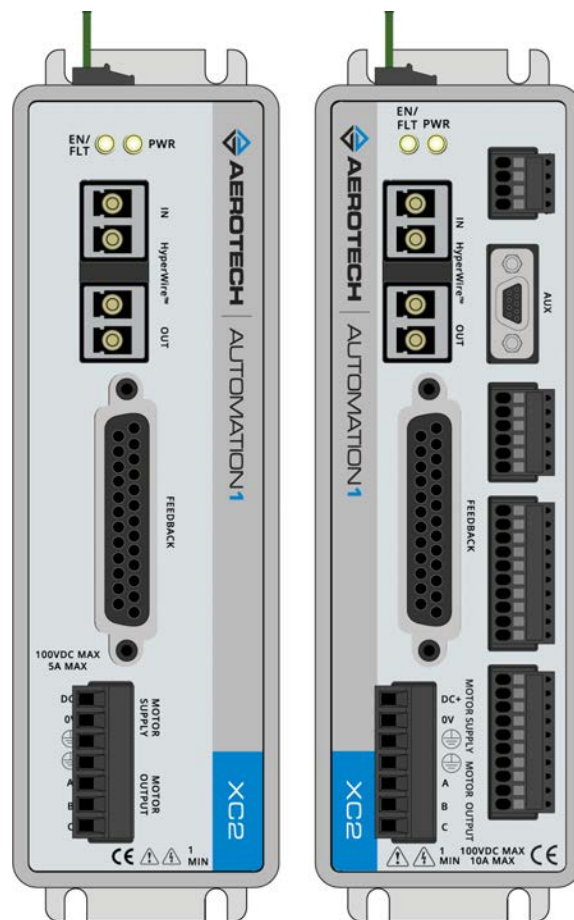


XC2 HARDWARE MANUAL

Revision: 1.02.00



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EU Declaration of Conformity

Manufacturer Aerotech, Inc.
Address 101 Zeta Drive
Pittsburgh, PA 15238-2811
USA
Product XC2
Model/Types All

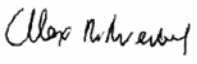
This is to certify that the aforementioned product is in accordance with the applicable requirements of the following Directive(s):

2014/30/EU	Electromagnetic Compatibility (EMC)
2014/35/EU	Low Voltage Directive
EU 2015/863	RoHS 3 Directive

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

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Location Pittsburgh, PA
Date 4/27/2020



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Agency Approvals

Aerotech tested its XC2 drives and found that they obey the standards that follow:

Approval / Certification:	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

This manual tells you how to carefully and correctly use and operate the XC2. Read all parts of this manual before you install or operate the XC2 or before you do maintenance to your system. To prevent injury to you and damage to the equipment, obey the precautions in this manual. The precautions that follow apply when you see a Danger or Warning symbol in this manual. If you do not obey these precautions, injury to you or damage to the equipment can occur. If you do not understand the information in this manual, contact Aerotech Global Technical Support.

This product has been designed for light industrial manufacturing or laboratory environments. The protection provided by the equipment could be impaired if the product is used in a manner not specified by the manufacturer.

NOTE: 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.



DANGER: The voltage from this product can kill you. To decrease the risk of electrical shock, injury, and death, you must obey the precautions that follow.

1. Before you do maintenance to the equipment, disconnect the electrical power.
2. Wait at least one (1) minute after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.
3. Before you connect wires to this product, disconnect the electrical power.
4. To decrease the risk of electrical shock and injury, you must supply operators with the necessary precautions and protection from live electrical circuits.
5. While the drive is connected to a power source, do not connect or disconnect electrical components and cables.
6. Make sure that all components are grounded correctly and that they obey the local electrical safety requirements.
7. Make sure that you install the necessary precautions to supply safety and protection to the operator.
8. Moving parts can cause crushing or shearing injuries. You must limit access to all motor and stage parts while your system is connected to a power source.



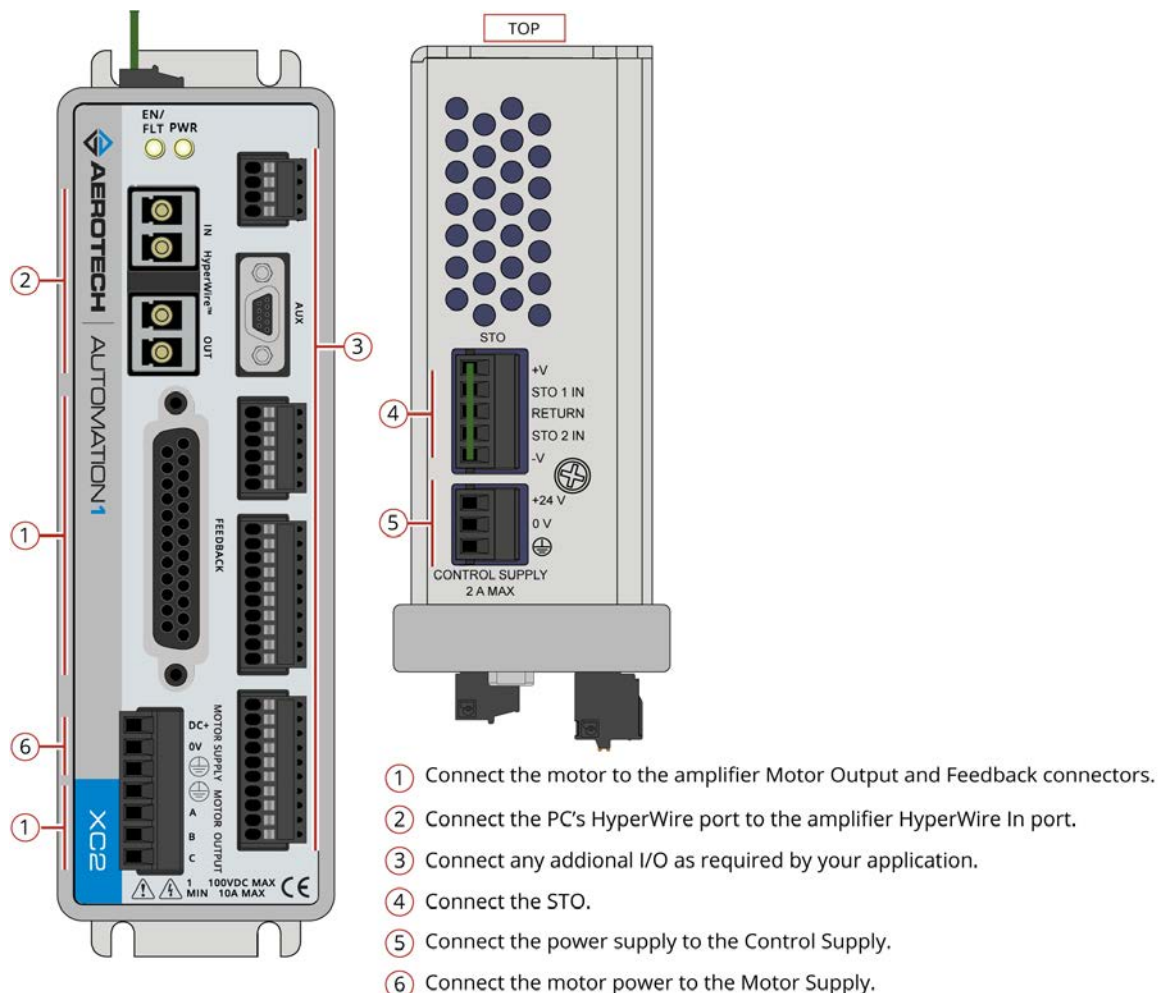
WARNING: To prevent damage to the equipment and decrease the risk of electrical shock, injury, and death, you must obey the precautions that follow.

1. Make sure that all system cables are correctly attached and positioned.
2. Use this product only in environments and operating conditions that are approved in this manual.
3. Only operators who have received training can operate this equipment. All servicing and maintenance must be done only by approved personnel.

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Quick Installation Guide

This image shows the order in which to make connections and settings that are typical to the XC2. 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.



Motor and Feedback Connections	Section 2.2. Motor Power Output Connector and Section 2.3. Feedback Connector
HyperWire	Section 2.5. HyperWire Interface
Digital / Analog I/O	Chapter 3: -EB1 I/O Option Board (if you purchased the I/O option)
STO	Section 2.4. Safe Torque Off Input (STO)
Control Supply	Section 2.1.1. Control Supply Connector
Motor Supply	Section 2.1.2. Motor Supply Connector

Figure 1: Quick Start Connections

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Chapter 1: Introduction

The XC2 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 XC2.

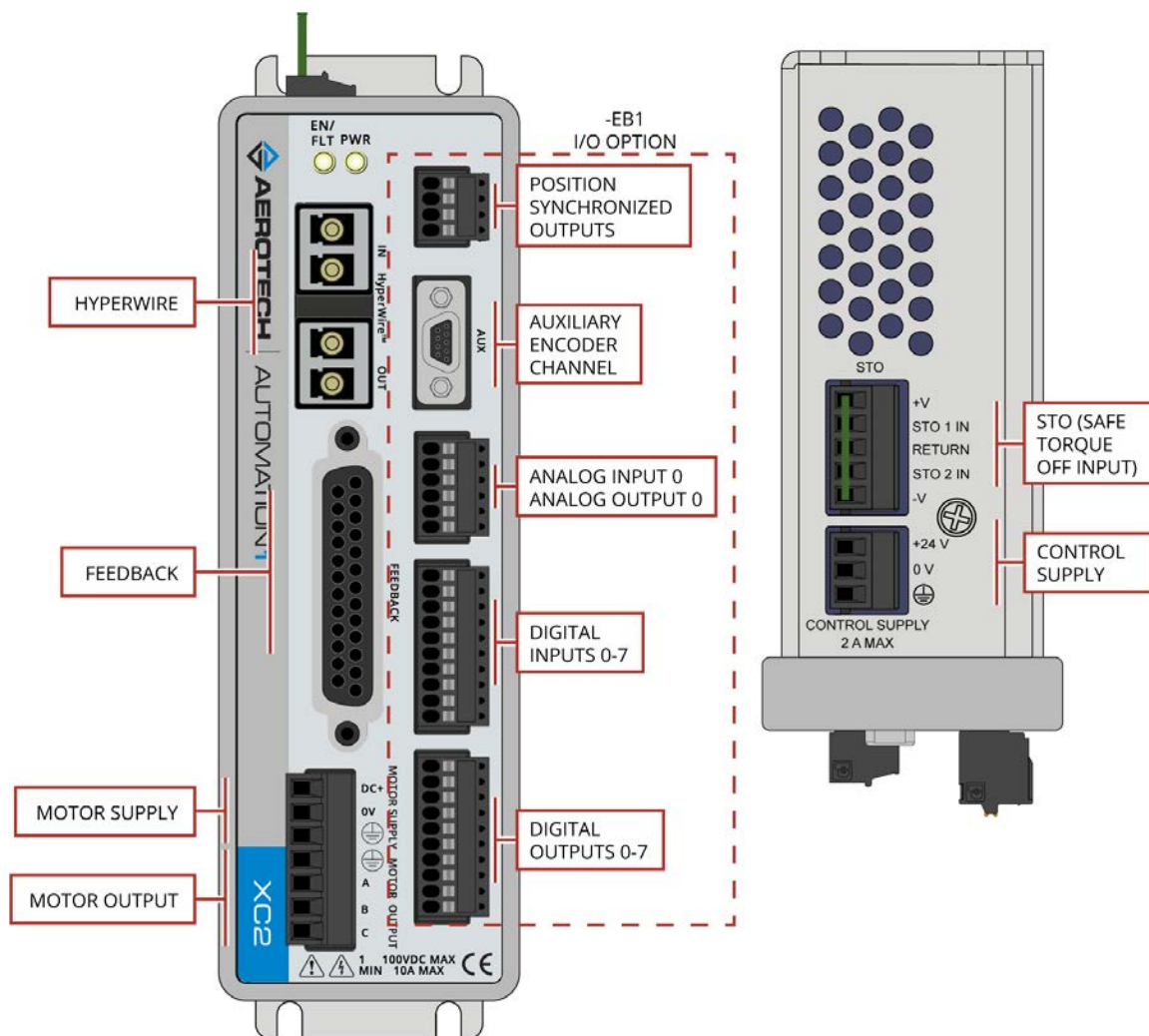


Figure 1-1: XC2 High Performance PWM Amplifier

Table 1-1: Feature Summary

Standard Features	
• 24 VDC control supply input	Section 2.1.1.
• 15-100 VDC motor supply inputs	Section 2.1.2.
• Line driver square wave quadrature encoder input for position and velocity feedback	Section 2.3.1.
• Absolute Encoder support	Section 2.3.1.2.
• One fail-safe brake	Section 2.3.6.
• Two STO sense inputs	Section 2.4.
Options	
Peak Current	
-10	10 A Peak, 5 A Continuous Current
Expansion Board	
-EB0	No expansion board
-EB1	I/O expansion board <ul style="list-style-type: none"> • 16-bit analog output (± 10 V) • 16-bit differential analog input (± 10 V) • 8 digital logic inputs (5 - 24 VDC), can be connected to current sourcing or sinking devices • 8 digital logic outputs (5 - 24 VDC), can be connected as current sourcing or sinking • Digital logic laser firing (PSO) output
PSO	
-PSO1	One axis PSO firing (requires -EB1 option)
Multiplier	
-MX0	No encoder multiplier
-MX1	Interpolation circuit allowing for analog sine wave input on the primary encoder channel with an interpolation factor of 16,384
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.

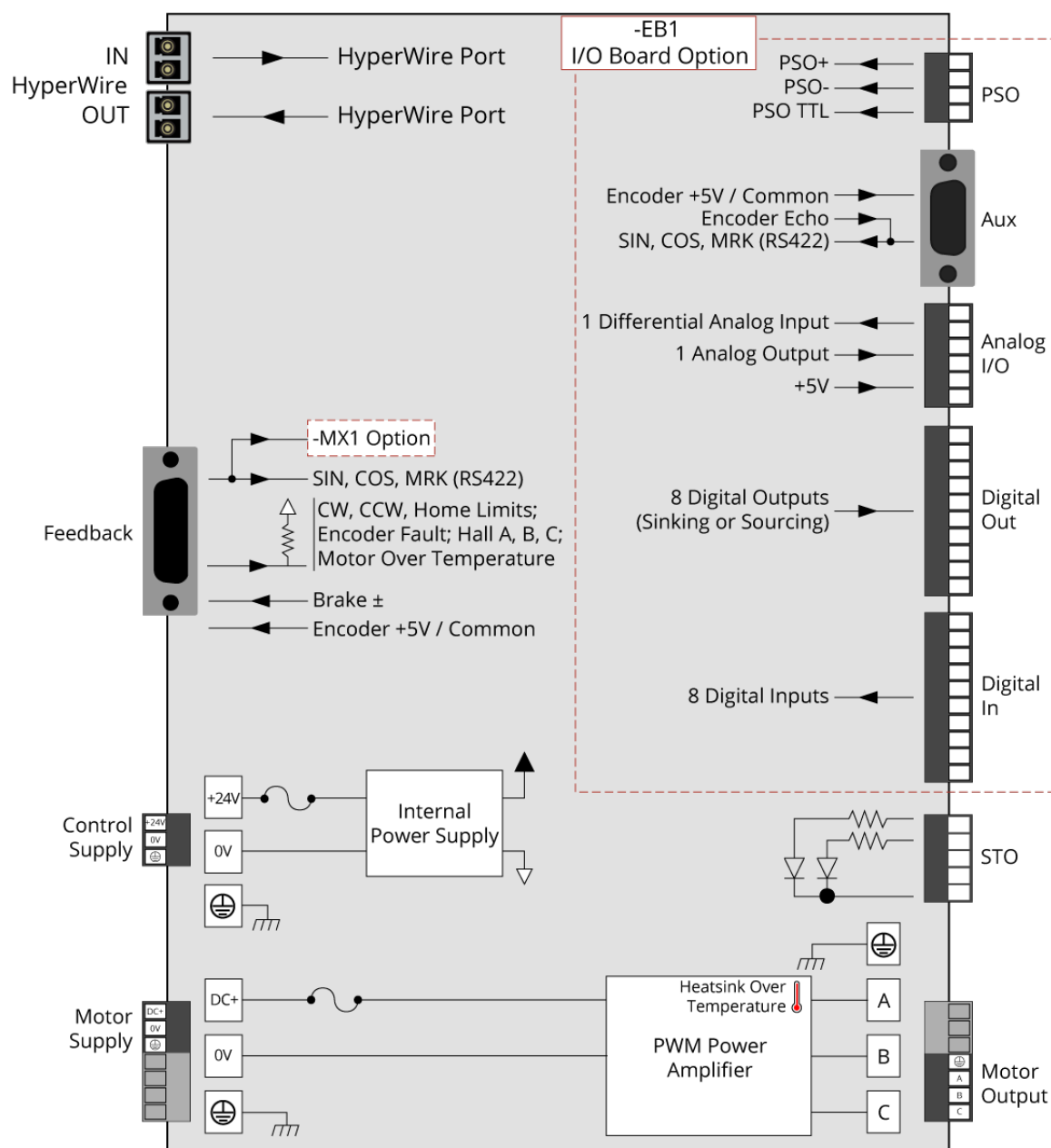


Figure 1-2: Functional Diagram

1.1. Electrical Specifications

Table 1-2: Electrical Specifications

Description		XC2-10
Motor Supply	Input Voltage	15-100 VDC max
	Input Current (Continuous)	5 A _{rms}
	Input Current	Refer to Section 1.1.1. System Power Requirements
Control Supply	Input Voltage	24 VDC
	Input Current	2 A max, 0.4 A typical without brake
Output Voltage ⁽¹⁾		15-100 VDC
Peak Output Current (1 second)		10 A
Continuous Output Current		5 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 @ 100 VDC
User Power Supply Output		5 VDC (@ 500 mA)
Modes of Operation		Brushless; Brush; Stepper
Protective Features		Output short circuit; Peak over current; RMS over current; Over temperature; Control power supply under voltage; Power stage bias supply under voltage
⁽¹⁾ DC input voltage and load dependent.		
⁽²⁾ Dependent on total output power: efficiency increases with increasing output power.		

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 $\text{Power Output [W]} = \text{Torque [N}\cdot\text{m]} * \text{Angular velocity[rad/sec]}$

Linear Motors $\text{Power Output [W]} = \text{Force [N]} * \text{Linear velocity[m/sec]}$

Rotary or Linear Motors $\text{Power Output [W]} = \text{Bemf [V]} * \text{I(rms)} * 3$

$\text{Power Loss} = 3 * \text{I(rms)}^2 * \text{R(line-line)}/2$

$\text{Power Input} = (\text{Power Output} + \text{Power Loss}) / \text{EfficiencyFactor}$

DC Brush Motor

$\text{Power Output [W]} = \text{Torque [N}\cdot\text{m]} * \text{Angular velocity[rad/sec]}$

$\text{Power Loss} = \text{I(rms)}^2 * \text{R}$

$\text{Power Input} = (\text{Pout} + \text{Ploss}) / \text{EfficiencyFactor}$

1.2. Mechanical Specifications

1.2.1. Mounting and Cooling

Install the XC2 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

		XC2
Enclosure		IP54 Compliant
		For DIN Rail Mounting, refer to Section 4.1. DIN Rail Mounting
Weight		~0.54 kg
Mounting Hardware		M3.5 [#6] 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

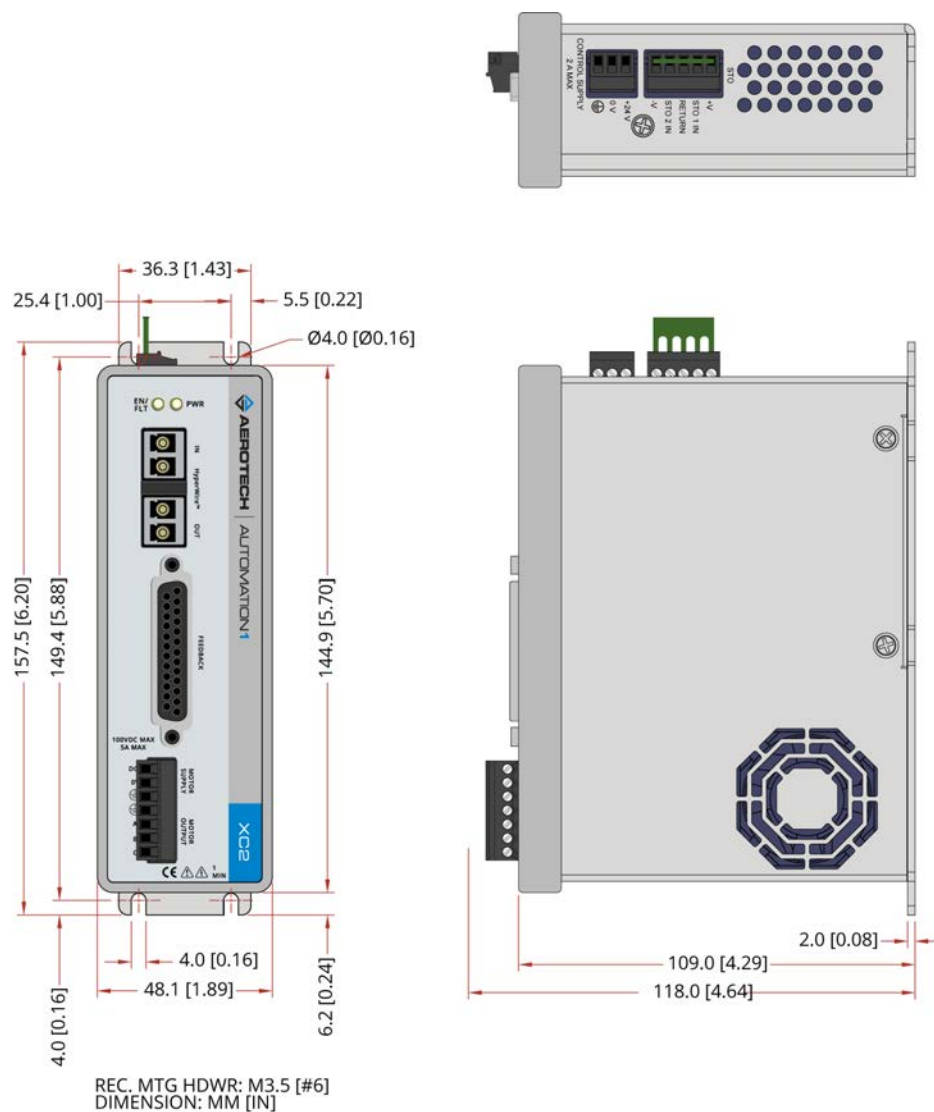
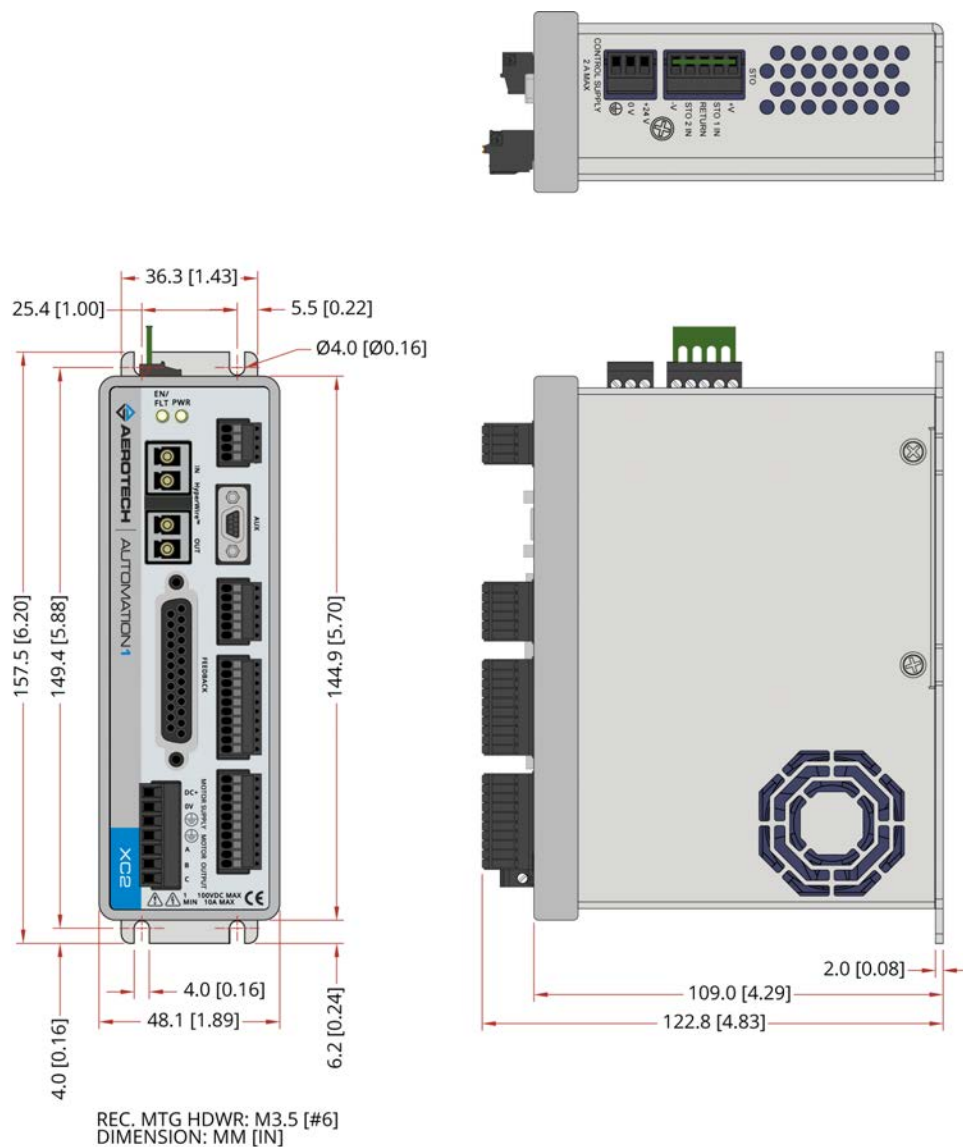


Figure 1-3: Dimensions



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. If you must operate this product above 2,000 m or below sea level, contact Aerotech, Inc.
Pollution	Pollution Degree 2 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	Firmware Revision	First Software Version	Last Software Version
XC2	-	6.04.000	Current

Chapter 2: Installation and Configuration

2.1. Input Power Connections

The XC2 has two DC 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 2.6](#) 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 XC2. The **+24V** input is connected to an internal fuse. Refer to [Table 5-2](#) for the internal fuse value and part number. For an isolated DC supply, connect **0V** to protective ground at the supply. Use twisted pair wiring to minimize radiated noise emissions (refer to [Figure 2-1](#)).

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

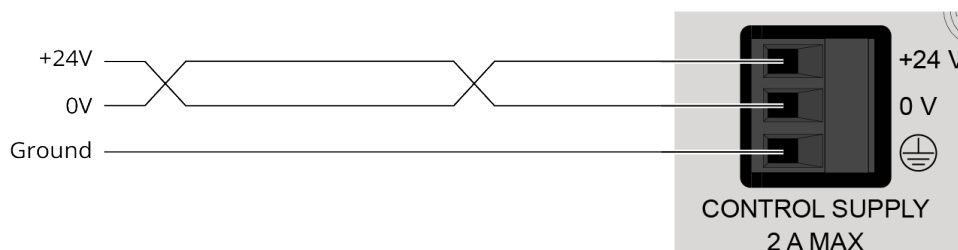


Figure 2-1: Control Supply Connections

Table 2-1: Control Supply Connector Wiring Specifications


Pin	Description	Recommended Wire Size
+24 V	24 VDC ($\pm 10\%$) Control Power Input (2 A max, 0.4 A typical without brake)	0.34 mm ² (#22 AWG)
0 V	Control Power Common Input	0.34 mm ² (#22 AWG)
	Protective Ground	0.34 mm ² (#22 AWG)

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

Type	Aerotech P/N	Third Party P/N	Screw Torque Value: N·m	Wire Size: mm ² [AWG]
3-Pin Terminal Block	ECK02456	Phoenix 1839610	0.22 - 0.25	2.5 - 0.05 [14-30]

2.1.2. Motor Supply Connector

Motor power is applied to the **DC+** and **0V** terminals of the XC2 Motor Supply connector. The **DC+** input is connected to an internal fuse. Refer to [Table 5-2](#) for the internal fuse value and part number. For an isolated DC supply, connect **0V** to protective ground at the supply. Use twisted pair wiring to minimize radiated noise emissions (refer to [Figure 2-2](#)).

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

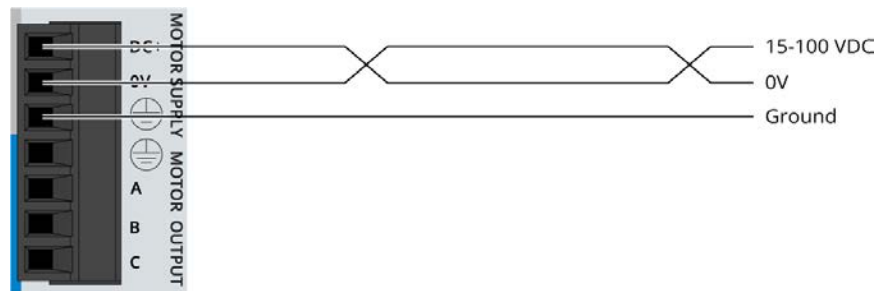


Figure 2-2: Motor Supply Connections

Table 2-3: Motor Supply Connector Wiring Specifications


Pin	Description	Recommended Wire Size
DC+	Motor Power Input (15-100 VDC)	0.5 mm ² (#20 AWG)
0 V	Motor Power Input Common	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 Party P/N	Screw Torque Value: Nm	Wire Size: mm ² [AWG]
7-Pin Terminal Block	ECK02457	Phoenix 1839678	0.22 - 0.25	2.5 - 0.05 [14-30]

2.1.3. Minimizing Conducted, Radiated, and System Noise for EMC/CE Compliance

NOTE: The XC2 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 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. Keep wire-run lengths to a minimum. For the AC power lines feeding the VDC Motor supply and VDC Control supply, place a line filter, such as Schaffner FN2070-10-06 (Aerotech# ECZ00284) between the VDC power supply's AC inputs and the AC power source.
4. Use the lowest motor voltage required by the application to reduce radiated emission.
5. Use a separate wire for each ground connection to the drive. Use the shortest possible wire length.

For additional XC2 system interconnection information, refer to [Section 2.6. System Interconnection](#).

2.2. Motor Power Output Connector



DANGER: Before you do maintenance to the equipment, disconnect the electrical power. Wait at least one (1) minute after removing the power supply before doing maintenance or an inspection. Otherwise, there is the danger of electric shock.

The XC2 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.](#)

The 7-pin terminal block style motor output connector is located on the front panel. The pinout for this connector is shown in [Table 2-5.](#)

Table 2-5: Motor Power Output Connector Pinout


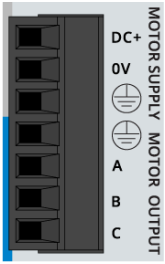
Pin	Description	Recommended Wire Size	Connector
	Earth Ground to Motor	0.5 mm ² (#20 AWG)	
A	Brushless Phase A Motor Lead DC Brush + Stepper	0.5 mm ² (#20 AWG)	
B	Brushless Phase B Motor Lead Stepper	0.5 mm ² (#20 AWG)	
C	Brushless Phase C Motor Lead DC Brush - Stepper Return	0.5 mm ² (#20 AWG)	

Table 2-6: Mating Connector Part Numbers for the Motor Power Output Connector

Type	Aerotech P/N	Third Party P/N	Screw Torque Value: Nm	Wire Size: mm ² [AWG]
7-Pin Terminal Block	ECK02457	Phoenix 1839678	0.22 - 0.25	2.5 - 0.05 [14-30]

2.2.1. Brushless Motor Connections

The configuration shown in [Figure 2-3](#) is an example of a typical brushless motor connection.

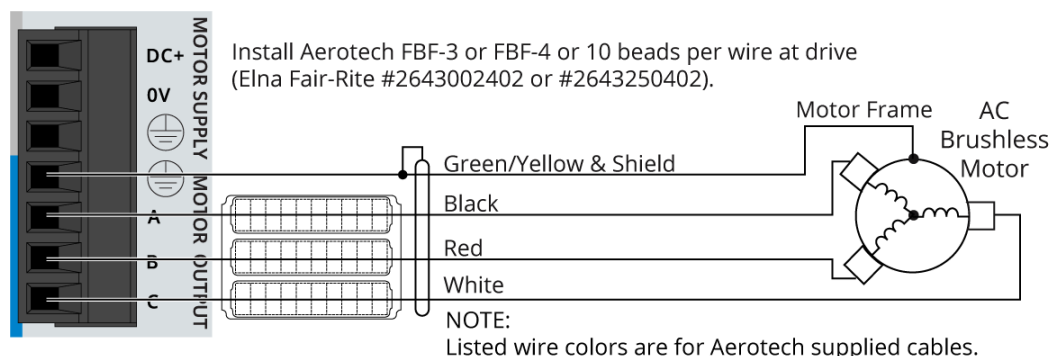


Figure 2-3: Brushless Motor Configuration

Table 2-7: 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

Refer to the Motor Phasing Calculator in the Configuration Manager for motor, Hall, and encoder phasing.

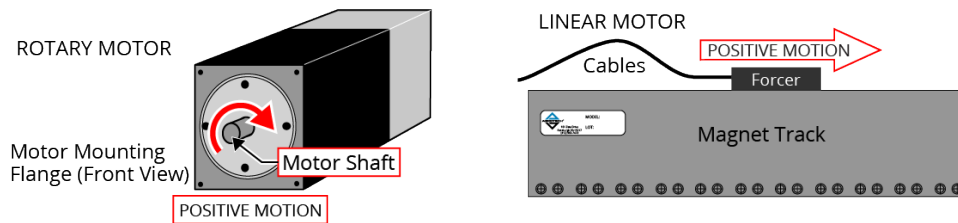


Figure 2-4: Positive Motor Direction

Feedback Monitoring

The state of the encoder and Hall-effect device signals can be observed in the Status Utility.

A “--” for the given Hall input indicates zero voltage or logic low, where “ON” indicates 5V or logic high.

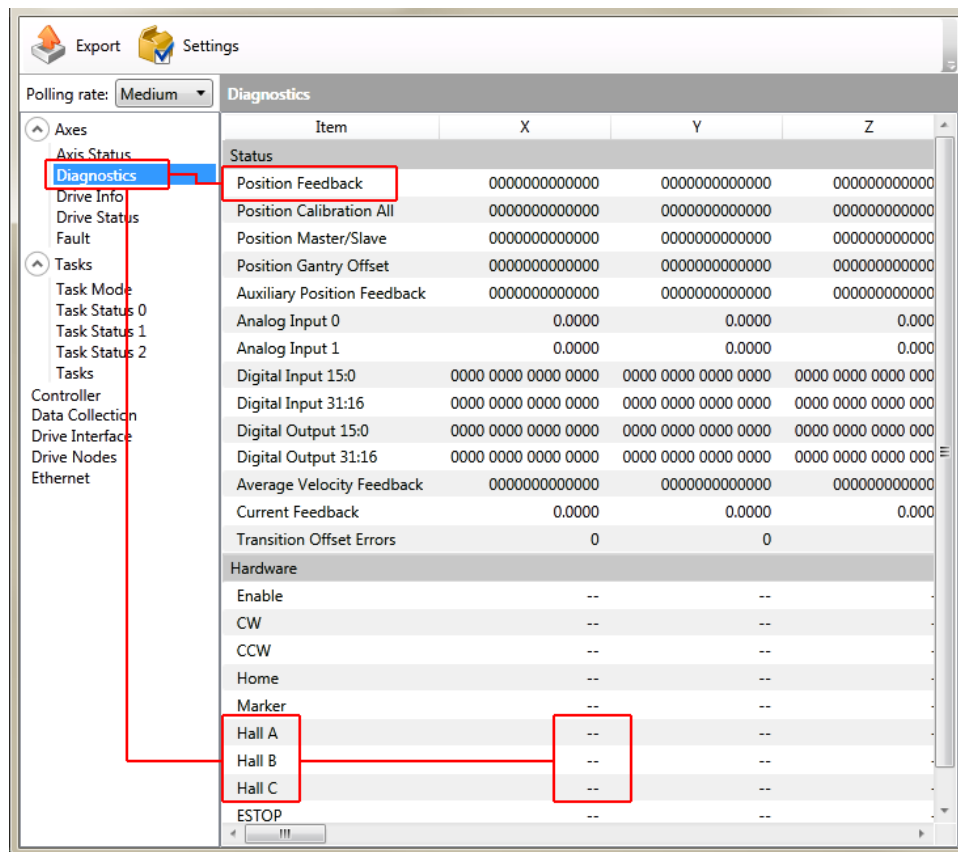


Figure 2-5: Encoder and Hall Signal Diagnostics

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 2-6](#). 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 2-6](#)). Wave forms are shown while moving the motor in the positive direction.

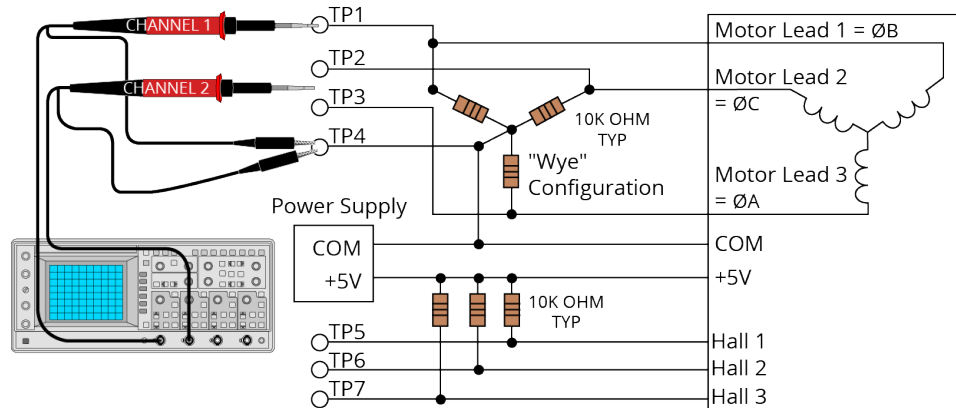


Figure 2-6: Brushless Motor Phasing Oscilloscope Example

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 2-7](#)). Use the CommutationOffset parameter to correct for Hall signal misalignment.

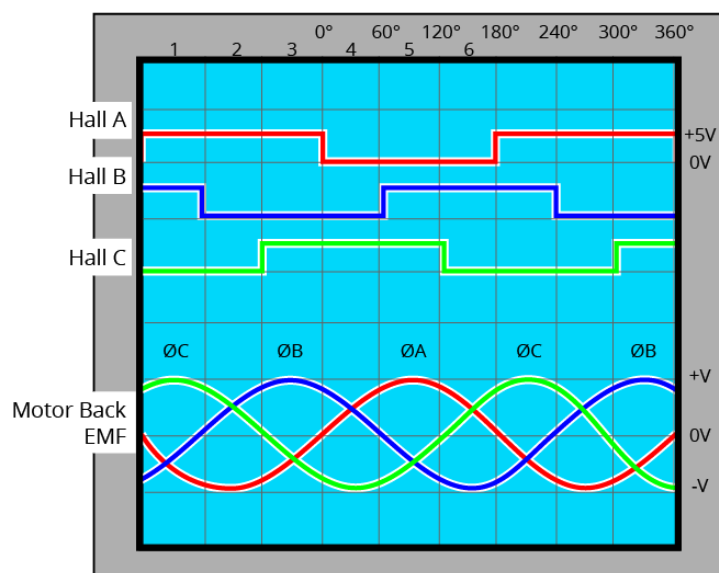


Figure 2-7: Brushless Motor Phasing Goal

2.2.2. DC Brush Motor Connections

The configuration shown in [Figure 2-8](#) is an example of a typical DC brush motor connection. Refer to [Section 2.2.2.1](#) for information on motor phasing.

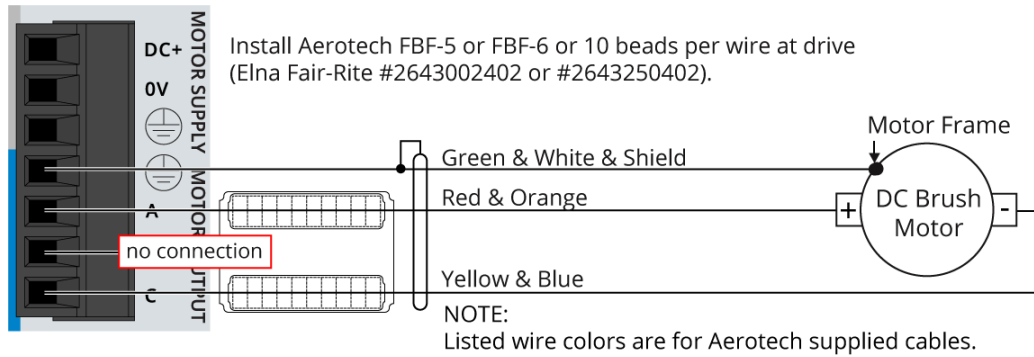


Figure 2-8: DC Brush Motor Configuration

Table 2-8: 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.
 (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.

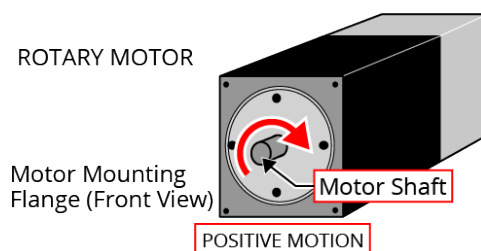


Figure 2-9: Positive Motor Direction

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 XC2. Connect the motor lead from the negative lead of the voltmeter to the ØC motor terminal on the XC2.

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 2-10](#) 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.

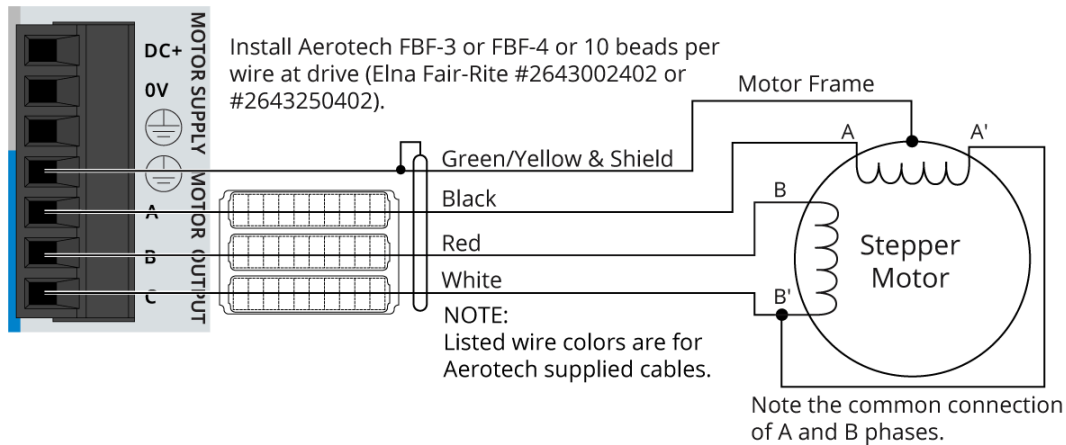


Figure 2-10: Stepper Motor Configuration

Table 2-9: 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. If an encoder is not being used, phasing is not necessary. With an encoder, test for proper motor phasing by running a positive motion command.

If there is a positive scaling factor (determined by the CountsPerUnit parameters) and the motor moves in a clockwise direction, as viewed looking at the motor from the front mounting flange, the motor is phased correctly. If the motor moves in a counterclockwise direction, swap the motor leads and re-run the command.

Proper motor phasing is important because the end of travel (EOT) limit inputs are relative to motor rotation.

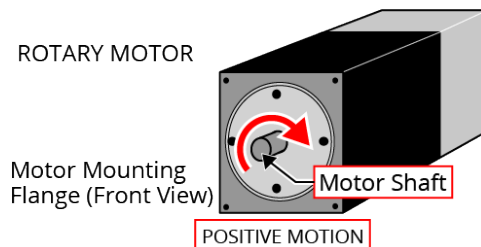


Figure 2-11: Positive Motor Direction

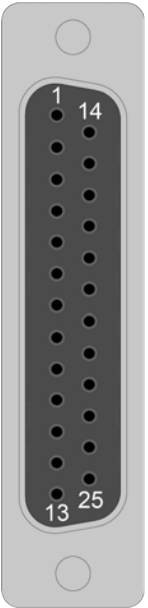
For Aerotech-supplied systems, the motor, encoder and Hall sensors are correctly configured and connection adjustments are not necessary.

NOTE: After the motor has been phased, use the ReverseMotionDirection parameter to change the direction of “positive” motion.

2.3. Feedback Connector

The Feedback connector (a 25-pin, D-style connector) has inputs for an encoder, limit switches, Hall-effect devices, motor over-temperature device, 5 V encoder and limit power, and optional brake connections. The connector pin assignment is shown in [Table 2-10](#) with detailed connection information in the following sections.

Table 2-10: Feedback Connector Pinout

Pin #	Description	In/Out/Bi	Connector
1	Reserved	Input	
2	Motor Over Temperature Thermistor	Input	
3	+5V Power ⁽¹⁾	Output	
4	Plug and Play Serial Data (for Aerotech stages only)	N/A	
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⁾	Output	
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 2-11: 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. The PrimaryFeedbackType [A3200: PositionFeedbackType or VelocityFeedbackType] parameter configures the XC2 to accept Square Wave encoder signals ([Section 2.3.1.1.](#)), Absolute encoder signals ([Section 2.3.1.2.](#)), or, as permitted by the multiplier option, Sine Wave encoder signals ([Section 2.3.1.3.](#)).

You cannot use a sine wave encoder with the -MX1 multiplier option as an input to the PSO. The -MX1 option does not generate emulated quadrature signals.

Refer to [Section 2.3.1.4.](#) for encoder feedback phasing.

Refer to [Section 3.2.](#) for the auxiliary encoder input on the AUX connector.

Table 2-12: Multiplier Options

Option	Primary Encoder Accepts...	Auxiliary Encoder Accepts...
-MX0	Square Wave or Absolute encoders	Square Wave encoders
-MX1	Sine Wave, Square Wave, or Absolute encoders	Square Wave encoders

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

Table 2-13: Primary Encoder Input Pins on the Feedback Connector

Pin #	Description	In/Out/Bi
3	+5V Power ⁽¹⁾	Output
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⁾	Output
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 XC2 accepts RS-422 square wave encoder signals. The XC2 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 2-14: Square Wave Encoder Specifications

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

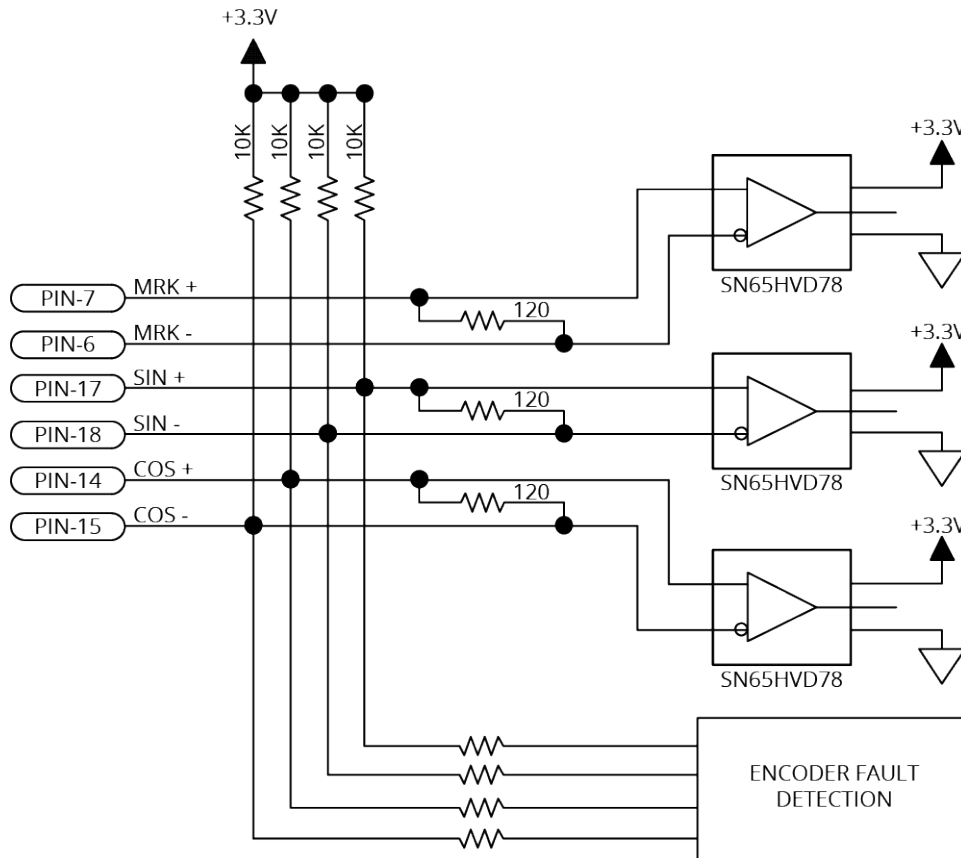


Figure 2-12: Square Wave Encoder Schematic (Feedback Connector)

2.3.1.2. Absolute Encoder

The XC2 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. Refer to [Figure 2-13](#) 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.

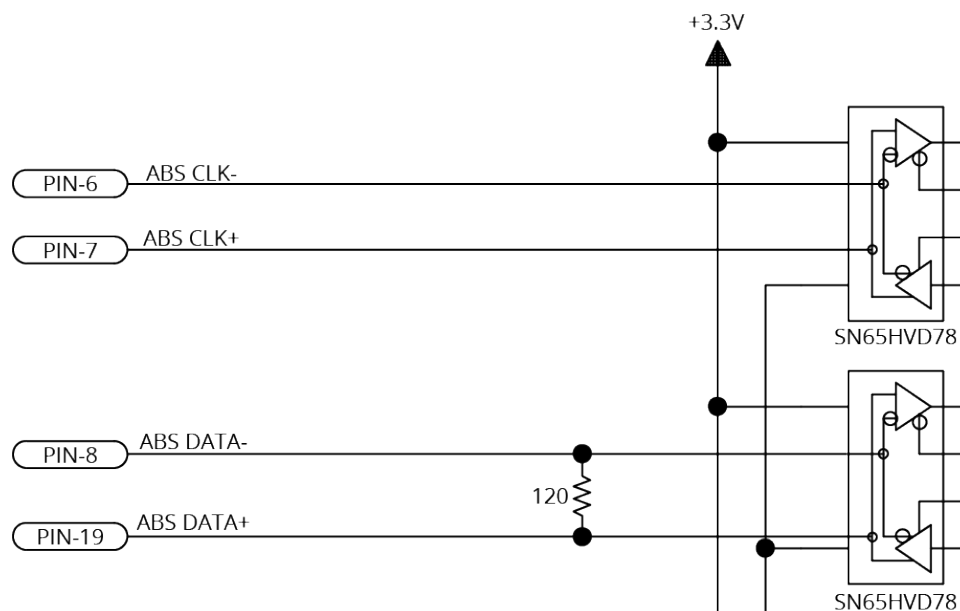


Figure 2-13: Absolute Encoder Schematic (Feedback Connector)

2.3.1.3. Sine Wave Encoder [-MX1 Option]

The Sine Wave Encoder option supplies 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 the Feedback Tuning tab of Digital Scope to automatically 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 a sine wave encoder with the -MX1 multiplier option as an input to the PSO. The -MX1 option does not generate emulated quadrature signals.

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 2-15: Analog Encoder Specifications

Specification	Value
Input Frequency (max)	450 kHz
Input Amplitude ⁽¹⁾	0.6 to 1.75 Vpk-pk
Interpolation Factor (max)	16,384
Input Common Mode	1.5 to 3.5 VDC

(1) Measured as SIN(+) - SIN(-) or COS(+) - COS(-)

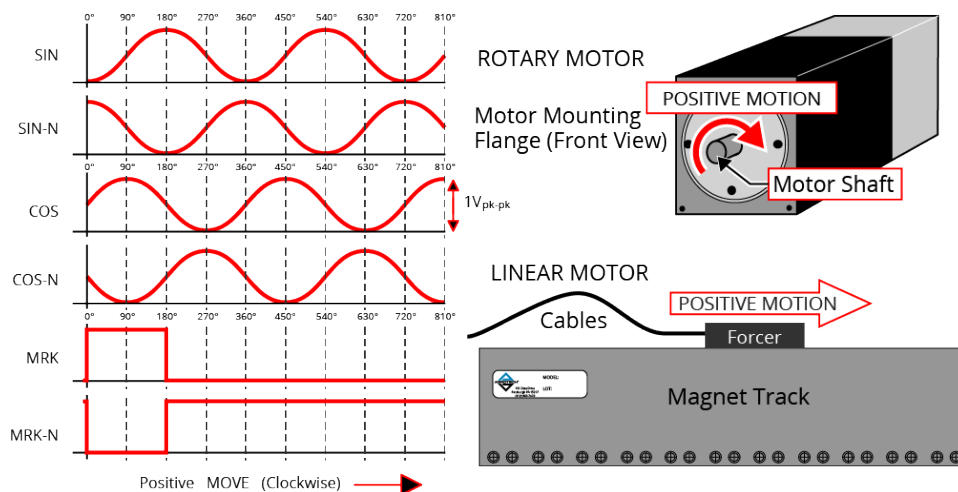


Figure 2-14: Analog Encoder Phasing Reference Diagram

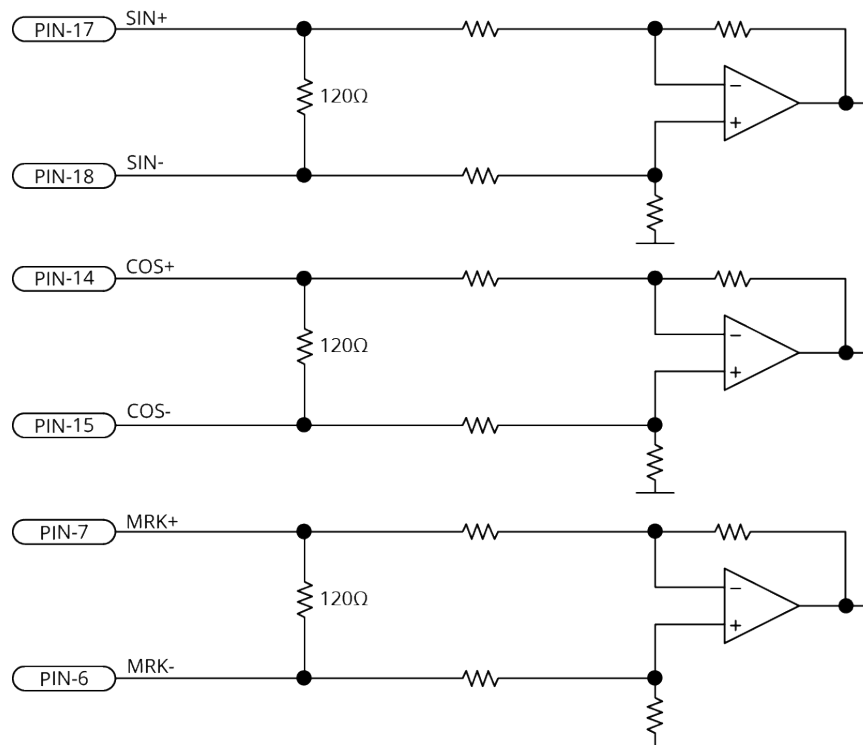


Figure 2-15: Analog Encoder Schematic (Feedback Connector)

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 2-16](#) 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 2-17](#)). The Motor Phasing Calculator in the Configuration Manager can be used to determine proper encoder polarity.

For dual loop systems, the velocity feedback encoder is displayed in the diagnostic display ([Figure 2-17](#)).

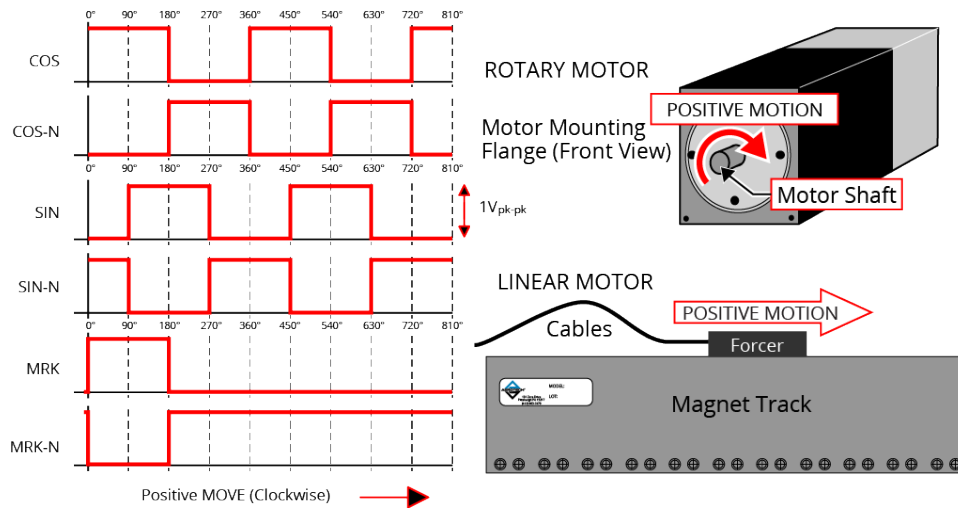
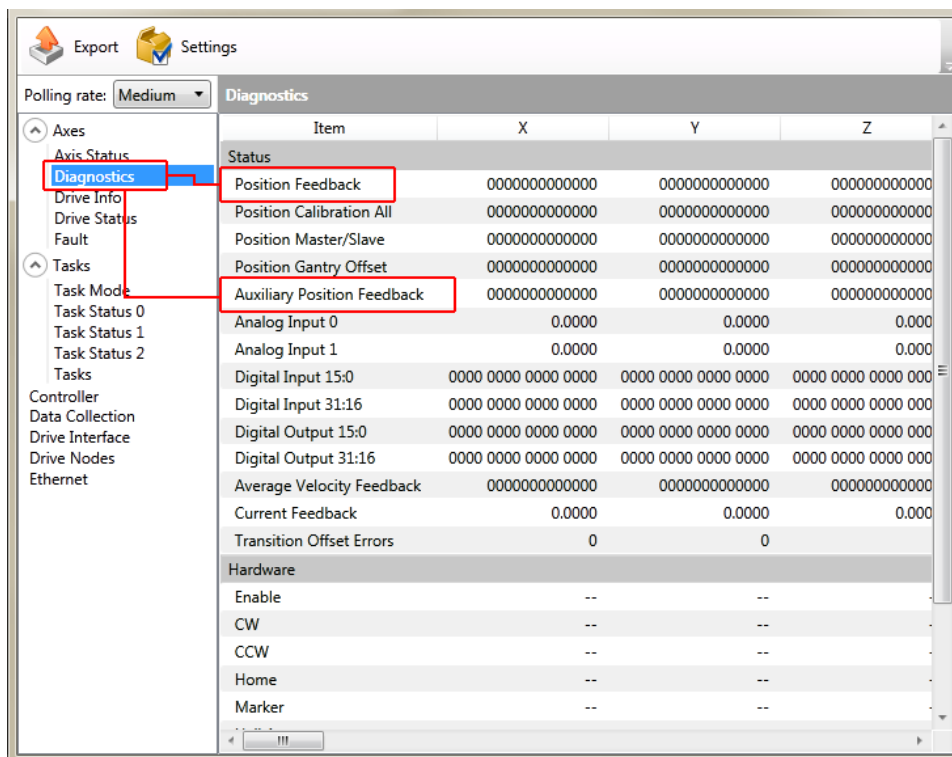


Figure 2-16: Encoder Phasing Reference Diagram (Standard)

NOTE: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in [Figure 2-16](#).



Export Settings

Polling rate: Medium

Diagnostics

Item	X	Y	Z
Status			
Position Feedback	000000000000	000000000000	000000000000
Position Calibration All	000000000000	000000000000	000000000000
Position Master/Slave	000000000000	000000000000	000000000000
Position Gantry Offset	000000000000	000000000000	000000000000
Auxiliary Position Feedback	000000000000	000000000000	000000000000
Analog Input 0	0.0000	0.0000	0.000
Analog Input 1	0.0000	0.0000	0.000
Digital Input 15:0	0000 0000 0000 0000	0000 0000 0000 0000	0000 0000 0000 000
Digital Input 31:16	0000 0000 0000 0000	0000 0000 0000 0000	0000 0000 0000 000
Digital Output 15:0	0000 0000 0000 0000	0000 0000 0000 0000	0000 0000 0000 000
Digital Output 31:16	0000 0000 0000 0000	0000 0000 0000 0000	0000 0000 0000 000
Average Velocity Feedback	000000000000	000000000000	000000000000
Current Feedback	0.0000	0.0000	0.000
Transition Offset Errors	0	0	
Hardware			
Enable	--	--	
CW	--	--	
CCW	--	--	
Home	--	--	
Marker	--	--	

Figure 2-17: 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 2-16: Hall-Effect Feedback Pins on the Feedback Connector

Pin #	Description	In/Out/Bi
3	+5V Power ⁽¹⁾	Output
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⁾	Output
20	Signal Common	N/A
21	Signal Common	N/A

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

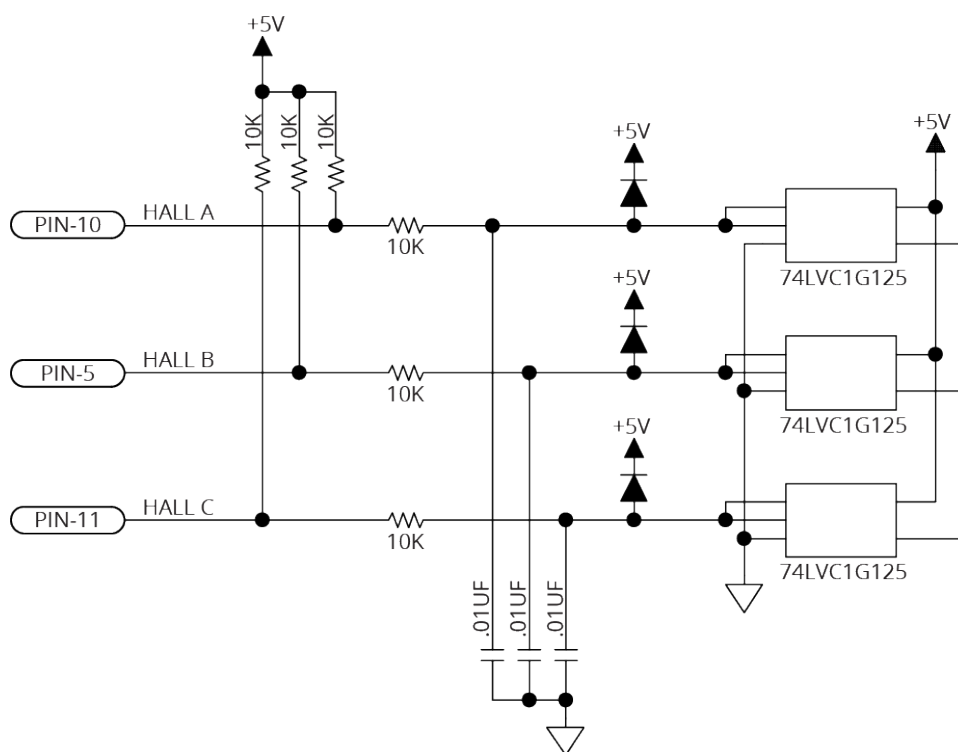


Figure 2-18: Hall-Effect Inputs Schematic (Feedback Connector)

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 k Ω . The circuit includes a 12 k Ω internal pull-up resistor which corresponds to a trip voltage of +0.52 V.

Table 2-17: Thermistor Input Pin on the Feedback Connector

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

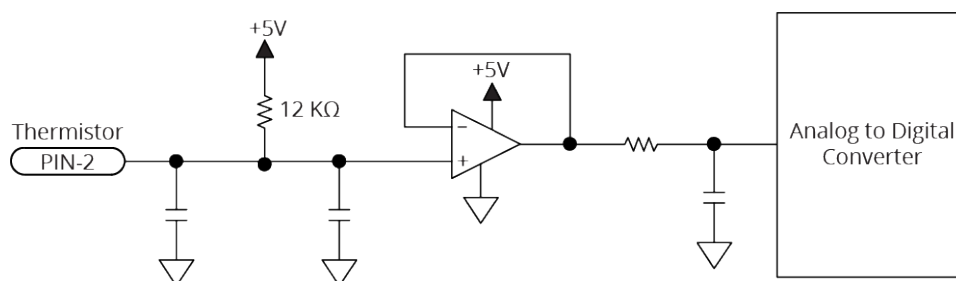


Figure 2-19: Thermistor Input Schematic (Feedback Connector)

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 2-18: Encoder Fault Input Pin on the Feedback Connector

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

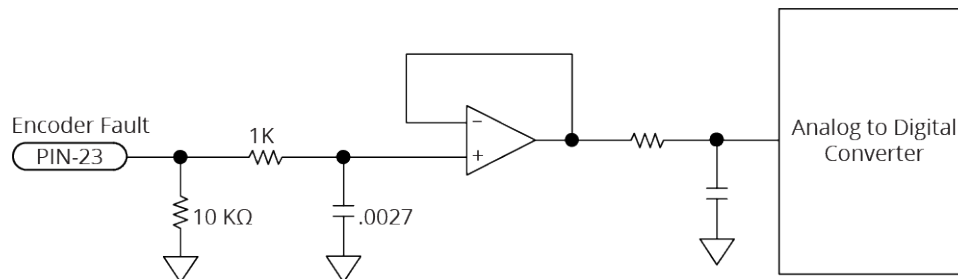


Figure 2-20: Encoder Fault Input Schematic (Feedback Connector)

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 2-23](#)).

Table 2-19: 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	Output
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 2-21](#) shows the possible wiring configurations for normally-open and normally-closed switches and the parameter setting to use for each configuration. Use NPN-type normally-closed limit switches (Active High) to provide fail-safe behavior in the event of an open circuit.

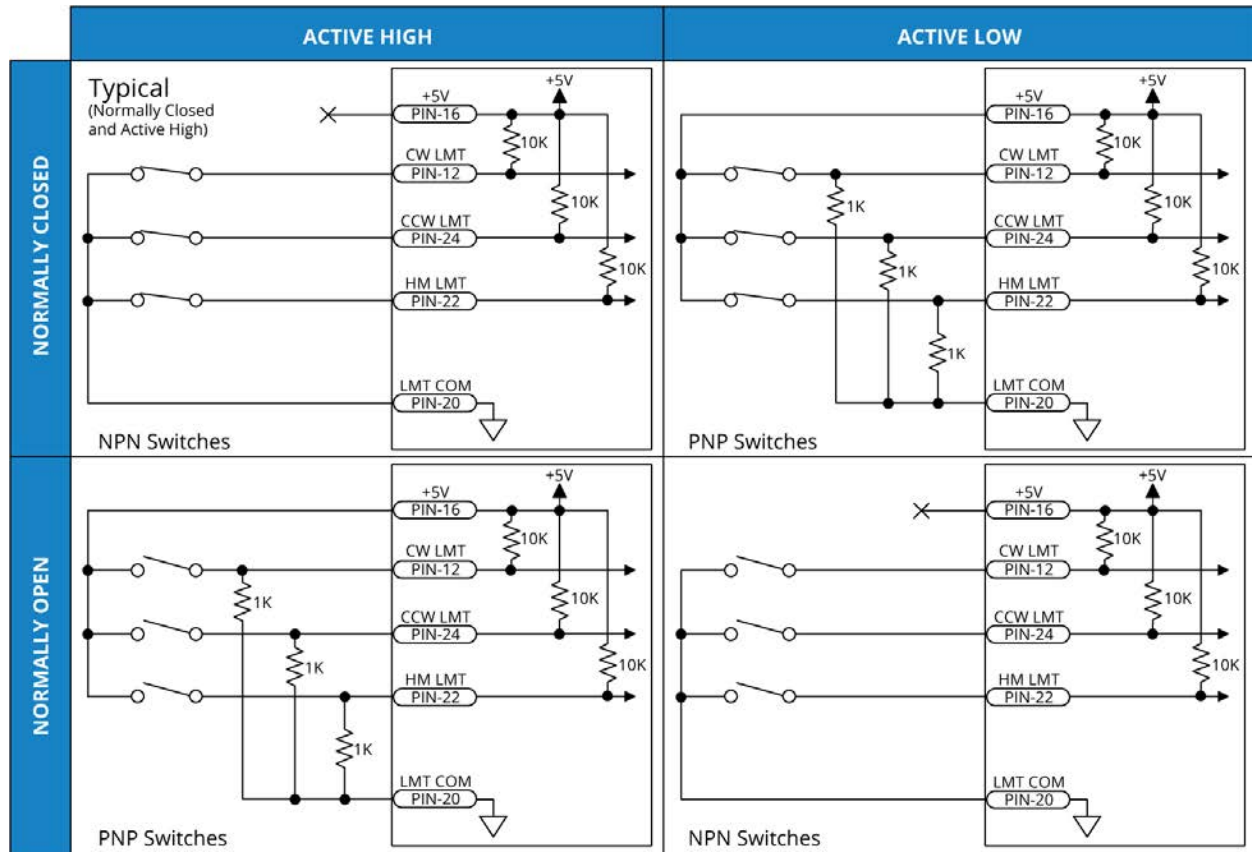


Figure 2-21: End of Travel and Home Limit Input Connections

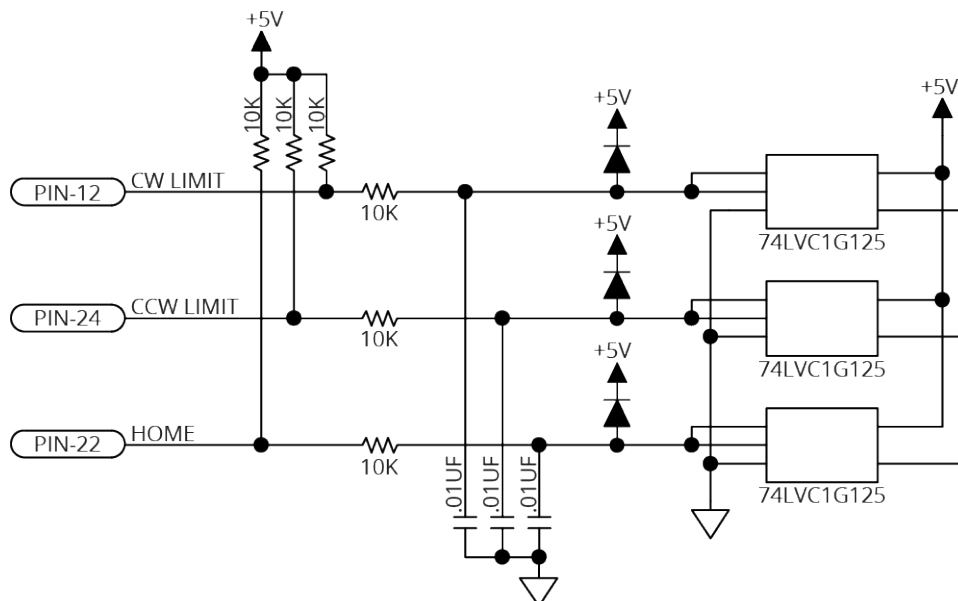


Figure 2-22: End of Travel and Home Limit Input Schematic (Feedback Connector)

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 2-23](#)).

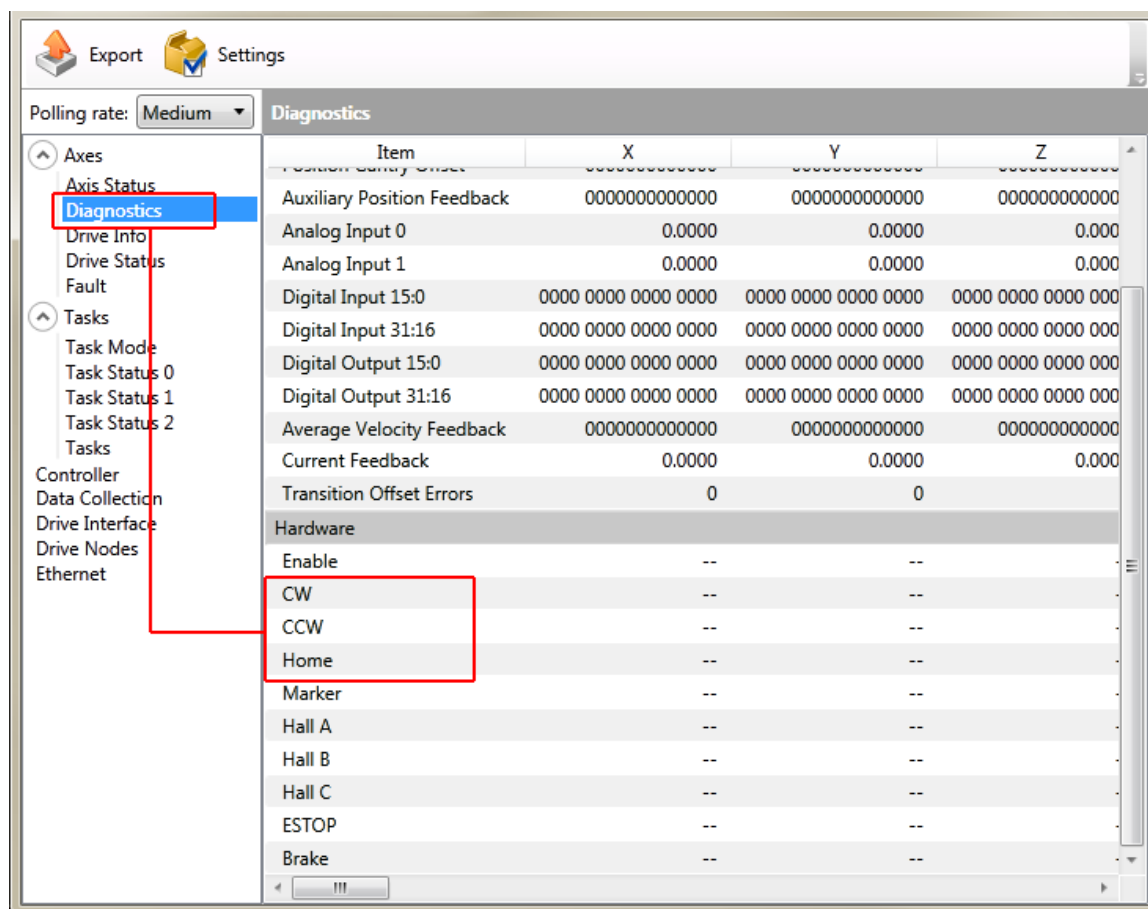


Figure 2-23: End of Travel and Home Limit Input Diagnostic Display

2.3.6. Brake Outputs

The XC2 has a dedicated brake control circuit. The brake is typically configured for automatic control using the BrakeSetup [A3200: EnableBrakeControl] parameter.

The brake output can also be manually controlled if you use the BRAKE command.

Table 2-20: Brake Output Pins on the Feedback Connector

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

Table 2-21: Brake Control Specifications

Specification	Value
Maximum Voltage	24 VDC
Maximum Current	.5 A

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

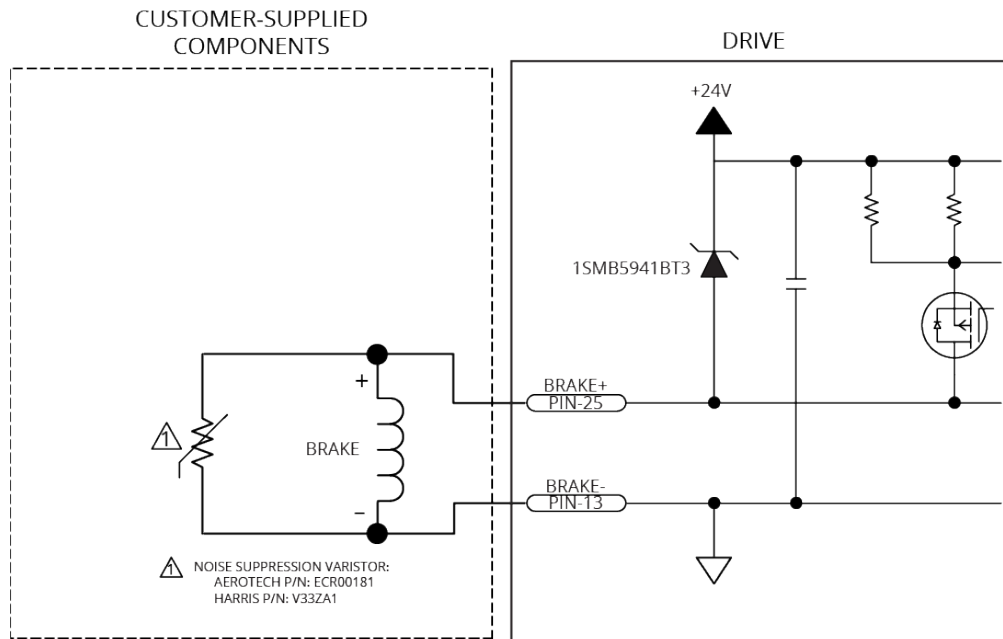


Figure 2-24: Brake Connected to the 25-Pin Feedback Connector (Typical)

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 XC2 to produce motion. Each STO input is opto-isolated and accepts 24V levels directly without the need for external current limiting resistors.

NOTE: The XC2 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.

NOTE: The application circuit and its suitability for the desired safety level is the sole responsibility of the user of XC2.



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 2-22: 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		
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		

Table 2-23: Mating Connector Part Numbers for the STO Connector

Description	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: AWG [mm ²]
5-Pin Terminal Block	ECK02393	1827622	0.22 - 0.25	2.5 - 0.05 [14-30]

Table 2-24: 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 2-25 shows one safety device connected to multiple XC2s in a parallel.



WARNING: The XC2 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.

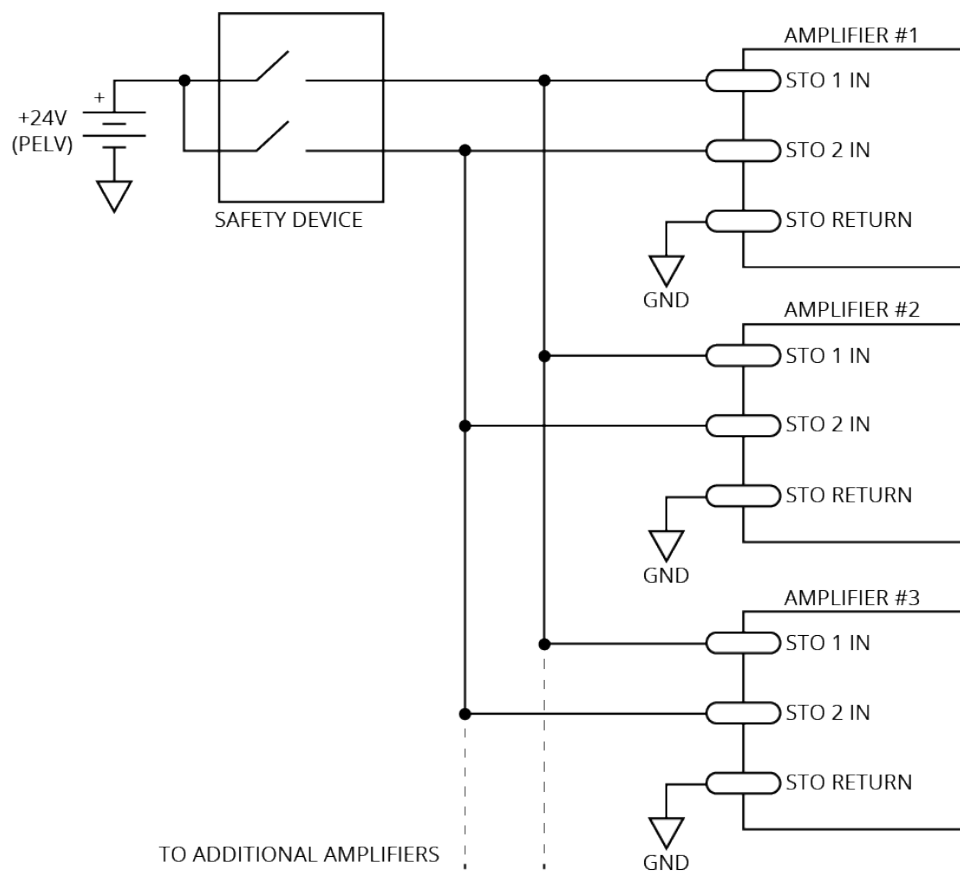


Figure 2-25: Typical Configuration

2.4.1. STO Standards

Table 2-25 describes and specifies the safety requirements at the system level for the Safe Torque Off (STO) feature of the XC2. This assumes that diagnostic testing is performed according to Section 2.4.4. and Table 2-26.

Table 2-25: 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 2-26: STO Standards Data

Standard	Value
EN ISO 13849-1:2015	MTTF _D > 1000 years, DC _{AVG} 99% Maximum PL e, Category 4
EN ISO 13849-1:2015 EN/IEC 61508	Lifetime = 20 years No proof test required Interval for manual STO test: <ul style="list-style-type: none"> Once per year for SIL2/PL d/category 3 Once per three months for SIL3/PL e/category 3 Once per day for SIL3/PL e/category 4
EN/IEC 61508	SIL3 PFH < 3 FIT 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 XC2 from being able to produce motion.

The XC2 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 XC2 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 XC2 will tolerate short diagnostic pulses on the STO 1+ and STO 2+ inputs. The parameter "STOPulseFilter" specifies the maximum pulse width that the XC2 will ignore.

To resume normal operation, apply power to both STO 1 and STO 2 inputs and clear the Emergency Stop software fault using the Fault Acknowledge button or command. 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 XC2's STO inputs. Connect the ESTOP signal directly to a digital input, in addition to the external timer, to allow the XC2 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 2-27: STO Signal Delay

	Value
STO Time Delay	450-550 msec

Table 2-28: 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 XC2's STO inputs. This is typically done by pressing the emergency stop switch. The XC2 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 XC2 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 2-26](#).

Table 2-29: 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

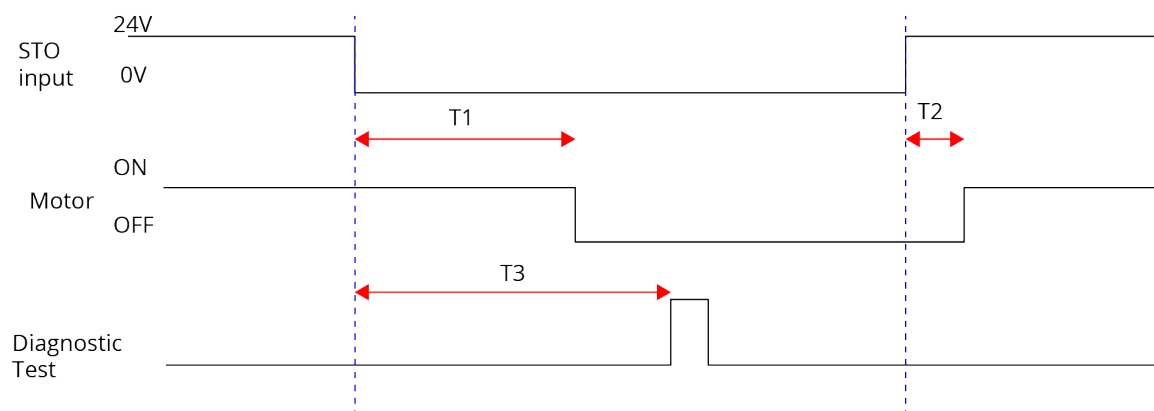


Figure 2-26: STO Timing

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. HyperWire Interface

The HyperWire bus is the high-speed communications connection to the XC2 operating at 2 gigabits per second. The PC sends all command and configuration information through the HyperWire bus.

Table 2-30: HyperWire Card Part Number

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

Table 2-31: 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

2.6. System Interconnection

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

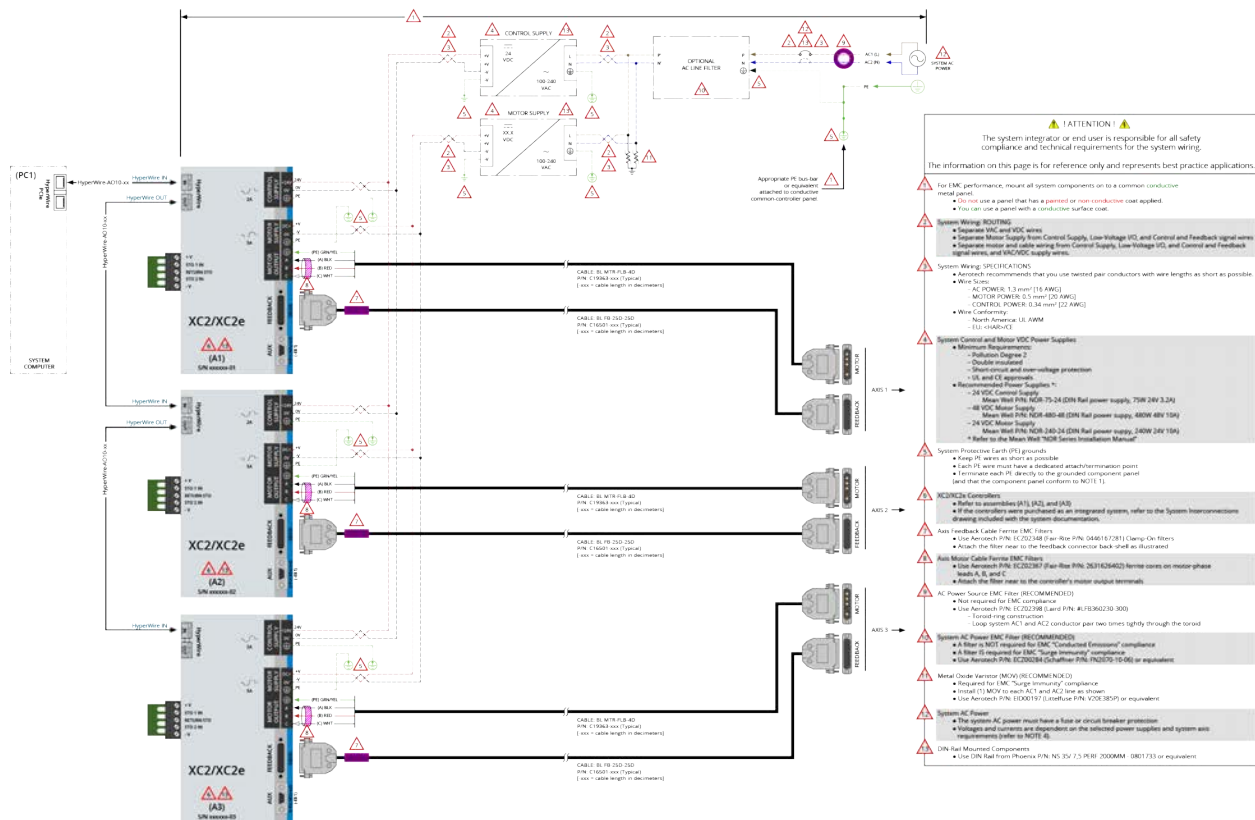


Figure 2-27: System Interconnection Drawing (Best Practice)

2.7. PC Configuration and Operation Information

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

Chapter 3: -EB1 I/O Option Board

The -EB1 I/O option board has 8 digital inputs, 8 digital outputs, 1 analog input, 1 analog output, and PSO outputs.

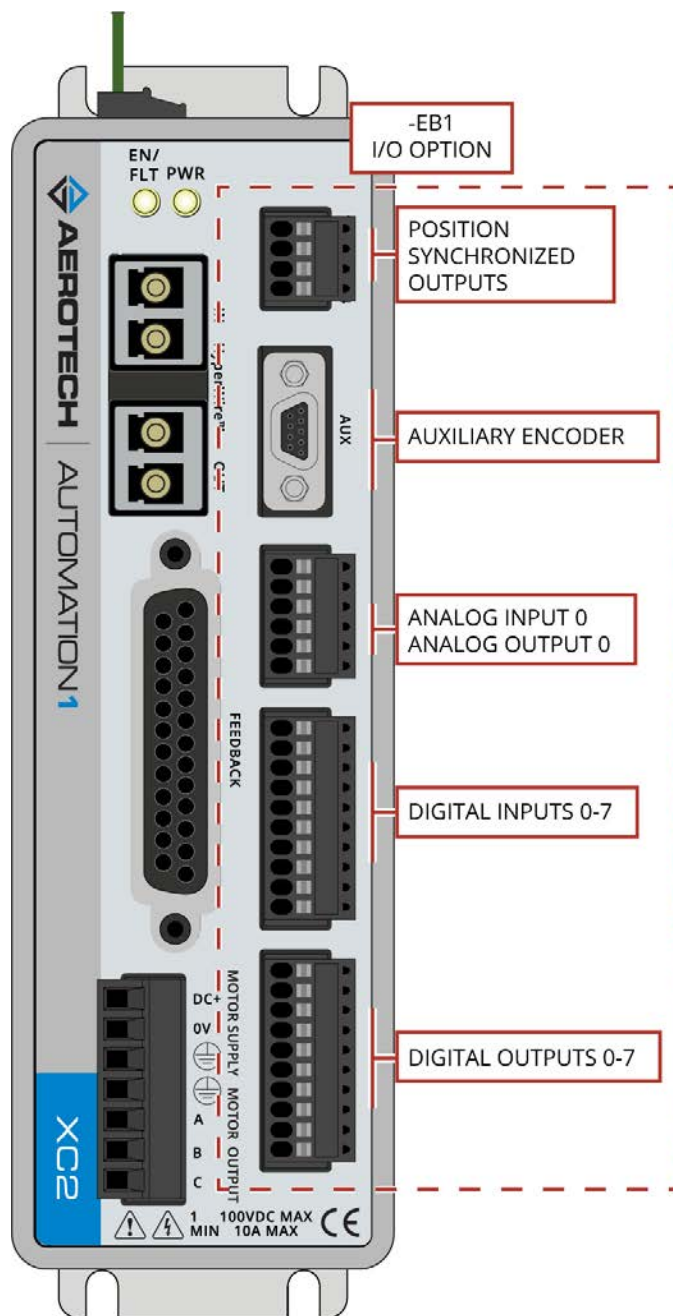


Figure 3-1: XC2 with -EB1 I/O Option Board Connectors

3.1. Position Synchronized Output (PSO) Interface [-EB1]

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

You cannot use a sine wave encoder with the -MX1 multiplier option as an input to the PSO. The -MX1 option does not generate emulated quadrature signals.

Table 3-1: PSO Specifications [-EB1]

Specification		Value
Output	TTL	5 V, 50 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 3-2: PSO Interface Connector Pinout [-EB1]

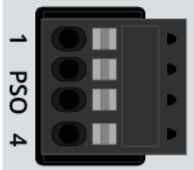
Pin #	Description	In/Out/Bi	Connector
1	PSO Output+	Output	
2	PSO Output-	Output	
3	PSO Output (TTL)	Output	
4	Ground	N/A	

Table 3-3: 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.

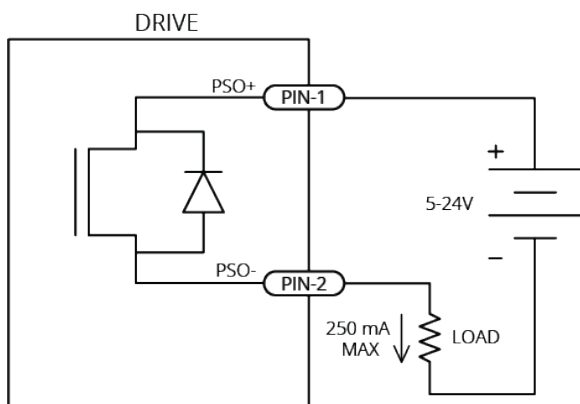


Figure 3-2: PSO Output Sources Current

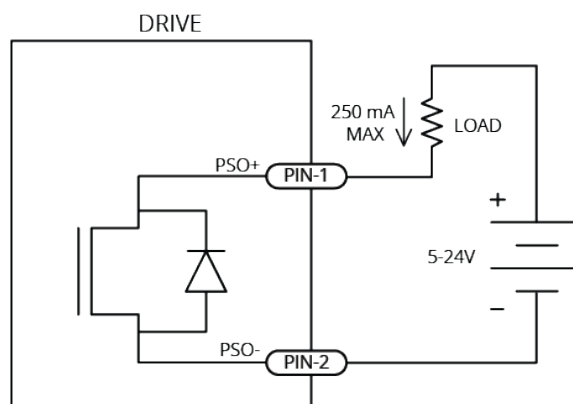


Figure 3-3: PSO Output Sinks Current

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.

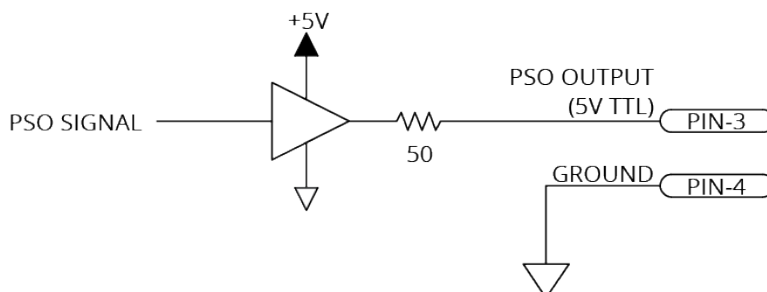


Figure 3-4: PSO TTL Outputs Schematic

3.2. Auxiliary Encoder Input [-EB1]

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

The Auxiliary Encoder input supports square wave encoder types.

With the -MX0 option, you can configure the Auxiliary Encoder Interface as an output that will transmit encoder signals for external use. Use the EncoderDivider parameter to configure the Sine \pm and Cosine \pm connector pins as RS-422 outputs.

Refer to the Help file for more information.

Invalid or missing signals will cause the XC2 to generate a feedback fault when the axis is enabled. Use twisted-pair wiring for the highest performance and noise immunity.

Table 3-4: Auxiliary Encoder RS-422 Specifications

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

Table 3-5: Auxiliary Encoder Connector Pinout

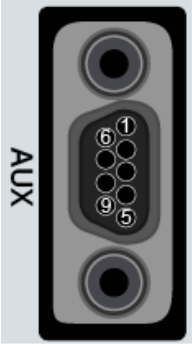
Pin#	Description	In/Out/Bi	Connector
1	Auxiliary Marker -	Input	
2	Auxiliary Cosine+	Bidirectional	
3	Auxiliary Cosine-	Bidirectional	
4	Auxiliary Sine+	Bidirectional	
5	Encoder Cable Shield	N/A	
6	Auxiliary Marker +	Input	
7	+5 Volt (500 mA max)	Output	
8	Signal Common	N/A	
9	Auxiliary Sine-	Bidirectional	

Table 3-6: Mating Connector Part Numbers for the AUX Connector

Adapter Cable	Aerotech P/N	Third Party P/N
9-Pin Standard D-style	C20931	N/A
25-Pin Standard D-style	C20932	N/A
Flying Leads	ECZ01343	Molex 83421-9042

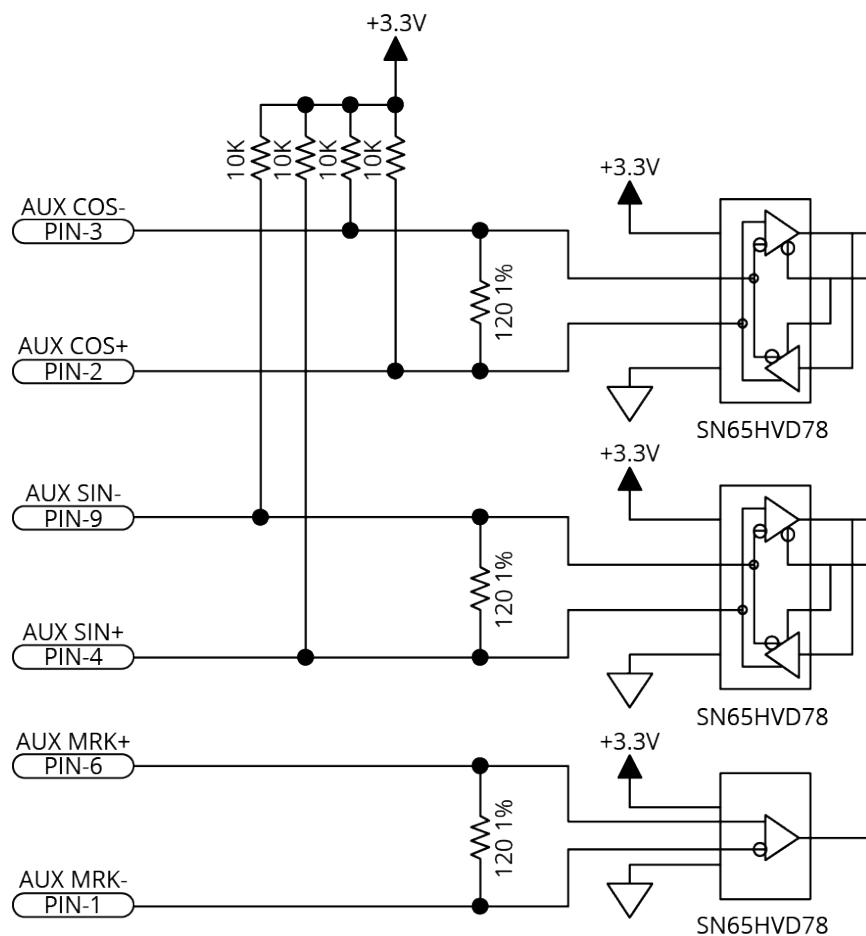


Figure 3-5: Auxiliary Encoder Interface

3.3. Analog I/O [-EB1]

The Analog I/O connector has one differential analog input and one analog output.

Table 3-7: AI/O Connector Pinout [-EB1]

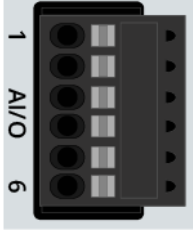
Pin#	Description	In/Out/Bi	Connector
1	+5 V	Output	
2	Analog Input 0+	Input	
3	Analog Input 0-	Input	
4	Ground	N/A	
5	Ground	N/A	
6	Analog Output 0	Output	

Table 3-8: Mating Connector Part Numbers for the Analog I/O Connector [-EB1]

Type	Aerotech P/N	Third Party P/N	Wire Size: mm ² [AWG]
6-Pin Terminal Block	ECK02405	Phoenix 1704755	0.5 - 0.14 [20-26]

3.3.1. Analog Input (Differential) [-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 3-6](#).

Table 3-9: Differential Analog Input Specifications [-EB1]

Specification	Value
(AI+) - (AI-)	+10 V to -10 V ⁽¹⁾
Resolution (bits)	16 bits
Input Impedance	1 M Ω

1. Signals outside of this range may damage the input

Table 3-10: Analog Input Pins on the Analog I/O Connector [-EB1]

Pin#	Description	In/Out/Bi
1	+5 V	Output
2	Analog Input 0+	Input
3	Analog Input 0-	Input
4	Ground	N/A

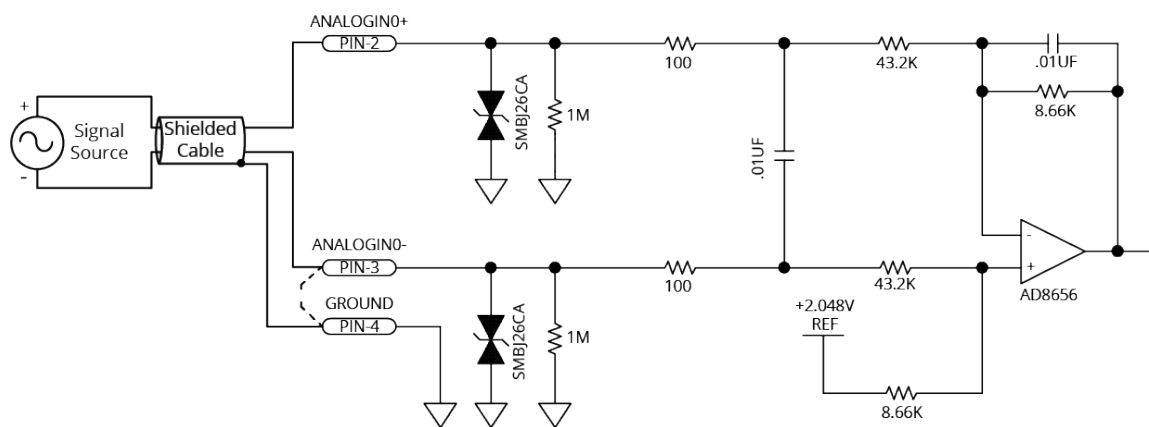


Figure 3-6: Analog Input Schematic [-EB1]

3.3.2. Analog Output 0 [-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 Pins on the Analog I/O Connector [-EB1]

Pin#	Description	In/Out/Bi
5	Ground	N/A
6	Analog Output 0	Output

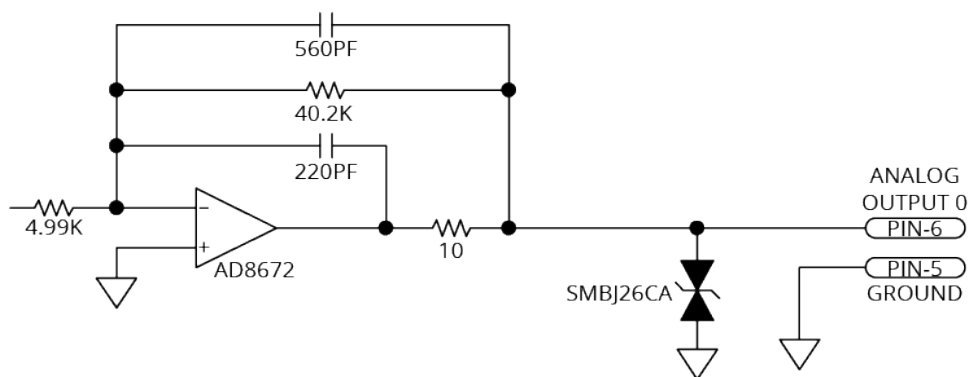


Figure 3-7: Analog Output Schematic [-EB1]

3.4. 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 3-9](#).

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 3-10](#).

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

Table 3-13: Digital Input Specifications [-EB1]

Input Voltage	Approximate Input Current	Turn On Time	Turn Off Time
+5 V to +24 V	6 mA	10 μ s	43 μ s

Table 3-14: Digital Input Connector Pinout [-EB1]


Pin#	Description	In/Out/Bi	Connector
1	Input Common for Inputs 0-4	N/A	
2	Input 0 (Optically-Isolated)	Input	
3	Input 1 (Optically-Isolated)	Input	
4	Input 2 (Optically-Isolated)	Input	
5	Input 3 (Optically-Isolated)	Input	
6	Input Common for Inputs 4-7	N/A	
7	Input 4 (Optically-Isolated)	Input	
8	Input 5 (Optically-Isolated)	Input	
9	Input 6 (Optically-Isolated)	Input	
10	Input 7 (Optically-Isolated)	Input	

Table 3-15: Mating Connector Part Numbers for the Digital Input 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]

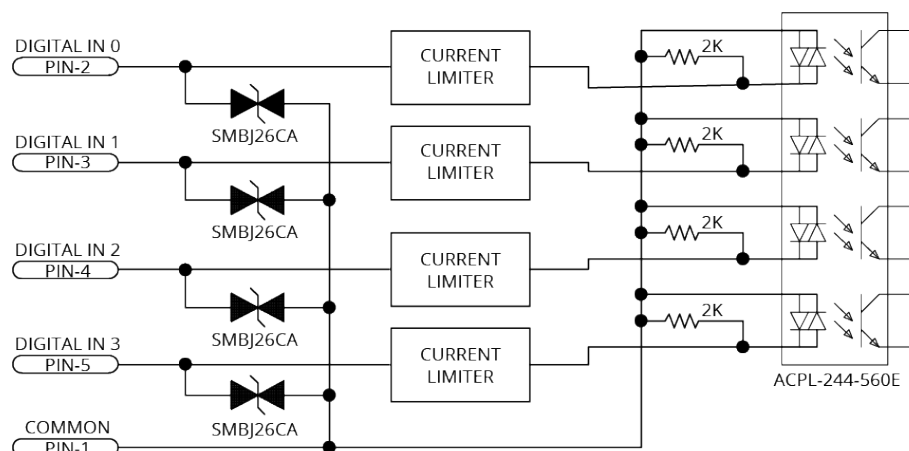


Figure 3-8: Digital Inputs Schematic [-EB1]

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

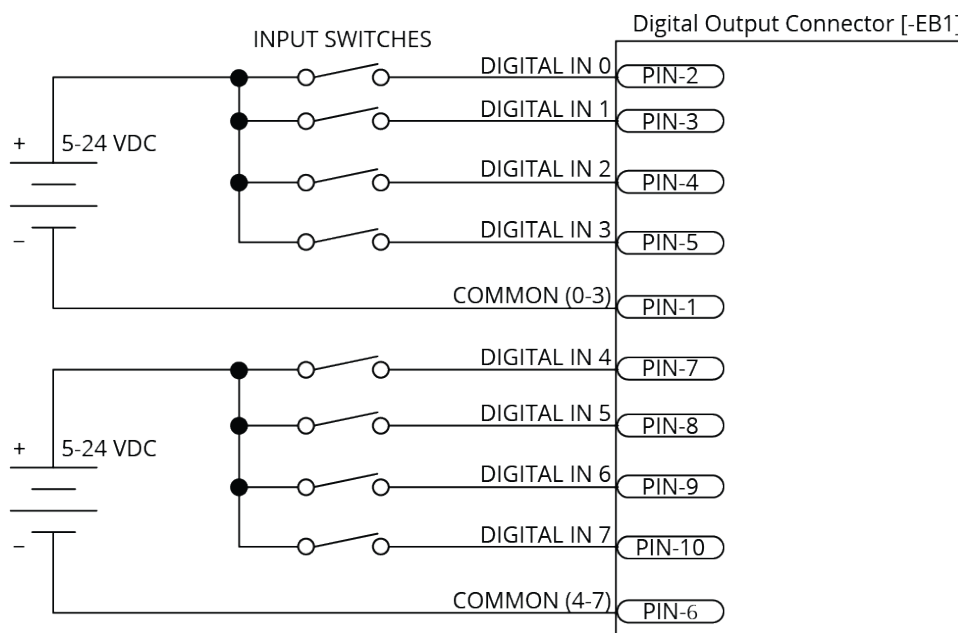


Figure 3-9: Digital Inputs Connected to Current Sourcing (PNP) Devices [-EB1]

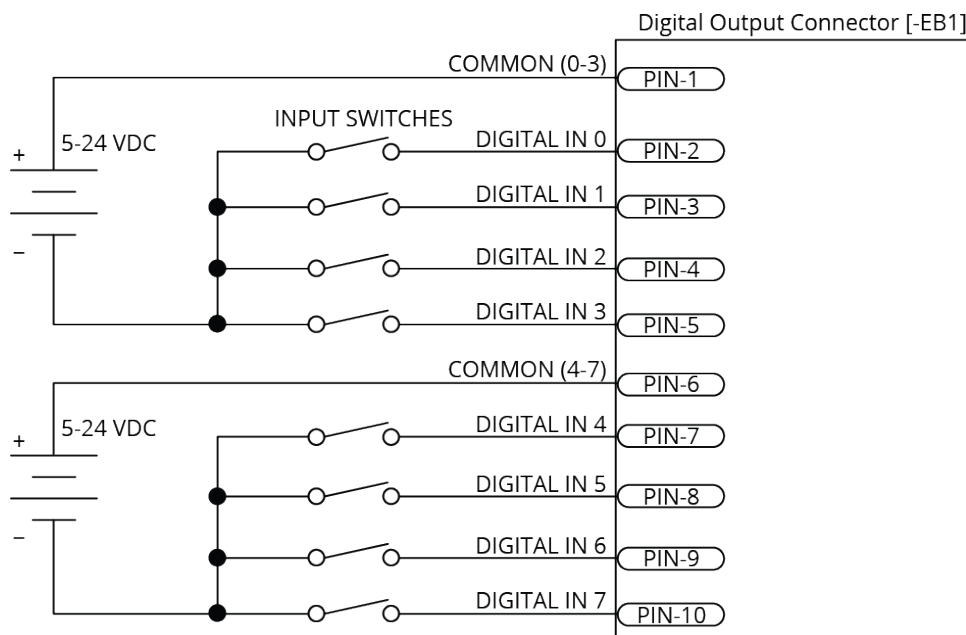


Figure 3-10: Digital Inputs Connected to Current Sinking (NPN) Devices [-EB1]

3.5. 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 3-12](#) and [Figure 3-13](#).

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 3-12](#). To see an example of a current sinking output that has diode suppression, refer to [Figure 3-13](#).

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

Table 3-16: 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 μ s (2K pull up to 24V)
Reset State	Output Off (High Impedance State)

Table 3-17: Digital Output Connector Pinout [-EB1]

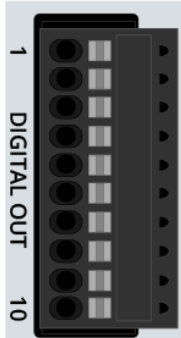
Pin#	Description	In/Out/Bi	Connector
1	Output Common for Outputs 0-3	N/A	
2	Output 0 (Optically-Isolated)	Output	
3	Output 1 (Optically-Isolated)	Output	
4	Output 2 (Optically-Isolated)	Output	
5	Output 3 (Optically-Isolated)	Output	
6	Output Common for Outputs 4-7	N/A	
7	Output 4 (Optically-Isolated)	Output	
8	Output 5 (Optically-Isolated)	Output	
9	Output 6 (Optically-Isolated)	Output	
10	Output 7 (Optically-Isolated)	Output	

Table 3-18: Mating Connector Part Numbers for the Digital Output 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]

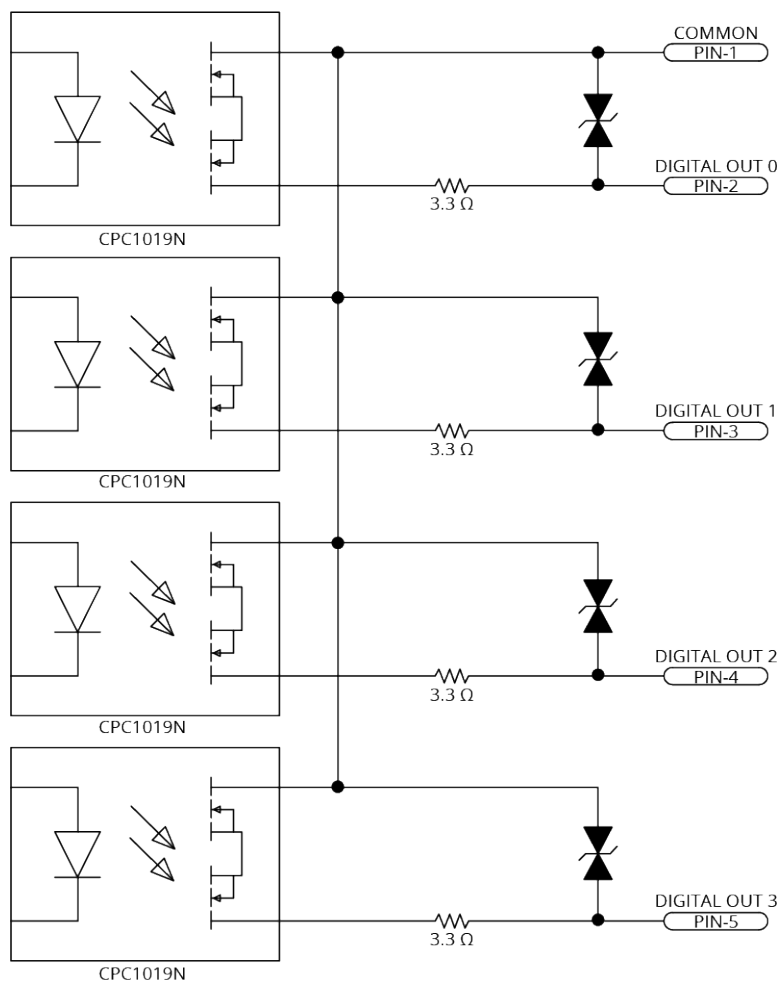
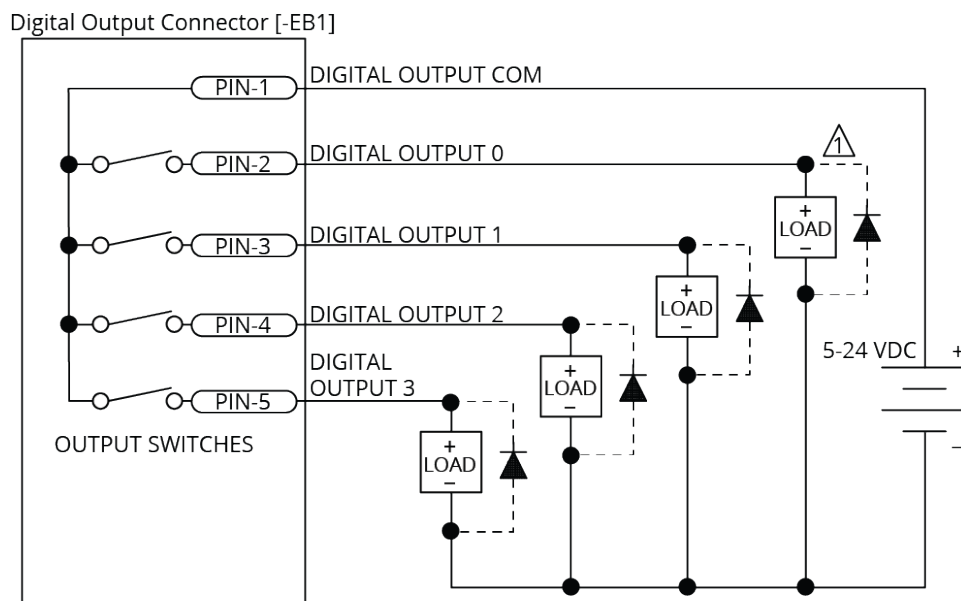
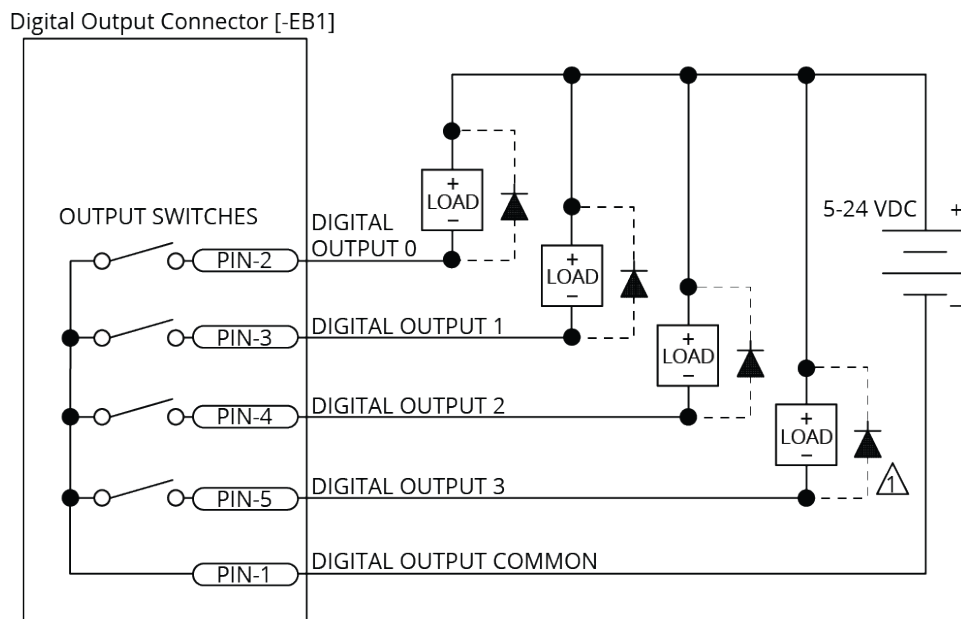


Figure 3-11: Digital Outputs Schematic [-EB1]



1 DIODE REQUIRED ON EACH OUTPUT THAT DRIVES AN INDUCTIVE DEVICE (COIL), SUCH AS A RELAY.

Figure 3-12: Digital Outputs Connected in Current Sourcing Mode [-EB1]



1 DIODE REQUIRED ON EACH OUTPUT THAT DRIVES AN INDUCTIVE DEVICE (COIL), SUCH AS A RELAY.

Figure 3-13: Digital Outputs Connected in Current Sinking Mode [-EB1]

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Chapter 4: Cables and Accessories

NOTE: 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 4.2 .
ECZ01231	BBA32 Interconnect Cable
(1) The “-xx” indicates length in decimeters. “-yy” would indicate length in feet.	

4.1. DIN Rail Mounting

DIN Rail Mounting Procedure:

1. Mount the DIN rail clip to the XC2. The clip and #6-32 x 1/4 flat head screws are included in the XC2-DIN clip kit.
2. Cut the DIN rail so that one complete mounting hole extends beyond the last component at each end.
3. Secure the DIN Rail to the mounting surface with #10-32 screws spaced every six inches.
NOTE: Do not install the DIN rail to the mounting surface with the components already attached.
4. Install all components on to the DIN rail.

Table 4-2: Mounting Parts

	Aerotech P/N
DIN Rail	EAM00914
DIN Rail Clip Kit	XC2-DIN

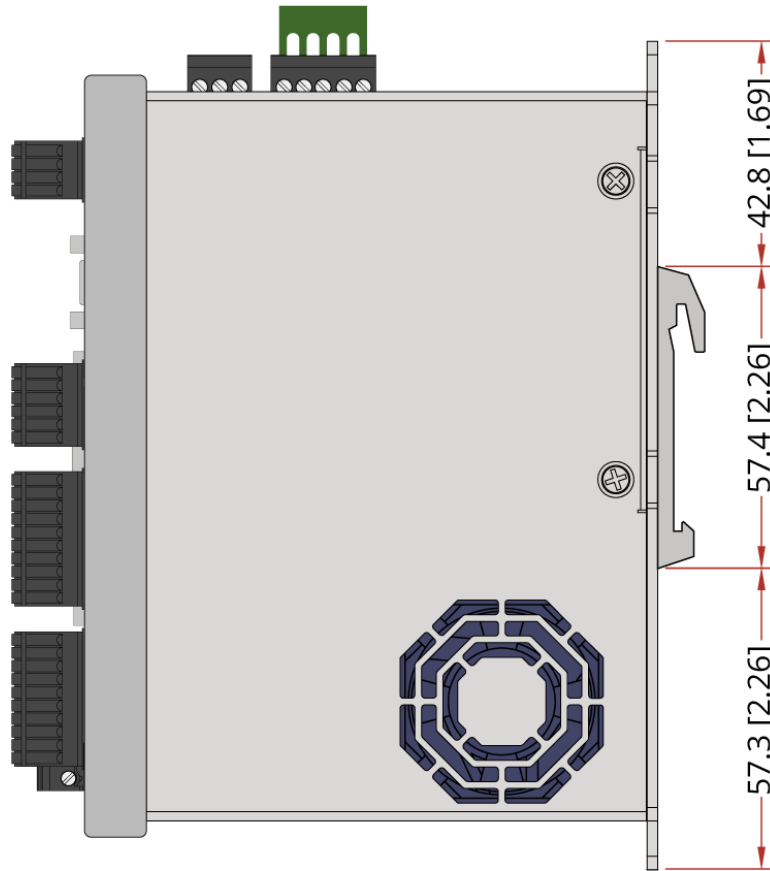


Figure 4-1: Din Rail Clip Dimensions

4.2. 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.

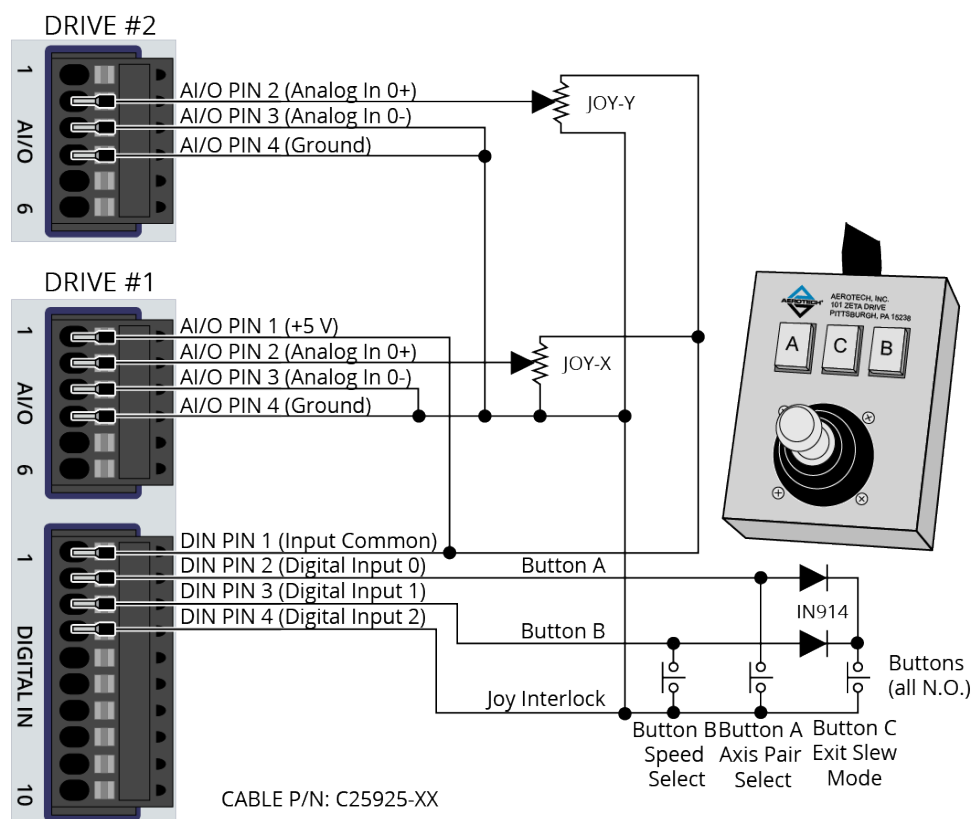


Figure 4-2: Two Axis Joystick Interface

4.3. Handwheel Interface

A handwheel can be used to manually control axis position. The handwheel must provide 5V differential quadrature signals to the XC2

NOTE: You can find instructions on how to enable the handwheel in the Help file.

Connect a handwheel to the Aux connector as shown in [Figure 4-3](#).

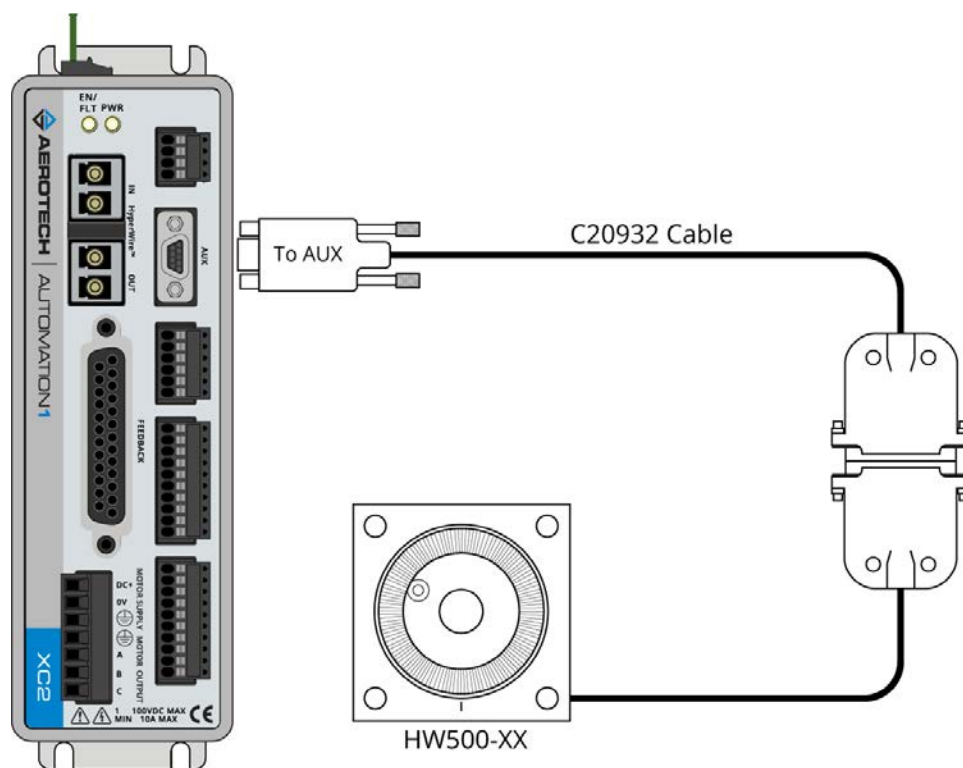


Figure 4-3: Handwheel Interconnection to the Aux Connector

Chapter 5: Maintenance



DANGER: Before you open the XC2 chassis, you must disconnect the Mains power connection.



DANGER: 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.

5.1. Preventative Maintenance

Do an inspection of the XC2 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 5-1: Preventative Maintenance

Check	Action to be Taken
Examine the chassis for hardware and parts that are damaged or loose. 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 XC2.
Examine all cables and connections to make sure they are correct.	Make sure that all connections are correctly attached and not loose. Replace cables that are worn. Replace all broken connectors.

Cleaning



DANGER: Before you clean the XC2, disconnect the electrical power from the drive.

Use a clean, dry, soft cloth to clean the chassis of the XC2. 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 XC2. Also make sure that it does not go onto the outer connectors and components.

Do not use fluids and sprays to clean the XC2 because they can easily go into the chassis or onto the outer connectors and components. If a cleaning solution goes into the XC2, 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 factory-specified value and type.

Table 5-2: Control Board Fuse Specifications

Fuse	Description	Size	Aerotech P/N	Third Party P/N
F1	Control Power at +24V Input	2 A S.B.	EIF01066	Littelfuse 0473002.MRT1L
F2	Motor Power at DC+ Input	5 A S.B.	EIF01061	Littelfuse 39215000440

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 <https://www.aerotech.com/global-technical-support.aspx> 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	CHINA	GERMANY
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720
TAIWAN	UNITED KINGDOM	
Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690	Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649	

Have your customer order number ready before calling.

Appendix B: Revision History

Revision	Description
1.02.00	The following section has been updated: <ul style="list-style-type: none">• Agency Approvals• Section 1.1. Electrical Specifications• Section 2.3.1. Primary Encoder Inputs
1.01.00	Added System Interconnection drawing: Section 2.6 . Updated Joystick Interface drawing: Figure 4-2
1.00.00	New Manual

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