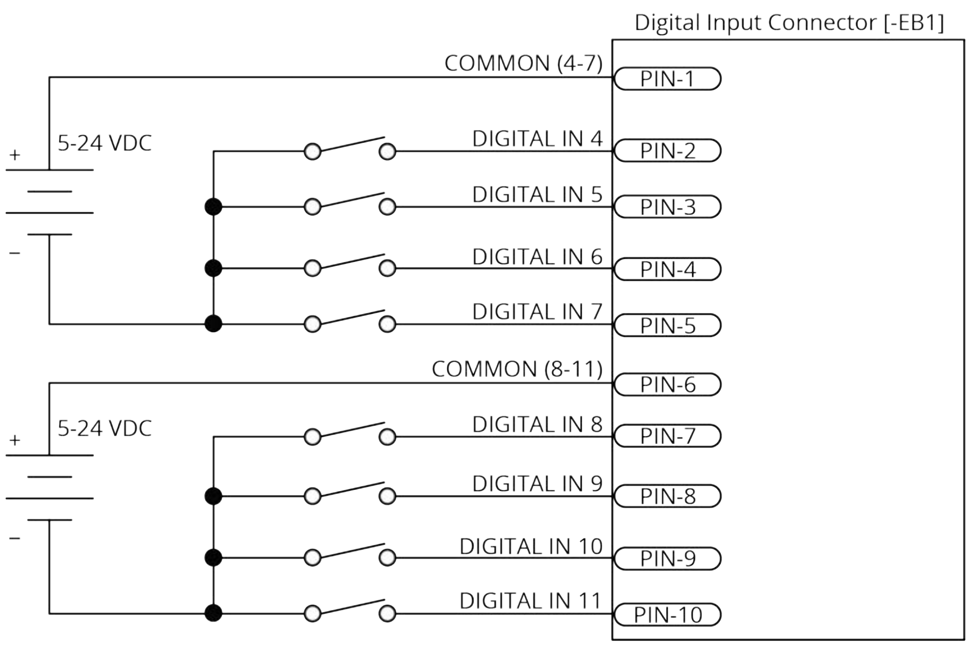



**Figure 3-7: Digital Inputs Connected to Current Sinking (NPN) Devices [-EB1]**

## 3.3. Analog Outputs [-EB1]

The analog output can be set from within a program or it can be configured to echo the state of select servo loop nodes.

The analog output is set to zero when you power on the system or reset the drive.

**Table 3-11: Analog Output Specifications [-EB1]**

| Specification | Value |
|---|---|
| Output Voltage | -10 V to +10 V |
| Output Current | 5 mA |
| Resolution (bits) | 16 bits |

**Table 3-12: Analog Output Connector Pinout [-EB1]**

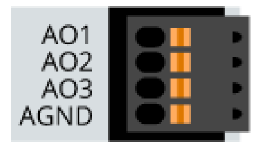
| Pin # | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Analog Output 1 | Output |   |
| 2 | Analog Output 2 | Output | |
| 3 | Analog Output 3 | Output | |
| 4 | Ground | N/A | |

**Table 3-13: Mating Connector Part Numbers for the Analog Output Connector [-EB1]**

| Type | Aerotech P/N | Third Party P/N | Wire Size: mm² [AWG] |
|---|---|---|---|
| 4-Pin Terminal Block | ECK02399 | Phoenix 1768004 | 0.5- 0.14 [20-26] |

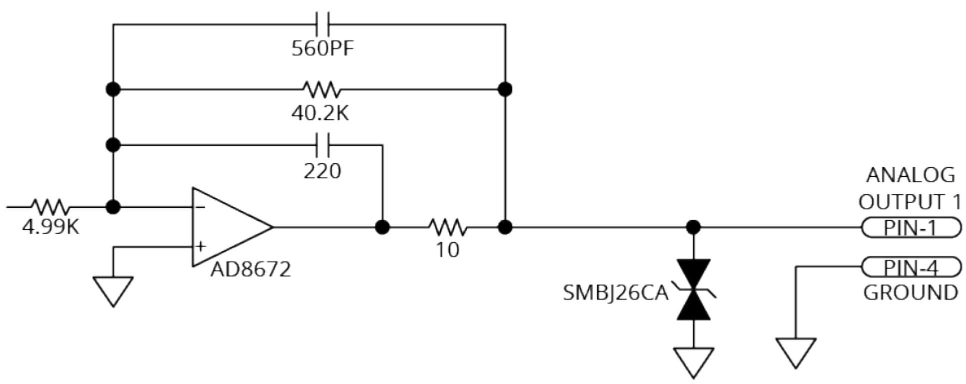



**Figure 3-8: Analog Output Typical Connection [-EB1]**

## 3.4. Analog Inputs [-EB1]

To interface to a single-ended, non-differential voltage source, connect the signal common of the source to the negative input and connect the analog source signal to the positive input. A floating signal source must be referenced to the analog common. Refer to Figure 3-9.

**Table 3-14: Differential Analog Input Specifications [-EB1]**

| Specification | Value |
|---|---|
| (AI+) - (AI-) | +10 V to -10 V [(1)] |
| Resolution (bits) | 16 bits |
| Input Impedance | 1 MΩ |
| 1. Signals outside of this range may damage the input | |

**Table 3-15: Analog Input Connector Pinout [-EB1]**

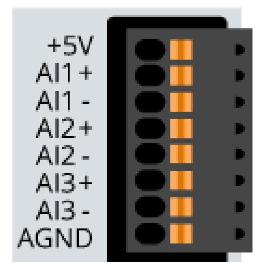
| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | +5V (250 mA max) | N/A |  |
| 2 | Analog Input 1+ | Input | |
| 3 | Analog Input 1- | Input | |
| 4 | Analog Input 2+ | Input | |
| 5 | Analog Input 2- | Input | |
| 6 | Analog Input 3+ | Input | |
| 7 | Analog Input 3- | Input | |
| 8 | Ground | N/A | |

**Table 3-16: Mating Connector Part Numbers for the Analog Input Connector [-EB1]**

| Mating Connector | Aerotech P/N | Third Party P/N | Wire Size: mm² [AWG] |
|---|---|---|---|
| 8-Pin Terminal Block | ECK02397 | Phoenix 1908101 | 0.5 - 0.14 [20-26] |

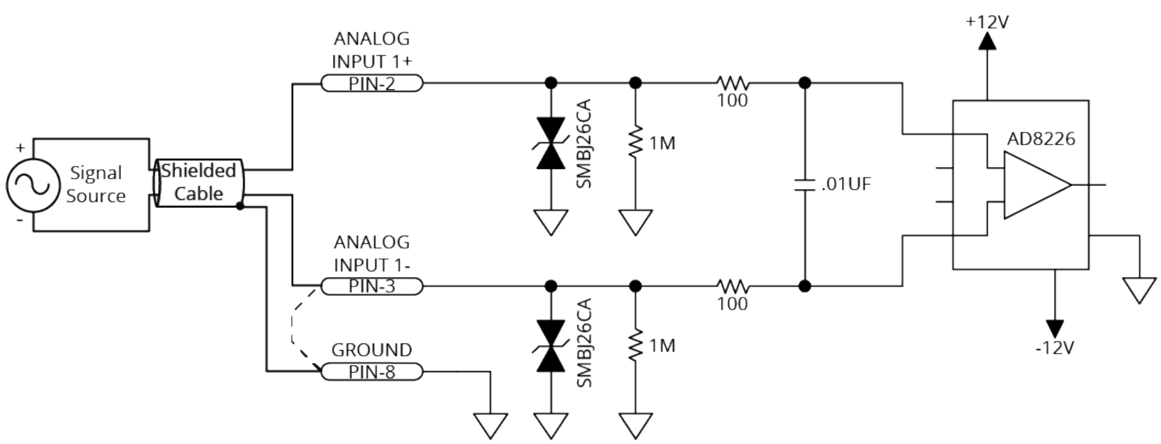



**Figure 3-9: Analog Input Typical Connection [-EB1]**

## 3.5. Position Synchronized Output Interface [-EB1]

The PSO output signal is available on the -EB1 option board in two signal formats: TTL and Isolated.

The PSO signal is also available on the AUX I/O connector. Refer to Section 2.5.2.

**Table 3-17: PSO Specifications [-EB1]**

| Specification | | Value |
|---|---|---|
| Output | TTL | 5 V, 16 mA (max) |
| | Isolated | 5-24 V, 250 mA |
| Maximum PSO Output (Fire) Frequency | TTL | 12.5 MHz |
| | Isolated | 5 MHz |
| Output Latency [Fire event to output change] | TTL | 5 ns |
| | Isolated | 150 ns |

**Table 3-18: PSO Interface Connector Pinout [-EB1]**

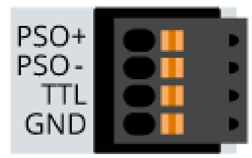
| Pin # | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | PSO Output+ | Output |   |
| 2 | PSO Output- | Output | |
| 3 | PSO Output (TTL) | Output | |
| 4 | Ground | N/A | |

**Table 3-19: Mating Connector Part Numbers for the PSO Interface Connector [-EB1]**

| Type | Aerotech P/N | Third Party P/N | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|
| 4-Pin Terminal Block | ECK02399 | Phoenix 1768004 | 0.5- 0.14 [20-26] |

### Isolated Signals

This output signal is a fully-isolated 5-24V compatible output capable of sourcing or sinking current. This output is normally open and only conducts current when a PSO fire event occurs.

The PSO Isolated Outputs are overload protected and will turn off if the maximum output current is exceeded.

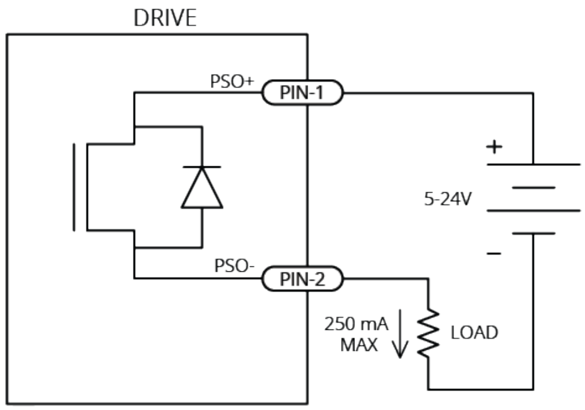



**Figure 3-10: PSO Output Sources Current**

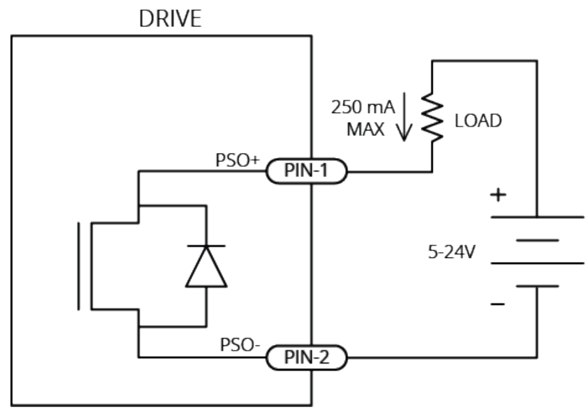



**Figure 3-11: PSO Output Sinks Current**

### TTL Signals

This output signal is a 5V TTL signal which is used to drive an opto coupler or general purpose TTL input. This signal is active high and is driven to 5V when a PSO fire event occurs.

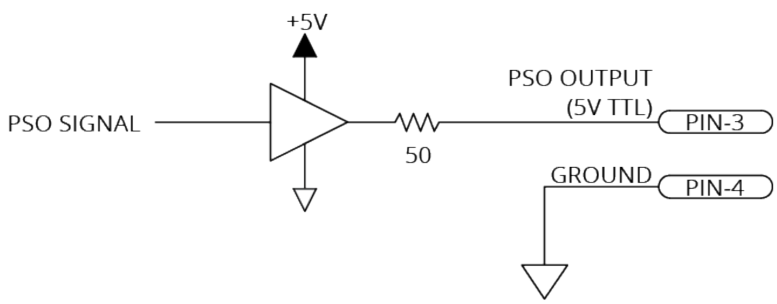



**Figure 3-12: PSO TTL Outputs Schematic**

# Chapter 4: Cables and Accessories

**IMPORTANT**: Find Aerotech cable drawings on the website at http://www.aerotechmotioncontrol.com/manuals/index.aspx.

**Table 4-1: Standard Interconnection Cables**

| Cable Part # | Description |
|---|---|
| Joystick | See Section 4.1. |
| ECZ01231 | BBA32 Interconnect Cable |

## 4.1. Joystick Interface

Aerotech Multi-Axis Joystick (NEMA12 (IP54) rated) is powered from 5 V and has a nominal 2.5 V output in the center detent position. Three buttons are used to select axis pairs and speed ranges. An optional interlock signal is used to indicate to the controller that the joystick is present. Joystick control will not activate unless the joystick is in the center location. Third party devices can be used provided they produce a symmetric output voltage within the range of -10 V to +10 V.

Connecting joystick with an Aerotech cable, all Aerotech cables are labeled to identify the connector and connections. The joystick parameters must be set to match the analog and digital I/O connections.

The following drawings illustrate how to connect a single- or two-axis joystick. Refer to the Help file for programming information about how to change joystick parameters.

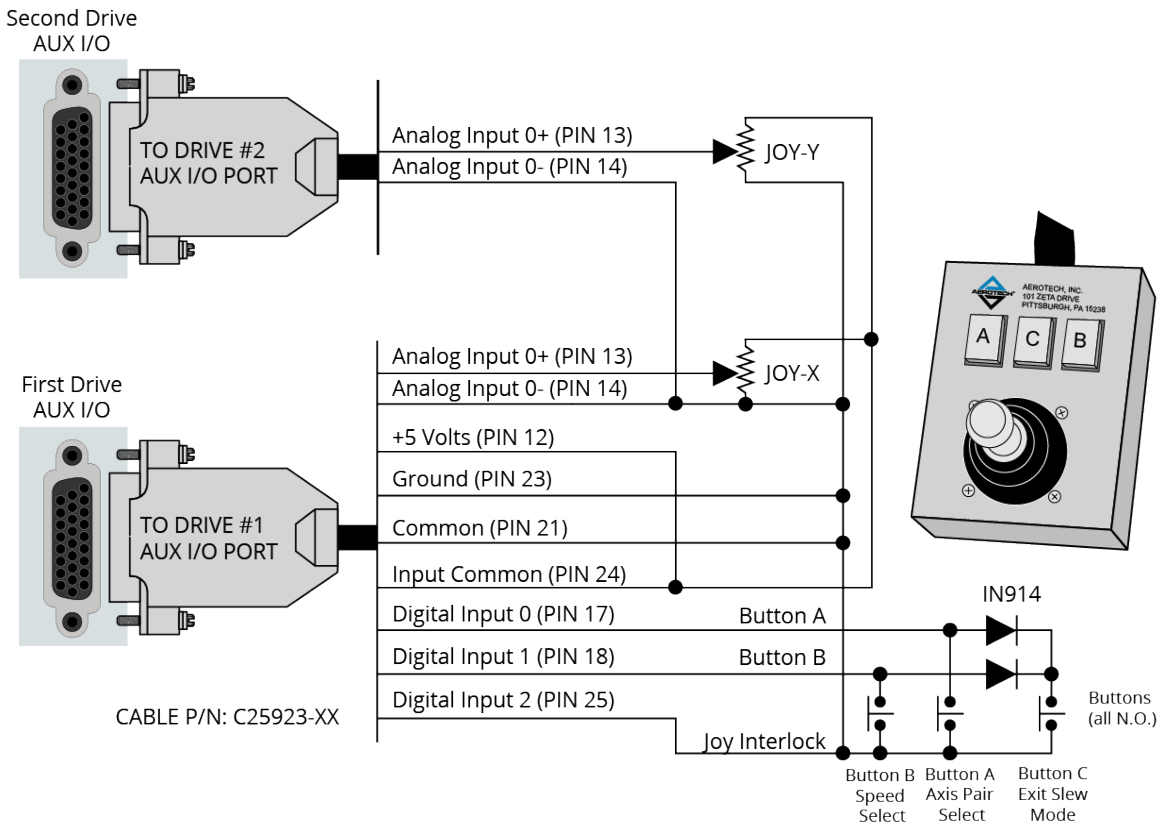



**Figure 4-1: Two Axis Joystick Interface (to the Aux I/O of two drives)**

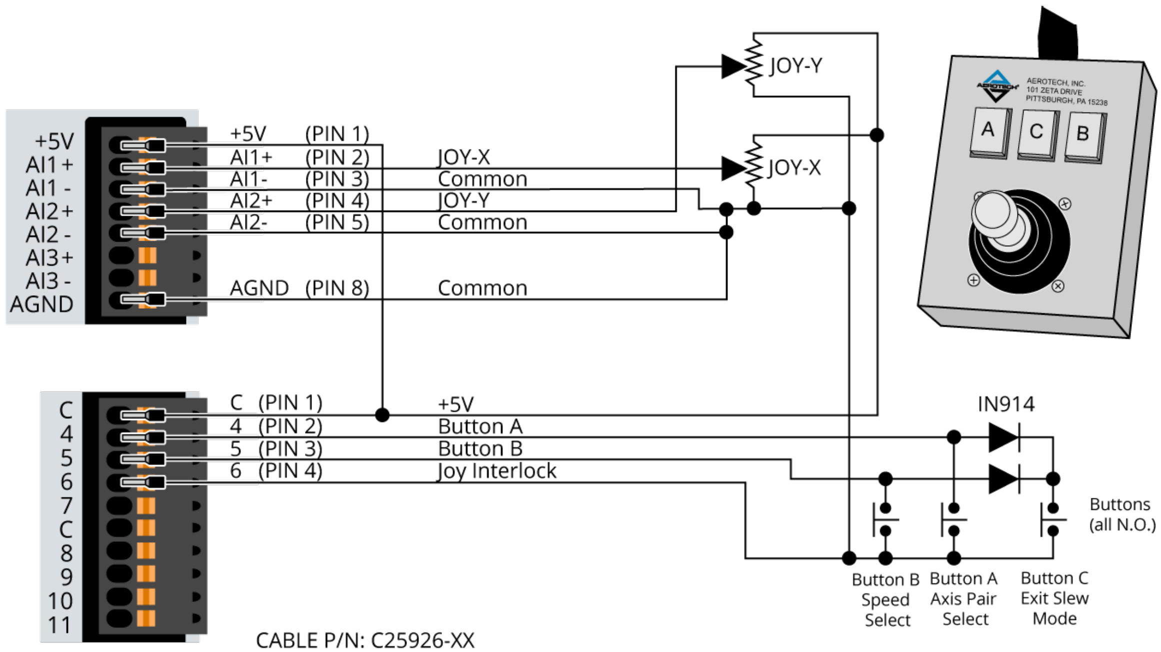



**Figure 4-2: Two Axis Joystick Interface (to the I/O board)**

## 4.2. Handwheel Interface

A handwheel can be used to manually control axis position. The handwheel must provide 5V differential quadrature signals to the XC4e

> **IMPORTANT**: You can find instructions on how to enable the handwheel in the Help file.

Connect a handwheel to the Aux I/O as shown in Figure 4-3 or Figure 4-4.

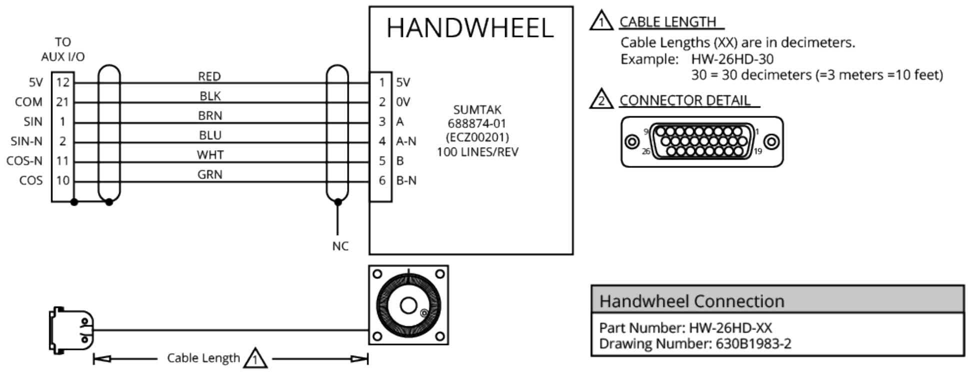



**Figure 4-3: Handwheel Interconnection to Aux I/O Connector**

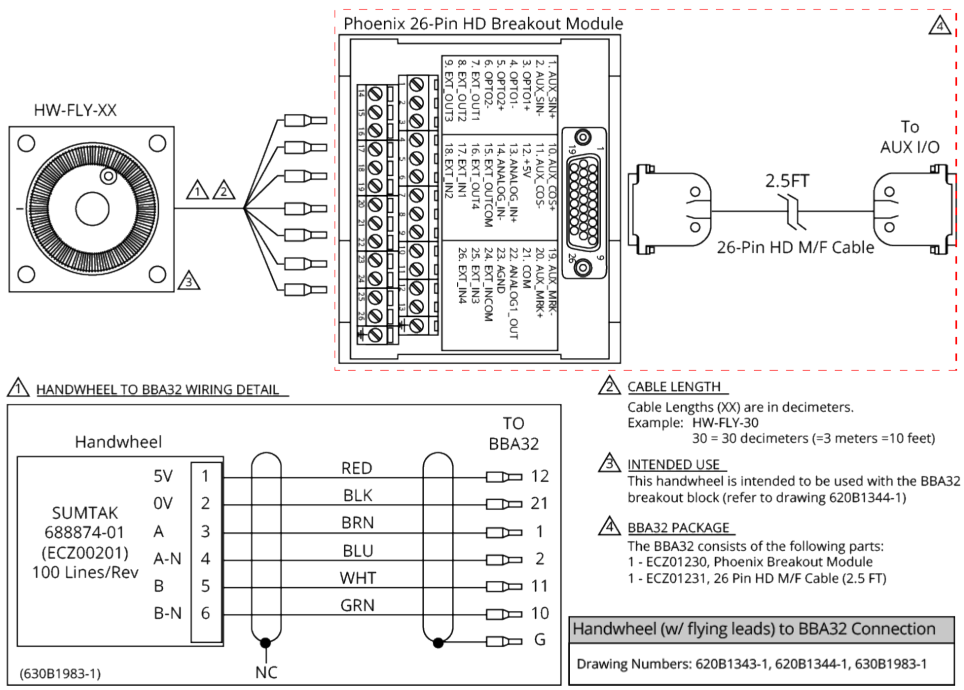



**Figure 4-4: Handwheel Interconnection to the Aux I/O through a BBA32 Module**

# Chapter 5: Maintenance

**IMPORTANT**: For your own safety and for the safety of the equipment:

- Do not remove the cover of the XC4e
- Do not attempt to access the internal components.

A fuse that needs to be replaced indicates that there is a more serious problem with the system or setup. Contact Global Technical Support for assistance.

**DANGER**: If you must remove the covers and access any internal components be aware of the risk of electric shock.

1. Disconnect the Mains power connection.
2. Wait at least ten (10) minutes after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.
3. All tests must be done by an approved service technician. Voltages inside the controller and at the input and output power connections can kill you.

**Table 5-1: LED Description**

| LED | Color | Description |
|---|---|---|
| PWR | GREEN | The light will illuminate and remain illuminated while power is applied. |
| EN/FLT | GREEN | The axis is Enabled. |
| | RED | The axis is in a Fault Condition. |
| | GREEN/RED (alternates) | The axis is Enabled in a Fault Condition.<br>or<br>The light is configured to blink for setup. |

**Table 5-2: Troubleshooting**

| Symptom | Possible Cause and Solution |
|---|---|
| No Communication | Make sure the power LED is illuminated (this indicates that power is present). |
| | Make sure that all communication cables (HyperWire, for example) are fully inserted in their ports. |

## 5.1. Preventative Maintenance

Do an inspection of the XC4e and the external wiring one time each month. It might be necessary to do more frequent inspections based on:

- The operating conditions of the system.
- How you use the system.

**Table 5-3: Preventative Maintenance**

| Check | Action to be Taken |
|---|---|
| Examine the chassis for hardware and parts that are damaged or loose.<br>It is not necessary to do an internal inspection unless you think internal damage occurred. | Repair all damaged parts. |
| Do an inspection of the cooling vents. | Remove all material that collected in the vents. |
| Examine the work area to make sure there are no fluids and no electrically conductive materials. | Do not let fluids and electrically conductive material go into the XC4e. |
| Examine all cables and connections to make sure they are correct. | Make sure that all connections are correctly attached and not loose.<br>Replace cables that are worn.<br>Replace all broken connectors. |

### Cleaning

**DANGER**: Before you clean the XC4e, disconnect the electrical power from the drive.

Use a clean, dry, soft cloth to clean the chassis of the XC4e. If necessary, you can use a cloth that is moist with water or isopropyl alcohol. If you use a moist cloth, make sure that moisture does not go into the XC4e. Also make sure that it does not go onto the outer connectors and components.

Do not use fluids and sprays to clean the XC4e because they can easily go into the chassis or onto the outer connectors and components. If a cleaning solution goes into the XC4e, internal contamination can cause corrosion and electrical short circuits.

Do not clean the labels with a cleaning solution because it might remove the label information.

## 5.2. Fuse Specifications

**WARNING**: Replace fuses only with the same type and value.

**Table 5-4: Control Board Fuse Specifications**

| Fuse | Description | Size | Aerotech P/N | Third Party P/N |
|---|---|---|---|---|
| F100 | Control Power at Line Input (L) | 2 A S.B. | EIF01044 | Littelfuse 0877002.MXEP |
| F101 | -SX1 (External Shunt) Option | 8 A S.B. | EIF01022 | Littelfuse 0215008.HXP |
| F102 | Motor Bus Supply at AC1 XC4e-10) | 5 A S.B. | EIF01023 | Littelfuse 215005.HXP |
| | Motor Bus Supply at AC1 XC4e-20/-30) | 10 A S.B. | EIF01020 | Littelfuse 0215010.HXP |

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# Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from harmful defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale, or use of any of its products shall in no event exceed the selling price of the unit.

THE EXPRESS WARRANTY SET FORTH HEREIN IS IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, BY OPERATION OF LAW OR OTHERWISE. IN NO EVENT SHALL AEROTECH BE LIABLE FOR CONSEQUENTIAL OR SPECIAL DAMAGES.

## Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within thirty (30) days of shipment of incorrect material. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. A "Return Materials Authorization (RMA)" number must accompany any returned product(s). The RMA number may be obtained by calling an Aerotech service center or by submitting the appropriate request available on our website (www.aerotech.com). Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than thirty (30) days after the issuance of a return authorization number will be subject to review.

Visit Global Technical Support Portal for the location of your nearest Aerotech Service center.

## Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an expedited method of return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

**Fixed Fee Repairs** - Products having fixed-fee pricing will require a valid purchase order or credit card particulars before any service work can begin.

**All Other Repairs** - After Aerotech's evaluation, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within thirty (30) days of notification will result in the product(s) being returned as is, at the buyer's expense.

Repair work is warranted for ninety (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

## Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

## On-site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

> Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special rates apply.
>
> If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following “On-Site Non-Warranty Repair” section apply.

## On-site Non-Warranty Repair

If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

> Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

## Service Locations

http://www.aerotech.com/contact-sales.aspx?mapState=showMap

**USA, CANADA, MEXICO**
Aerotech, Inc.
Global Headquarters

**CHINA**
Aerotech China
Full-Service Subsidiary

**GERMANY**
Aerotech Germany
Full-Service Subsidiary

**TAIWAN**
Aerotech Taiwan
Full-Service Subsidiary

**UNITED KINGDOM**
Aerotech United Kingdom
Full-Service Subsidiary

# Appendix B: Revision History

| Revision | Description |
|---|---|
| 2.01 | • Absolute Encoder support on the Auxiliary I/O connector has been added.<br>• System Wiring (best practices) drawing has been added |
| 2.00 | General Update |
| 1.02 | The following sections have been updated:<br>• Agency Approvals<br>• Section 2.3.1. Primary Encoder Inputs<br>• Section 2.5.1. Auxiliary Encoder Inputs |
| 1.01 | The following sections have been updated:<br>• Section 2.1.2.<br>• Section 2.10. |
| 1.00 | New Manual |

| Revision | Description |
|---|---|
| 2.01 | New Manual |

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# Index

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**S**



**T**

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