Npaq MR Hardware Manual

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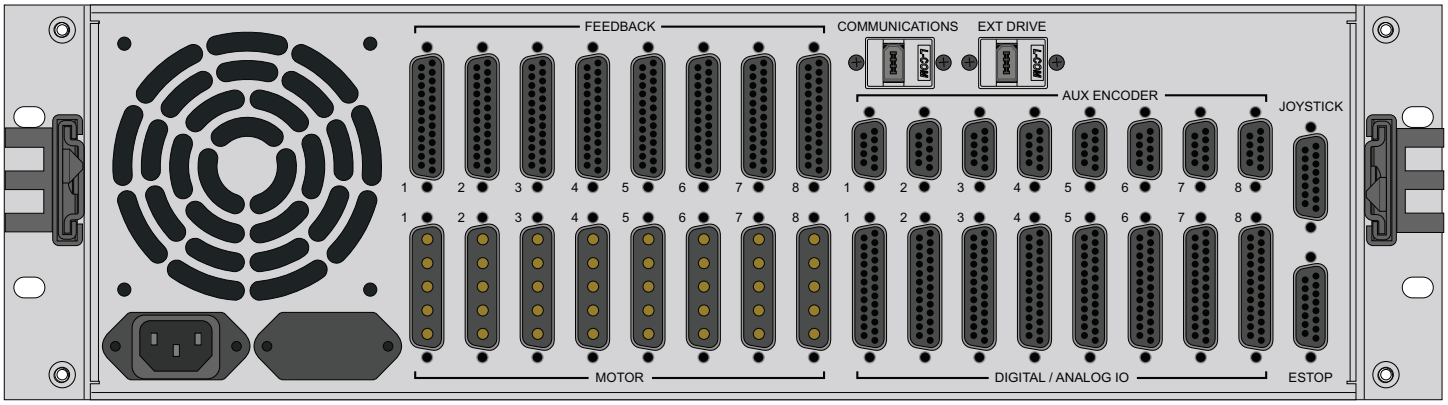

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EU Declaration of Conformity

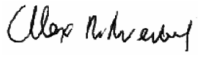
Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238-2811 USA
Product	Npaq MR
Model/Types	All

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

2014/35/EU	Low Voltage Directive LVD
2006/42/EC	Safety of Machinery
2011/65/EU	RoHS 2 Directive

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

EN 61010-1:2010	Safety requirements for electrical equipment
ISO 13849-1 & -2	Safety of Machinery - General Principals of Design

Name	 / Alex Weibel
Position	Engineer Verifying Compliance
Location	Pittsburgh, PA

Agency Approvals

Aerotech, Inc. Model Npaq MR Drive Racks have 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 13 10 68995 012
Standards:	UL 61010-1:2004; CAN/CSA-C22.2 No. 61010-1:2004; EN 61010-1:2010

Safety Procedures and Warnings

The following statements apply wherever the Warning or Danger symbol appears within this manual. Failure to observe these precautions could result in serious injury to those individuals performing the procedures and/or damage to the equipment.

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. Ensure that all electrical power switches are in the off position when servicing the equipment.
2. Disconnect electrical power before servicing equipment.
3. Disconnect electrical power before performing any wiring.
4. Access to the Npaq MR and component parts must be restricted while connected to a power source.
5. Residual voltages greater than 60V may be present inside Npaq MR chassis for longer than 10 seconds after power has been disconnected.
6. 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.
7. Install the Npaq MR inside a rack or enclosure.
8. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
9. All components must be properly grounded in accordance with local electrical safety requirements.
10. Operator safeguarding requirements must be addressed during final integration of the product.

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

1. Use of this equipment in ways other than described by this manual can cause personal injury or equipment damage.
2. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
3. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
4. 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.
5. 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.
6. Operators must be trained before operating this equipment.
7. All service and maintenance must be performed by qualified personnel.
8. This product is intended for light industrial manufacturing or laboratory use. Use of this product for unintended applications can result in injury and damage to the equipment.

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Quick Installation Guide

This chapter describes the order in which connections and settings should typically be made to the Npaq MR. 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.

There are four standard connections that must be made to the Npaq MR.

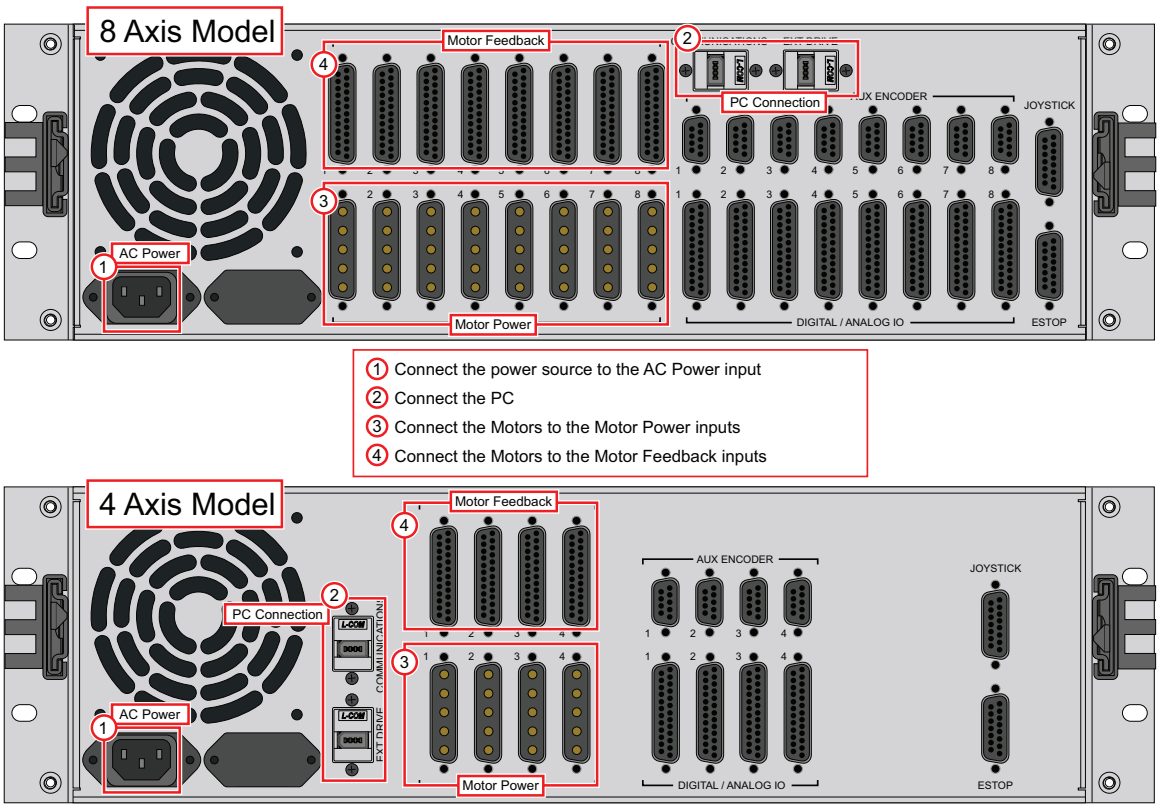

Figure 1: Quick Start Connections

Quick Start Summary

Topic	Section
AC Power	Section 2.2.1. AC Power Connections
PC Communication	Section 2.7. Communications Connector
Motor Power	Section 2.3. Motor Output Connections
Motor Feedback	Section 2.4. Motor Feedback Connections

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Chapter 1: Introduction

Aerotech's Npaq MR is a 3U height, 19" wide, rack-mountable, intelligent drive chassis, that consists of up to eight ultra-compact PWM and Linear network digital drives providing up to eight axes of motion. Each drive provides deterministic behavior, auto-identification, and easy software setup. High performance double precision floating point DSP controls the digital PID and current loops. All system configuration is done using software-settable parameters, including control loop gains and system safety functions.

Communicate with the PC with a standard commercial FireWire communication bus. I/O options are configurable per axis and include a 16 channel digital I/O interface (8 inputs and 8 outputs), one analog input, one analog output, and a single axis Position Synchronized Output (PSO) signal. Other features and options available with the MR drive chassis include: an external joystick connection port, integral encoder resolution multiplication, and integral emergency stop components.

NOTE: The Npaq MR can contain a mix of multiple discrete ML and MP drives. When using the A3200 software, the drives inside the Npaq MR will appear as if they were individual drives on the network. Motion and I/O commands on axes within the Npaq MR are programmed in the same manner as would be done for discrete units.

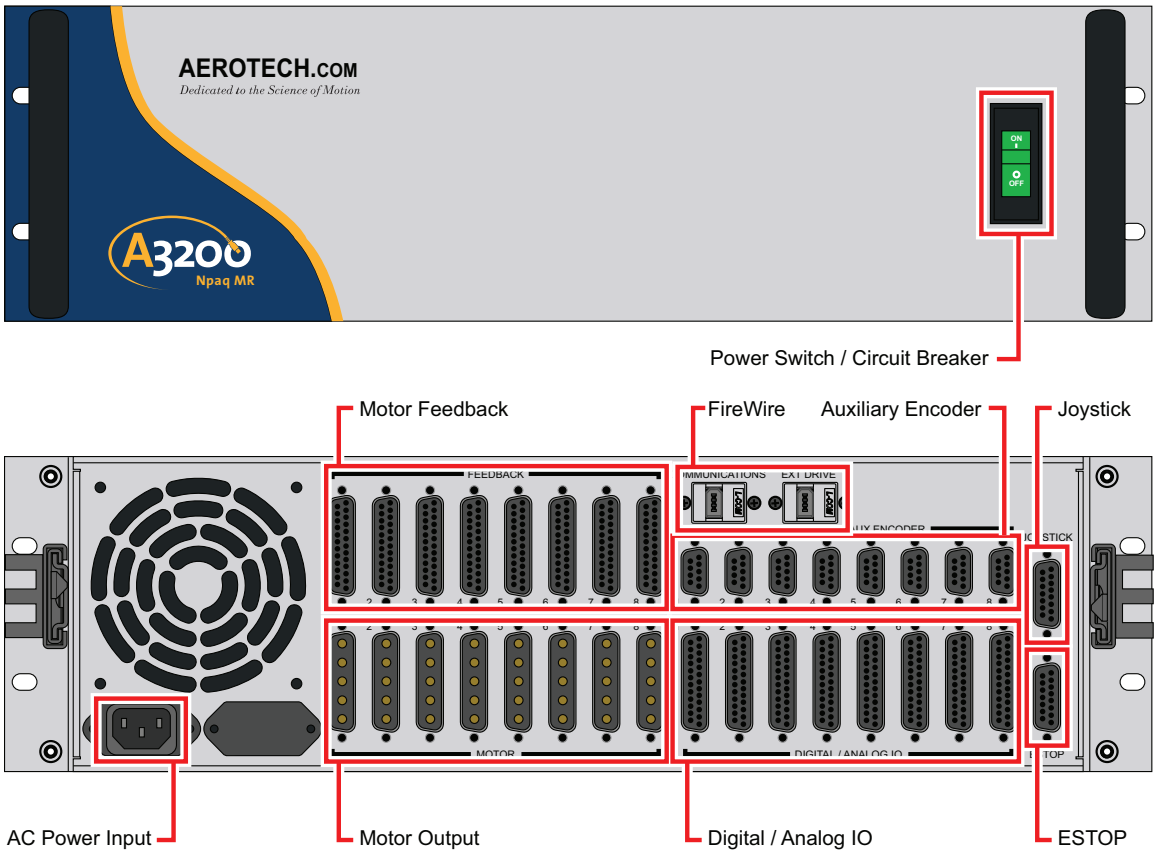

Figure 1-1: Chassis Layout

Table 1-1: Feature Summary

Standard Features	
• Line driver square wave quadrature encoder input for standard position and velocity feedback • One 12- or 16-bit differential analog input (±10 V) • Dedicated 5-24 V Emergency Stop sense input • Dedicated Hall inputs (3 per axis) • Dedicated over travel and home input limits	
Options	
-IO	• One 16-bit analog output (±10 V) • One 12- or 16-bit differential analog input (±10 V) • One fail-safe brake or user relay output • 8 optically isolated logic inputs (5 - 24 VDC), may be connected in current sourcing or sinking mode • 8 optically isolated logic outputs (5 - 24 VDC), user defined as current sourcing or sinking • Auxiliary encoder input channel • RS-422 differential PSO signal
-MXU (option on the MP)	x4,096 encoder interpolation for sine/cosine encoders
-MXU (option on the ML)	x4,096 encoder interpolation for sine/cosine encoders
-MXH (option on the ML)	x65,536 encoder interpolation for sine/cosine encoders

The following block diagram illustrates the features and options of the Npaq MR.

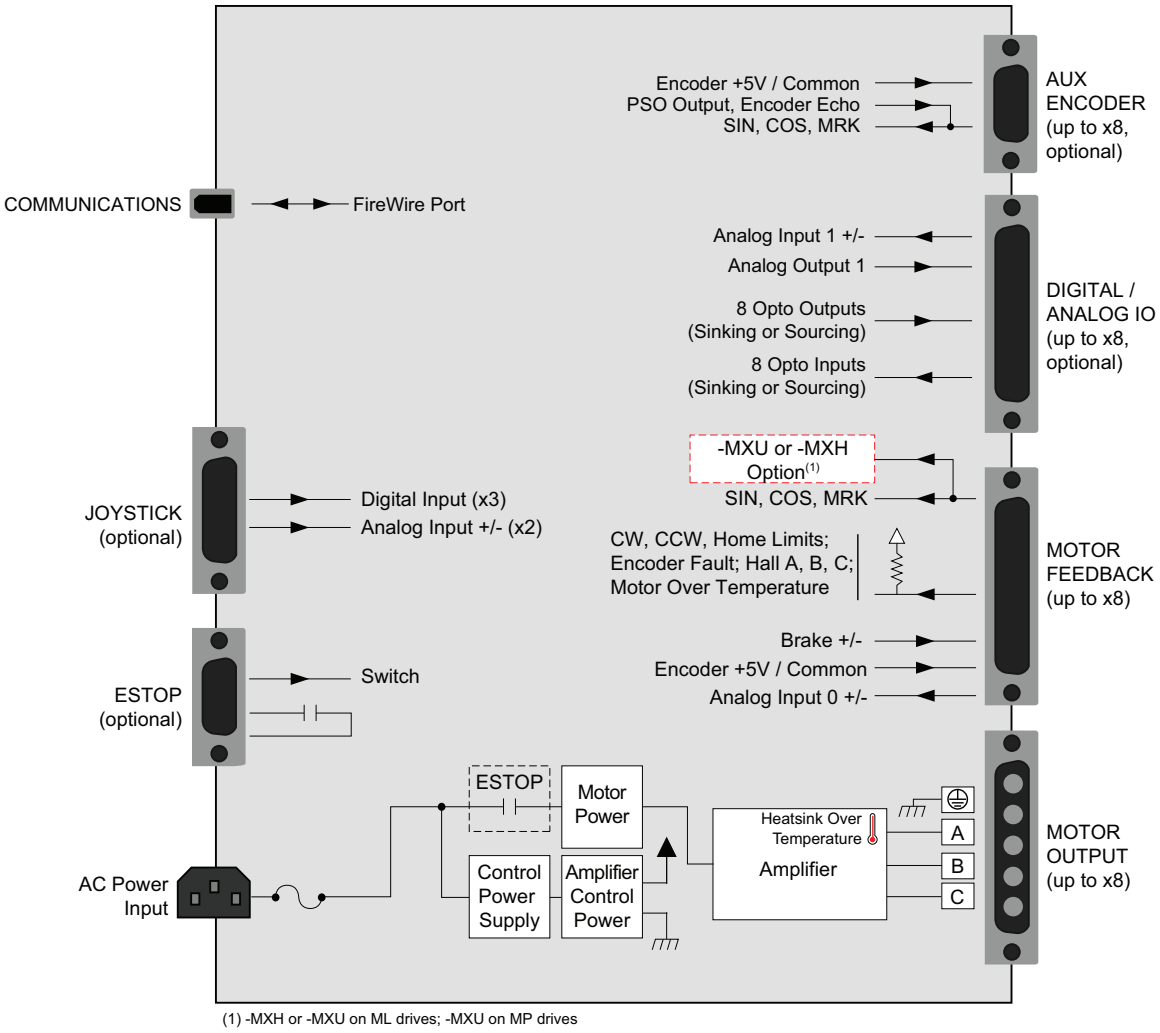

Figure 1-2: Functional Diagram

1.1. Electrical Specifications

The electrical specifications for the Npaq MR drive chassis are listed in Table 1-2 and the electrical specifications for the servo amplifiers in Table 1-3 and Table 1-4.

NOTE: Specifications represent the maximum capability of a feature. Other system constraints may result in significantly less performance. This is particularly applicable to the motor output specifications. 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 1-2: Chassis Electrical Specifications

Description		Specifications			
Bus Voltage Options		4-Axis		8-Axis	
		Unipolar	Bipolar	Unipolar	Bipolar
		40 LP@ 300W	10B @ 400W	40LP @ 500W	10B @ 400W
		80 LP @ 300W	20B @ 500W	40LP @ 500W	20B @ 500W
		40 @ 600W	30B @ 500W	40LP @1000W	30B @ 500W
		80 @ 600W	40B @ 600W	40LP @1000W	40B @ 1000W
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		<1/5 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 Amps, 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.			

Aerotech doesn't specify the input current or power to the drives because it is dependent on the amount of real power being delivered to the drive (refer to Section 1.1.1.).

Table 1-3: Servo Amplifier Electrical Specifications (MP)

		MP 10
Motor Supply	Input Voltage	10-80 VDC
	Input Current (Continuous)	5 A_{rms}
Control Supply	Input Voltage	24-80 VDC (±10%)
	Input Current	1 A max
Output Voltage (1)		10-80 VDC
Peak Output Current (1 second)		10 A
Continuous Output Current		5 A
Power Amplifier Bandwidth		2500 Hz maximum (software selectable)
Power Amplifier Efficiency		85% - 95%(2)
PWM Switching Frequency		20 kHz
Minimum Load Inductance		0.1 mH @ 80 VDC
User Power Supply Output		5 VDC (@ 500 milliamps)
Modes of Operation		Brushless; Brush; Stepper
Protective Features		Output short circuit; Peak over current, DC bus over voltages; RMS over current; Over temperature; Control power supply under voltage; Power stage bias supply under voltage
Isolation		Optical and transformer isolation between control and power stages.

1. AC input voltage and load dependent.
2. Dependent on total output power: efficiency increases with increasing output power.

Table 1-4: Linear Amplifier Electrical Specifications (ML)

Description		ML 10
Motor Supply	Input Voltage	±40 VDC (max)
	Input Current (continuous)	5 A
	Input Current (peak)	10 A
Control Supply	Input Voltage	24 VDC typical (18-36 VDC)
	Input Current	700 mA (max)
Output Voltage (1)		±38V @ 10 A
Peak Output Current (2)		10
Continuous Output Current (2)		5
Power Amplifier Bandwidth		2500 Hz maximum (software selectable)
Minimum Load Resistance		0.5 Ω
Output Impedance		0.2 Ω (each phase)
User Power Supply Output		5 VDC (@ 500 mA)
Modes of Operation		Brushless; Brush; Stepper
Protective Features		Peak current limit; Over temperature; RMS current limit; Dynamic power dissipation limit
Isolation		Isolation between control and power stages.

1. Load Dependent
2. Peak and continuous output current is load dependent (the amplifier will limit its output current based on motor speed and motor resistance).

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.

For switching amplifier types:

An EfficiencyFactor of approximately 90% should be used in the following equations.

Brushless Motor

Output Power

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

Ploss = 3 * I(rms)^2 * R(line-line)/2

Pin = SUM (Pout + Ploss) / EfficiencyFactor

DC Brush Motor

Pout [W] = Torque [N·m] * Angular velocity[rad/sec]

Ploss = I(rms)^2 * R

Pin = SUM (Pout + Ploss) / EfficiencyFactor

For linear amplifier types:

An EfficiencyFactor of approximately 50% should be used in the following equations.

Linear Motor

Pdiss[W] = MotorCurrentPeak[A] * TotalBusVoltage[V] * 3 / 2

Pin = SUM (Pdiss) / EfficiencyFactor

1.2. Mechanical Specifications

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

WARNING: Use both handles to lift and carry the Npaq MR.

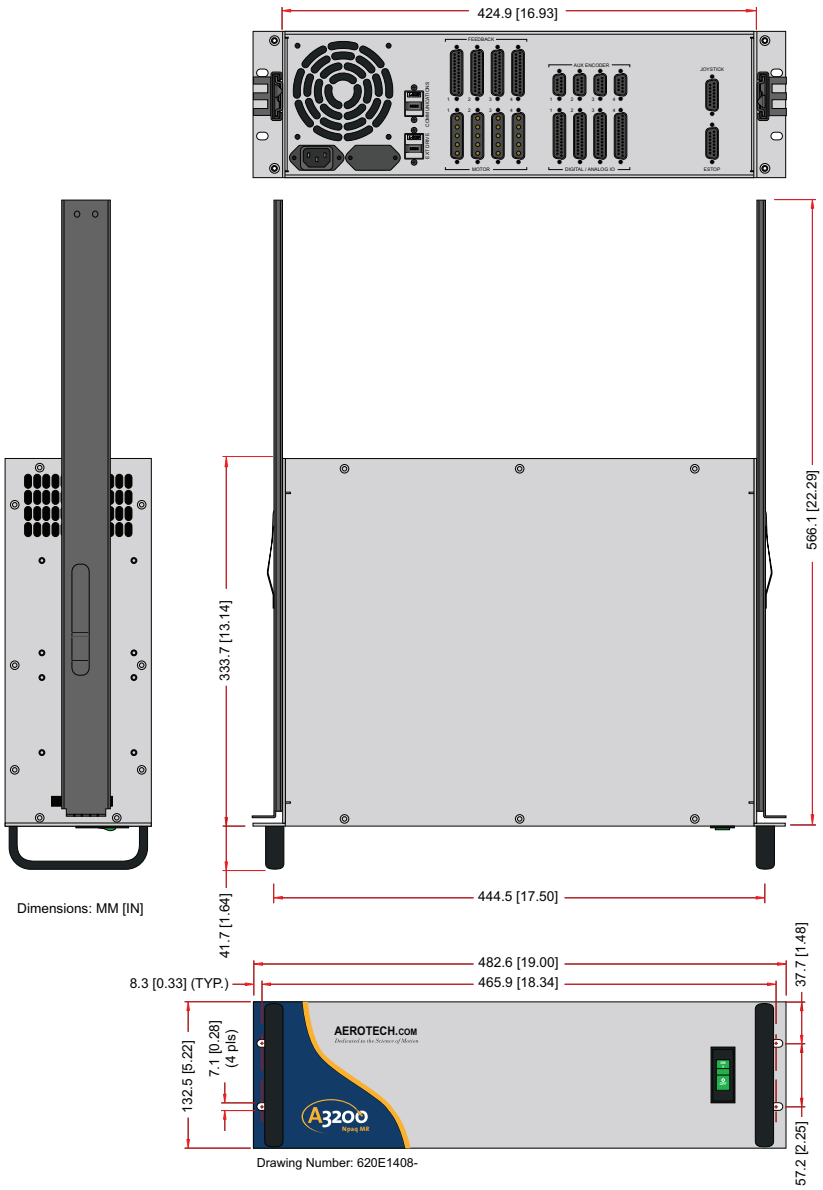

Figure 1-3: Dimensions (4 Axis Version)

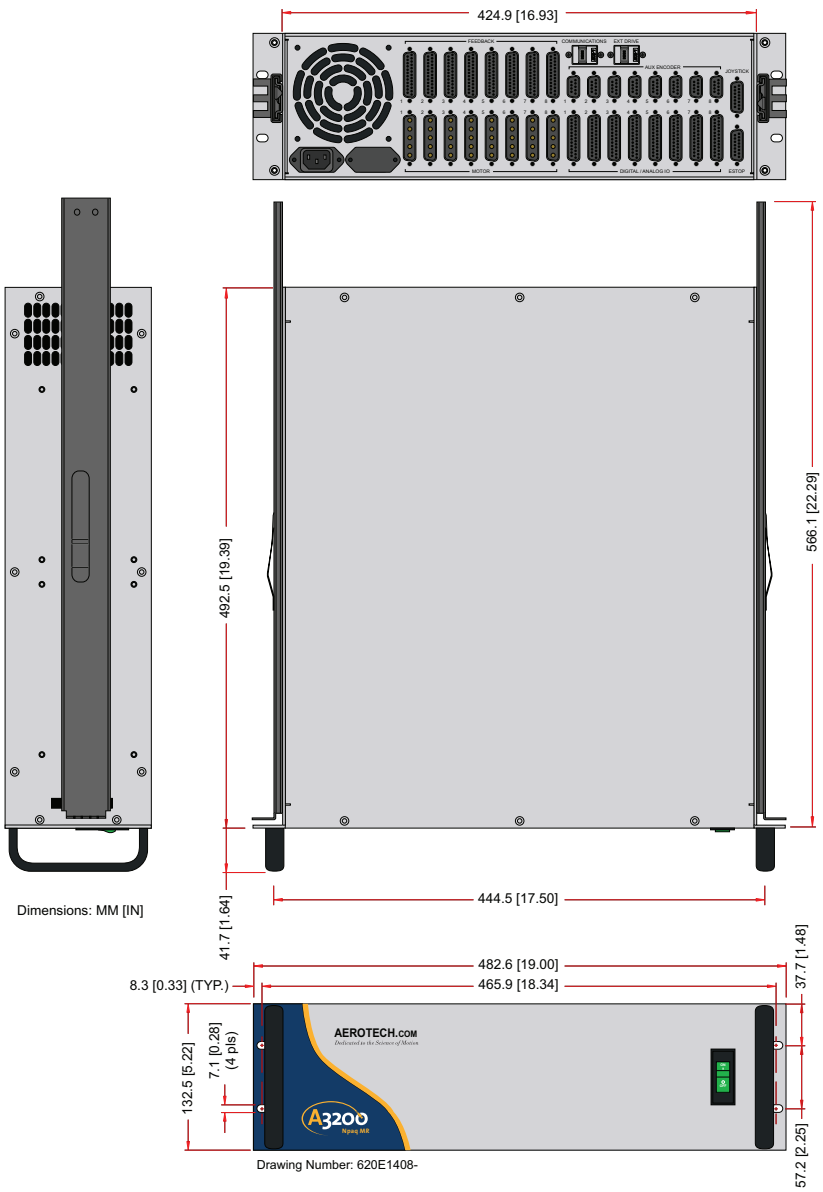

Figure 1-4: Dimensions (8 Axis Version)

All Npaq MR chassis's are built to the user's specifications causing a variation in actual product weight.

Table 1-5: Unit Weight

Description	Weight
Chassis Weight (typical)	23 kg

1.3. Environmental Specifications

The environmental specifications for the Npaq MR are listed below.

Ambient Temperature	Operating: 5° to 40°C (41° to 104° F)
	Storage: -20° to 70°C (-4° to 158° F)
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
Ndrive CL	-	2.18	5.02
	A	2.55	5.02
Ndrive CP	-	2.03	2.55
	A	2.10	Current
	B	2.19	Current
Ndrive FLS	-	4.03	Current
Ndrive FLS	A	4.06.001	Current
Ndrive HL	-	1.01	2.55
Ndrive HLe	-	2.22	Current
Ndrive HP	-	1.01	2.55
	A	1.08	2.55
Ndrive HPe	-	2.22	Current
Ndrive ML	-	3.00	Current
Ndrive MP	-	2.14	Current
Ndrive QL and QLe	-	5.01	Current
Nmark CLS	-	4.02	Current
	A	4.06.001	Current
Ndrive FCL	-	6.00	Current
Nmark GCL	-	5.04.000	Current
GL4	-	5.04.000	Current
Nmark SSaM	-	2.21	Current
	A	4.06.001	Current
Npaq	-	1.07	2.55
	A	2.09	Current
Npaq MR with ML drives	-	3.00	Current
Npaq MR with MP drives	-	2.14	Current
Nservo	-	2.08	Current
Nstep	-	2.14	Current

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Chapter 2: Installation and Configuration

2.1. Unpacking the Chassis

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

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

DANGER: Cables should not be connected to or disconnected from the Npaq MR drive chassis while power is applied, nor should any drive modules be removed or inserted into it with power applied. Doing so may cause damage to the system or its components.

A documentation package is provided with the Npaq MR either in a large manilla envelope or on the installation device containing manuals, interconnection drawings, and other documentation pertaining to the Npaq MR system. This information should be saved for future reference. Additional information about the Npaq MR system is provided on the Serial and Power labels that are placed on the Npaq MR chassis.

The system serial number label, located on the rear of the chassis, 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.

For label locations, refer to Figure 2-1

2.2. Electrical Installation

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

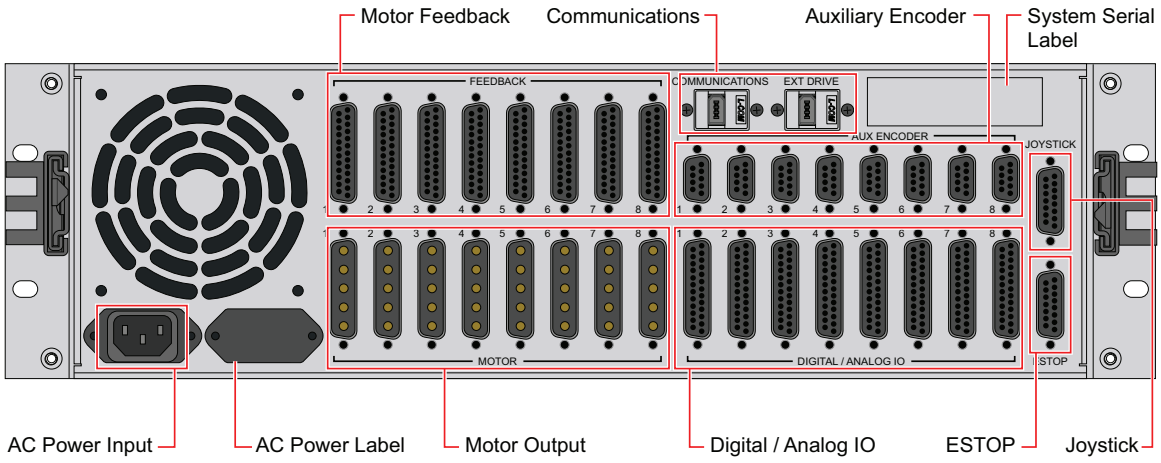


Figure 2-1: Power and Control Connections

Figure 2-2: Power Switch

All low voltage connections must be made using cables/wires sized for the maximum currents that will be carried. Insulation on these cables/wires must be rated at 300 V if this wiring can come into contact with wiring operating above 100 V (AC Power Input 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.

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

2.2.1. AC Power Connections

AC input power to the Npaq MR 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 Npaq MR drive chassis also functions as a 10 A breaker (supplementary protection only) for the incoming AC power.

The Npaq MR 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 Npaq MR drive chassis, are listed in Table 2-1.

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	6 A
230 VAC 50/60 Hz	5 A

The AC power cord/wiring specifications are listed in Table 2-2. 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 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.	

Refer to Figure 2-1 for label locations.

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 earth ground.
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. Motor cables must be physically separated from low level cables carrying FireWire, encoder, and I/O signals.
4. 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 the radiated emission standards.
5. The Npaq MR is a component designed to be integrated with other electronics. EMC testing must be conducted on the final product configuration.

The Npaq MR can generate conducted (AC line) and radiated noise when configured with MP drives. Minimize conducted emissions by using line filters. A line filter should be located as close to the drive as possible for maximum effectiveness. Aerotech recommends Schaffner FN2080-10-06 (Aerotech P/N: ECZ01449) or Aerotech's UFM-ST product (refer to Figure 2-3).

Table 2-3: UFM-ST Electrical Specifications

Specification	Value
Input Voltage Range	0-240 VAC
Output Voltage Range	0-240 VAC
Maximum Continuous Current	8 A_{rms} with convection cooling 10 A_{rms} with forced air cooling
Frequency	50/60 Hz
Phases	Single Phase
Leakage Current	1.1 mA (max)
Fuse Protection	Internal 10 A fuses on AC1 and AC2 inputs

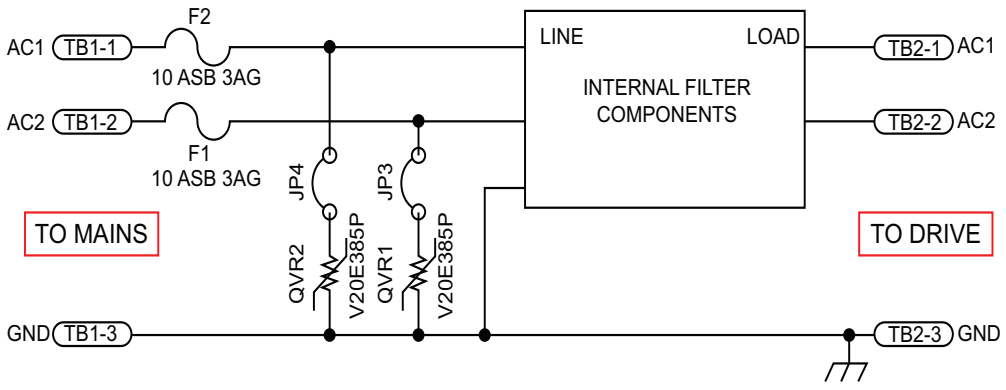


Figure 2-3: AC Line Filter (UFM-ST)

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 2-4: I/O and Signal Power 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.

2.2.4. Voltage Selection

You can reconfigure the transformers primary windings to support different AC line voltages by changing the Voltage Selection switches that are located on the left side of the chassis. 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.

If you change the Voltage Selector settings, you must also update the AC power label located next to the AC inlet to reflect the new settings.

DANGER: Disconnect Mains power before changing the voltage selector settings.

WARNING: The Voltage Selector must be configured to match the AC line voltage. You could damage the unit if the Voltage Selector is set for the incorrect AC line voltage.

For systems ordered with 115VAC (-A) or 230VAC (-B) input voltage:

Table 2-5: AC Voltage Selector Switch Settings for 115 VAC or 230 VAC Option

Input Voltage	Switch 1 Position	Switch 2 Position
115 VAC	DOWN	DOWN
230 VAC	UP	UP

For systems ordered with 100VAC (-C) or 200VAC (-D) input voltage:

Table 2-6: AC Voltage Selector Switch Settings for 100 VAC or 200 VAC Option

Input Voltage	Switch 1 Position	Switch 2 Position
100 VAC	DOWN	DOWN
200 VAC	UP	UP

NOTE: The Voltage Selection switches will be partially hidden if you purchased the MR with the -SLIDE option.

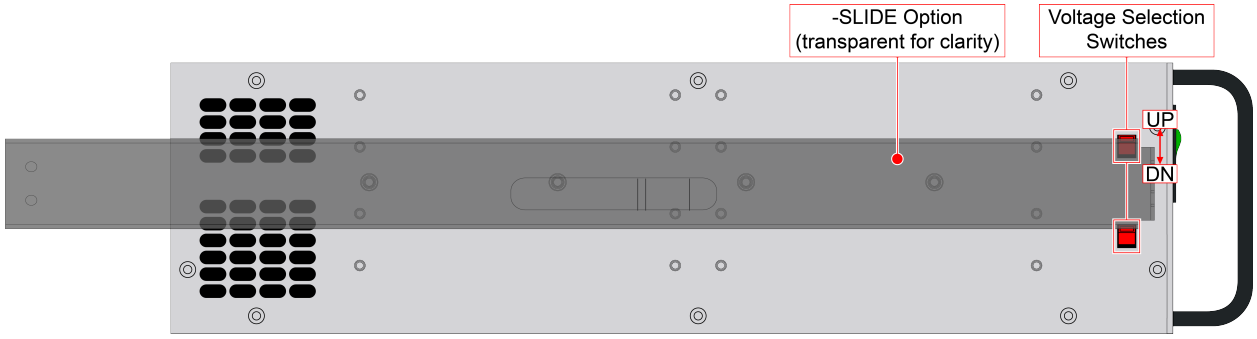


Figure 2-4: Voltage Selection Switch Access

2.3. Motor Output Connections

The Npaq MR can be used to drive three motor types: Brushless, DC Brush, and Stepper motors.

The DC brush, brushless, and stepper motor connections are made to the 5-pin high power “D” style motor power connectors (Axis 1-8) that are located on the rear panel. The pin assignments for these connectors are shown in Table 2-7.

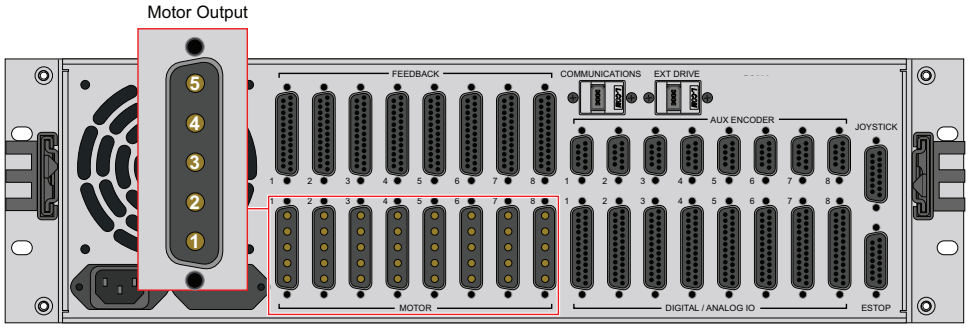


Figure 2-5: Motor Output Connections

Table 2-7: Motor Power Output Connector Pin Assignment

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

Table 2-8: Motor Power Output Mating 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

2.3.1. Brushless Motor Connections

The configuration shown in Figure 2-6 is an example of a typical brushless motor connection.

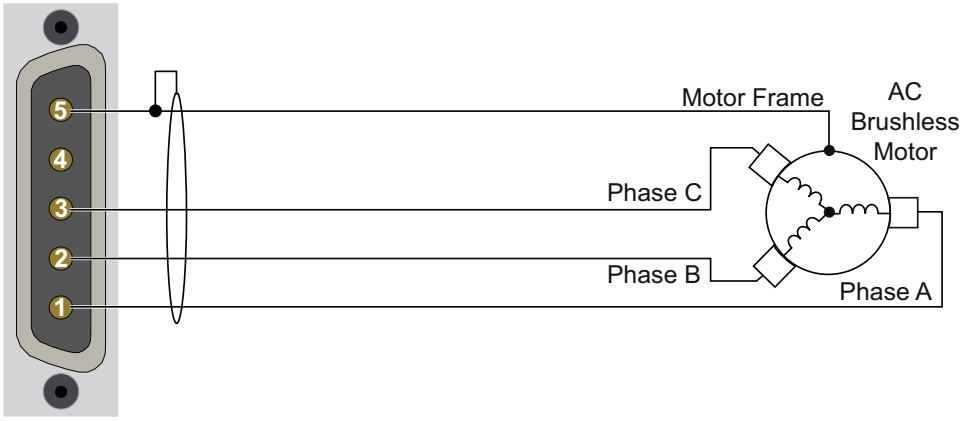


Figure 2-6: Brushless Motor Configuration

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. Refer to Section 2.3.1.1. for powered motor phasing or Section 2.3.1.2. for unpowered motor and feedback phasing.

2.3.1.1. Powered Motor Phasing

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

Feedback Monitoring

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

An “L” for the given Hall input indicates zero voltage or logic low, where a “H” indicates 5V or logic high.

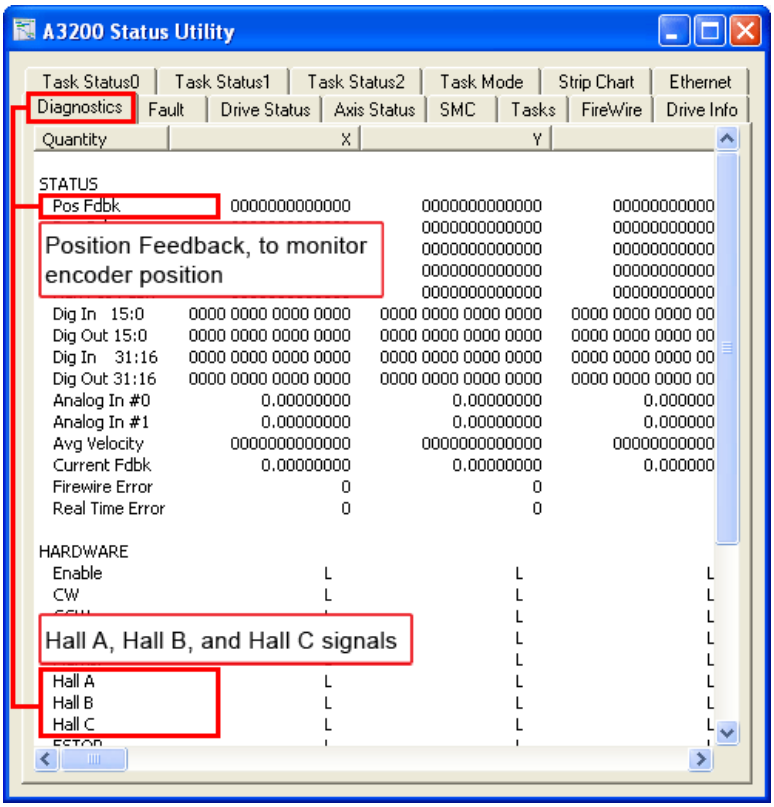


Figure 2-7: Encoder and Hall Signal Diagnostics

2.3.1.2. Unpowered Motor and Feedback Phasing

Disconnect the motor from the controller and connect the motor in the test configuration shown in Figure 2-8. 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 2-8). Wave forms are shown while moving the motor in the positive direction.

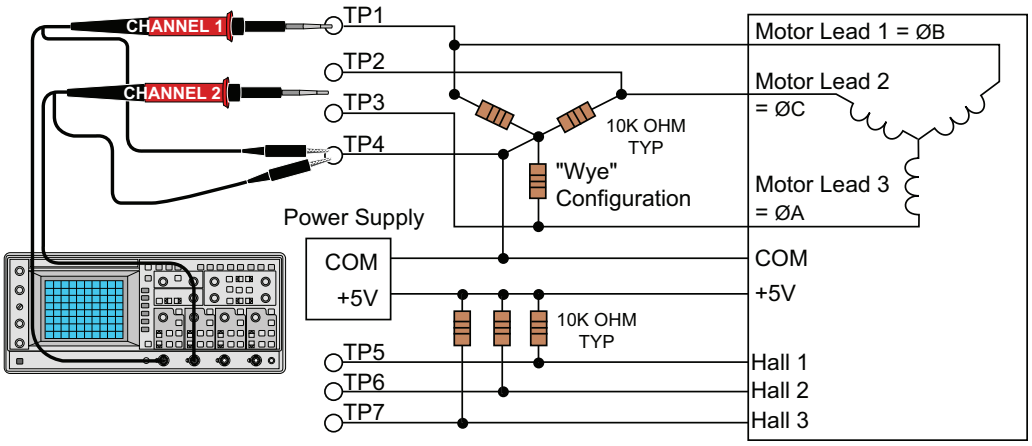


Figure 2-8: Motor Phasing Oscilloscope Example

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 2-9). Use the CommutationOffset parameter to correct for Hall signal misalignment.

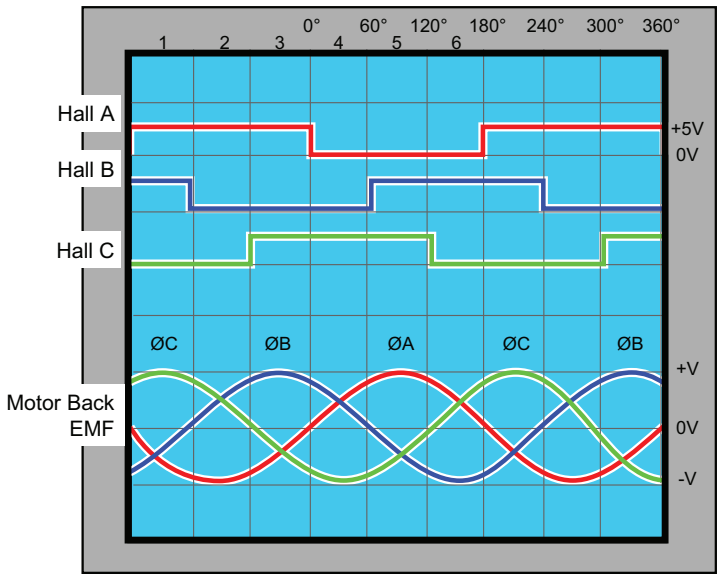


Figure 2-9: Brushless Motor Phasing Goal

2.3.2. DC Brush Motor Connections

The configuration shown in Figure 2-10 is an example of a typical DC brush motor connection. Refer to Section 2.3.2.1. for information on motor phasing.

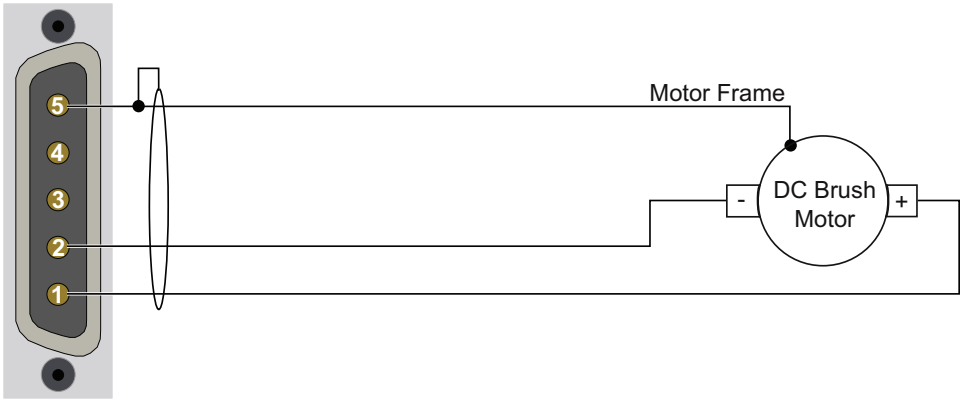


Figure 2-10: DC Brush Motor Configuration

2.3.2.1. 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. Rotate the motor clockwise by hand.

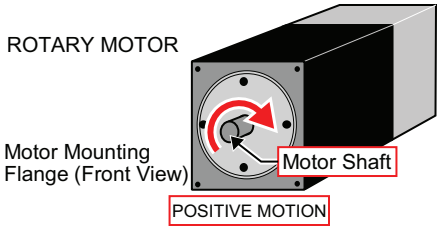


Figure 2-11: Clockwise Motor Rotation

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

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

2.3.3. Stepper Motor Connections

The configuration shown in Figure 2-12 is an example of a typical stepper motor connection. Refer to Section 2.3.3.1. 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.

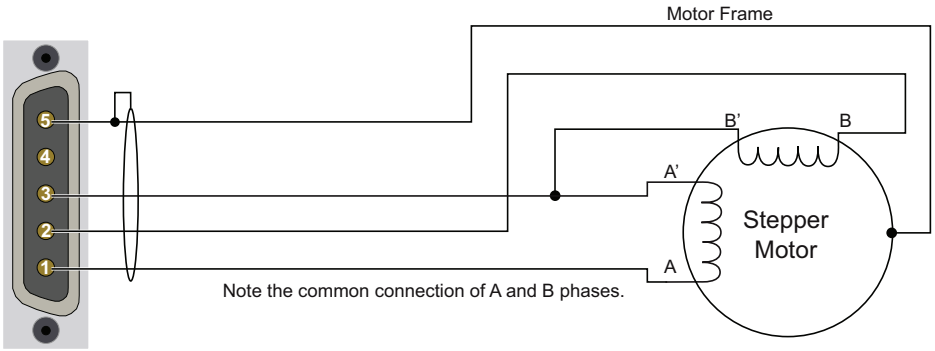


Figure 2-12: Stepper Motor Configuration

2.3.3.1. 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.

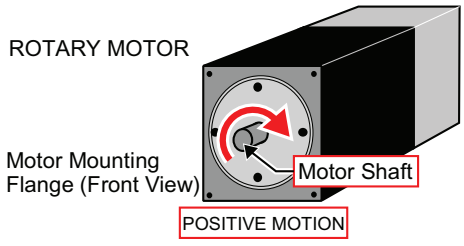


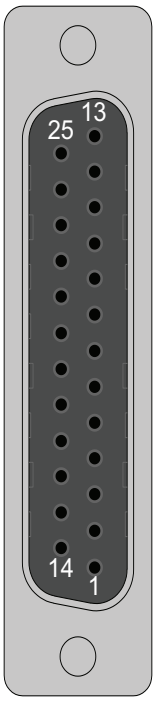
Figure 2-13: Clockwise Motor Rotation

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

2.4. Motor Feedback Connections

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 optional brake connections. The connector pin assignment is shown in Table 2-9 with detailed connection information in the following sections.

Table 2-9: Motor Feedback Connector Pin Assignment

Pin#	Description	In/Out/Bi	Connector
1	Chassis Frame Ground	N/A	
2	Motor Over Temperature Thermistor	Input	
3	+5V Power for Encoder (500 mA max)	Output	
4	Reserved	N/A	
5	Hall-Effect Sensor B (brushless motors only)	Input	
6	Encoder Marker Reference Pulse -	Input	
7	Encoder Marker Reference Pulse +	Input	
8	Analog Input 0 -	Input	
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	Optional Brake - Output	Output	
14	Encoder Cosine +	Input	
15	Encoder Cosine -	Input	
16	+5V Power for Limit Switches (500 mA max)	Output	
17	Encoder Sine +	Input	
18	Encoder Sine -	Input	
19	Analog Input 0 +	Input	
20	Signal Common for Limit Switches	N/A	
21	Signal Common for Encoder	N/A	
22	Home Switch Input	Input	
23	Encoder Fault Input	Input	
24	Counterclockwise End of Travel Limit	Input	
25	Optional Brake + Output	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. Encoder Inputs

The Npaq MR is equipped with standard and auxiliary encoder feedback channels. The standard encoder interface is accessible through the Motor Feedback connector. By default, it accepts an RS-422 differential line driver signal. If the -MXU or -MXH option has been purchased, the standard encoder interface has been configured for an analog encoder input via parameter settings.

Refer to Section 2.4.1.3. for encoder feedback phasing. Refer to Section 2.6. for the auxiliary encoder channel.

NOTE: Encoder wiring should be physically isolated from motor, AC power and all other power wiring.

NOTE: The PSO feature is **not** compatible with the -MXU option. The PSO feature operates with the -MXH option and with square wave encoders.

Table 2-10: Encoder Pin Assignment

Pin#	Description	In/Out/Bi
1	Chassis Frame Ground	N/A
3	+5V Power for Encoder (500 mA max)	Output
6	Encoder Marker Reference Pulse -	Input
7	Encoder Marker Reference Pulse +	Input
14	Encoder Cosine +	Input
15	Encoder Cosine -	Input
17	Encoder Sine +	Input
18	Encoder Sine -	Input
21	Signal Common for Encoder	N/A

2.4.1.1. RS-422 Line Driver Encoder (Standard)

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.

An analog encoder is used with the -MXH/-MXU option (refer to Section 2.4.1.2. for more information).

Table 2-11: Encoder Specifications

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

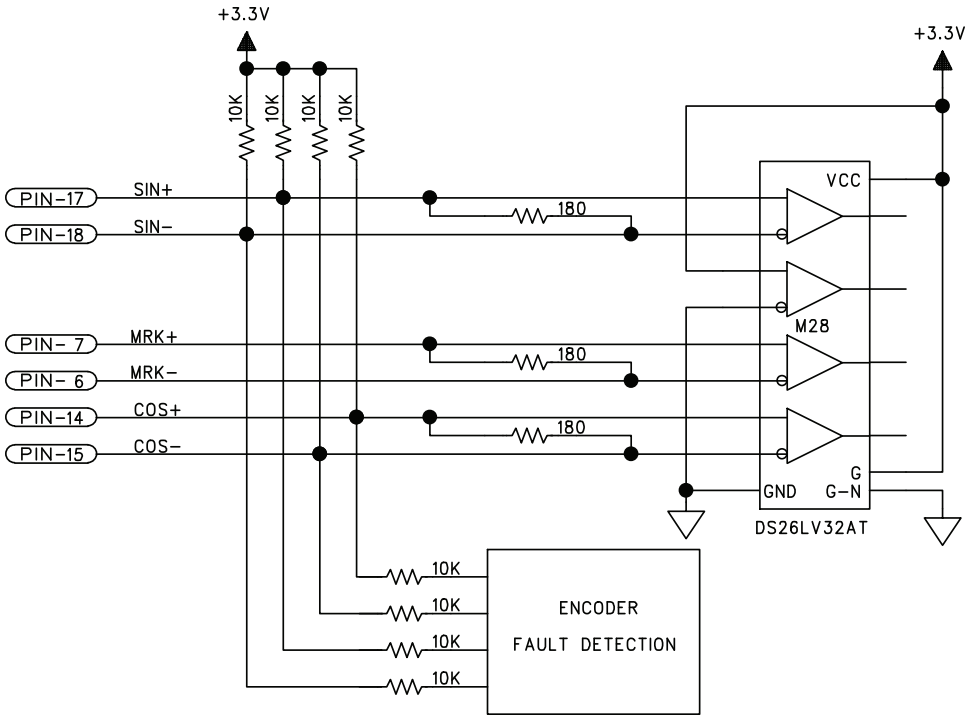


Figure 2-14: Line Driver Encoder Interface

2.4.1.2. Analog Encoder Interface

If the -MXH/-MXU option has been purchased, the standard encoder channel will accept a differential analog encoder input signal. The interpolation factor is determined by the EncoderMultiplicationFactor parameter and is software selectable (refer to the A3200 Help file).

Table 2-12: Analog Encoder Specifications

Specification	MP (MXU)	ML (MXU)	ML (MXH)
Input Frequency (max)	200 kHz	500 kHz	500 kHz
Input Amplitude	0.6 to 2.25 Vpk-Vpk	0.6 to 2.25 Vpk-Vpk	0.6 to 2.25 Vpk-Vpk
Interpolation Factor (software selectable)	4,096	4,096	65,536
MXH Interpolation Latency	N/A	N/A	~ 3.25 µsec (analog input to quadrature output)

Refer to Figure 2-15 for the MXU/MXH typical input circuitry.

The encoder interface pin assignment is indicated in Section 2.4.1.

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.

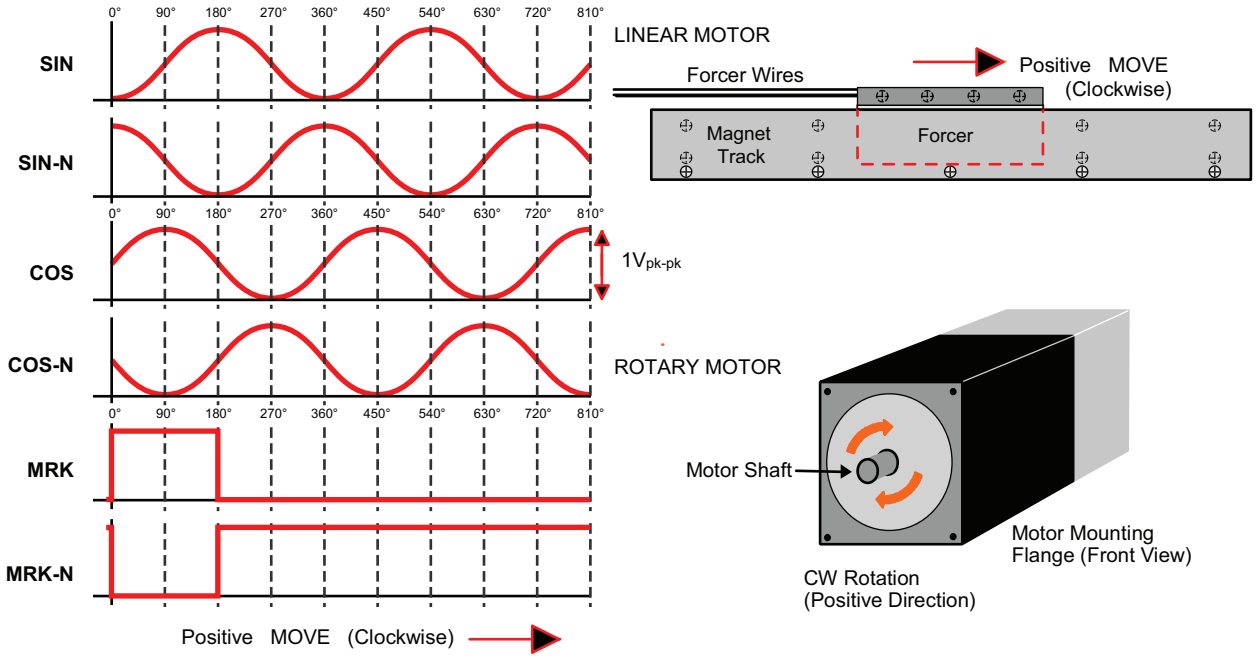


Figure 2-15: Analog Encoder Phasing Reference Diagram

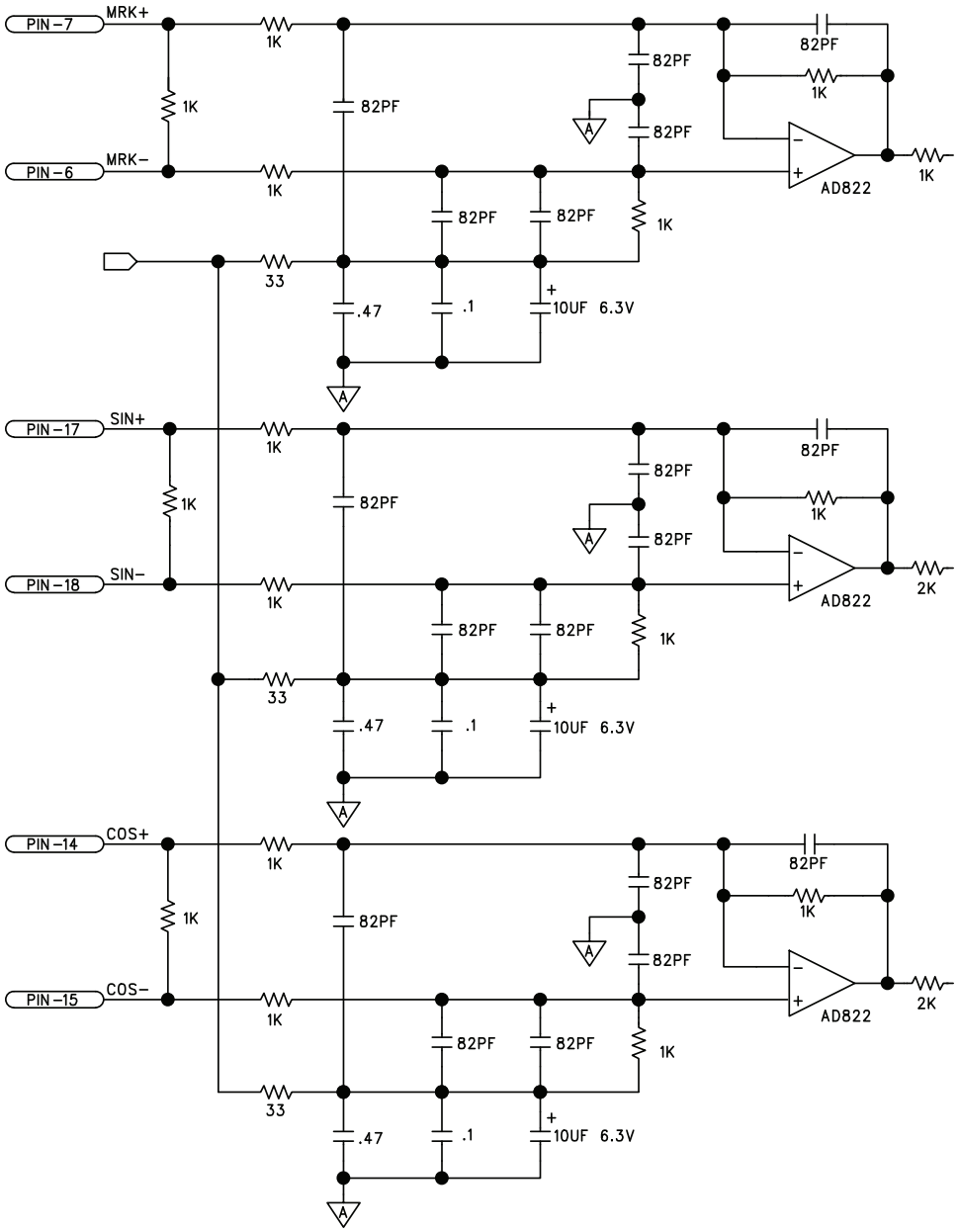


Figure 2-16: Analog Encoder Signals

2.4.1.3. Encoder Phasing

Incorrect encoder polarity will cause the system to fault when enabled or when a move command is issued. Figure 2-17 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 2-18). The Motor Phasing Calculator in the Configuration Manager can be used to determine proper encoder polarity.

For dual loop systems, the velocity feedback encoder is displayed in the diagnostic display (Figure 2-18).

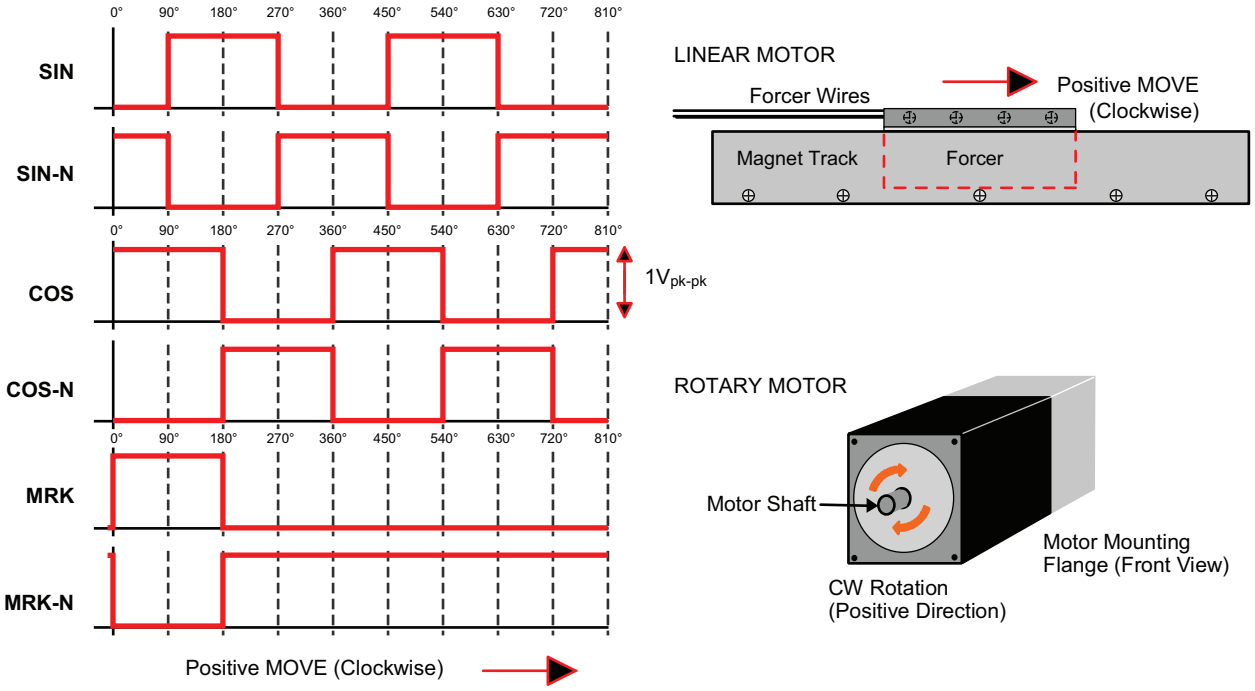


Figure 2-17: Encoder Phasing Reference Diagram (Standard)

NOTE: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-17.

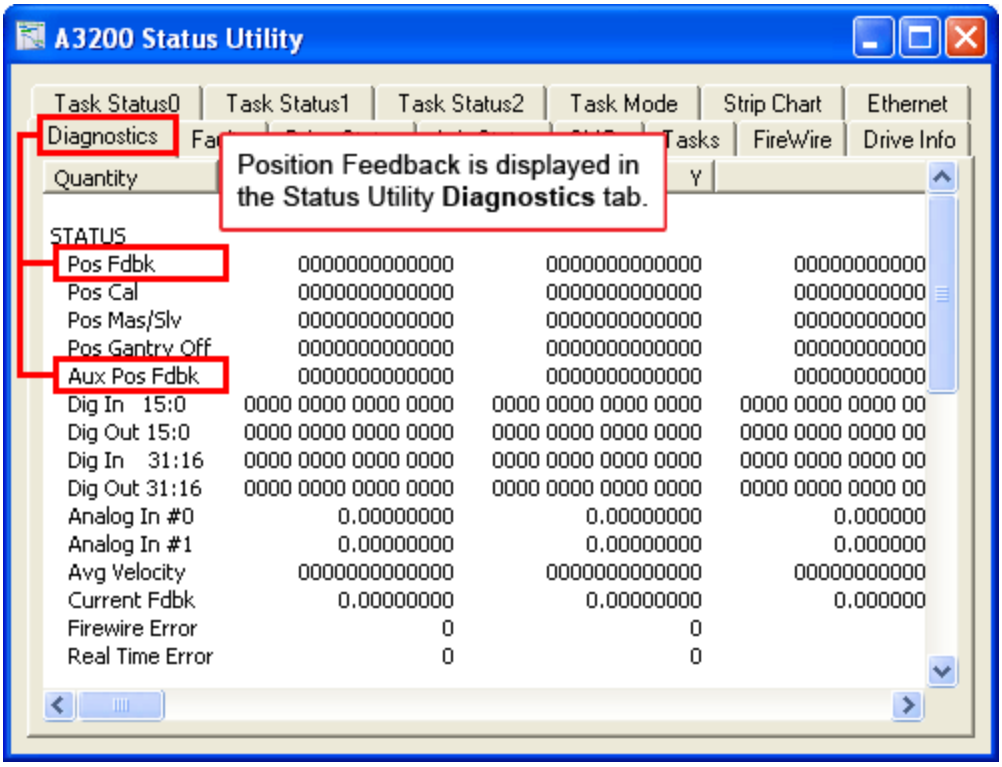


Figure 2-18: Position Feedback in the Diagnostic Display

2.4.2. 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 2.3.1.1. for Hall-effect device phasing.

Table 2-13: Hall-Effect Feedback Pin Assignment

Pin#	Description	In/Out/Bi
1	Chassis Frame Ground	N/A
3	+5V Power for Encoder (500 mA max)	Output
5	Hall-Effect Sensor B (brushless motors only)	Input
10	Hall-Effect Sensor A (brushless motors only)	Input
11	Hall-Effect Sensor C (brushless motors only)	Input
21	Signal Common for Encoder	N/A

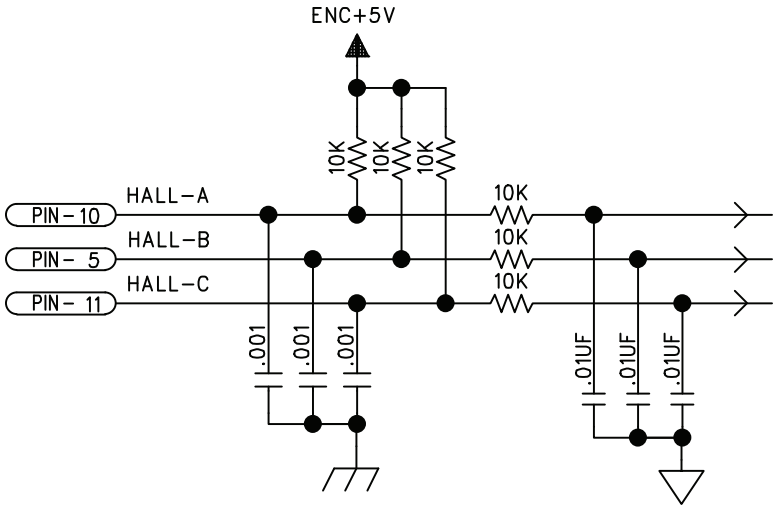


Figure 2-19: Hall-Effect Inputs

2.4.3. 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 2-14: Thermistor Interface Pin Assignment

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

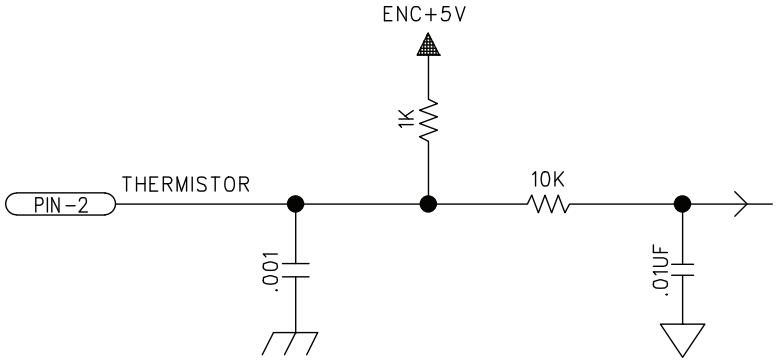


Figure 2-20: Thermistor Input

2.4.4. 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.

Table 2-15: Encoder Fault Pin Assignment

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

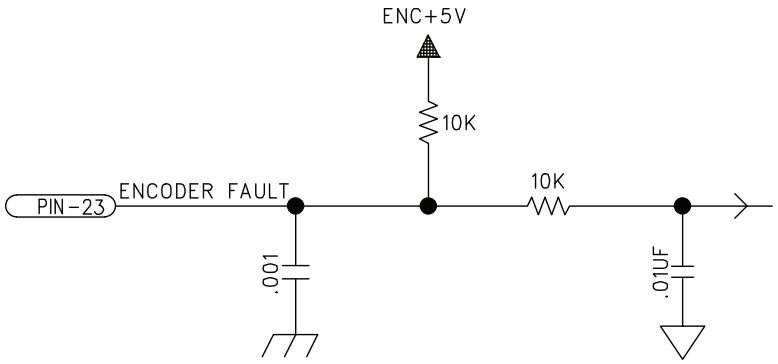


Figure 2-21: Encoder Fault Interface Input

2.4.5. 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 2-23).

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.

Table 2-16: End of Travel Limit Inputs Pin Assignment

Pin#	Description	In/Out/Bi
12	Clockwise End of Travel Limit	Input
16	+5V Power for Limit Switches (500 mA max)	Output
20	Signal Common for Limit Switches	N/A
22	Home Switch Input	Input
24	Counterclockwise End of Travel Limit	Input

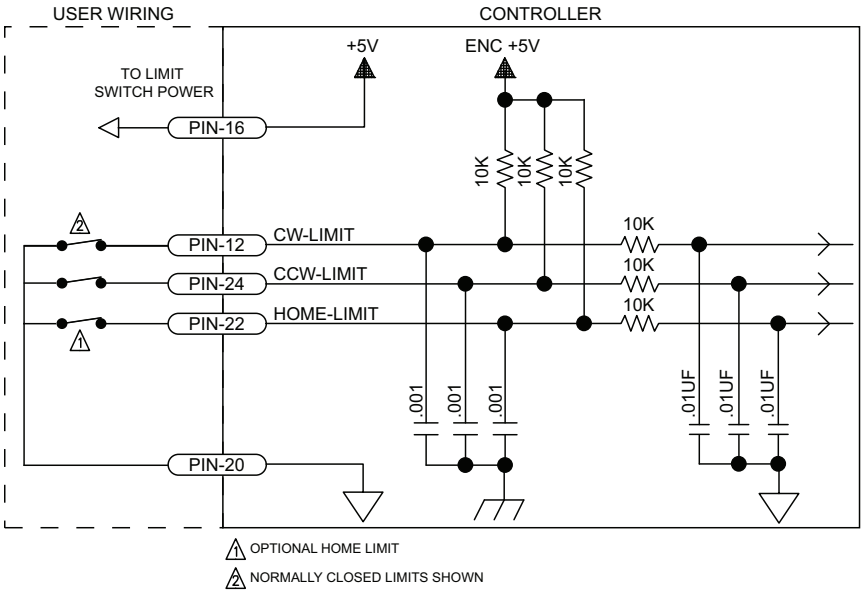


Figure 2-22: End of Travel Limit Inputs

2.4.5.1. 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 2-23).

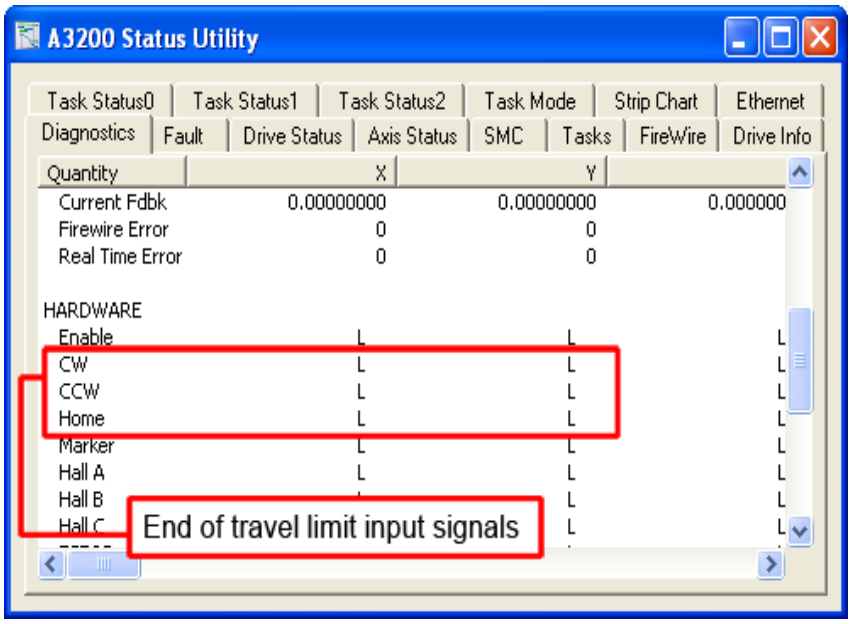


Figure 2-23: Limit Input Diagnostic Display

2.4.6. Brake Output

The Brake Output is a factory wired option allowed for one or more axes. The brake pins are used to automatically control a fail-safe brake (typically used on a vertical axis). The I/O option is required for each axis with a brake. The brake is configured for automatic or manual control using controller parameters (refer to the A3200 Help file for more information).

Table 2-17: Brake Output Pin Assignment

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

Table 2-18: Relay Specifications

Solid State Relay Rating	
Maximum Voltage	24 VDC
Maximum Current	0.5 Amps
Maximum Power	560 mW
Output Resistance	0.1 ohm (typical)
Turn-on/Turn-off Time	< 3 ms (with 500 ohm load at 5 VDC)

2.4.7. Differential Analog Input 0

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 analog common as shown in Figure 2-24.

Table 2-19: Differential Analog Input 0 Specifications

Specification	MP Drive Value	ML Drive Value
(AI+) - (AI-)	+10 V to -10 V (1)	+10 V to -10 V (1)
Resolution (bits)	12 bits	16 bits
Resolution (volts)	4.88 mV	305 µV
1. Signals outside of this range may damage the input		

Table 2-20: Differential Analog Input 0 Pin Assignment

Pin#	Description	In/Out/Bi
8	Analog Input 0 -	Input
19	Analog Input 0 +	Input
21	Signal Common for Encoder	N/A

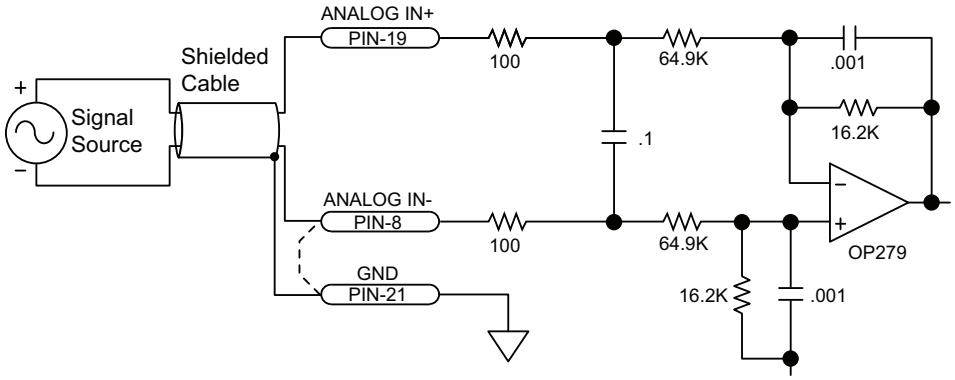
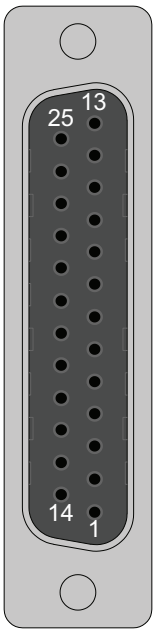


Figure 2-24: Analog Input 0

2.5. Digital / Analog IO Connections

The IO 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. This connector is installed only if the -IO option has been ordered for the axis.

Table 2-21: Digital / Analog IO Connector Pin Assignment

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

2.5.1. Analog Input 1

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 analog common as shown in Figure 2-25.

Table 2-22: Analog Input 1 Specifications

Specification	MP Drive Value	ML Drive Value
(AI+) - (AI-)	+10 V to -10 V (1)	+10 V to -10 V (1)
Resolution (bits)	12 bits	16 bits
Resolution (volts)	4.88 mV	305 µV
1. Signals outside of this range may damage the input		

Table 2-23: Analog Inputs Connector Pin Assignment

Pin#	Description	In/Out/Bi
1	Non-Inverting Analog Input 1+	Input
2	InvertingAnalog Input 1-	Input
15	Ground	N/A

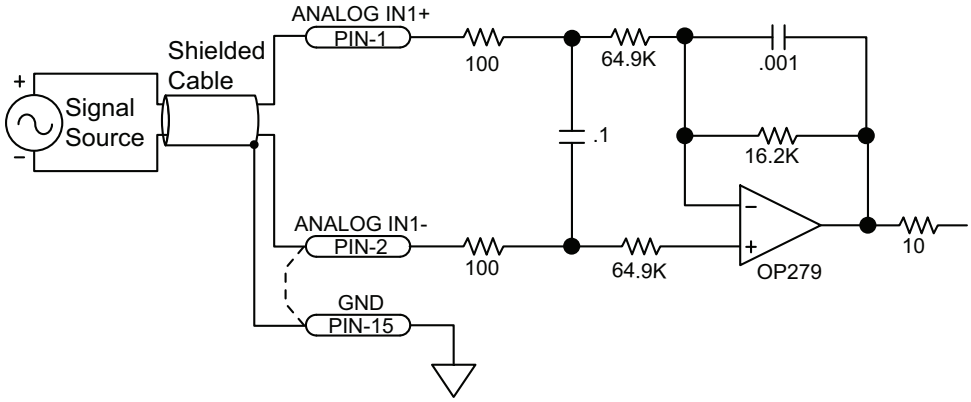


Figure 2-25: Analog Input 1

2.5.2. Analog Output 1

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

NOTE: The Npaq MR does not have an "Analog Output 0".

Table 2-24: Analog Output Specifications (TB102 B)

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

Table 2-25: Analog Output Connector Pin Assignment

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

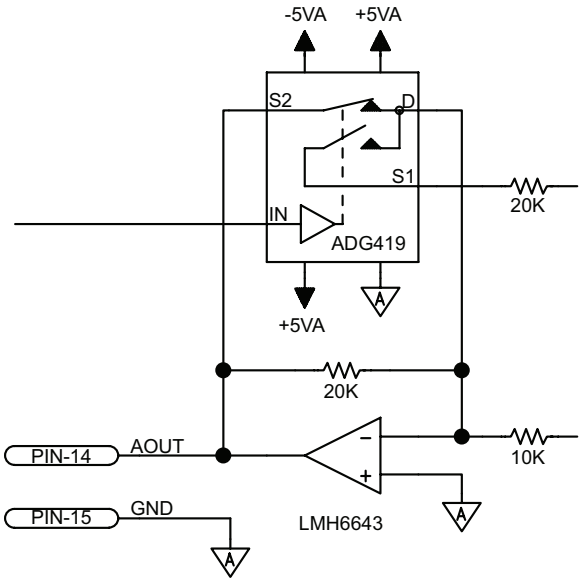


Figure 2-26: Analog Output 1

2.5.3. Opto-Isolated Outputs

The digital outputs are optically-isolated and may 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 2-27 and Figure 2-28 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 2-27 and Figure 2-28.

Table 2-26: Opto-Isolated Output Connector Pin Assignment

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

Table 2-27: 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)

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 2-28 for an example of a current sinking output with diode suppression and Figure 2-27 for an example of a current sourcing output with diode suppression.

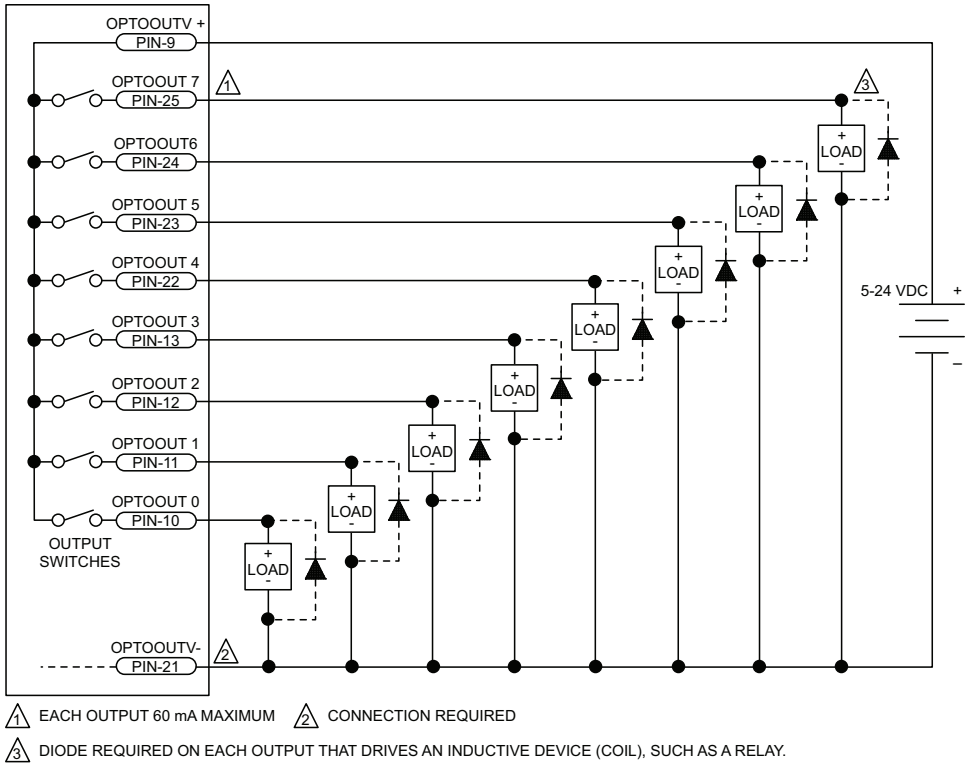


Figure 2-27: Outputs Connected in Current Sourcing Mode

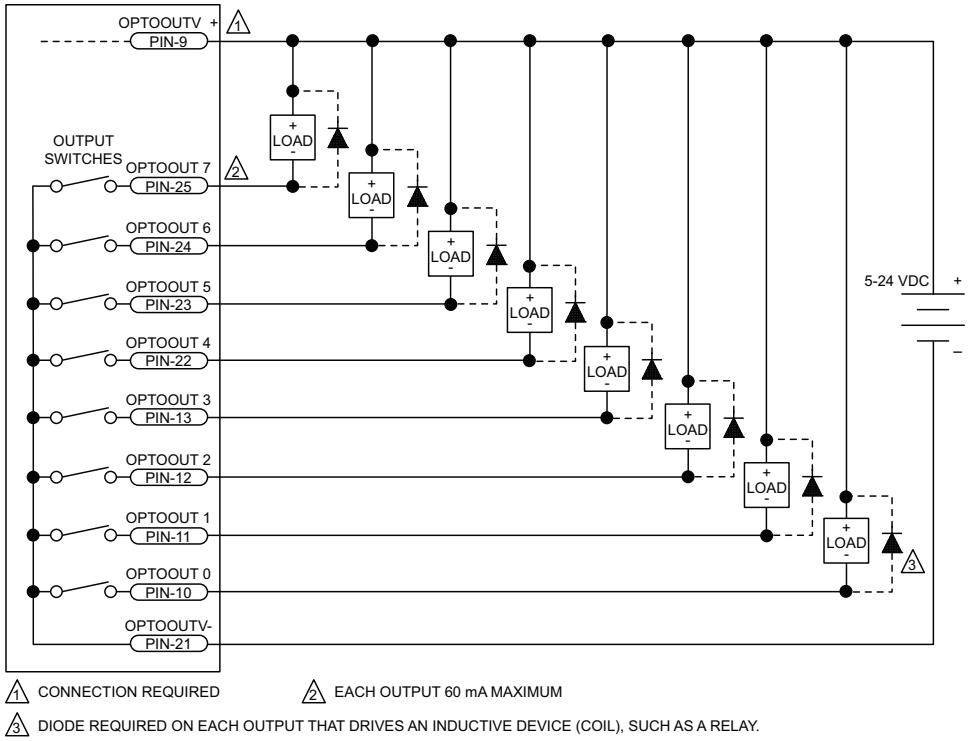


Figure 2-28: Outputs Connected in Current Sinking Mode

2.5.4. Opto-Isolated Inputs

The digital inputs are opto-isolated and may be connected to current sourcing or current sinking devices, as shown in Figure 2-29 and Figure 2-30. These inputs are designed to connect to other ground-referenced circuits and are not intended for high-voltage isolation.

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 2-28: 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 2-29: Opto-Isolated Input Connector Pin Assignment

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

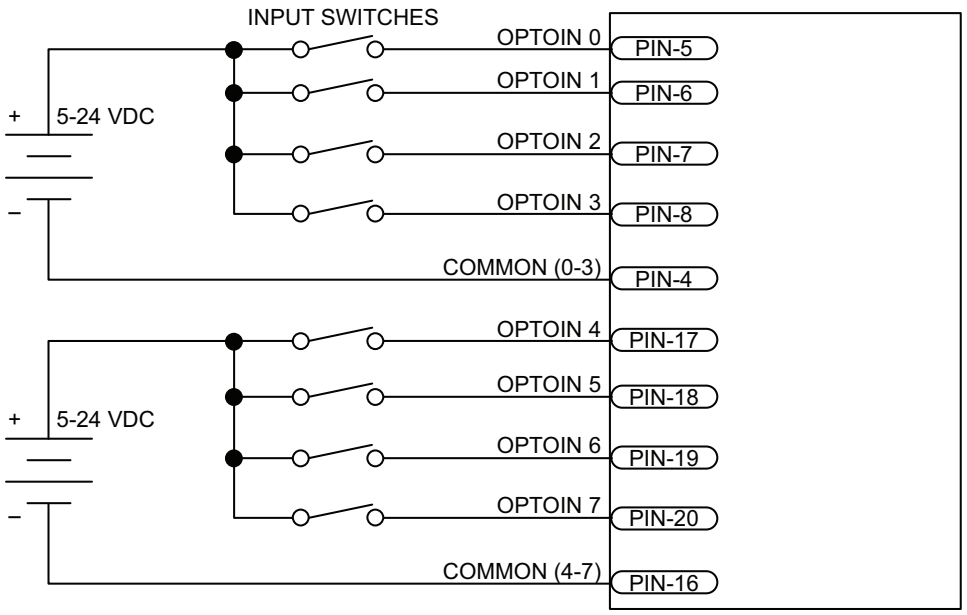


Figure 2-29: Inputs Connected to a Current Sourcing Device

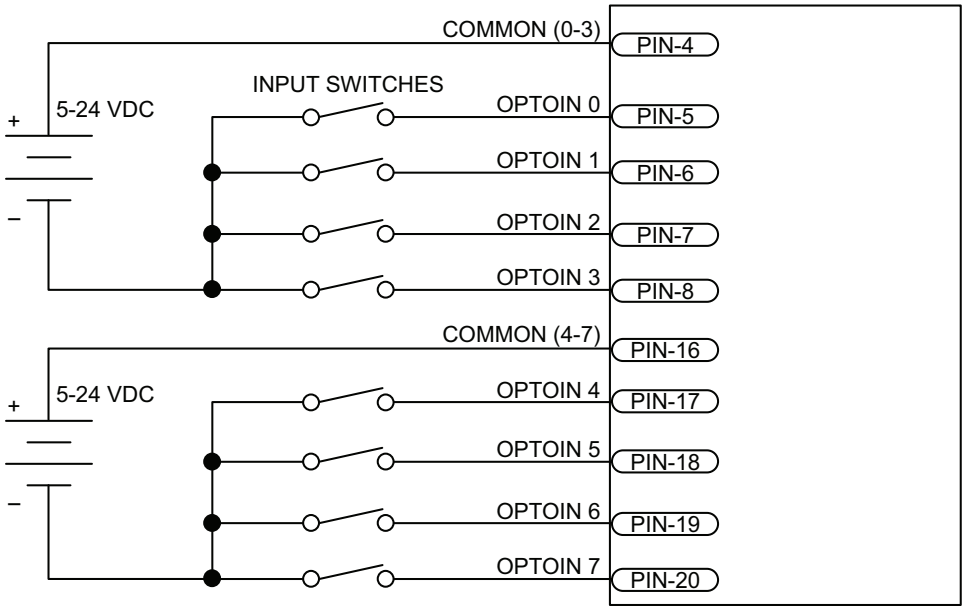


Figure 2-30: Inputs Connected to a Current Sinking Device

2.6. Aux Encoder

The auxiliary encoder interface accepts a RS-422 differential quadrature line driver signal. This encoder channel can be used as an input for master/slave operation (handwheel), for dual feedback systems, or as an output to echo the standard encoder signals.

The auxiliary encoder channel can also be used as the PSO output. Configuring the PSO hardware will automatically configure this encoder channel as an output (refer to Section 2.6.1.) and will remove the 180 ohm terminator resistors.

The auxiliary encoder interface does not support analog encoders and thus cannot be used as an input for the -MXU or -MXH option in MP and ML drives.

This connector is installed only if the -IO option has been ordered for the axis.

Table 2-30: Aux Encoder Specifications

Specification	Value
Encoder Frequency	10 MHz maximum (25 nsec minimum edge separation)
x4 Quadrature Decoding	40 million counts/sec
MXH Interpolation Latency	~ 3.25 µsec (analog input to quadrature output)

Table 2-31: Auxiliary Encoder Channel Pin Assignment

Pin#	Description	In/Out/Bi	Connector
1	Auxiliary RS-422 Encoder Sine +	Bidirectional	
2	Auxiliary RS-422 Encoder Cosine +	Bidirectional	
3	Auxiliary RS-422 Marker Pulse +/ PSO Output (1)	Bidirectional	
4	Encoder +5 Volt Power	Output	
5	Encoder Power Common	N/A	
6	Auxiliary RS-422 Encoder Sine -	Bidirectional	
7	Auxiliary RS-422 Encoder Cosine -	Bidirectional	
8	Auxiliary RS-422 Marker Pulse - / PSO Output (1)	Bidirectional	
9	Encoder Power Common	N/A	
(1) For PSO, see Section 2.6.1. Position Synchronized Output (PSO)/Laser Firing			

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

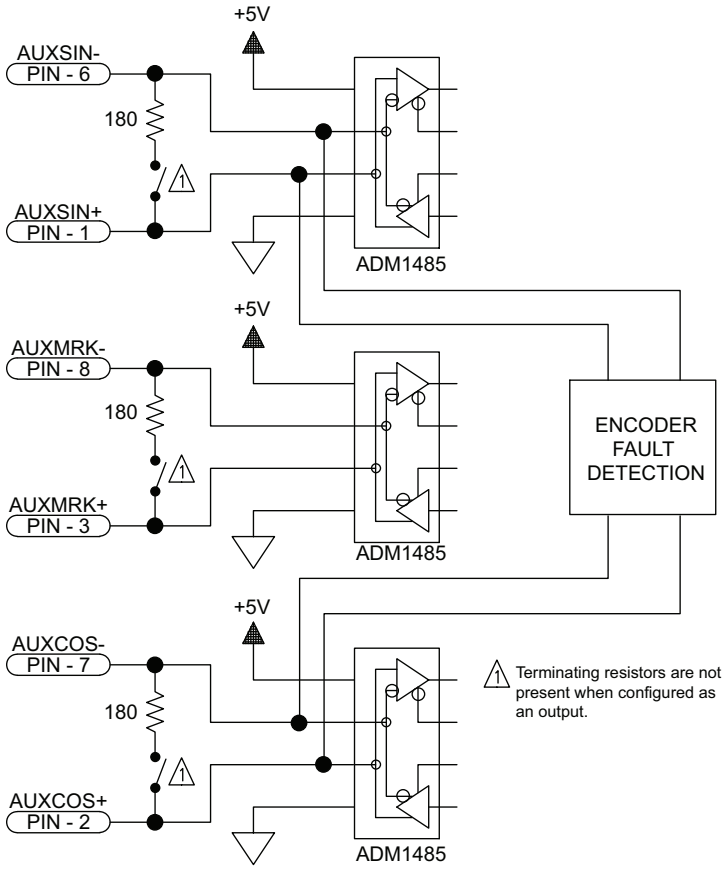


Figure 2-31: Auxiliary Encoder Channel

2.6.1. Position Synchronized Output (PSO)/Laser Firing

The PSO can be programmed to generate an output synchronized to the feedback position and is typically used to fire a laser or sequence an external device. Trigger signals may be derived from a feedback channel or a software trigger. The position synchronized output pulse is generated using high-speed hardware, allowing minimal latency between the trigger condition and the output.

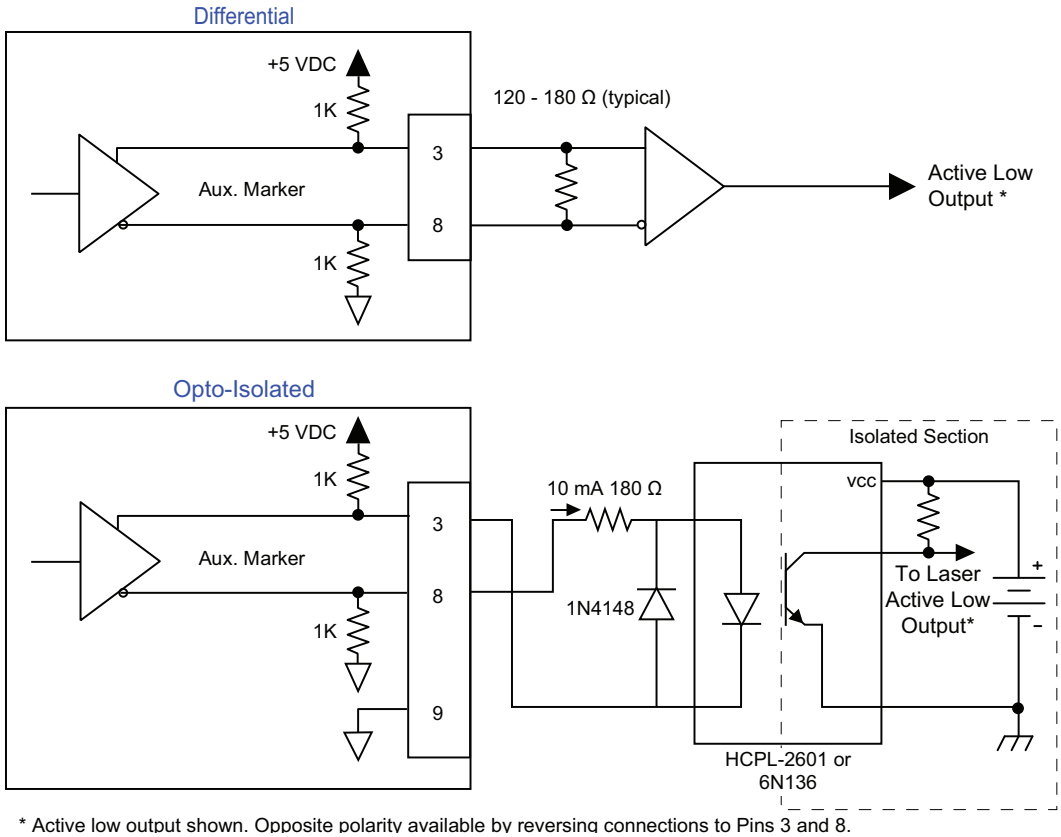
An RS-422 line receiver or opto-isolator is recommended, especially when using long cable lengths in noisy environments or when high frequency pulse transmission is required. It is best to locate the line receiver or opto-isolator close to the receiving electronics.

NOTE: The PSO feature is **not** compatible with the -MXU option. The PSO feature operates with the -MXH option and with square wave encoders.

Table 2-32: PSO Specifications

Specification		Value
Maximum Input Tracking Rate (1)	Single-Axis Tracking	16.6 MHz
	Dual-Axis Tracking (3)	8.33 MHz
Maximum Quadrature Encoder Output Frequency	Standard Feedback	40 MHz
	-MXH Feedback (3)	25 MHz
Maximum PSO Output (Fire) Frequency (2)		12.5 MHz
Firing Latency	Single-Axis Tracking	160 nsec
	Dual-Axis Tracking (3)	220 nsec

1. Signals in excess of this rate will cause a loss of PSO accuracy.
2. The optocoupler that you use on the output might have an effect on this rate.
3. Npaq MR with ML drives



* Active low output shown. Opposite polarity available by reversing connections to Pins 3 and 8.

Figure 2-32: PSO Interface

2.7. Communications Connector

The FireWire bus is the high-speed communications connection to the Npaq MR operating at 400 megabits per second. All command and configuration information is sent via the FireWire port.

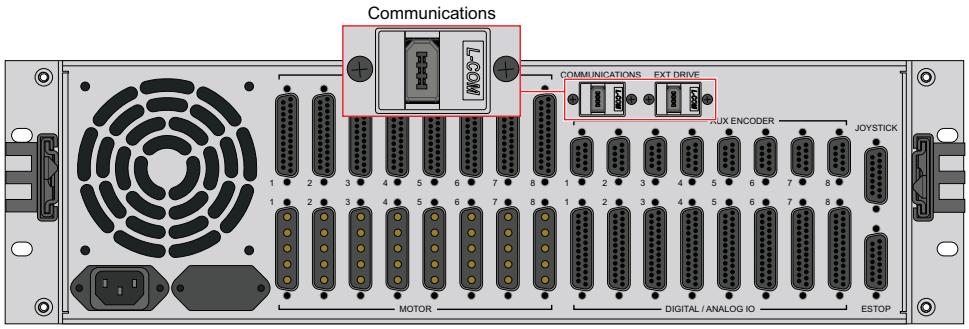


Figure 2-33: FireWire Interface

Table 2-33: FireWire Card Part Numbers

Part Number	Description
NFIRE-PCI	OHCI compliant FireWire PCI interface card, 3 port
NFIRE-PCIE	OHCI compliant FireWire PCIe x1 interface card, 2 port
NFIRE-PCI-TI-LP	Low Profile, OHCI compliant, PCI
NFIRE-PCIE-GOF	FireWire PCIE X1 Glass Optical Fiber Board

Table 2-34: 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 2-35: FireWire Cables (copper and glass fiber)

Part Number	Description
NCONNECT-4500-66	4.5 m (15 ft) long, 6 pin to 6 pin
NCONNECT-3000-66	3 m (10 ft) long, 6 pin to 6 pin
NCONNECT-1800-66	1.8 m (6 ft) long, 6 pin to 6 pin
NCONNECT-900-66	900 mm (3 ft) long, 6 pin to 6 pin
NCONNECT-500-66	500 mm (19 in) long, 6 pin to 6 pin
NCONNECT-228-66	228 mm (9 in) 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

2.8. PC Configuration and Operation Information

For additional information about PC configuration, hardware requirements, programming, utilities, and system operation refer to the A3200 Help file.

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Chapter 3: Options

Table 3-1 provides a description of the various Npaq MR options.

Table 3-1: Options and Capabilities

Option	Section	Description / Capabilities
Chassis Slides	Section 1.2. Mechanical Specifications	Mounting option
Emergency Stop	Section 3.1. Emergency Stop (ESTOP1,2,3)	ESTOP Sense Input EN ISO 13849-1, Category 2, Category 3
MXU	Section 2.4.1.2. Analog Encoder Interface	Encoder Resolution Multiplier, up to 1,024 times 200 kHz / 2 MHz max input freq. respectively
Failsafe Brake Output	Section 2.4.6. Brake Output	Brake is configured to an axis Standard brake voltage is 24 VDC Opto 22 module controlled brake output
Joystick Inter-face	Section 3.2. Joystick Interface	Joystick option

3.1. Emergency Stop (ESTOP1,2,3)

ESTOP1, 2, and 3 are integrated emergency stop hardware options available on the Npaq MR. User connections are made via the optional 15D ESTOP connector.

- ESTOP1 uses a single relay to disconnect the motor power supply from the internal drive modules.
- ESTOP2 uses two relays in series to disconnect the motor power supply from the drive modules.
- ESTOP3 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.

All relays are force guided and have a monitor contact.

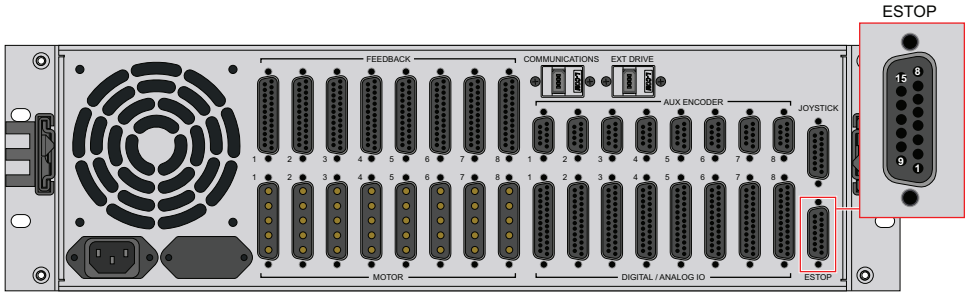

Figure 3-1: ESTOP Option Interface

Table 3-2: ESTOP Option Mating Connector

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

The ESTOP1,2,3 options 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
ESTOP1	1 force guided relay with monitor contact	Category 2, PL d
ESTOP2	2 force guided relays with monitor contacts	Category 3, PL d
ESTOP3	2 force guided relays with monitor contracts	Category 3, PL d

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.

Table 3-4: Relay Specifications

ESTOP1 CR1 and ESTOP2 CR1 and CR2	
Relay Part Number	Aerotech: ECW01106 Sprecher & Schuh: CA7-16E-01-24E
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)
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)

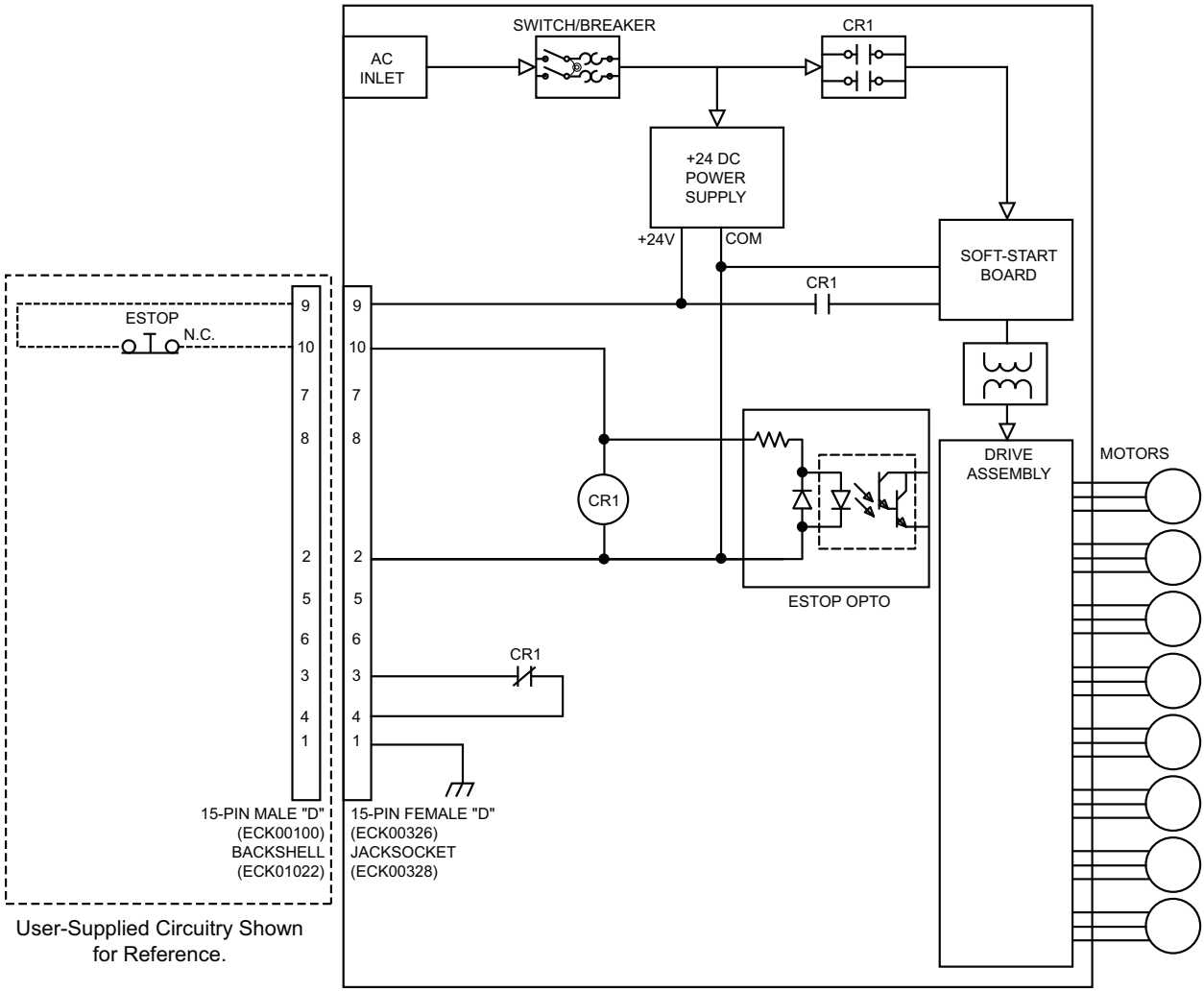

Figure 3-2: ESTOP1

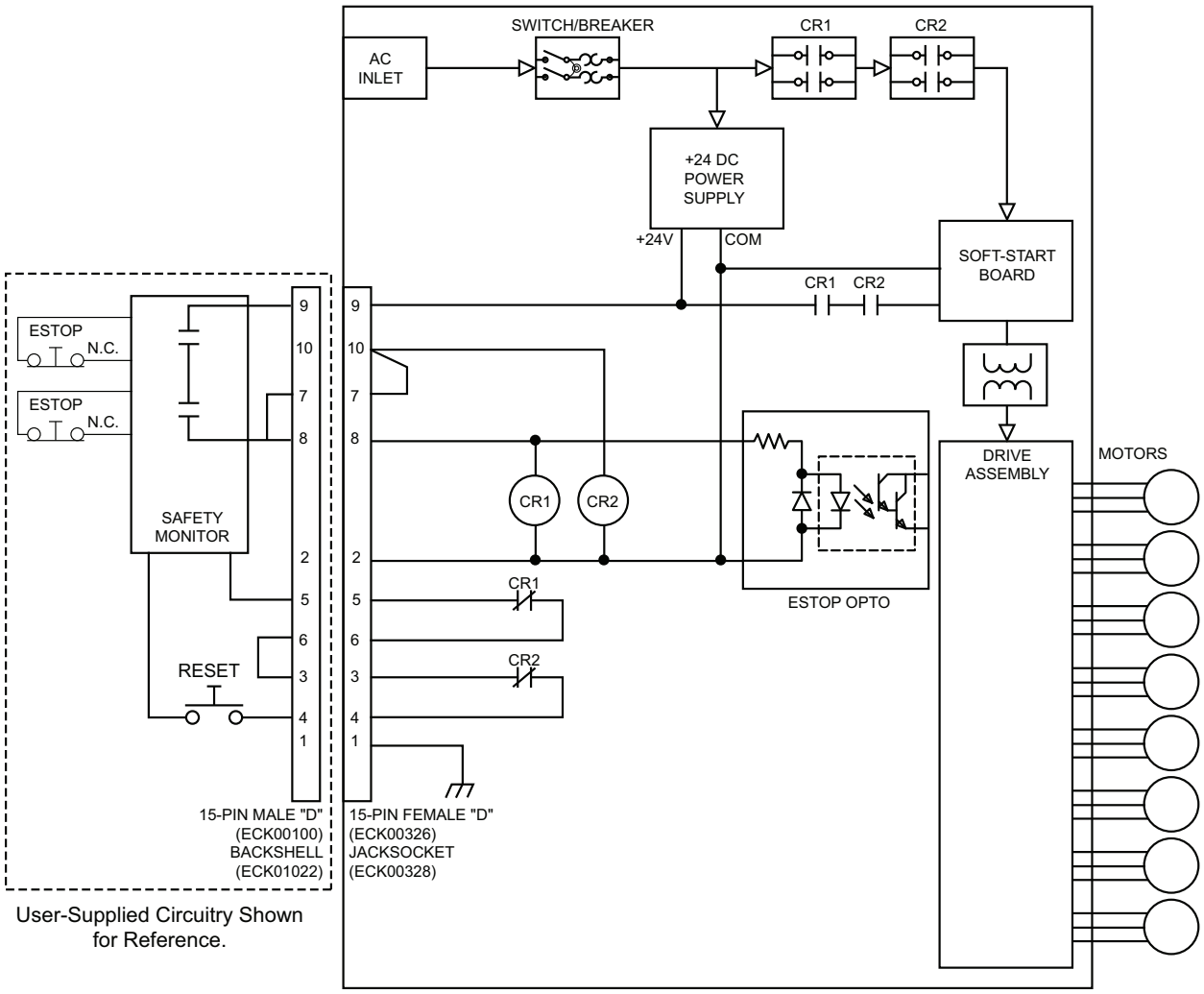

Figure 3-3: ESTOP2

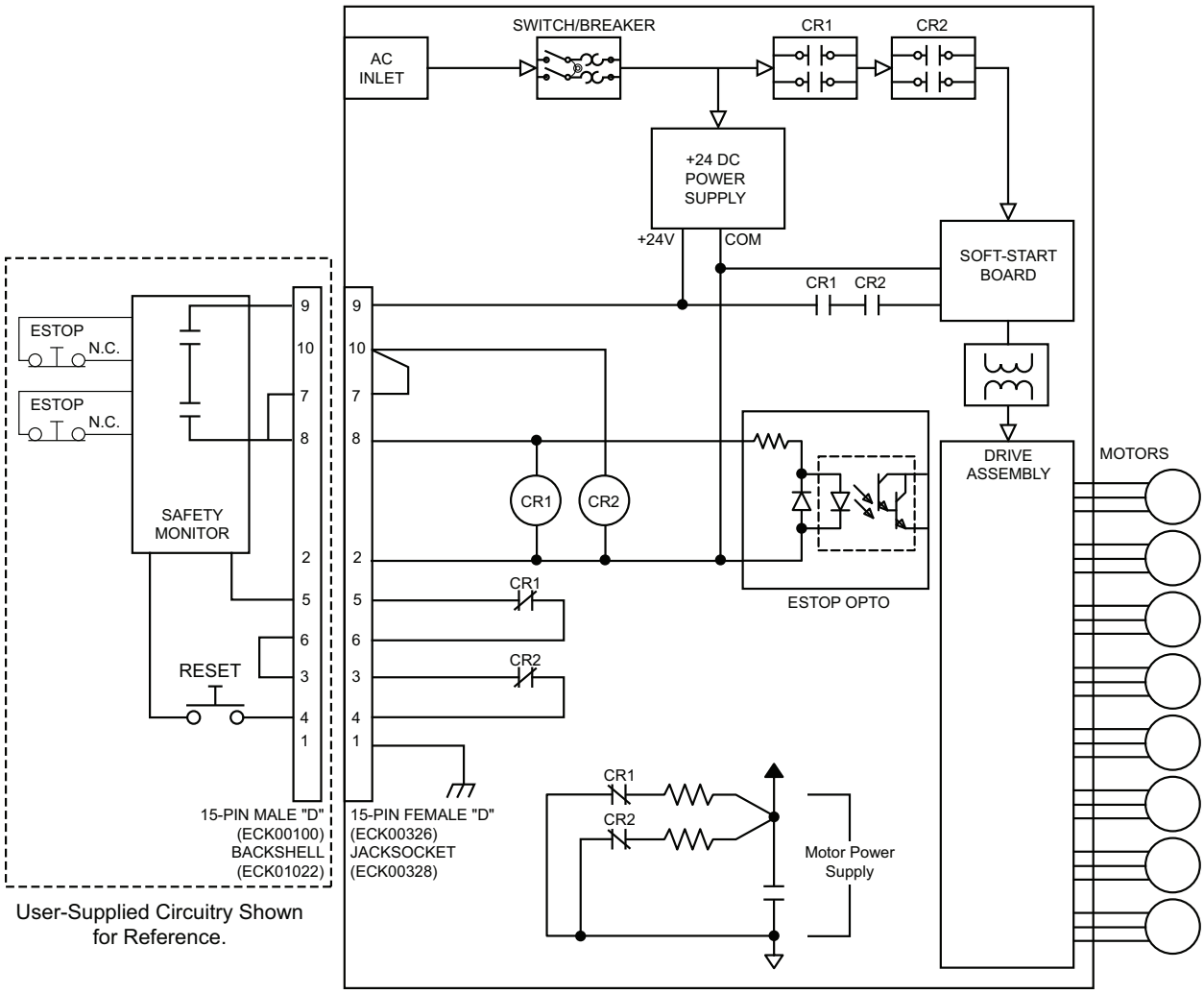

Figure 3-4: ESTOP3

3.2. Joystick Interface

The Joystick Interface is an optional 15-pin 'D' style connector accessible at the rear of the Npaq MR chassis. The joystick option is factory wired to a specified axis' I/O option board. The Joystick Interface uses two analog inputs and three dedicated inputs (joystick buttons). IO signals not used by the joystick are not available to the user. Joystick electrical connections are shown in Figure 3-6.

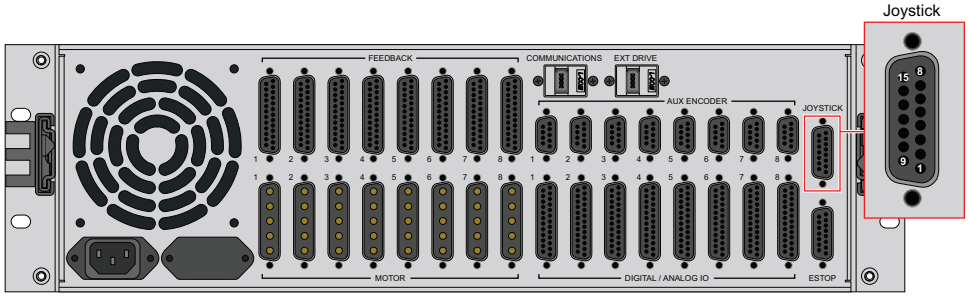

Figure 3-5: Joystick Interface

Table 3-5: Joystick Interface Connector Pin Assignment

Pin #	Label	Description	In/Out/Bi
1	+5V	+5V power	Output
2	JSA	Joystick button A (Input 5) Axis Select	Input
3	JOY X	Analog Input 0	Input
4	Common	Joystick power common	N/A
5	Not Used	Not Used	N/A
6	JOY Y	Analog Input 1	Input
7	JS B	Joystick button B (Input 6) Speed Select	Input
8	Not Used	Not Used	N/A
9	Not Used	Not Used	N/A
10	Not Used	Not Used	N/A
11	Not Used	Not Used	N/A
12	Shield	Shield	N/A
13	Interlock	Joystick Interlock (Input 7)	Input
14	Not Used	Not Used	N/A
15	Not Used	Not Used	N/A

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

Aerotech joysticks JI (NEMA12 (IP54) rated) and JBV are powered from 5V and have a nominal 2.5V 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.

All joystick operating parameters are software configurable. Refer to the A3200 Help file for additional information.

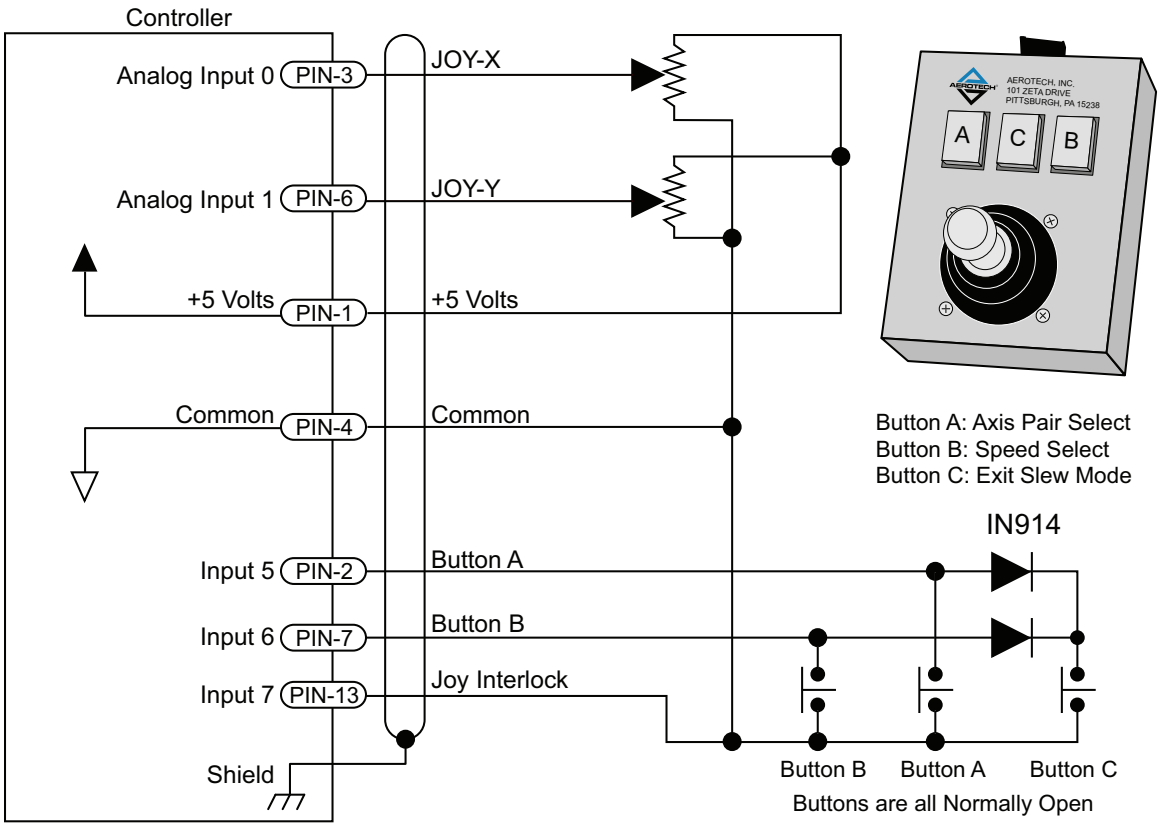

Figure 3-6: Joystick Interface

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Chapter 4: Maintenance

This section covers the internal boards, important board components, and how to clean the drive.

DANGER: Always disconnect the Mains power connection before opening the Npaq MR 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

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

The Npaq MR is factory wired for either 100/200 VAC or 115/230 VAC input voltage. The input voltage select switches (S1 and S2) are located on the left side of the Npaq MR power board. Both switches must be set the same, all UP or all DOWN. The UP setting on S1 and S2 configures the Npaq MR for high voltage (200 or 230 V). The DOWN setting is for low voltage (100 or 115 V).

WARNING: Do not change power switches while power is connected.

WARNING: Improper configuration will cause fuses F1-F4 to open.

WARNING: An input power label is affixed to the back of the Npaq MR at the factory. If you change the input voltage, you are responsible for changing the label on the back of the unit.

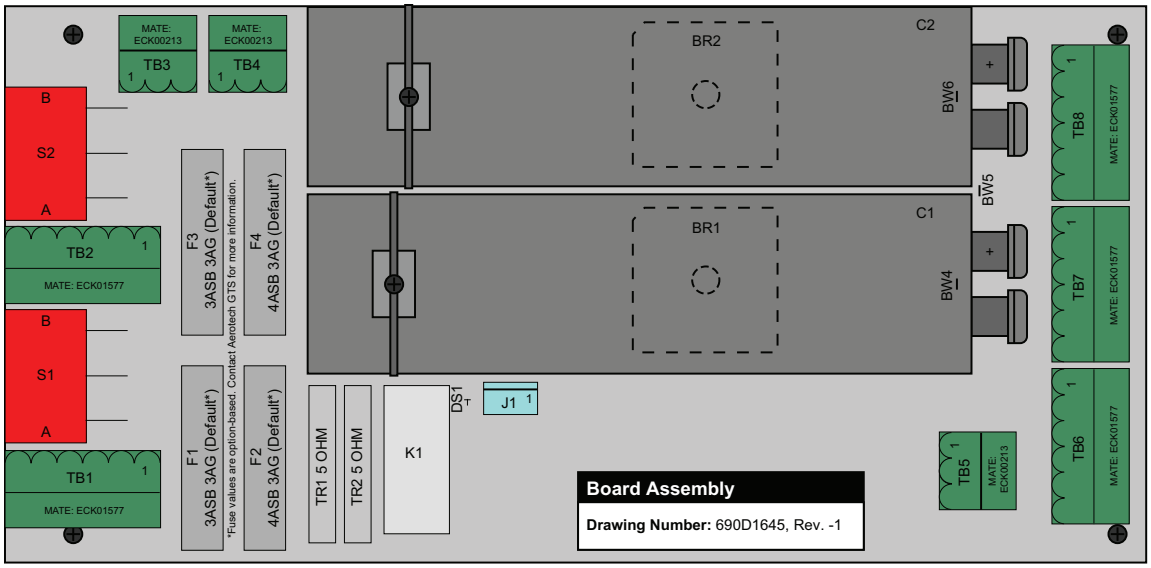

Figure 4-1: Power Board

Table 4-1: Component Select

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

4.2. Preventative Maintenance

The Npaq MR 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 Npaq MR 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 Npaq MR.
Visually inspect all cables and connections.	Tighten or re-secure any loose connections. Replace worn or frayed cables. Replace broken connectors.

Cleaning

The Npaq MR 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 Npaq MR 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 Npaq MR while cleaning. Do not allow cleaning substances or other fluids to enter the Npaq MR 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) 3319 7715	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720

JAPAN	TAIWAN	UNITED KINGDOM
Aerotech Japan Full-Service Subsidiary Phone: +81 (0)50 5830 6814 Fax: +81 (0)43 306 3773	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

1.07.00a Changes: Updated fuse information on Figure 4-1.

Revision	Description
1.07.00	The following sections have been updated: • EU Declaration of Conformity • Agency Approvals • Section 2.2.3. I/O and Signal Wiring Requirements • Section 2.3.1.2. Unpowered Motor and Feedback Phasing • Section 2.4.1.3. Encoder Phasing • Section 2.4.7. Differential Analog Input 0 • Analog Input 1 • Section 2.5.2. Analog Output 1 • Section 2.5.4. Opto-Isolated Inputs • Section 2.6. Aux Encoder
1.06.00	• Declaration of Conformity updated: EU Declaration of Conformity • AC Power Connections section updated: Section 2.2.1. • I/O and Signal Wiring Requirements section updated: Section 2.2.3. • Brushless Motor Connections updated: Section 2.3.1. • Powered Motor Phasing section updated:Section 2.3.1.1. • Unpowered Motor and Feedback Phasing updated: Section 2.3.1.2. • Analog Input 0 section updated: Section 2.4.7. • Analog Input 1 section updated: Section 2.5.1. • Opto-Isolated Inputs section updated: Section 2.5.4. • Opto-Isolated Outputs section updated: Section 2.5.3. • Aux Encoder section updated: Section 2.6. • PSO/Laser Firing Section updated: Section 2.6.1.
1.05.00	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
1.04.00	
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