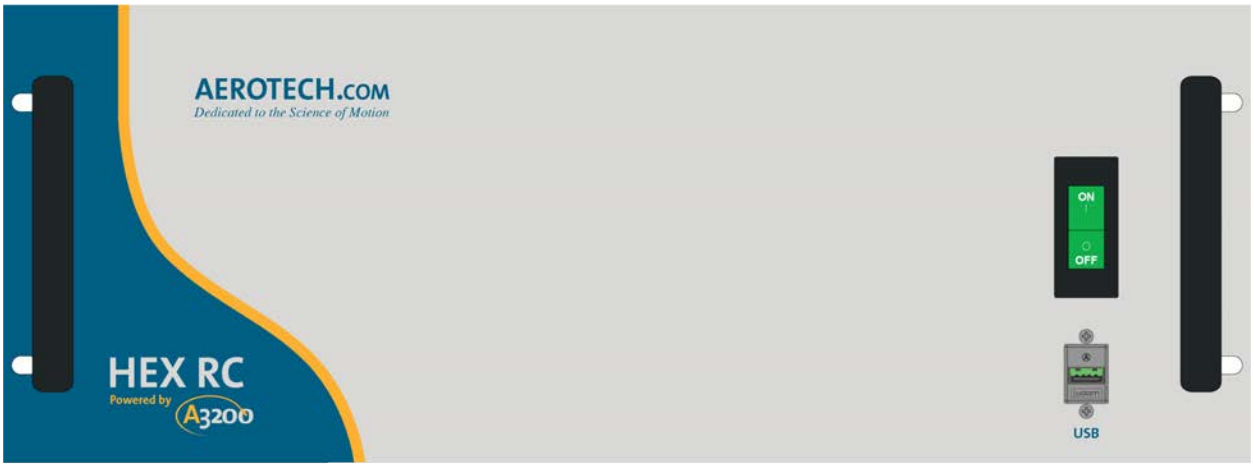
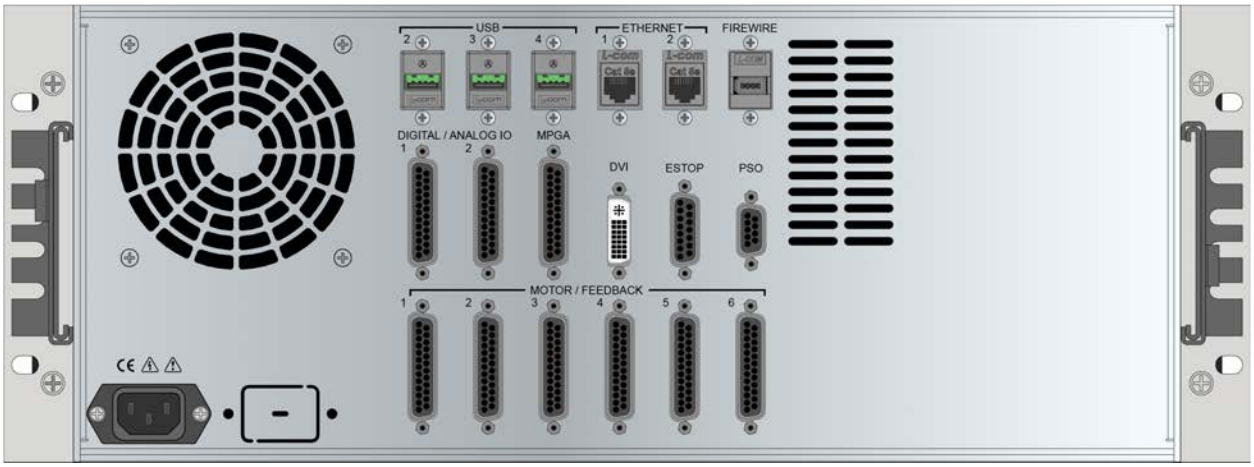
HEX RC Hardware Manual

Revision: 1.04.00





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EU Declaration of Conformity

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

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

2006/42/EC	Safety of Machinery
2014/35/EU	Low Voltage Directive
2011/65/EU	RoHS 2 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	Safety requirements for Electrical Equipment for measurement, control, and laboratory use
ISO 13849-1 & -2	Safety of Machinery - General Principals of Design

Authorized Representative:	Simon Smith, European Director
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Position	Engineer Verifying Compliance
Location	Pittsburgh, PA
Date	9/4/2019

CE

Agency Approvals

Aerotech, Inc. Model HEX RC 6-Axis Robotic Controller has been tested and found to be in accordance to the following listed Agency Approvals:

Approval / Certification:	CUS NRTL
Approving Agency:	TUV SUD America Inc.
Certificate #:	U8 068995 0029 Rev. 00
Standards:	CAN/CSA-C22.2 No. 61010-1:2012; UL 61010-1:2012; EN 61010-1:2010

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.

Safety Procedures and Warnings

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

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

DANGER: This product contains potentially lethal voltages. To reduce the possibility of electrical shock, bodily injury, or death the following precautions must be followed.

1. Disconnect electrical power before servicing equipment.
2. Disconnect electrical power before performing any wiring.
3. To minimize the possibility of electrical shock and bodily injury, extreme care must be exercised when any electrical circuits are in use. Suitable precautions and protection must be provided to warn and prevent persons from making contact with live circuits.
4. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
5. All components must be properly grounded in accordance with local electrical safety requirements.
6. Operator safeguarding requirements must be addressed during final integration of the product.

DANGER/HEAVY: To avoid injury, use two or more people to move and install this product.

- Refer to Table 1-1 for chassis mass specifications.
- Use a cart to move the product.
- 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.
- Lift this product only by the base. Do not use the cables or the connectors to lift or move this product.

WARNING: To minimize the possibility of electrical shock, bodily injury or death the following precautions must be followed.

1. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
2. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
3. Do not expose this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
4. If the product is used in a manner not specified by the manufacturer, the protection provided by the product can be impaired and result in damage, shock, injury, or death.
5. Operators must be trained before operating this equipment.
6. All service and maintenance must be performed by qualified personnel.

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Quick Installation Guide

This chapter describes the order in which connections and settings should typically be made to the HEX RC. If a custom interconnection drawing was created for your system (look for a line item on your Sales Order under the heading “Integration”), that drawing can be found on your installation device.

The HEX RC is provided to the user fully configured for operation of a Hexapod, including servo tuning for the user's load requirements if the load requirements have been provided to Aerotech.

For additional information about HEX RC, refer to the HexGen Programming Guide and the A3200 Help file.

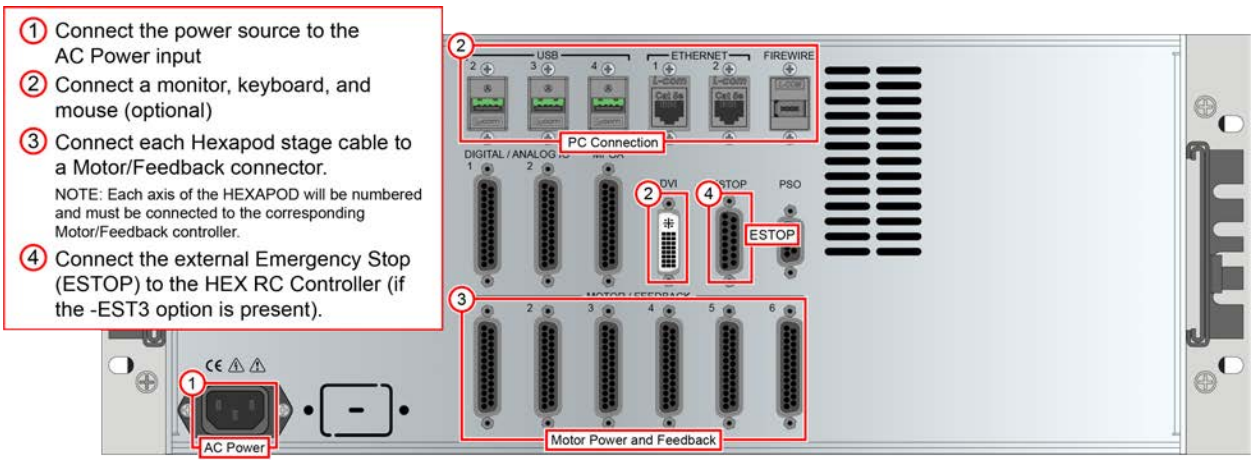

Figure 1: Quick Start Connections

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Chapter 1: Introduction

Aerotech's HEX RC is a high-performance, 6-axis motion controller ideal for controlling robotic systems like hexapods. The HEX RC is 4U high, rack-mountable, and compatible with the Automation 3200 motion platform.

The HEX RC performs both current loop and servo loop closures digitally to ensure the highest level of positioning accuracy and performance. With the A3200 distributed control architecture, the HEX RC can connect and control up to 26 additional external axes.

In environments such as beamlines, the HEX RC can interface with a host control platform and receive control commands via an ASCII command interface over TCP/IP. Alternatively, the HEX RC can act as a master controller and control other A3200 external drives via the FireWire interface.

The HEX RC can accept amplified-sine or digital encoders. With on-board encoder multiplication up to 4096 times high-resolution positioning is realized in a cost-effective, high-performance package.

An optional 6-axis jog pendant can be added for manual control of the positioning system. In safety critical applications, an emergency stop option with redundant safety relays is available.

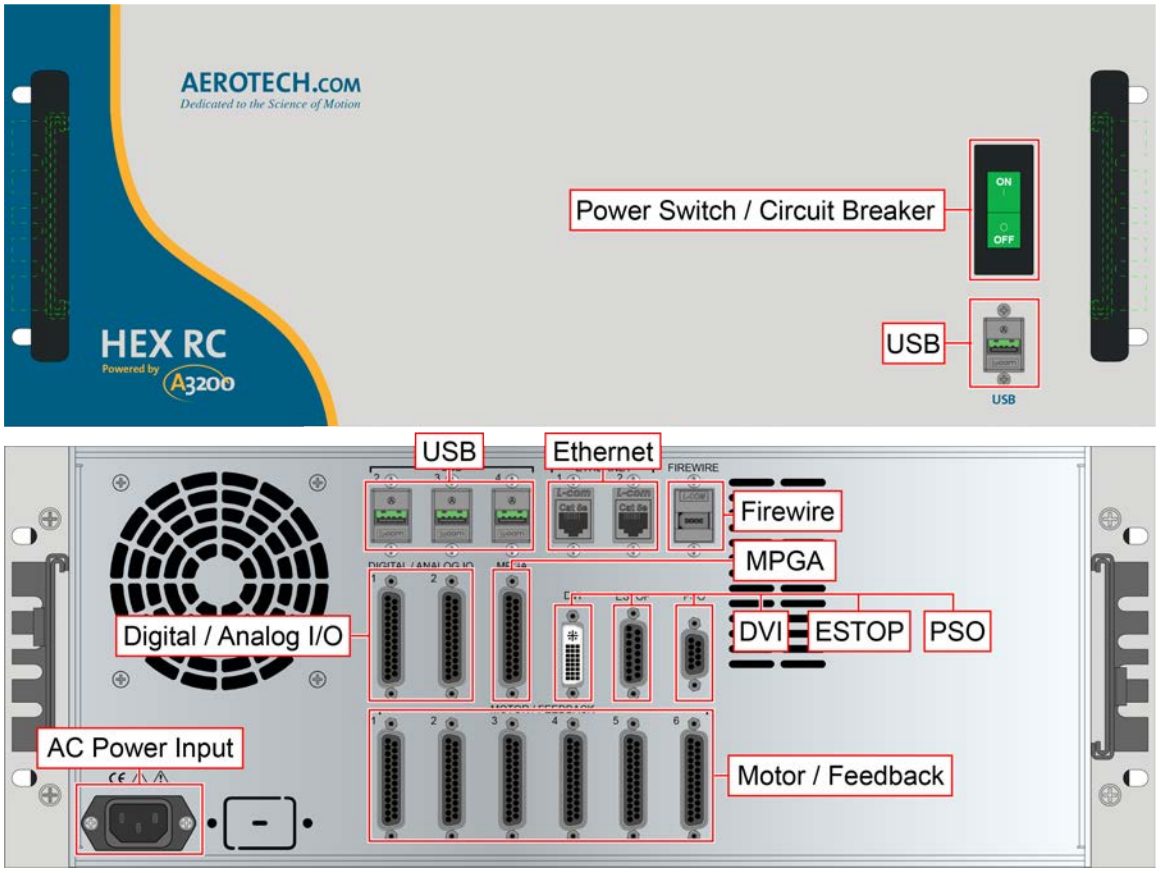


Figure 1-1: Chassis Layout

Table 1-1: Feature Summary

Feature	Description
Processor	Intel Core i7-6700, 4 Core, 3.4 GHz, 8 MB Cache, 2 x 8 GB DDR4 2133 MHz, Dual channel memory
Number of Axes	Six
Encoder Inputs	Six (1 Vpp or RS-422)
Motor Style	Brush, Brushless, Stepper
Power Supply	Single-Phase 100-230 VAC; 50/60 Hz (factory configured)
Power Output	600 w continuous
Bus Voltage	80 VDC
Peak Output Current (1 sec) (1)	10 Apk
Continuous Output Current (1)	5 Apk
Digital Inputs	16, opto-isolated
Digital Outputs	16, opto-isolated
Analog Inputs	Two total, ±10 V 12-bit differential One on each I/O connector
Analog Outputs	Two, ±5 V 16-bit
High-Speed Data Capture	Yes (50 ns latency)
Emergency Stop (ESTOP)	Optional
Position Synchronized Output (PSO)	Single Axis Standard
Primary Encoder Input Frequency (1 Vpp)	200 kHz sine wave
Primary Encoder Input Frequency (RS-422)	10 MHz square wave / 40 MHz count rate
Interfaces	ASCII command interface via TCP/IP; FireWire (IEEE-1394)
Fieldbus	Modbus TCP on PC
USB Ports	Four (USB 3.0 / USB 2.0), Used for Peripheral Device Connection
Video Port	DVI-I
Jog Pendant	Optional, Six Axis (MPGA)
Encoder Multiplication	Programmable up to x4096
Current Loop Update Rate	20 kHz
Servo Loop Update Rate	8 kHz
Power Amplifier Bandwidth	Selectable through software
Minimum Load Inductance	0.1 mH
Operating Temperature	5 to 40°C
Storage Temperature	5 to 80°C
Weight	25 kg
(1) Peak value of the sine wave; rms current for AC motors is 0.707* Apk	

Table 1-2: Ordering Options

HEX RC Multi-Axis Robotic Controller	
HEX RC	Rack-mount, six-axis, robotic controller with FireWire® with TCP/IP ASCII interfaces; 100-230 VAC single-phase power supply.
Line Voltage	
-A	115 VAC line
-B	230 VAC line
-C	100 VAC line
-D	200 VAC line
Feedback and Jog Pendant Configuration	
-FC1	Standard TTL encoder feedback
-FC2 (1)	Amplified sine encoder feedback with programmable encoder multiplier up to x4096
-FC3	Standard TTL encoder feedback and connector interface for 6-axis jog pendant (MPG). Jog-pendant must be ordered as separate line item.
-FC4 (1)	Amplified sine encoder feedback with programmable encoder multiplier up to x4096 and connector interface for 6-axis jog pendant (MPG). Jog pendant must be ordered as separate line item.
(1) Internal Ndrive MP10s are configured with the -MXU option	
PSO	
-PSO1	One-axis PSO firing.
-PSO5	Two-axis part-speed PSO firing. Use the PSO firing circuit based on the commanded vector velocity of up to 2 axes.
-PSO6	Three-axis part-speed PSO firing. Use the PSO firing circuit based on the commanded vector velocity of up to 2 axes.
Line Cord	
-LC1	US 115 VAC line cord
-LC2	US 230 VAC line cord
-LC3	UK compatible line cord
-LC4	German compatible line cord
-LC5	Israel compatible line cord
-LC6	India compatible line cord
-LC7	Australian compatible line cord
Options	
-EST3	ESTOP3 - controller stops motion, then disables servo control; internal positive guided relays with monitor contact disconnect AC power source from motor (uses two relays for redundancy); contains one-second bus discharge resistors; operator risk assessment is the responsibility of the end user or integrator
-SL1	Rack-mount slides
Accessories (Ordered as a separate line item)	
MPG	Six-axis jog pendant

The following block diagram illustrates the features and options of the HEX RC.

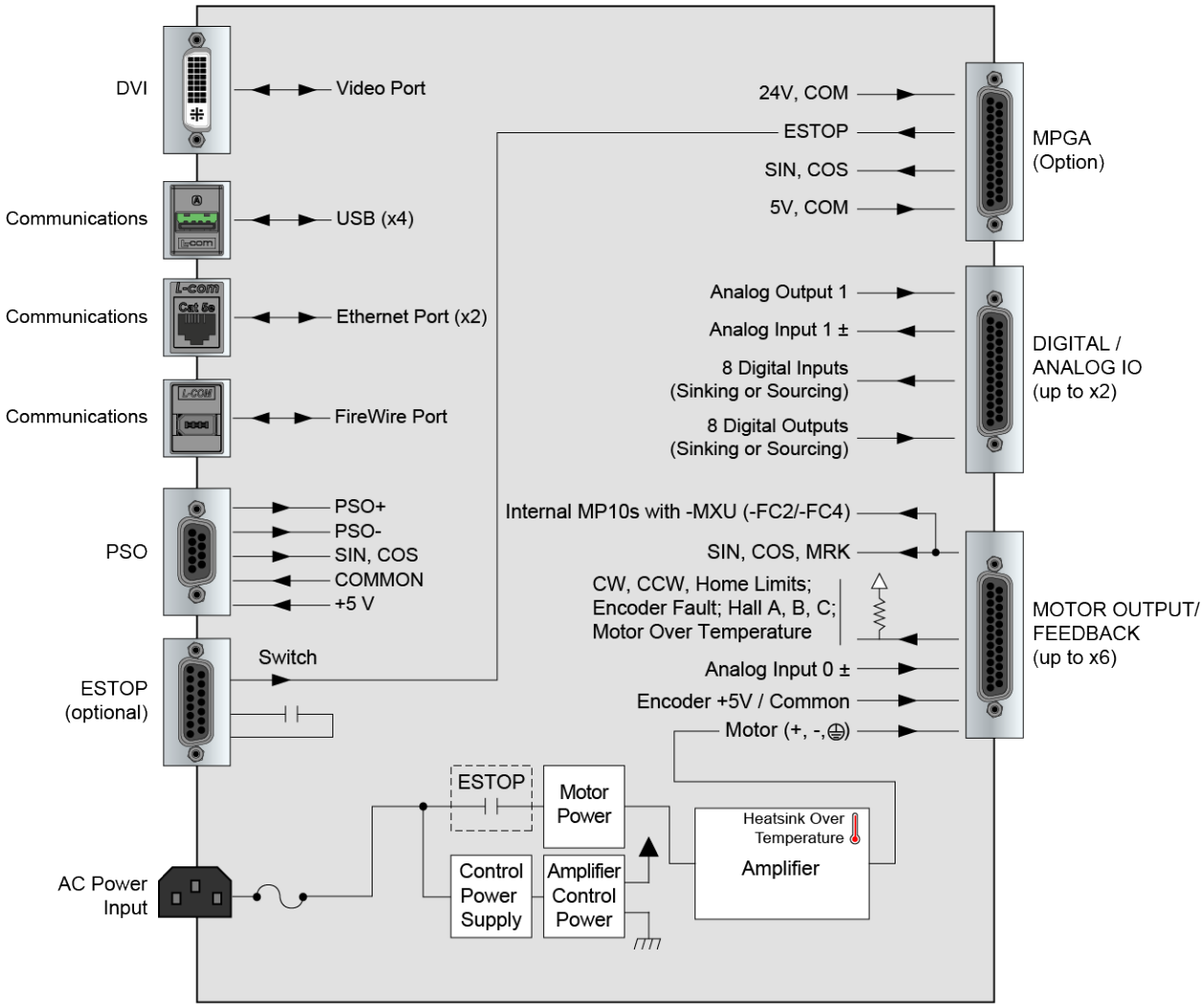


Figure 1-2: Functional Diagram

1.1. Electrical Specifications

The electrical specifications for the HEX RC drive chassis are listed in Table 1-3 and the electrical specifications for the servo amplifiers in Table 1-4 and 1.1.

Table 1-3: Chassis Electrical Specifications

Description		Specifications
Total Motor Power Supply		80 V @ 600W
Input Current	100 VAC	10 A Maximum
	115 VAC	10 A Maximum
	200 VAC	6 A Maximum
	230 VAC	5 A Maximum
Inrush Current		100 A @ 254 VAC
Leakage Current		<2 mA @ 60 Hz / 254 VAC
AC Power Input		AC input (factory configured): AC Hi, AC Lo, Earth Ground (⏚), • 100 VAC (90-112 VAC, 49-63 Hz) • 115 VAC (103-127 VAC, 49-63 Hz) • 200 VAC (180-224 VAC, 49-63 Hz) • 230 VAC (207-254 VAC, 49-63 Hz)
Auxiliary Power Outputs		+5 V is provided on all axis feedback connectors for encoder, Hall, and limit power.
Protection		• Power switch / breaker (10 A, Supplemental Protection only). • Fuses on motor bus supply transformer. • Bus supply inrush current limit during power-on.
Indicator (Power)		Power switch contains a power-on indicator.

The HEX RC uses an Ndrive MP10 with encoder multiplier (MXU) for each axis. The first two axes contain the I/O option, which is available to the user through the two Digital/Analog I/O connectors on the rear panel of the HEX RC.

Table 1-4: Servo Amplifier Electrical Specifications (MP)

	MP 10
Output Voltage	80 VDC (referenced to earth ground)
Peak Output Current (1 second)	10 A
Continuous Output Current	5 A
Power Amplifier Bandwidth	2500 Hz maximum (software selectable)
Power Amplifier Efficiency	85% - 95%
PWM Switching Frequency	20 kHz
Minimum Load Inductance	0.1 mH @ 80 VDC
User Power Supply Output	5 VDC (@ 500 mA)
Modes of Operation	Brushless; Brush; Stepper
Protective Features	Output short circuit; Peak over current; RMS over current; Over temperature; Control power supply under voltage; Power stage bias supply under voltage
Isolation	Optical and transformer isolation between control and power stages.

1.2. Mechanical Specifications

The HEX RC must be installed in a rack mount console to comply with safety standards. Mount the HEX RC so free airflow is available at the rear of the chassis. Allowance must also be made for the rear panel connections and cables.

DANGER/HEAVY: To avoid injury, use two or more people to move and install this product.

- Refer to Table 1-1 for chassis mass specifications.
- Use a cart to move the product.
- 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.
- Lift this product only by the base. Do not use the cables or the connectors to lift or move this product.

Table 1-5: Unit Weight

Description	Weight
Chassis Weight (typical)	25 kg

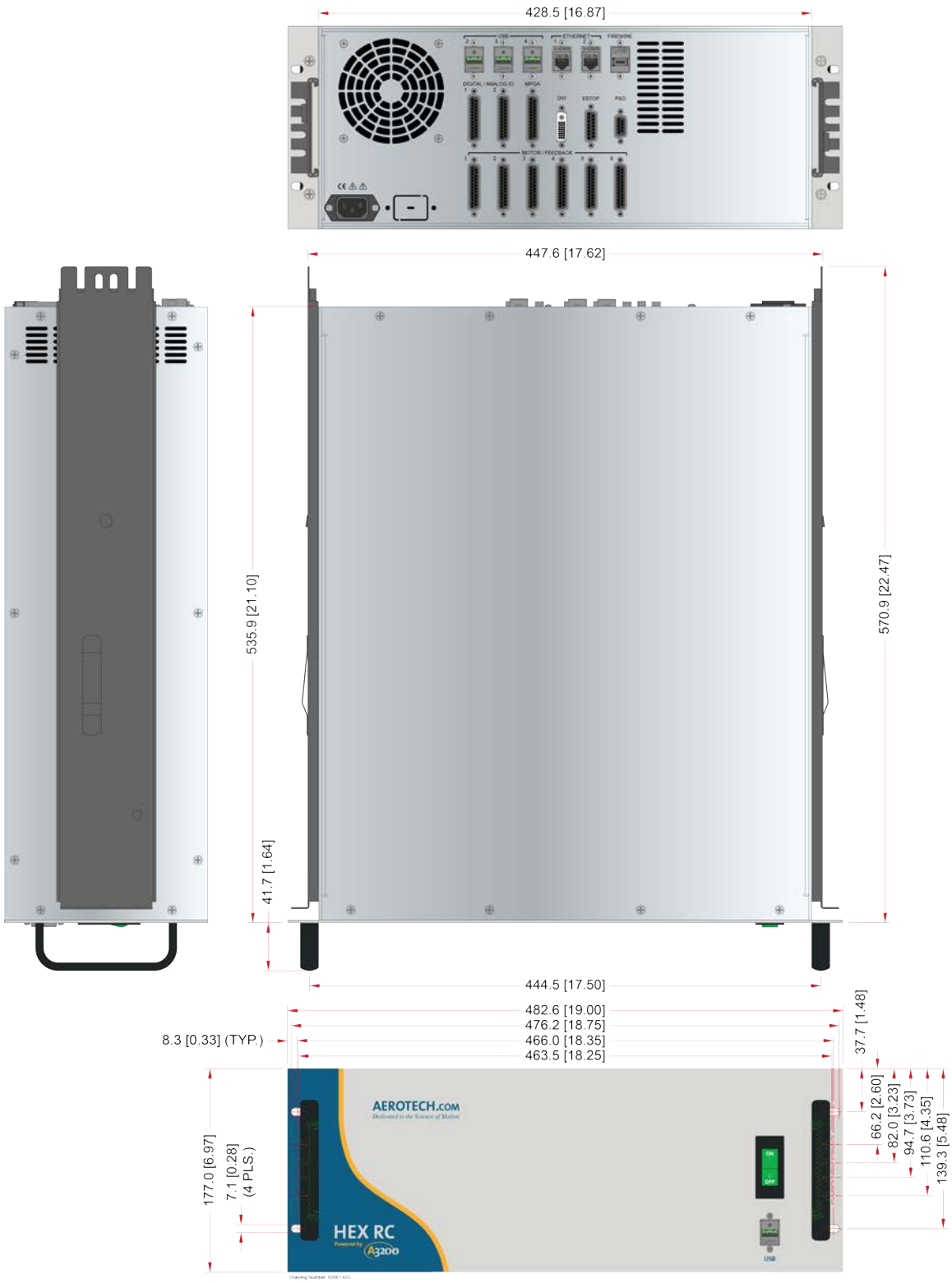


Figure 1-3: Dimensions

1.3. Environmental Specifications

The environmental specifications for the HEX RC are listed below.

Ambient Temperature	Operating: 5° to 40°C
	Storage: 5° to 80°C
Humidity	Maximum relative humidity is 80% for temperatures up to 31°C. Decreasing linearly to 50% relative humidity at 40°C. Non condensing.
Altitude	Up to 2000 meters.
Pollution	Pollution degree 2 (normally only non-conductive pollution).
Use	Indoor use only.
Audible Noise	71 db at 1 meter (rear fan and side fan)
	77 db at 1 meter (rear fan and side fan)

1.4. Drive and Software Compatibility

The following table lists the available drives and which version of the software first supported the drive. Drives that list a specific version number in the **Last Software Version** column will not be supported after the listed version.

Table 1-6: Drive and Software Compatibility

Drive Type	Firmware Revision	First Software Version	Last Software Version
HEX RC	-	2.14	Current

Chapter 2: Installation and Configuration

2.1. Unpacking the Chassis

Visually inspect the container of the HEX RC for any evidence of shipping damage. If any such damage exists, notify the shipping carrier immediately.

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

DANGER/HEAVY: To avoid injury, use two or more people to move and install this product.

- The HEX RC exceeds 25 kg (55 lbs).
- Use a cart to move the product.
- 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.
- Lift this product only by the base. Do not use the cables or the connectors to lift or move this product.

All of the documentation provided with the HEX RC should be saved for future reference. Additional information about the HEX RC system is provided on the Serial and Power labels that are placed on the HEX RC 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 AC power input label is located beside the AC power inlet and contains the factory configured AC power requirements.

2.2. Electrical Installation

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

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

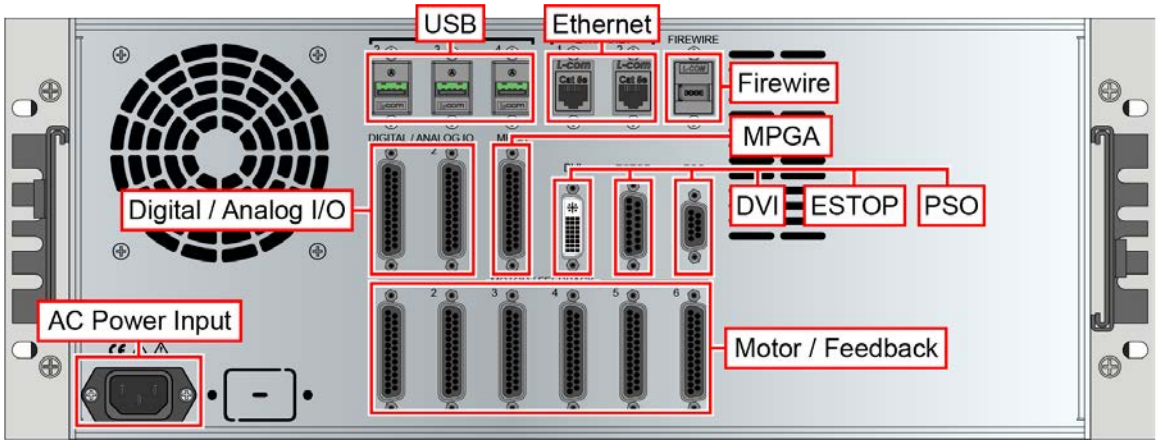


Figure 2-1: Power and Control Connector Locations

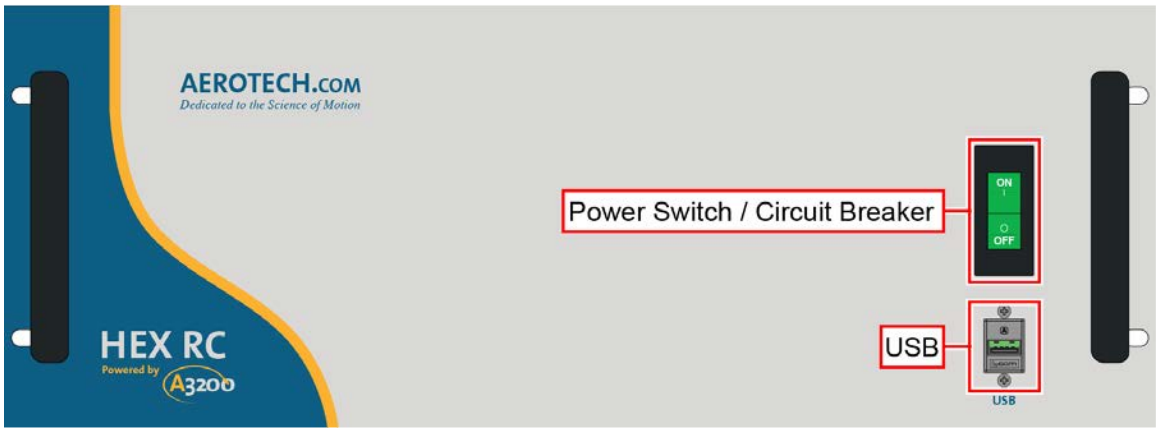


Figure 2-2: Power Switch Location

All low voltage connections must be made using cables and wires sized for the maximum currents that will be carried. Low voltage wiring should not be bundled with AC and motor wiring to minimize signal disturbances due to EMI interference and coupling.

2.2.1. AC Power Connections

AC input power to the HEX RC is applied to the receptacle that is located on the rear panel. The main power switch is located on the front panel of the HEX RC. The main power switch also functions as a 10 A breaker (supplementary protection only) for the incoming AC power. Refer to Section 1.1. Electrical Specifications for the electrical specifications.

The HEX RC drive chassis is factory-configured for one of four specified input voltages. The factory configured AC input voltages, along with the current requirements for the HEX RC drive chassis, are listed in Table 2-1.

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

AC Input Voltage	Input Amps (maximum continuous)	Wire Size
100 VAC 50/60 Hz	10 A	16 AWG (1.5 mm^2)
115 VAC 50/60 Hz	10 A	16 AWG (1.5 mm^2)
200 VAC 50/60 Hz	6 A	18 AWG (1 mm^2)
230 VAC 50/60 Hz	5 A	18 AWG (1 mm^2)

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.

Table 2-2: AC Power Cord Wiring Specifications

Specification	Value
Cord/Wire Rating	300 V
Minimum Current Capacity	10 A
Temperature Rating (Insulation)(1)	80°C
1. The insulation rating for the AC power wiring must be appropriately rated for the operating environment.	

2.2.2. Minimizing Conducted, Radiated, and System Noise

To reduce electrical noise, observe the following wiring techniques.

1. Use shielded cable to carry the motor current and tie the shield to the connector backshell.
2. Use a cable with sufficient insulation. This will reduce the capacitive coupling between the leads that, in turn, reduces the current generated in the shield wire.
3. User connections to the product must be made using shielded cables with metal D-style connectors and back shells. The shield of the cables must be connected to the metal back shell in order for the product to conform to radiated emission standards.
4. The HEX RC is a component designed to be integrated with other electronics. EMC testing must be conducted on the final product configuration.

2.2.3. I/O and Signal Wiring 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 2-3: I/O and Signal Wiring 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.

Table 2-4: I/O and Signal Wiring Recommended Wire Sizes

AWG	mm^2
22	.34
24	.25
26	.14
28	.08

2.3. Motor Feedback Connector

The motor feedback connector (a 25-pin, D-style connector) has connections for an encoder, limit switches, Hall-effect devices, motor over-temperature device, 5 V encoder and limit power, and motor connections.

Table 2-5: Motor Feedback Connector Pinout

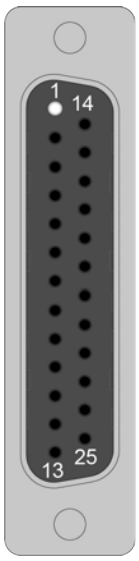
Pin#	Description	In/Out/Bi	Connector
1	Key (Ensures that correct cable is plugged into the correct jack)	Input	
2	Cosine-N	Input	
3	Sine-N	Input	
4	Marker-N	Input	
5	Common	--	
6	Common	--	
7	Negative (CCW) hardware limit	Input	
8	Hall Effect sensor, phase A	Input	
9	Hall Effect sensor, phase C	Input	
10	Frame Ground	--	
11	Motor Phase A	Output	
12	Motor Phase B	Output	
13	Motor Phase C	Output	
14	Cosine	Input	
15	Sine	Input	
16	Marker	Input	
17	+5 V power supply	Output	
18	Reserved	Input	
19	Positive (CW) hardware limit	Input	
20	Motor Thermistor	Input	
21	Hall Effect sensor, phase B	Input	
22	Frame Ground	--	
23	Motor Phase A	Output	
24	Motor Phase B	Output	
25	Motor Phase C	Output	

Table 2-6: Mating Connector Part Numbers for the Motor 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. Encoder Inputs

The HEX RC contains Ndrive MP10 drives.

Standard Encoder Interface (-FC1, -FC3)

The MP10 drives are parameter-configured for square wave (RS-422) encoder signals. Refer to Section 2.3.1.1.

Analog Encoder Interface (-FC2, -FC4)

The MP10 drives have the -MXU option and are parameter-configured for analog encoder signals. Refer to Section 2.3.1.2.

Refer to Section 2.3.1.3. for encoder feedback phasing.

NOTE: Encoder wiring should be physically isolated from AC power and other high-voltage wiring.

NOTE: The PSO feature is **not** compatible with the -MXU option.

Table 2-7: Encoder Pins on the Motor Feedback Connector

Pin#	Description	In/Out/Bi
2	Cosine-N	Input
3	Sine-N	Input
4	Marker-N	Input
5	Common	--
14	Cosine	Input
15	Sine	Input
16	Marker	Input
17	+5 V power supply	Output

2.3.1.1. Square Wave (RS-422) Encoder Interface (-FC1, -FC3 Options)

The standard encoder interface accepts an RS-422 differential quadrature line driver signal. Invalid or missing signals will cause a feedback fault when the axis is enabled.

Table 2-8: Square Wave Encoder Specifications

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

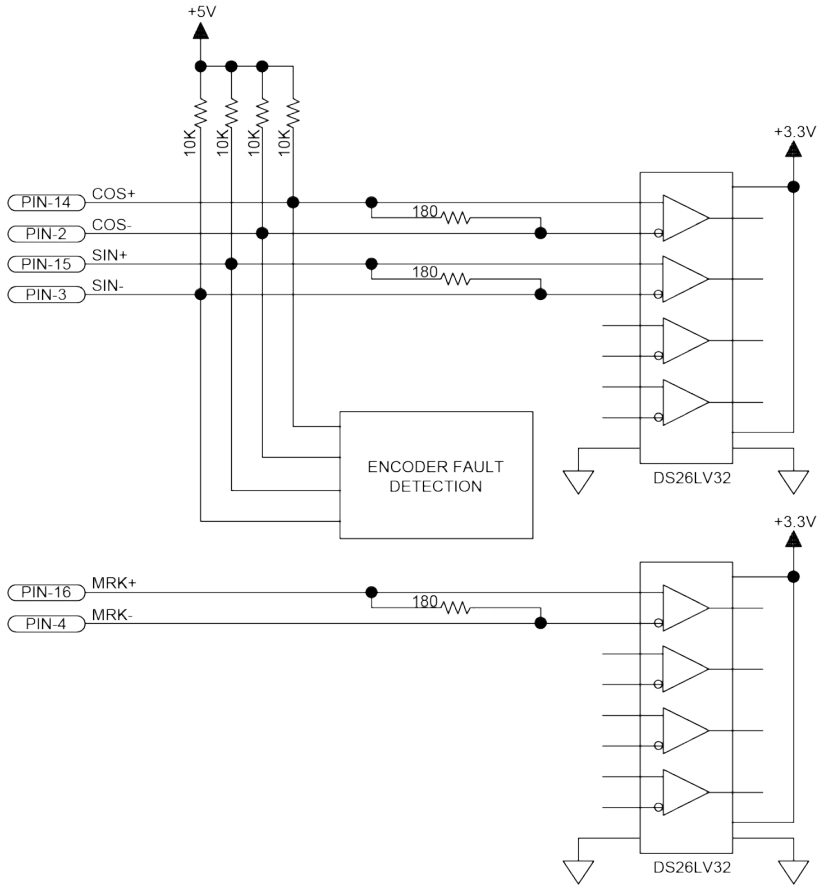


Figure 2-3: Line Driver Encoder Interface

2.3.1.2. Analog Encoder Interface (-FC2, -FC4 Options)

The HEX RC controller contains Ndrive MP10 drives with the -MXU option. The drive is software-configured to accept analog encoder signals (refer to the A3200 Help file for information on the PositionFeedbackType and EncoderMultiplicationFactor parameters). The encoder interpolation factor is software-selectable (refer to the A3200 Help file).

Table 2-9: Analog Encoder Specifications

Specification	Value
Input Frequency (max)	200 kHz
Input Amplitude	0.6 to 2.25 Vpk-Vpk
Interpolation Factor (software selectable)	4,096

NOTE: The PSO feature is **not** compatible with the -MXU option.

Refer to Figure 2-4 for the typical analog encoder input circuitry.

The gain, offset, and phase balance of the analog Sine and Cosine encoder input signals can all be adjusted via controller parameters. Encoder signals should be adjusted using the Feedback Tuning tab of the Digital Scope, which will automatically adjust the encoder parameters for optimum performance. See the A3200 Help file for more information.

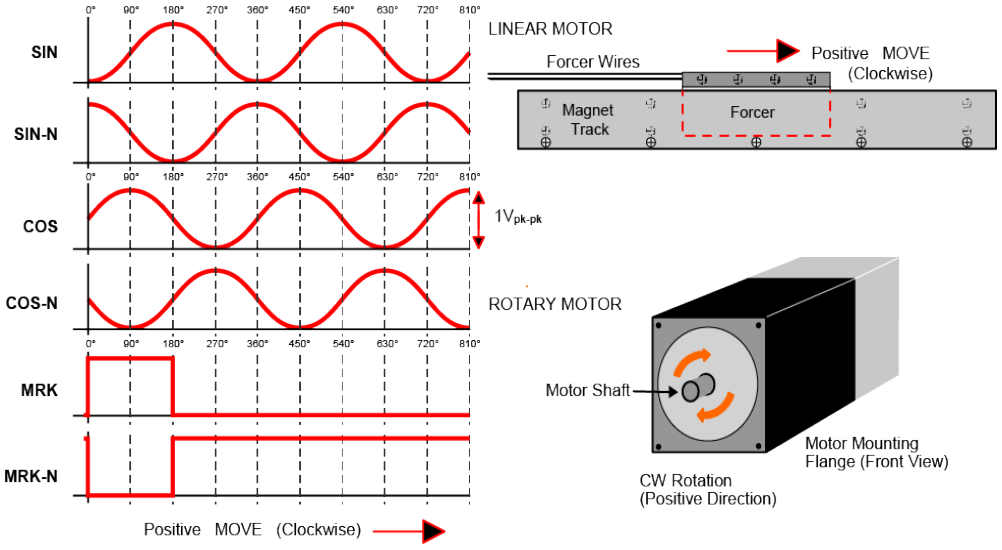


Figure 2-4: Analog Encoder Phasing Reference Diagram

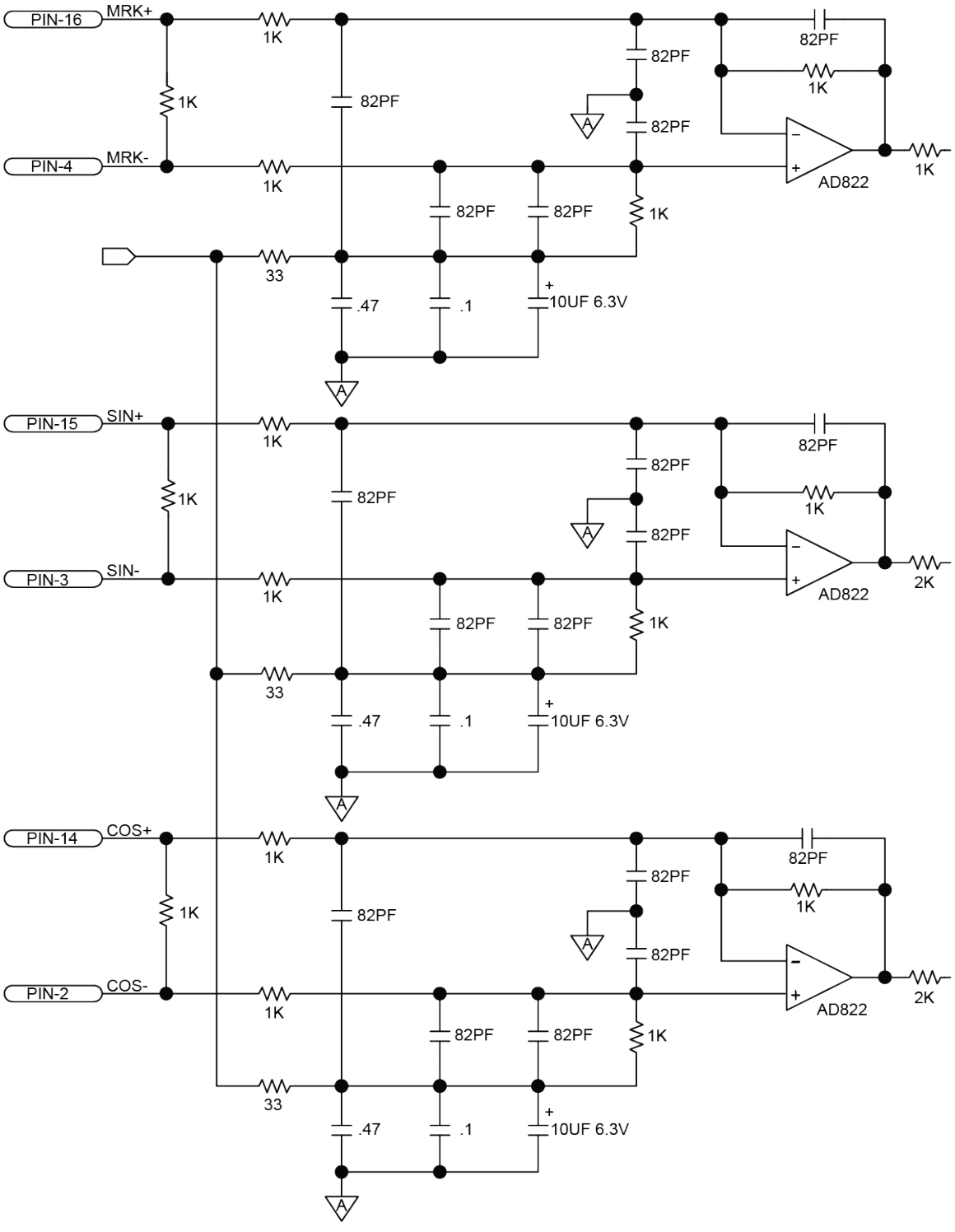


Figure 2-5: Analog Encoder Signals Schematic

2.3.1.3. Encoder Phasing

Incorrect encoder polarity will cause the system to fault when enabled or when a move command is issued. Figure 2-6 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 2-7). The Motor Phasing Calculator in the Configuration Manager can be used to determine proper encoder polarity.

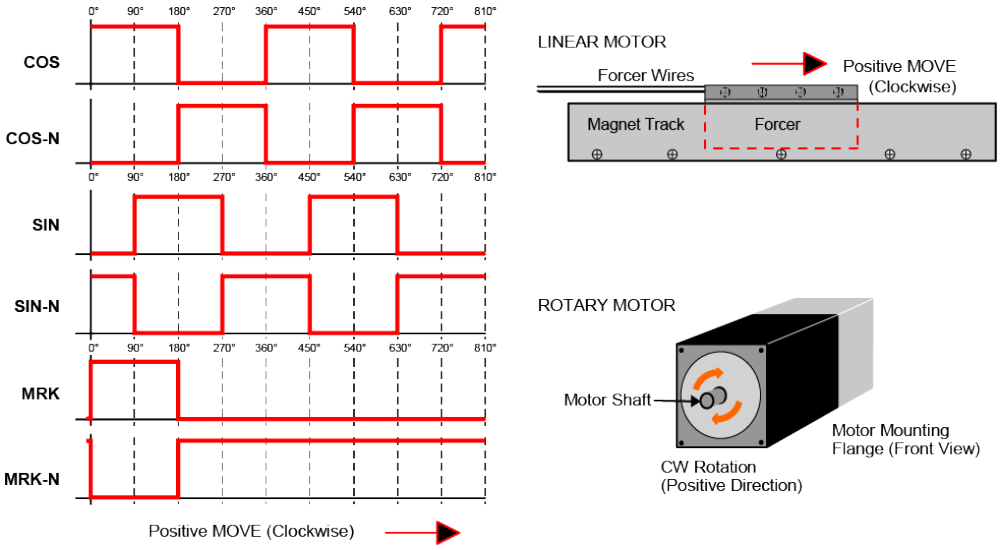


Figure 2-6: Encoder Phasing Reference Diagram (Standard)

NOTE: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-6.

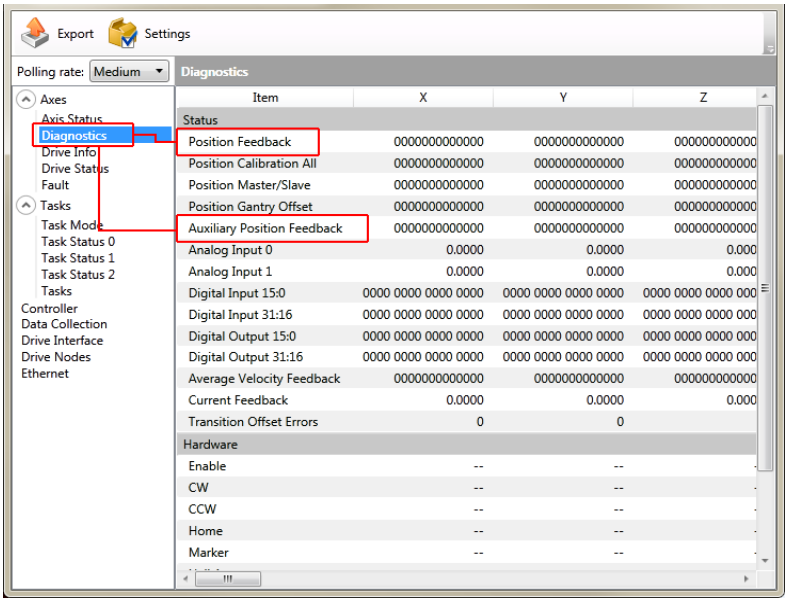


Figure 2-7: Position Feedback in the Diagnostic Display

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 5-24 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 2.3.5.1. for Hall-effect device phasing.

Table 2-10: Hall-Effect Feedback Pins on the Motor Feedback Connector

Pin#	Description	In/Out/Bi
5	Common	--
8	Hall Effect sensor, phase A	Input
9	Hall Effect sensor, phase C	Input
10	Frame Ground	--
17	+5 V power supply	Output
21	Hall Effect sensor, phase B	Input

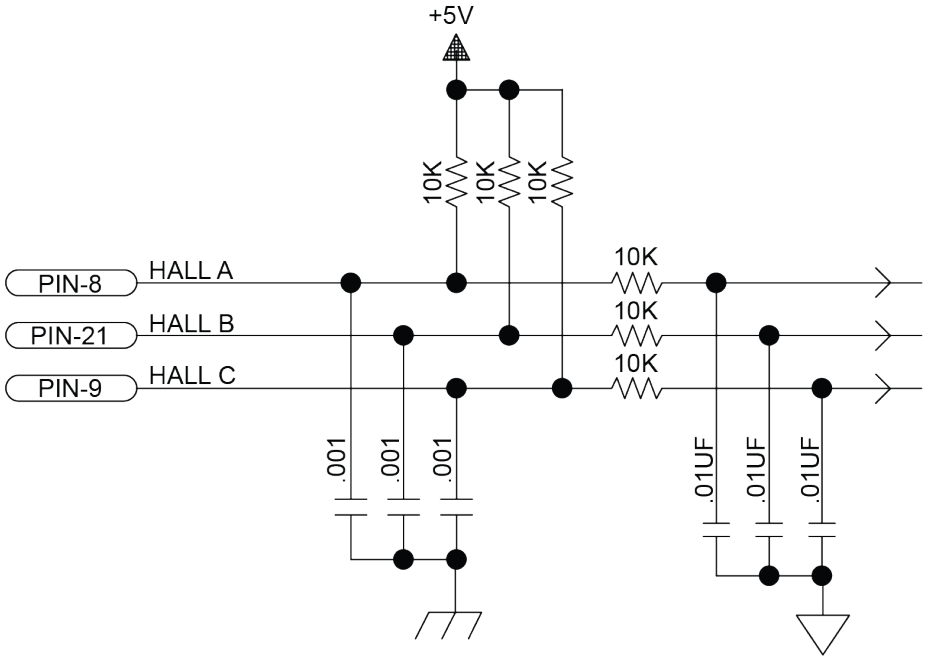


Figure 2-8: Hall-Effect Inputs Schematic

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 (i.e., 100 ohms) which will result in a low input signal. As the increasing temperature causes the thermistor's resistance to increase, the signal will be seen as a logic high triggering an over temperature fault. The nominal trip value of the sensor is 1k Ohm.

Table 2-11: Thermistor Input Pin on the Motor Feedback Connector

Pin#	Description	In/Out/Bi
20	Motor Thermistor	Input

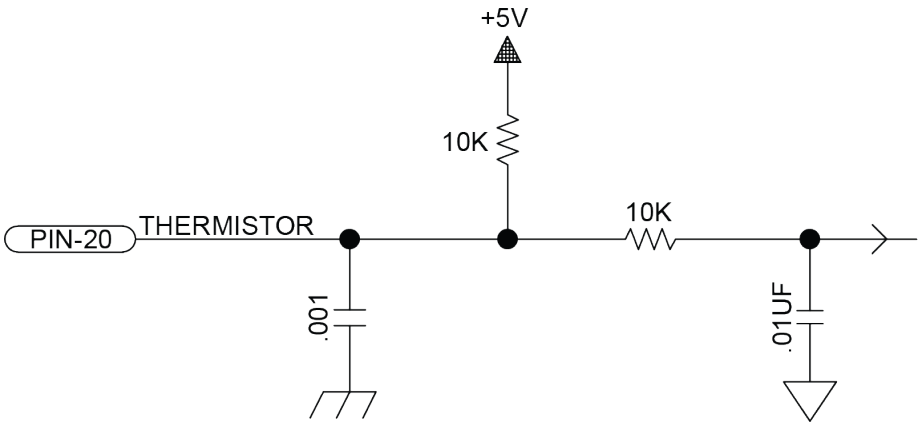


Figure 2-9: Thermistor Input Schematic

2.3.4. End Of Travel Limit Inputs

End of Travel (EOT) limits are used to define the end of physical travel. The EOT limit inputs accept 5-24 VDC level signals. The active state of the EOT limits is software selectable by the EndOfTravelLimitSetup axis parameter (refer to the A3200 Help file). Limit directions are relative to the encoder polarity in the diagnostics display (refer to Figure 2-12).

Positive motion is stopped by the clockwise (CW) end of travel limit input. Negative 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.

NOTE: The Home Limit signal is not available on the HEX RC. The end of travel limits must be used during homing.

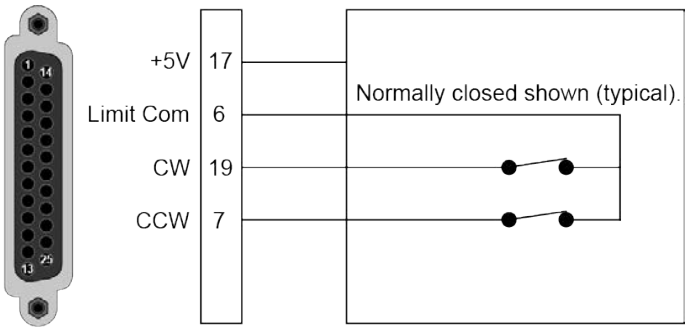


Figure 2-10: End of Travel Limit Input Connections

Table 2-12: End of Travel Limit Input Pins on the Motor Feedback Connector

Pin#	Description	In/Out/Bi
6	Common	--
7	Negative (CCW) hardware limit	Input
17	+5 V power supply	Output
19	Positive (CW) hardware limit	Input

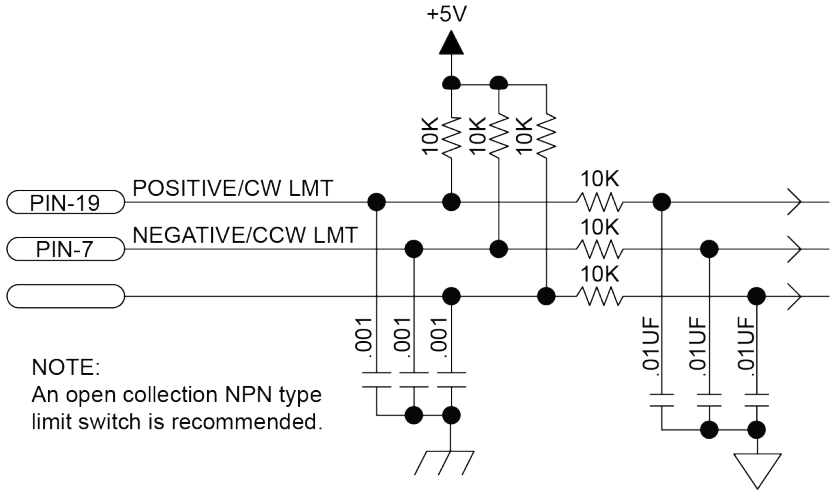


Figure 2-11: End of Travel Limit Inputs Schematic

2.3.4.1. End Of Travel 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 motor feedback connector. The logic level of the EOT limit inputs may be viewed in the Status Utility (shown in Figure 2-12).

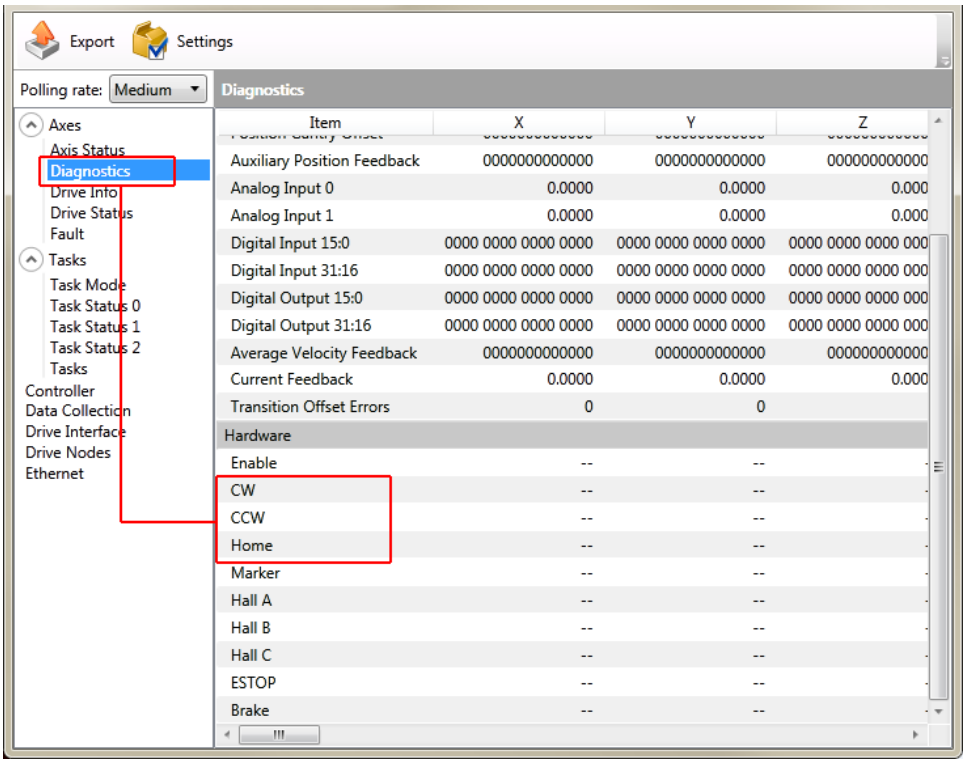


Figure 2-12: Limit Inputs in the Diagnostic Display

2.3.5. Motor Output Interface

The HEX RC is capable of driving three motor types:

- Brushless Motors (Hexapod): refer to Section 2.3.5.1.
- DC Brush Motors: refer to Section 2.3.5.2.
- Stepper Motors: refer to Section 2.3.5.3.

Table 2-13: Motor Output Connection Pins on the Motor Feedback Connector

Pin#	Description	In/Out/Bi
10	Frame Ground	--
11	Motor Phase A	Output
12	Motor Phase B	Output
13	Motor Phase C	Output
22	Frame Ground	--
23	Motor Phase A	Output
24	Motor Phase B	Output
25	Motor Phase C	Output

2.3.5.1. Brushless Motor Connections

The configuration shown in Figure 2-13 is an example of a typical brushless motor connection.

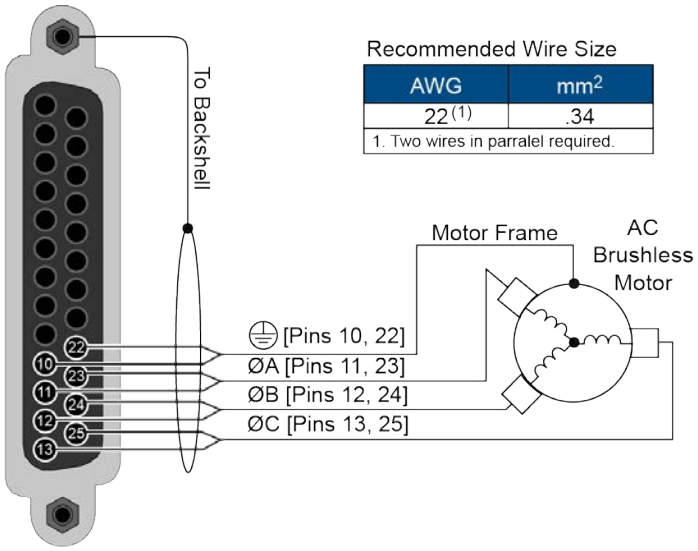


Figure 2-13: Brushless Motor Configuration

Brushless Motor Phasing

Brushless motors are commutated electronically by the controller, typically using Hall-effect devices. If you are using standard Aerotech motors and cables, motor phasing adjustments are not required and this section may be skipped.

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.

Powered Motor Phasing

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

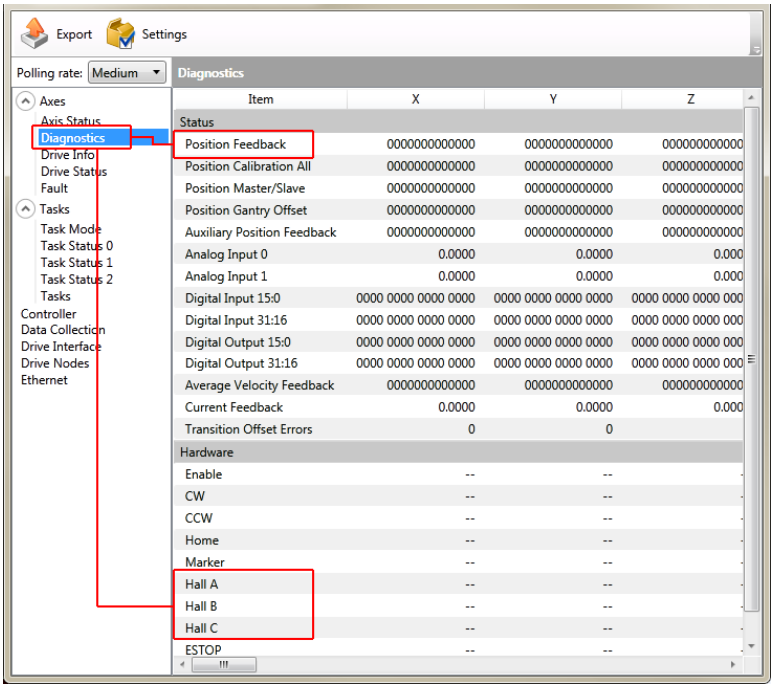


Figure 2-14: Encoder and Hall Signals in the Diagnostic Display

Unpowered Motor Phasing

Disconnect the motor from the controller and connect the motor in the test configuration shown in Figure 2-15. 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 2-15). Wave forms are shown while moving the motor in the positive direction.

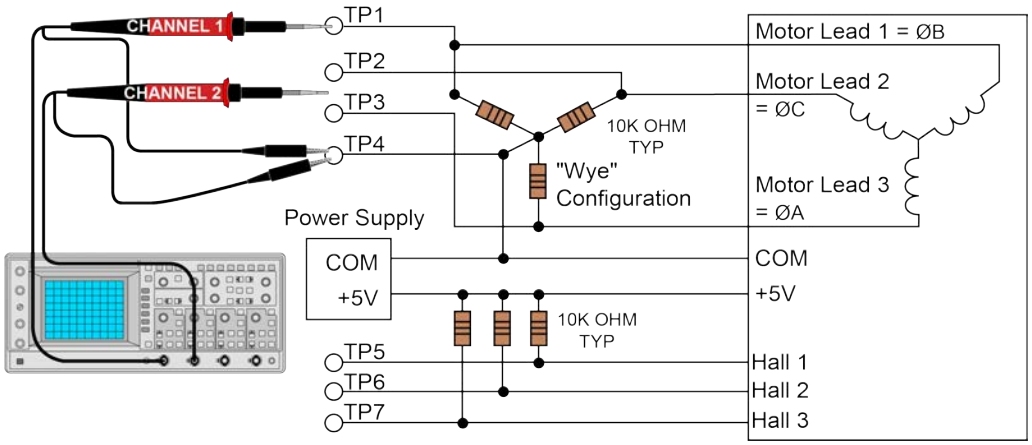


Figure 2-15: Motor Phasing Oscilloscope Example

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 2-16). Use the CommutationOffset parameter to correct for Hall signal misalignment.

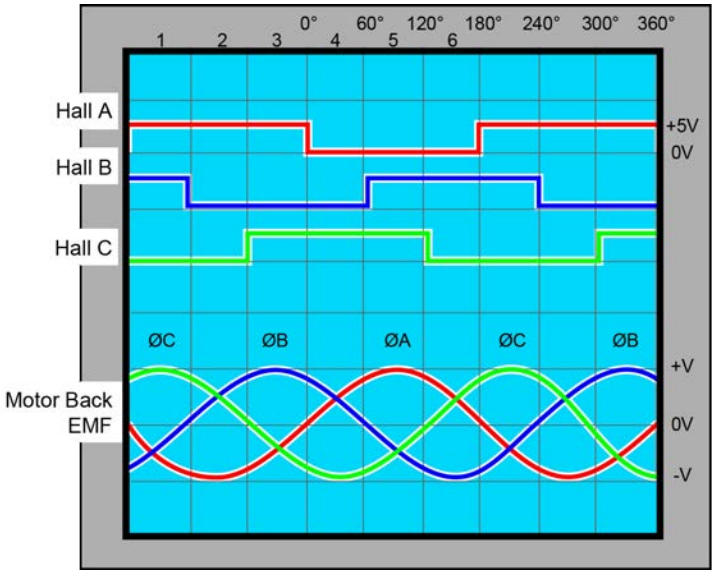


Figure 2-16: Brushless Motor Phasing Goal

2.3.5.2. DC Brush Motor Connections

The configuration shown in Figure 2-17 is an example of a typical DC brush motor connection.

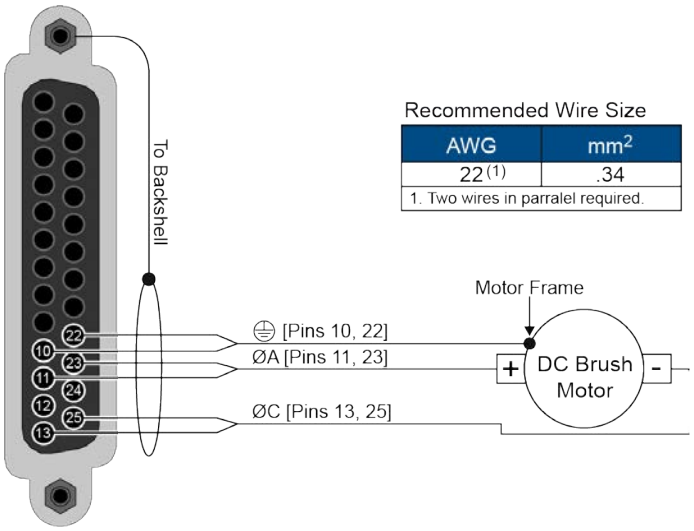


Figure 2-17: DC Brush Motor Configuration

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. Rotate the motor clockwise by hand.

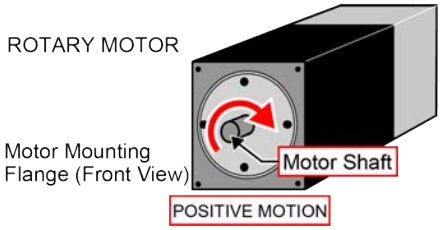


Figure 2-18: Clockwise Motor Rotation

4. If the voltmeter indicates a negative value, swap the motor leads and rotate the motor (CW, by hand) again. When the voltmeter indicates a positive value, the motor leads have been identified.
5. Connect the motor lead from the voltmeter to the ØA motor terminal on the HEX RC. Connect the motor lead from the negative lead of the voltmeter to the ØC motor terminal on the HEX RC.

NOTE: If using standard Aerotech motors and cables, motor and encoder connection adjustments are not required.

2.3.5.3. Stepper Motor Connections

The configuration shown in Figure 2-19 is an example of a typical stepper motor connection.

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.

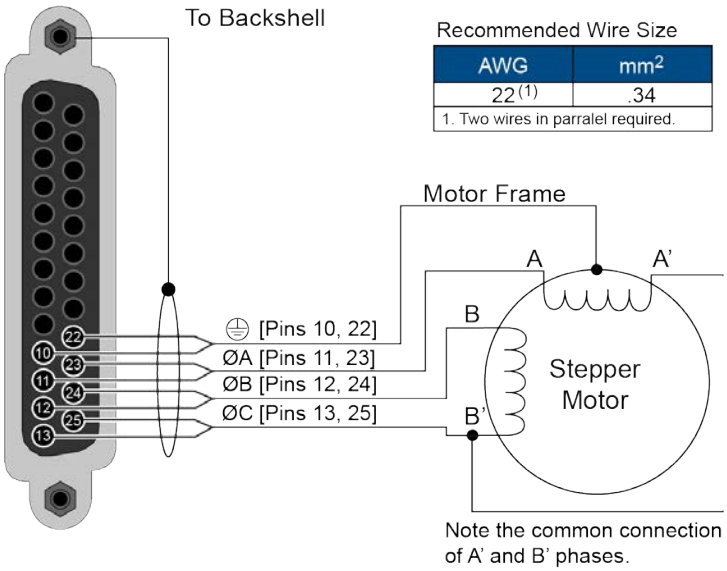


Figure 2-19: Stepper Motor Connection Schematic

Stepper Motor Phasing

NOTE: If using standard Aerotech motors and cables, motor and encoder connection adjustments are not required.

A stepper motor can be run with or without an encoder. If an encoder is not being used, phasing is not necessary. With an encoder, test for proper motor phasing by running a positive motion command.

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

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

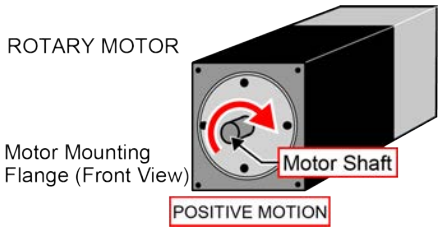
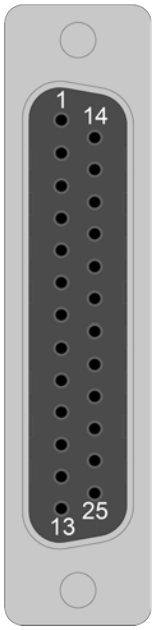


Figure 2-20: Clockwise Motor Rotation

2.4. Digital and Analog I/O Connections

The HEX RC includes Ndrive MP10 I/O connectors for axes one and two. The I/O connections includes 8 digital opto-inputs, 8 digital opto-outputs, 1 analog input, 1 analog output, a second encoder channel, and a brake/relay output.

Table 2-14: Digital / Analog IO Connector Pinout

Pin#	Description	In/Out/Bi	Connector
1	Analog Input 1+ (Differential)	Input	
2	Analog Input 1- (Differential)	Input	
3	Internal +5 Volt Power Supply (500 mA max)	Output	
4	Input Common for Digital Inputs 0 - 3	Input	
5	Digital Input 0	Input	
6	Digital Input 1	Input	
7	Digital Input 2	Input	
8	Digital Input 3	Input	
9	Digital Output Common +	Input	
10	Digital Output 0	Output	
11	Digital Output 1	Output	
12	Digital Output 2	Output	
13	Digital Output 3	Output	
14	Analog Output 1	Output	
15	Ground	N/A	
16	Input Common for Digital Inputs 4 - 7	Input	
17	Digital Input 4	Input	
18	Digital Input 5	Input	
19	Digital Input 6	Input	
20	Digital Input 7	Input	
21	Digital Output Common -	Input	
22	Digital Output 4	Output	
23	Digital Output 5	Output	
24	Digital Output 6	Output	
25	Digital Output 7	Output	

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

2.4.1. Analog Input 1

Analog Input 1 is a differential input. To interface to a single-ended (non-differential) voltage source, connect the signal common of the source to the negative input and the analog source signal to the positive input. A floating signal source should be referenced to the ground as shown in Figure 2-21.

Table 2-15: Analog Input 1 Specifications

Specification	Value
(AI+) - (AI-)	+10 V to -10 V (1)
Resolution (bits)	12 bits
Resolution (volts)	4.88 mV
1. Signals outside of this range may damage the input	

Table 2-16: Analog Input Pins on the Digital/Analog I/O Connector

Pin#	Description	In/Out/Bi
1	Analog Input 1+ (Differential)	Input
2	Analog Input 1- (Differential)	Input
15	Ground	N/A

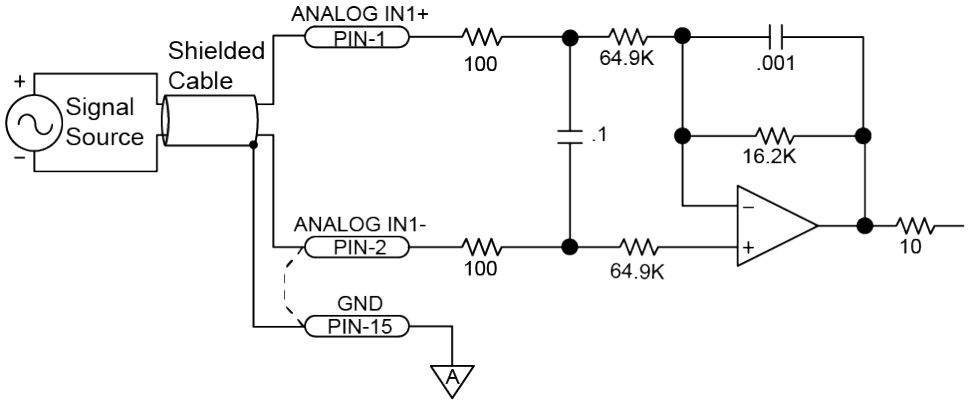


Figure 2-21: Analog Input 1

2.4.2. Analog Output 1

The ground pin is set to zero when power is first applied to the system or during a system reset.

Table 2-17: Analog Output 1 Specifications

Specification	Value
Output Voltage	-5 V to +5 V
Output Current	5 mA
Resolution (bits)	16 bits
Resolution (volts)	153 µV

Table 2-18: Analog Output Pins on the Digital/Analog I/O Connector

Pin#	Description	In/Out/Bi
14	Analog Output 1	Output
15	Ground	N/A

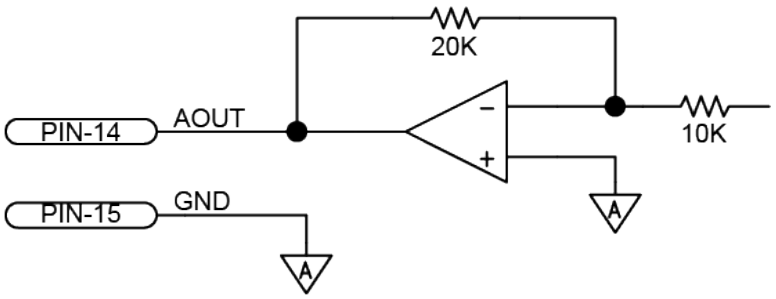


Figure 2-22: Analog Output 1

2.4.3. Digital Outputs

The digital outputs are optically-isolated and can be connected in sourcing or sinking configurations. The digital outputs are designed to connect to other ground referenced circuits and are not intended to provide high-voltage isolation.

The outputs are software-configurable and must be connected in either all sinking or all sourcing mode. Figure 2-23 and Figure 2-24 illustrate how to connect to an output in current sourcing and current sinking modes.

The opto-isolator's common connections can be directly connected to the drive's power supply; however, doing so will effectively defeat the isolation and will reduce noise immunity.

NOTE: Power supply connections must always be made to both the Output Common Plus (OP) and Output Common Minus (OM) pins as shown in Figure 2-23 and Figure 2-24.

Table 2-19: Digital Output Specifications

Opto Device Specifications	Value
Maximum Voltage	24 V maximum
Maximum Sink/Source Current	60 mA/channel @ 50°C
Output Saturation Voltage	2.75 V at maximum current
Output Resistance	33 Ω
Rise / Fall Time	250 usec (typical)
Reset State	Output Off (High Impedance State)

Table 2-20: Digital Output Pins on the Digital/Analog I/O Connector

Pin#	Description	In/Out/Bi
9	Digital Output Common +	Input
10	Digital Output 0	Output
11	Digital Output 1	Output
12	Digital Output 2	Output
13	Digital Output 3	Output
21	Digital Output Common -	Input
22	Digital Output 4	Output
23	Digital Output 5	Output
24	Digital Output 6	Output
25	Digital Output 7	Output

Suppression diodes must be installed on outputs driving relays or other inductive devices. This protects the outputs from damage caused by inductive spikes. Suppressor diodes, such as the 1N914, can be installed on all outputs to provide protection. It is important that the diode be installed correctly (normally reversed biased). Refer to Figure 2-24 for an example of a current sinking output with diode suppression and Figure 2-23 for an example of a current sourcing output with diode suppression.

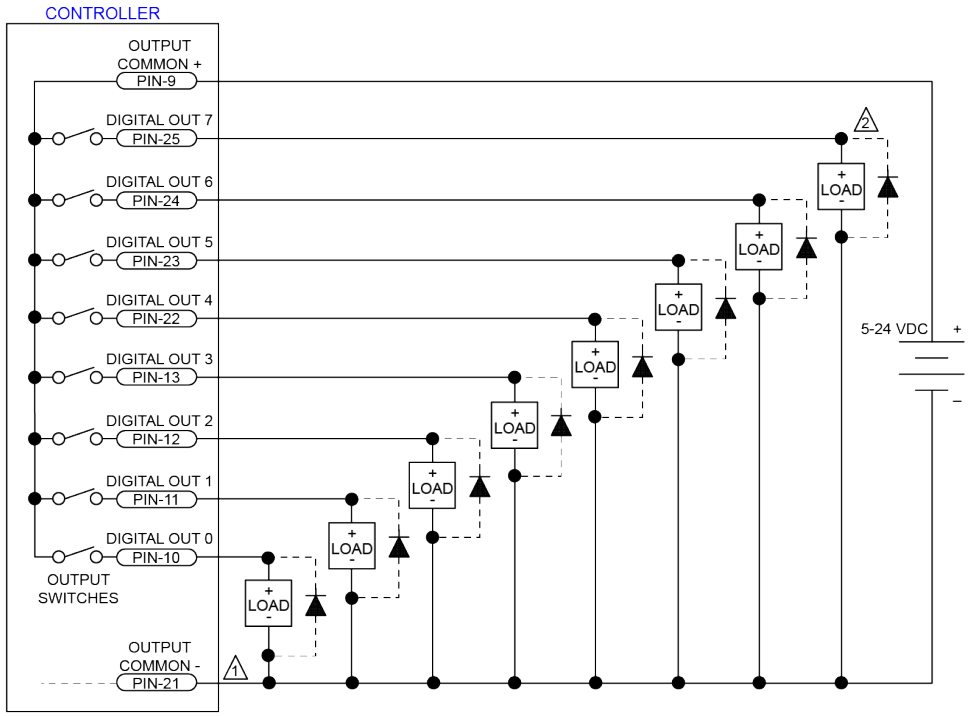


Figure 2-23: Digital Outputs Connected in Current Sourcing Mode

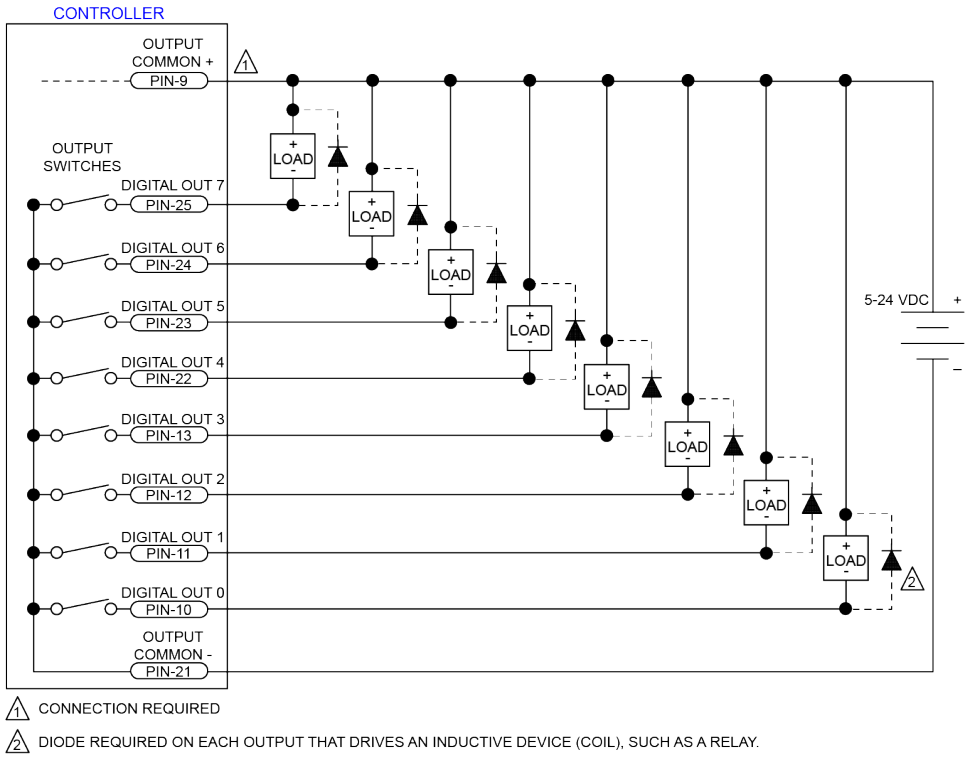


Figure 2-24: Digital Outputs Connected in Current Sinking Mode

2.4.4. Digital Inputs

The digital inputs are opto-isolated and may be connected to current sourcing or current sinking devices, as shown in Figure 2-25 and Figure 2-26. These inputs are designed to connect to other ground-referenced circuits and are not intended for high-voltage isolation.

Inputs 0-3 and inputs 4-7 have separate common inputs (refer to Table 2-22). Each 4-bit bank of inputs must be connected in the same configuration (sinking or sourcing). Bank 1 can be connected differently from Bank 2, however.

The opto-isolator's common connections can be directly connected to the drive's power supply; however, doing so will effectively defeat the isolation and will reduce noise immunity.

Table 2-21: Digital Input Specifications

Input Voltage	Approximate Input Current	Turn On Time	Turn Off Time
+5 V	1 mA	200 usec	2000 usec
+24 V	6 mA	4 usec	1500 usec

Table 2-22: Digital Input Pins on the Digital/Analog I/O Connector

Pin#	Description	In/Out/Bi
4	Input Common for Digital Inputs 0 - 3	Input
5	Digital Input 0	Input
6	Digital Input 1	Input
7	Digital Input 2	Input
8	Digital Input 3	Input
16	Input Common for Digital Inputs 4 - 7	Input
17	Digital Input 4	Input
18	Digital Input 5	Input
19	Digital Input 6	Input
20	Digital Input 7	Input

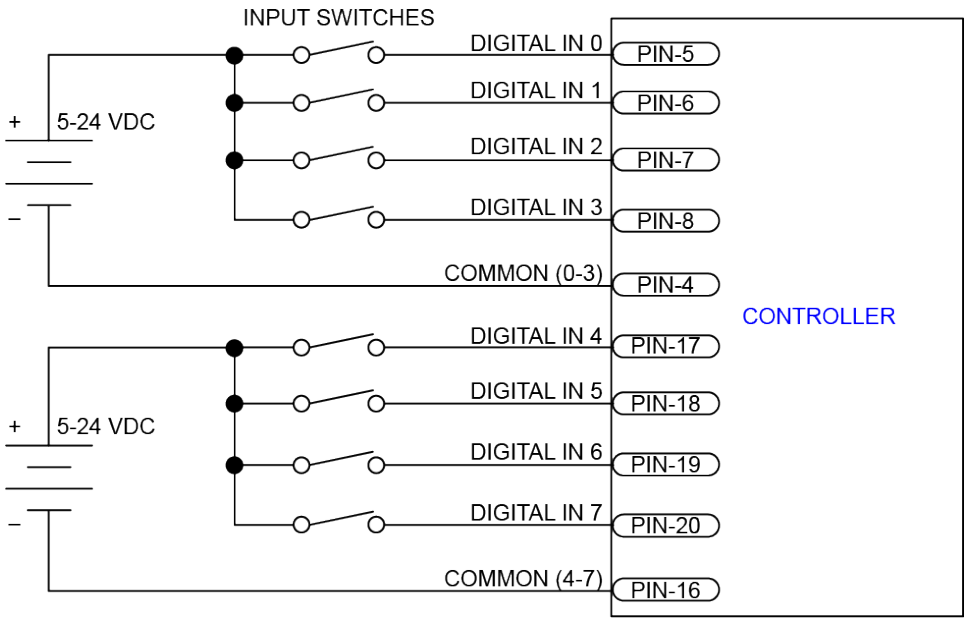


Figure 2-25: Digital Inputs Connected to a Current Sourcing Device

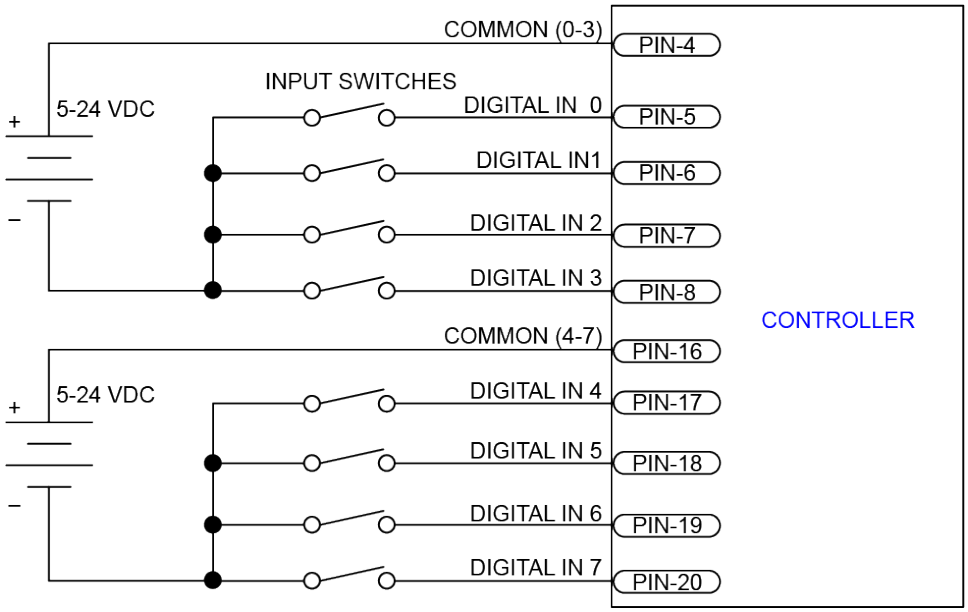


Figure 2-26: Digital Inputs Connected to a Current Sinking Device

2.5. Position Synchronized Output (PSO)

The PSO signal is available when the auxiliary marker is configured as an output using the PSOOUTPUT CONTROL command. Refer to the Help file for more information.

The PSO output signal uses an isolated digital switch that closes when a PSO fire event occurs. When the drive is reset or after initial power up, Pins 1 and 6 are a high impedance.

Table 2-23: PSO Specifications

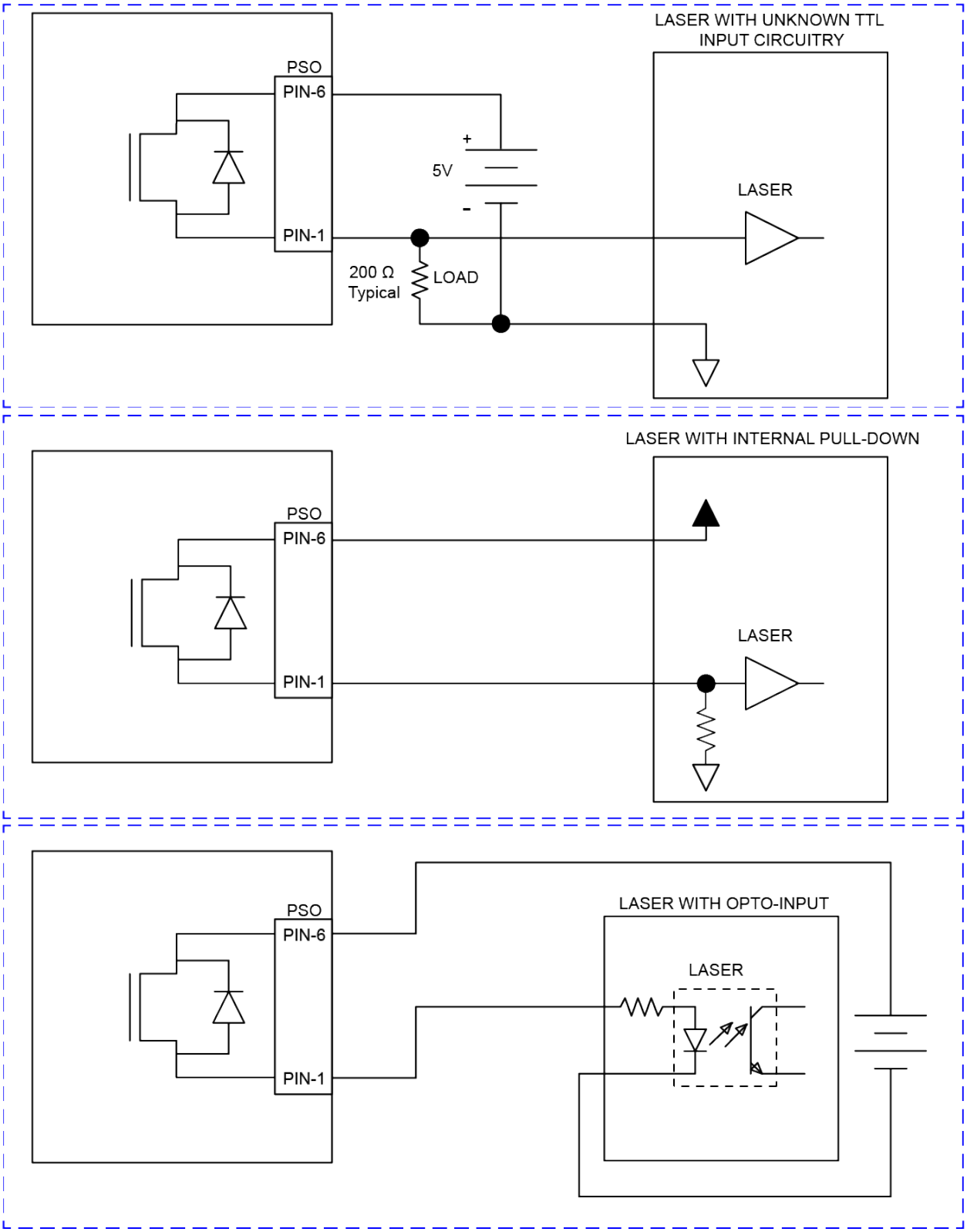
Specification	Value
Maximum Voltage	24 V
Current	250 mA
Latency	120 ns
Maximum Frequency	12.5 MHz

Table 2-24: PSO Connector Pinout

Pin#	Description	In/Out/Bi	Connector
1	PSO-	Bidirectional	
2	Cosine+	Bidirectional	
3	Cosine-	Bidirectional	
4	Sine+	Bidirectional	
5	Reserved	N/A	
6	PSO+	Bidirectional	
7	+5 Volt (500 mA max)	Output	
8	Common	Output	
9	Sine-	Bidirectional	

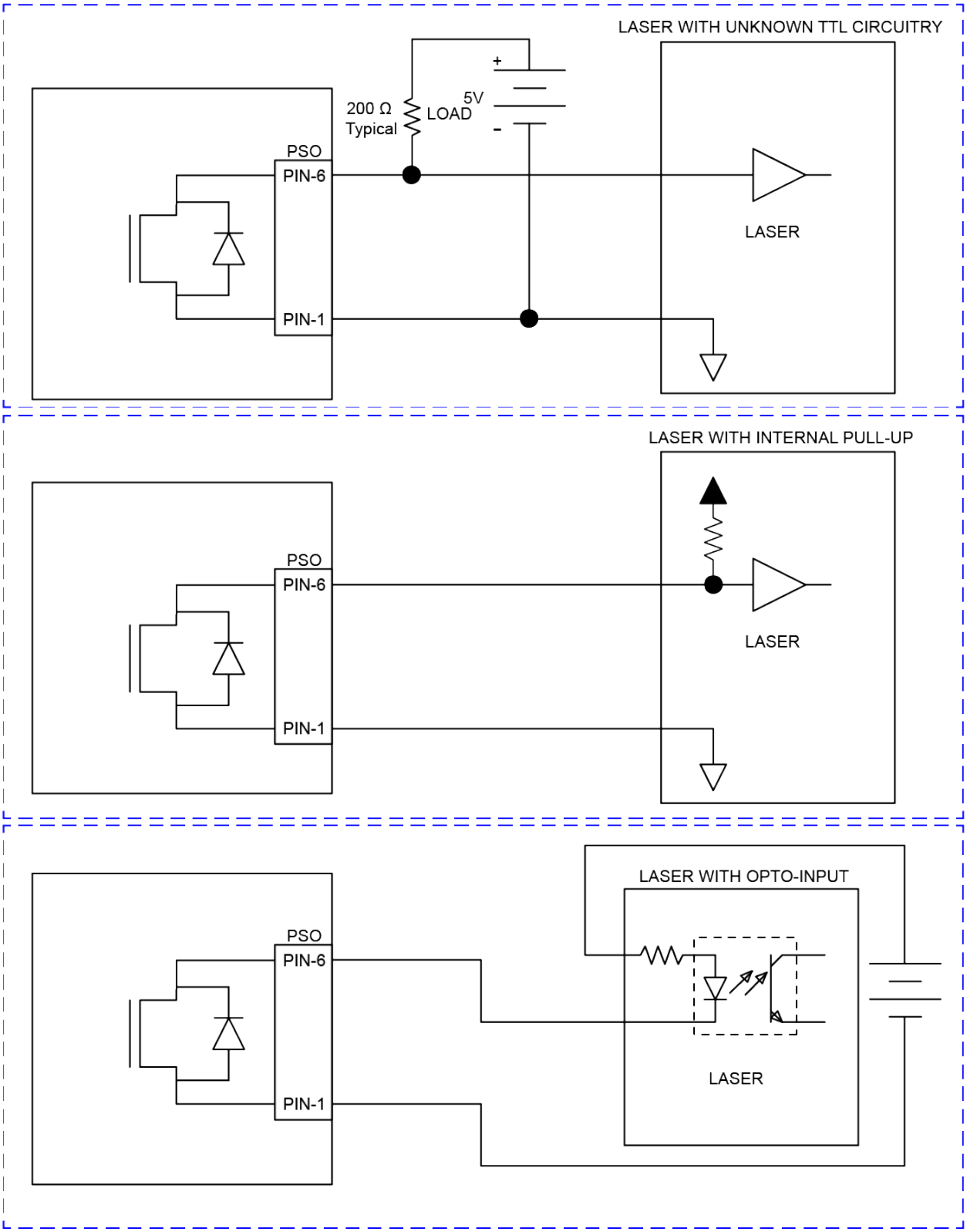
Table 2-25: Mating Connector for the PSO Connector

Mating Connector	Aerotech P/N	Third Party P/N
9-Pin D-Connector	ECK00137	FCI# DE09P064TXLF
Backshell	ECK01021	Amphenol 17E-1724-2



All examples are Active High (V+ = Laser On)

Figure 2-27: PSO Outputs Connected in Sourcing Mode



All examples are Active Low (0V = Laser On)

Figure 2-28: PSO Outputs Connected in Sinking Mode

2.6. DVI Connector

The DVI connector is a video display interface.

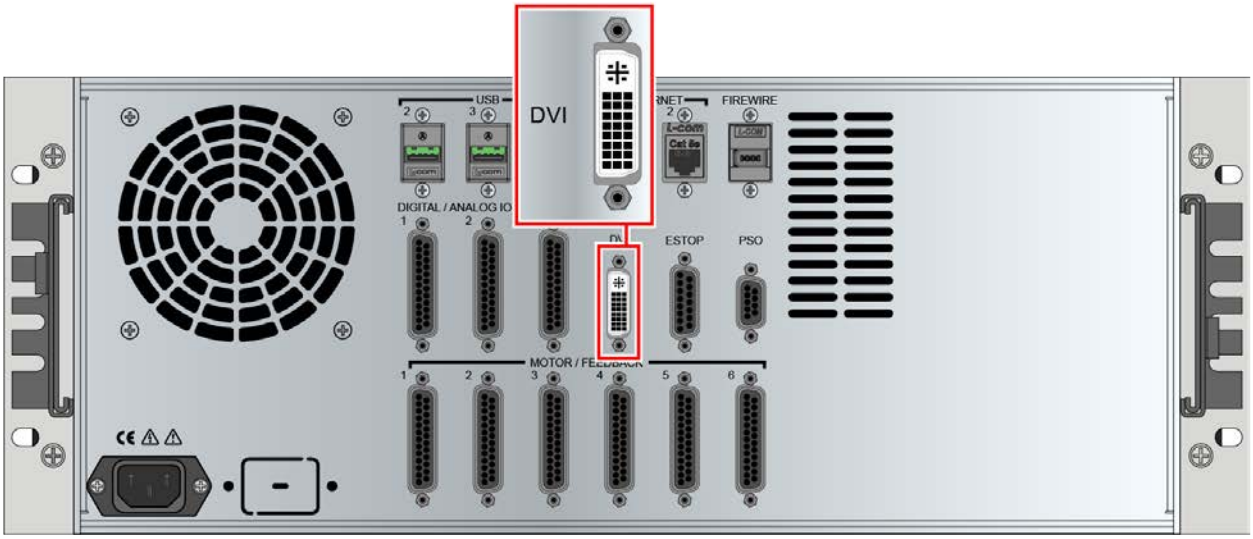


Figure 2-29: DVI Connector Location

2.7. USB Connectors

The HEX RC supplies four USB ports for peripheral device connection.

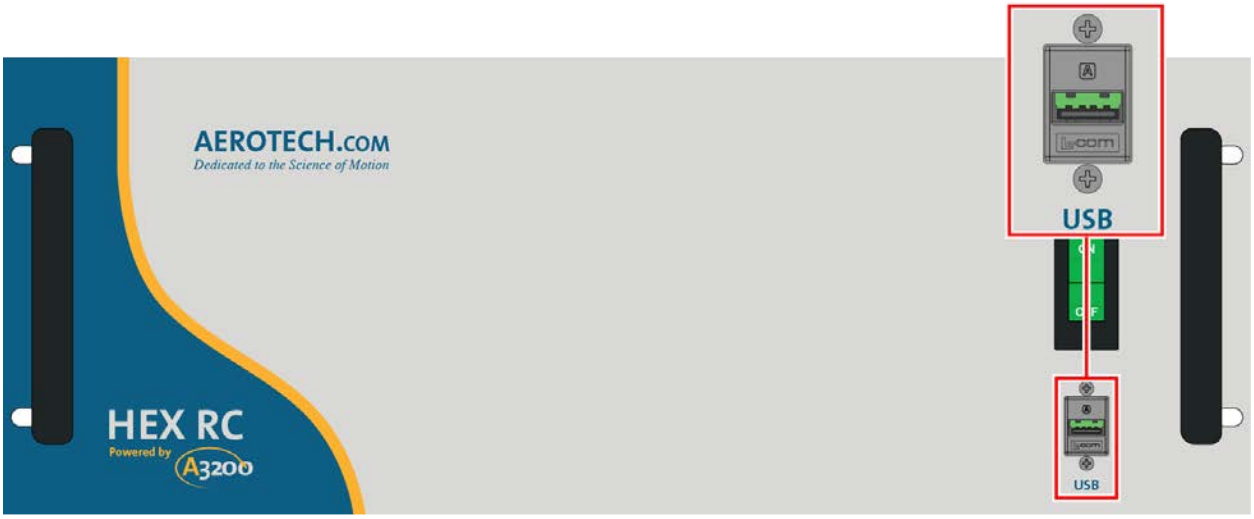


Figure 2-30: USB 2.0 Connector Location

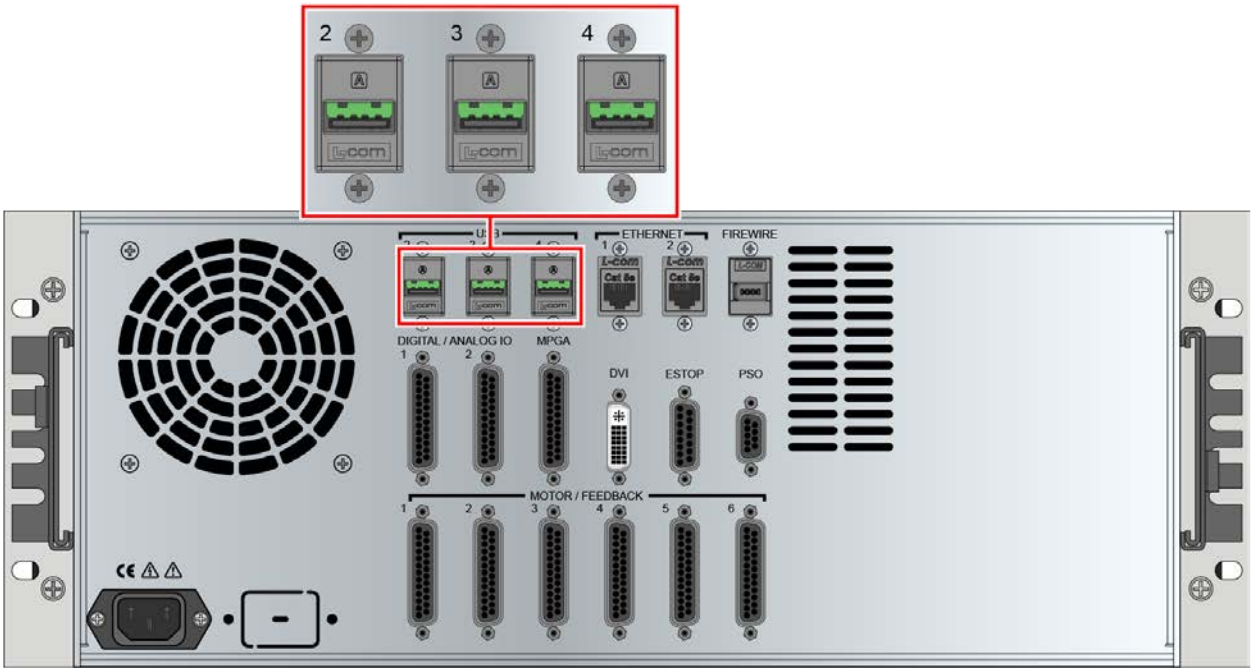


Figure 2-31: USB 3.0 Connector Locations

2.8. Ethernet Connector

The Ethernet connector provides a 10/100 Ethernet connection to the HEX RC controller. This may be connected directly to a hub or switch, or to a PC using a crossover cable. This port is viewed by the supplied software applications to communicate with the controller. It may also be configured for Modbus TCP/IP or simple ASCII communications.

Table 2-26: Ethernet Cable Specifications

Cable Name	Length
ENET-XOVER-X	x = 9, 15, 30, 45, 60, 75, 100 or 150 decimeters

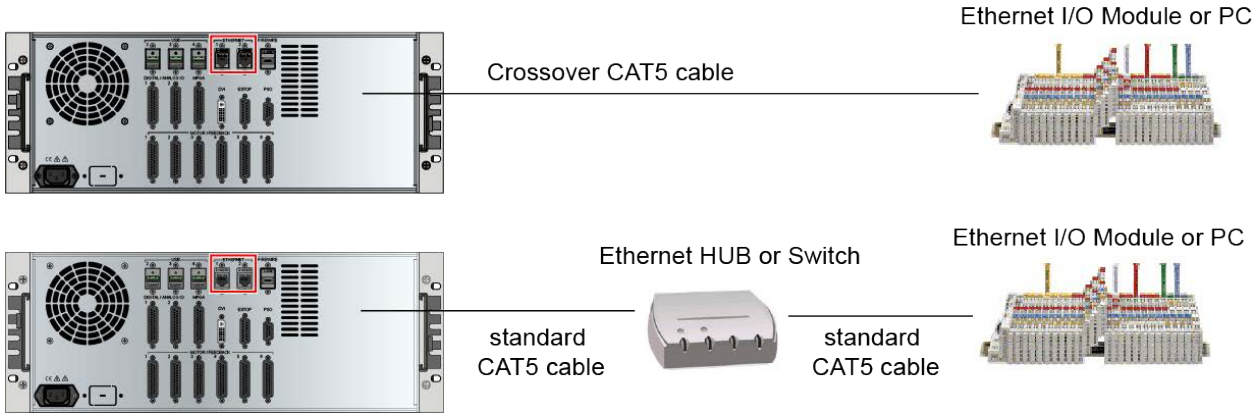


Figure 2-32: Ethernet Connection

2.9. FireWire® Connector

The FireWire interface allows the user to control up to 26 additional A3200 drives.

Table 2-27: FireWire Repeaters (for cables exceeding 4.5 m (15 ft) specification)

Part Number	Description
NFIRE-RPTR-1394A-1394A	Extender for copper cable lengths greater than 4.5 m (15 feet).
NFIRE-RPTR-1394A-GOF	Glass Optical Fiber FireWire Repeater, Qty. 1 (Fiber Cable not included)

Table 2-28: FireWire Cables (copper and glass fiber)

Part Number	Description
NCONNECT-60	6 m (20 ft) long, 6 pin to 6 pin
NCONNECT-45	4.5 m (15 ft) long, 6 pin to 6 pin
NCONNECT-30	3 m (10 ft) long, 6 pin to 6 pin
NCONNECT-15	1.5 m (5 ft) long, 6 pin to 6 pin
NCONNECT-9	0.9 m (3 ft) long, 6 pin to 6 pin
NCONNECT-10000-GOF	10 m (32.8 ft), glass fiber optical cable
NCONNECT-15000-GOF	15 m (49.2 ft), glass fiber optical cable
NCONNECT-20000-GOF	20 m (65.6 ft), glass fiber optical cable
NCONNECT-30000-GOF	30 m (101.7 ft), glass fiber optical cable

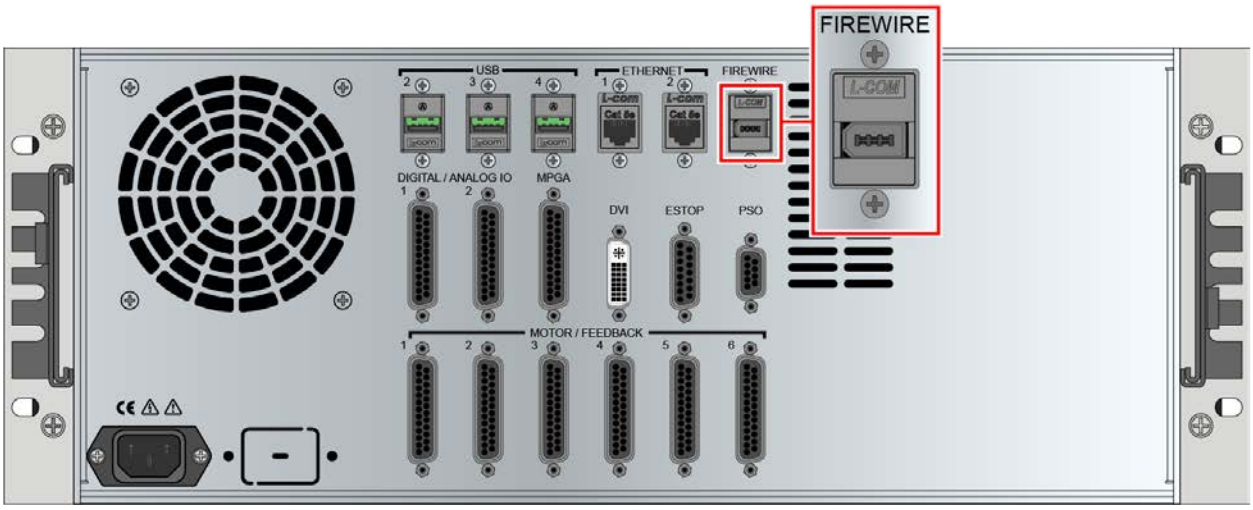


Figure 2-33: FireWire Connector Location

Chapter 3: Options

Table 3-1 provides a description of the various HEX RC options.

Table 3-1: Options and Capabilities

Option	Section	Description / Capabilities
-SL1	Section 1.2.	Rack mount slides
-EST3	Section 3.1.	ESTOP Sense Input EN ISO 13849-1, Category 2, Category 3
MPGA	Section 3.2.	Six-Axis Jog Pendant.

3.1. Emergency Stop (-EST3)

-EST3 is an integrated emergency stop hardware option available on the HEX RC. -EST3 uses two relays in series to disconnect the motor power supply from the drive modules and dissipates the stored energy in the motor power supply. User connections are made via the optional 15D ESTOP connector.

All relays are force guided and have a monitor contact.

WARNING: The machine integrator, OEM, or end user is responsible for performing the design, integration, and test of the safety system in accordance with the relevant safety standards. This responsibility includes the use of safety monitoring devices, interlocks, switches, light curtains and all other means of providing operator protection.

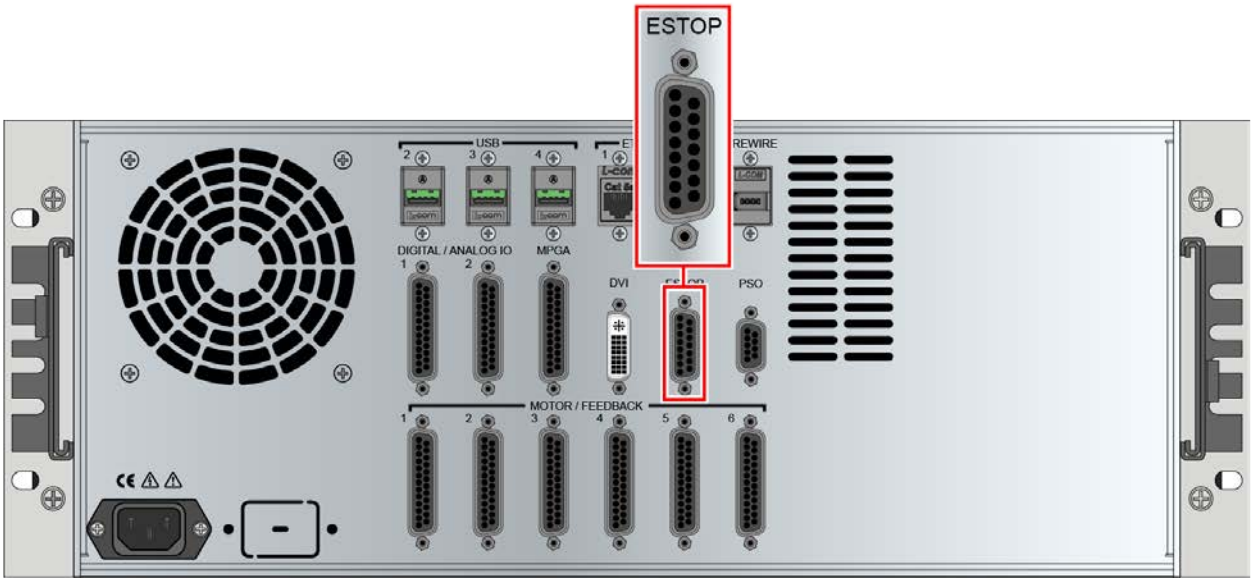


Figure 3-1: ESTOP Option Interface

Table 3-2: Mating Connector Part Numbers for the ESTOP Connector

Mating Connector	Aerotech P/N	Third Party P/N
15-Pin D-Connector	ECK00100	Amphenol DA15P064TXLF
Backshell	ECK01022	Amphenol 17E-1725-2

The -EST3 option can be used to provide performance in accordance with EN ISO 13849-1 as shown in Table 3-3.

Table 3-3: ESTOP Safety Ratings

Option	Relays	EN ISO 13849-1
-EST3	2 force guided relays with monitor contracts	Category 3, PL d

Table 3-4: ESTOP Relay Specifications

ESTOP3 CR1 and CR2	
Relay Part Number	Aerotech: ECW01107 Sprecher & Schuh: CA7-16E-M31-24E
AC-1 (resistive load)	Rating of 32 A
Turn On	The coil requires 17.0 W to turn on (which is equal to 700 mA @ 24 V)
On / Holding	The coil requires 1.7 W on (holding) current (which is equal to 70 mA @ 24 V)

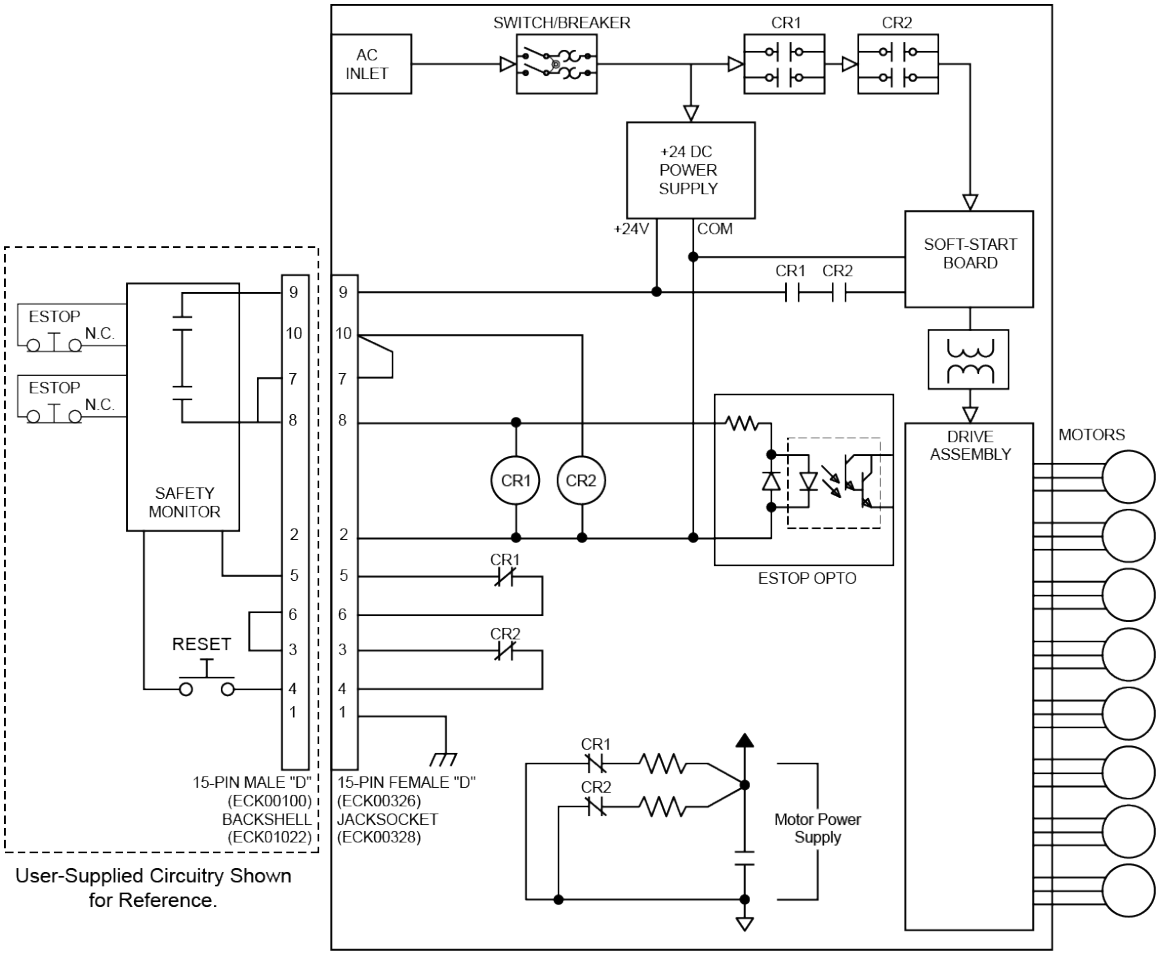


Figure 3-2: -EST3 Option Schematic

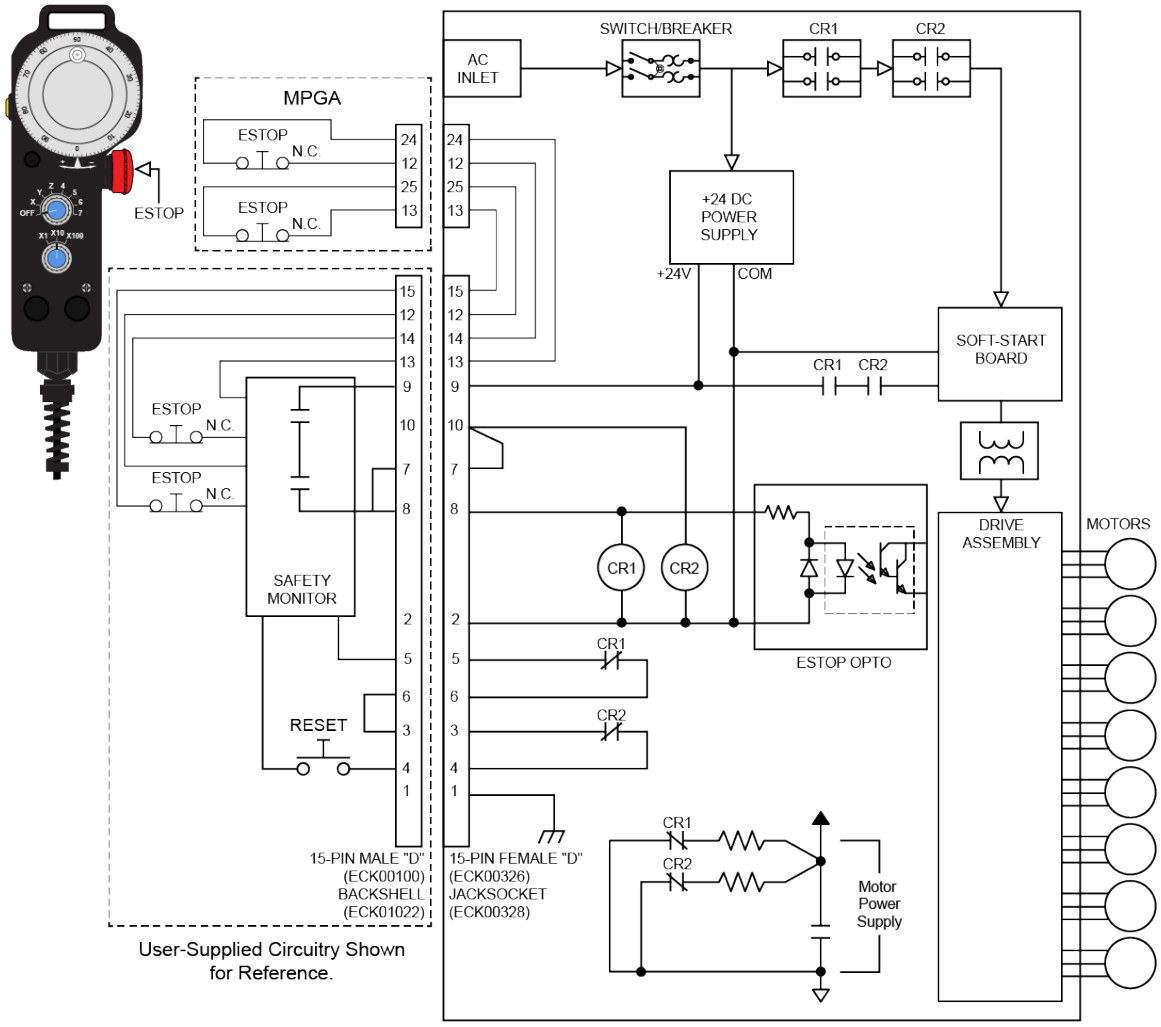


Figure 3-3: -EST3 with MPGA Option Schematic

3.2. MPGA Connector

The MPGA is the connector interface for a six-axis jog pendant. The MPG input device provides the capability to manually fine-position up to six axes. Refer to the MPG hardware manual for more information (http://www.aerotechmotioncontrol.com/manuals/index.aspx).

The ESTOP switch on the MPG will have no functionality without the -EST3 option (refer to Figure 3-3).

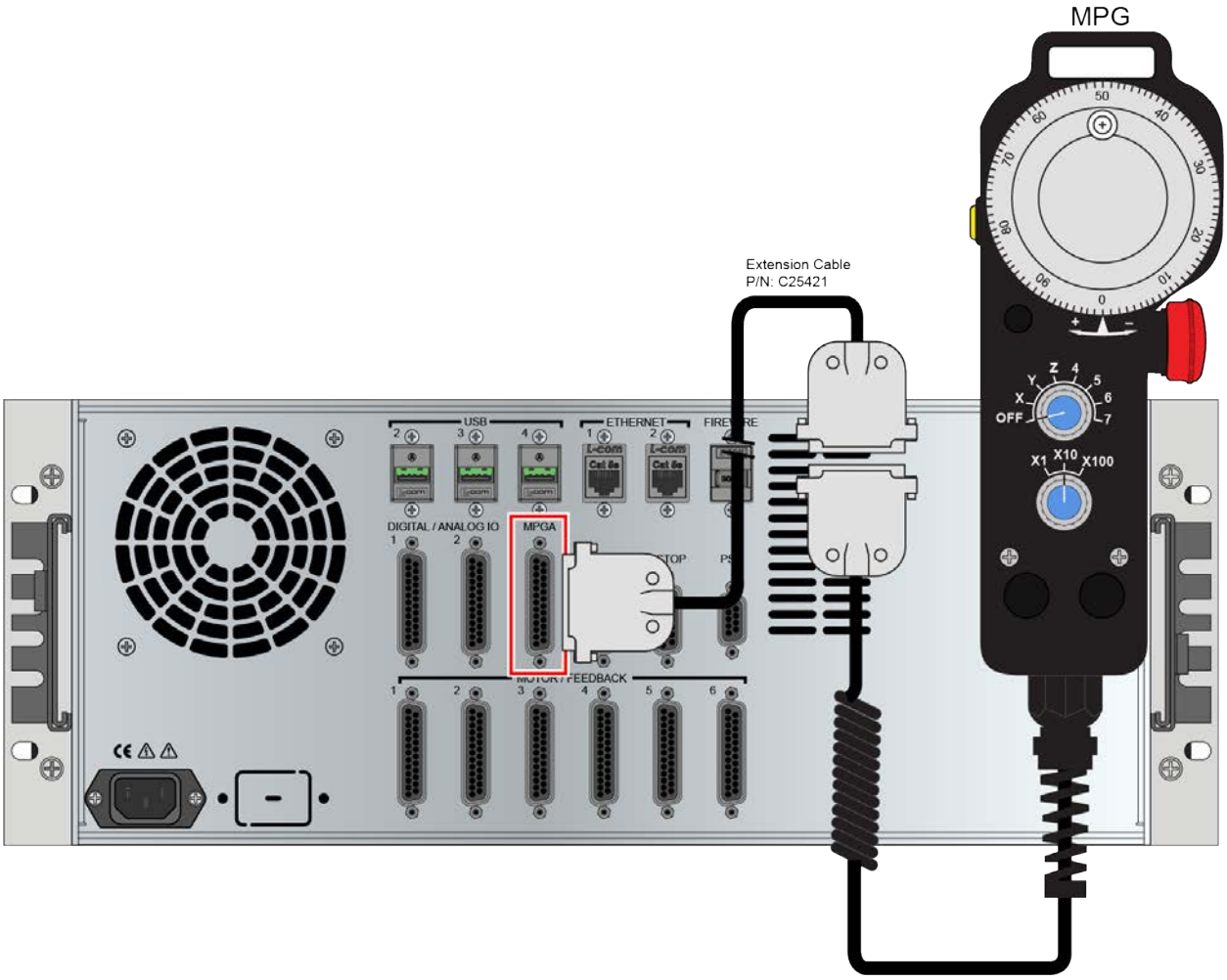
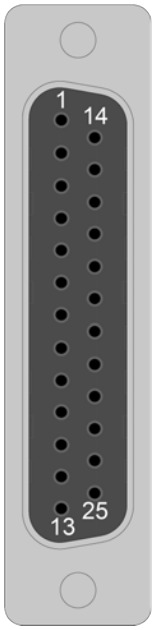


Figure 3-4: MPGA Connector Location

Table 3-5: MPGA Connector Pinout

Pin#	Description	Connector
1	Shield	
2	Common	
3	A	
4	B	
5	24 V Input	
6	Y Axis Switch	
7	4 Axis Switch	
8	6 Axis Switch	
9	x10 Mult Switch	
10	Reserved	
11	Reserved	
12	ESTOP NC1	
13	ESTOP NC2	
14	Reserved	
15	5 V Input	
16	A-N	
17	B-N	
18	X Axis Switch	
19	Z Axis Switch	
20	5 Axis Switch	
21	x1 Mult Switch	
22	x100 Mult Switch	
23	Reserved	
24	ESTOP NC1	
25	ESTOP NC2	

Chapter 4: Maintenance

Aerotech does not recommend opening the HEX RC to access internal boards, fuses, or components. Contact the factory for more details.

DANGER: Always disconnect the Mains power connection before opening the HEX RC chassis.

DANGER: Before performing any tests, be aware of lethal voltages inside the controller and at the input and output power connections. A qualified service technician or electrician should perform these tests.

4.1. Power Board Assembly

The HEX RC is factory wired for either 100/200 VAC or 115/230 VAC input voltage.

DANGER: Always disconnect the Mains power connection before opening the HEX RC chassis. Fuses must not be changed with Mains power applied to unit.

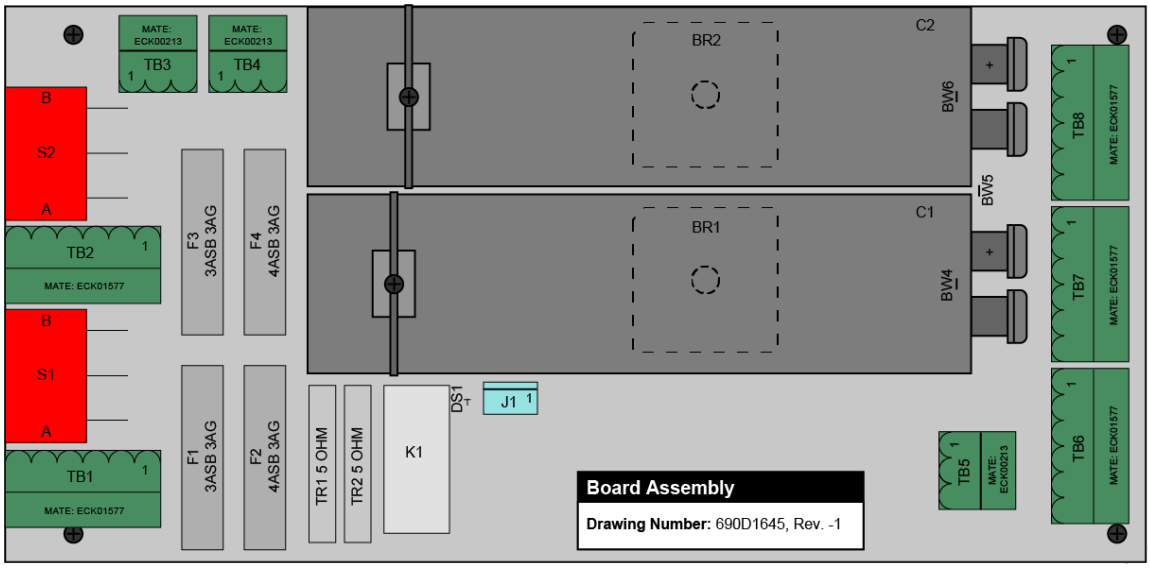


Figure 4-1: Power Board

Table 4-1: Component Select

Component	100/115 VAC	200/230VAC	Bipolar	Unipolar
SW1, SW2	B	A	-	-
BW4, BW6	-	-	Factory Select	Installed
BW5	-	-	Installed	Factory Select

4.2. Preventative Maintenance

The HEX RC and external wiring should be inspected monthly. Inspections may be required at more frequent intervals, depending on the environment and use of the system. The table below lists the recommended checks that should be made during these inspections.

DANGER: Disconnect power to HEX RC main supply before servicing.

DANGER: Disconnect power to avoid shock hazard.

Table 4-2: Preventative Maintenance

Check	Action to be Taken
Visually Check chassis for loose or damaged parts / hardware. **Note:** Internal inspection is not required.	Parts should be repaired as required. If internal damage is suspected, these parts should be checked and repairs made if necessary.
Inspect cooling vents.	Remove any accumulated material from vents.
Check for fluids or electrically conductive material exposure.	Any fluids or electrically conductive material must not be permitted to enter the HEX RC.
Visually inspect all cables and connections.	Tighten or re-secure any loose connections. Replace worn or frayed cables. Replace broken connectors.

Cleaning

The HEX RC chassis can be wiped with a clean, dry, soft cloth. The cloth may be slightly moistened if required with water or isopropyl alcohol to aid in cleaning if necessary. In this case, be careful not to allow moisture to enter the HEX RC or onto exposed connectors / components. Fluids and sprays are not recommended because of the chance for internal contamination, which may result in electrical shorts and/or corrosion. The electrical power must be disconnected from the HEX RC while cleaning. Do not allow cleaning substances or other fluids to enter the HEX RC or to get on to any of the connectors. Avoid cleaning labels to prevent removing the label information.

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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 https://www.aerotech.com/global-technical-support.aspx for the location of your nearest Aerotech Service center.

Returned Product Warranty Determination

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

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

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

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

Rush Service

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

On-site Warranty Repair

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

Aerotech will provide an on-site Field Service Representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following “On-Site Non-Warranty Repair” section apply.

On-site Non-Warranty Repair

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

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

Service Locations

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

USA, CANADA, MEXICO	CHINA	GERMANY
Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 5508 6731	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720

TAIWAN	UNITED KINGDOM
Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690	Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649

Have your customer order number ready before calling.

Appendix B: Revision History

Revision	Description
1.04.00	Updated Agency Approvals
1.03.00	Updates have been made to the following section: • Table 1-1 • Table 1-2 • Table 1-3
1.02.00	Updates have been made to the following section: • Table 1-2
1.01.00	Updates have been made to the following sections: • General product update: ▪ back panel connector layout has changed ▪ lifting instructions have been updated • EU Declaration of Conformity • Table 1-2 • Section 2.5. Position Synchronized Output (PSO)
1.00.00	New manual

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