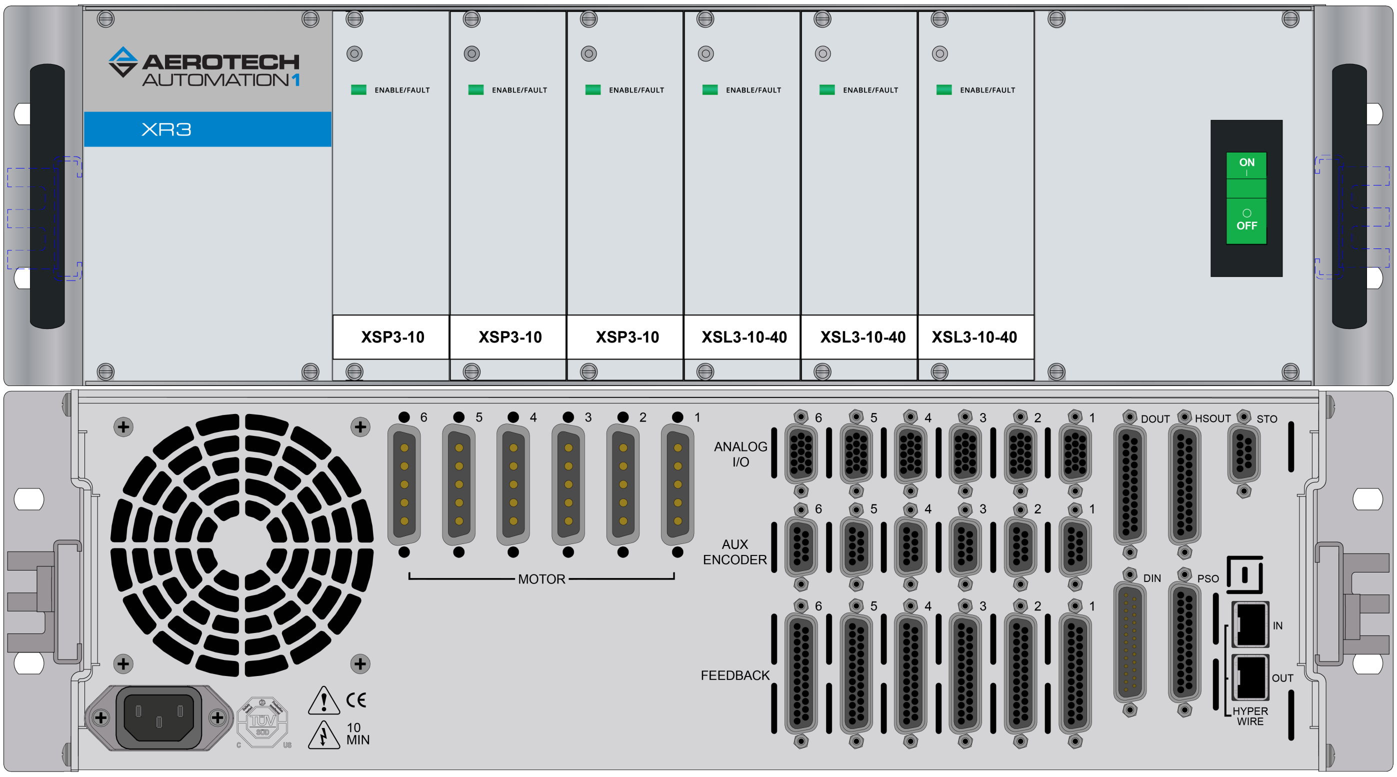
Automation1 XR3 Drive Rack

HARDWARE MANUAL

Revision 2.03



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EU Declaration of Conformity

Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238-2811 USA
Product	XR3
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
2011/65/EU	RoHS 2 Directive
EU 2015/863	Amendment 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 61010-1:2010/A1:2016	Safety Requirements for Electrical Equipment
EN 61800-3:2004/A1:2011	EMC Requirements for Power Drives
IEC 61800-5-1:2016	Electrical Safety for Power Drive Systems
IEC 61800-5-2:2016	Functional Safety for Power Drive Systems
EN 55011:2000/A2:2003	Conducted and Radiated Emissions
EN 55022:1998	Conducted and Radiated Emissions

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Engineer Verifying Compliance	/ Alex Weibel Aerotech, Inc. 101 Zeta Drive Pittsburgh, PA 15238-2811 USA
Date	6/30/2021

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Agency Approvals

Aerotech tested its XR3 drive racks and found that they obey the standards that follow:

Approval:	CUS NRTL
Approving Agency:	TUV SUD America Inc.
Certificate #:	U8 068995 0027 Rev. 02
Standards:	CAN/CSA-C22.2 No. 61010-1:2012, EN 61010-1:2010/A1:2016, UL 61010-1:2012

Approval:	Safety Components (STO)
Approving Agency:	TUV SUD
Certificate #:	Z10 068995 0030 Rev. 00
Standards:	EN ISO 13849-1:2015 (up to PL e), IEC 61508-1:2010 (up to SIL3), IEC 61508-2:2010 (up to SIL3), IEC 61800-5-2:2016, IEC 62061:2005 (up to SILCL3), IEC 62061:2005/AMD1:2012 (up to SILCL3), IEC 62061:2005/AMD2:2015 (up to SILCL3)

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 drive rack.

- Read all parts of this manual before you install or operate the drive rack 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 drive rack 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: Heavy Object

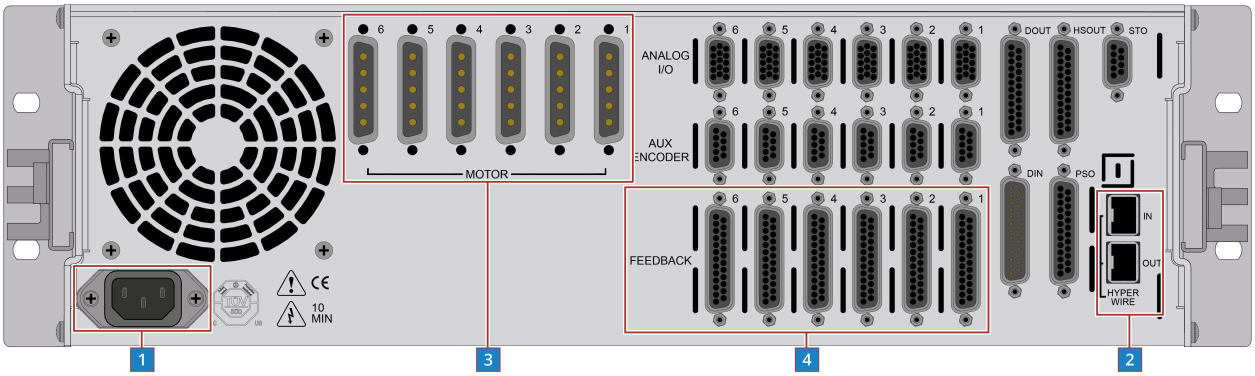
1. Use a cart to move the product.
2. To avoid injury, use two or more people to move and install this product.
3. Lift this product only by the base. Do not use the cables or the connectors to lift or move this product.
4. Do not use the handles on the front of the product to lift or move this product. Use the handles only to slide the product in and out of its enclosure.

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.

Installation Overview

This image shows the order in which to make connections and settings that are typical to the XR3. 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 power source to the AC Power Input.	Section 2.1.1.
2	Connect a PC HyperWire port to the HyperWire In port.	Section 2.11.
3	Connect the motors to the Motor Power inputs.	Section 2.2.
4	Connect the motors to the Motor Feedback inputs.	Section 2.3.

Figure 1: Installation Connection Overview

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Chapter 1: Introduction

The XR3 is a high-performance, 6-axis drive rack with field replaceable front-mounted amplifiers. All versions are 3U in size and rack-mountable.

Table 1-1: Feature Summary

Standard Features	
• Two independent bus supplies (factory configured)	Section 1.1.
• Linear or PWM amplifiers	Section 1.1.
• Software configurable for brush, brushless, ceramic, and stepper motor operation (the XR3 must be factory wired for an XSL3-10-40 amplifier to drive a stepper motor)	Section 2.2.
• 6 channels of line driver square wave or optional analog sine wave quadrature encoder position and/or velocity feedback	Section 2.3.
• Single axis PSO (Laser Firing) standard (2- and 3-axis firing optional)	Section 2.4.
Auxiliary Power Outputs	
• +5 V provided on all axis feedback connectors for encoder, Hall, and limit power	Section 2.3.
• +5 V provided on I/O connectors	Section 2.8.
I/O	
• Brake Output	Section 2.3.
• Three PSO External Sync inputs	Section 2.4.
• Three TTL or isolated PSO outputs	Section 2.4.2.
• One Data Acquisition Input	Section 2.4.4.
• Up to 12 High Speed Differential outputs	Section 2.5.
• 16 digital outputs	Section 2.6.
• 16 digital inputs	Section 2.7.
• Two 16-bit analog outputs per axis	Section 2.9.1.
• Two 16-bit differential analog inputs per axis; two inputs used for joystick inputs	Section 2.9.2.
• Three dedicated joystick digital inputs	Section 2.9.3.
• Two STO sense Inputs	Section 2.10.
Feedback / Limit Inputs	
• Encoder / Marker Inputs (primary)	Section 2.3.1.
• Hall Inputs (3 per axis)	Section 2.3.2.
• Four analog sensor inputs per axis with one used as a motor over-temperature input and one used as an encoder fault input	
▪ Thermistor	Section 2.3.3.
▪ Encoder Fault	Section 2.3.4.
• CW, CCW, and Home Limit Inputs	Section 2.3.5.
• Encoder / Marker Inputs (auxiliary)	Section 2.8.

Table 1-2: Configurations and Options

Input Line Voltage			
-VL1	115 VAC		
-VL2	230 VAC		
-VL3	100 VAC		
-VL4	200 VAC		
Bus Voltage 1 and Bus Voltage 2 Configurations			
Bus Voltage 1 (Required)		**Bus Voltage 2 (Optional)**	
--	--	-VB0	Not wired (Bus Voltage 2 only)
-VB1	±10 VDC (200 W Power Supply), bipolar	-VB1	±10 VDC (200 W Power Supply), bipolar
-VB2	±20 VDC (200 W Power Supply), bipolar	-VB2	±20 VDC (200 W Power Supply), bipolar
-VB3	±30 VDC (200 W Power Supply), bipolar	-VB3	±30 VDC (200 W Power Supply), bipolar
-VB4	±40 VDC (300 W Power Supply), bipolar	-VB4	±40 VDC (300 W Power Supply), bipolar
-VB5	±80 VDC (300 W Power Supply), bipolar	-VB5	±80 VDC (300 W Power Supply), bipolar
-VB7	160 VDC, unipolar	-VB7	160 VDC, unipolar
-VB8	320 VDC, unipolar	-VB8	320 VDC, unipolar
Split Bus Options			
-SB0	No split, Axis 1-6 Bus Voltage 1		
-SB1	Axis 1 Bus Voltage 1, Axis 2-6 Bus Voltage 2		
-SB2	Axis 1-2 Bus Voltage 1, Axis 3-6 Bus Voltage 2		
-SB3	Axis 1-3 Bus Voltage 1, Axis 4-6 Bus Voltage 2		
-SB4	Axis 1-4 Bus Voltage 1, Axis 5-6 Bus Voltage 2		
-SB5	Axis 1-5 Bus Voltage 1, Axis 6 Bus Voltage 2		
Axis Control Board			Section 2.3.1.3.
Axis 1 (Required)		**Axis 2-6 (Optional)**	
-CT0	No control board	0	No control board
-CTN	No multiplier	N	No multiplier
-CT1	Primary feedback multiplier (standard performance)	1	Primary feedback multiplier (standard performance)
-CT2	Primary feedback multiplier (high performance)	2	Primary feedback multiplier (high performance)
-CT4	Primary and auxiliary multiplier (high performance)	4	Primary and auxiliary multiplier (high performance)
Note: "-CT" is applied to the first axis option only. A three axis order would look like: -CT111.			
Axis Amplifier			Section 1.1.
Axis 1 (Required)		**Axis 2-6 (Optional)**	
-P0	None	P0	None
-P1	XSP3-10 PWM amplifier	P1	XSP3-10 PWM amplifier
-P2	XSP3-20 PWM amplifier	P2	XSP3-20 PWM amplifier
-P3	XSP3-30 PWM amplifier	P3	XSP3-30 PWM amplifier
-L1	XSL3-10-40 linear amplifier	L1	XSL3-10-40 linear amplifier
Note: "-" is applied to the first axis option only. A three axis order would look like: -P1P1P1.			

Cooling Options	Section 2.12.
-C0	Built-in fan pulls cooling air from left side through the amplifier compartment
-C1	No cooling fan. External cooling through vented covers is required.
-C2	1U-high fan tray for cooling
Mounting Options	Section 1.2.
-MT0	Rack-mounted configuration
-MT1	Rack-mounted configuration with drawer slides
Line Cord Options	
-LC0	No line cord
-LC1	U.S. 115 VAC line cord
-LC2	U.S. 230 VAC line cord
-LC3	German compatible line cord
-LC4	U.K. compatible line cord
-LC5	Israel compatible line cord
-LC6	India compatible line cord
-LC7	Australia compatible line cord
PSO	Section 2.4.
-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).
Internal Shunt	Section 2.1.4.
-SI0	No internal shunt
-SI1	Internal shunt for first bus
-SI2	Internal shunt for second bus
-SI3	Internal shunt for first and second bus
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.

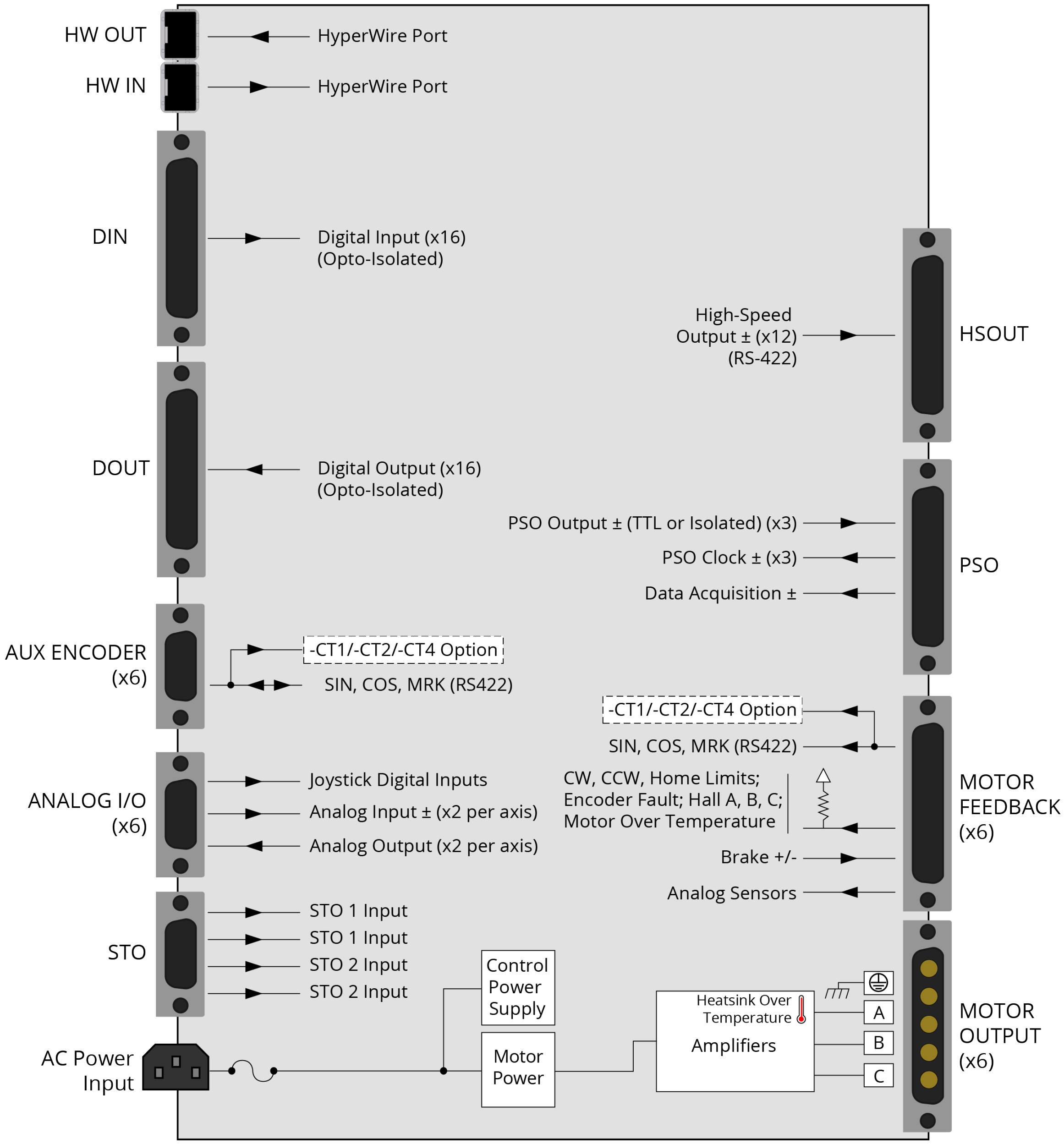


Figure 1-1: Functional Diagram

1.1. Electrical Specifications

The electrical specifications for the XR3 drive chassis are listed in Table 1-3 and the electrical specifications for the servo amplifiers in Table 1-4 and Table 1-5.

IMPORTANT: These electrical specifications represent the maximum capability of a feature. System constraints can result in lower performance. For example, the motor output specifications are affected by the Bus supply, the number of axes that are operating at the same time, the type of motion, the AC Line voltage, and motor requirements.

Table 1-3: Chassis Electrical Specifications

Description	Option	Specification
Bus Voltage Options [Factory Configured]	-VB1	±10 VDC (200 W Power Supply), bipolar
	-VB2	±20 VDC (200 W Power Supply), bipolar
	-VB3	±30 VDC (200 W Power Supply), bipolar
	-VB4	±40 VDC (300 W Power Supply), bipolar
	-VB5	±80 VDC (300 W Power Supply), bipolar
	-VB7	+160 VDC, unipolar
	-VB8	+320 VDC, unipolar
Input Current	-VL1	115 VAC, 10 A Maximum
	-VL2	230 VAC, 5 A Maximum
	-VL3	100 VAC, 10 A Maximum
	-VL4	200 VAC, 5 A Maximum
AC Power Input		AC input (Switch Selectable): AC Hi, AC Lo, Earth Ground (⏚), • 100 VAC (90-112 VAC, 50/60 Hz) • 115 VAC (103-127 VAC, 50/60 Hz) • 200 VAC (180-224 VAC, 50/60 Hz) • 230 VAC (207-254 VAC, 50/60 Hz) Note: If the XR3 contains an offline Bus power supply, the AC Input will be limited to one AC input range.
Inrush Current		32 A Peak
Auxiliary Power Outputs		+5 V provided on all axis feedback connectors for encoder, Hall, and limit power. +5 V provided on I/O connectors
Protection		The AC power cord serves as the mains breaker and provides 10 A, Supplemental Protection only.
		Internal Bus supply fusing.
		Amplifier Output short circuit protection.
		Peak and RMS over current limit.
		Over Temperature shutdown.
		Bus supply inrush current limit during initial power-on.
Indicator (Power)		Opto and transformer isolation between control and power stages.
Indicator (Enabled)		Power switch contains a power-on indicator.
Protection		Individual Amplifier LED's indicates drive enabled state.

Table 1-4: PWM Amplifier Electrical Specifications

	XSP3-10	XSP3-20	XSP3-30
Option Code	-P1	-P2	-P3
Peak Motor Output Current (2 sec) (1)	10 A (pk)	20 A (pk)	30 A (pk)
Continuous Current	5 A	10 A	10 A
Peak Bus Voltage	320 VDC		
Maximum Power Amplifier Bandwidth (3)	2 kHz		
PWM Switching Frequency	20 kHz		
Minimum Load Inductance	0.1 mH @ 160 VDC (1.0 mH @ 320 VDC)		
Heat Sink Temperature (maximum allowable)	75 °C (All Amplifiers)		

1. AC voltage, Bus supply / load may result in significantly lower maximum peak currents.
2. Peak and continuous output current is load dependent. The controller will limit its output current based on velocity and motor resistance.
3. Selectable through parameters.

Table 1-5: Linear Amplifier Electrical Specifications

	XSL3-10-40 (5)(6)(7)(8)
Option Code	-L1
Continuous Output Current, ±40V bus (A_{pk}) (2)(3)(4)	1.5 A | 2.0 A
Peak Current (A_{pk})	10 A (1)
Maximum Continuous Total Power Dissipation (3)(4)	120 W | 160 W
Peak Amplifier Power Dissipation per phase	400 W
Effective Heatsink Thermal Resistance (3)	0.42°C/W | 0.31°C/W
Maximum Transistor Temperature	75°C
Time to reach maximum temperature at maximum continuous power	20 minutes

(1) This specification depends on the motor supply voltage, the motor speed, and motor resistance. Contact an Aerotech sales engineer for more information.
(2) This specification assumes that an AC or DC motor type with a 0 Ω winding resistance is used.
(3) The first number is for a stationary AC or DC motor. The second number is for an AC motor that is in motion.
(4) The specification will de-rate when the ambient temperature exceeds 25°C.
(5) The XSL3 amplifier has circuitry that will limit peak power to protect itself from damage. In the Status Utility, the Power Limiting bit under Drive Status monitors the condition of the circuitry. If the circuit is open, the Power Limiting bit will show as "ON".
(6) All linear amplifier (XSL3-10-40) specifications assume that the fan tray is installed, the fans are set to full-speed mode, and the ambient temperature is 25°C.
(7) The transistor temperature can be up to 25°C higher than the heat sink temperature that is shown in the Status Utility. Set the AverageCurrentFault parameter to ensure that the heat sink power dissipation is not exceeded.
(8) Aerotech recommends that you do not use high-current stepper motors with the XSL3-10-40 linear amplifier because of high-power dissipation. Contact Aerotech for additional information.

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

Linear Motor

Power Dissipation [W] = MotorCurrentPeak[A] * TotalBusVoltage[V] * 3 / 2
Power Input = (Power Dissipation) / EfficiencyFactor

1.2. Mechanical Specifications

1.2.1. Mounting and Cooling

Install the XR3 in an IP54 compliant rack mount console to comply with safety standards. Make sure that there is sufficient clearance for free airflow at the rear and along the sides of the chassis and for clearance at the rear panel for cables and connections.

External cooling and Fan Tray cooling options require airflow clearance above and below the XR3 drive chassis. Refer to Section 2.12. Cooling Options [-C0/-C1/-C2 Option].

Table 1-6: Mounting Specifications

		XR3
Customer-Supplied Enclosure		IP54 Compliant
Weight		~25 kg
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

WARNING: **Heavy Object**

1. Use a cart to move the product.
2. To avoid injury, use two or more people to move and install this product.
3. Lift this product only by the base. Do not use the cables or the connectors to lift or move this product.
4. Do not use the handles on the front of the product to lift or move this product. Use the handles only to slide the product in and out of its enclosure.

1.2.2. Dimensions

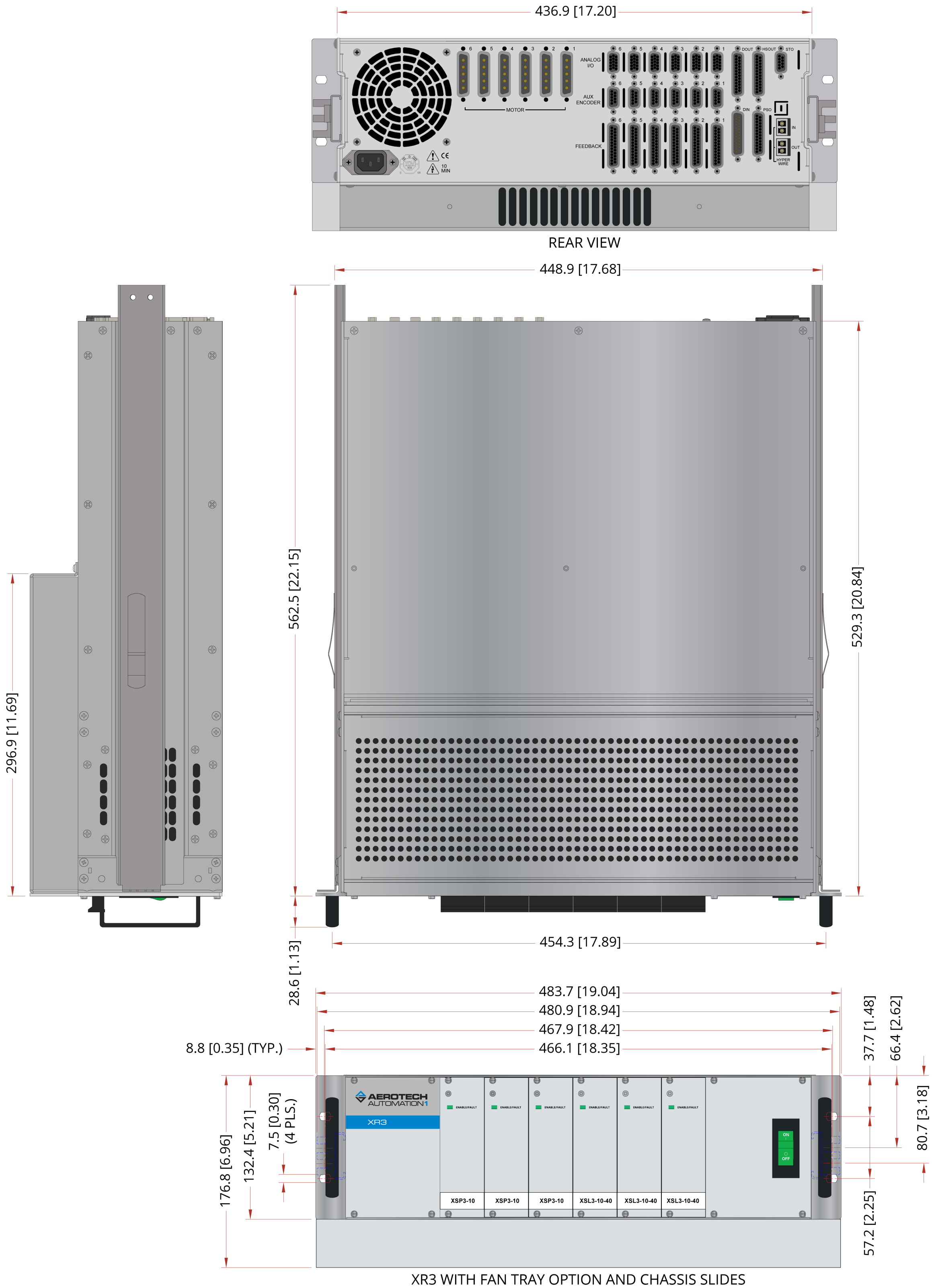


Figure 1-2: Dimensions with Chassis Slides

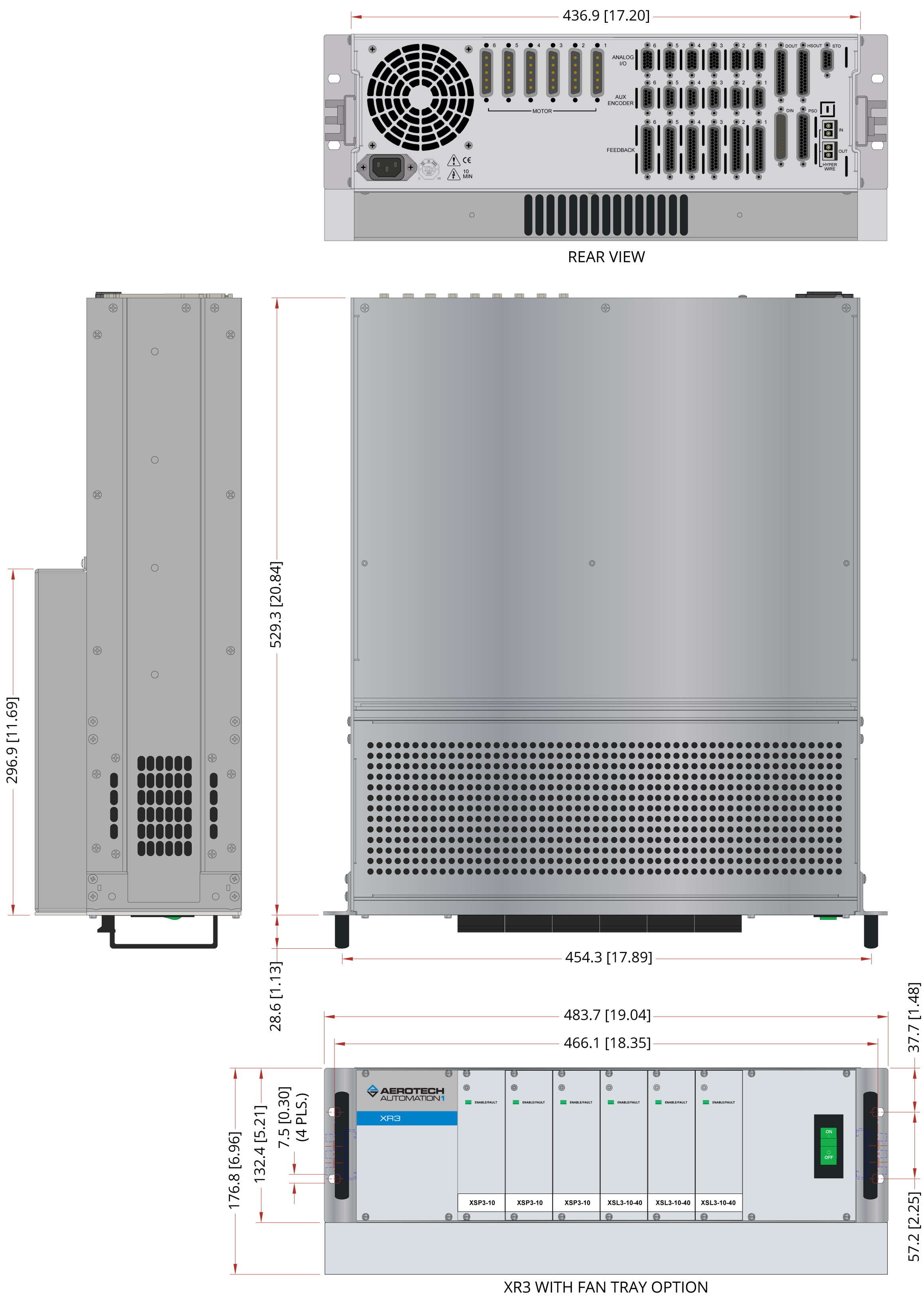


Figure 1-3: Dimensions without Chassis Slides

1.3. Environmental Specifications

Table 1-7: 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 1-8: Drive and Software Compatibility

Drive Type	Software	First Software Version	Last Software Version
Automation1 XR3	Automation1	1.2.0	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 XR3 for any evidence of shipping damage. If any damage exists, notify the shipping carrier immediately.

Remove the packing list from the XR3 container. Make sure that all the items specified on the packing list are contained within the package.

The documentation for the XR3 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 XR3 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

The XR3 power label contains the factory configured AC power requirements.

DANGER: Update the AC power label if you reconfigure the AC Input Voltage.

WARNING: **Heavy Object**

1. Lift this product only by the base.Do not use the cables or the connectors to lift or move this product.
2. Do not use the handles on the front of the product to lift or move this product. Use the handles only to slide the product in and out of its enclosure.

2.1. Electrical Installation

Motor, power, control and position feedback cable connections are made to the rear of the XR3.

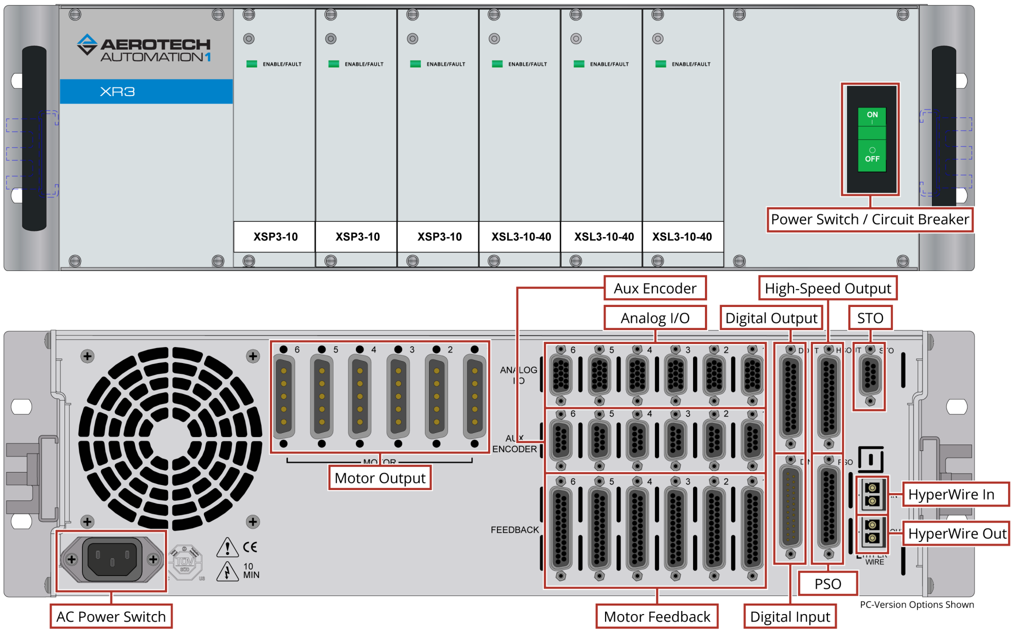


Figure 2-1: Power and Control Connections

A combination power switch/circuit breaker is located on the front of the XR3. This breaker is connected to the incoming AC power and provides protection to the XR3 system in case of severe overloads. This breaker is selected to meet the maximum current requirements of the XR3 system and is normally a 10 A breaker

All low voltage connections must be made using cables and wires sized for the maximum currents that will be carried. Insulation on these cables and wires must be rated at 300 V if this wiring can come into contact with wiring operating above 100 V (AC and motor wiring). Low voltage wiring should not be bundled with AC and motor wiring to minimize signal disturbances due to EMI interference and coupling.

IMPORTANT: The machine integrator, OEM or end user is responsible for meeting the final protective grounding requirements of the system.

DANGER: Disconnect power before you do maintenance to the equipment. 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.

WARNING: Before powering on the XR3, verify that all drive modules and cables to the XR3 have been properly installed. Refer to the remaining chapters of this manual for installation and configuration procedures.

Confirm that the AC power is the correct voltage before turning on power to the XR3.

2.1.1. AC Power Connections

AC input power to the XR3 drive chassis is applied to the AC power receptacle that is located on the rear panel. The power cord connected to this receptacle also provides the protective earth ground connection and may serve as a Mains disconnect. The main power switch located on the front panel of the XR3 drive chassis also functions as a 10 A breaker (supplementary protection only) for the incoming AC power.

Most XR3 drive chassis can be configured for operation at any of four different AC input voltages (refer to Section .). Before attempting to reconfigure the AC input voltage for the XR3 drive chassis, the user must verify that drive chassis does not contain an offline bus supply (Ex. 160LT Bus) or other option that would limit or restrict the AC input voltages that it may operate at. These standard AC input voltages along with the current requirements for the XR3 drive chassis are listed in Table 2-1.

WARNING: The AC power cord is the Mains disconnect.

Table 2-1: Main AC Power Input Voltages and Current Requirements

AC Input Voltage	Input Amps (maximum continuous)
100 VAC 50/60 Hz	10 A
115 VAC 50/60 Hz	10 A
200 VAC 50/60 Hz	5 A
230 VAC 50/60 Hz	5 A

The AC power cord wiring to the XR3 must be rated for at least 300 V and have a minimum current capacity of 10 A. The insulation rating for the AC power wiring must be appropriately rated for the environment. The temperature rating of the insulation must be at least 80°C. Environmental conditions may necessitate the need to meet additional AC wiring requirements or specifications. AC wiring should not be bundled with signal wiring to minimize EMI coupling and interference.

DANGER: See the user documentation provided with your XR3 system to determine if the XR3 chassis is limited to only one AC input voltage. Operation at other voltages may result in damage to the XR3 chassis.

2.1.2. Minimizing Noise for EMC/CE Compliance

IMPORTANT: The XR3 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. Use the lowest motor voltage required by the application to reduce radiated emission.

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]

2.1.3. I/O and Signal Requirements

The I/O, communication, and encoder feedback connections are typically very low power connections. In some applications, especially when there are significant wire distances, a larger wire size may be required to reduce the voltage drop that occurs along the wire. This increase may be necessary in order to keep the voltage within a specified range at a remote point.

Low voltage and high voltage wires should be kept physically separated so that they cannot contact one another. This reduces the risk of electric shock and improves system performance.

Table 2-2: I/O and Signal Specifications

Connection	Specification	Value
Signal Wiring	Cable/Wire Rating (1)	300 V
	Minimum Current Capacity	.25 A
	Temperature Rating (Insulation) (2)	80°C
Low Voltage Power	Cable/Wire Rating (1)	300 V
	Minimum Current Capacity (3)	1 A
	Temperature Rating (Insulation) (2)	80°C

1. ≥ 30 V if the wiring is **not** in close proximity to wiring operating at voltages above 60 V.
2. Insulation rating will need to be rated for the higher voltage if the wiring is in proximity to wiring operating at voltages above 60 V.
3. Larger gauge wire may be required to minimize voltage drop due to voltage (IR) loss in the cable.

2.1.4. Internal Shunt Option [-SI#]

The internal shunt option is used to limit the internal bus voltage caused by regeneration. Regeneration occurs during deceleration as mechanical energy is converted to electrical energy and stored in the internal power supply capacitors. Regeneration only occurs with PWM amplifier types (XSP3) and not linear amplifier types (XSL3).

The maximum amount of energy that the XR3 can safely absorb depends on the line voltage and motor bus configuration as shown in Table 2-3.

Table 2-3: Maximum Energy That The XR3 Can Safely Absorb During Regeneration

Bus Option	Input Voltage	Internal Capacitance	Energy (J)
VB7 - with split bus	125 VAC	8000 uF / 200 VDC	35
VB7 - without split bus	125 VAC	16000 uF / 200 VDC	70
VB8 - with split bus	240 VAC	2300 uF / 400 VDC	52
VB8 - without split bus	240 VAC	4600 uf / 400 VDC	104

To determine if the shunt option is required, use one of the equations that follow to calculate the stored mechanical energy. If the calculated value exceeds the value listed in Table 2-3, the shunt option is required. For multiple axes, add the energy contribution for each axis that shares a power supply and decelerates simultaneously. Compare the sum against the maximum energy limits shown in Table 2-3.

For Linear Axes:

$$E = \frac{1}{2} m \cdot v^2$$

m moving mass [kg]
v speed [m/s]
E stored energy [J]

For Rotary Axes:

$$E = \frac{1}{2} J \cdot w^2$$

J inertia [kg·m 2]
w speed [rad/s]
E stored energy [J]

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 XR3 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 5-pin high power "D" style motor power connectors (Axis 1-6) are located on the rear panel. The pin assignments for these connectors are shown in Table 2-4.

Table 2-4: Motor Power Output Connector Pinout

Pin	Description	Recommended Wire Size	Connector
5	Ground	1.3 mm^2 (#16 AWG)	
4	Reserved	1.3 mm^2 (#16 AWG)	
3	Brushless Phase C Motor Power DC Brush - Stepper Return	1.3 mm^2 (#16 AWG)	
2	Brushless Phase B Motor Power Stepper	1.3 mm^2 (#16 AWG)	
1	Brushless Phase A Motor Power DC Brush + Stepper	1.3 mm^2 (#16 AWG)	

Table 2-5: Mating Connector Part Numbers for the Motor Power Output Connector

Description	Aerotech P/N	Third Party Source P/N
Male 5 Pin D-Style	ECK01236	ITT Cannon DBM5W5PK87
Contact (QTY. 5)	ECK00660	ITT Cannon DM53745-7
Backshell	ECK00656	Amphenol 17-1726-2

2.2.1. Brushless Motor Connections

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

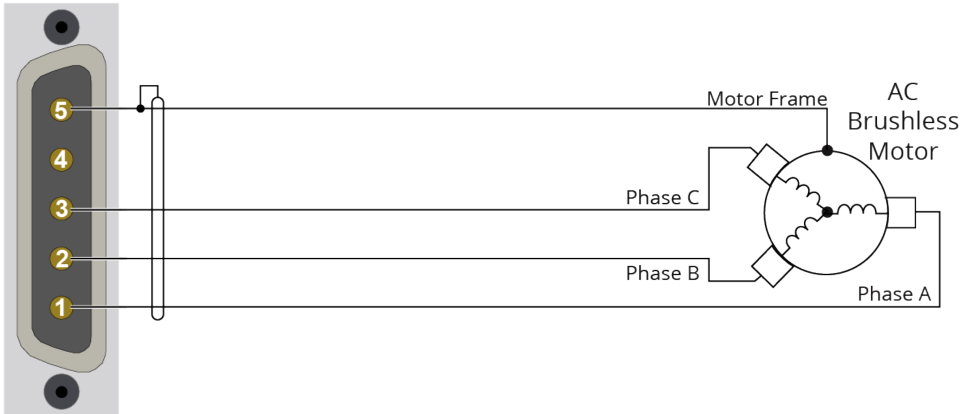


Figure 2-2: Brushless Motor Configuration

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 2-6: Hall Signal Diagnostics

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

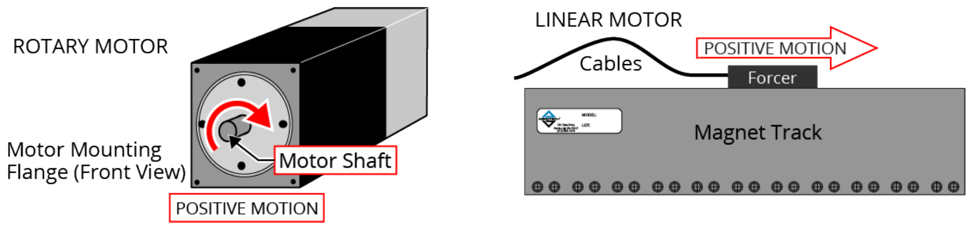


Figure 2-3: Positive Motor Direction

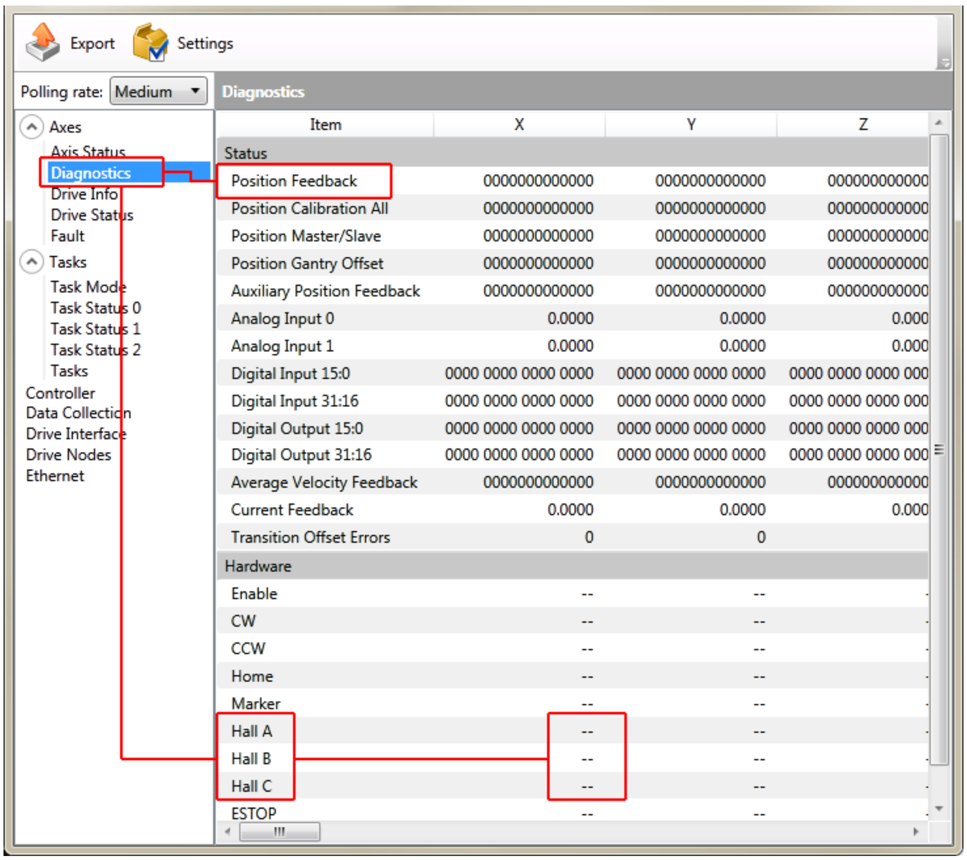


Figure 2-4: Encoder and Hall Signal Diagnostics

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 2-5. 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 2-5). Wave forms are shown while moving the motor in the positive direction.

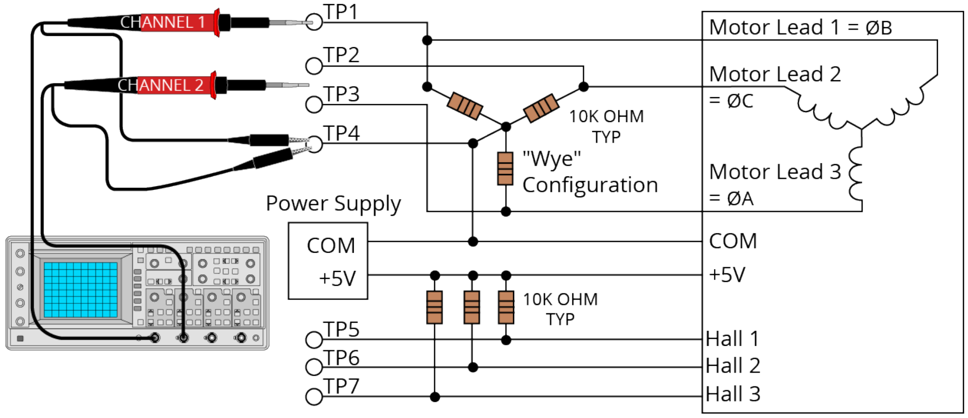


Figure 2-5: Brushless Motor Phasing Oscilloscope Example

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 2-6). Use the CommutationOffset parameter to correct for Hall signal misalignment.

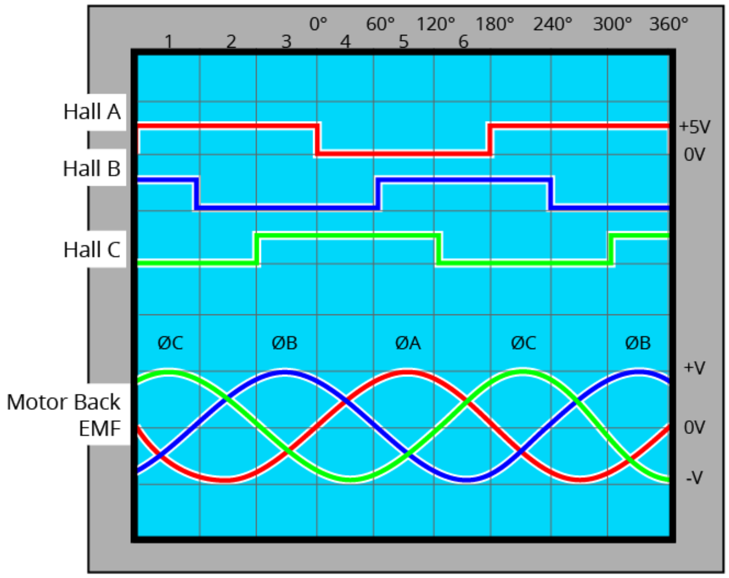


Figure 2-6: Brushless Motor Phasing Goal

2.2.2. DC Brush Motor Connections

The configuration shown in Figure 2-7 is an example of a typical DC brush motor connection. Refer to Section 2.2.2.1. for information on motor phasing.

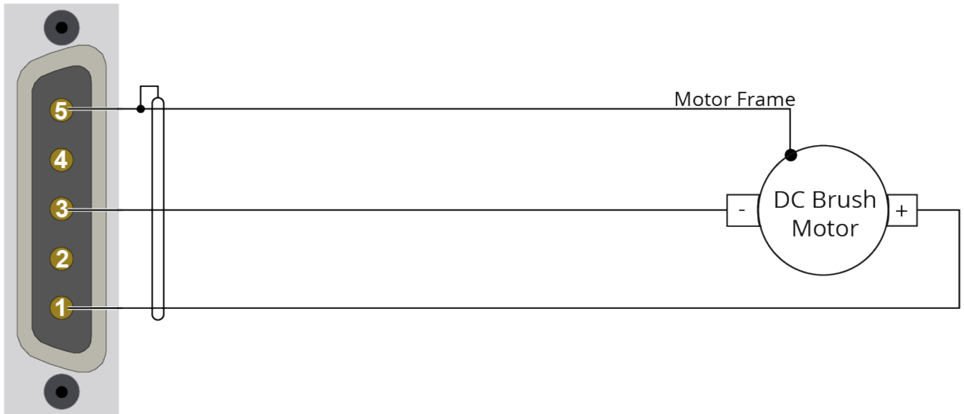


Figure 2-7: DC Brush Motor Configuration

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.

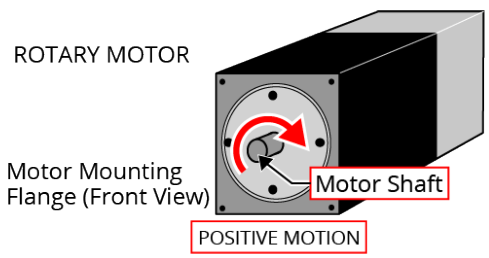


Figure 2-8: Positive Motor Direction

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

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 2-9 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.

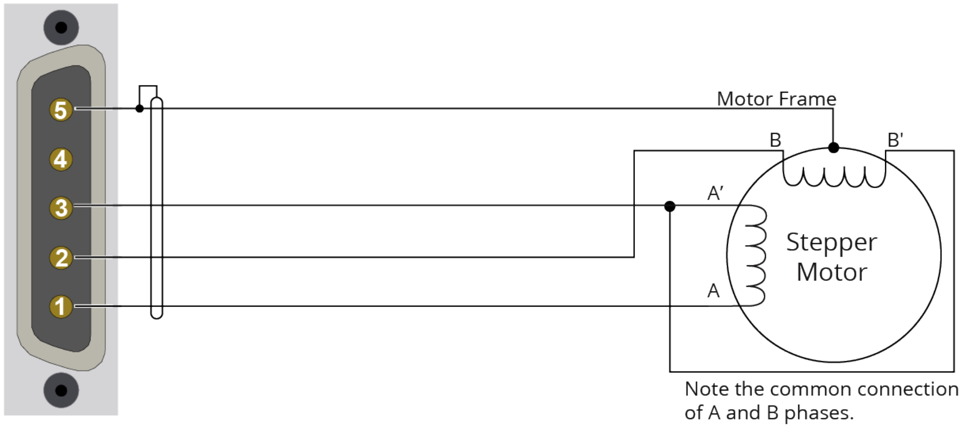


Figure 2-9: Stepper Motor Configuration

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 2-10). 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.

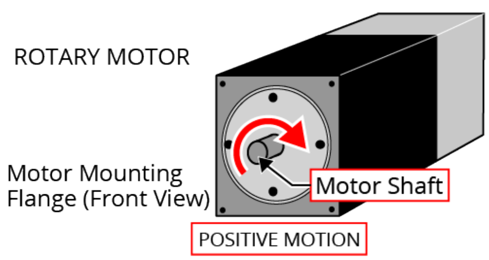


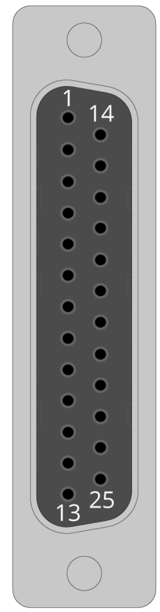
Figure 2-10: Positive Motor Direction

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 2-7 with detailed connection information in the following sections.

Table 2-7: 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 2-8: 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 XR3 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 2.8. for the auxiliary encoder input on the Aux Encoder connectors.

Table 2-9: Multiplier Options

Option	Primary Encoder Accepts...	Auxiliary Encoder Accepts...
-CTN	Square Wave or Absolute encoders	Square Wave or Absolute encoders
-CT1	Sine Wave (standard performance), Square Wave, or Absolute encoders	Square Wave or Absolute encoders
-CT2	Sine Wave (high performance), Square Wave, or Absolute encoders	Square Wave or Absolute encoders
-CT4	Sine Wave (high performance), Square Wave, or Absolute encoders	Sine Wave (high performance), Square Wave, or Absolute encoders

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

Table 2-10: 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 controller accepts RS-422 square wave encoder signals. The controller 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 2-11: Square Wave Encoder Specifications

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

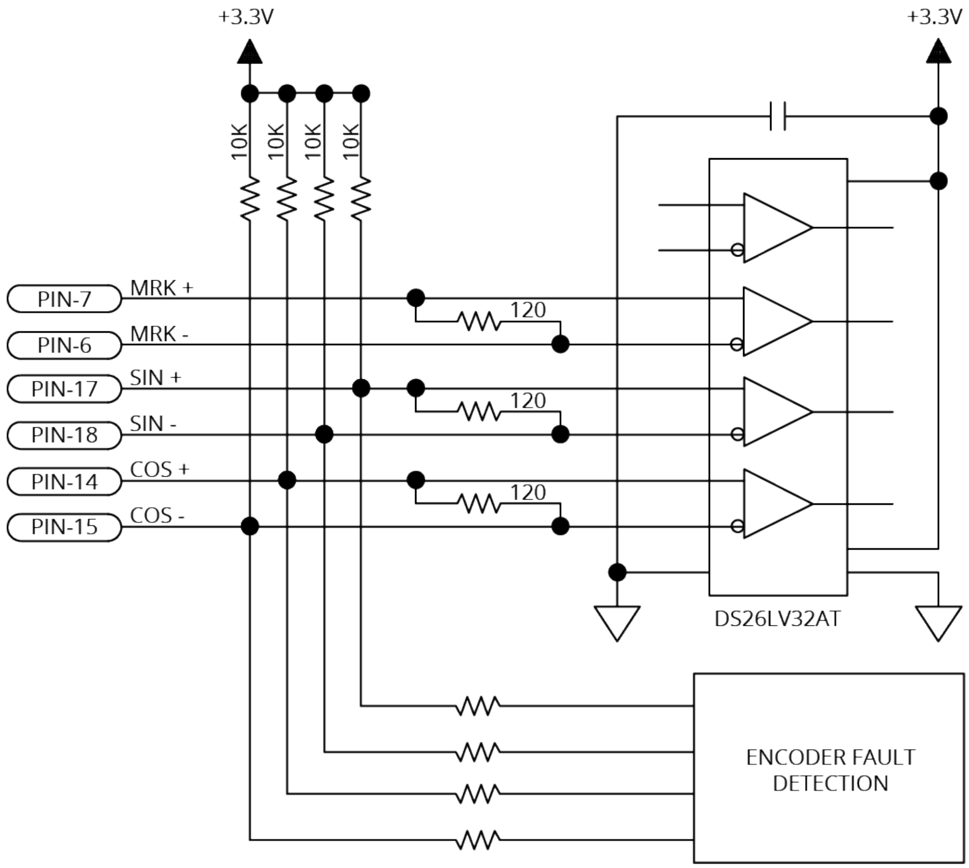


Figure 2-11: Square Wave Encoder Schematic (Feedback Connector)

2.3.1.2. Absolute Encoder

The controller 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 2-12 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.

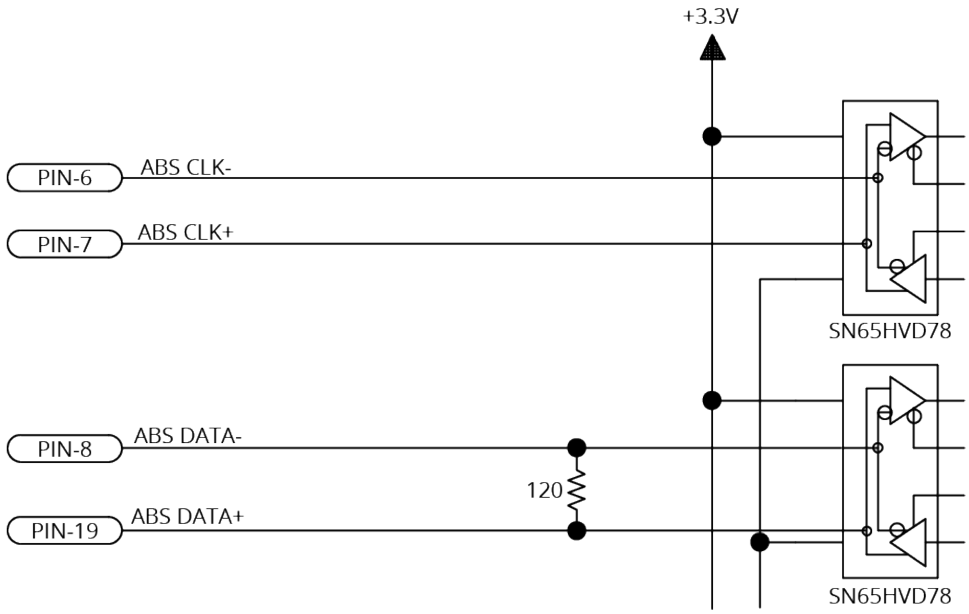


Figure 2-12: Absolute Encoder Schematic (Feedback Connector)

2.3.1.3. Sine Wave Encoder [-CT1/-CT2/-CT4 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 XR3 with the -CT2 and -CT4 options can generate emulated encoder signals. These signals can be output on the AUX ENCODER connector, the HSOUT (High-Speed Output) 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.

You cannot use a sine wave encoder with the -CT1 multiplier option as an input to the PSO. The -CT1 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 2-12: Sine Wave Encoder Specifications

Specification		Value	
		Primary	Auxiliary
Input Frequency (max)		450 kHz, 2 MHz	
Input Amplitude (1)		0.6 to 1.75 Vpk-pk	
Interpolation Factor (max)	-CT1	16,384	N/A
	-CT2	65,536	N/A
	-CT4	65,536	65,536
-CT2/-CT4 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(-)			

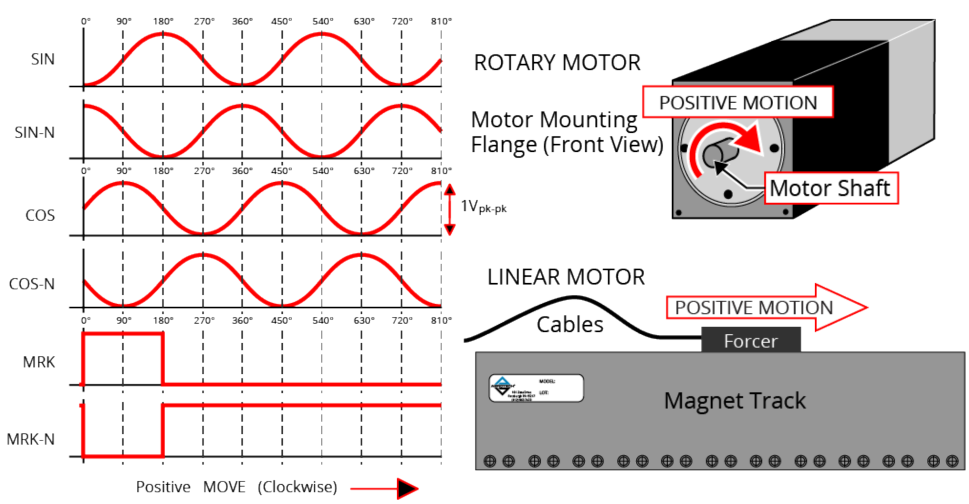


Figure 2-13: Sine Wave Encoder Phasing Reference Diagram

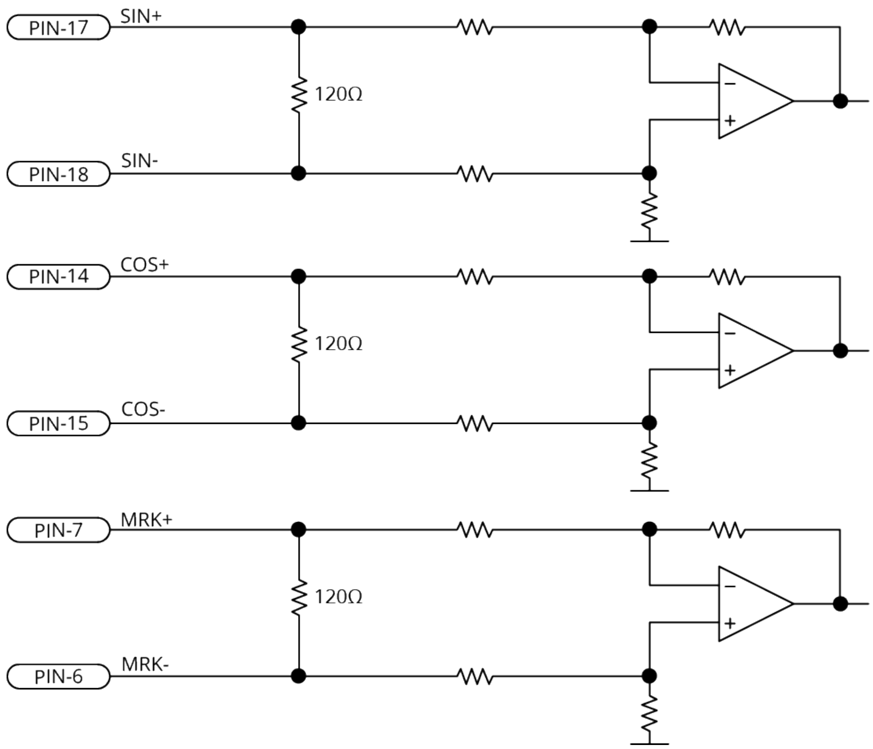


Figure 2-14: Sine Wave Encoder Schematic (Feedback Connector)

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 2-15 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 2-16).

For dual loop systems, the velocity feedback encoder is displayed in the diagnostic display (Figure 2-16).

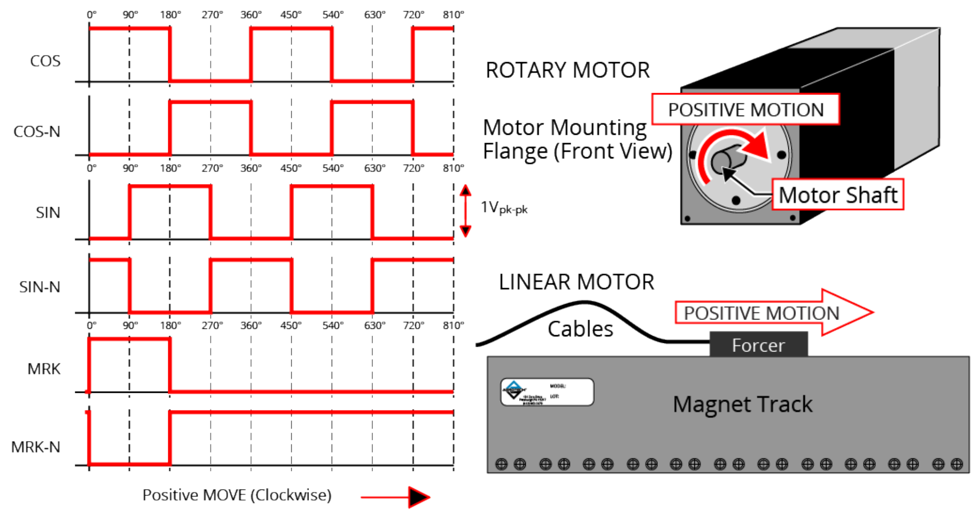


Figure 2-15: Encoder Phasing Reference Diagram (Standard)

> **IMPORTANT**: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-15.

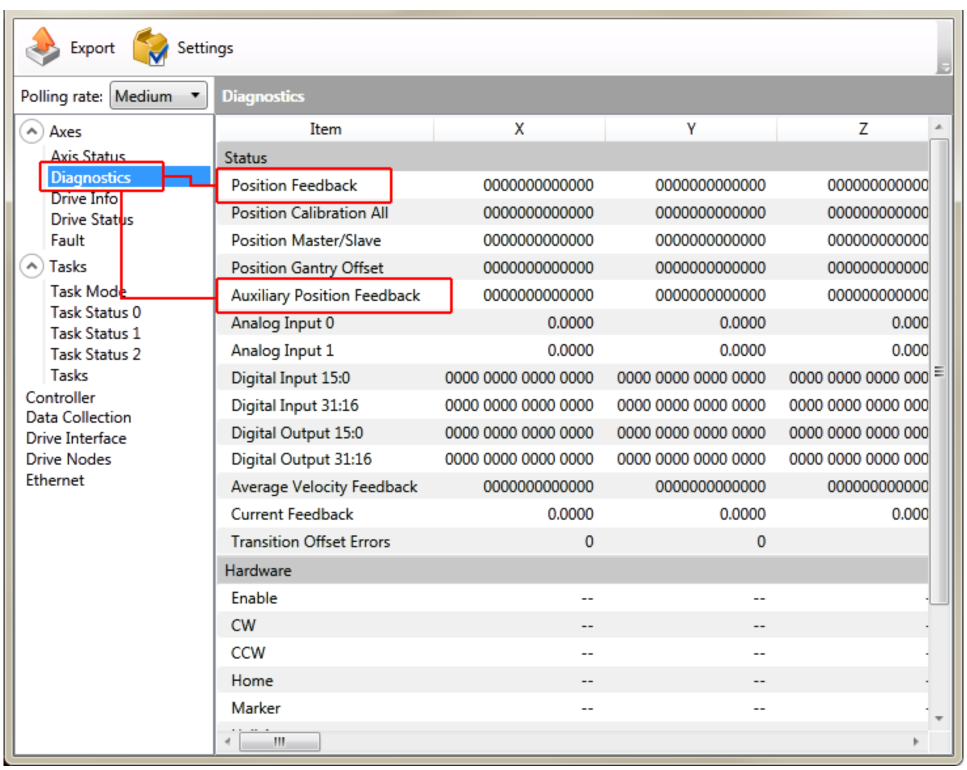


Figure 2-16: Position Feedback in the Diagnostic Display

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 2-13: 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.		

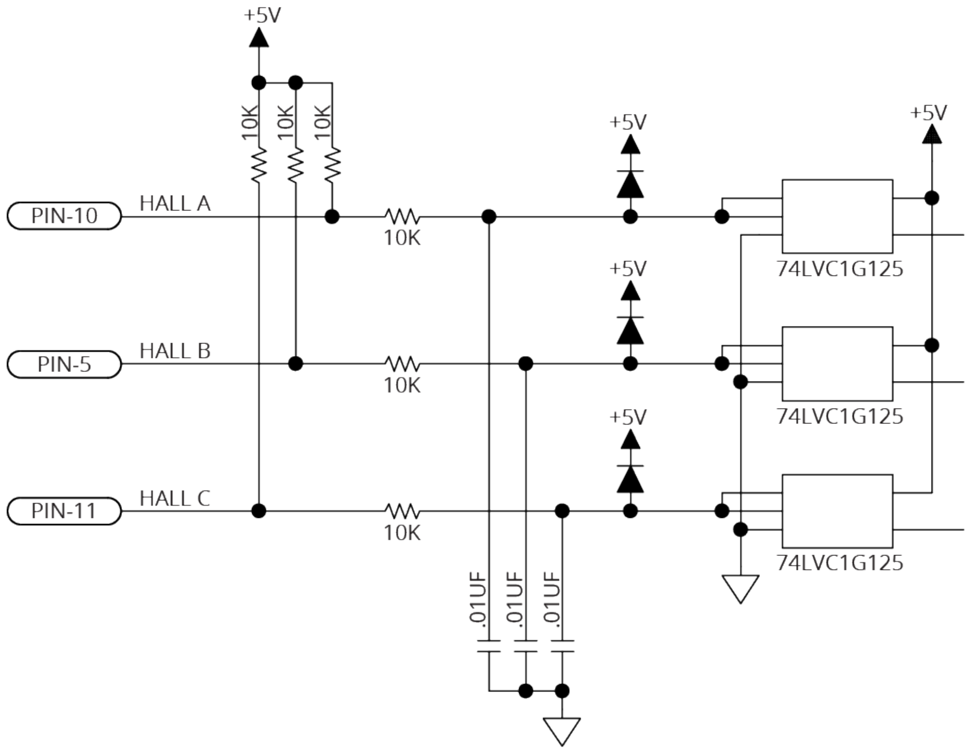


Figure 2-17: Hall-Effect Inputs Schematic (Feedback Connector)

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 2-14: Thermistor Input Pin on the Feedback Connector

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

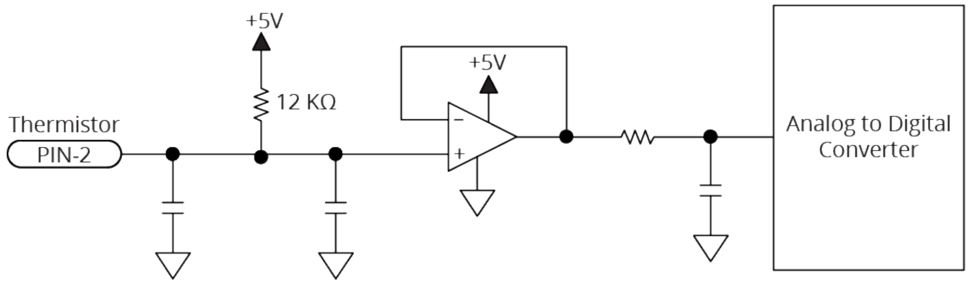


Figure 2-18: Thermistor Input Schematic (Feedback Connector)

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 2-15: Encoder Fault Input Pin on the Feedback Connector

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

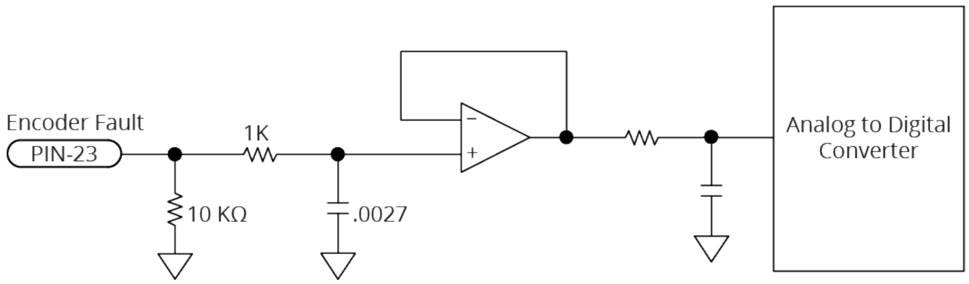


Figure 2-19: Encoder Fault Input Schematic (Feedback Connector)

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 2-22).

Table 2-16: 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 2-20 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.

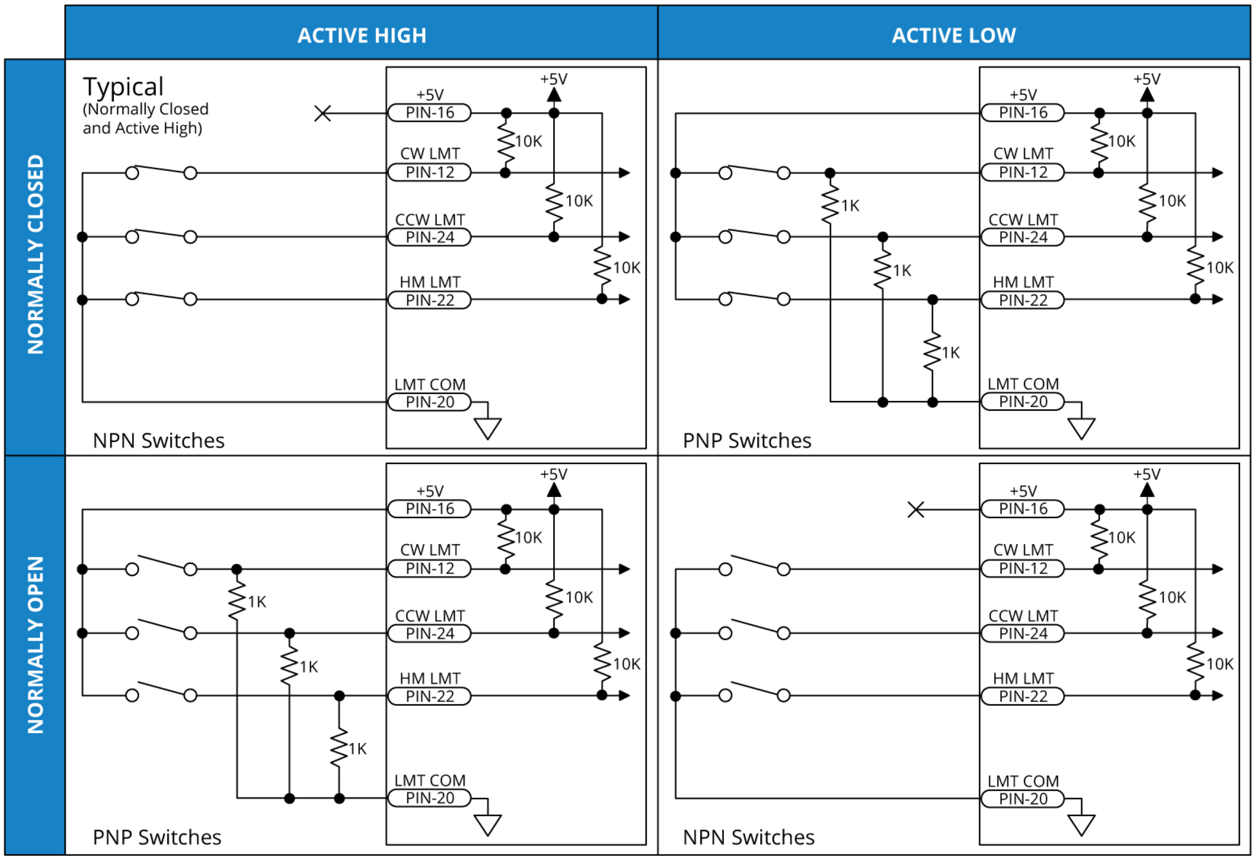


Figure 2-20: End of Travel and Home Limit Input Connections

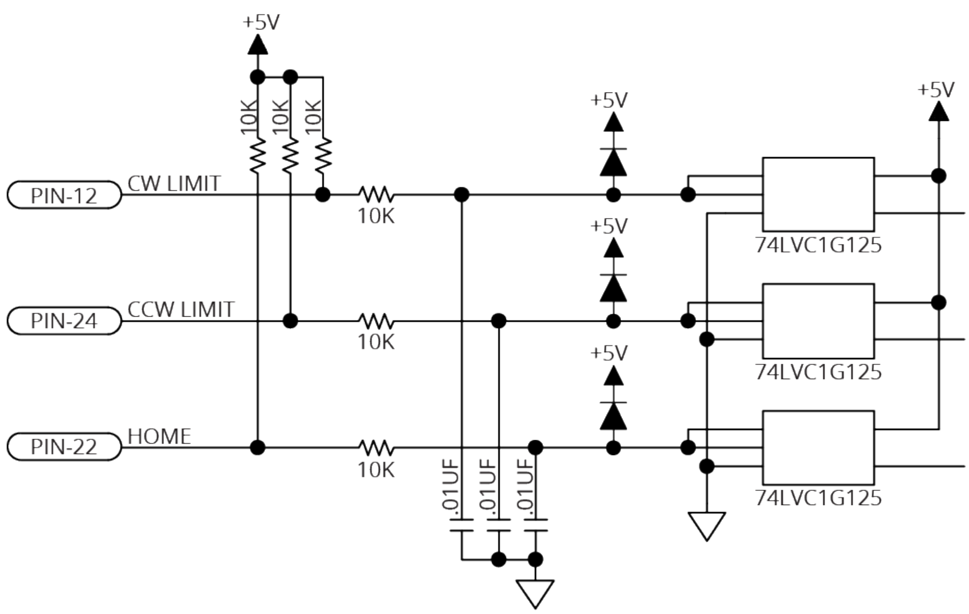


Figure 2-21: End of Travel and Home Limit Input Schematic (Feedback Connector)

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 2-22).

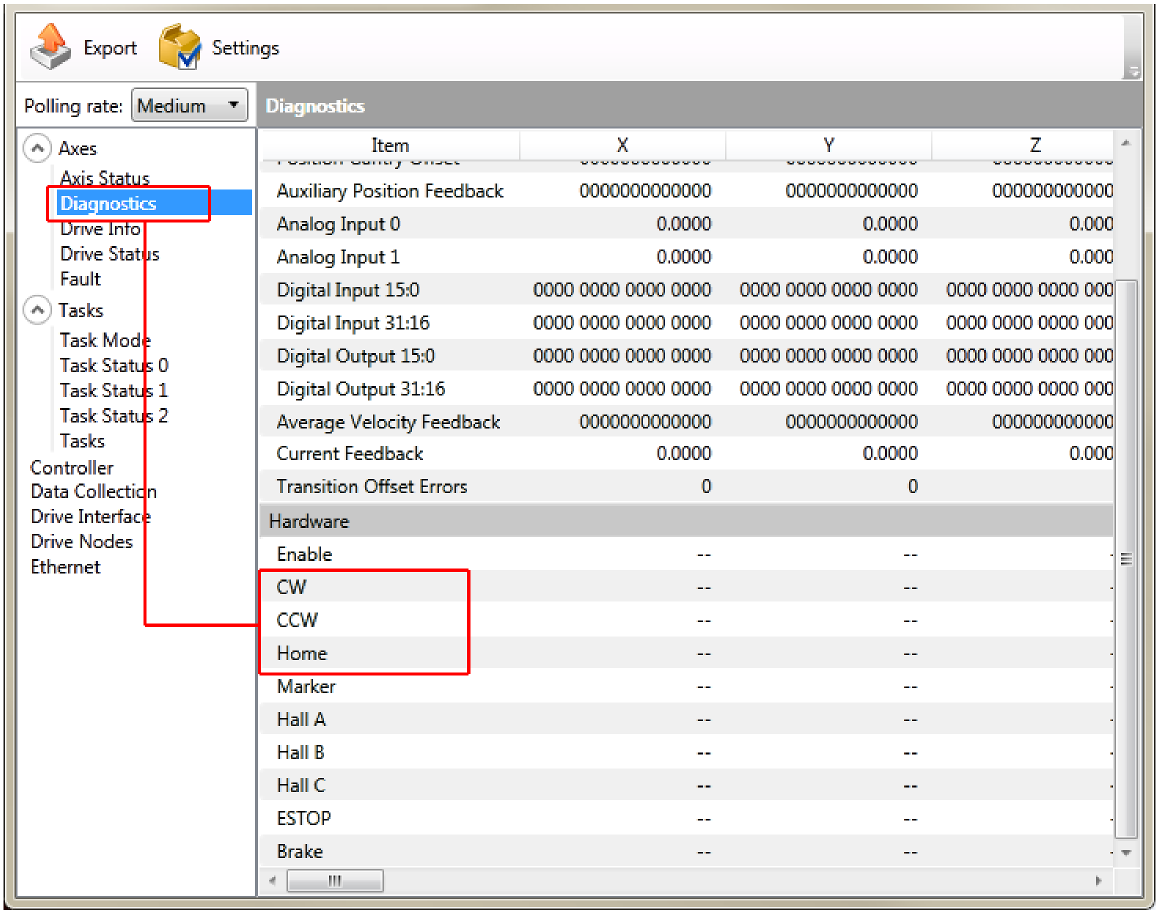


Figure 2-22: End of Travel and Home Limit Input Diagnostic Display

2.3.6. Brake Output

Each axis has a dedicated brake output circuit. An internal 24 V power supply is used to energize the brake. The brake output is driven by +24 V to release the brake.

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 the Help file for more information.

Table 2-17: Brake Output Pins on the Feedback Connector

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

Table 2-18: Brake Output Specifications

Specification	Value
Output Voltage	24 V
Output Current	.5 A
Total Brake Current with all Axes Combined	3 A

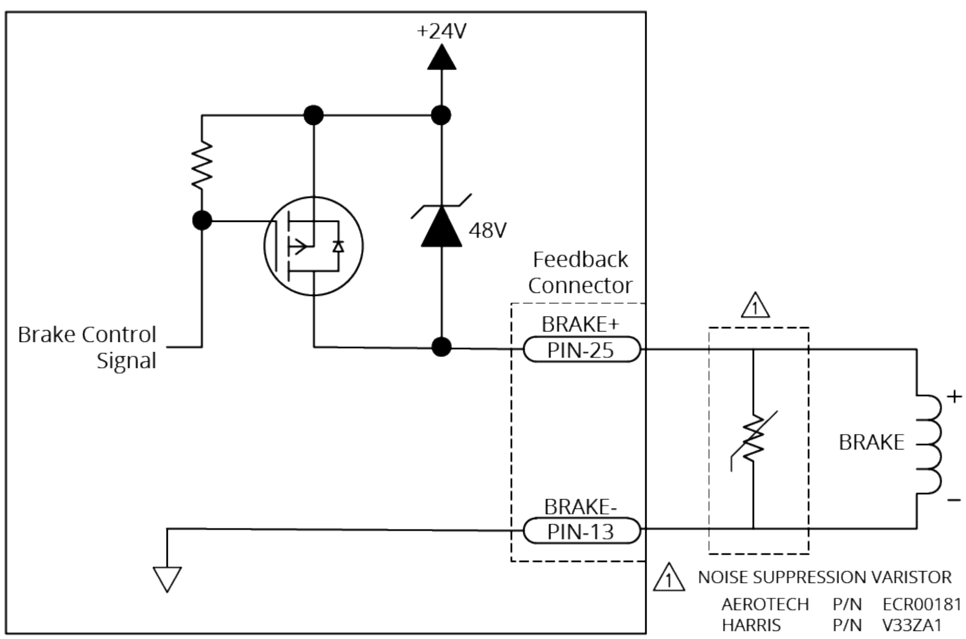


Figure 2-23: Brake Output Connections (Feedback Connector)

IMPORTANT: The brake itself will normally cause a small change in axis position when activated.

2.4. Position Synchronized Output Connector (PSO)

The PSO output signal is available in two signal formats:

- Isolated Signals (Section 2.4.1.)
- TTL Signals (Section 2.4.2.)

Table 2-19: PSO Connector Pinout

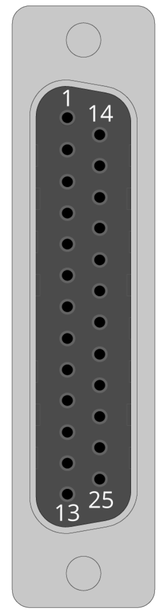
Pin #	Description	In/Out/Bi	Connector
1	Data Acquisition +	Input	
2	External PSO Sync 1 + [A3200: External PSO Sync 0 +]	Input	
3	External PSO Sync 1 - [A3200: External PSO Sync 0 -]	Input	
4	External PSO Sync 2 + [A3200: External PSO Sync 1 +]	Input	
5	External PSO Sync 2 - [A3200: External PSO Sync 1 -]	Input	
6	External PSO Sync 3 + [A3200: External PSO Sync 2 +]	Input	
7	External PSO Sync 3 - [A3200: External PSO Sync 2 -]	Input	
8	PSO Output 3 (5 V TTL) [A3200: PSO Output 2]	Output	
9	Ground	N/A	
10	PSO Output 2 (5 V TTL) [A3200: PSO Output 1]	Output	
11	Ground	N/A	
12	Ground	N/A	
13	PSO Output 1 (5 V TTL) [A3200: PSO Output 0]	Output	
14	Data Acquisition -	Input	
15	PSO Output 3 - (Isolated) [A3200: PSO Output 2 -]	Output	
16	PSO Output 3 + (Isolated) [A3200: PSO Output 2 +]	Output	
17	PSO Output 2 - (Isolated) [A3200: PSO Output 1 -]	Output	
18	PSO Output 2 + (Isolated) [A3200: PSO Output 1 +]	Output	
19	PSO Output 1 - (Isolated) [A3200: PSO Output 0 -]	Output	
20	PSO Output 1 + (Isolated) [A3200: PSO Output 0 +]	Output	
21	+5 V (500 mA max)	N/A	
22	+5 V (500 mA max)	N/A	
23	Key	N/A	
24	Ground	N/A	
25	Ground	N/A	

Table 2-20: PSO Specifications

Specification		Value
Maximum PSO Output (Fire) Frequency	TTL	12.5 MHz
	Isolated	5 MHz
Output Latency [Fire event to output change]	TTL	50 ns
	Isolated	150 ns
1. Signals in excess of this rate will cause a loss of PSO accuracy		

2.4.1. PSO Isolated Outputs

This output signal is a fully-isolated 5-24V compatible output capable of sourcing or sinking current. Refer to Figure 2-24 and Figure 2-25.

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.

Table 2-21: PSO Isolated Output Specification

Specification	Value
Outputs (±)	5-24 V, 250 mA

Table 2-22: Isolated Output Pins on the PSO Connector

Pin #	Description	In/Out/Bi
15	PSO Output 3 - (Isolated) [A3200: PSO Output 2 -]	Output
16	PSO Output 3 + (Isolated) [A3200: PSO Output 2 +]	Output
17	PSO Output 2 - (Isolated) [A3200: PSO Output 1 -]	Output
18	PSO Output 2 + (Isolated) [A3200: PSO Output 1 +]	Output
19	PSO Output 1 - (Isolated) [A3200: PSO Output 0 -]	Output
20	PSO Output 1 + (Isolated) [A3200: PSO Output 0 +]	Output

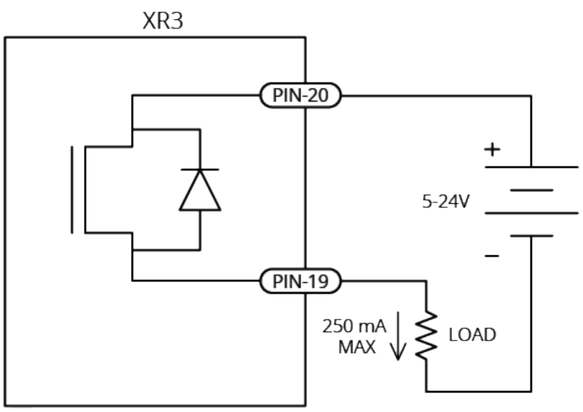


Figure 2-24: PSO Output Sources Current

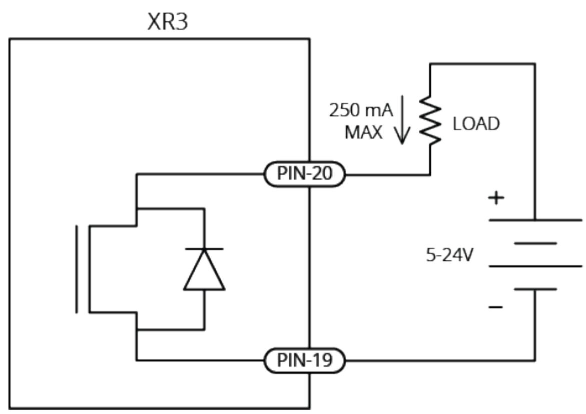


Figure 2-25: PSO Output Sinks Current

2.4.2. PSO TTL Outputs

This output signal is a 5V TTL signal which is used to drive an opto coupler or general purpose TTL input. The TTL PSO outputs are active high and designed to drive a 50 Ω minimum load.

Table 2-23: PSO TTL Outputs Specification

Specification	Value
Outputs (TTL)	5 V, 50 mA

Table 2-24: TTL Output Pins on the PSO Connector

Pin #	Description	In/Out/Bi
8	PSO Output 3 (5 V TTL) [A3200: PSO Output 2]	Output
9	Ground	N/A
10	PSO Output 2 (5 V TTL) [A3200: PSO Output 1]	Output
11	Ground	N/A
12	Ground	N/A
13	PSO Output 1 (5 V TTL) [A3200: PSO Output 0]	Output

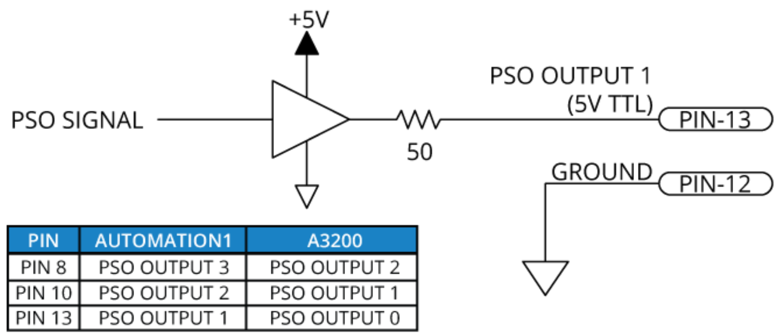


Figure 2-26: PSO TTL Outputs Schematic

2.4.3. External PSO Synchronization

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 2-25: External PSO Sync Input Pins on the PSO Connector

Pin #	Description	In/Out/Bi
2	External PSO Sync 1 + [A3200: External PSO Sync 0 +]	Input
3	External PSO Sync 1 - [A3200: External PSO Sync 0 -]	Input
4	External PSO Sync 2 + [A3200: External PSO Sync 1 +]	Input
5	External PSO Sync 2 - [A3200: External PSO Sync 1 -]	Input
6	External PSO Sync 3 + [A3200: External PSO Sync 2 +]	Input
7	External PSO Sync 3 - [A3200: External PSO Sync 2 -]	Input

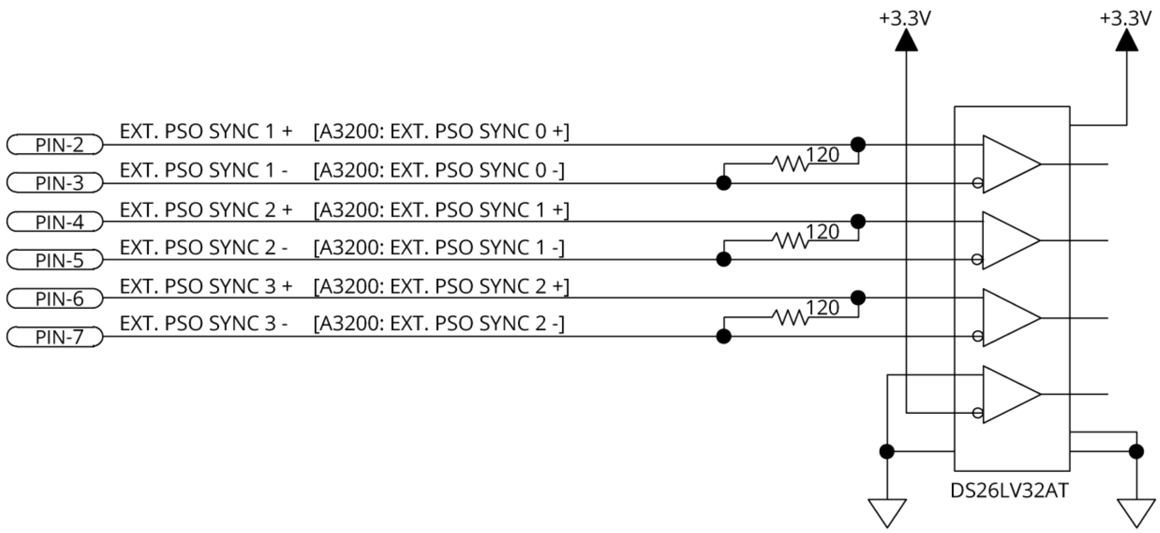


Figure 2-27: PSO Clock Inputs Schematic

2.4.4. Data Acquisition Inputs

The Data Acquisition ± input is used for the hardware Data Acquisition feature. The delay time through the high-speed opto devices is 50 nsec (typical). The high-speed input is scaled for 5-24 VDC input and can be used with sourcing or sinking drivers.

Table 2-26: Data Acquisition Input Pins on the PSO Connector

Pin #	Description	In/Out/Bi
1	Data Acquisition +	Input
14	Data Acquisition -	Input

Table 2-27: Data Acquisition Opto-Isolator Input Specifications

Specification (HCPL-0630)	Value
Input Voltage	5-24 V
Input Current	10 mA

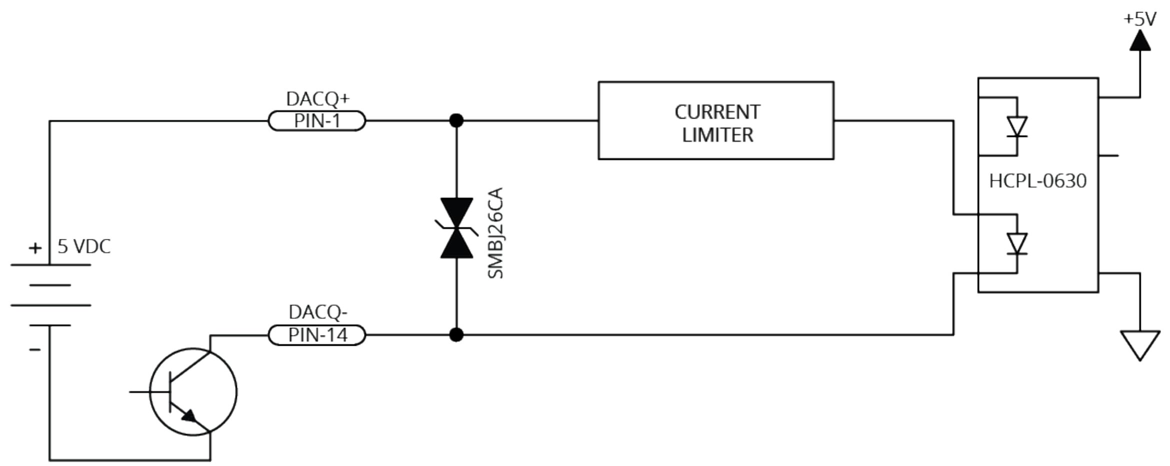


Figure 2-28: Data Acquisition Input Schematic

2.5. HSOUT Connector (High-Speed Outputs)

The HSOUT port is a 25 pin 'D' style connector located at the rear of the XR3 chassis. Each axis controls two high-speed RS-422 differential outputs which are software-configuratble, as explained below.

Table 2-28: High-Speed Output Specifications

Digital Output Specifications	Value
Maximum Output Rate	32 MHz
Maximum Encoder Multiplier Output Date (x4 decoding)	30 MHz counts / second
Maximum Encoder Echo Output Date (x4 decoding)	50 MHz counts / second

Table 2-29: HSOUT Connector Pinout

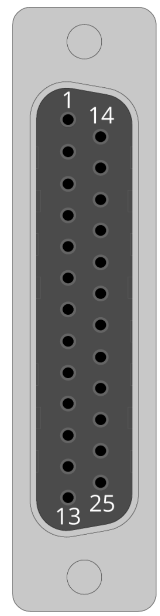
Pin #	Description	In/Out/Bi	Connector
3	Axis 1 High-Speed Output 0 +	Output	
2	Axis 1 High-Speed Output 0 -	Output	
1	Axis 1 High-Speed Output 1 +	Output	
14	Axis 1 High-Speed Output 1 -	Output	
16	Axis 2 High-Speed Output 0 +	Output	
15	Axis 2 High-Speed Output 0 -	Output	
4	Axis 2 High-Speed Output 1 +	Output	
5	Axis 2 High-Speed Output 1 -	Output	
7	Axis 3 High-Speed Output 0 +	Output	
6	Axis 3 High-Speed Output 0 -	Output	
18	Axis 3 High-Speed Output 1 +	Output	
17	Axis 3 High-Speed Output 1 -	Output	
20	Axis 4 High-Speed Output 0 +	Output	
19	Axis 4 High-Speed Output 0 -	Output	
8	Axis 4 High-Speed Output 1 +	Output	
9	Axis 4 High-Speed Output 1 -	Output	
11	Axis 5 High-Speed Output 0 +	Output	
10	Axis 5 High-Speed Output 0 -	Output	
23	Axis 5 High-Speed Output 1 +	Output	
22	Axis 5 High-Speed Output 1 -	Output	
25	Axis 6 High-Speed Output 0 +	Output	
24	Axis 6 High-Speed Output 0 -	Output	
12	Axis 6 High-Speed Output 1 +	Output	
13	Axis 6 High-Speed Output 1 -	Output	
21	Key	N/A	

Table 2-30: Mating Connector Part Numbers for the HSOUT Connector

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

Encoder Quadrature Output (compatible with -CT2 and -CT4 options)

The high-speed outputs can be used to transmit encoder quadrature signals. In this configuration, high-speed output 0 transmits the sine encoder signal and high-speed output 1 transmits the cosine encoder signal. For more information on transmitting encoder signals out of the XR3, refer to the encoder output functions [A3200: ENCODER OUT command] or pulse functions [A3200: PULSE command] command in the Help file.

Clock and Direction Output

The high-speed outputs can be used to transmit clock and direction signals for driving an external device. In this configuration, High-Speed Output 0 transmits the direction signal and High-Speed Output 1 transmits the clock signal. For more information on transmitting clock and direction signals out of the XR3, refer to the pulse functions [A3200: PULSE command] command in the Help file.

IMPORTANT: The High-Speed Output signal format is not directly compatible with clock and direction inputs found on most stepper motor drives. Use an external RS-422 line receiver to provide the signal level translation.

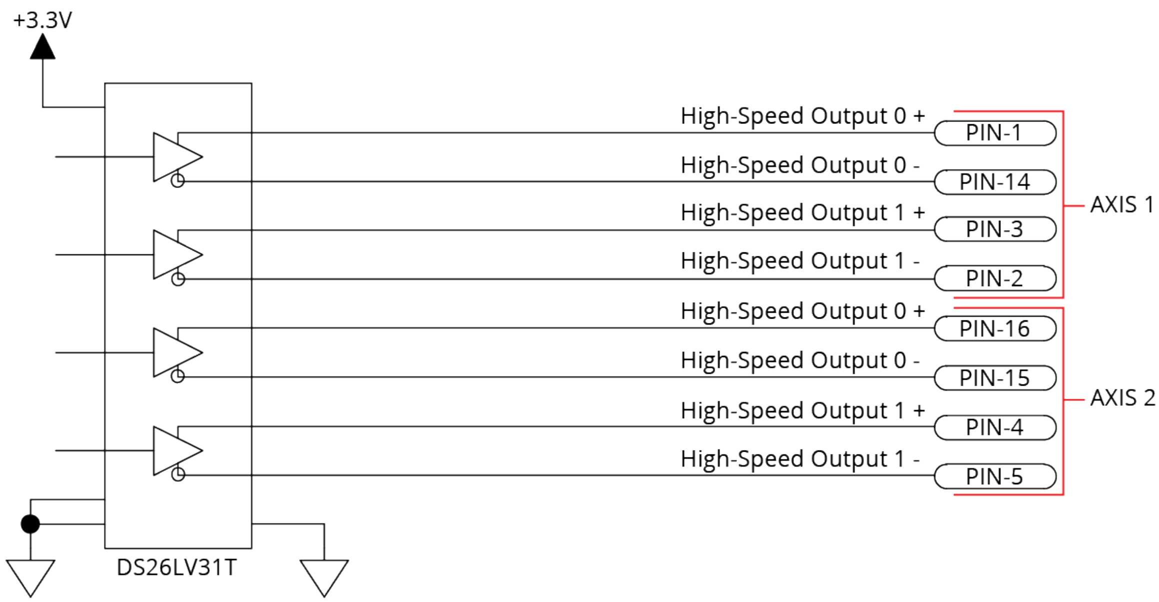


Figure 2-29: Diagram Showing Axis 1 and Axis 2 High-Speed Outputs

2.6. DOUT Connector (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 a port in the same configuration. Refer to Figure 2-31 and Figure 2-32.

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 2-31. To see an example of a current sinking output that has diode suppression, refer to Figure 2-32

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

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

Table 2-31: 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 2-32: DOUT Connector Digital Outputs Pinout

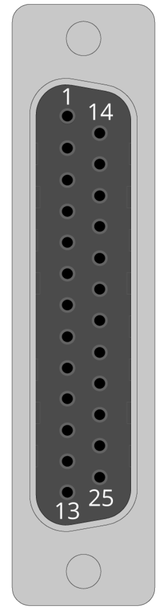
Pin #	Description	In/Out/Bi	Connector
1	Port 0 Digital Output Common	N/A	
2	Port 0 Digital Output 0	Output	
3	Port 0 Digital Output 1	Output	
4	Port 0 Digital Output 2	Output	
5	Port 0 Digital Output 3	Output	
6	Port 1 Digital Output Common	N/A	
7	Port 1 Digital Output 4	Output	
8	Port 1 Digital Output 5	Output	
9	Port 1 Digital Output 6	Output	
10	Port 1 Digital Output 7	Output	
11	+5 V	N/A	
12	+5 V	N/A	
13	Ground	N/A	
14	Port 2 Digital Output Common	N/A	
15	Port 2 Digital Output 8	Output	
16	Port 2 Digital Output 9	Output	
17	Port 2 Digital Output 10	Output	
18	Port 2 Digital Output 11	Output	
19	Port 3 Digital Output Common	N/A	
20	Port 3 Digital Output 12	Output	
21	Port 3 Digital Output 13	Output	
22	Port 3 Digital Output 14	Output	
23	Port 3 Digital Output 15	Output	
24	Ground	N/A	
25	Key	N/A	

Table 2-33: Mating Connector Part Numbers for the DOUT Connector

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

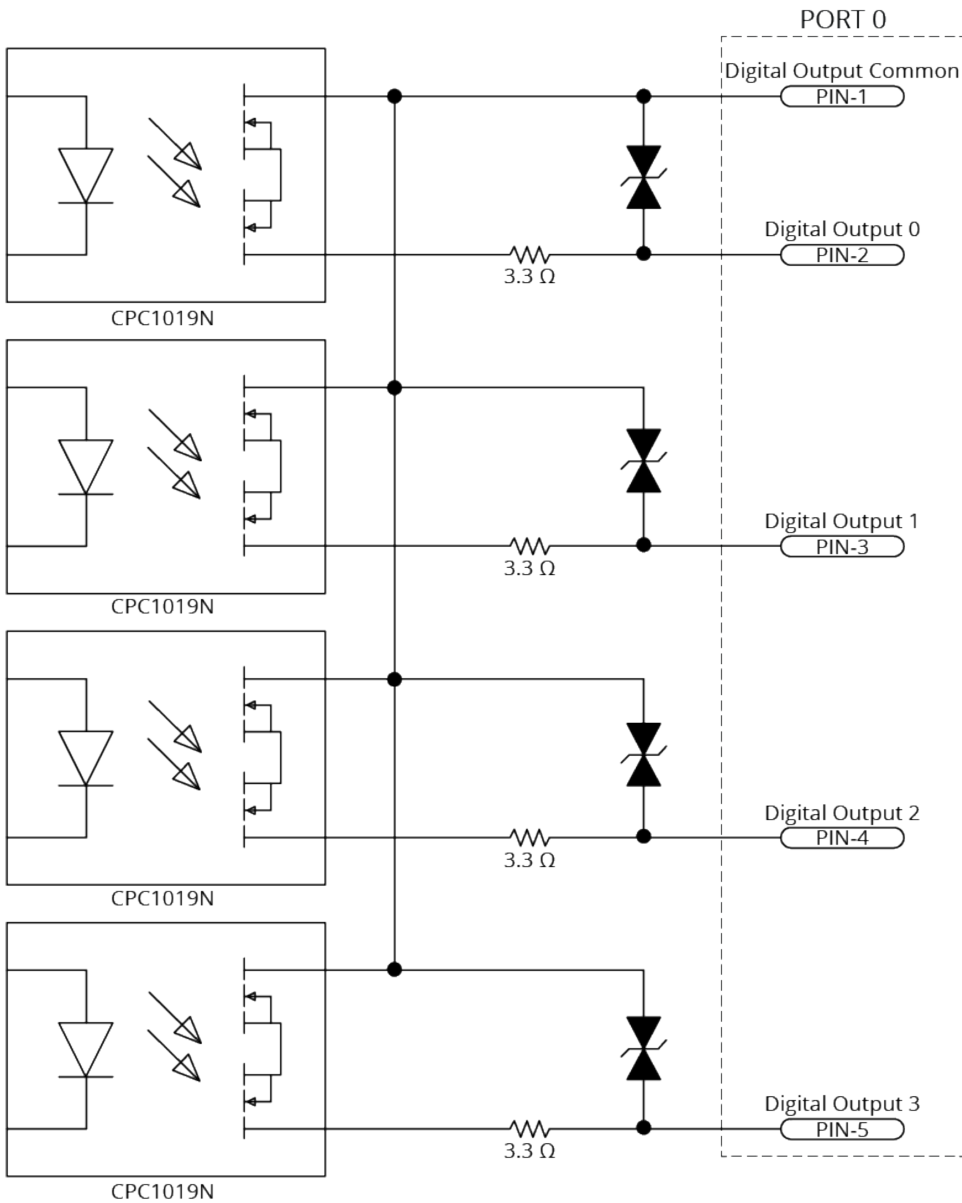


Figure 2-30: Digital Output Schematic

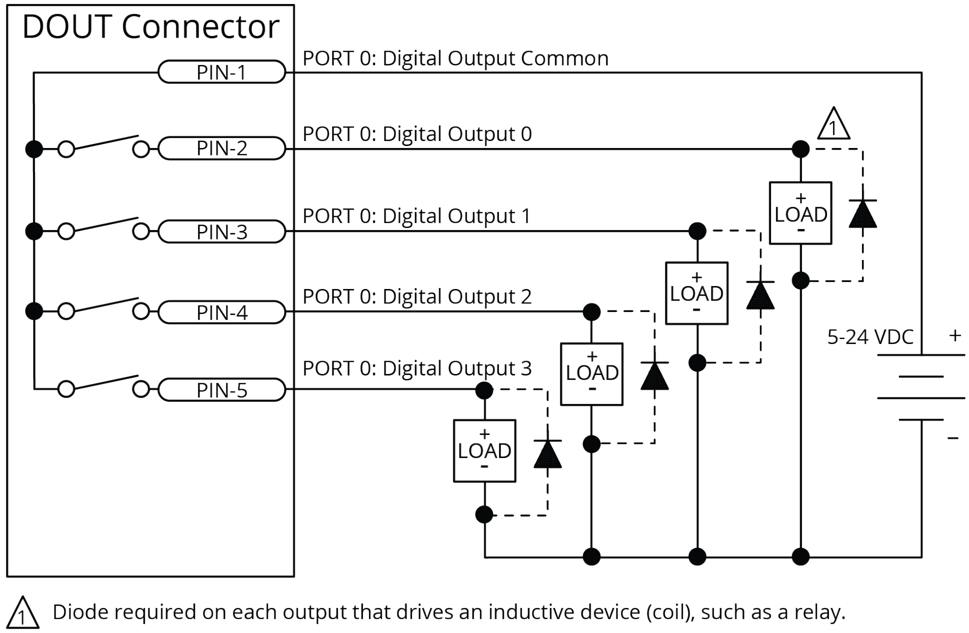


Figure 2-31: Digital Outputs Connected in Current Sourcing Mode

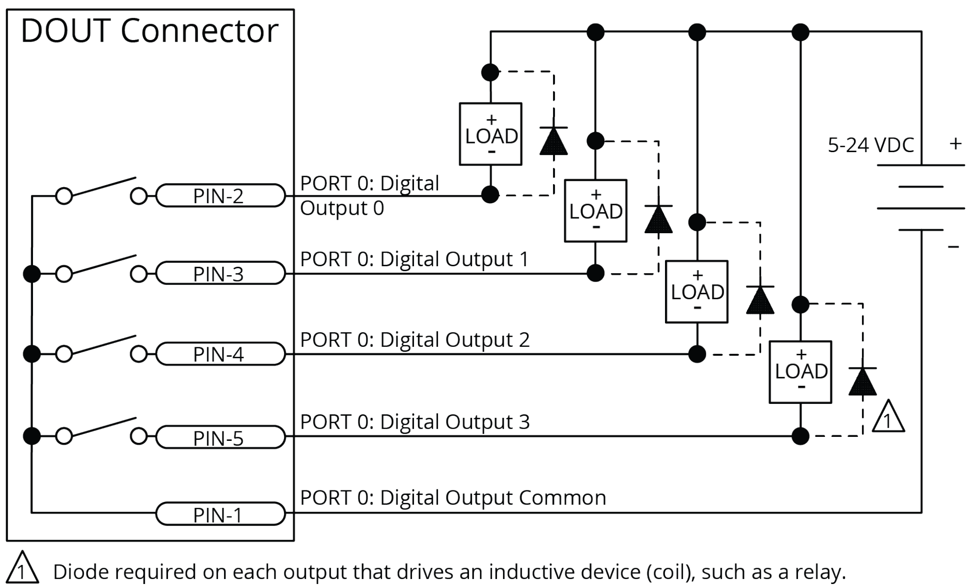


Figure 2-32: Outputs Connected in Current Sinking Mode

2.7. DIN Connector (Digital Inputs)

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 2-34.

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 2-35.

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

Table 2-34: DIN Connector Digital Inputs Pinout

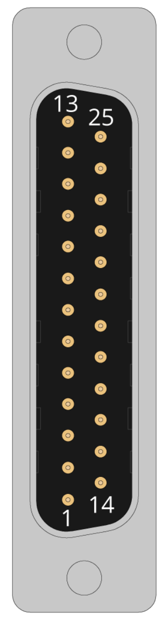
Pin #	Description	In/Out/Bi	Connector
1	Ground	N/A	
2	+5 V	N/A	
3	+5 V	N/A	
4	Port 3 Digital Input 15	Input	
5	Port 3 Digital Input 14	Input	
6	Port 3 Digital Input 13	Input	
7	Port 3 Digital Input 12	Input	
8	Port 3 Digital Input Common	N/A	
9	Port 2 Digital Input 11	Input	
10	Port 2 Digital Input 10	Input	
11	Port 2 Digital Input 9	Input	
12	Port 2 Digital Input 8	Input	
13	Port 2 Digital Input Common	N/A	
14	Ground	N/A	
15	Port 1 Digital Input 7	Input	
16	Port 1 Digital Input 6	Input	
17	Port 1 Digital Input 5	Input	
18	Port 1 Digital Input 4	Input	
19	Port 1 Digital Input Common	N/A	
20	Port 0 Digital Input 3	Input	
21	Port 0 Digital Input 2	Input	
22	Port 0 Digital Input 1	Input	
23	Port 0 Digital Input 0	Input	
24	Port 0 Digital Input Common	N/A	
25	Key	N/A	

Table 2-35: Mating Connector Part Numbers for the DIN Connector

Mating Connector	Aerotech P/N	Third Party P/N
25-Socket D-Connector	ECK00300	Cinch DB-25S
Backshell	ECK00656	Amphenol 17E-1726-2

Table 2-36: 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

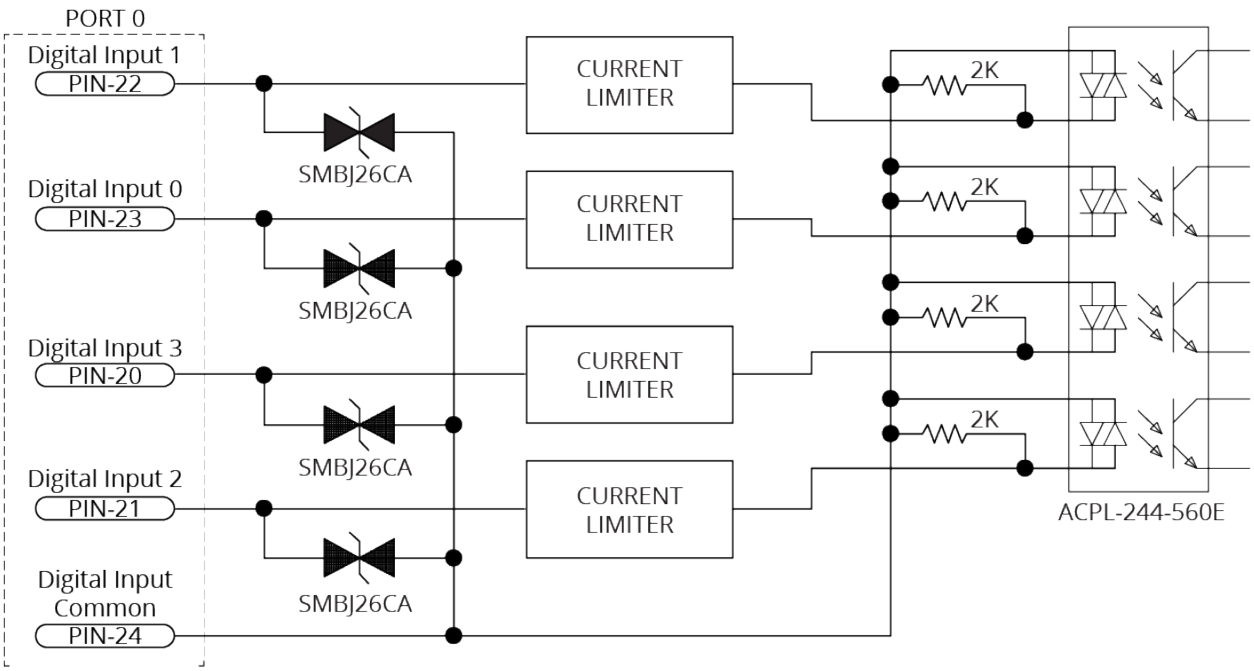


Figure 2-33: Digital Input Schematic

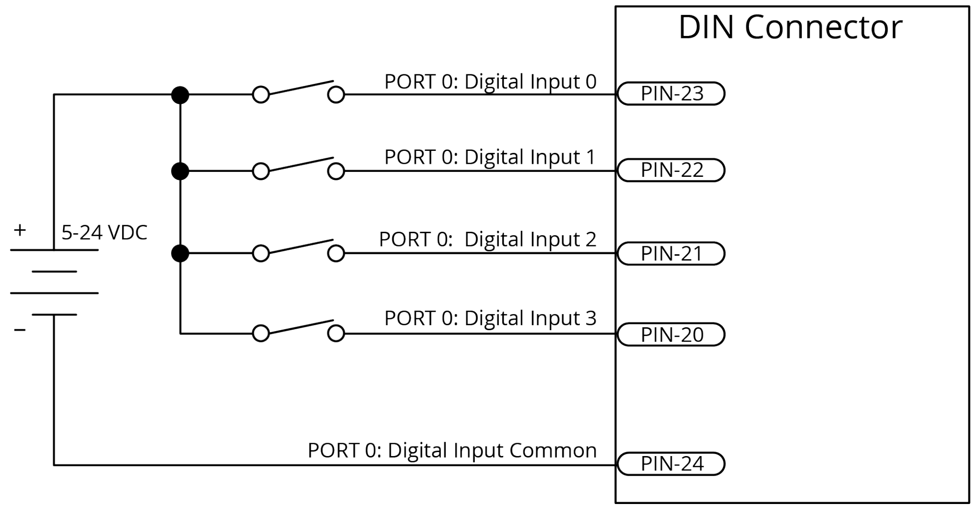


Figure 2-34: Digital Inputs Connected to Current Sourcing (PNP) Devices

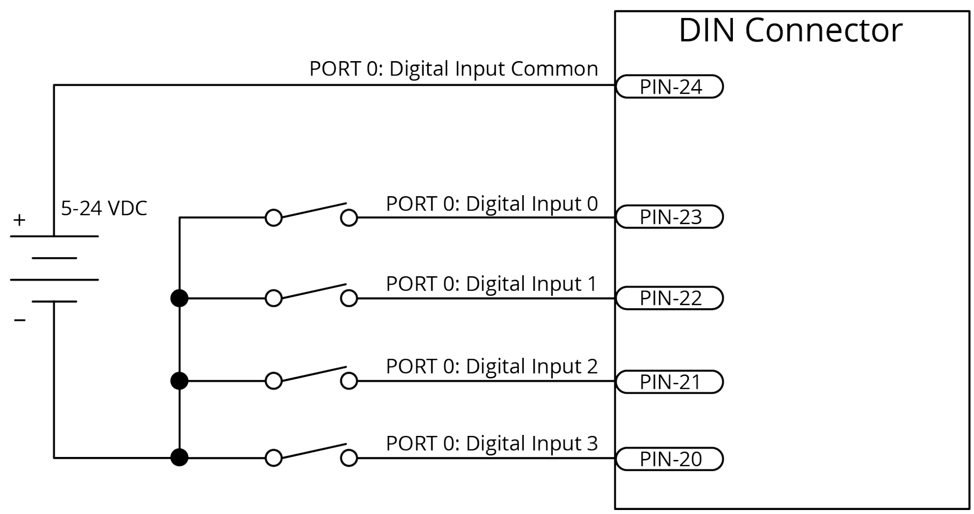


Figure 2-35: Digital Inputs Connected to Current Sinking (NPN) Devices

2.8. Aux Encoder Connectors

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 XR3 to accept an encoder signal type.

Square Wave encoder signals: Section 2.8.1.

Absolute encoder signals: Section 2.8.2.

Sine Wave encoder signals (with the -CT4 option): Section 2.8.3.

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

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 -CT2 or -CT4 option, incremental sine wave inputs. You cannot use the absolute encoder interface when you echo incremental signals.

Table 2-37: Aux Encoder Connector Pinout

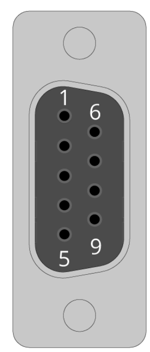
Pin #	Description	In/Out/Bi	Connector
1	Auxiliary Sine +	Bidirectional	
	Absolute Encoder Data +	Bidirectional	
2	Ground	N/A	
3	Auxiliary Cosine -	Bidirectional	
	Absolute Encoder Clock -	Output	
4	+5 VA Auxiliary Encoder Power	N/A	
5	Auxiliary Marker +	Input	
6	Auxiliary Sine -	Bidirectional	
	Absolute Encoder Data -	Bidirectional	
7	Ground	N/A	
8	Auxiliary Cosine +	Bidirectional	
	Absolute Encoder Clock +	Output	
9	Auxiliary Marker -	Input	

Table 2-38: Mating Connector Part Numbers for the Aux Encoder Connectors

Mating Connector	Aerotech P/N	Third Party P/N
9-Pin D-Connector	ECK00137	Cinch DE-9P
Backshell	ECK01021	Amphenol 17E-1724-2

2.8.1. Square Wave Encoder

The controller accepts RS-422 square wave encoder signals. The controller 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 2-39: Square Wave Encoder Specifications

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

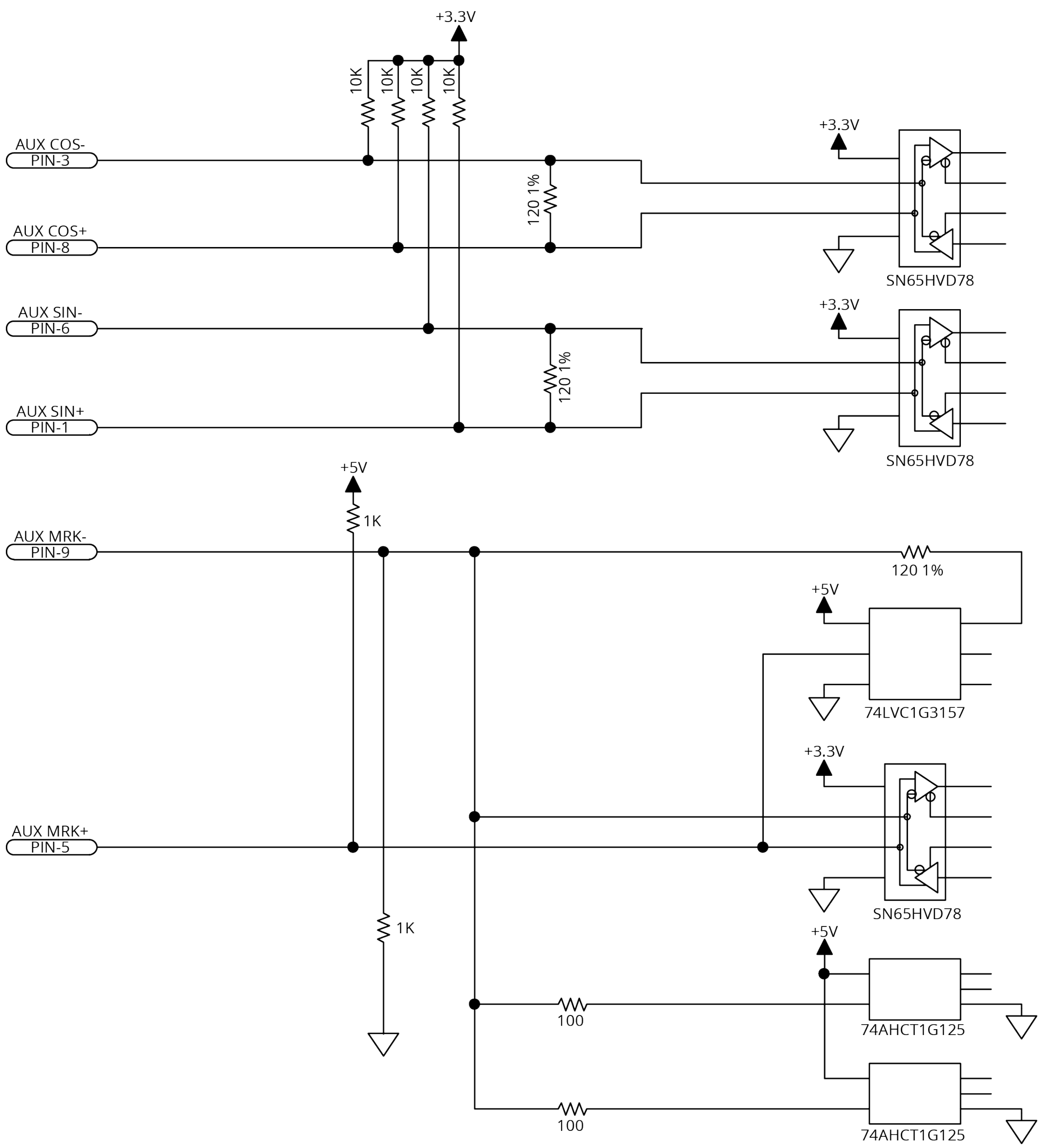


Figure 2-36: Square Wave Encoder Interface (Aux Encoder Connector)

2.8.2. Absolute Encoder

The controller 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 Aux Encoder Connector.

Refer to Figure 2-37 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.

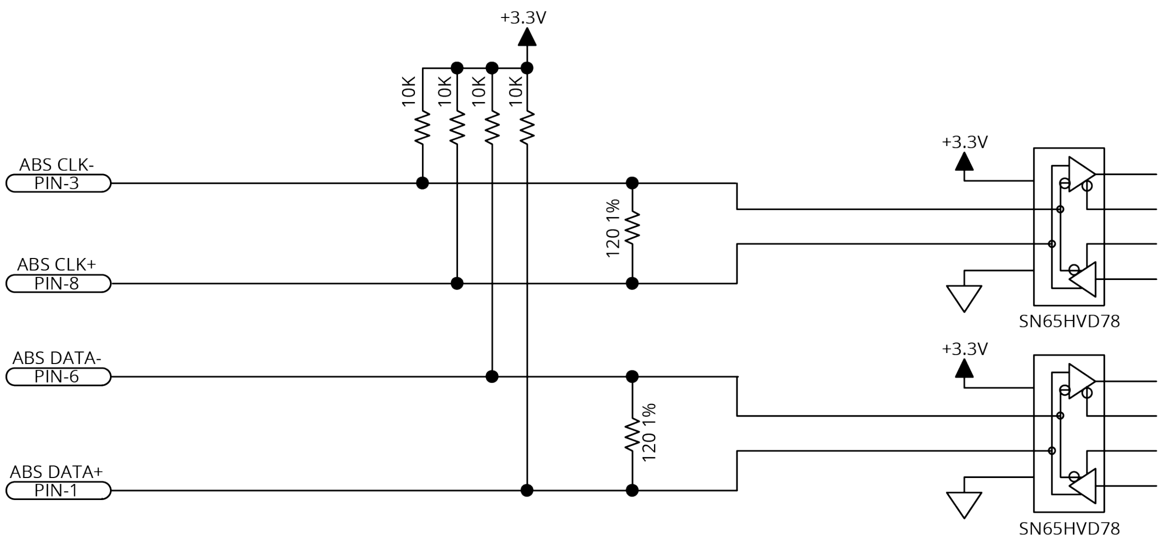


Figure 2-37: Absolute Encoder Schematic (Aux Encoder Connector)

2.8.3. Sine Wave Encoder [-CT4 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.

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

You can use a sine wave encoder with the -CT4 multiplier option as an input to the PSO. The -CT4 option generates 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 2-40: Sine Wave Encoder Specifications

Specification		Value	
		Primary	Auxiliary
Input Frequency (max)		450 kHz, 2 MHz	
Input Amplitude (1)		0.6 to 1.75 Vpk-pk	
Interpolation Factor (max)	-CT1	16,384	N/A
	-CT2	65,536	N/A
	-CT4	65,536	65,536
-CT2/-CT4 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(-)			

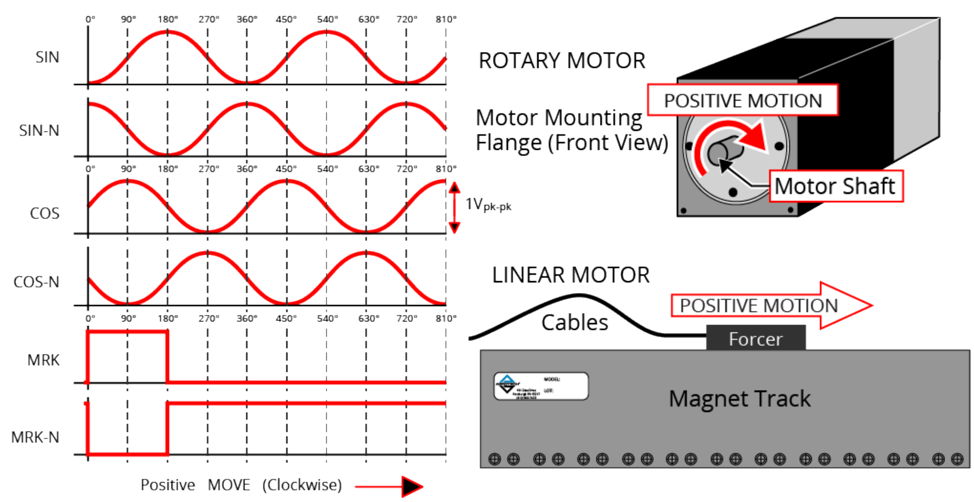


Figure 2-38: Sine Wave Encoder Phasing Reference Diagram

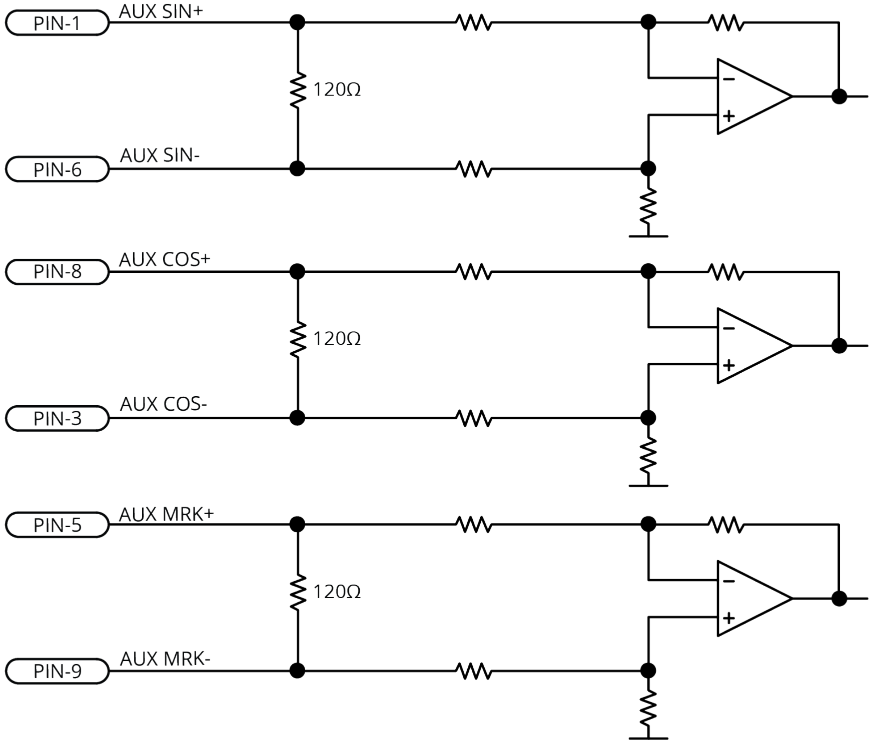


Figure 2-39: Sine Wave Encoder Schematic (Aux Encoder Connector)

2.9. Analog I/O Connectors

There is a 15-pin D-style Analog I/O connector for each axis accessible at the rear of the XR3 chassis. The Analog I/O interface provides the user with two differential 16-bit analog inputs and two single-ended 16-bit analog outputs.

IMPORTANT: Analog inputs 0 and 1 are required for Joystick operation. They will not be otherwise accessible if a joystick option is present (see Section 2.9.3.).

Table 2-41: Analog I/O Connector Pinout

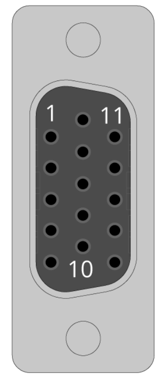
Pin #	Description	In/Out/Bi	Connector
1	Analog Input 0+	Input	
2	Analog Input 0-	Input	
3	Ground	N/A	
4	Analog Output 0	Output	
5	Ground	N/A	
6	Analog Input 1 +	Input	
7	Analog Input 1 -	Input	
8	Ground	N/A	
9	Analog Output 1	Output	
10	Ground	N/A	
11	+5 VA	N/A	
12	Ground	N/A	
13	Joystick Button A	Input	
14	Joystick Button B	Input	
15	Joystick Interlock	Input	

Table 2-42: Mating Connector Part Numbers for the Analog I/O Connectors

Mating Connector	Aerotech P/N	Third Party P/N
15-Pin D-Connector	ECK01287	Amphenol 17EHD-015P-AA000
Backshell	ECK01021	Amphenol 17-1724-2

2.9.1. Analog Outputs

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

The analog outputs are set to zero when you power on the system or reset the drive.

Table 2-43: Analog Output Specifications

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

Table 2-44: Analog Output Pins on the Analog I/O Connector

Pin #	Description	In/Out/Bi
3	Ground	N/A
4	Analog Output 0	Output
5	Ground	N/A
8	Ground	N/A
9	Analog Output 1	Output
10	Ground	N/A
12	Ground	N/A

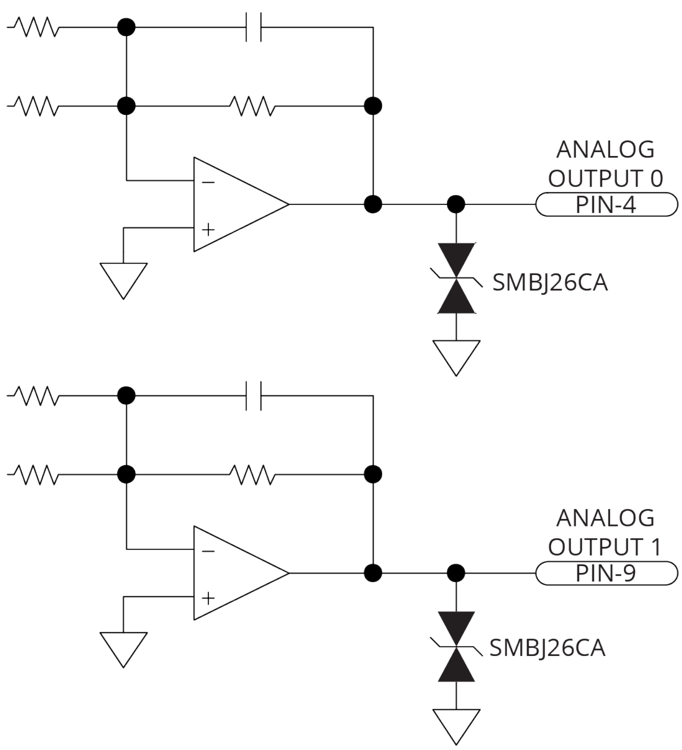


Figure 2-40: Analog Outputs Schematic

2.9.2. Analog Inputs (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 2-41.

Table 2-45: 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 2-46: Analog Input Pins on the Analog I/O Connector

Pin #	Description	In/Out/Bi
1	Analog Input 0+	Input
2	Analog Input 0-	Input
3	Ground	N/A
5	Ground	N/A
6	Analog Input 1 +	Input
7	Analog Input 1 -	Input
8	Ground	N/A
10	Ground	N/A
12	Ground	N/A

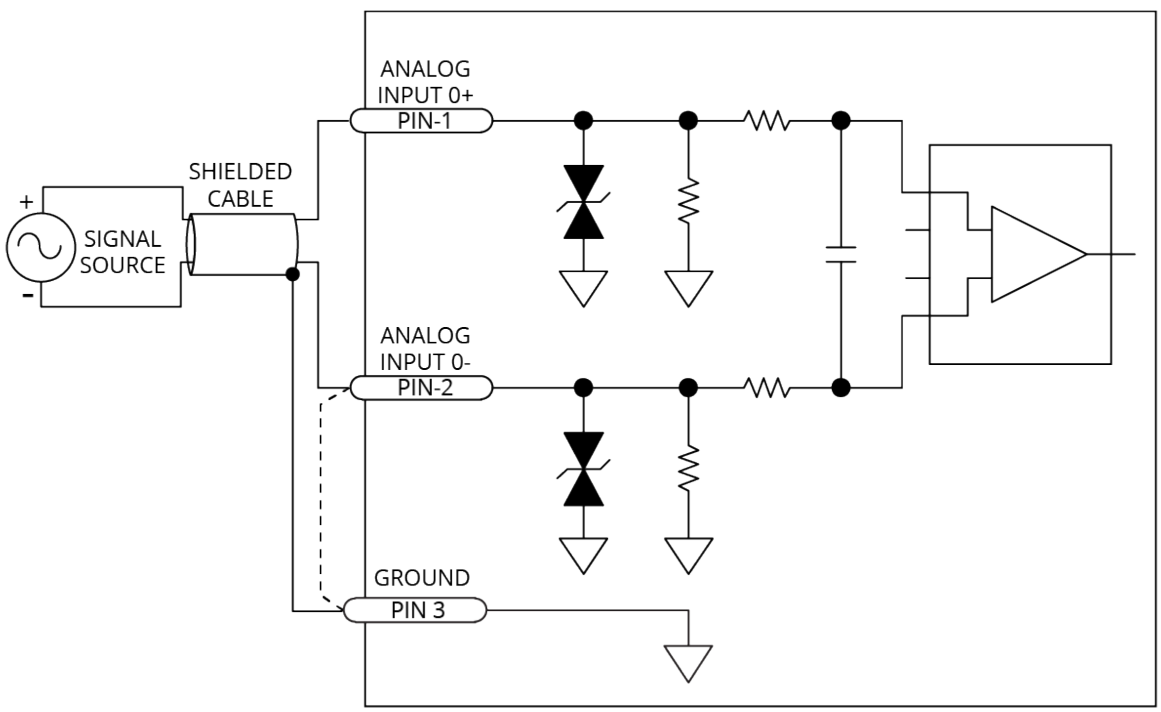


Figure 2-41: Analog Inputs Schematic

2.9.3. Joystick Interface

The Joystick Interface uses the two analog inputs and three dedicated inputs on the Analog I/O connector. Joystick operation requires that the two analog inputs be configured as single-ended inputs. The joystick interface is shown in Figure 2-42. Figure 2-43 shows you how to connect a joystick to the Analog I/O connector.

Table 2-47: Joystick Interface Pins on the Analog I/O Connectors

Pin #	Description	In/Out/Bi
1	Analog Input 0+	Input
2	Analog Input 0-	Input
6	Analog Input 1 +	Input
7	Analog Input 1 -	Input
11	+5 VA	N/A
12	Ground	N/A
13	Joystick Button A	Input
14	Joystick Button B	Input
15	Joystick Interlock	Input

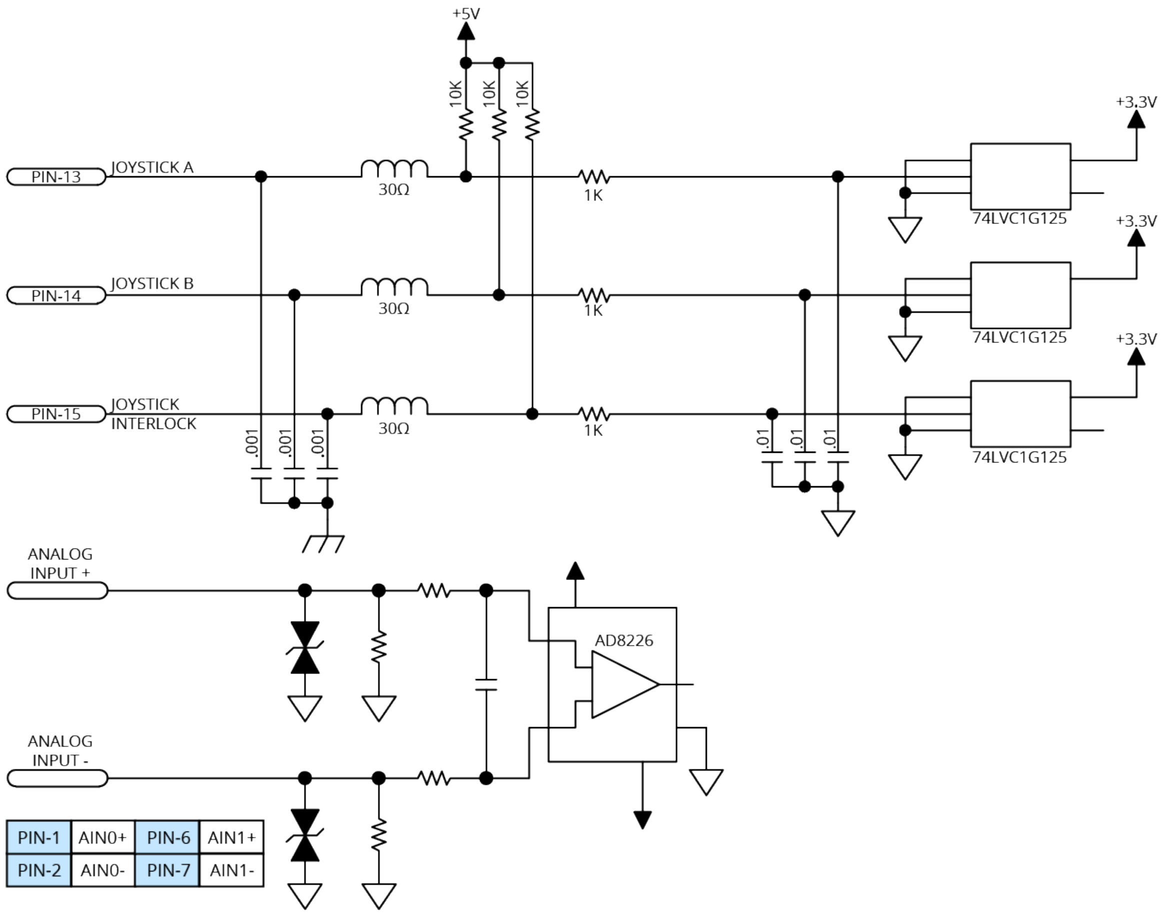


Figure 2-42: Joystick Interface Inputs Schematic

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 -10V to +10V.

Refer to the Help file for programming information about how to change joystick parameters.

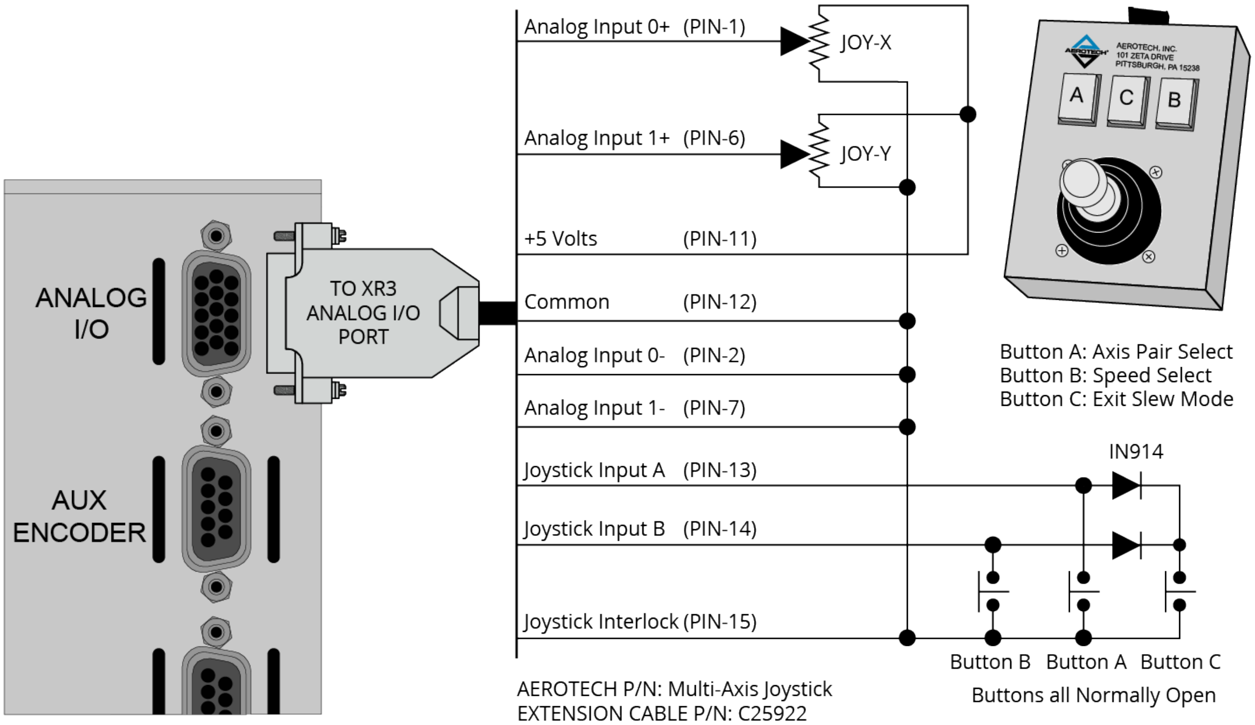


Figure 2-43: Joystick Cable Wiring Schematic

2.10. Safe Torque Off Input (STO)

The STO circuit is comprised of two identical channels, each of which must be energized in order for the controller to produce motion. Each channel is opto-isolated and provides individual connections to each terminal of the opto-coupler LED. Current limiting resistors are provided internally and the STO inputs are designed to work with 24 V signals.

IMPORTANT: The controller might be equipped with an STO bypass plug. The bypass plug defeats the STO safety circuit and allows the system to run at all times. To use the STO safety functionality, remove the plug 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 controller.

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

Table 2-48: STO Connector Pinout

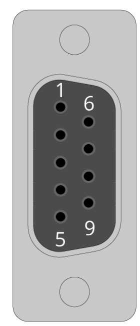
Pin #	Signal	Description	In/Out/Bi	Connector
1	STO 1+	STO Channel 1 Positive Input	Input	
2	STO 2+	STO Channel 2 Positive Input	Input	
3	Reserved	Reserved	N/A	
4	Power Supply +	Used to defeat STO by connecting to STO 1+ and STO 2+	N/A	
5	Reserved	Reserved	N/A	
6	STO 1-	STO Channel 1 Negative Input	Input	
7	STO 2-	STO Channel 2 Negative Input	Input	
8	Reserved	Reserved	N/A	
9	Power Supply -	Used to defeat STO by connecting to STO 1- and STO 2-	N/A	

Table 2-49: Mating Connector Part Numbers for the STO Connector

Mating Connector	Aerotech P/N	Third Party P/N
9-Pin D-Connector	ECK00137	Cinch DE-9P
Backshell	ECK01021	Amphenol 17E-1724-2

Table 2-50: 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 2-44 shows one safety device connected to multiple controllers in parallel.

WARNING: The controller 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.

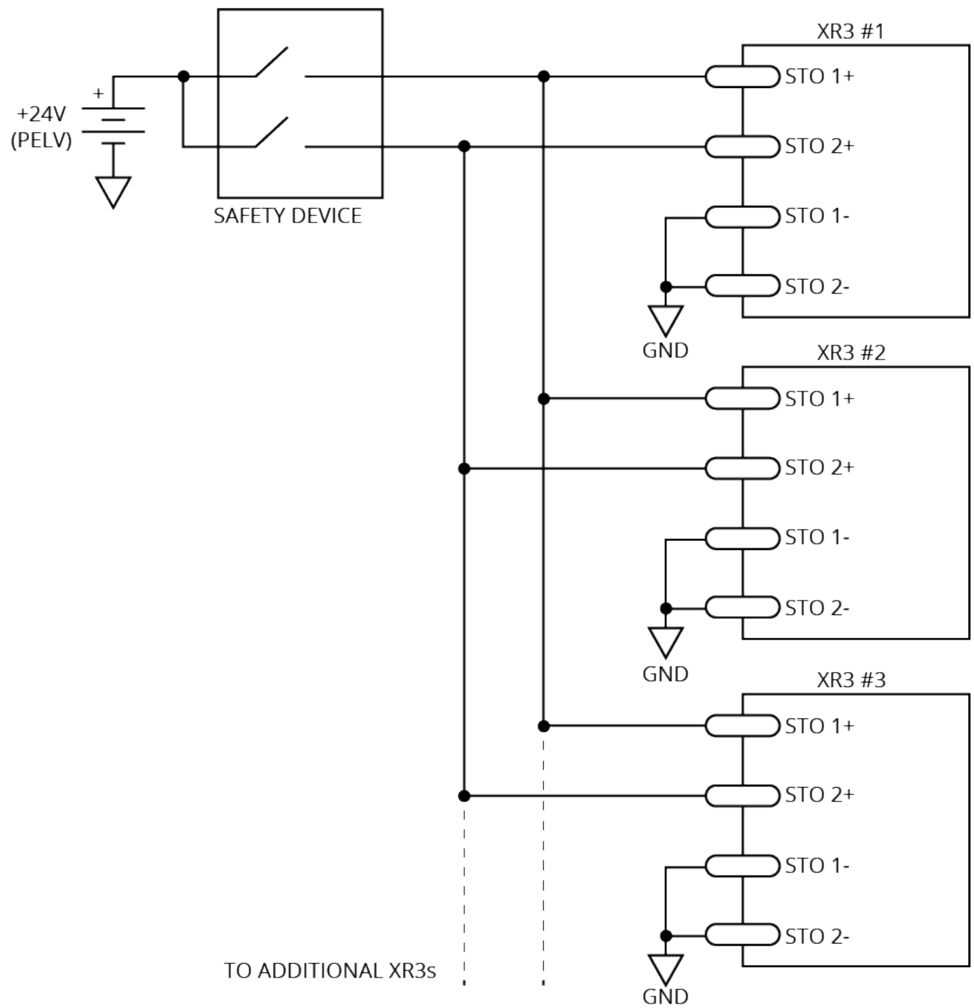


Figure 2-44: Typical Configuration

2.10.1. STO Standards

Table 2-51 describes and specifies the safety requirements at the system level for the Safe Torque Off (STO) feature of the XSP3-10, -20, -30 and XSL3-10-40 products. This assumes that diagnostic testing is performed according to Section 2.10.4. and Table 2-52.

Table 2-51: 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 2-52: 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: • 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%

2.10.2. 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 controller from being able to produce motion.

The controller 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 controller 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 controller will tolerate short diagnostic pulses on the STO 1+ and STO 2+ inputs. The parameter "STOPulseFilter" specifies the maximum pulse width that the controller 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 controller's STO inputs. Connect the ESTOP signal directly to a digital input, in addition to the external timer, to allow the controller 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 2-53: STO Signal Delay

	Value
STO Time Delay	450-550 msec

Table 2-54: 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 2.10.4.		

2.10.3. 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.

2.10.4. STO Diagnostics

Activation of STO means removing power from the controller's STO inputs. This is typically done by pressing the emergency stop switch. The controller 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 controller 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 2.10.3.). 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 2-52.

Table 2-55: 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

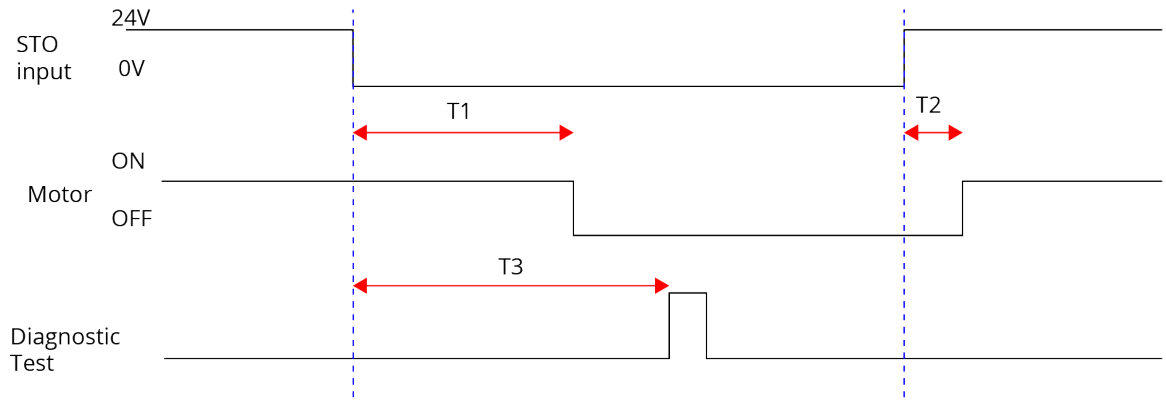


Figure 2-45: STO Timing

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.

2.11. 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 2-56: HyperWire Card Part Number

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

Table 2-57: 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

2.12. Cooling Options [-C0/-C1/-C2 Option]

WARNING: To prevent the XR3 from over-heating, do not obstruct the airflow path at the perforated covers on the chassis.

The XR3 has a standard rear fan on all models. The fan pulls air into the chassis. Refer to Figure 2-46.

Figure 2-46: Location of the Rear Fan and Air Flow

Built In Cooling [-C0]

Built-in fans pull cooling air from the left side through the amplifier compartment. Refer to Figure 2-47.

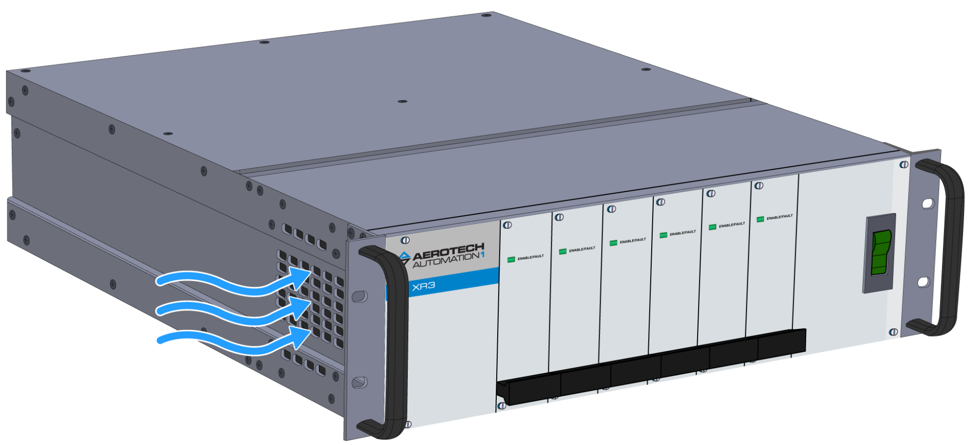


Figure 2-47: -C0 Fan Location and Direction of Air Flow

External Cooling Option [-C1]

If you ordered an XR3 with the External Cooling option, you will be required to provide forced air-cooling to the XR3 drive chassis. Provide cooling to the XR3 by directing the airflow through the perforated covers of the XR3 chassis. Refer to Figure 2-48.

Table 2-58: -C1 Option Airflow Specifications

Amplifier Type	Airflow Specification
XSP Amplifiers (PWM)	50 CFM
XSL Amplifiers (linear)	300 CFM

Figure 2-48: -C1 Model Showing Perforated Covers for External Fans

Fan Tray Option [-C2]

If you ordered an XR3 with the Fan Tray option, Aerotech will attach a 1U fan tray to the bottom of the chassis at the factory. The tray houses two fans that will direct airflow through the XR3 drive chassis from the bottom to the top. Refer to Figure 2-49. The dimensions of the XR3 with the optional fan trays are shown in Section 1.2.

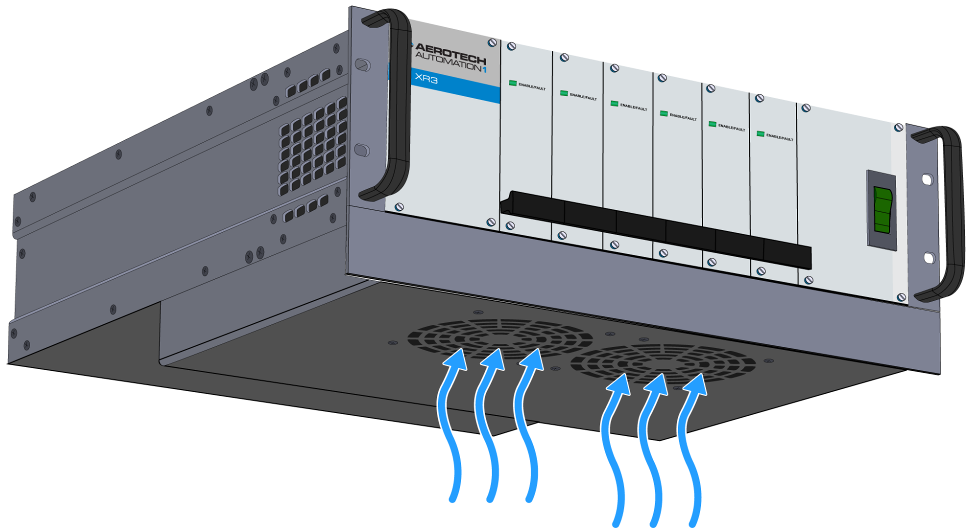


Figure 2-49: -C2 1U Fan Location and Air Flow

2.13. 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: Maintenance

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

- Do not remove the cover of the XR3.
- 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 3-1: 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. or The light is configured to blink for setup.

Table 3-2: 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.

3.1. Preventative Maintenance

Do an inspection of the XR3 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 3-3: 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 controller.
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 XR3, disconnect the electrical power from the drive.

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

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

3.2. Fuse Specifications

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

Always disconnect the Mains power connection before opening the XR3 chassis. Fuses must not be changed with Mains power applied to the unit.

The fuses on the drive interface board are factory-configured based on the bus voltage configuration that you ordered. The fuses are not likely to blow under normal operating conditions.

The most likely reason for a fuse to blow is if you have connected the unit to the wrong AC line voltage.

Table 3-4: Drive Interface Board Motor Power Fuse Replacement Part Numbers

Bus	Fuse	Description	Aerotech P/N	Manufacturer P/N
Bus 1	F1 (-VB1 to -VB2)	2 A SLO BLO, 3AG	EIF00102	Littelfuse 313002
	F1 (-VB3 to -VB5)	3 A SLO BLO, 3AG	EIF00103	Littelfuse 313003
	F1 (-VB7 to -VB8)	Not Used	--	--
	F2 (-VB1 to -VB5)	4 A SLO BLO, 3AG	EIF00104	Littelfuse 313004
	F2 (-VB7 to -VB8)	7 A SLO BLO, 3AG	EIF00107	Littelfuse 313007
Bus 2	F3 (-VB1 to -VB2)	2 A SLO BLO, 3AG	EIF00102	Littelfuse 313002
	F3 (-VB3 to -VB5)	3 A SLO BLO, 3AG	EIF00103	Littelfuse 313003
	F3 (-VB7 to -VB8)	Not Used	--	--
	F4 (-VB1 to -VB5)	4 A SLO BLO, 3AG	EIF00104	Littelfuse 313004
	F4 (-VB7 to -VB8)	7 A SLO BLO, 3AG	EIF00107	Littelfuse 313007

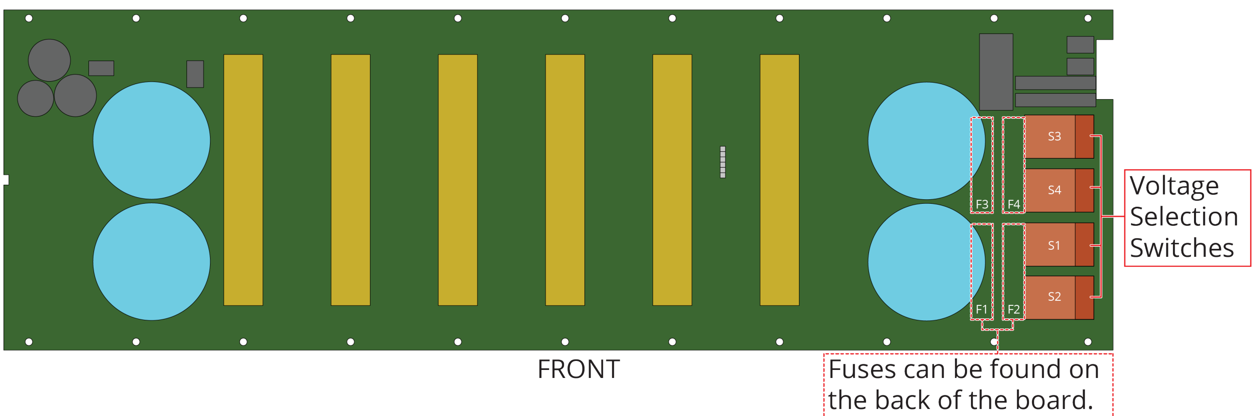


Figure 3-1: Drive Interface Board

IMPORTANT: Due to inrush currents, these fuses must be of the Slow Blow type.

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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: Voltage Selection Operation

DANGER: Disconnect Mains power before opening chassis. Voltage selector settings must not be changed with Mains power applied to the unit.

DANGER: Wait at least ten (10) minutes after removing the power supply before performing maintenance or an inspection. Otherwise, there is the danger of electric shock.

WARNING: The voltage selector must be configured to match the AC line voltage and is factory-configured based on the options that you ordered. You could damage the unit if the voltage selector is set for the incorrect AC input voltage.

The voltage selector can only be used with transformer-derived bus voltages. This voltage selector function should not be changed when using off-line supplies. Damage to the unit may result if this function is used improperly.

If the user changes the voltage selector settings, it is also the user's responsibility to change the XR3 AC power label located next to the AC inlet. Refer to the Section 1.1. for power ratings.

Procedure for setting AC voltage selector switches:

1. Turn-off and disconnect all power from unit.
2. Remove the four screws that secure the panel on the front of the XR3
3. Carefully remove the panel without pulling out the wiring connected to the Power Switch.
4. Use Table B-1 to set all of the voltage selector switches to the position indicated for the desired operating voltage.

WARNING: Table B-1 applies to the Drive Interface Board with the P/N: EFN01746-01 (manual revision 1.00.00 and up). Customers with the Beta hardware and Beta manual revision should contact Aerotech for more information if you need to change voltage settings.

Table B-1: AC Voltage Selector Switch Settings

	S1	S2	S3	S4
100 VAC	A	B	A	B
115 VAC	A	A	A	A
200 VAC	B	B	B	B
230 VAC	B	A	B	A

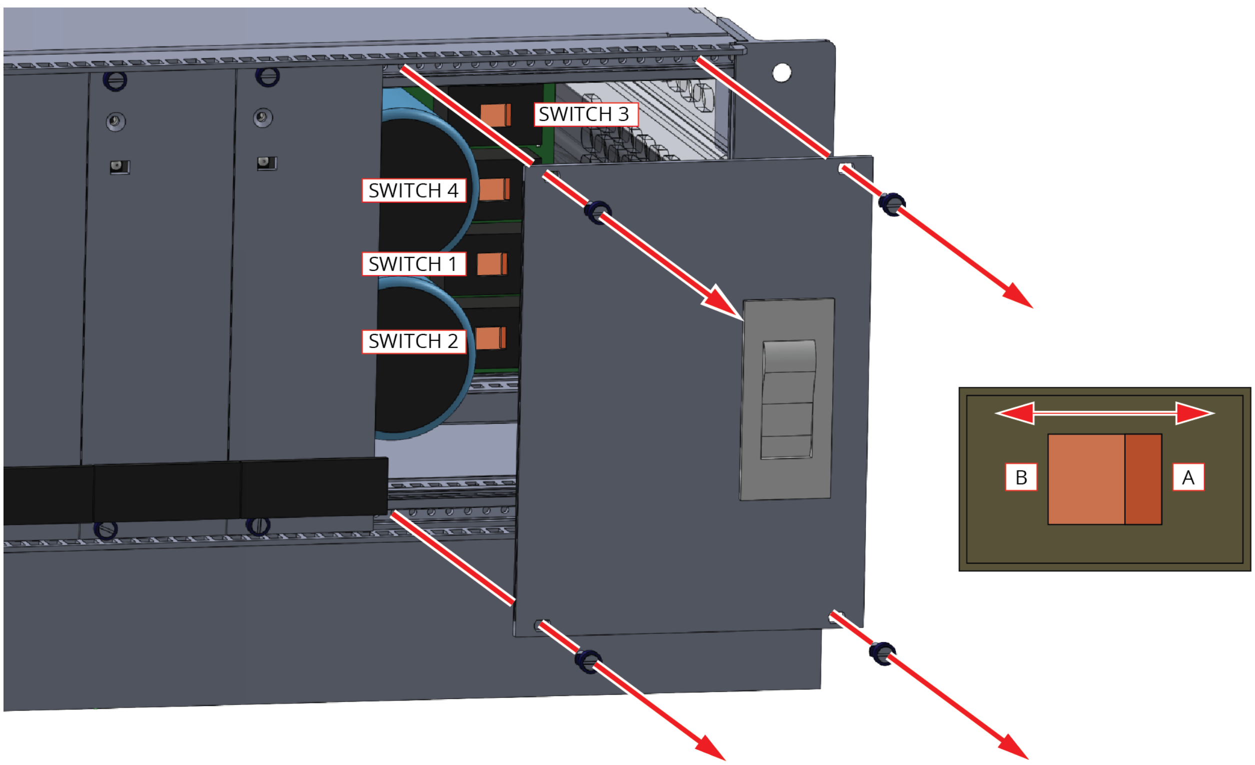

Figure B-1: Voltage Selection Switch Access

Appendix C: Revision History

Revision	Description
2.03	The following sections have been updated: • EU Declaration of Conformity • Agency Approvals • Added -C1 airflow specifications: Table 2-58
2.02	Updated: • EU Declaration of Conformity • Agency Approvals
2.01	Updated: Table 2-12 and Table 2-40 Added Absolute Encoder support on the Auxiliary I/O connector: Section 2.8.2. Absolute Encoder
2.00	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
1.03	
1.02	
1.01	
1.00	
Beta	

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