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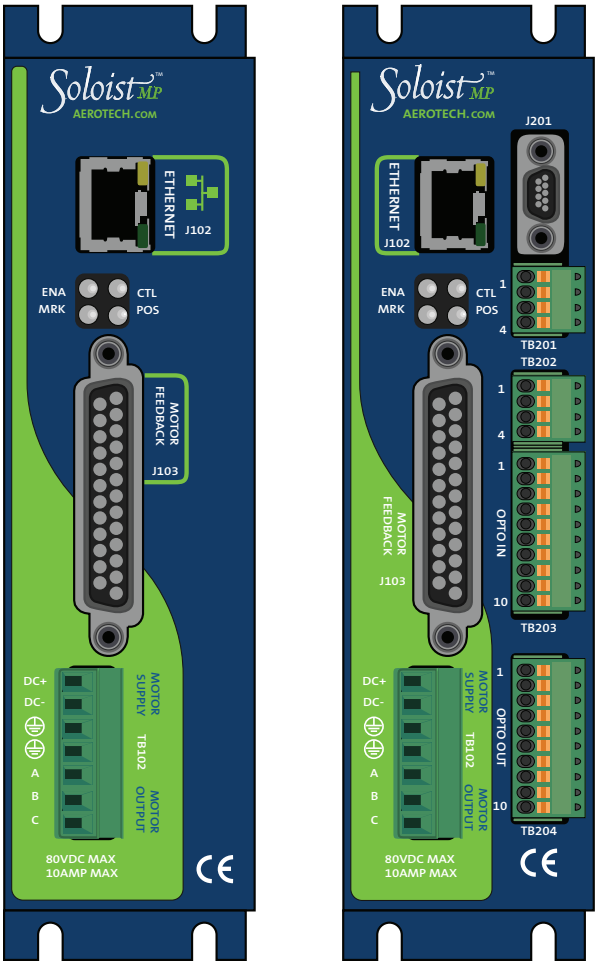
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# Soloist MP
# Hardware Manual

**Revision: 4.08.00**




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# EC Declaration of Conformity

| | |
|---|---|
| ***Manufacturer*** | Aerotech, Inc. |
| ***Address*** | 101 Zeta Drive<br>Pittsburgh, PA 15238-2897<br>USA |
| ***Product*** | Soloist MP |
| ***Model/Types*** | All |

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

| | |
|---|---|
| 2004/108/EC | Electromagnetic Compatibility Directive |
| 2006/95/EC | Low Voltage Directive |
| 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 55011 | RFI Limits and Measurement |
| EN 61800-3 | EMC requirements for power drives |
| EN 61000-3-2 | Harmonic Current Emissions |
| EN 61000-3-3 | Voltage Fluctuation and Flicker |
| EN 61000-4-2 | ESD Immunity |
| EN 61000-4-3 | Radiated RFI/EMI Immunity |
| EN 61000-4-4 | EFT/Burst Immunity |
| EN 61000-4-5 | Surge Immunity |
| EN 61000-4-6 | Conducted Immunity |
| EN 61000-4-11 | Voltage Dips and Interruptions |
| EN 61010-1 | Safety requirements for electrical equipment |

| | |
|---|---|
| ***Name*** |  / Alex Weibel |
| ***Position*** | Engineer Verifying Compliance |
| ***Location*** | Pittsburgh, PA |
| ***Date*** | July 9, 2015 |



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# Agency Approvals

Aerotech, Inc. Model Soloist MP Series Digital Drives 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 11 68995 013 |
| **File / Report #**: | 090-1309372-000 |
| **Standards**: | UL 61010-1; CAN/CSA-C22.2 No. 61010-1 |



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# 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.

**NOTE:** Read this manual in its entirety before installing, operating, or servicing this product. If you do not understand the information contained herein, contact an Aerotech representative before proceeding. Strictly adhere to the statements given in this section and other handling, use, and operational information given throughout the manual to avoid injury to you and damage to the equipment.

**NOTE:** Aerotech continually improves its product offerings; listed options may be superseded at any time. All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. Refer to www.aerotech.com for the most up-to-date information.



**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. Access to the Soloist MP and component parts must be restricted while connected to a power source.
4. 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.
5. Install the Soloist MP inside a rack or enclosure.
6. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
7. Make sure the Soloist MP and all components are properly grounded in accordance with local electrical safety requirements.
8. Operator safeguarding requirements must be addressed during final integration of the product.



**DANGER:** The Soloist MP case temperature may exceed 70°C in some applications.



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**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 the Soloist MP to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
5. If the Soloist MP is used in a manner not specified by the manufacturer, the protection provided by the Soloist MP 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. The Soloist MP is intended for light industrial manufacturing or laboratory use. Use of the Soloist MP 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 Soloist MP. 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.

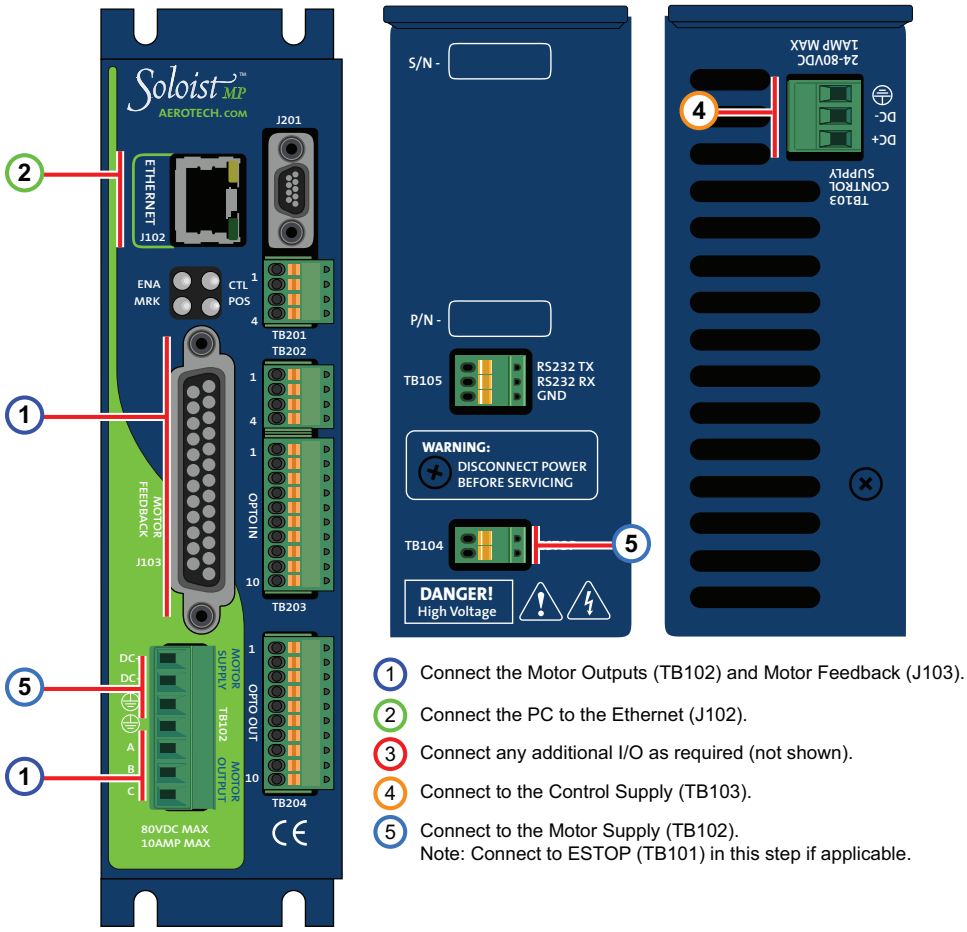



**Figure 1: Quick Start Connections**

| Topic | Section |
|---|---|
| Motor Output | Section 2.2. Motor Output Connections |
| Motor Feedback | Section 2.3. Motor Feedback Connections (J103) |
| Ethernet / USB | No Section / Standard Connection |
| Control Supply | Section 2.1.1. Control Supply Connections (TB103) |
| Motor Supply | Section 2.1.2. Motor Supply Connections (TB102) |
| Additional I/O | User / Application dependent |



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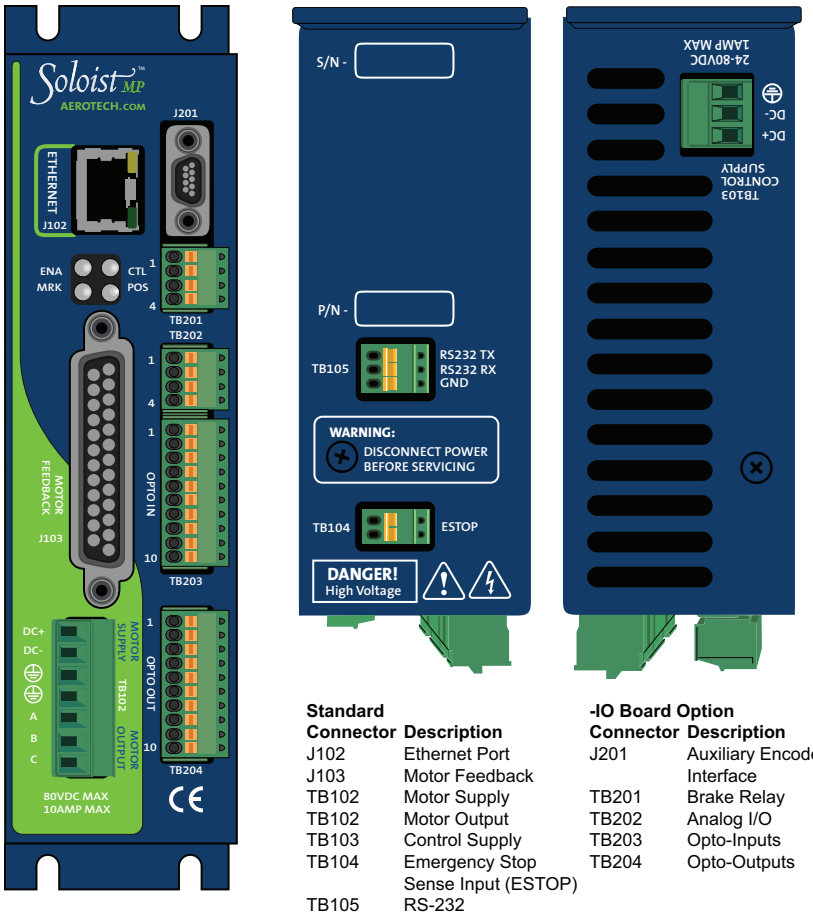


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# Chapter 1: Introduction

Aerotech's Soloist MP (Ultra-Compact "Micro" PWM) network digital drive is a high performance amplifier.The drive provides deterministic behavior, auto-identification, and easy software setup. The Soloist MP's 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.

The Soloist MP is offered with an optional encoder interpolation feature (-MXU), an auxiliary square wave encoder input for dual loop control, dedicated analog and digital I/O (expandable with the -IO option), and separate power connections for motor and control supply voltages.




| Standard | | -IO Board Option | |
|---|---|---|---|
| Connector | Description | Connector | Description |
| J102 | Ethernet Port | J201 | Auxiliary Encoder Interface |
| J103 | Motor Feedback | | |
| TB102 | Motor Supply | TB201 | Brake Relay |
| TB102 | Motor Output | TB202 | Analog I/O |
| TB103 | Control Supply | TB203 | Opto-Inputs |
| TB104 | Emergency Stop Sense Input (ESTOP) | TB204 | Opto-Outputs |
| TB105 | RS-232 | | |

**Figure 1-1: Soloist MP Networked Digital Drive**



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**Table 1-1: Feature Summary**

| Standard Features | |
|---|---|
| • Line driver square wave quadrature encoder input for position and velocity feedback<br>• One 16-bit differential analog input (± 10 V)<br>• Dedicated 5-24 V Emergency Stop sense input<br>• 10 - 80 VDC motor supply inputs<br>• 24 - 80 VDC control supply inputs<br>• Calibration (refer to the Soloist Help file for more information)<br>• Camming (refer to the Soloist Help file for more information)<br>• 10/100 BASE-T Ethernet port for use with Ethernet I/O modules | |
| **Options** | |
| -IO | • One 16-bit analog output (±5 V)<br>• One 12-bit differential analog input<br>• One fail-safe brake or user relay output<br>• 8 optically isolated logic inputs (5 - 24 VDC), may be connected in current sourcing or sinking mode<br>• 8 optically isolated logic outputs (5 - 24 VDC), user defined as current sourcing or sinking |
| -MXU | Interpolation circuit allowing for analog sine wave input on the standard encoder channel. Interpolation factor: 4,096 |

**Table 1-2: Accessories**

| Accessories | |
|---|---|
| JI | Industrial Joystick (NEMA12 (IP54) rated); refer to Section 4.1. |
| PS24-1 | 24 VDC, 1 A power supply for optional brake/relay output |
| BRAKE24-2 | 24 VDC, 2 A power supply for optional brake |
| **External Power Supply Options** | |
| | Refer to Section 2.1.3. for more information |
| **Cables** | |
| Interconnection | A complete list of Aerotech cables can be found on the website at http://www.aerotechmotioncontrol.com/manuals/index.aspx |
| Joystick/Handwheel | Refer to Section 4.1. or Section 4.2. |



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The following block diagram shows a connection summary. For detailed connection information, refer to Chapter 2 and Chapter 3.

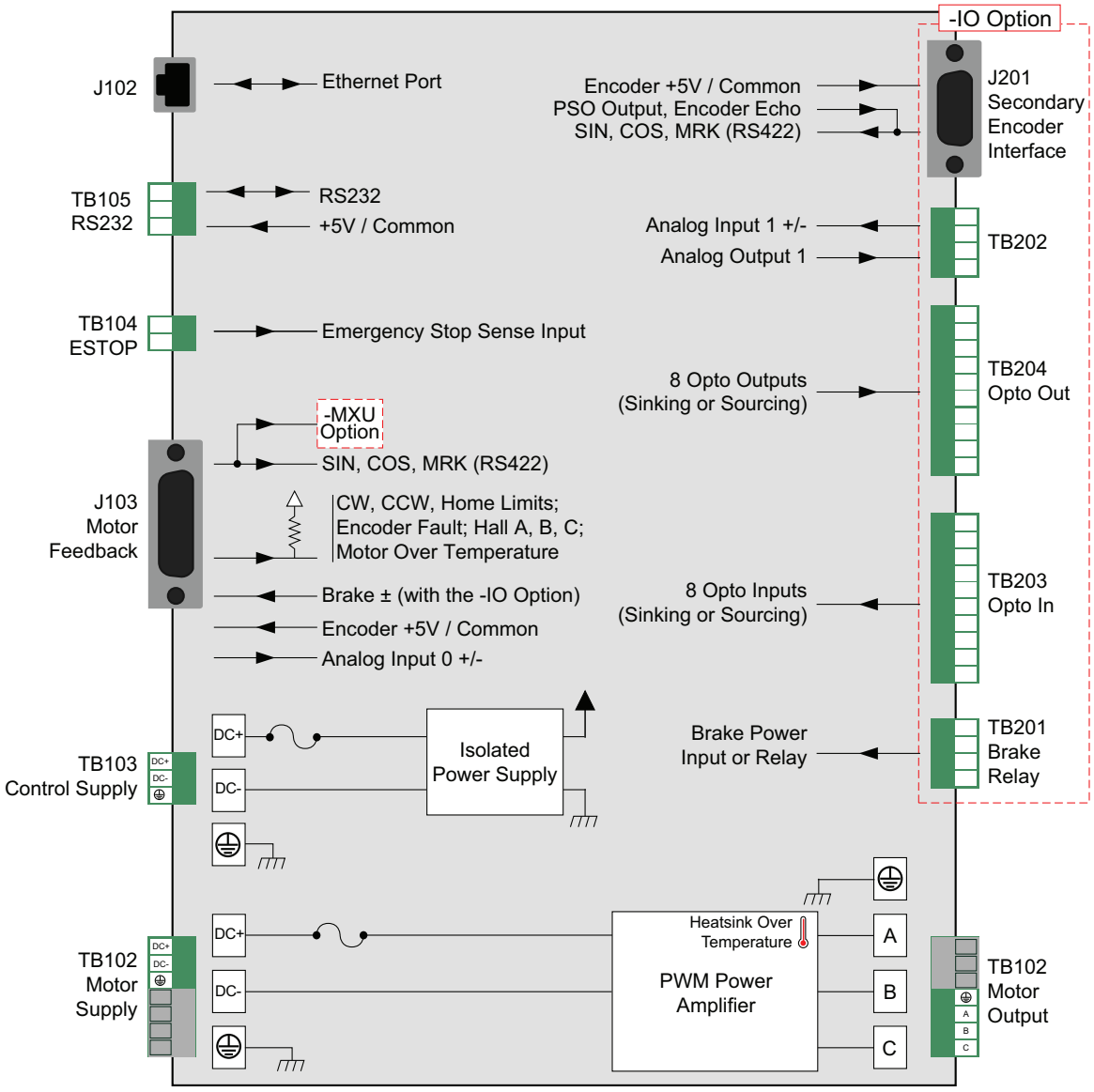



**Figure 1-2: Functional Diagram**



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## 1.1. Drive and Software Compatibility

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

**Table 1-3: Soloist Drive and Software Compatibility**

| Drive Type | Firmware Revision | First Software Version | Last Software Version |
|---|---|---|---|
| CL | - | 2.06 | Current |
| | A | 2.55 | Current |
| CP | - | 1.00 | Current |
| | A | 2.01 | Current |
| | B | 2.54 | Current |
| HLe | - | 2.51 | Current |
| HPe | - | 2.51 | Current |
| ML | - | 3.00 | Current |
| MP | - | 2.01 | Current |
| | A | 2.55 | Current |



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## 1.2. Electrical Specifications

**Table 1-4: Electrical Specifications**

| | | MP 10 |
|---|---|---|
| Motor Supply | Input Voltage | 10-80 VDC |
| | Maximum Continuous Input Current | 5 $A_{rms}$ |
| | Input Current | Refer to Section 1.2.1. System Power Requirements |
| 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.



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### 1.2.1. 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. 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



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### 1.2.2. Power Dissipation

The first figure below shows the amplifier power dissipation under continuous power supply and output current conditions. The values on the graph represent the peak current that the amplifier would provide during operation. When the bus voltage and output current are known, the amplifier power dissipation is found using this graph. The second figure shows the maximum recommended ambient temperature as a function of amplifier power dissipation. Use this graph along with the power dissipation obtained from the first graph to determine the maximum ambient temperature. If the result is lower than the known operating ambient temperature, additional measures are required to cool the Soloist MP. Mounting it to a large metal plate for extra heat-sinking and providing additional fan flow are suggested.

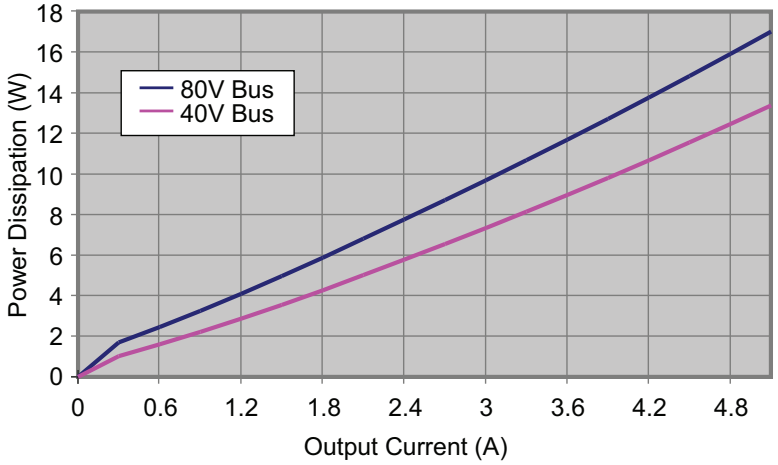



**Figure 1-3: Power Dissipation vs. Output Current**

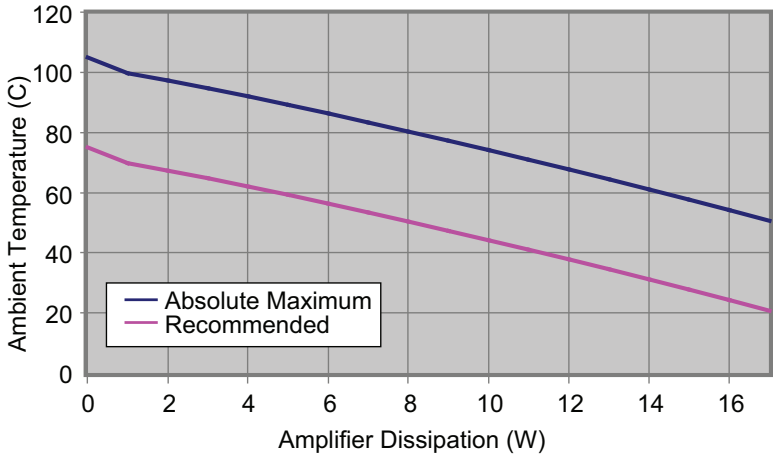



**Figure 1-4: Ambient Temperature vs. Power Dissipation**

**EXAMPLE:**

80 VDC Bus operation at 2.4 A
Power Dissipation = 7.5 Watts
Maximum Ambient Temperature = 53°C



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## 1.3. Mechanical Design

Install the unit into a construction compliant for unlimited circuits enclosure. Each unit should be separated from other drives and surrounded by 25 mm (1") of free air space. A space of 100 mm (4") should be allowed along the front of the unit for cable connections.

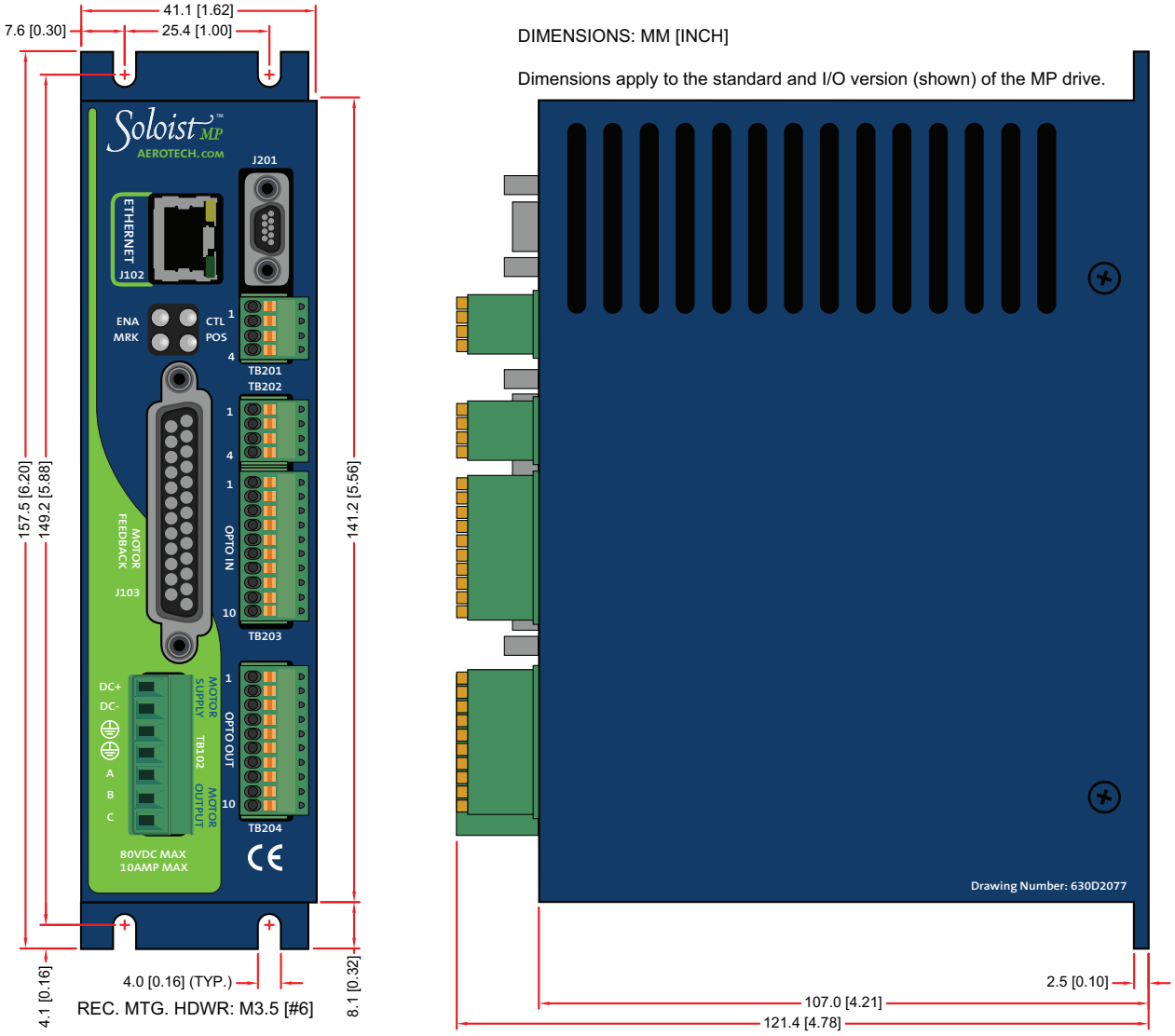



**Figure 1-5: Dimensions**

**Table 1-5: Physical Specifications**

| | Weight |
|---|---|
| Standard | 0.454 kg (1.0 lb) |
| w/ -IO option | 0.544 kg (1.2 lb) |
| w/ -MXH option | 0.544 kg (1.2 lb) |

| | |
|---|---|
| Typical Size | 100 mm x 125 mm x 2.4 mm (4 in x 5 in x 0.094 in) |



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## 1.4. Environmental Specifications

The environmental specifications for the Soloist MP are listed below.

| | |
|---|---|
| Ambient Temperature | Operating: 0° to 50°C (32° to 122° F) |
| | Storage: -30° to 85°C (-22° to 185° 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. |



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# Chapter 2: Installation and Configuration

## 2.1. Power Connections

The Soloist MP has two DC input connectors; one for control power and a second for motor power. For a complete list of electrical specifications, refer to Section 1.2.

An example of a wiring drawing for a typical PS-MP system showing the power inputs, as well as wiring for the optional fail-safe brake, is provided in Figure 2-4. The AC operating voltage of the PS-MP system can be configured for different operating voltages. The example system shown in Figure 2-4 is configured for 115 VAC. Purchased PS-MP systems are configured at the factory according to the users order request. System wiring and operating voltage information can be found on the System Wiring Drawing that is provided with the unit. The machine integrator, OEM, or end user is responsible for providing two fused or circuit breaker protected AC power connections and a Protective Ground connection to the system (see the table below for specifications).

**Table 2-1: PS-MP AC Power Wiring Requirements**

| Connection | Description | Wire Size (minimum) |
|---|---|---|
| AC1 | AC Power | 1.3 $mm^2$ (#16 AWG) 300 V wire |
| AC2 | AC Power | 1.3 $mm^2$ (#16 AWG) 300 V wire |
| GND | Protective Ground (required for safety) | 1.3 $mm^2$ (#16 AWG) 300 V wire |
| User must provide 10 A, 250 VAC fuse(s) or circuit breaker(s) to protect AC inputs | | |

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



**WARNING:** All service and maintenance must be performed by qualified personnel.



**DANGER:** Hazardous Voltages are present on Soloist MP systems.



**DANGER:** Soloist MP and PS-MP systems must be installed inside a rack or enclosure to restrict access while energized.



**DANGER:** To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.



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### 2.1.1. Control Supply Connections (TB103)

**NOTE:** This product requires two power supply connections. The Motor Supply and Control Supply must both be connected for proper operation.

The control power supply input allows the Soloist MP to maintain communications if the motor power is removed, such as in an Emergency Stop condition. The control power supply operates from 24-80 VDC (±10%). The DC+ input is internally fused.

A small ferrite filter may be required to minimize radiated emissions. This should be located close to the Soloist MP.

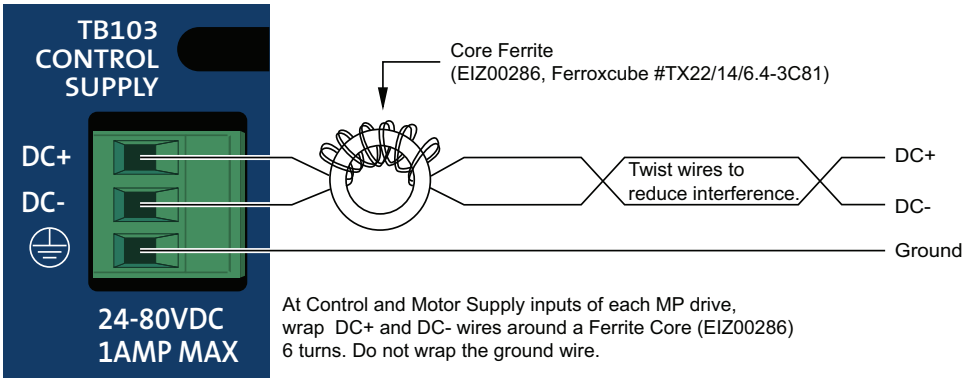



**Figure 2-1: Control Supply Connections**

**Table 2-2: Control Supply DC Input Wiring**

| Pin | Description | Recommended Wire Size |
|---|---|---|
| DC+ | 24 - 80 VDC (±10%) Control Power Input (20 Watt Max) | 0.5 $mm^2$ (#20 AWG) |
| DC- | Control Power Common Input (1) | 0.5 $mm^2$ (#20 AWG) |
| ⏚ | Protective Ground (Required for Safety) | 0.5 $mm^2$ (#20 AWG) |
| (1) For an isolated DC supply, connect DC- to protective ground at the supply. | | |

**Table 2-3: Control Supply Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 3-Pin Terminal Block | ECK01387 | 1803581 | 0.22 - 0.25 | 2.0 - 0.516 [14-30] |



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### 2.1.2. Motor Supply Connections (TB102)

**NOTE:** This product requires two power supply connections. The Motor Supply and Control Supply must both be connected for proper operation.

Motor power is applied to the Soloist MP Motor Supply connector (refer to Figure 2-2 for locations).

The recommended wire size is 0.5 $mm^2$ (#20 AWG). For an isolated DC supply, connect DC- to Protective Ground at the supply. The wire must be properly matched to the fuses or circuit breakers and must be sized to meet local electrical safety codes.

A small ferrite filter may be required to minimize radiated emissions. This should be located close to the MP. See Figure 2-2 for more details.

**WARNING:** Do not operate the Soloist MP without the safety ground connection in place.

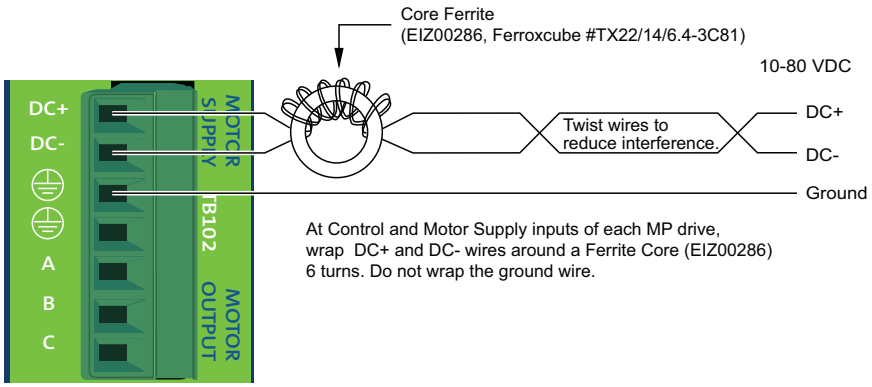



**Figure 2-2: Motor Bus Input Connections**

**Table 2-4: Motor Supply Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 7-Pin Terminal Block | ECK01389 | 1803620 | 0.22 - 0.25 | 2.0 - 0.516 [14-30] |



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## 2.1.3. External Power Supply Options

Two VDC power options are available to power up to four MPs.

**Table 2-5: External Power Supply Options**

| | Description |
|---|---|
| TM3 (1) | Power up to 4 drives, providing 300 watts of power (refer to Figure 2-3). |
| PS-MP | Din-rail mounted DC power supply for up to 4 axes (refer to Figure 2-4). The din-rail mounting clip requires 6-32 x 5/16 flat head screws to attach the MP to the din-rail clip. |
| (1) Refer to the TM3 Users Manual, EDO117, for more information. | |

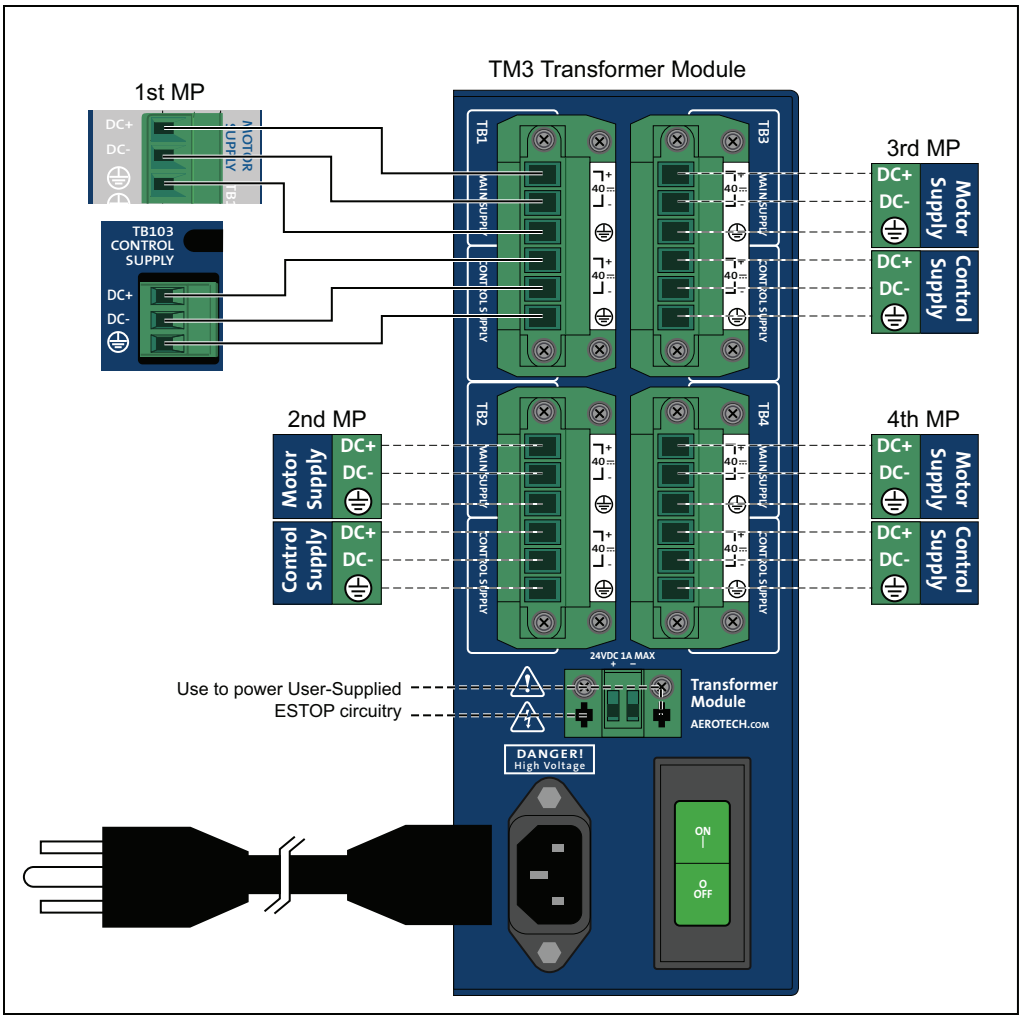



**Figure 2-3: Control and Motor Power Wiring using a TM3 Transformer**



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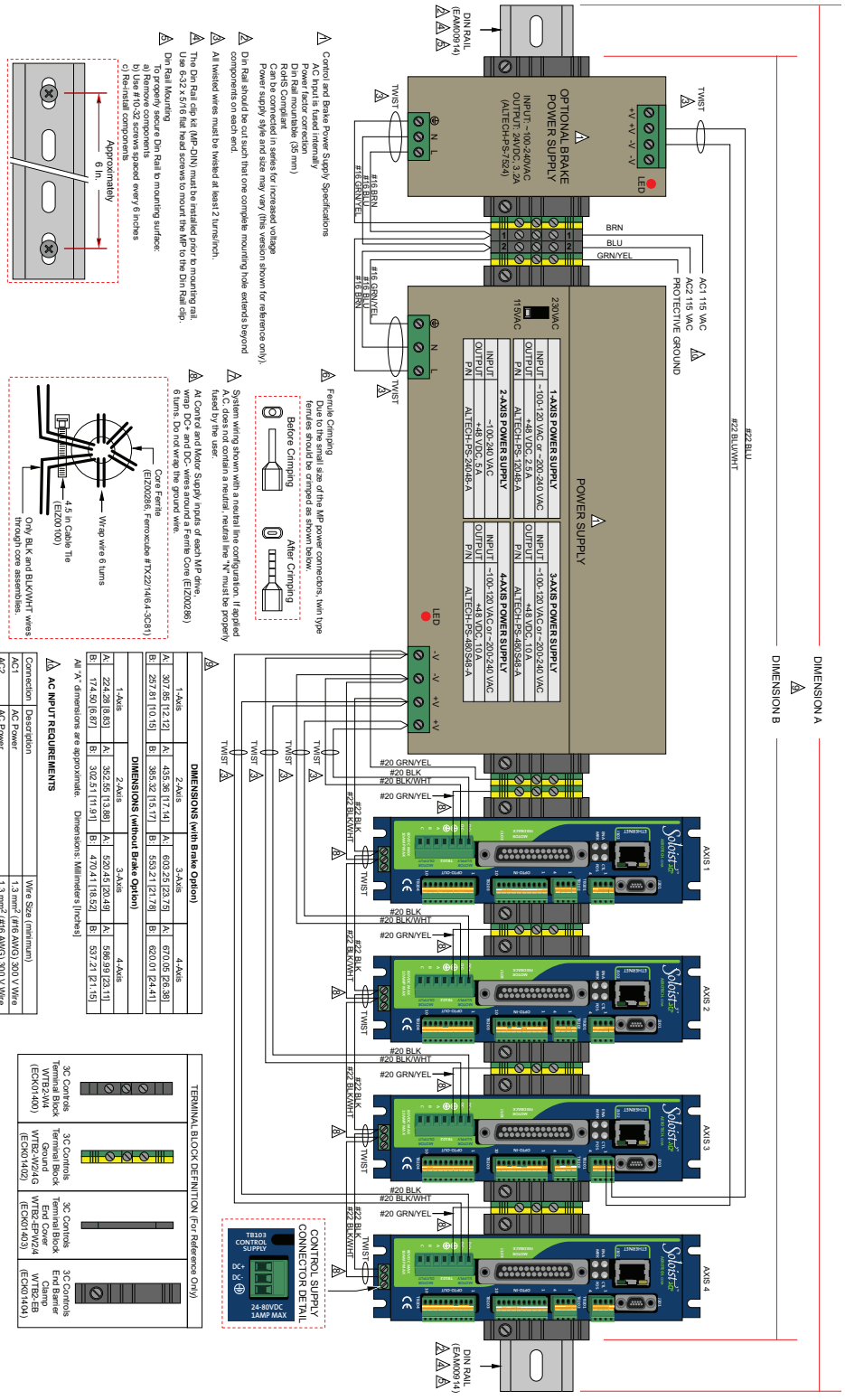



**Figure 2-4: PS-MP Option**



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### 2.1.4. Minimizing Conducted, Radiated, and System Noise

The Soloist MP generates conducted (AC line) and radiated noise. Conducted emissions are minimized by using line filters and should be located as close to the drive as possible for maximum effectiveness.

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.

The Soloist MP is a component designed to be integrated with other electronics. EMC testing must be conducted on the final product configuration.

Ferrite beads (Aerotech's FBF-1 or FBF-2 filter adapters) can be used on the motor leads to reduce the effects of PWM noise.

**Table 2-6: Motor Supply Input Wiring**

| Wire Size | Aerotech P/N | Third Party P/N |
|---|---|---|
| 13.3 $mm^2$ (#6 AWG) | N/A | #2643626502 Elna Fair-Rite Products |
| 8.3 $mm^2$ (#8 AWG) | ECZ00285 | #2643626502 Elna Fair-Rite Products |
| 2.0 $mm^2$ (#14 AWG) | EIZ01027 | #2643002402 Elna Fair-Rite Products |
| 1.3 $mm^2$ (#16 AWG) | EIZ01025 | #2643250402 Elna Fair-Rite Products |
| 0.8 $mm^2$ (#18 AWG) | EIZ01001 | #2673000801 Elna Fair-Rite Products |



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## 2.2. Motor Output Connections

The Soloist MP is capable of controlling three motor types:

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

For a complete list of electrical specifications, refer to Section 1.2.

**Table 2-7: Motor Power Output Connections (TB102)**

| Pin | Description | Recommended Wire Size |
|---|---|---|
| ØA | Phase A Motor Lead | 0.5 $mm^2$ (#20 AWG) |
| ØB | Phase B Motor Lead | 0.5 $mm^2$ (#20 AWG) |
| ØC | Phase C Motor Lead | 0.5 $mm^2$ (#20 AWG) |
| ⏚ | Earth Ground to Motor (required for safety) | 0.5 $mm^2$ (#20 AWG) |

**Table 2-8: Motor Power Output Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 7-Pin Terminal Block | ECK01389 | 1803620 | 0.22 - 0.25 | 2.0 - 0.516 [14-30] |



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### 2.2.1. Brushless Motor Connections

The configuration shown in Figure 2-5 is an example of a typical brushless motor connection.

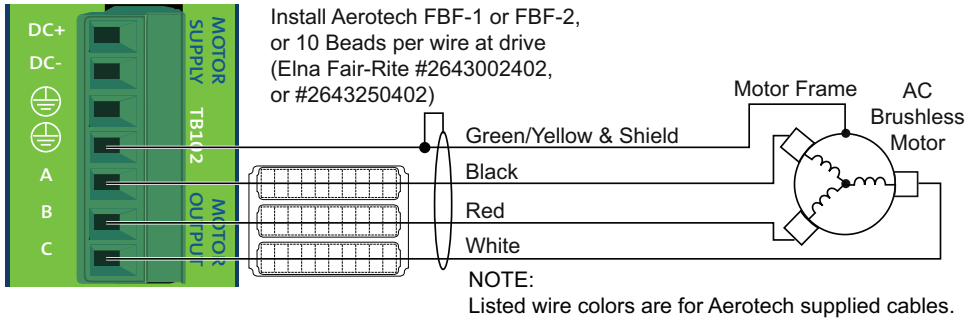



**Figure 2-5: Brushless Motor Configuration**

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

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

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

The drive 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.

There are two methods for verifying motor connections: powered, through the use of a test program; and an unpowered method using an oscilloscope. Both methods will identify the A, B, and C Hall/motor lead sets and indicate the correct connections to the drive.

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



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#### 2.2.1.1. Powered Motor Phasing

To test the initial set of motor connections, run the MotorVerification.ab test program.

The program will attempt to move the motor forward in a positive (CW) direction. Depending on the information that the program gathers during the test, you may be prompted to rearrange motor lead connections and run the test again. Refer to Section 2.2.1. for connector pin output information.



**WARNING:** The MotorVerification.ab program moves the motor in "Open-Loop" mode, bypassing many of the standard safety faults.



**WARNING:** It is recommended that rotary motors be disconnected from the stage/load before running this test. Linear motor systems must be free from obstruction to prevent damage to other components. Operators must remain clear of all moving parts during the test.

**Hall Signal Phasing (connections to J103):**

With the information gathered while the program is running, the Hall signal wires may have to be swapped. After the Hall sequence is correct, the program will determine if a commutation offset is required (and calculate a value for the CommutationOffset[1] parameter that will have to be entered into the parameter editor). Refer to Section 2.3.2. for more information and connector pin output assignments.

**Encoder Phasing (connections to J103):**

The MotorVerification.ab program also determines if the feedback wiring is correct. Follow the program prompts to establish the correct feedback wiring. Refer to Section 2.3. for connector pin output assignments and Section 2.3.1.3. for phasing information.

**Feedback Monitoring:**

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

A "0" for the given Hall input indicates zero voltage or logic low, where a "1" indicates 5V or logic high.

[1] CommutationOffset has replaced CfgMotOffsetAng in software version 3.00.000.



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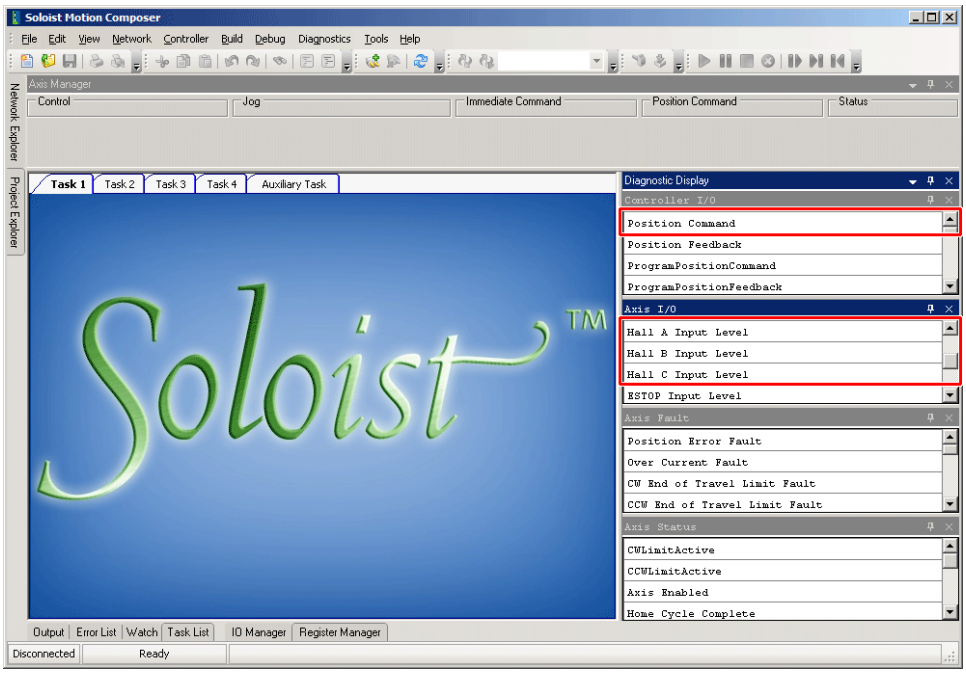



**Figure 2-6: Encoder and Hall Signal Diagnostics**



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### 2.2.1.2. Unpowered Motor and Feedback Phasing

Disconnect the motor from the controller and connect the motor in the test configuration (as shown in Figure 2-7). 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 2-7).

To determine the relative phasing/order of the three motor lead signals in relation to each other, connect channel 1 of the oscilloscope to TP1. Connect channel 2 to TP2 and move the motor in the positive direction (CW) by hand. Note the peak of the sine wave signal of channel 1 in comparison to the peak of the sine wave signal of channel 2. Next, disconnect channel 2 from TP2 and reconnect it to TP3 and again move the motor in the positive direction. Note the peak of the sine wave signal of channel 3 in comparison to the peak of the sine wave signal of channel 1.

Aerotech phasing configuration expects ØC to be the lead signal (in time), ØB to follow it, and ØA to follow ØB. This means that whichever signal has its sine wave peak farthest to the left should be designated as the ØC signal.

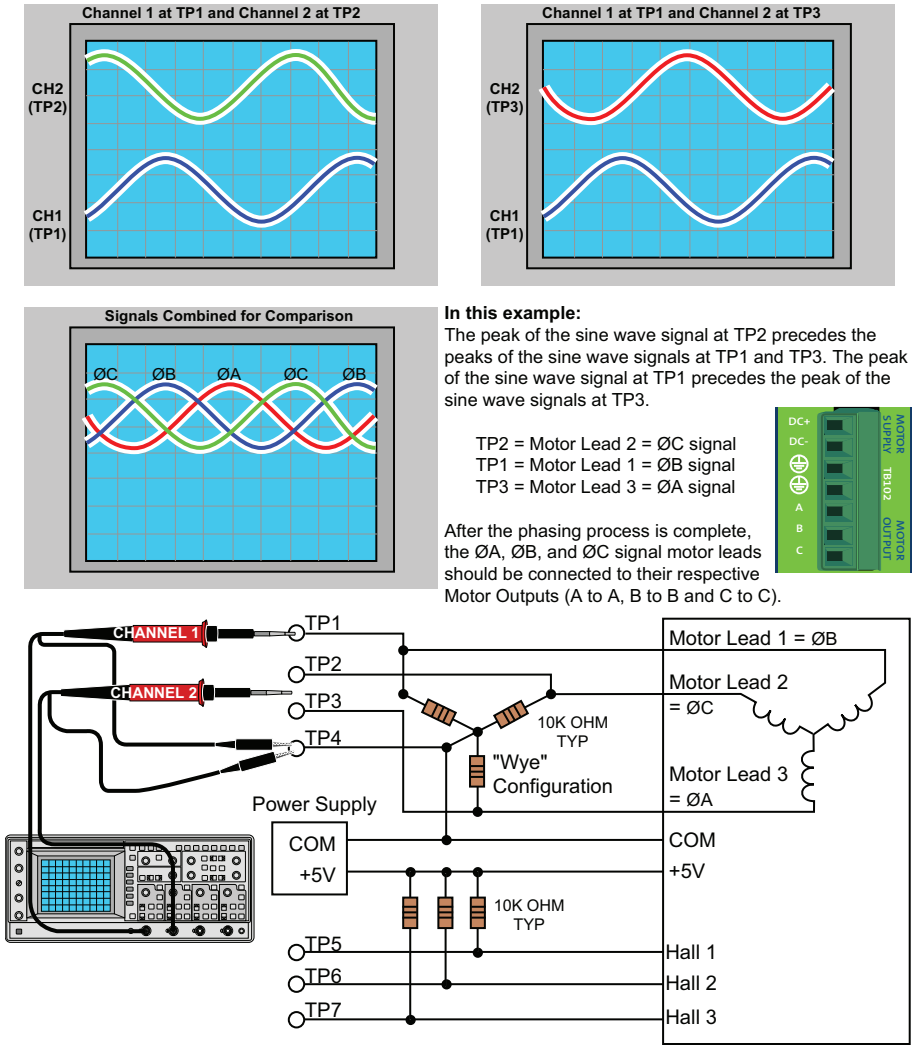



**Figure 2-7: Motor Phasing Oscilloscope Example**

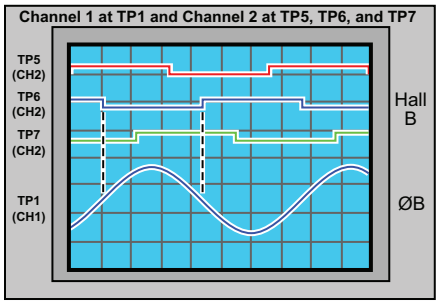


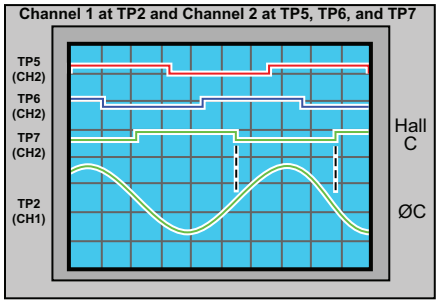
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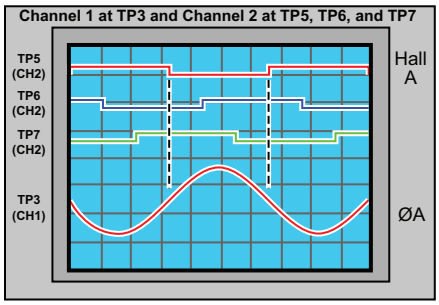
After the motor leads have been tested, the next step is to determine the phase of the Hall signals. The required (by an Aerotech system) relationship between motor and Hall leads is that the peak of a motor lead signal should correspond to the low voltage phase of the Hall signal (as shown in Figure 2-8).

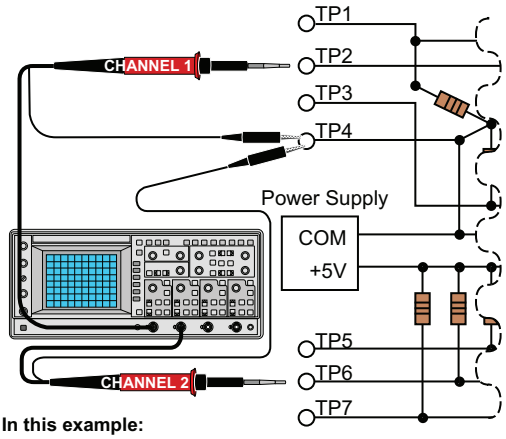
With channel 1 still connected to one of the motor leads, connect channel 2 of the oscilloscope to TP5, TP6, and then TP7, while advancing the motor in the positive direction after each connection. Note which of the three Hall signals has the complimentary phase relationship to the motor lead that channel 1 is connected to (as shown in Figure 2-8).

Move channel 1 of the oscilloscope to the second motor lead and repeat the steps from above. Note which Hall signal corresponds to the currently selected motor lead and repeat the process for the 3rd motor lead.



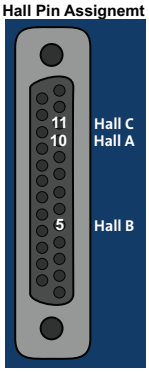

**In this example:**
The low voltage phase of the TP6 Hall signal corresponds with the peak phase of the motor sine wave of TP1 (in the previous example designated as ØB). The signal at TP6 should be designated as Hall B.

The low voltage phase of the TP7 Hall signal corresponds with the peak phase of the motor sine wave of TP2 (in the previous example designated as ØC). The signal at TP7 should be designated as Hall C.

The low voltage phase of the TP5 Hall signal corresponds with the peak phase of the motor sine wave of TP3 (in the previous example designated as ØA). The signal at TP5 should be designated as Hall A.

After the phasing process is complete, the Hall A, Hall B, and Hall C signal leads should be connected to their respective Motor Feedback connector inputs (Hall A to Pin 10, Hall B to Pin 5, and Hall C to Pin 11).

**Motor Feedback Hall Pin Assignemt**




| Pin | Hall Positions |
|---|---|
| 10 | Hall A |
| 5 | Hall B |
| 11 | Hall C |

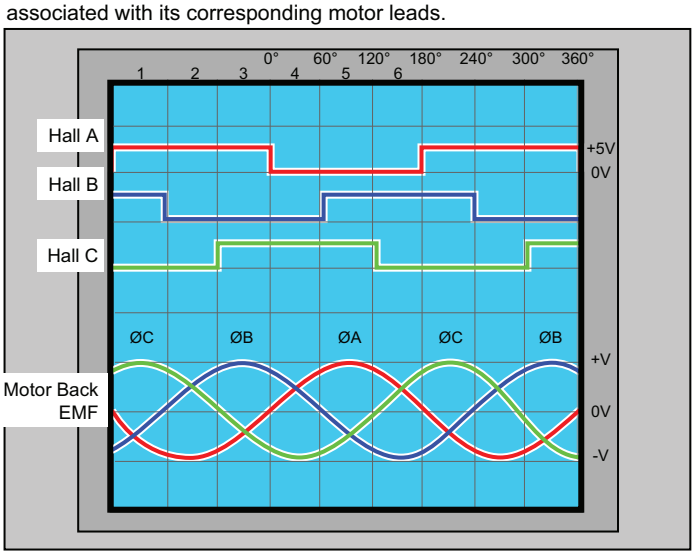
**Figure 2-8: Hall Phasing with Oscilloscope**



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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. Connect Hall lead A to Pin 10 of the feedback connector. Hall lead B should connected to Pin 5 and Hall lead C should connect to Pin 11 of the feedback connector.

The motor is correctly phased when the Hall states correspond to the states at each of the electrical angles. The Hall signal leads must be associated with its corresponding motor leads.




| Motor Feedback Connector | Hall Positions | Corresponding Motor Lead | Motor Output Connector |
|---|---|---|---|
| Pin 10 | Hall A | → | ØA |
| Pin 5 | Hall B | → | ØB |
| Pin 11 | Hall C | → | ØC |

**Figure 2-9: Brushless Motor Phasing Goal**



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### 2.2.2. DC Brush Motor Connections

The configuration shown in Figure 2-10 is an example of a typical DC brush motor connection. Refer to Section 2.2.2.1. for information on motor phasing.

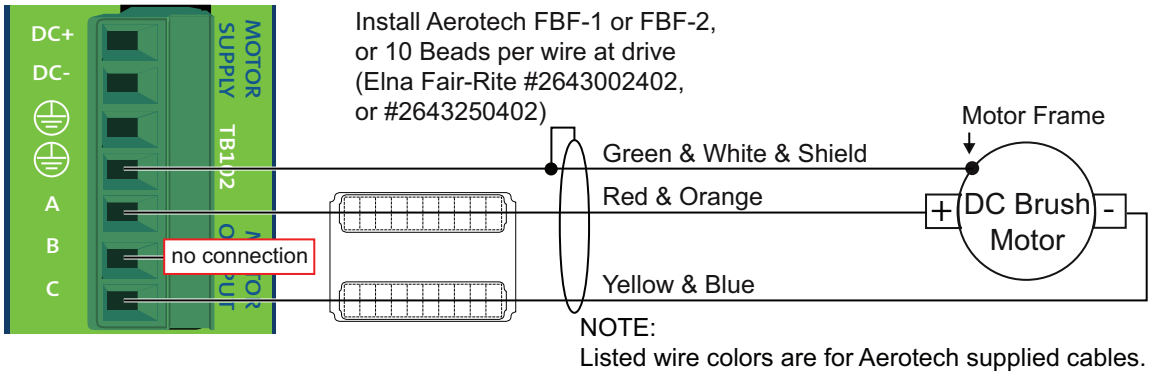



**Figure 2-10: DC Brush Motor Configuration**

**Table 2-10: Wire Colors for Aerotech Supplied Cables (DC Brush)**

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



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#### 2.2.2.1. DC Brush Motor Phasing

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

1. Connect the positive lead of the voltmeter to the one of the motor terminals.
2. Connect the negative lead of the voltmeter to the other motor terminal.
3. Rotate the motor clockwise by hand.

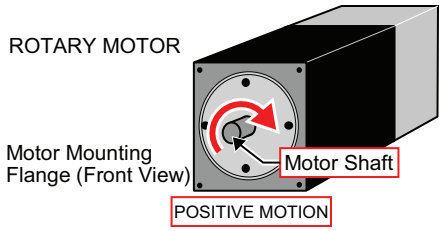



**Figure 2-11: Clockwise Motor Rotation**

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

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



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### 2.2.3. Stepper Motor Connections

The configuration shown in Figure 2-12 is an example of a typical stepper motor connection. Refer to Section 2.2.3.1. for information on motor phasing.

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

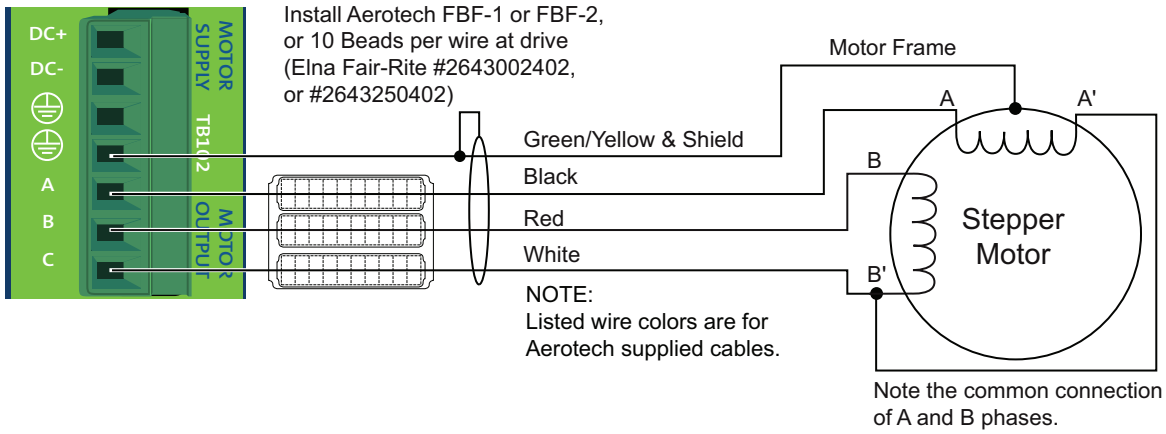



**Figure 2-12: Stepper Motor Configuration**

**Table 2-11: Wire Colors for Aerotech Supplied Cables (Stepper)**

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



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#### 2.2.3.1. Stepper Motor Phasing

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

If there is a positive scaling factor (determined by the CountsPerUnit[1] 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.

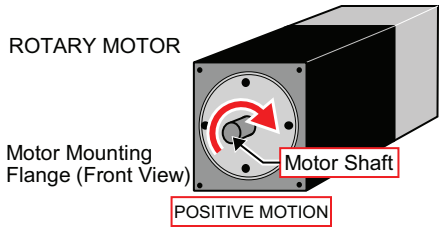



**Figure 2-13: Clockwise Motor Rotation**

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

**NOTE:** After the motor has been phased, use the ReverseMotionDirection[2] parameter to change the direction of "positive" motion.

[1] CountsPerUnit has replaced PosScaleFactor in software version 3.00.000.
[2] ReverseMotionDirection has replaced the functionality of reversing the sign on the PosScaleFactor to change the direction of positive motion in software version 3.00.000.

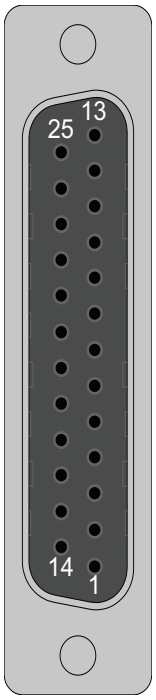


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## 2.3. Motor Feedback Connections (J103)

The motor feedback connector (a 25-pin, D-style connector) has inputs for an encoder, limit switches, Hall-effect devices, motor over-temperature device, 5 Volt encoder and limit power, and optional brake connection. The connector pin assignment is shown below with detailed connection information in the following sections.

**Table 2-12: Motor Feedback Connector Pin Assignment (J103)**

| 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 |



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### 2.3.1. Encoder Interface (J103)

The Soloist MP is equipped with standard and auxiliary encoder feedback channels. The standard encoder interface is accessible through the Motor Feedback (J103) connector. The standard encoder interface will accept an RS-422 differential line driver signal.

Refer to Section 2.3.1.3. for encoder feedback phasing.

**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 2-13: Encoder Interface 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 |



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#### 2.3.1.1. RS-422 Line Driver Encoder (Standard)

The standard encoder interface accepts an RS-422 differential quadrature line driver signal in the range of 0 to 5 Volts. It accepts a 10 MHz (max) encoder signal frequency (25 nsec minimum edge separation), producing 40 million counts per second after times four (x4) quadrature decoding.

An analog encoder is used with the -MXU option (refer to Section 2.3.1.2. for more information).

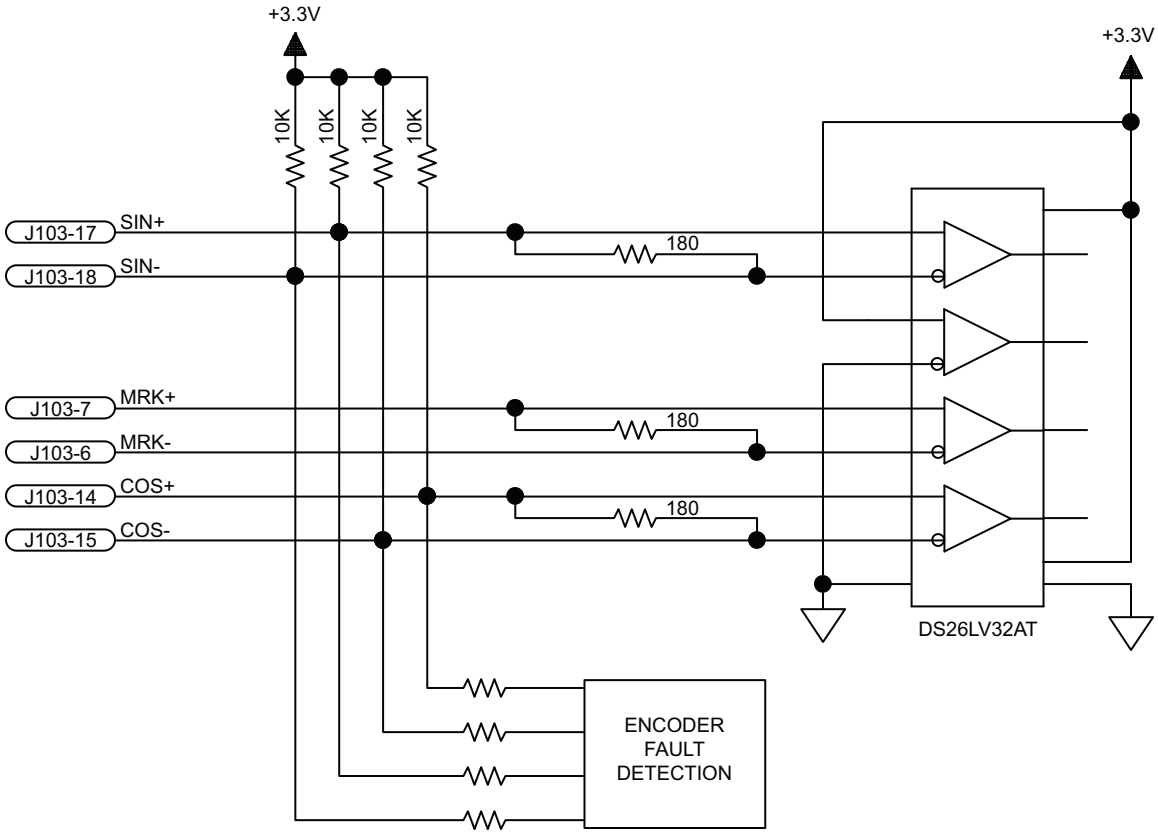



**Figure 2-14: Line Driver Encoder Interface (J103)**



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### 2.3.1.2. Analog Encoder Interface

If the -MXU option has been purchased, the standard encoder channel will accept an analog encoder input signal. The multiplication (interpolation) factor is determined by the EncoderMultiplicationFactor[1] parameter.

**Table 2-14: Analog Encoder Specifications**

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

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

The encoder interface pin assignment is indicated in Section 2.3.1.

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 Soloist Help file for more information.

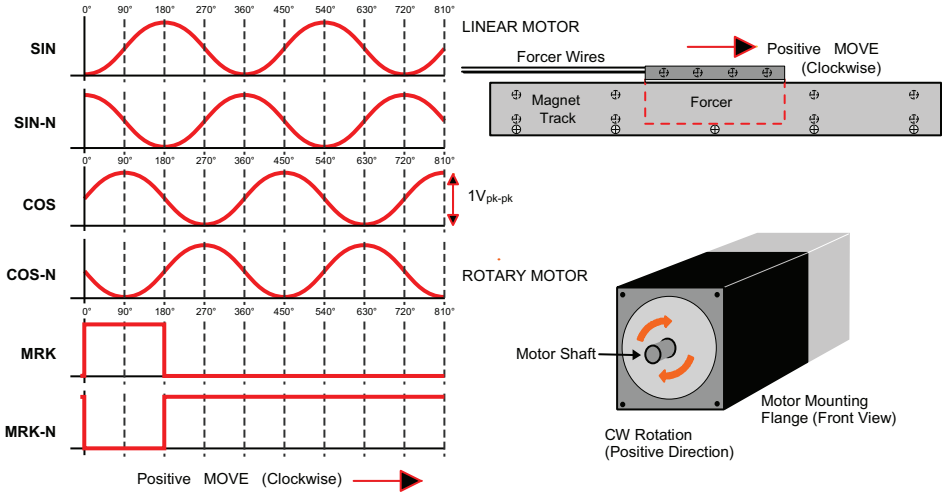



**Figure 2-15: Analog Encoder Phasing Reference Diagram**

**NOTE:** The input amplitude is measured peak to peak for any encoder signal (sin, sin-n, cos, cos-n) relative to signal common. These signals have a typical offset voltage of 2V to 2.5V.

[1] EncoderMultiplicationFactor has replaced CfgFbkEncMultFactorMxu in software version 3.00.000.



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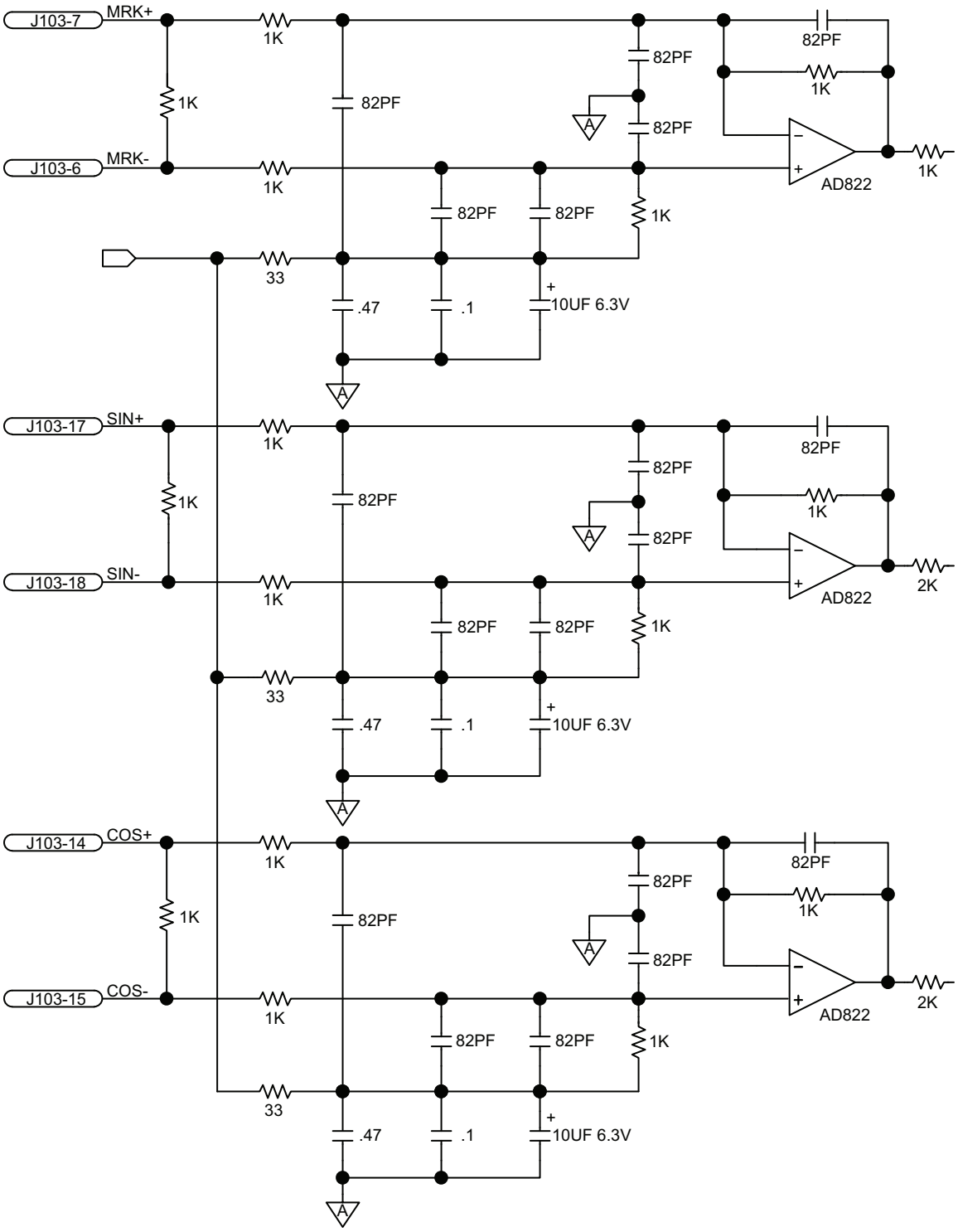



**Figure 2-16: Analog Encoder Interface (J103)**



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### 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 2-17 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 MotorVerification.ab program can be used if the motor can not be moved by hand. If the program causes the Position Feedback to count more negative, swap the connections to the controllers SIN and the SIN-N encoder inputs.

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

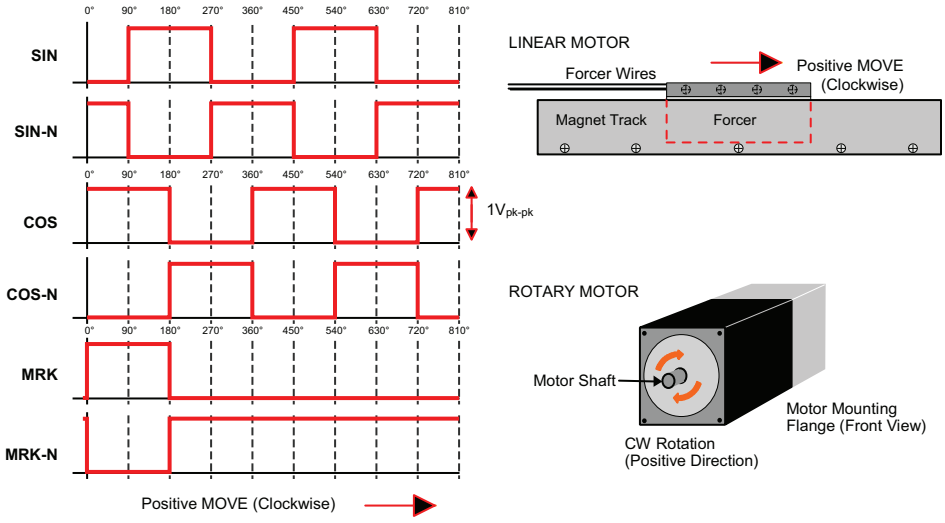



**Figure 2-17: Encoder Phasing Reference Diagram (Standard)**

**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.



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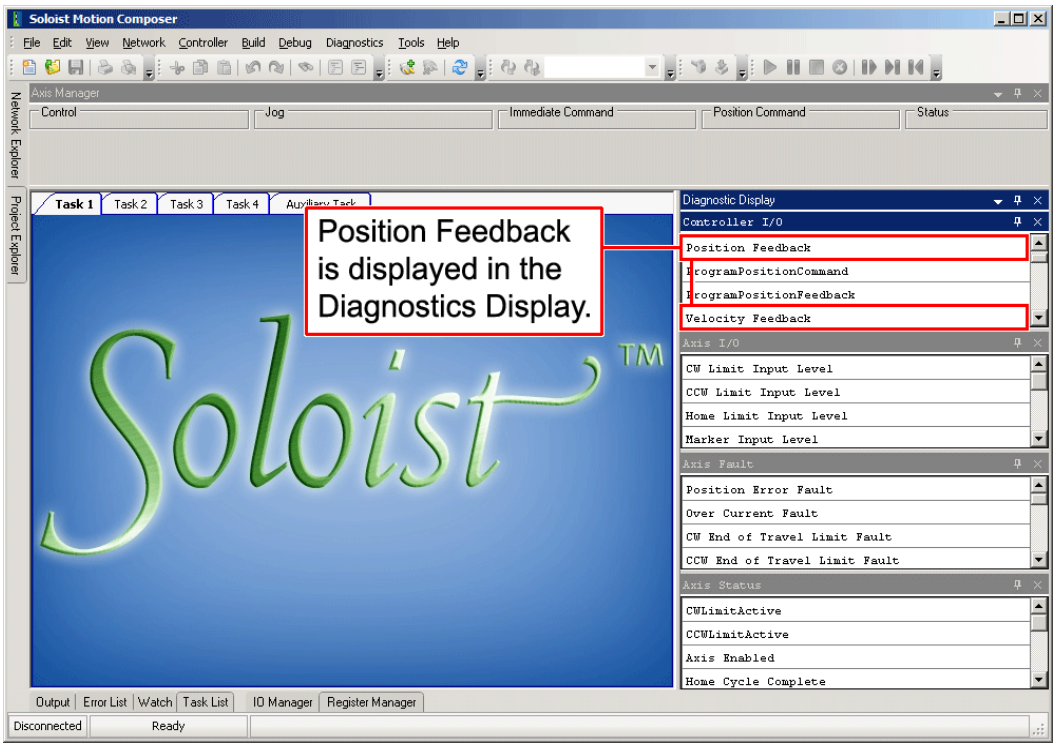



**Figure 2-18: Position Feedback in the Diagnostic Display**



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### 2.3.2. Hall-Effect Interface (J103)

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.

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

**Table 2-15: Hall-Effect Feedback Interface Pin Assignment (J103)**

| 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 |

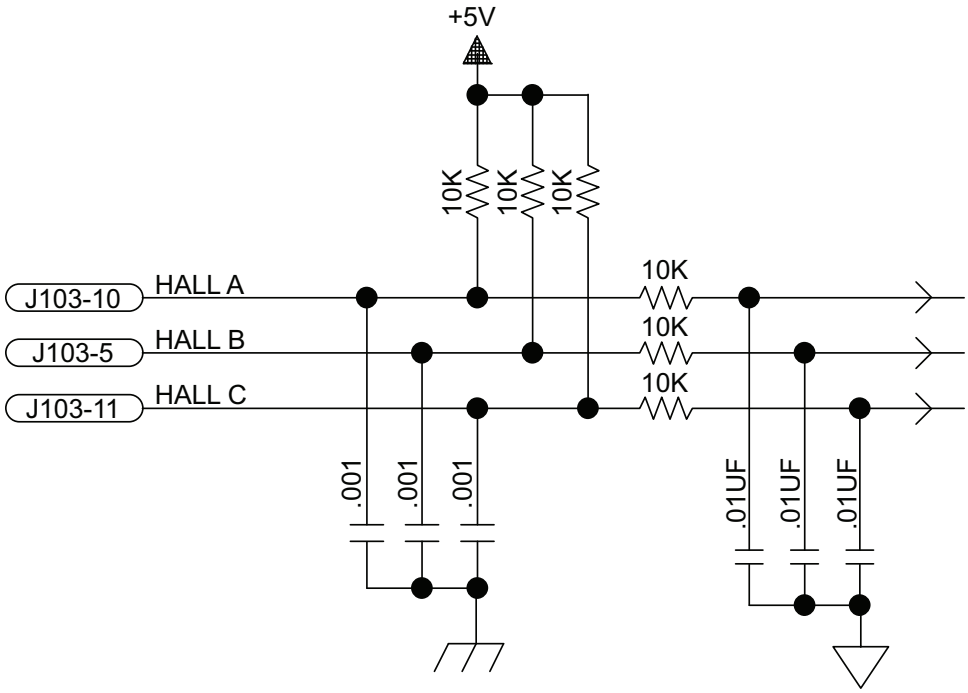



**Figure 2-19: Hall-Effect Inputs (J103)**



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### 2.3.3. Thermistor Interface (J103)

The thermistor input is used to detect an over temperature condition in a motor 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. If the increasing temperature causes the thermistor's resistance to increase, the signal will be seen as a logic high, triggering an over temperature fault.

**Table 2-16: Hall-Effect Feedback Interface Pin Assignment (J103)**

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

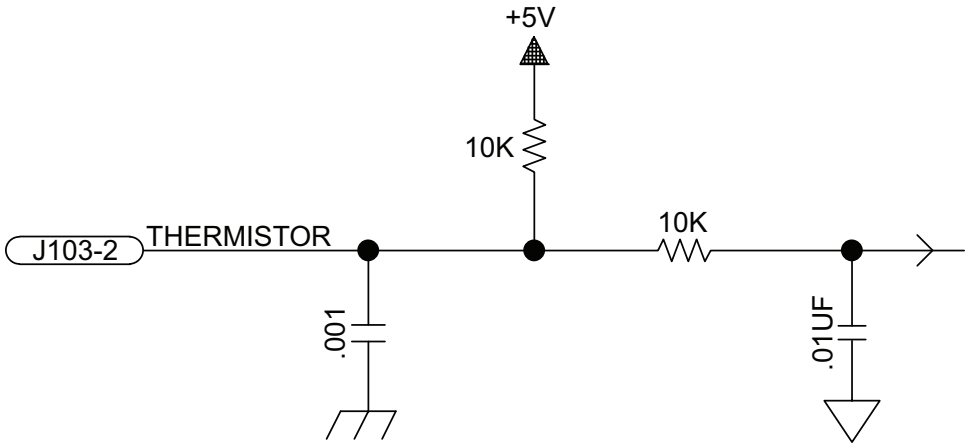



**Figure 2-20: Thermistor Interface Input (J103)**



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### 2.3.4. Encoder Fault Interface (J103)

The encoder fault input is used with encoders having a fault output. Each manufacturer uses this signal to indicate different faults.

**Table 2-17: Encoder Fault Interface Pin Assignment (J103)**

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

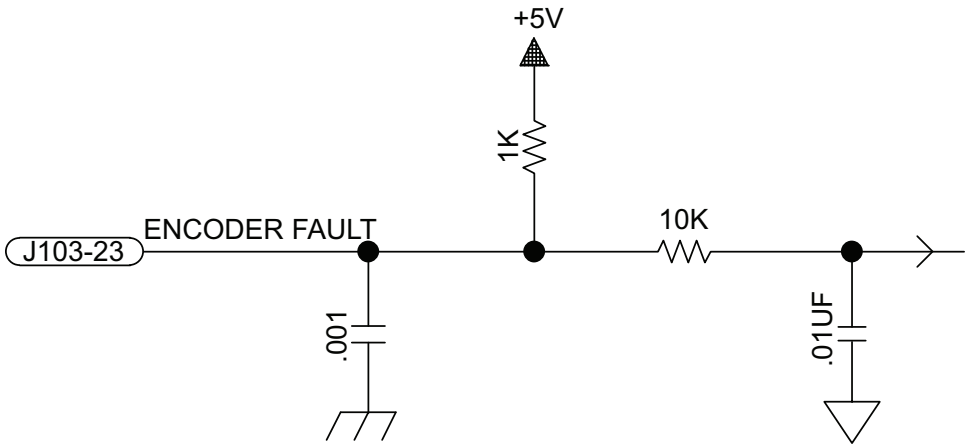



**Figure 2-21: Encoder Fault Interface Input (J103)**



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### 2.3.5. End Of Travel Limit Input Interface (J103)

End of Travel (EOT) limits are required to define the end of the physical travel on linear axes. Positive or clockwise motion is stopped by the clockwise (CW) end of travel limit input. Negative or counterclockwise motion is stopped by the counterclockwise (CCW) end of travel limit input. The Home Limit switch can be parameter configured for use during the home cycle, however, the CW or CCW EOT limit is typically used instead. All of the end-of-travel limit inputs accept 5-24 VDC level signals. Limit directions are relative to the encoder polarity in the status display (refer to Figure 2-24).

The active state of the EOT limits is software selectable (by the EndOfTravelLimitSetup[1] parameter).

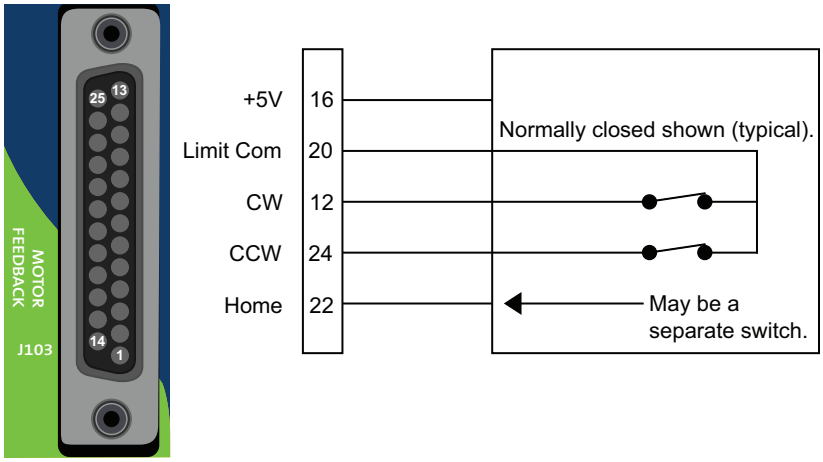



**Figure 2-22: End of Travel Limit Input Connections**

**Table 2-18: End of Travel Limit Input Interface Pin Assignment (J103)**

| 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 |

[1] EndofTravelLimitSetup has replaced LimitLevelMask in software version 3.00.000.



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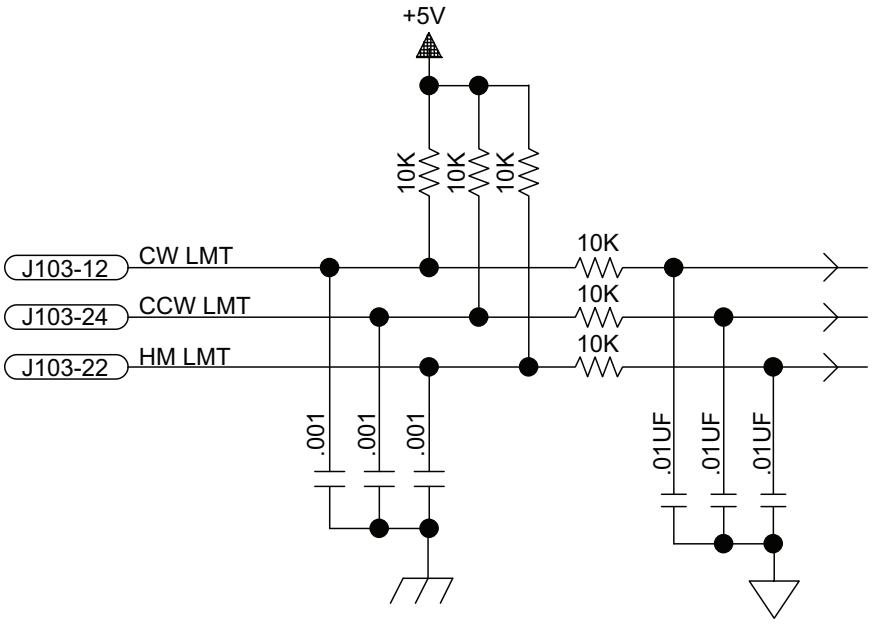



**Figure 2-23: End of Travel Limit Interface Input (J103)**



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#### 2.3.5.1. 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 J103 connector. The logic level of the EOT limit inputs may be viewed in the diagnostic display (shown in Figure 2-24).

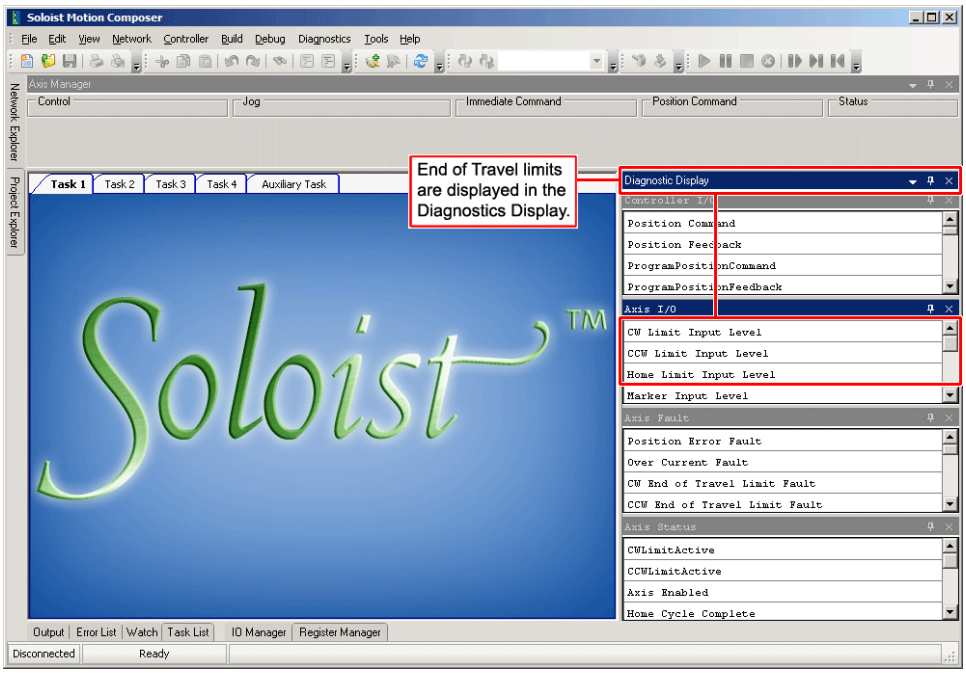



**Figure 2-24: Limit Input Diagnostic Display**



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### 2.3.6. Brake Output (J103)

The Brake Output pins provide a direct connection to the solid state relay on the optional -IO board. The brake output pins in J103 permit the brake to be wired with other signals in the feedback cable. The brake is configured for automatic or manual control using controller parameters (refer to the Soloist Help file for more information).

Refer to Section 3.2. for more information on using the brake output with the solid-state relay.

**Table 2-19: Brake Output Pin Assignment (J103)**

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



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### 2.3.7. Analog Input 0 (J103)

Analog Input 0 is a 16-bit differential input that accepts a voltage in the range of ±10 volts with a resolution of 305 µVolts. Signals outside of this range may damage the input. To interface to a single-ended (non-differential) voltage source, connect the signal common of the source to the negative input (pin 8, ANALOG_IN-) and the analog source signal to the positive input (pin 19, ANALOG_IN+). A floating signal source should be referenced to the signal common (pin 20 or pin 21, AGND) as shown in Figure 2-25.

**Table 2-20: Port 0 Analog Input Connector Pin Assignment (J103)**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 8 | Analog Input 0 - | Input |
| 19 | Analog Input 0 + | Input |
| 20 | Signal Common for Limit Switches | N/A |
| 21 | Signal Common for Encoder | N/A |

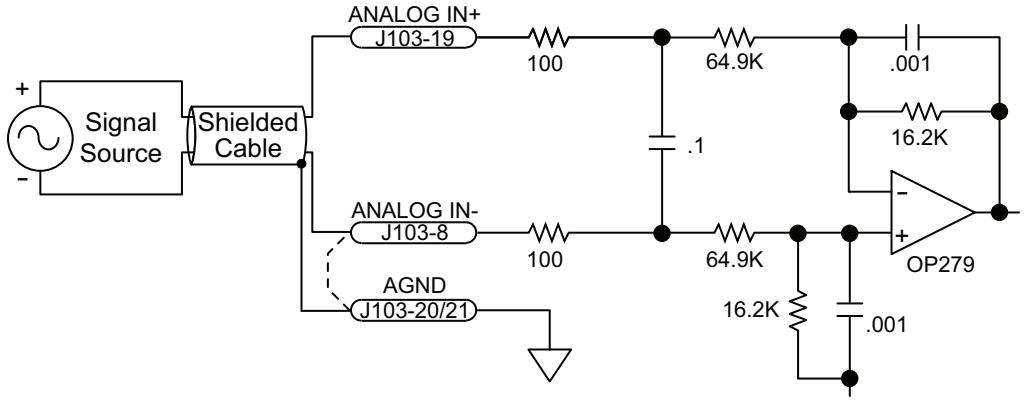



**Figure 2-25: Analog Input 0 (J103)**



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## 2.4. Emergency Stop Sense Input (TB104)

The ESTOP sense input (TB104) is used to monitor the state of an external safety circuit only. This state is indicated by the software and may be used to facilitate system restart. This ESTOP sense input is not intended to be a complete safety system. The ESTOP sense input should be driven by the user's ESTOP circuit to either force the drive to disable, or decelerate to a stop then disable. Refer to Section 2.4.1. for interconnection details.

**WARNING:** The user is responsible for accessing operator risk levels and designing the external safety circuits appropriately.

**WARNING:** Opening the motor leads at the Motor Output while the axis is enabled will damage the drive. To protect the drive, the ESTOP circuit should open the DC motor power input (Motor Supply). Refer to Figure 2-27 for interconnection details

TB104 is scaled for an input voltage of 5-24 volts. Using a higher input voltage requires adding an external series resistor to limit the current to 10 mA.

If the ESTOP bit is enabled in the FaultMask parameter, the ESTOP input must be driven to prevent the ESTOP fault condition.

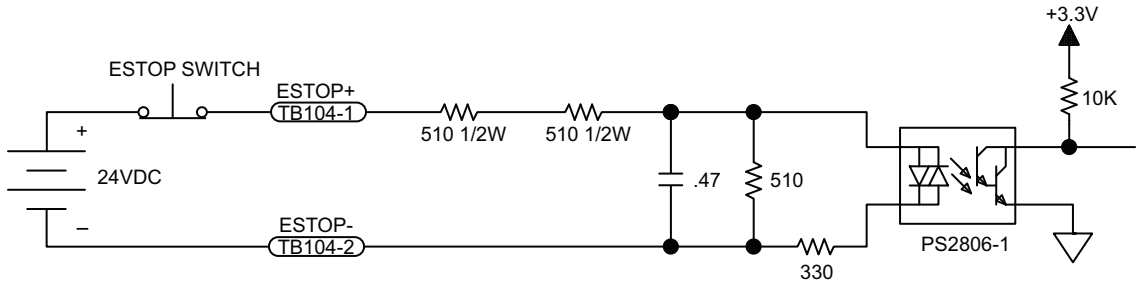



**Figure 2-26: ESTOP Sense Input (TB104)**

**Table 2-21: Electrical Noise Suppression Devices**

**NOTE:** Connecting the ESTOP input to a relay or other noise producing device requires the use of noise suppression devices such as those in Table 2-21. These devices are applied across the switched coil to suppress transient voltages.

**Table 2-22: Electrical Noise Suppression Devices**

| Device | Aerotech P/N | Third Party P/N |
|---|---|---|
| RC (.1uf / 200 ohm) Network | EIC240 | Electrocube RG1782-8 |
| Varistor | EID160 | Littelfuse V250LA40A |

**Table 2-23: TB104 Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 2-Pin Terminal Block | ECK01448 | 1881325 | N/A | 0.5 - 0.080 [20-28] |

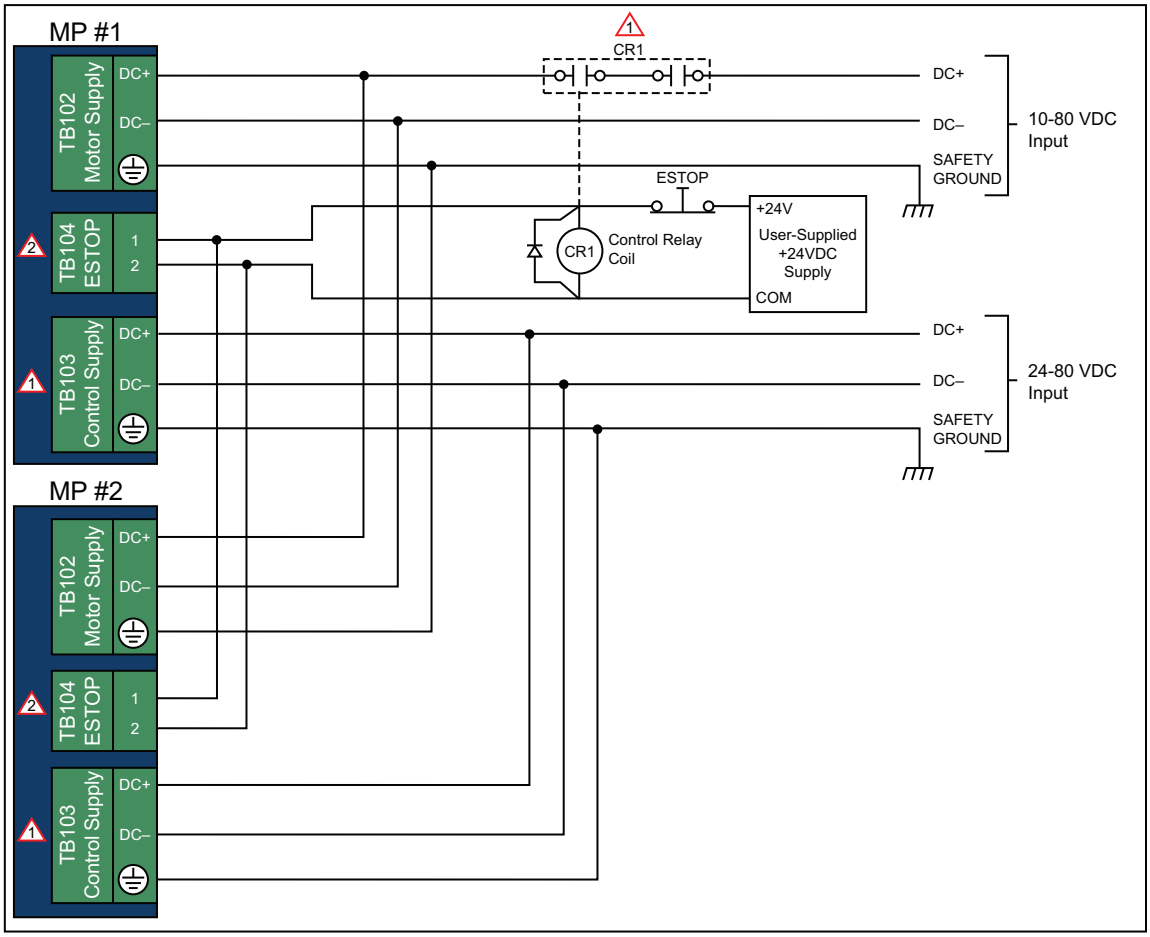


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### 2.4.1. Typical ESTOP Interface

The user can connect an external emergency stop relay circuit to the Soloist MP's motor power supply input. This will remove power to the motor while maintaining control power, as shown in the Figure 2-27.

The external relay must be sized based on the number of the Soloist MPs connected and the peak current rating of each drive.




HAZARDOUS VOLTAGES PRESENT FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES

1. Multiple contacts are used in series to achieve the desired DC contact rating. Motor power may be removed during an Emergency Stop (ESTOP) condition while control and encoder power is maintained.

2. For the ESTOP input to be active, set the appropriate FaultMask axis parameters (the FaultMask axis parameters set the action to be taken when an ESTOP condition occurs).

**Figure 2-27: Typical Emergency Stop Circuit**

**Table 2-24: Typical ESTOP Relay Ratings**

| Axes | DC1 | Aerotech P/N | Third Party P/N |
|---|---|---|---|
| Up to 5 | 32 | ECW1018 | Sprecher & Schuh CA7-16C-01-24D |

**NOTE:** Multiple contacts are used in series to achieve desired DC contact rating.



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## 2.5. RS-232 Interface (TB105)

Connecting the RS-232 port to a user's PC requires a standard cable (not a null modem).

**Table 2-25: RS-232 Connector Pin Assignment (TB105)**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 1 | RS-232 Transmit | Output |
| 2 | RS-232 Receive | Bidirectional |
| 3 | Signal Common | N/A |

**Table 2-26: RS-232 Port Connector Mating Connector (TB105)**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 3-Pin Terminal Block | ECK01449 | 1881338 | N/A | 0.5 - 0.080 [20-28] |

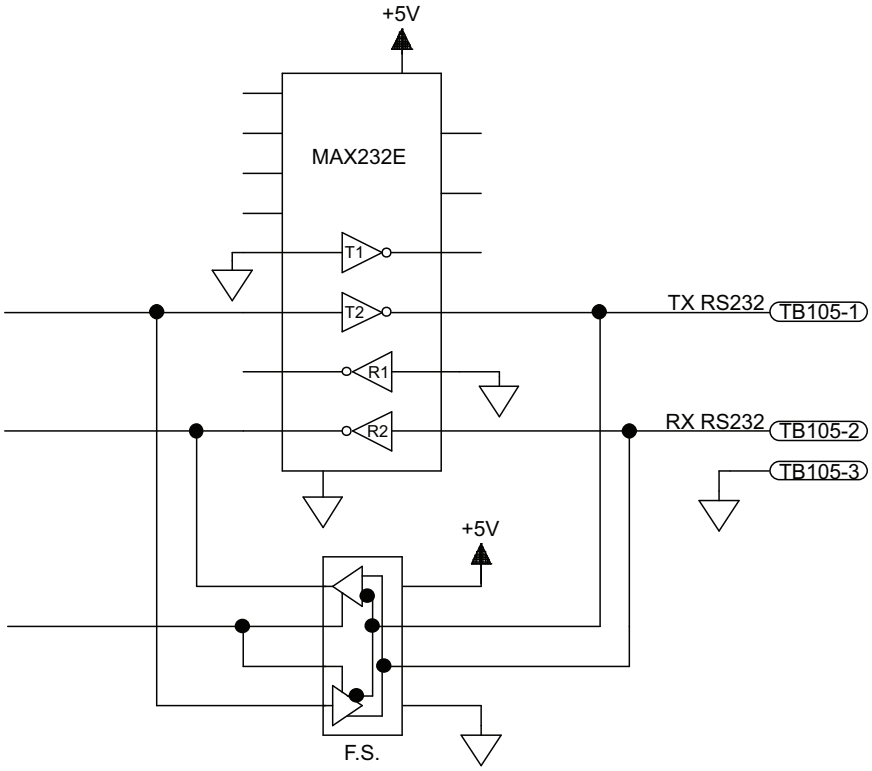



**Figure 2-28: RS-232 Interface (TB105)**



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## 2.6. PC Configuration and Operation Information

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



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# Chapter 3: -I/O Expansion Board

The -IO option board is 8 digital opto-inputs, 8 digital opto-outputs, 1 analog input, 1 analog output, a second encoder channel, and a brake/relay output.

**DANGER:** Always disconnect the Mains power connection before opening the Soloist MP chassis.

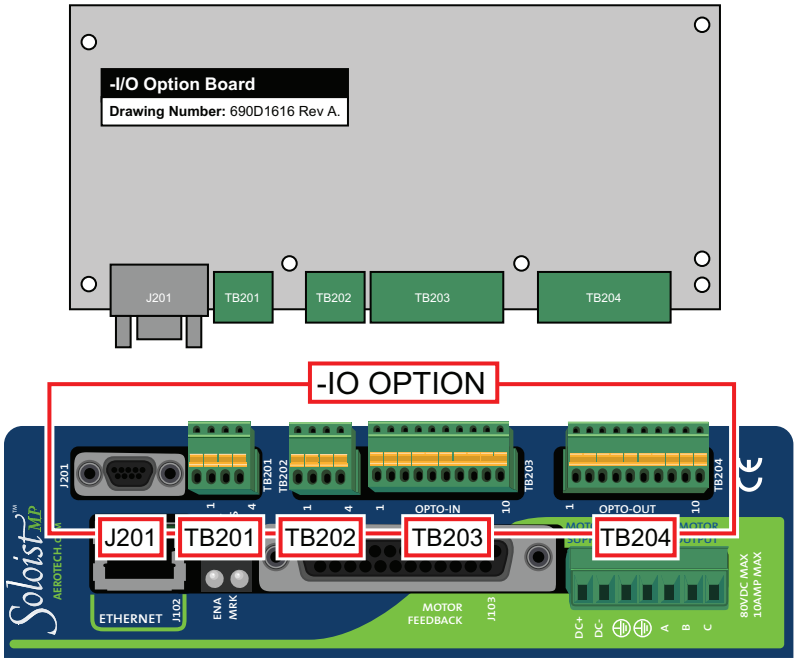



**Figure 3-1: Soloist MP with -IO Option Board**



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## 3.1. User Power (TB201)

A user accessible power supply (+5V at 0.5 A) is available between the TB201 pin 3 +5V terminal and TB201 pin 4 GND terminal.

**Table 3-1: User Common Connector Pin Assignment (TB201)**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 3 | Internal +5 Volt Power Supply (0.5 A max) | Output |
| 4 | Signal Common | N/A |



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## 3.2. Brake Power Supply (TB201)

TB201 is the power supply connection to the onboard solid state brake control relay.

The relay is typically used to automatically control a fail-safe brake on a vertical axis. It can also be used as a general purpose output.

Typically the brake is wired directly to the Motor Feedback (J103) connector and the brake power supply is connected to TB201. This is shown in Figure 3-2. The brake may also be connected in series with the Brake Power Supply and interlocked using Motor Feedback (J103) brake pins (Table 3-4 and Figure 3-3).

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

The brake output can be software configured; refer to the Soloist Help File for more information (see topics for the EnableBrakeControl[1] parameter and the BRAKE command).

**NOTE:** The brake power supply must be externally fused.

**Table 3-2: Brake Output Connector Pin Assignment (TB201)**

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

**Table 3-3: Mating Connector (TB201)**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 4-Pin Terminal Block | ECK01293 | 1881341 | N/A | 0.5 - 0.080 [20-28] |

**Table 3-4: Brake Output Connector Pin Assignment (J103)**

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

[1] EnableBrakeControl has replaced BrakeOnDriveDisable in software version 3.00.000.



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Figure 3-2 is an example of a +24 VDC Brake connected to J103, the Motor Feedback connector. In this example the external +24 VDC power source is connected to TB201.

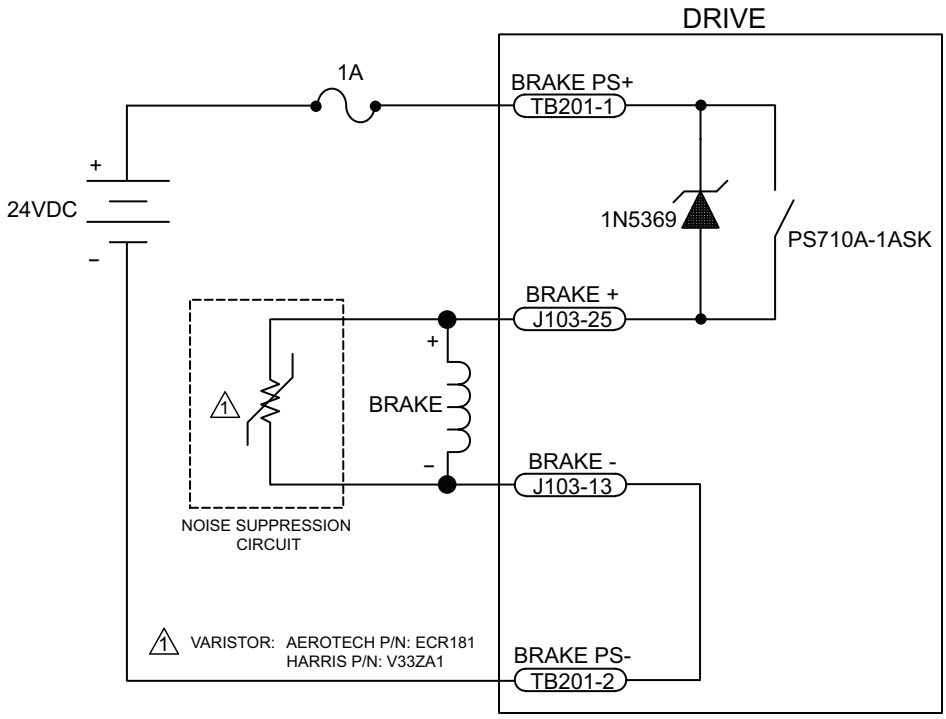



**Figure 3-2: Brake Connected to J103**

**NOTE:** The user is responsible for providing fuse protection for the brake circuit.



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Figure 3-3 is an example of a 24 VDC Brake connected to TB201. The user must connect J103 pin 13 to J103 pin 25. In this case, J103 would function as an interlock to prevent the brake from releasing if the Motor Feedback connector is not connected.

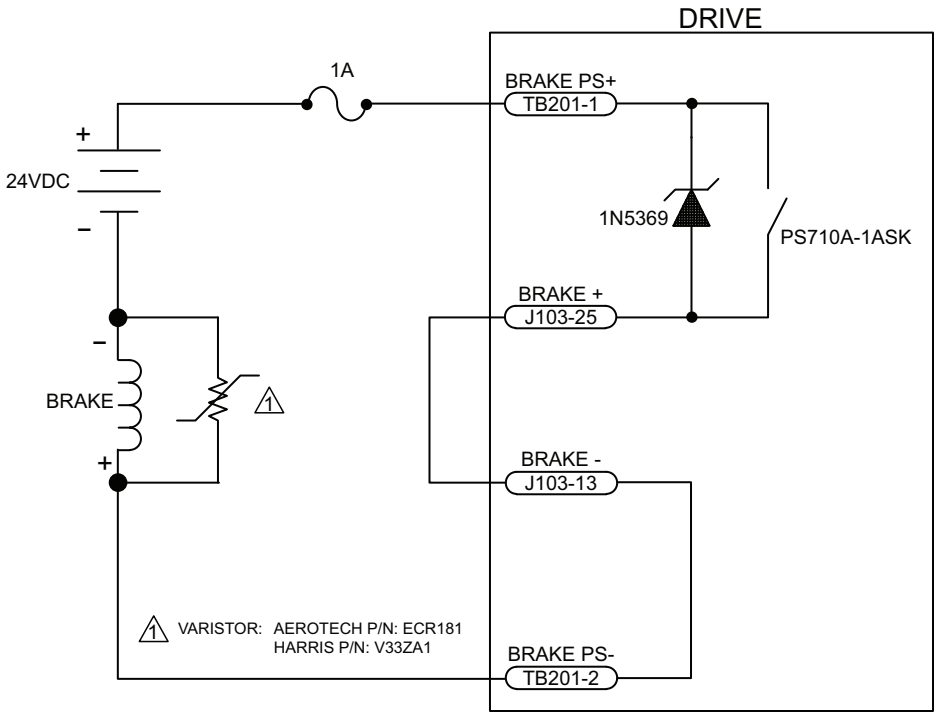



**Figure 3-3: Brake Connected to TB201**



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### 3.2.1. Solid State Relay Specifications (TB201)

The user must verify that the brake power requirements are within the specifications of the Brake control relay listed below.

**Table 3-5: Relay Specifications**

| Solid State Relay Rating (M36), Aerotech PN: ECS1074 | |
|---|---|
| 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) |



**WARNING:** Do not exceed the maximum specifications.



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## 3.3. Analog Output (TB202)

The 16-bit analog output produces a single-ended output voltage in the range of ±5 V with a resolution of 153 µV. The maximum recommended output current is 5 mA. Analog outputs are referenced to TB202-1. The analog output is set to zero when the system is powered-up or during a system reset.

**NOTE:** Analog Output 0 is not present on the MP.

**Table 3-6: Port 1 Analog Output Connector Pin Assignment (TB202)**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 1 | Analog Common | N/A |
| 4 | Analog Output 1 | Output |

**Table 3-7: Analog Output Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 4-Pin Terminal Block | ECK01293 | 1881341 | N/A | 0.5 - 0.080 [20-28] |

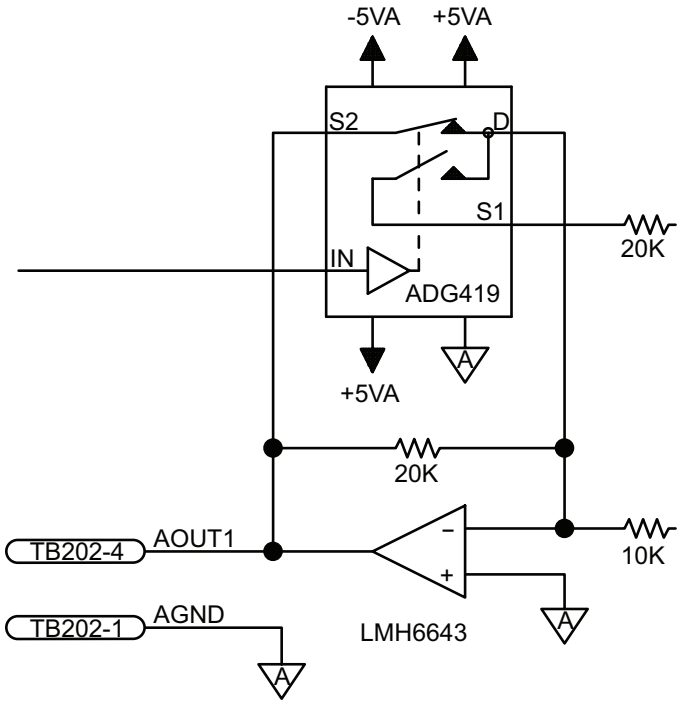



**Figure 3-4: Analog Output 1 Connector (TB202)**



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## 3.4. Analog Input (TB202)

The I/O board analog input is a 12-bit differential input that accepts a voltage in the range of ±10 volts with a resolution of 4.88 millivolts. Signals outside of this range may damage the 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 signal common (pin 1, AGND) as shown in Figure 3-5.

**NOTE:** Analog Input 0 is available on J103 (see Section 2.3.7.).

**Table 3-8: Port 1 Analog Inputs Connector Pin Assignment (TB202)**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 1 | Analog Common | N/A |
| 2 | Non-inverting Analog Input 1 | Input |
| 3 | Inverting Analog Input 1 | Input |

**Table 3-9: Analog Input Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 4-Pin Terminal Block | ECK01293 | 1881341 | N/A | 0.5 - 0.080 [20-28] |

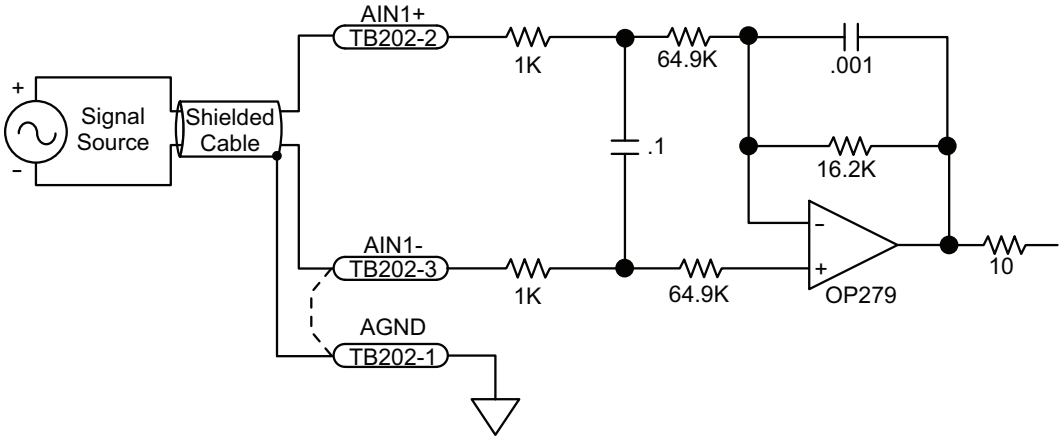



**Figure 3-5: Analog Input Typical Connection (TB202)**



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## 3.5. Opto-Isolated Inputs (TB203)

These opto-isolated inputs use a PS2806-4 device and are configured for 5-24 volt input levels. The inputs may be connected to current sourcing or current sinking devices, as shown in Figure 3-7 and Figure 3-8. See Section 2.3.5. for opto-isolated EOT limits.

Inputs 0-3 and inputs 4-7 have separate common inputs, pin 1 and pin 10, respectively. Each 4-bit bank of inputs must be connected in the same configuration (sinking or sourcing)

**Table 3-10: PS2806-4 Opto-Device 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 3-11: Port 1 Opto-Isolated Input Connector Pin Assignment (TB203)**

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

**Table 3-12: Opto-Isolated Input Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 10-Pin Terminal Block | ECK01294 | 1881406 | N/A | 0.5 - 0.080 [20-28] |



**WARNING:** Opto-isolated inputs and outputs should not be powered by the user output power. Doing so would compromise the isolation provided by the opto-isolator.

**NOTE:** Inputs must be connected in the all sourcing or all sinking configuration.



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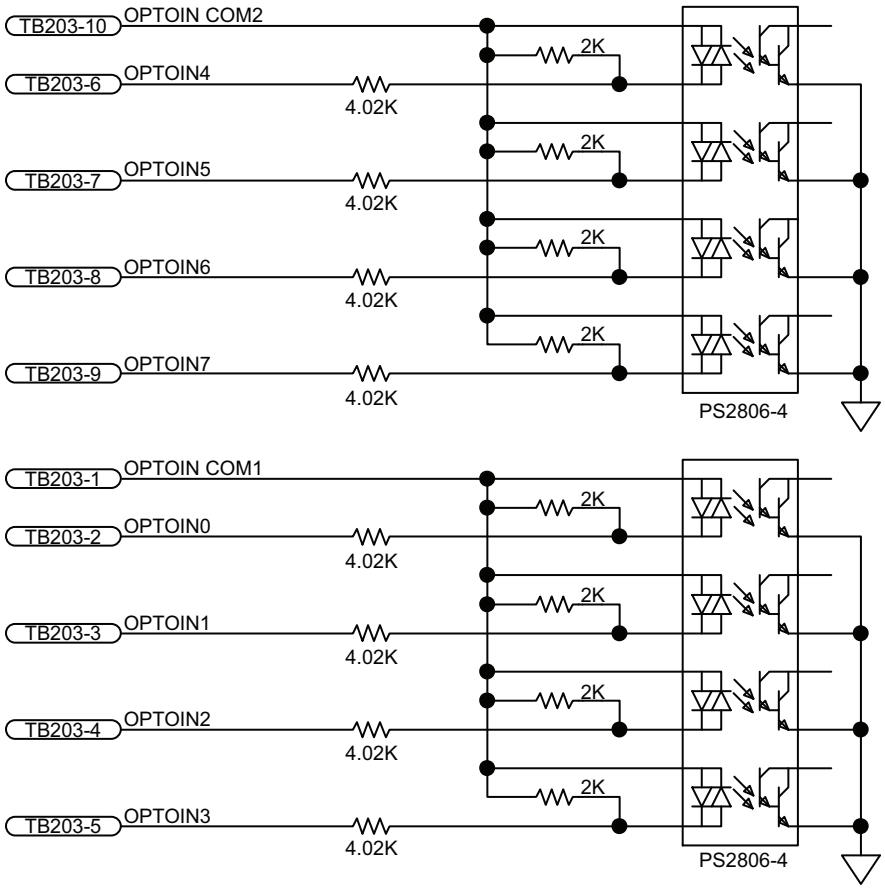



**Figure 3-6: Opto-Isolated Inputs**



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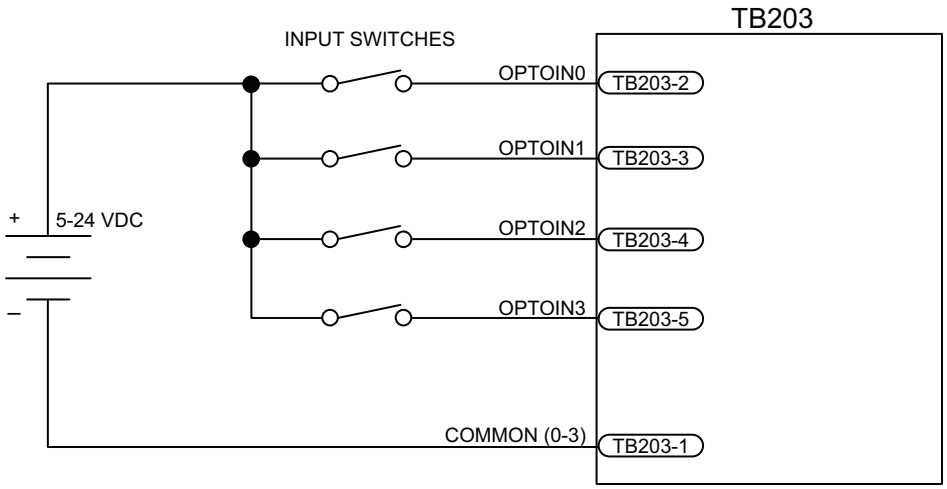



**Figure 3-7: Inputs Connected to a Current Sourcing Device**

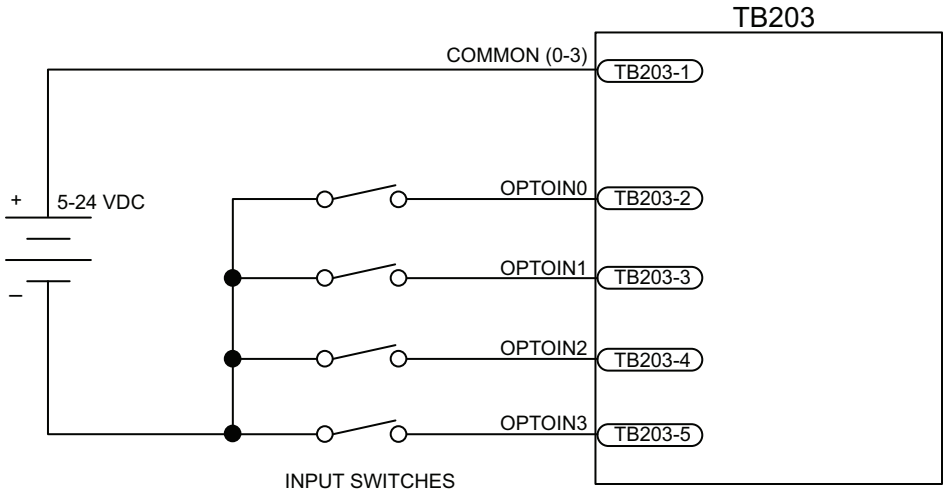



**Figure 3-8: Inputs Connected to a Current Sinking Device**



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## 3.6. Opto-Isolated Outputs (TB204)

The outputs are software configurable as sourcing or sinking. The outputs are driven by PS2802-4 opto-isolators rated for 24 volts maximum and up to 80 mA/output @ 20°C.

Outputs must be connected in either all sinking or all sourcing mode. Figure 3-10 and Figure 3-11 illustrate how to connect to an output in current sourcing and current sinking modes, respectively.

**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 3-10 and Figure 3-11.

**Table 3-13: Port 1 Opto-Isolated Output Connector Pin Assignment (TB204)**

| Pin# | Description | In/Out/Bi |
|---|---|---|
| 1 | Output Common Plus | Input |
| 2 | Output Common Minus | Input |
| 3 | Output 0 (Optically-Isolated) | Output |
| 4 | Output 1 (Optically-Isolated) | Output |
| 5 | Output 2 (Optically-Isolated) | Output |
| 6 | Output 3 (Optically-Isolated) | Output |
| 7 | Output 4 (Optically-Isolated) | Output |
| 8 | Output 5 (Optically-Isolated) | Output |
| 9 | Output 6 (Optically-Isolated) | Output |
| 10 | Output 7 (Optically-Isolated) | Output |

**Table 3-14: Opto-Isolated Output Mating Connector**

| Type | Aerotech P/N | Phoenix P/N | Tightening Torque (Nm) | Wire Size: $mm^2$ [AWG] |
|---|---|---|---|---|
| 10-Pin Terminal Block | ECK01294 | 1881406 | N/A | 0.5 - 0.080 [20-28] |



**WARNING:** Opto-isolated inputs and outputs should not be powered by the user output power. Doing so would compromise the isolation provided by the opto-isolator.



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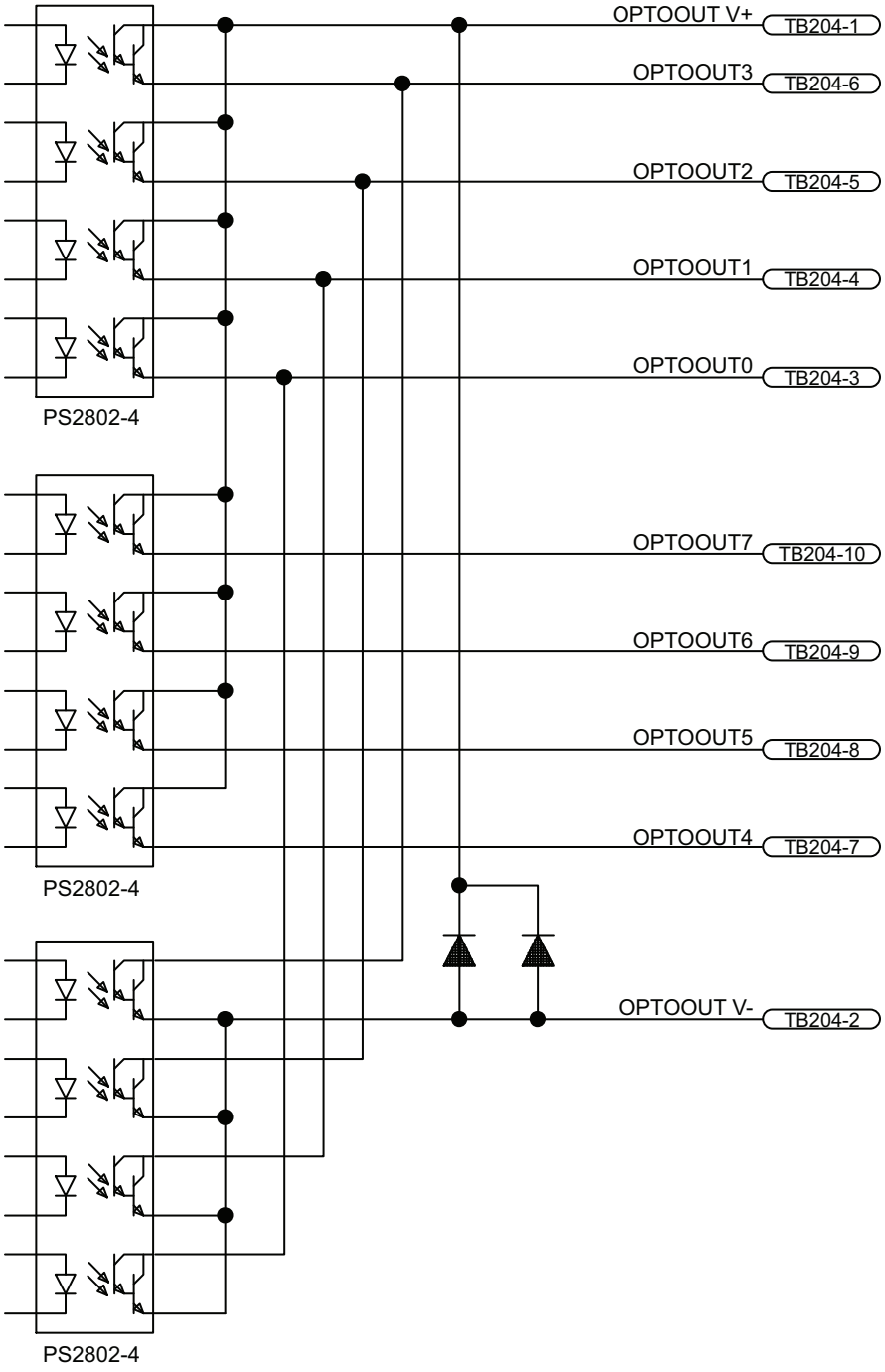



**Figure 3-9: Opto-Isolated Outputs (-IO Board)**

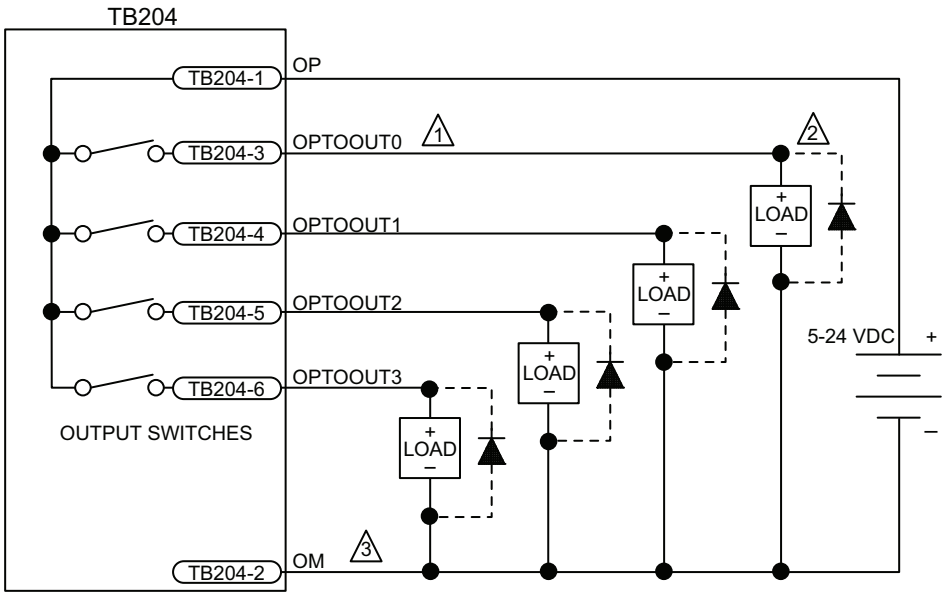


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**Table 3-15: Output Specifications (TB204)**

| PS2802-4 Opto Device Specifications | Value |
|---|---|
| Maximum Voltage | 24 V maximum |
| Maximum Sink/Source Current | 80 mA/channel @ 20°C; 60 mA/channel @ 50°C |
| Output Saturation Voltage | 2.75 V at maximum current |
| Output Resistance | 33 Ω |
| Rise / Fall Time | 250 usec (typical) |
| Maximum Output Frequency | 1 kHz |

**NOTE:** Outputs must be connected as all sourcing or all sinking.




1 EACH OUTPUT 80 mA MAXIMUM

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

3 CONNECTION REQUIRED TO MINIMIZE GLITCHING

**Figure 3-10: Outputs Connected in Current Sourcing Mode**



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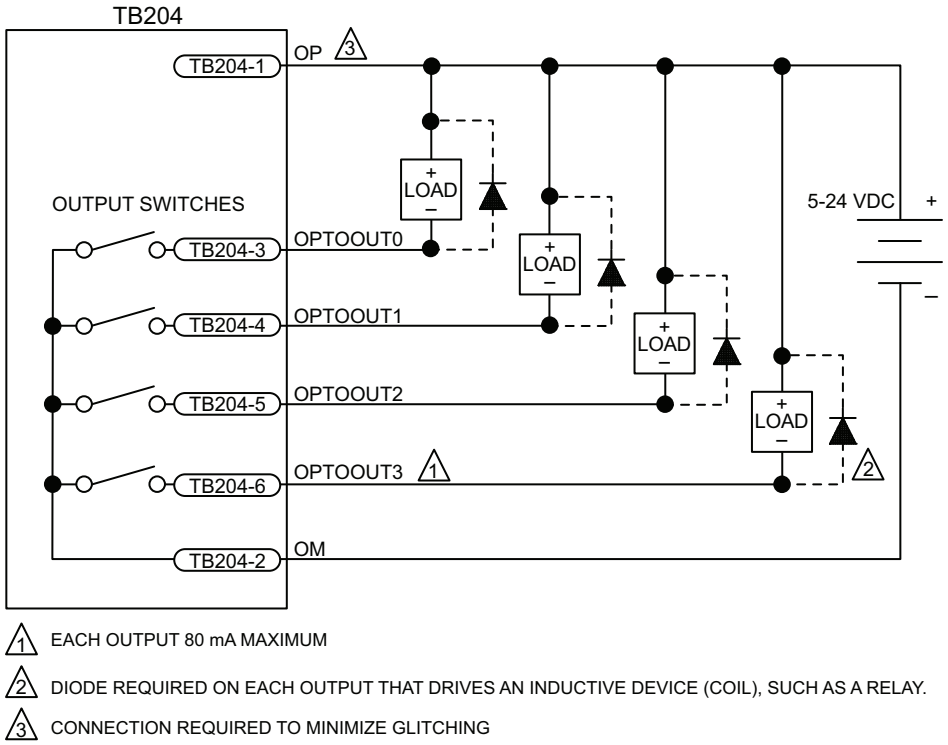



**Figure 3-11: Outputs Connected in Current Sinking Mode**

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). See Figure 3-11 for an example of a current sinking output with diode suppression and Figure 3-10 for an example of a current sourcing output with diode suppression.



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## 3.7. Auxiliary Encoder Channel/PSO Output (J201)

The auxiliary encoder interface accepts a 5 VDC RS-422 differential quadrature line driver signal. It accepts a 10 MHz (max) encoder signal frequency (25 nsec minimum edge separation), producing 40 million counts per second, after times four (x4) quadrature decoding.

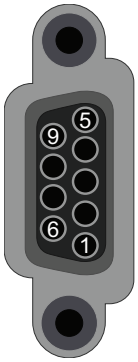
This encoder channel can be used as an input for master/slave operation (handwheel) or for dual feedback systems. The auxiliary encoder interface does not support analog encoders and cannot be used as an input for the -MXU option.

The auxiliary encoder channel can also be used to echo the standard encoder signals or as the PSO output. Configuring the PSO hardware will automatically configure this encoder channel as an output (refer to Section 3.7.1.) and will remove the 180 ohm terminator resistors.

**NOTE:** Use the EncoderDivider parameter to configure the bi-directional encoder interface on the auxiliary I/O connector. The EncoderDivider parameter converts the auxiliary encoder interface to an output and defines a divisor for the encoder echo. Refer to the Soloist Help file for more information.

**NOTE:** You cannot echo the standard encoder signals on the MP with the -MXU option.

**Table 3-16: Auxiliary Encoder Channel Pin Assignment (J201)**

| Pin# | Description | In/Out/Bi | Connector |
|---|---|---|---|
| 1 | Auxiliary RS-422 Marker Pulse - / PSO Output (1) | Bidirectional |  |
| 2 | Auxiliary RS-422 Encoder Cosine + | Bidirectional | |
| 3 | Auxiliary RS-422 Encoder Cosine - | Bidirectional | |
| 4 | Auxiliary RS-422 Encoder Sine + | Bidirectional | |
| 5 | Encoder Cable Shield | N/A | |
| 6 | Auxiliary RS-422 Marker Pulse +/ PSO Output (1) | Bidirectional | |
| 7 | Encoder +5 Volt Power | Output | |
| 8 | Encoder Power Common | N/A | |
| 9 | Auxiliary RS-422 Encoder Sine - | Bidirectional | |



(1) For PSO, see Section 3.7.1.

| J201 Adapter Cable Assembly | Aerotech P.N. (1) | Third Party P.N. |
|---|---|---|
| 9 Pin Standard D-style | C20931 | N/A |
| 25 Pin Standard D-style | C20932 | N/A |
| Flying Leads | ECZ01343 | Molex 83421-9042 |

(1) See the cable drawings on your software CD ROM



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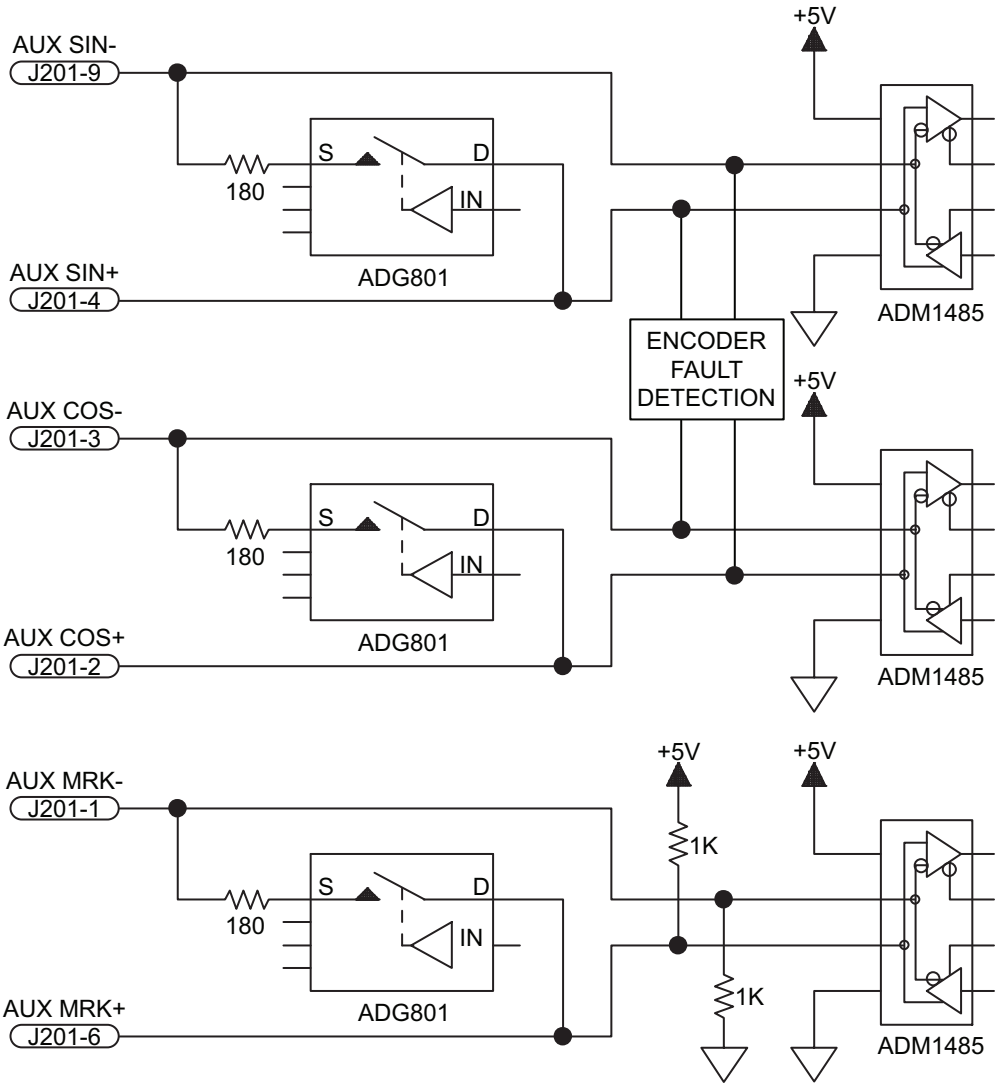



**Figure 3-12: Auxiliary Encoder Channel (J201)**



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### 3.7.1. Position Synchronized Output (PSO)/Laser Firing (J201)

The Soloist MP includes a Position Synchronized Output (PSO) feature. The PSO output is available on the dual function AUXMRK± differential signal lines (use of an RS-422 line receiver or opto-isolator is recommended). The auxiliary marker must be configured as an output using the PSOOUTPUT CONTROL command, see the Soloist Help file for specific details.

The PSO can be programmed to generate an output synchronized to the encoder position, typically used to fire a laser or sequence an external device. Trigger signals may be derived from the standard encoder channel, auxiliary encoder channel, or a software trigger. The synchronized output pulse is generated using high-speed hardware, allowing minimal latency (200 nanoseconds) between the trigger condition and the output.

The Soloist MP provides only single-axis laser firing.

**NOTE:** When using the MRK± signals with single-ended systems, **do not** connect MRK+ or MRK- to GROUND (GND).

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

The PSO can track an encoder with a maximum data (count) rate of 16.7 MHz (single axis tracking). Signals in excess of this rate will cause a loss of PSO accuracy.

Multi-axis PSO can track encoder signals with a maximum data rate of 8.33 MHz. Signals in excess of this rate will cause a loss of PSO accuracy. Software controlled PSO pre-scalars may be used to limit the data rate of each encoder being tracked without affecting the servo loop data rate.

**Table 3-17: PSO Output Pin Assignment (J201)**

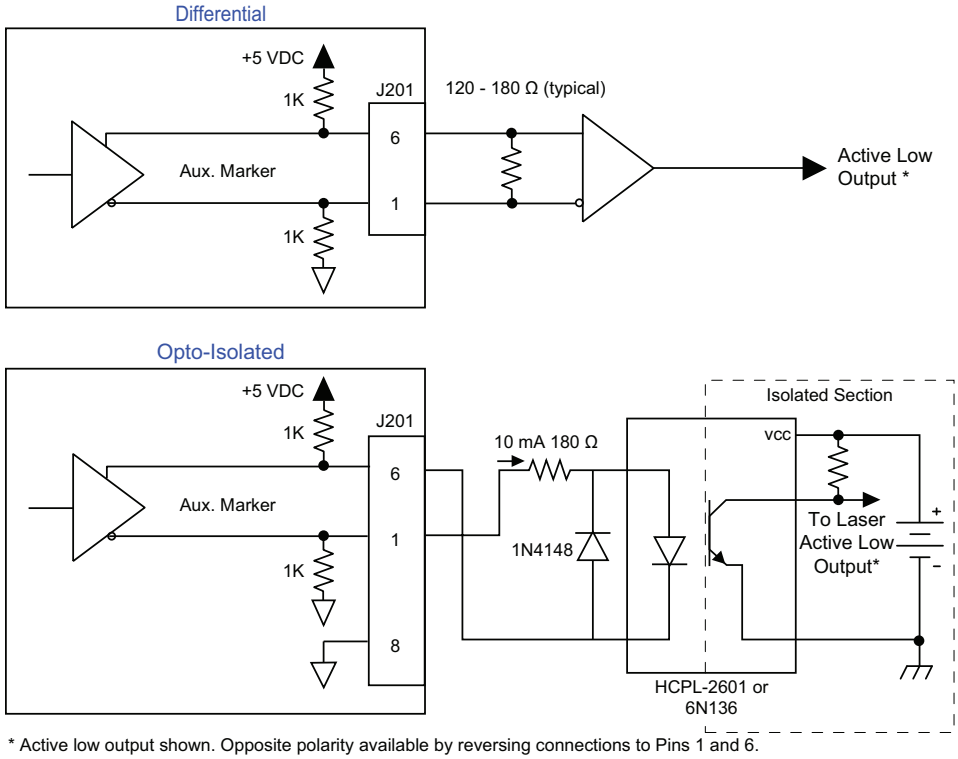
| Pin# | Description | In/Out/Bi |
|---|---|---|
| 1 | Auxiliary RS-422 Marker Pulse - / PSO Output (1) | Bidirectional |
| 6 | Auxiliary RS-422 Marker Pulse +/ PSO Output (1) | Bidirectional |
| 8 | Encoder Power Common | N/A |
| (1) For PSO, see Section 3.7.1. | | |

**Table 3-18: PSO Output Sources**

| PSO Output Type | Max Frequency | See Also |
|---|---|---|
| RS-422 Marker (1) | 12.5 MHz | Section 3.7. |
| (1) software configurable as the PSO output or Marker input Refer to the Soloist Help File for programming information. | | |



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* Active low output shown. Opposite polarity available by reversing connections to Pins 1 and 6.

**Figure 3-13: PSO Interface**



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# Chapter 4: Standard Interconnection Cables

**NOTE:** A complete list of Aerotech cables can be found on the website at http://www.aerotechmotioncontrol.com/manuals/index.aspx.

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

| Cable Part # | Description |
|---|---|
| Joystick | See Section 4.1. |
| ECZ01231 | BBA32 Interconnect Cable |
| (1) The “-xx” indicates length in decimeters. “-yy” would indicate length in feet. | |



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## 4.1. Joystick Interface

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.

Refer to the Soloist Help file for programming information about how to change joystick parameters (see the Joystick.ab example). The following drawings illustrate how to connect a single- or two-axis joystick (a two-axis joystick requires two Soloist MPs). For cable details refer to Table 4-2.

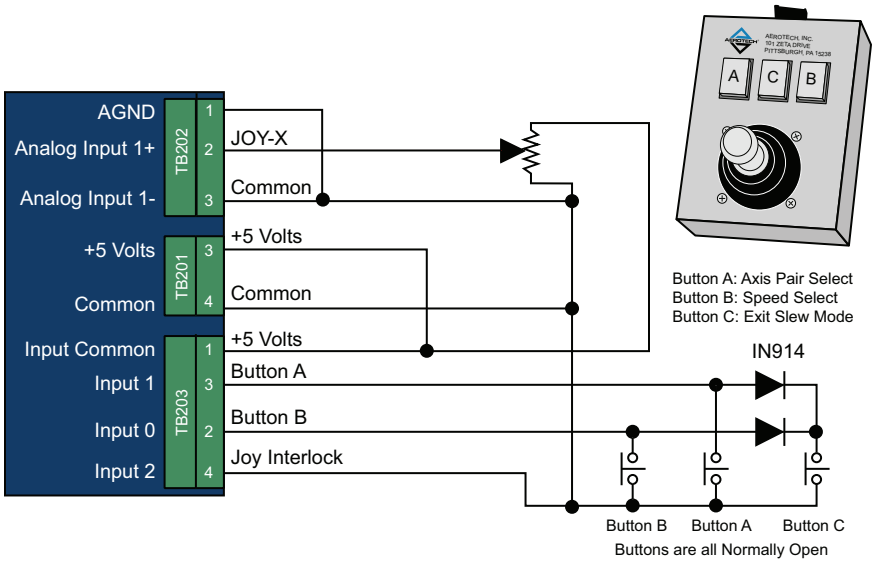



**Figure 4-1: Single Axis Joystick Interface**



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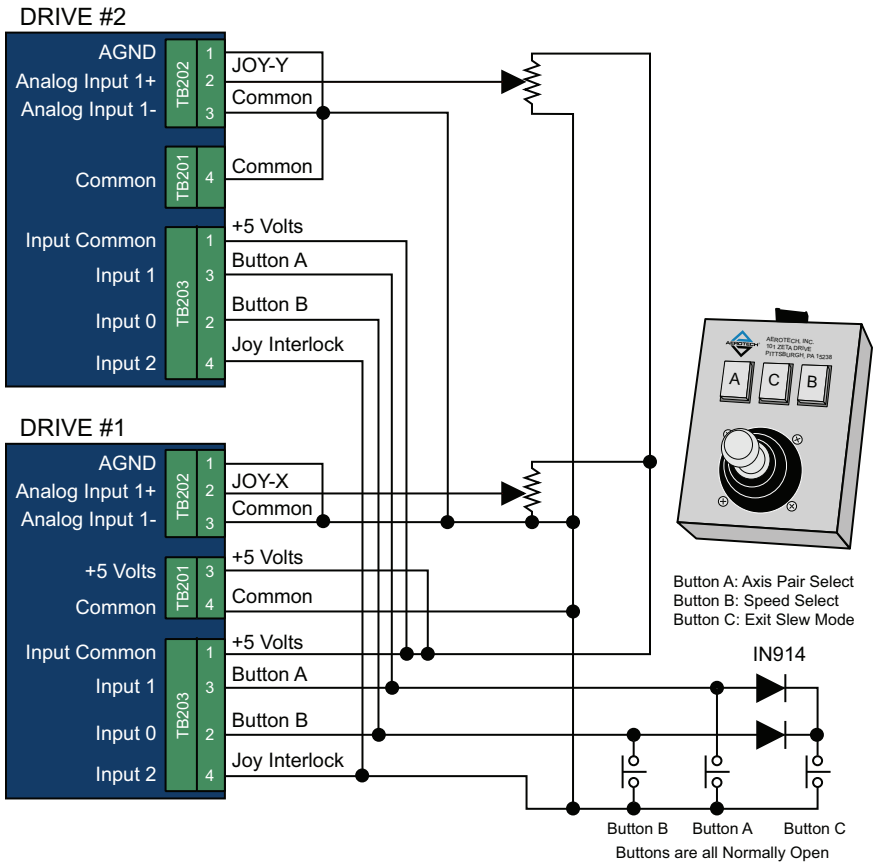



**Figure 4-2: Two Axis Joystick Interface**

**Table 4-2: Cable Part Numbers**

| Part # | Cable Description | UPC # |
|---|---|---|
| C22761-XX | JSXT-FLY-15DU-MAX300DM SOLOISTMP/ML SINGLE AXIS | 630B2276-1 |
| C22762-XX | JSXT-FLY FLY-15DU-MAX300DM SOLOISTMP/ML DUAL AXIS | 630B2276-2 |



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## 4.2. Handwheel Interface

A handwheel (such as the Aerotech HW-xxx-xx) can be used to manually control axis position. The handwheel must provide 5V differential quadrature signals to the Soloist MP.

A handwheel can be connected to the Aux I/O as shown in Figure 4-3.

**NOTE:** See the Soloist Help file for information on enabling the handwheel.

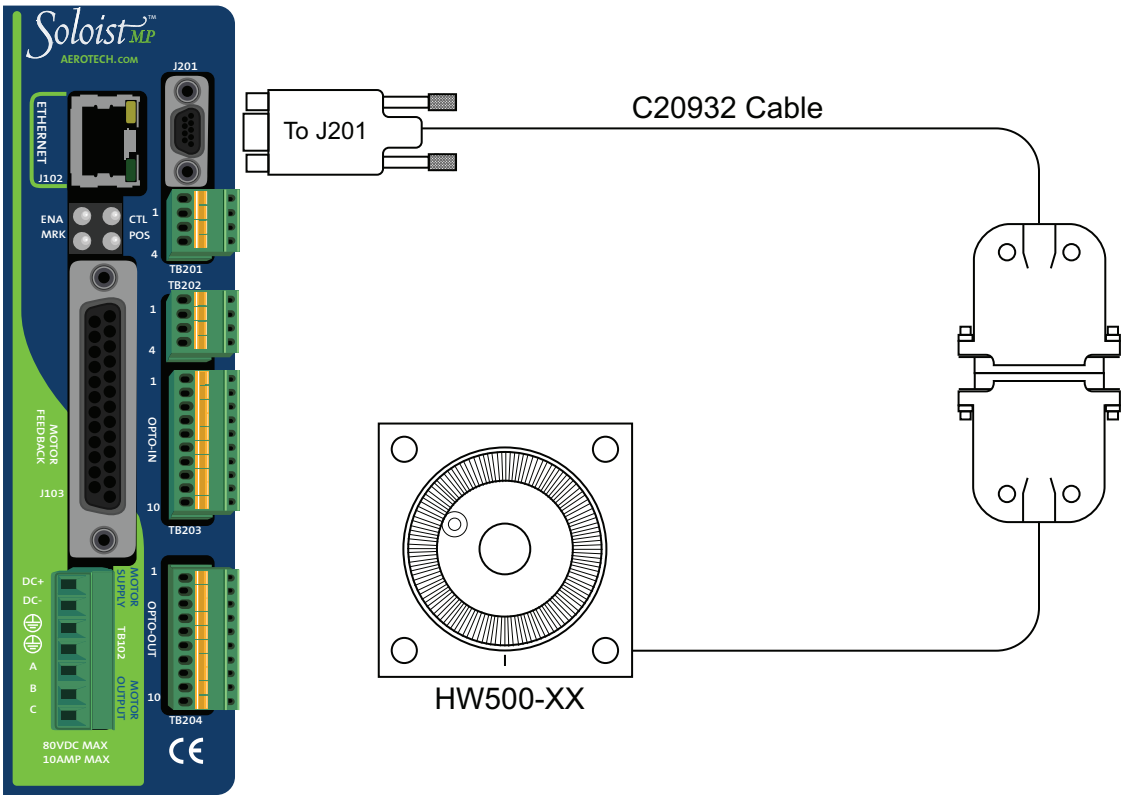



**Figure 4-3: Handwheel Interconnection (to Aux I/O)**



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# Chapter 5: Maintenance

This section covers the internal boards, important board components, and how to clean the drive. Troubleshooting is covered in-depth in the Soloist Help file.



**DANGER:** Always disconnect the Mains power connection before opening the Soloist MP 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.

**Table 5-1: LED Description**

| LED | Description |
|---|---|
| ENB/FLT | Turns green to indicate that the axis is enabled. Turns red to indicate a fault condition. The ENB/FLT LED will flash between RED and GREEN if the drive is enabled and in a fault condition. |
| MARKER | Turns green to indicate that the marker input is high. |
| CTL* | Turns green when power is applied. |
| POS | Turns green to indicate that the axis is in position. |
| * If the power light flashes continuously and the unit does not operate, there is too much current draw from the 5V power supply or the control supply voltage level is low. | |



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## 5.1. Control Board

The figure below highlights the important components located on the control board.

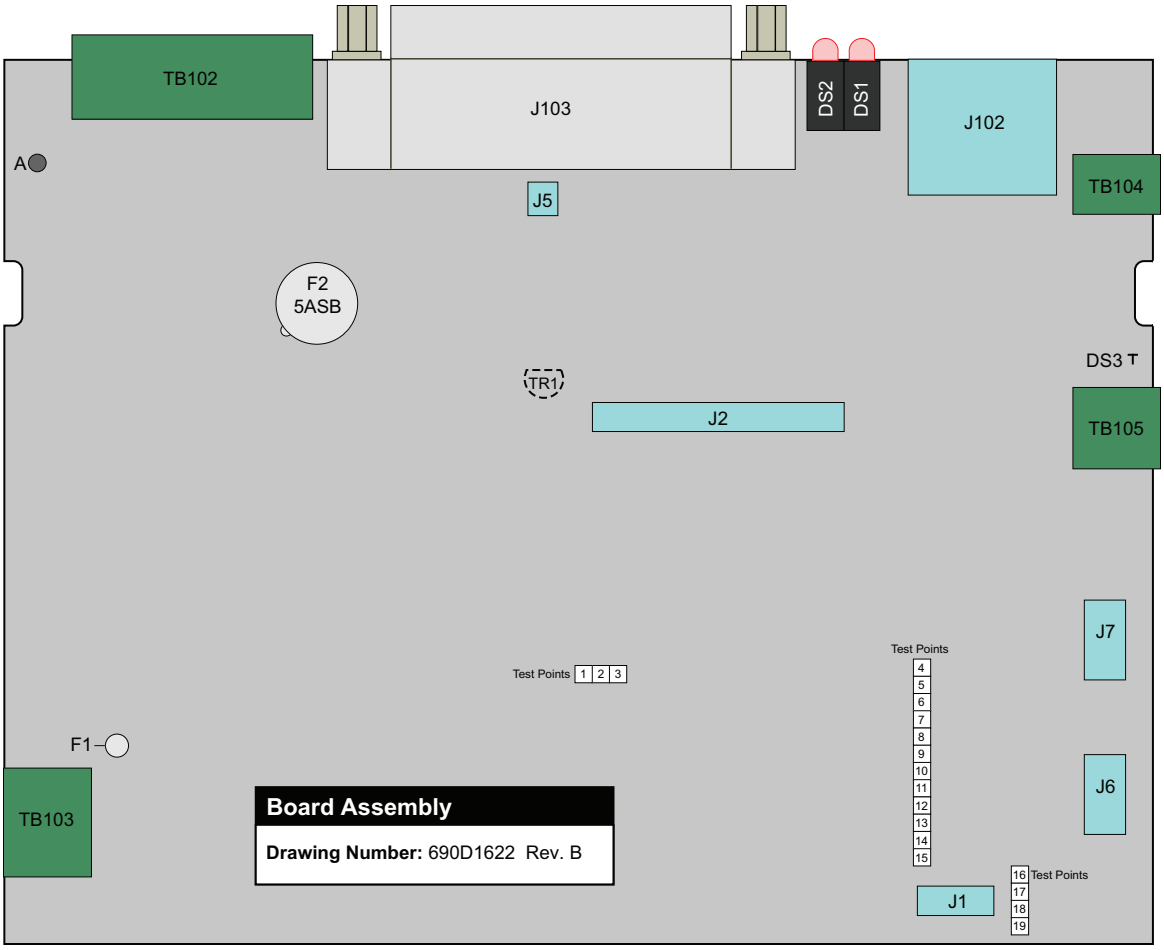



**Figure 5-1: Control Board Assembly**

**DANGER:** Always disconnect the Mains power connection before opening the Soloist MP chassis.



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**Table 5-2: Control Board Fuse Information**

| Fuse | Description | Size | Aerotech P/N | Manufacturer's P/N |
|---|---|---|---|---|
| F1 | Control Power at TB103-1 | 2 A S.B. | EIF00136 | LittelFuse 255002 |
| F2 | Bus Power at TB102-1 | 5 A S.B. (5 mm) | EIF00179 | Wickman 1951500 |
| Note: F1 is soldered to the circuit board. | | | | |

**Table 5-3: LED Description**

| LED | Description |
|---|---|
| ENB/FLT | Turns green to indicate that the axis is enabled. Turns red to indicate a fault condition. The ENB/FLT LED will flash between RED and GREEN if the drive is enabled and in a fault condition. |
| MARKER | Turns green to indicate that the marker input is high. |
| CTL* | Turns green when power is applied. |
| POS | Turns green to indicate that the axis is in position. |
| * If the power light flashes continuously and the unit does not operate, there is too much current draw from the 5V power supply or the control supply voltage level is low. | |



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## 5.2. Preventative Maintenance

The Soloist MP and external wiring should be inspected monthly. Inspections may be required at more frequent intervals, depending on the environment and use of the system.



**DANGER:** To minimize the possibility of bodily injury or death, disconnect all electrical power prior to performing any maintenance or making adjustments to the equipment.

**Table 5-4: Preventative Maintenance**

| Check | Action to be Taken |
|---|---|
| Visually Check chassis for loose or damaged parts / hardware.<br>**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 Soloist MP. |
| Visually inspect all cables and connections. | Tighten or re-secure any loose connections. Replace worn or frayed cables. Replace broken connectors. |

### Cleaning

The Soloist MP 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 Soloist MP 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 Soloist MP while cleaning. Do not allow cleaning substances or other fluids to enter the Soloist MP 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 http://www.aerotech.com/service-and-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.



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## 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.<br>Global Headquarters<br>Phone: +1-412-967-6440<br>Fax: +1-412-967-6870 | Aerotech China<br>Full-Service Subsidiary<br>Phone: +86 (21) 3319 7715 | Aerotech Germany<br>Full-Service Subsidiary<br>Phone: +49 (0)911 967 9370<br>Fax: +49 (0)911 967 93720 |

| JAPAN | TAIWAN | UNITED KINGDOM |
|---|---|---|
| Aerotech Japan<br>Full-Service Subsidiary<br>Phone: +81 (0)50 5830 6814<br>Fax: +81 (0)43 306 3773 | Aerotech Taiwan<br>Full-Service Subsidiary<br>Phone: +886 (0)2 8751 6690 | Aerotech United Kingdom<br>Full-Service Subsidiary<br>Phone: +44 (0)1256 855055<br>Fax: +44 (0)1256 855649 |

Have your customer order number ready before calling.



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# Appendix B: Revision History

| Revision | Date | Description |
|---|---|---|
| 4.08.00 | July 9, 2015 | • Updated the Electrical Specifications (Input Power and related equation): Section 1.2.<br>• Updated PSO maximum frequency specification:Table 3-18 |
| 4.07.00 | March 31, 2015 | Added RoHS statement to Declaration of Conformity |
| 4.06.00 | April 22, 2014 | Added TUV certification information: Agency Approvals |
| 4.05.00 | September 7, 2012 | Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support. |
| 4.04.00 | May 09, 2011 | |
| 4.03.00 | July 01, 2010 | |
| 4.02.00 | April 23, 2010 | |
| 4.01.00 | December 01, 2009 | |
| 4.00.00 | September 03, 2009 | |
| 2.02.00 | September 18, 2008 | |
| 2.01.00 | August 19, 2008 | |
| 2.00.00 | September 04, 2007 | |
| 1.01 | July 24, 2006 | |
| 1.00a | May 08, 2005 | |
| Prelim | December 05, 2005 | |



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