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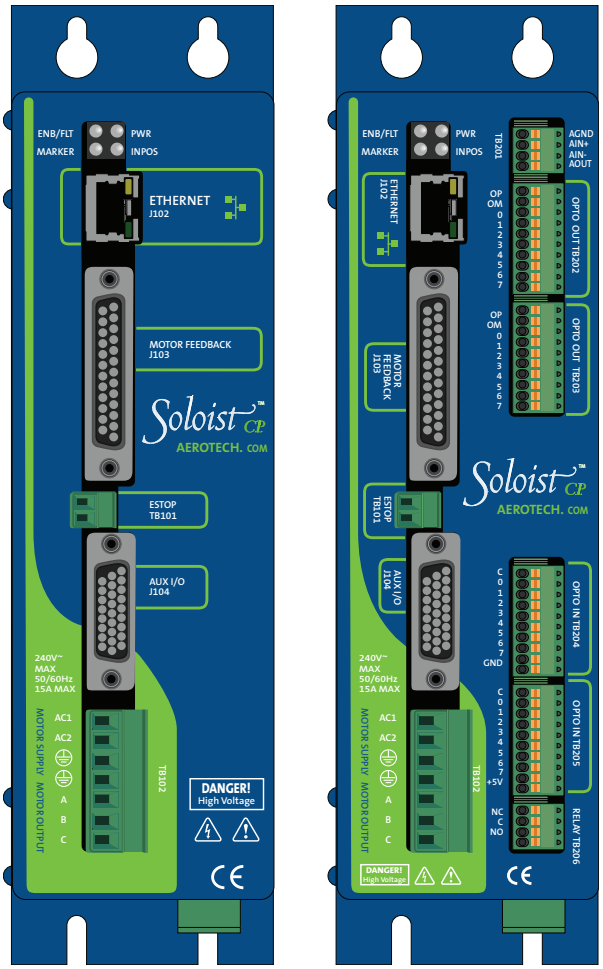
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Soloist CP
Hardware Manual

P/N: EDU180
Revision: 4.05.00



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Table of Contents

Table of Contents ... iii
List of Figures ... v
List of Tables ... vii

EC Declaration of Conformity ... ix

Agency Approvals ... x

Safety Procedures and Warnings ... xi

Quick Installation Guide ... xiii

Chapter 1: Introduction ... 1
1.1. Drive and Software Compatibility ... 5
1.2. Electrical Specifications ... 6
1.2.1. System Power Requirements ... 7
1.2.2. Power Dissipation ... 8
1.3. Mechanical Design ... 9
1.4. Environmental Specifications ... 10

Chapter 2: Installation and Configuration ... 11
2.1. Power Connections ... 11
2.1.1. Control Supply Connections (TB106) ... 12
2.1.2. Motor Supply Connections (TB102) ... 13
2.1.3. Transformer Options ... 14
2.1.4. Minimizing Conducted, Radiated, and System Noise ... 21
2.2. Motor Output Connections ... 22
2.2.1. Brushless Motor Connections ... 23
2.2.1.1. Powered Motor Phasing ... 24
2.2.1.2. Unpowered Motor and Feedback Phasing ... 26
2.2.2. DC Brush Motor Connections ... 29
2.2.2.1. DC Brush Motor Phasing ... 30
2.2.3. Stepper Motor Connections ... 31
2.2.3.1. Stepper Motor Phasing ... 32
2.3. Motor Feedback Connections (J103) ... 33
2.3.1. Encoder Interface (J103) ... 34
2.3.1.1. RS-422 Line Driver Encoder (Standard) ... 35
2.3.1.2. EnDat Encoder Interface (J103) ... 36
2.3.1.3. Resolute Encoder Interface (J103) ... 37
2.3.1.4. Analog Encoder Interface ... 38
2.3.1.5. Encoder Phasing ... 40
2.3.2. Hall-Effect Interface (J103) ... 42
2.3.3. Thermistor Interface (J103) ... 43
2.3.4. Encoder Fault Interface (J103) ... 44
2.3.5. End Of Travel Limit Input Interface (J103) ... 45
2.3.5.1. End Of Travel Limit Phasing ... 47
2.3.6. Brake Output (J103) ... 48
2.4. Emergency Stop Sense Input (TB101) ... 49
2.4.1. Typical ESTOP Interface ... 50
2.5. Auxiliary I/O Connector (J104) ... 51
2.5.1. Auxiliary Encoder Channel (J104) ... 52
2.5.2. Position Synchronized Output (PSO)/Laser Firing (J104) ... 54
2.5.3. Opto-Isolated Outputs (J104) ... 56
2.5.4. Opto-Isolated Inputs (J104) ... 58
2.5.5. High Speed User Inputs 4-5 (J104) ... 60

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2.5.6. Analog Output 0 (J104) 61
2.5.7. Analog Input 0 (J104) 62
2.6. Brake Power Supply (TB103) 63
2.6.1. Solid State Relay Specifications (TB103) 66
2.7. RS-232 Interface (TB103) 67
2.8. -EXTSHUNT Option (TB104) 68
2.9. PC Configuration and Operation Information 71

Chapter 3: -I/O Expansion Board 73
3.1. Analog Output (TB201) 74
3.2. Analog Input (TB201) 75
3.3. Opto-Isolated Inputs (TB204, TB205) 76
3.4. Opto-Isolated Outputs (TB202, TB203) 79
3.5. User Power (TB204, TB205) 83
3.6. Brake / Mechanical Relay (TB206) 84
3.6.1. Brake Configuration Jumpers 84
3.6.2. Mechanical Relay Specifications 84
3.6.3. Brake / Mechanical Relay Interface Connector 85

Chapter 4: Standard Interconnection Cables 87
4.1. Joystick Interface 88
4.2. Handwheel Interface 91

Chapter 5: Maintenance 93
5.1. Control Board 94
5.2. Preventative Maintenance 96

Appendix A: Warranty and Field Service 97

Appendix B: Revision History 99

Index 101

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

List of Figures

Figure 1-1: Soloist CP Networked Digital Drive 1
Figure 1-2: Functional Diagram 4
Figure 1-3: Power Dissipation vs. Output Current 8
Figure 1-4: Ambient Temperature vs. Power Dissipation 8
Figure 1-5: Dimensions 9
Figure 2-1: Control Supply Connections 12
Figure 2-2: Motor Bus Input Connections 13
Figure 2-3: Transformer Examples 14
Figure 2-4: 40 VDC Motor Power with a TV0.3-28-56-ST Transformer 15
Figure 2-5: 80 VDC Motor Power with a TV0.3-28-56-ST Transformer 16
Figure 2-6: 40 Volt DC Bus from 115 and 230 VAC Source 17
Figure 2-7: 80 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 18
Figure 2-8: 160 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 19
Figure 2-9: Control and Motor Power Wiring using a TM3 or TM5 Transformer 20
Figure 2-10: AC Line Filter (UFM-ST) 21
Figure 2-11: Brushless Motor Configuration 23
Figure 2-12: Encoder and Hall Signal Diagnostics 25
Figure 2-13: Motor Phasing Oscilloscope Example 26
Figure 2-14: Hall Phasing with Oscilloscope 27
Figure 2-15: Brushless Motor Phasing Goal 28
Figure 2-16: DC Brush Motor Configuration 29
Figure 2-17: Clockwise Motor Rotation 30
Figure 2-18: Stepper Motor Configuration 31
Figure 2-19: Clockwise Motor Rotation 32
Figure 2-20: Line Driver Encoder Interface (J103) 35
Figure 2-21: Serial Data Stream Interface 36
Figure 2-22: Serial Data Stream Interface 37
Figure 2-23: Analog Encoder Phasing Reference Diagram 38
Figure 2-24: Analog Encoder Interface (J103) 39
Figure 2-25: Encoder Phasing Reference Diagram (Standard) 40
Figure 2-26: Position Feedback in the Diagnostic Display 41
Figure 2-27: Hall-Effect Inputs (J103) 42
Figure 2-28: Thermistor Interface Input (J103) 43
Figure 2-29: Encoder Fault Interface Input (J103) 44
Figure 2-30: End of Travel Limit Input Connections 45
Figure 2-31: End of Travel Limit Interface Input (J103) 46
Figure 2-32: Limit Input Diagnostic Display 47
Figure 2-33: ESTOP Sense Input (TB101) 49
Figure 2-34: Typical Emergency Stop Circuit 50
Figure 2-35: Auxiliary Encoder Channel (J104) 53
Figure 2-36: PSO Interface 55
Figure 2-37: Outputs Connected in Current Sinking Mode (J104) 57
Figure 2-38: Outputs Connected in Current Sourcing Mode (J104) 57
Figure 2-39: Inputs Connected in Current Sinking Mode (J104) 59
Figure 2-40: Inputs Connected in Current Sourcing Mode (J104) 59
Figure 2-41: High Speed User Inputs (J104) 60
Figure 2-42: Analog Output 0 (J104) 61
Figure 2-43: Analog Input 0 (J104) 62
Figure 2-44: Brake Connected to J103 64
Figure 2-45: Brake Connected to TB103 65
Figure 2-46: RS-232 Interface (TB103) 67

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Figure 3-1: Soloist CP with -IO Option Board 73
Figure 3-2: Analog Output 1 Connector (TB201) 74
Figure 3-3: Analog Input Typical Connection (TB201) 75
Figure 3-4: Opto-Isolated Inputs 77
Figure 3-5: Inputs Connected to a Current Sourcing Device 78
Figure 3-6: Inputs Connected to a Current Sinking Device 78
Figure 3-7: Opto-Isolated Outputs (-IO Board) 80
Figure 3-8: Outputs Connected in Current Sourcing Mode 81
Figure 3-9: Outputs Connected in Current Sinking Mode 82
Figure 3-10: Brake Connected to J103 85
Figure 3-11: Brake Connected to TB206 86
Figure 4-1: Single Axis Joystick Interface (to Aux I/O) 88
Figure 4-2: Two Axis Joystick Interface (to the Aux I/O of two drives) 89
Figure 4-3: Two Axis Joystick Interface (to the Aux I/O and I/O Board) 89
Figure 4-4: Two Axis Joystick Interface (to the I/O board of two drives) 90
Figure 4-5: Handwheel Interconnection (to Aux I/O) 91
Figure 4-6: Handwheel Interconnection (to Aux I/O via a BBA32 Module) 91
Figure 5-1: Control Board Assembly 94

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List of Tables

Table 1-1: Feature Summary 2
Table 1-2: Accessories 3
Table 1-3: Soloist Drive and Software Compatibility 5
Table 1-4: Electrical Specifications 6
Table 1-5: Physical Specifications 9
Table 1-6: Heat Sink Specifications 9
Table 2-1: Control Supply AC Input Wiring 12
Table 2-2: Control Supply Mating Connector 12
Table 2-3: Motor Supply Mating Connector 13
Table 2-4: Nominal Motor Operating Voltages / Required AC Voltages 14
Table 2-5: Transformer Options 14
Table 2-6: Motor Supply Input Wiring 21
Table 2-7: UFM-ST Electrical Specifications 21
Table 2-8: Motor Power Output Connections (TB102) 22
Table 2-9: Motor Power Output Mating Connector 22
Table 2-10: Wire Colors for Aerotech Supplied Cables (Brushless) 23
Table 2-11: Wire Colors for Aerotech Supplied Cables (DC Brush) 29
Table 2-12: Wire Colors for Aerotech Supplied Cables (Stepper) 31
Table 2-13: Motor Feedback Connector Pin Assignment (J103) 33
Table 2-14: Encoder Interface Pin Assignment 34
Table 2-15: Analog Encoder Specifications 38
Table 2-16: Hall-Effect Feedback Interface Pin Assignment (J103) 42
Table 2-17: Hall-Effect Feedback Interface Pin Assignment (J103) 43
Table 2-18: Encoder Fault Interface Pin Assignment (J103) 44
Table 2-19: End of Travel Limit Input Interface Pin Assignment (J103) 45
Table 2-20: Brake Output Pin Assignment (J103) 48
Table 2-21: Electrical Noise Suppression Devices 49
Table 2-22: Electrical Noise Suppression Devices 49
Table 2-23: TB101 Mating Connector 49
Table 2-24: Typical ESTOP Relay Ratings 50
Table 2-25: Auxiliary I/O Connector Pin Assignment (J104) 51
Table 2-26: Auxiliary Encoder Channel Pin Assignment (J104) 52
Table 2-27: PSO Output Pin Assignment (J104) 54
Table 2-28: PSO Output Sources 54
Table 2-29: Port 0 Digital Output Connector Pin Assignment (J104) 56
Table 2-30: Digital Output Specifications 56
Table 2-31: Port 0 Digital Input Connector Pin Assignment (J104) 58
Table 2-32: PS2806-4 Opto-Device Specifications 58
Table 2-33: Port 0 High Speed Digital Input Connector Pin Assignment (J104) 60
Table 2-34: Input Voltage Jumper Configuration 60
Table 2-35: Analog Output Connector Pin Assignment (J104) 61
Table 2-36: Analog Input Connector Pin Assignment (J104) 62
Table 2-37: Brake Output Connector Pin Assignment (TB103) 63
Table 2-38: Mating Connector (TB103) 63
Table 2-39: Brake Output Connector Pin Assignment (J103) 63
Table 2-40: Relay Specifications 66
Table 2-41: RS-232 Connector Pin Assignment (TB103) 67
Table 2-42: RS-232 Port Connector Mating Connector (TB103) 67
Table 2-43: Recommended Shunt Resistors and Wire Gauge 68
Table 2-44: External Shunt Mating Connector 68
Table 2-45: Maximum Storage Energy 69

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Table 3-1: -IO Expansion Board Jumper Configuration 73
Table 3-2: -IO Option Board Fuse Information 73
Table 3-3: Analog Output Connector Pin Assignment (TB201) 74
Table 3-4: Analog Output Mating Connector 74
Table 3-5: Analog Inputs Connector Pin Assignment (TB201) 75
Table 3-6: Analog Input Mating Connector 75
Table 3-7: PS2806-4 Opto-Device Specifications 76
Table 3-8: Port 1 Opto-Isolated Input Connector Pin Assignment (TB204) 76
Table 3-9: Port 2 Opto-Isolated Input Connector Pin Assignment (TB205) 76
Table 3-10: Opto-Isolated Input Mating Connector 76
Table 3-11: Port 1 Opto-Isolated Output Connector Pin Assignment (TB202) 79
Table 3-12: Port 2 Opto-Isolated Output Connector Pin Assignment (TB203) 79
Table 3-13: Opto-Isolated Output Mating Connector 79
Table 3-14: Output Specifications (TB202, TB203) 81
Table 3-15: User Common Connector Pin Assignment (TB204) 83
Table 3-16: +5 Volt Power Connector Pin Assignment (TB205) 83
Table 3-17: -IO Expansion Board Brake Jumper Configuration 84
Table 3-18: Voltage and Current Specifications (TB206) 84
Table 3-19: Brake / Mechanical Relay Connector Pin Assignment (TB206) 85
Table 3-20: Mating Connector 85
Table 3-21: Brake / Mechanical Relay Connector Pin Assignment (J103) 85
Table 4-1: Standard Interconnection Cables 87
Table 4-2: Cable Part Numbers 90
Table 5-1: LED Description 93
Table 5-2: Control Board Jumper Configuration 95
Table 5-3: Control Board Fuse Information 95
Table 5-4: LED Description 95
Table 5-5: Preventative Maintenance 96

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EC Declaration of Conformity

Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238-2897 USA
Product	Soloist CP
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 CP 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 CP 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 CP 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 CP 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 CP 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 CP to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
5. If the Soloist CP is used in a manner not specified by the manufacturer, the protection provided by the Soloist CP 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 CP is intended for light industrial manufacturing or laboratory use. Use of the Soloist CP 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 CP. 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.

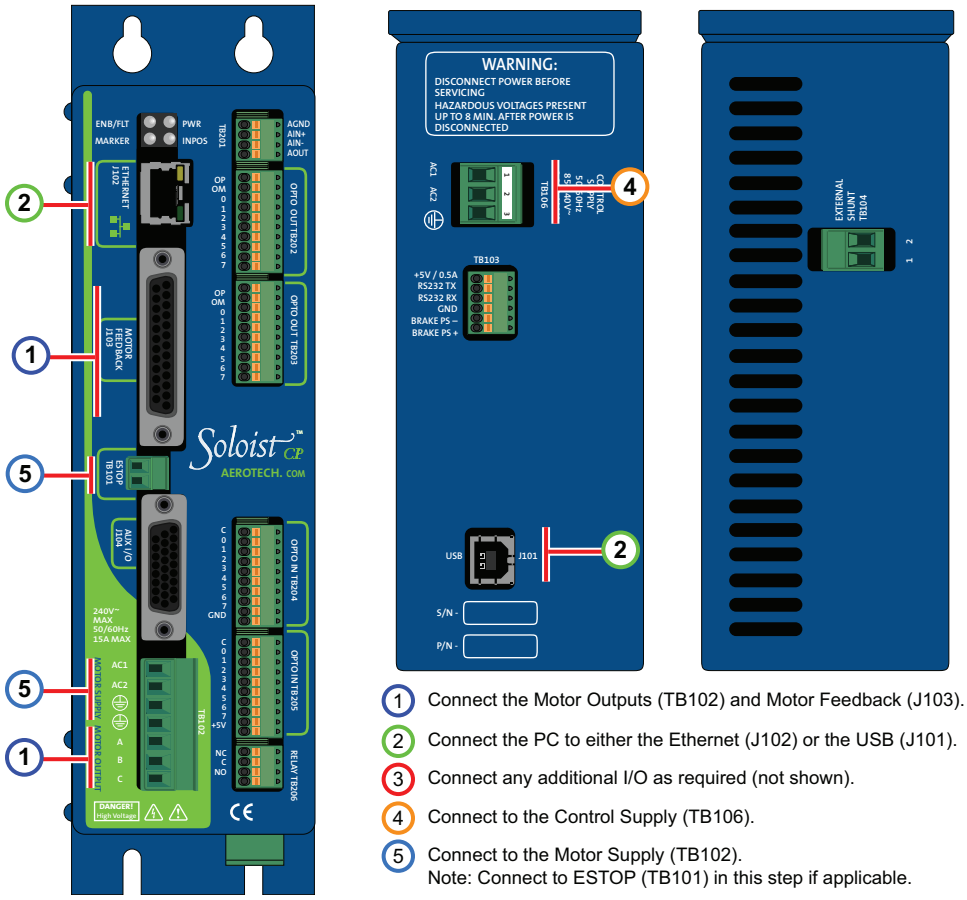


Figure 1: Quick Start Connections

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 (TB106)
Motor Supply	Section 2.1.2. Motor Supply Connections (TB102)
Additional I/O	User / Application dependent

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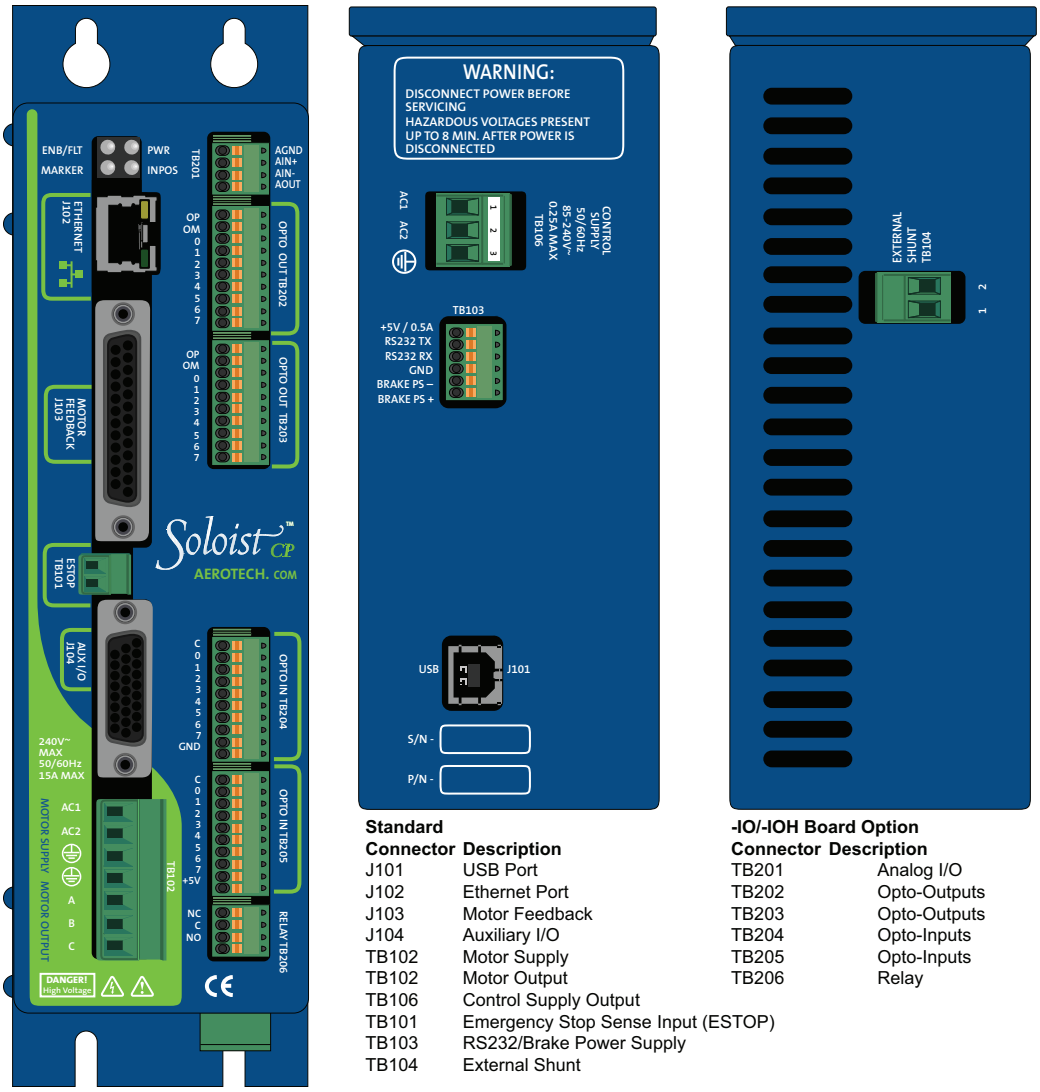
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Chapter 1: Introduction

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

Connector	Description
J101	USB Port
J102	Ethernet Port
J103	Motor Feedback
J104	Auxiliary I/O
TB102	Motor Supply
TB102	Motor Output
TB106	Control Supply Output
TB101	Emergency Stop Sense Input (ESTOP)
TB103	RS232/Brake Power Supply
TB104	External Shunt

-IO/-IOH Board Option

Connector	Description
TB201	Analog I/O
TB202	Opto-Outputs
TB203	Opto-Outputs
TB204	Opto-Inputs
TB205	Opto-Inputs
TB206	Relay

Figure 1-1: Soloist CP 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 • Line driver square wave auxiliary quadrature encoder input or output for PSO • Four opto-isolated user outputs • Six opto-isolated user inputs (two high speed) • One 16-bit differential analog input (± 10 V) • One 16-bit analog output (±10 V) • Dedicated 5-24 V Emergency Stop sense input • 85 - 240 VAC control supply inputs • One fail-safe brake • Single axis Position Synchronized Output (PSO) • Absolute Encoder support • Calibration (refer to the Soloist Help file for more information) • Camming (refer to the Soloist Help file for more information) • 10/100 BASE-T Ethernet port for use with Ethernet I/O modules	
Options	
-S	Internal shunt resistor network (standard on CP 30). A shunt circuit prevents the bus voltage from causing damage to the amplifier (available for high-energy systems). 40 W Continuous; 400 W Peak (5 seconds)
-IO	• One 16-bit analog output (±10 V) • One 12-bit differential analog input • One fail-safe brake or user relay output • 16 optically isolated logic inputs (5 - 24 VDC), may be connected in current sourcing or sinking mode • 16 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
-EXTSHUNT	Connection provided for an external shunt resistor network. A shunt circuit prevents the bus voltage from causing damage to the amplifier (available for high-energy systems).

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Table 1-2: Accessories

Accessories	
UFM-ST	AC Line Filter Module (required for CE compliance; refer to Section 2.1.)
MCK-NDRIVE	Mating connector kit for J103 (J104 mate is always provided)
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
Transformers	
	Refer to Section 2.1.3. for listings, wiring, and specifications
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.

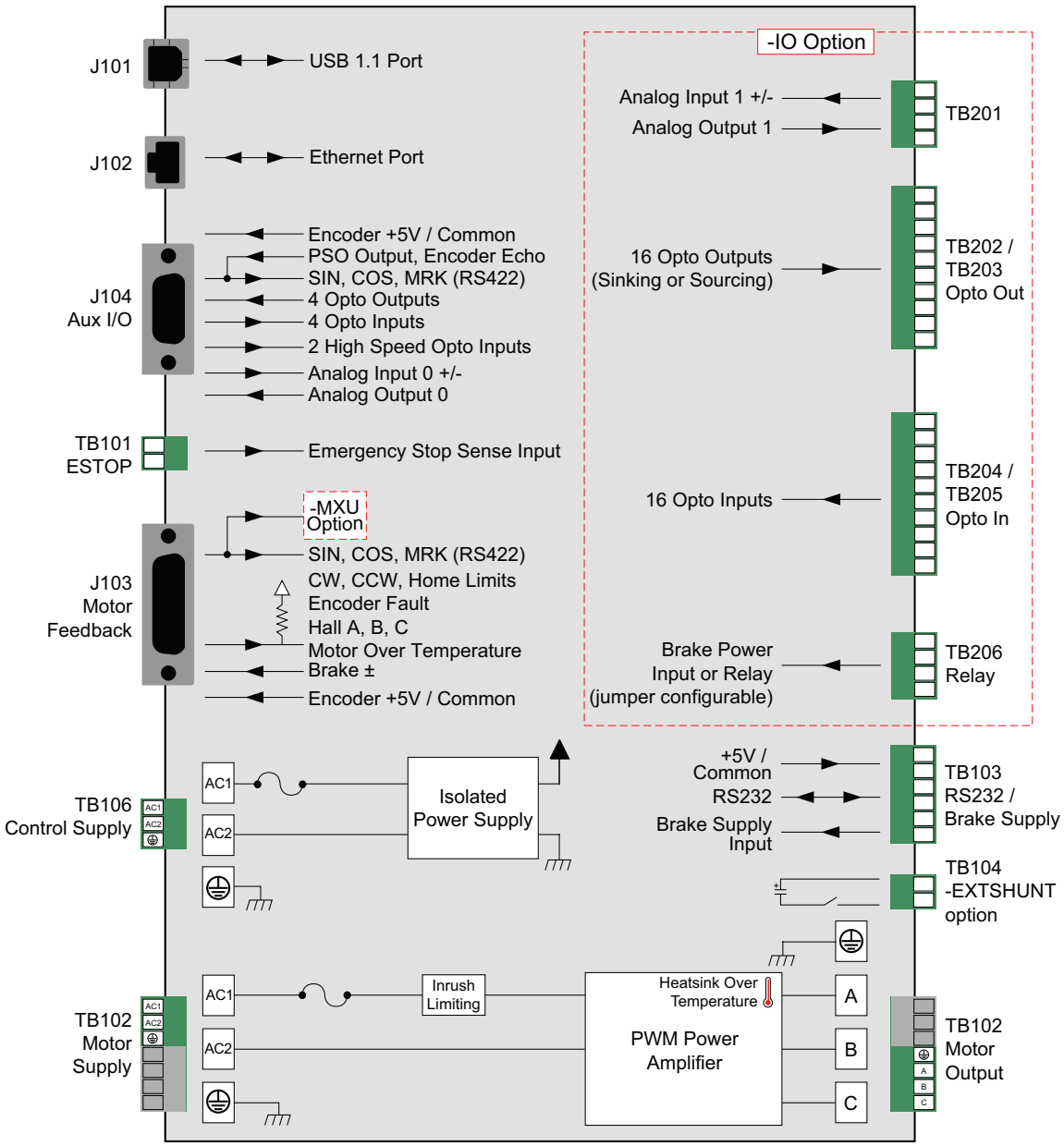


Figure 1-2: Functional Diagram

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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

Description		CP 10	CP 20	CP 30
Motor Supply	Input Voltage	14-240 VAC		
	Input Frequency	50-60 Hz		
	Inrush Current	32 A @ 230 VAC; 16 A @ 115 VAC		
	Maximum Continuous Input Current	5 A_{rms}	10 A_{rms}	10 A_{rms}
	Input Current	Refer to Section 1.2.1. System Power Requirements		
Control Supply	Input Voltage	85-240 VAC		
	Input Frequency	50-60 Hz		
	Inrush Current	26 A		
	Input Current	.25 A max		
Output Voltage (1)		20-340 VDC		
Peak Output Current (1 second)		10 A	20 A	30 A
Continuous Output Current		5 A	10 A	10 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 @ 160 VDC (1 mH @ 320 VDC)		
User Power Supply Output		5 VDC (@ 500 mA)		
Modes of Operation		Brushless; Brush; Stepper		
Protective Features		Output short circuit; Peak over current; DC bus over voltage; 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 CP. Mounting it to a large metal plate for extra heat-sinking and providing additional fan flow are suggested.

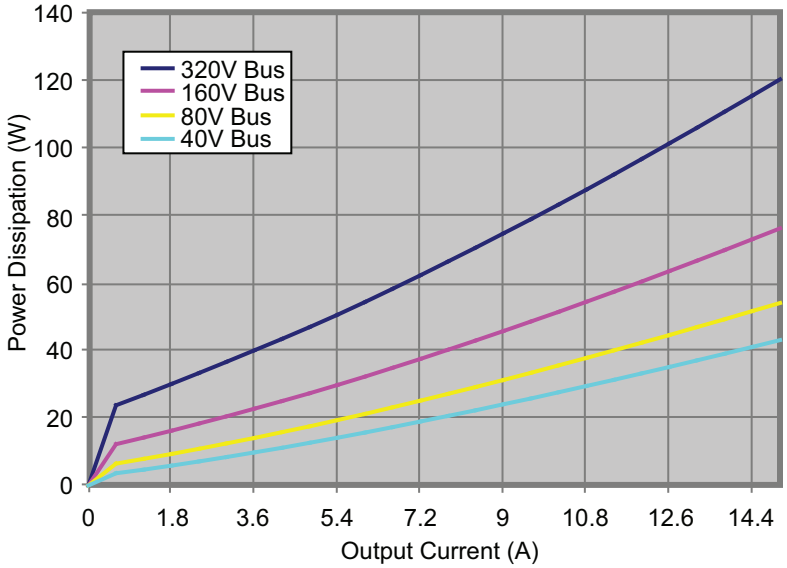


Figure 1-3: Power Dissipation vs. Output Current

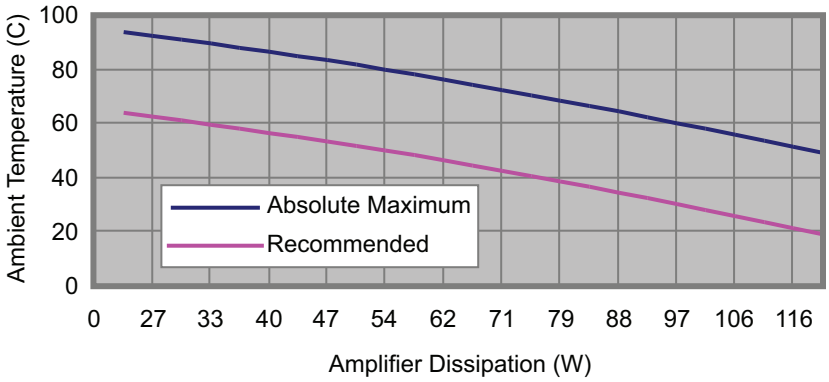


Figure 1-4: Ambient Temperature vs. Power Dissipation

EXAMPLE:

320 VDC Bus operation at 5 A
Power Dissipation = 47 Watts
Maximum Ambient Temperature = 54°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.

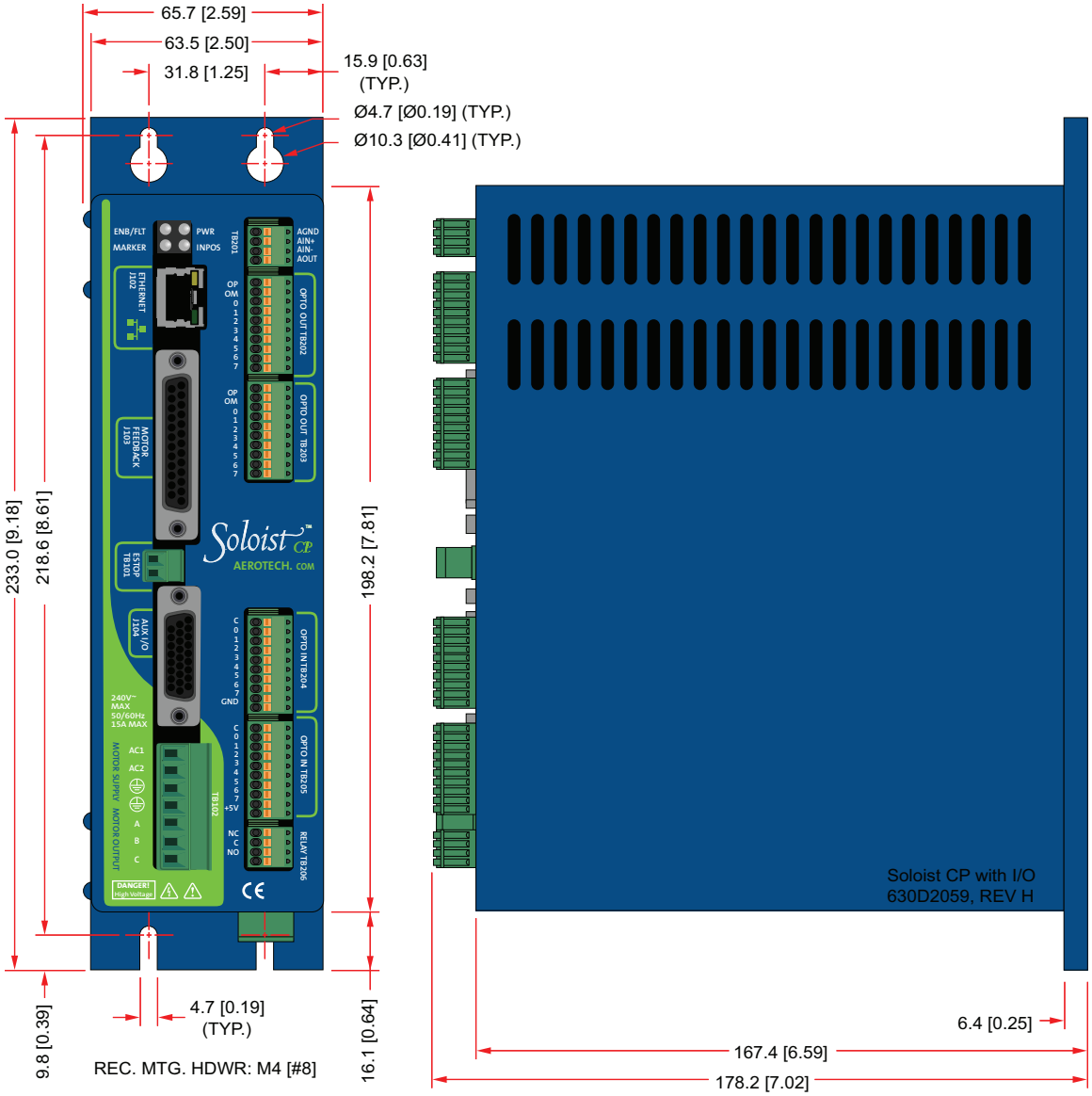


Figure 1-5: Dimensions

Table 1-5: Physical Specifications

	Weight
Standard	1.63 kg (3.6 lb)

Table 1-6: Heat Sink Specifications

Typical Size	304.8 mm x 609.6 mm x 6.4 mm (12 in x 24 in x 0.25 in)

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1.4. Environmental Specifications

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

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

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2.1.1. Control Supply Connections (TB106)

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 CP to maintain communications if the motor power is removed, such as in an Emergency Stop condition. The control power supply requires a minimum of 85 VAC input to operate properly. The AC1 input is internally fused. The AC2 input is not internally fused but can be connected to a voltage source other than Neutral if an external 2 A time-delay fuse is used.

Although the control power supply contains an internal filter, an additional external filter located as close as possible to the Soloist CP may be required for CE compliance (Aerotech recommends Schaffner FN2080 or Aerotech UFM-ST).

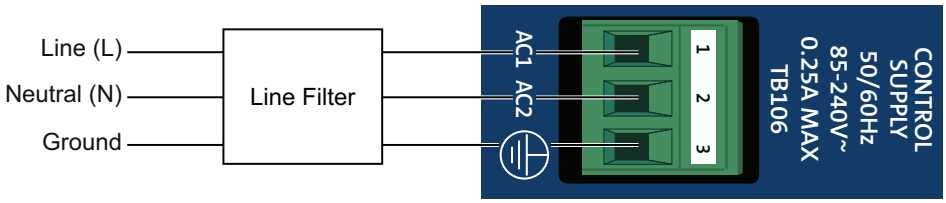


Figure 2-1: Control Supply Connections

Table 2-1: Control Supply AC Input Wiring

Pin	Description	Recommended Wire Size
AC1	Line (L): 85-240 VAC Control Power Input	0.8 mm^2 (#18 AWG)
AC2	Neutral (0V) or 85-240 VAC Control Power Input with external fuse	0.8 mm^2 (#18 AWG)
⏚	Protective Ground (Required for Safety)	0.8 mm^2 (#18 AWG)

Table 2-2: Control Supply Mating Connector

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
3-Pin Terminal Block	ECK00213	1754465	0.5 - 0.6	3.3 - 0.516 [12-30]

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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 CP Motor Supply connector (refer to Figure 2-2 for locations). The AC1 input is internally fused (5A CP10, 10A CP20/30).

External fuses or a circuit breaker (15 A maximum, time delay type) are required for the AC1 and AC2 inputs. The AC2 input can be connected directly to Neutral without a fuse for single phase power systems.

The recommended wire size is 1.3 mm^2 (#16 AWG). The wire must be properly matched to the fuses or circuit breakers and must be sized to meet local electrical safety codes.

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

WARNING: Do not operate the Soloist CP without proper branch protection.

An AC Line Filter may be required for CE compliance and should be located as close as possible to the drive. For more information about the AC Line Filter, refer to Section 2.1.4. Wiring between the filter and drive can be twisted and/or shielded to reduce radiated emissions.

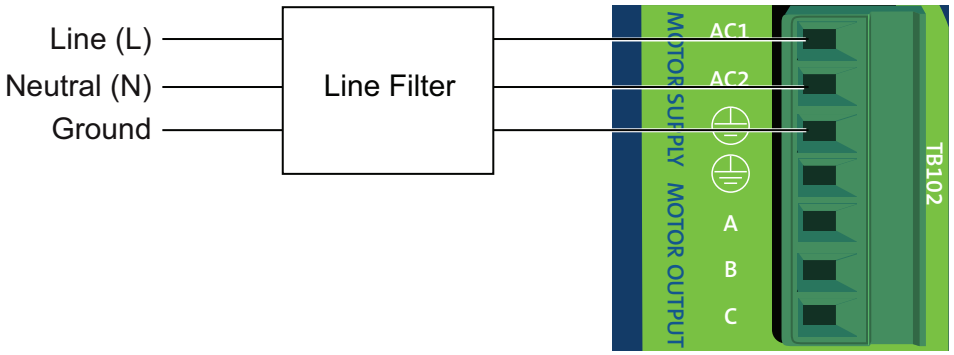


Figure 2-2: Motor Bus Input Connections

Table 2-3: Motor Supply Mating Connector

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
7-Pin Terminal Block	ECK01114	1754546	0.5 - 0.6	3.3 - 0.516 [12-30]

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2.1.3. Transformer Options

An external isolation transformer can be connected to the motor supply AC input. This is done to reduce the operating voltage of the motor and may also reduce electrical noise.

Table 2-4: Nominal Motor Operating Voltages / Required AC Voltages

AC Voltage	DC Voltage
28	40
56	80
115	160
230	320

Table 2-5: Transformer Options

Transformer	Description
TV0.3-28-56-ST	Generate 28 or 56 VAC from 115 VAC or 230 VAC input source voltage. When rectified by the drive, it produces a 40 or 80 VDC power bus.
TM3	Power up to 4 drives, providing 300 watts of power
TM5	Power up to 4 drives providing 500 watts of power
TV0.3-28	Generate 28 VAC from 115 VAC or 230 VAC input source voltage. When rectified by the drive, it produces a 40 VDC power bus.
TV0.3-56	Generate 56 VAC from 115 VAC or 230 VAC input source voltage. When rectified by the drive, it produces an 80 VDC power bus.
TV1.5, TV2.5, or TV5	1.5 kVA, 2.5 kVA, or 5 kVA isolation transformer; 115/230 VAC input; 28, 43, 56, 70, 115 VAC output

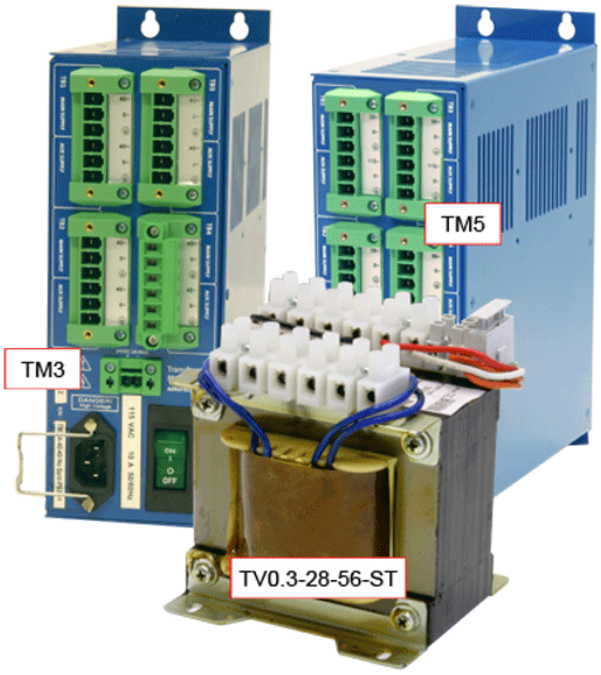


Figure 2-3: Transformer Examples

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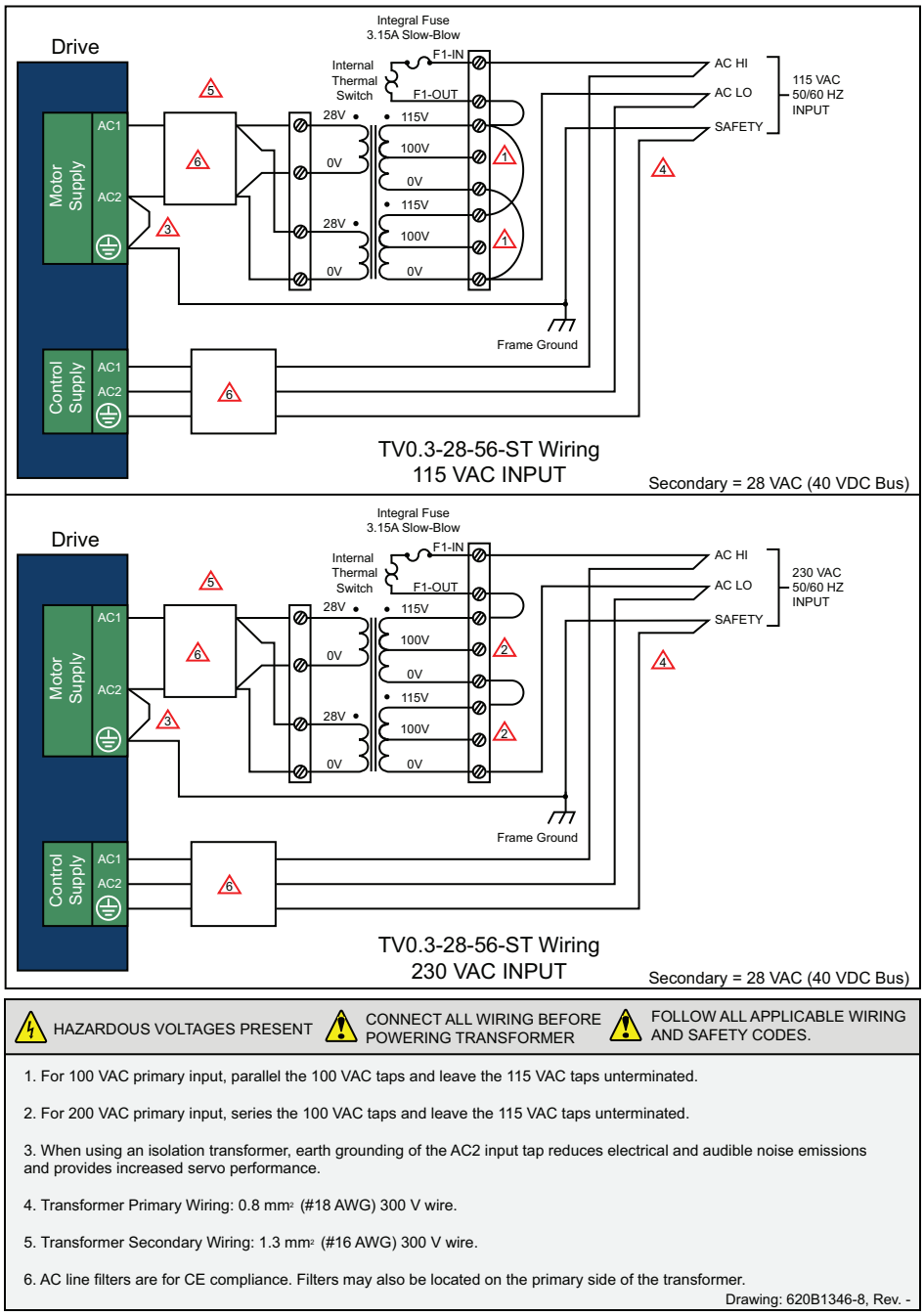


Figure 2-4: 40 VDC Motor Power with a TV0.3-28-56-ST Transformer

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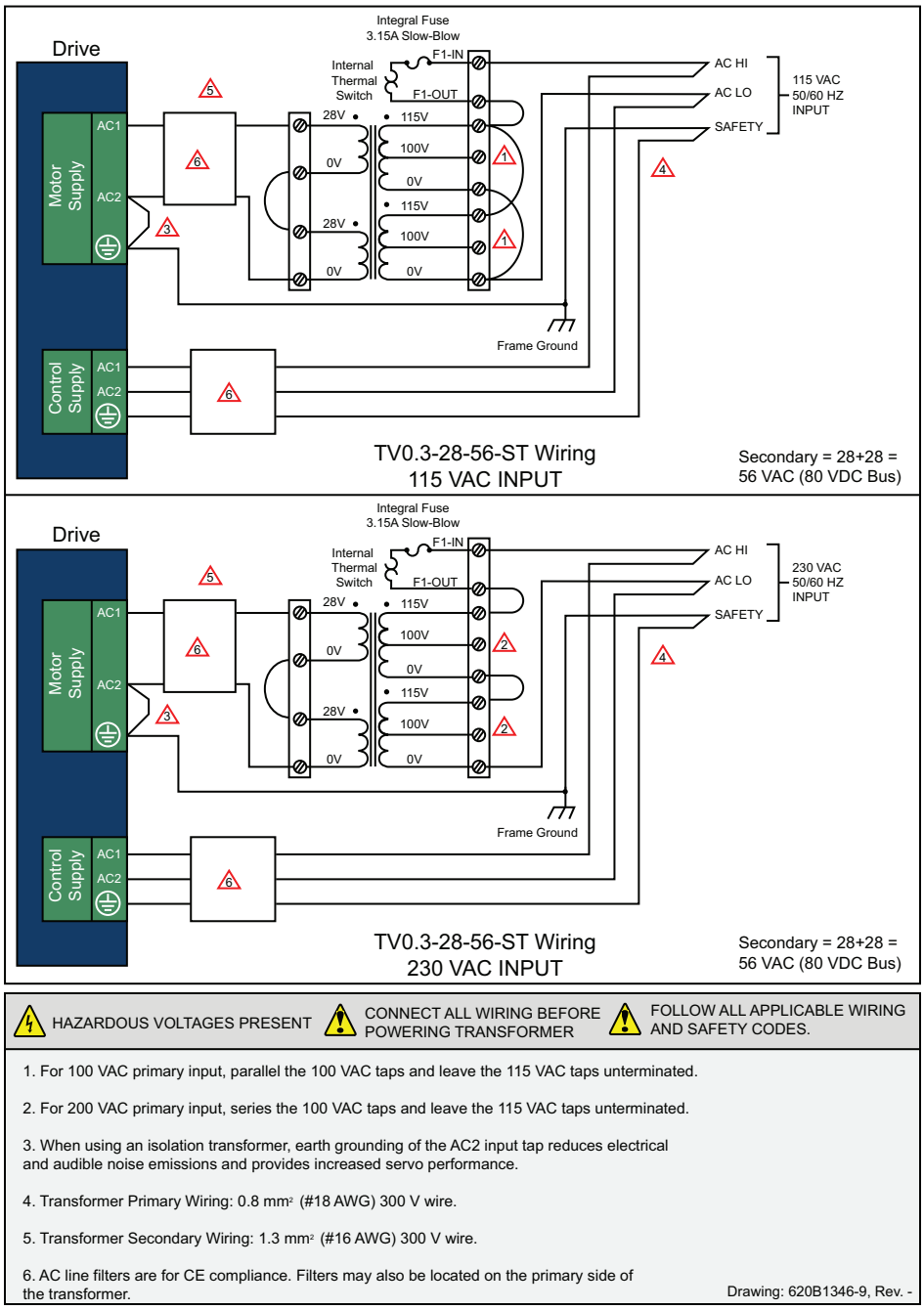


Figure 2-5: 80 VDC Motor Power with a TV0.3-28-56-ST Transformer

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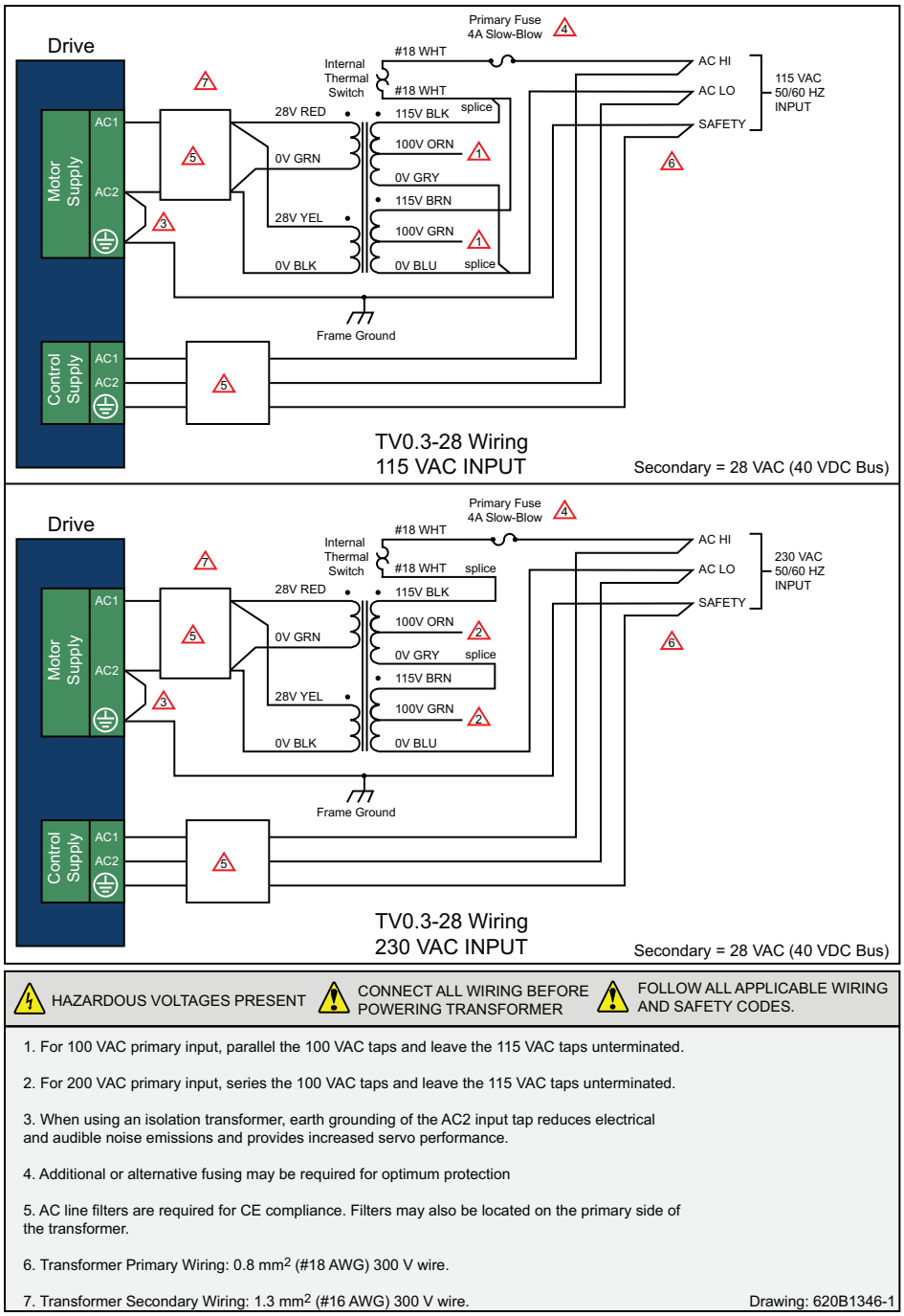
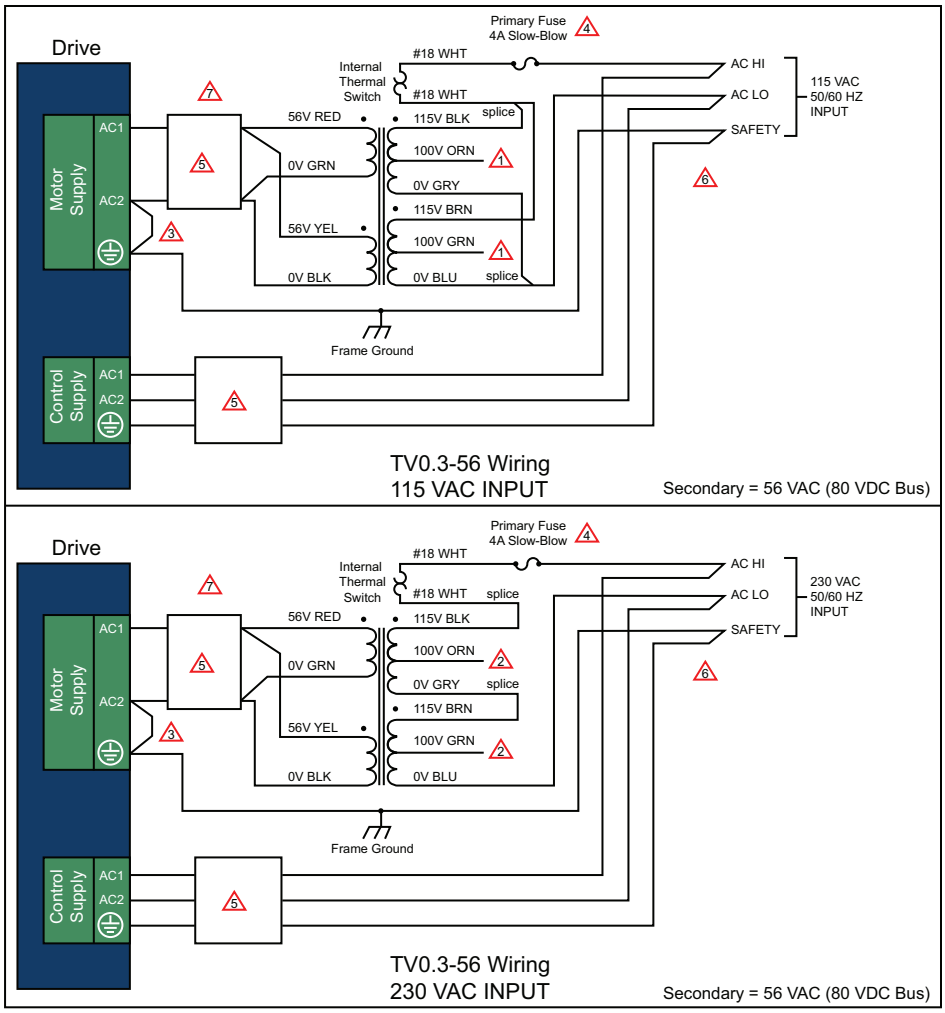


Figure 2-6: 40 Volt DC Bus from 115 and 230 VAC Source

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HAZARDOUS VOLTAGES PRESENT | CONNECT ALL WIRING BEFORE POWERING TRANSFORMER | FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES

1. For 100 VAC primary input, parallel the 100 VAC taps and leave the 115 VAC taps unterminated.

2. For 200 VAC primary input, series the 100 VAC taps and leave the 115 VAC taps unterminated.

3. When using an isolation transformer, earth grounding of the AC2 input tap reduces electrical and audible noise emissions and provides increased servo performance.

4. Additional or alternative fusing may be required for optimum protection

5. AC line filters are required for CE compliance. Filters may also be located on the primary side of the transformer.

6. Transformer Primary Wiring: 0.8 mm^2 (#18 AWG) 300 V wire.

7. Transformer Secondary Wiring: 1.3 mm^2 (#16 AWG) 300 V wire.

Figure 2-7: 80 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56)

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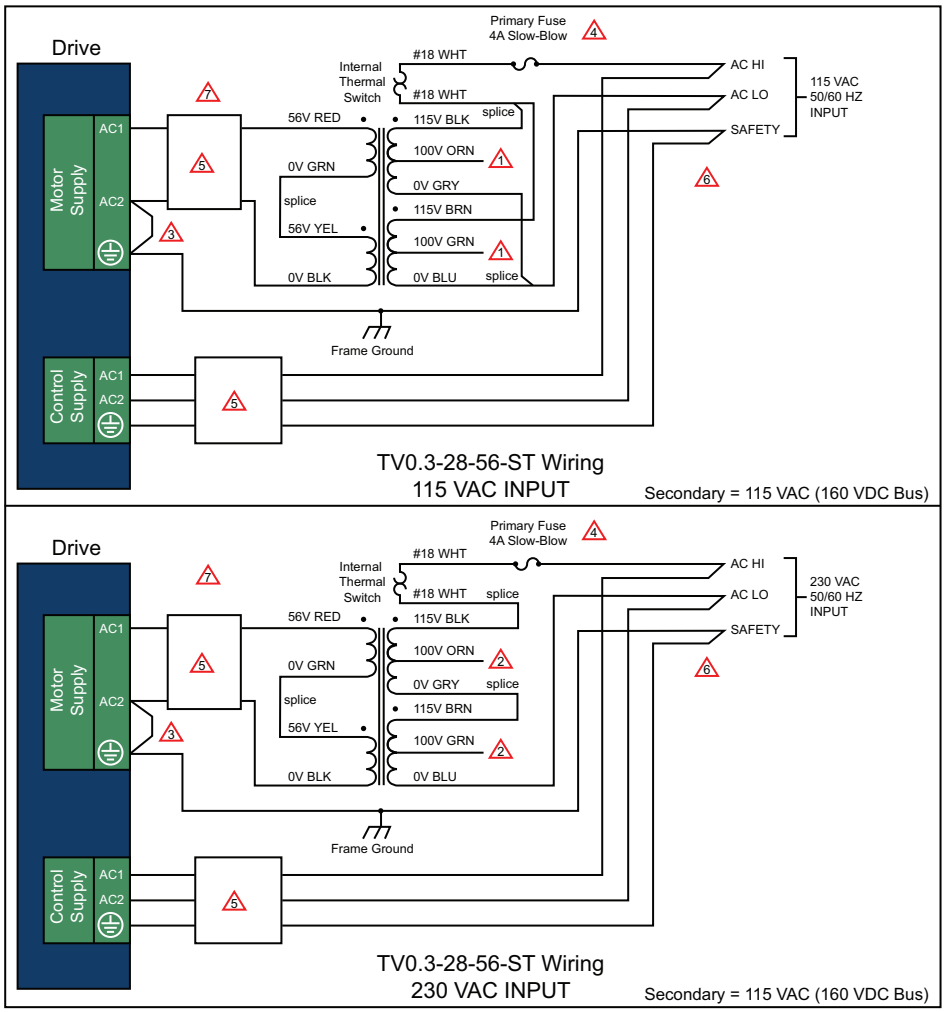
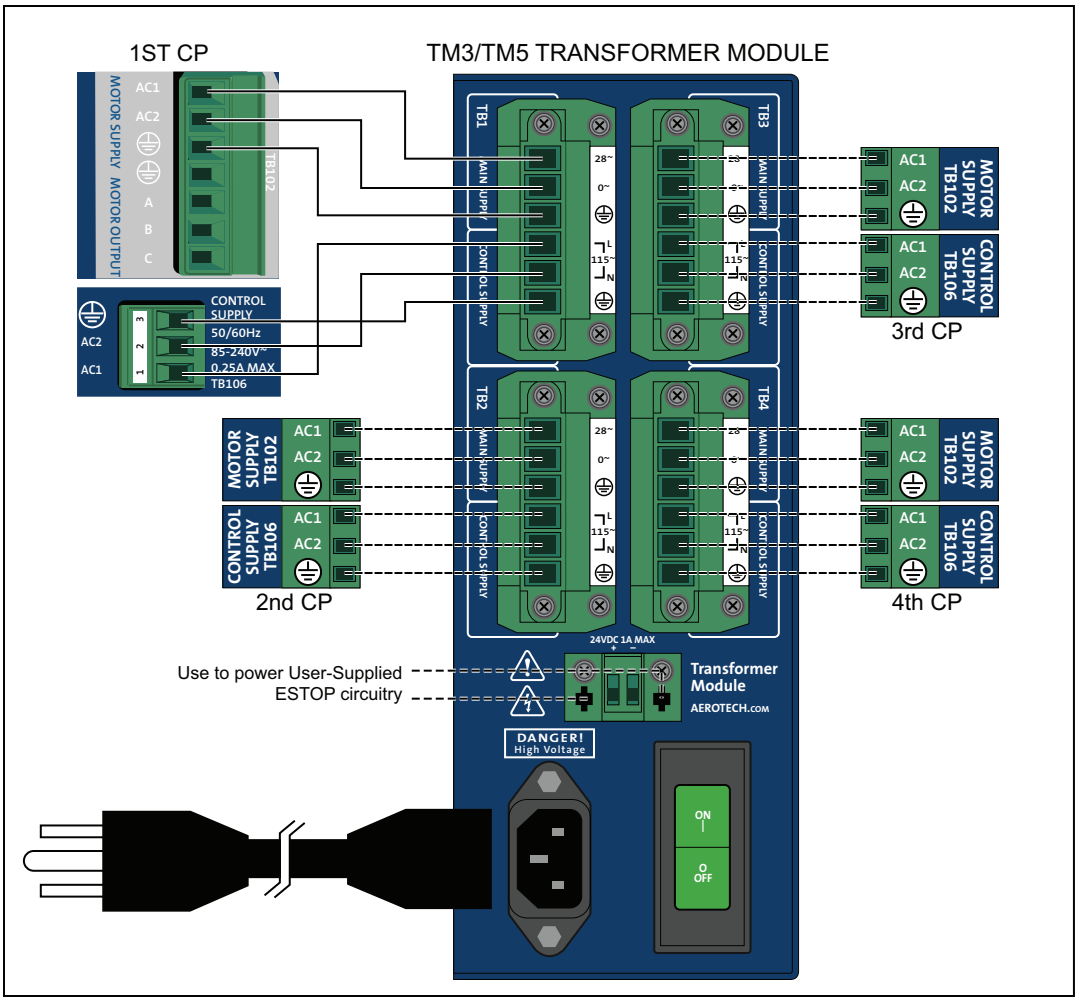


Figure 2-8: 160 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56)

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HAZARDOUS VOLTAGES PRESENT	CONNECT ALL WIRING BEFORE POWERING TRANSFORMER	FOLLOW ALL APPLICABLE WIRING AND SAFETY CODES.

1. See the TM3 or TM5 manual for input voltage configuration
2. Wiring Specifications: 1.3 mm^2 (#16 AWG) 300 V wire.
3. Control Supply output voltage (115 VAC in this example) is always the same as the AC Input Voltage to the unit.

Figure 2-9: Control and Motor Power Wiring using a TM3 or TM5 Transformer

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2.1.4. Minimizing Conducted, Radiated, and System Noise

The Soloist CP 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 CP 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

Aerotech's UFM-ST AC line filter and isolation transformers connected to the motor supply AC input are also effective in reducing PWM generated noise and improving performance (refer to Section 2.1.3.).

Table 2-7: UFM-ST Electrical Specifications

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

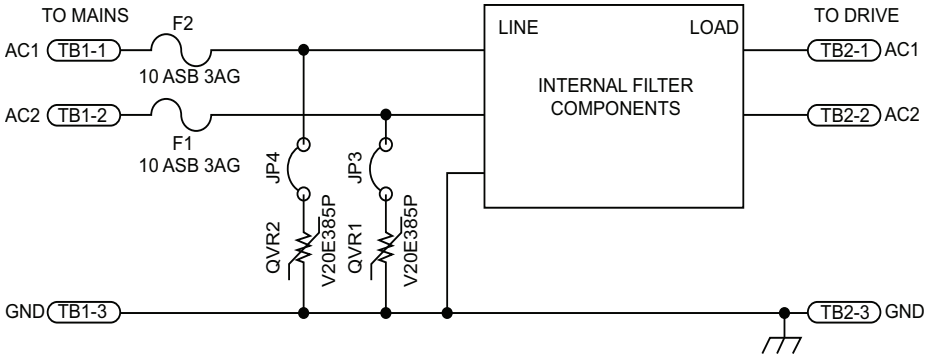


Figure 2-10: AC Line Filter (UFM-ST)

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2.2. Motor Output Connections

The Soloist CP 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 2-8: Motor Power Output Connections (TB102)

Pin	Description	Recommended Wire Size
ØA	Phase A Motor Lead	1.3 mm^2 (#16 AWG)
ØB	Phase B Motor Lead	1.3 mm^2 (#16 AWG)
ØC	Phase C Motor Lead	1.3 mm^2 (#16 AWG)
⏚	Earth Ground to Motor (required for safety)	1.3 mm^2 (#16 AWG)

Table 2-9: Motor Power Output Mating Connector

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
7-Pin Terminal Block	ECK01114	1754546	0.5 - 0.6	3.3 - 0.516 [12-30]

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2.2.1. Brushless Motor Connections

The configuration shown in Figure 2-11 is an example of a typical brushless motor connection.

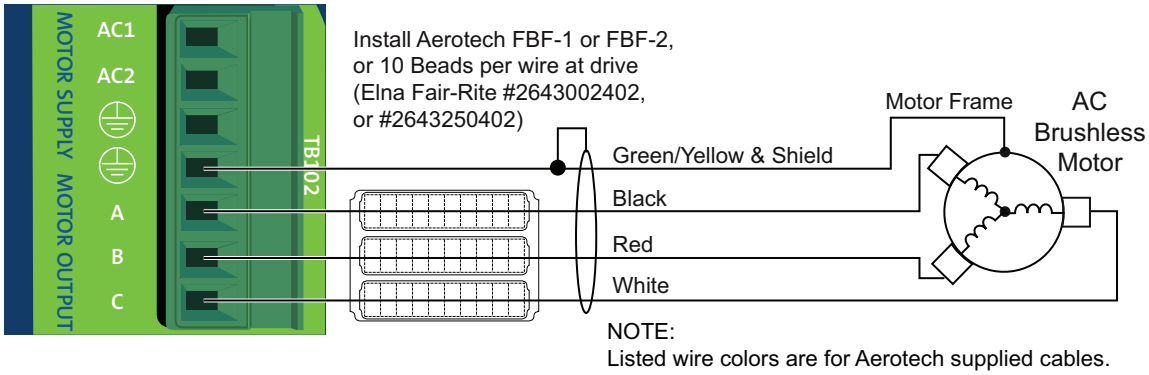


Figure 2-11: Brushless Motor Configuration

Table 2-10: 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.
(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 2.3.1.5. 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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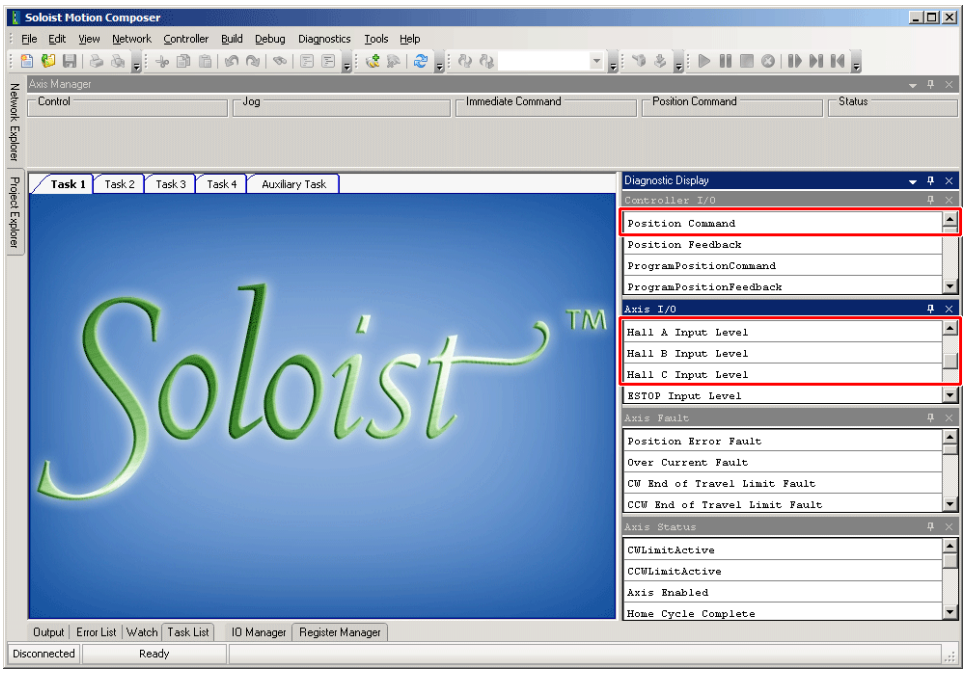


Figure 2-12: Encoder and Hall Signal Diagnostics

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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 2-13). 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 2-13).

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.

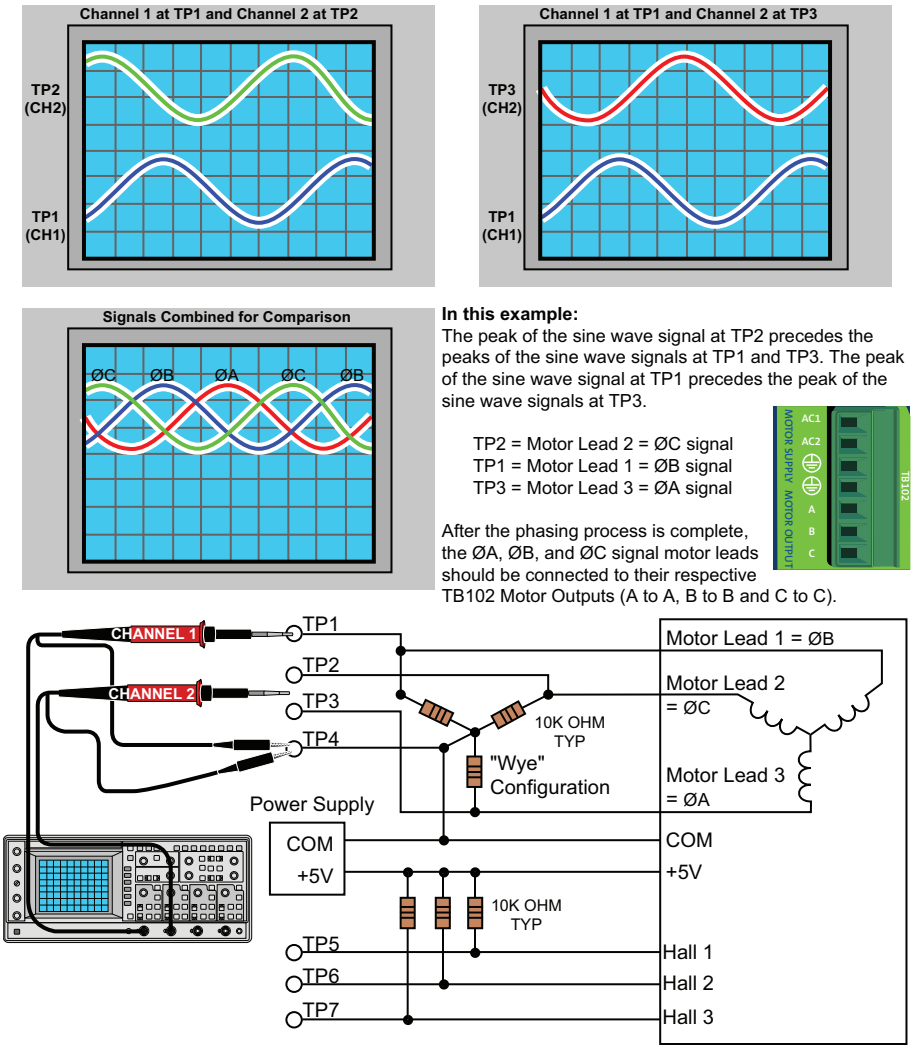


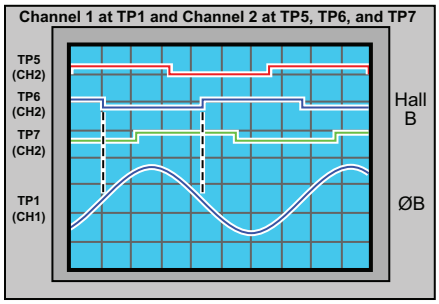
Figure 2-13: Motor Phasing Oscilloscope Example

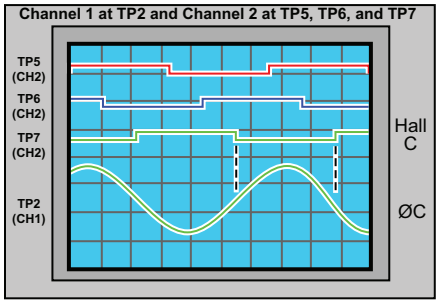
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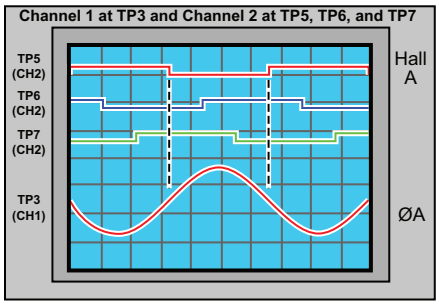
After the motor leads have been tested, the next step is to determine the phase of the Hall signals. The required (by an Aerotech system) relationship between motor and Hall leads is that the peak of a motor lead signal should correspond to the low voltage phase of the Hall signal (as shown in Figure 2-14).

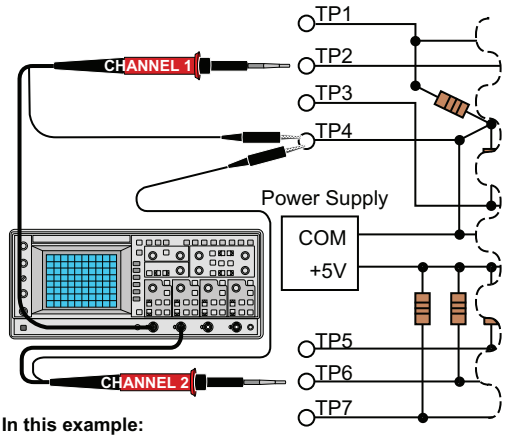
With channel 1 still connected to one of the motor leads, connect channel 2 of the oscilloscope to TP5, TP6, and then TP7, while advancing the motor in the positive direction after each connection. Note which of the three Hall signals has the complimentary phase relationship to the motor lead that channel 1 is connected to (as shown in Figure 2-14).

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.









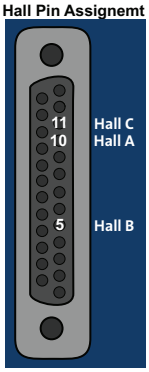
In this example:
The low voltage phase of the TP6 Hall signal corresponds with the peak phase of the motor sine wave of TP1 (in the previous example designated as ØB). The signal at TP6 should be designated as Hall B.

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



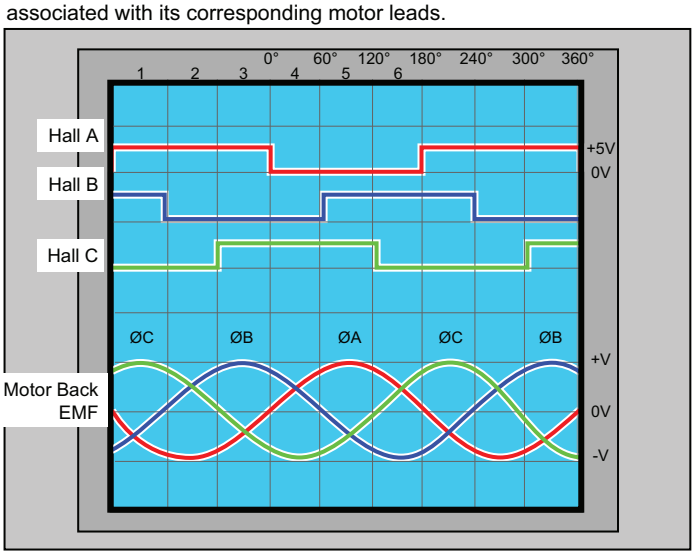
Pin	Hall Positions
10	Hall A
5	Hall B
11	Hall C

Figure 2-14: 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 2-15: Brushless Motor Phasing Goal

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2.2.2. DC Brush Motor Connections

The configuration shown in Figure 2-16 is an example of a typical DC brush motor connection. Refer to Section 2.2.2.1. for information on motor phasing.

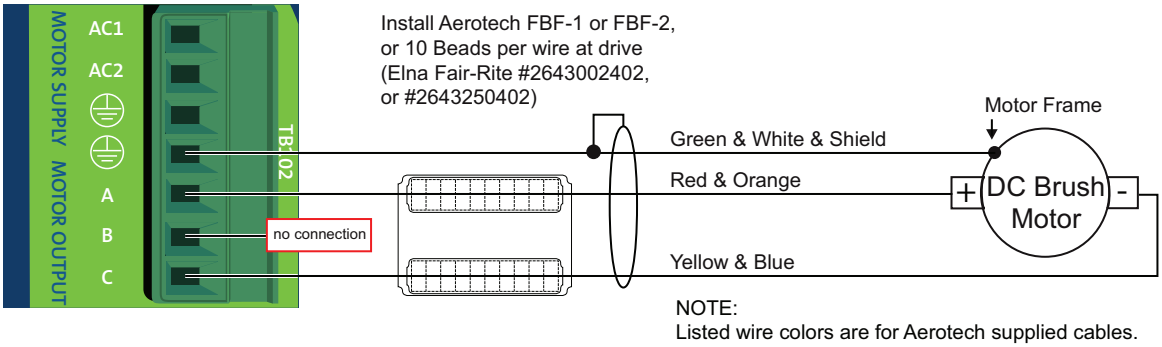


Figure 2-16: DC Brush Motor Configuration

Table 2-11: 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. (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.

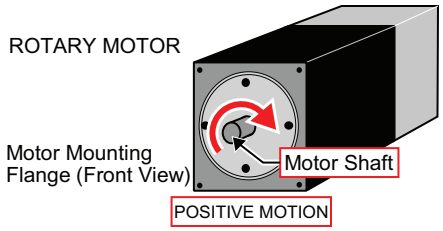


Figure 2-17: Clockwise Motor Rotation

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

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 2-18 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.

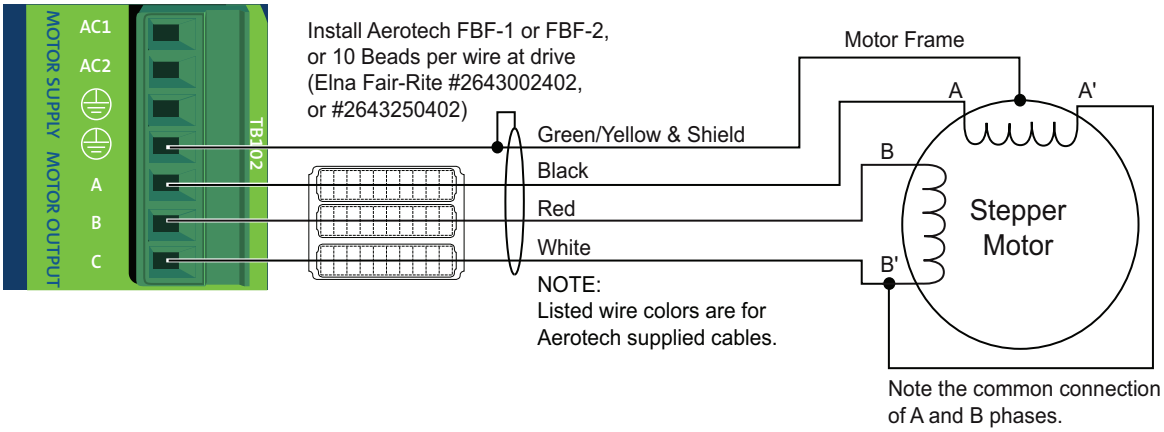


Figure 2-18: Stepper Motor Configuration

Table 2-12: 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. (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.

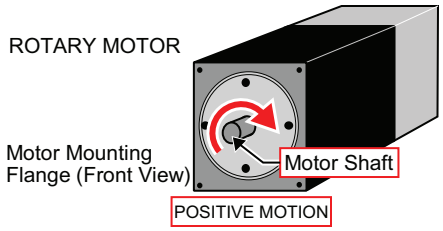


Figure 2-19: Clockwise Motor Rotation

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.

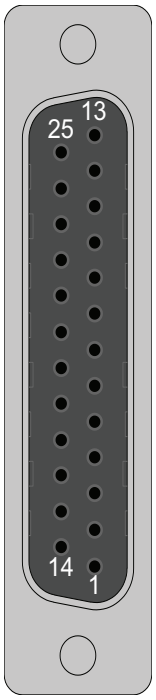
[1] CountsPerUnit has replaced PosScaleFactor in software version 3.00.000.
[2] ReverseMotionDirection has replaced the functionality of reversing the sign on the PosScaleFactor to change the direction of positive motion in software version 3.00.000.

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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 2-13: 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	
	Absolute Encoder Interface Clock -	Output	
7	Encoder Marker Reference Pulse +	Input	
	Absolute Encoder Interface Clock +	Output	
8	Absolute Encoder Interface Data -	Bidirectional	
9	Reserved	N/A	
10	Hall-Effect Sensor A (brushless motors only)	Input	
11	Hall-Effect Sensor C (brushless motors only)	Input	
12	Clockwise End of Travel Limit	Input	
13	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	Absolute Encoder Interface Data +	Bidirectional	
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 CP 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. If the Soloist CP has been purchased with the -MXU option, the standard encoder interface can optionally be configured for an analog encoder input via parameter settings.

Refer to Section 2.3.1.5. for encoder feedback phasing. Refer to Section 2.5. for the auxiliary encoder channel.

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

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

Table 2-14: 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
	Absolute Encoder Interface Clock -	Output
7	Encoder Marker Reference Pulse +	Input
	Absolute Encoder Interface Clock +	Output
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 2.3.1.4. for more information).

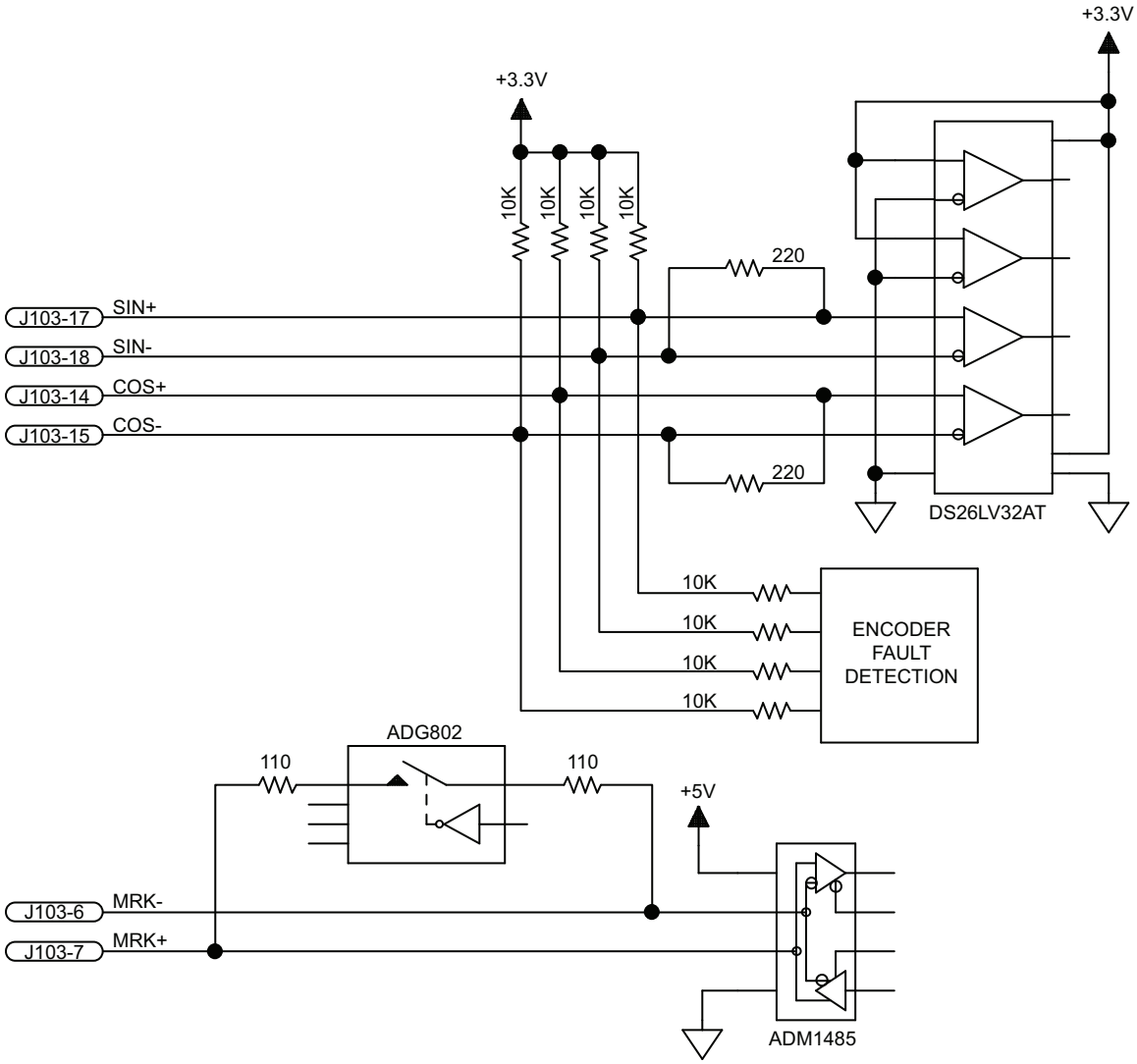


Figure 2-20: Line Driver Encoder Interface (J103)

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2.3.1.2. EnDat Encoder Interface (J103)

The Soloist CP retrieves absolute position data along with encoder fault information via a serial data stream from the absolute encoder. See Figure 2-21 for the serial data stream interface. Set up of this interface requires setting parameters EnDatEncoderResolution[1], EnDatEncoderSetup[2], EnDatEncoderTurns[3].

The encoder interface pin assignment is indicated in Section 2.3.1.

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

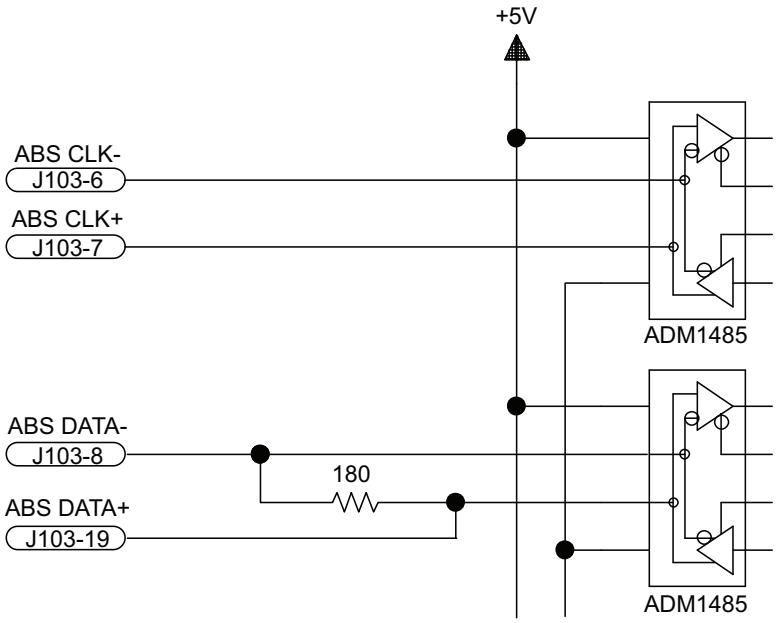


Figure 2-21: Serial Data Stream Interface

[1]EnDatEncoderResolution has replaced CfgFbkEncAbsPosBits in software version 3.00.000.
[2]EnDatEncoderSetup has replaced CfgFbkEncAbsSetup in software version 3.00.000.
[3]EnDatEncoderTurns has replaced CfgFbkEncAbsRevBits in software version 3.00.000.

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2.3.1.3. Resolute Encoder Interface (J103)

The Soloist CP retrieves absolute position data along with encoder fault information via a serial data stream from the resolute encoder. See Figure 2-22 for the serial data stream interface. Set up of this interface requires setting parameters ResoluteEncoderResolution, ResoluteEncoderSetup, and ResoluteEncoderUserResolution.

The encoder interface pin assignment is indicated in Section 2.3.1.

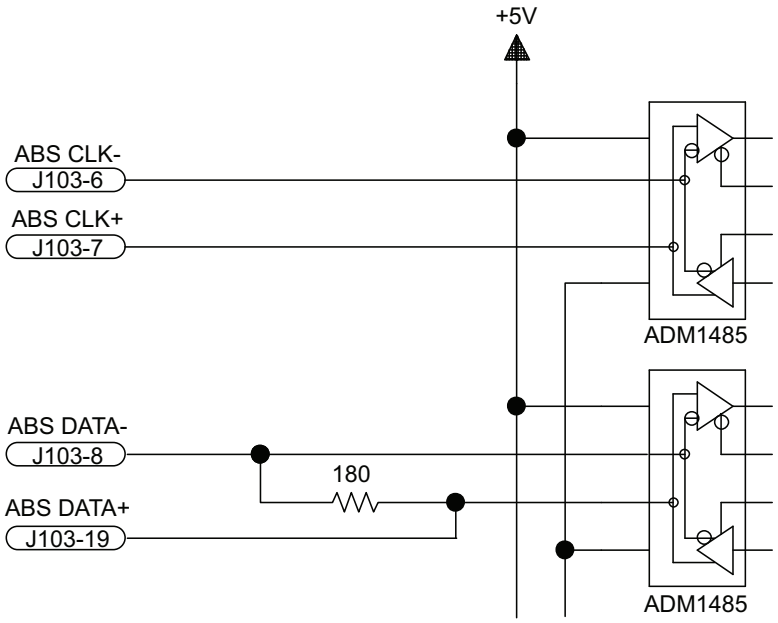


Figure 2-22: Serial Data Stream Interface

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2.3.1.4. 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 2-15: 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 2-23 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.

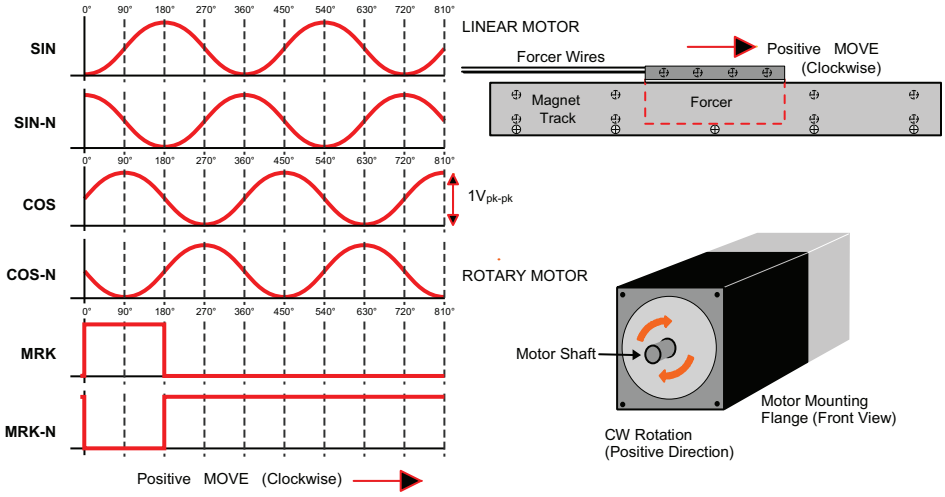


Figure 2-23: Analog Encoder Phasing Reference Diagram

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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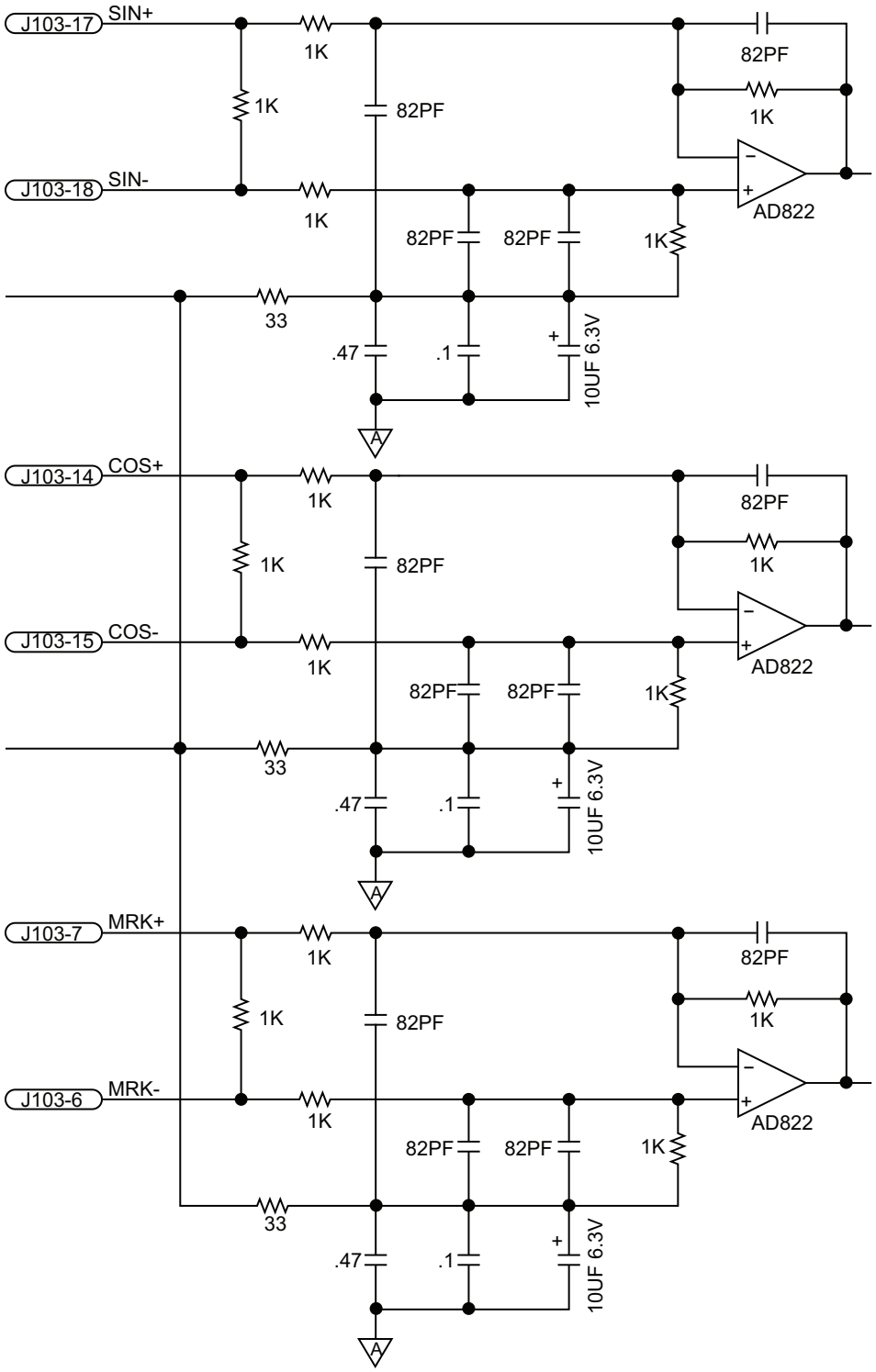


Figure 2-24: Analog Encoder Interface (J103)

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2.3.1.5. Encoder Phasing

Incorrect encoder polarity will cause the system to fault when enabled or when a move command is issued. Figure 2-25 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 2-26). 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 2-26).

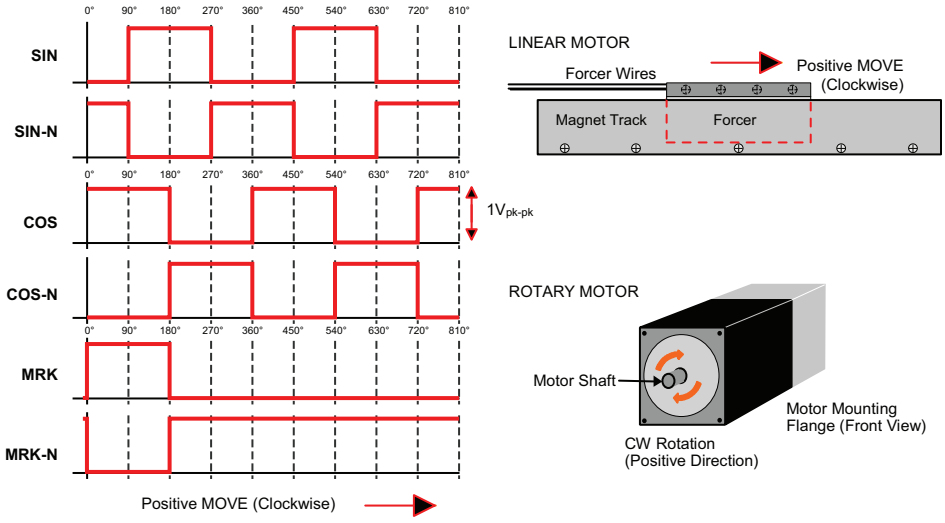


Figure 2-25: Encoder Phasing Reference Diagram (Standard)

NOTE: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-25.

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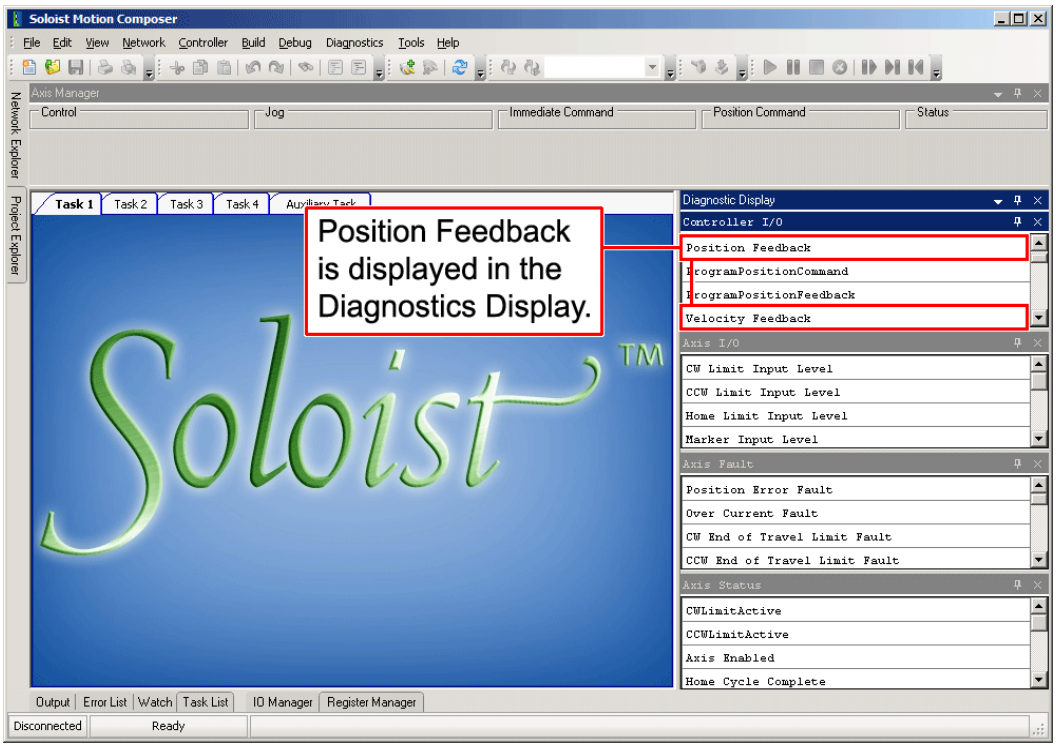


Figure 2-26: Position Feedback in the Diagnostic Display

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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 2-16: 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

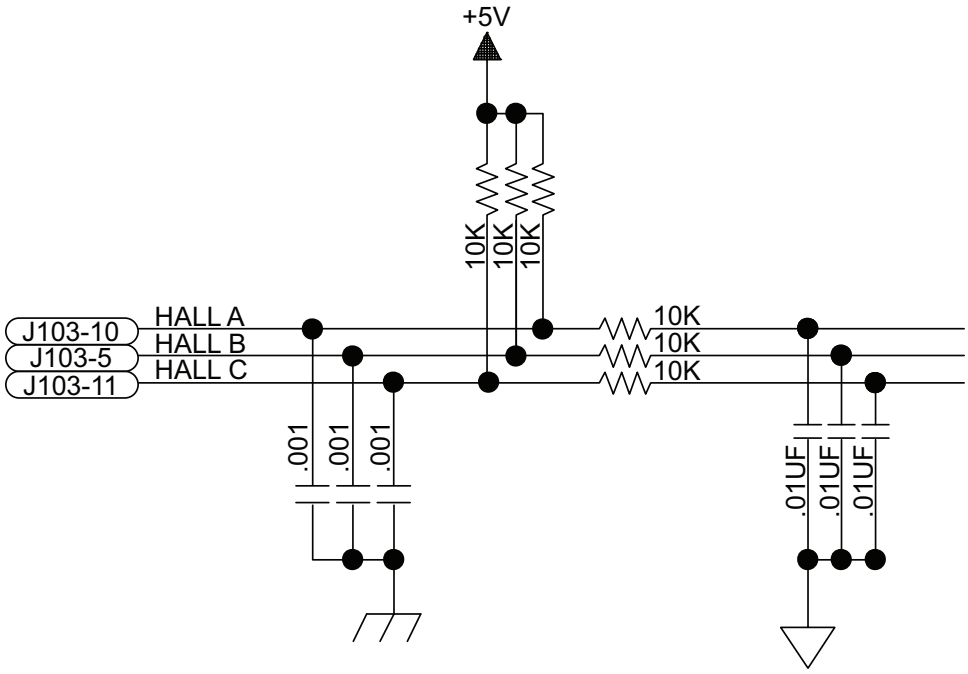


Figure 2-27: Hall-Effect Inputs (J103)

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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 2-17: Hall-Effect Feedback Interface Pin Assignment (J103)

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

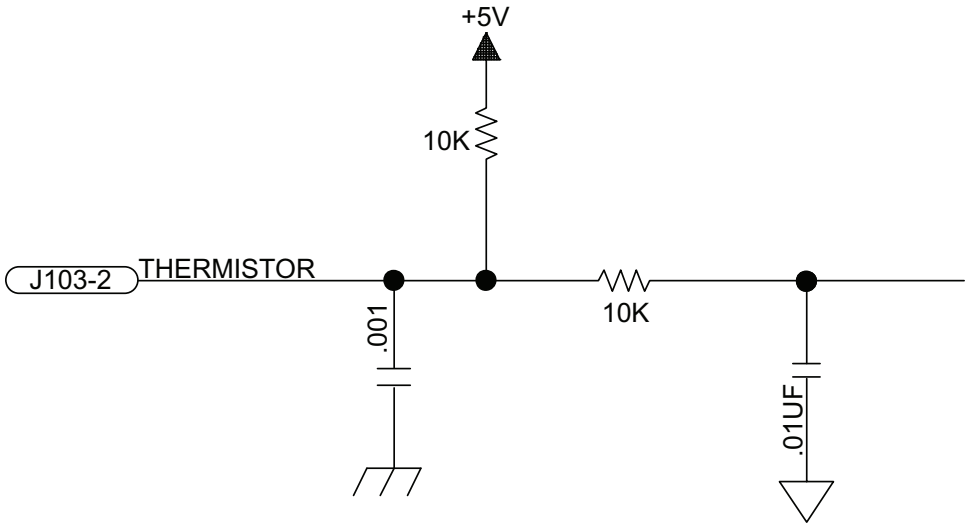


Figure 2-28: Thermistor Interface Input (J103)

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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 2-18: Encoder Fault Interface Pin Assignment (J103)

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

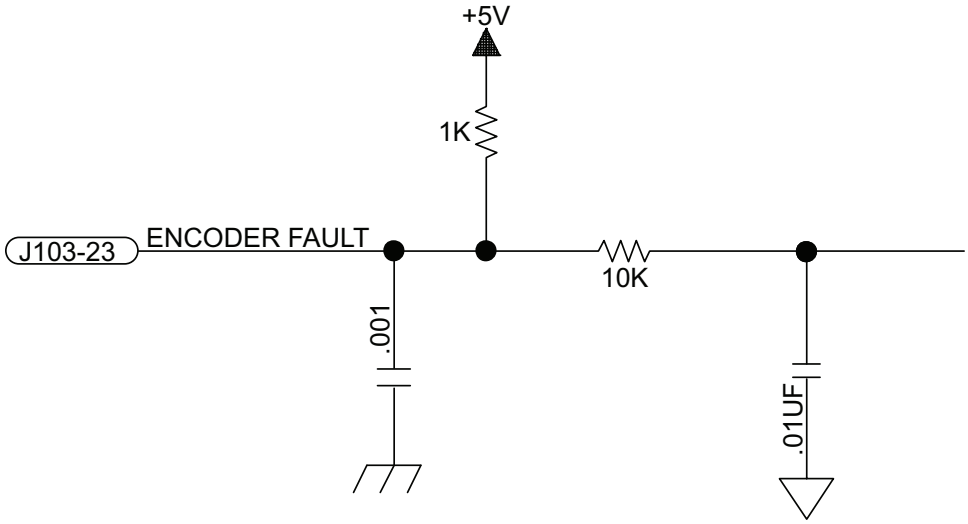


Figure 2-29: Encoder Fault Interface Input (J103)

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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 2-32).

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

Opto-isolated user inputs 0-3 can also be used as the end-of-travel limit inputs, see Section 2.5.4.

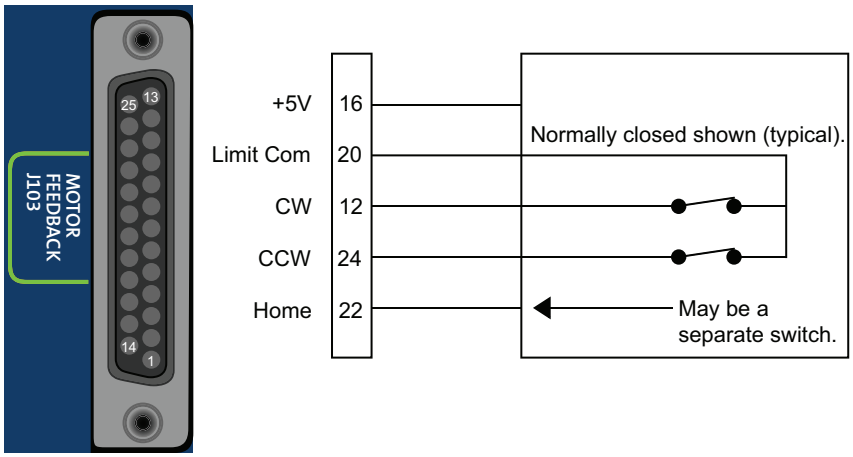


Figure 2-30: End of Travel Limit Input Connections

Table 2-19: 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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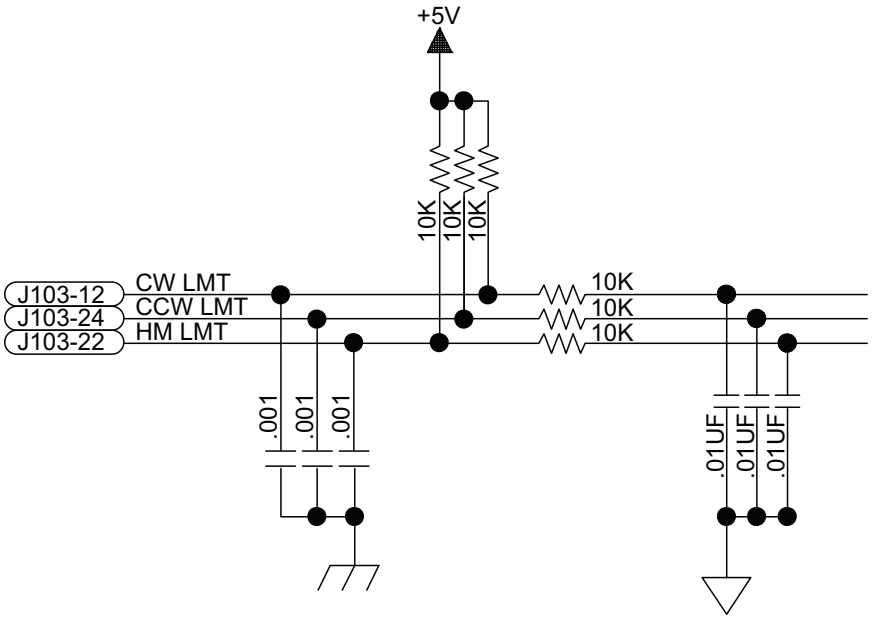


Figure 2-31: End of Travel Limit Interface Input (J103)

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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 2-32).

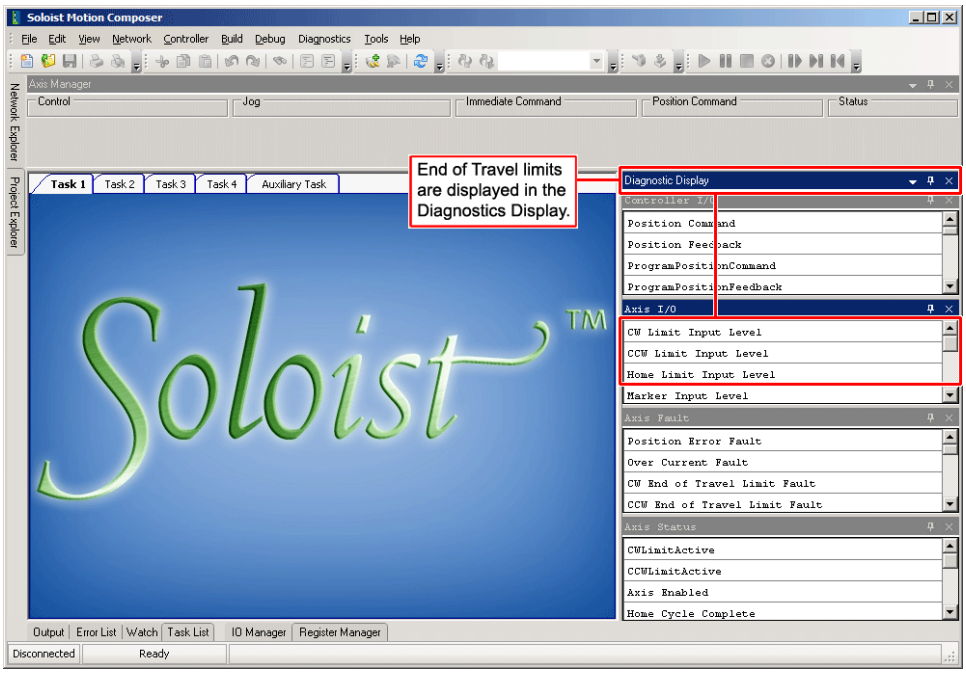


Figure 2-32: Limit Input Diagnostic Display

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2.3.6. Brake Output (J103)

The Brake Output pins provide a direct connection to either the solid state relay on the Soloist CP or the mechanical 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).

Use either the solid state relay on the Soloist CP or the mechanical relay on the -IO board when connecting a power supply to the brake outputs on J103. Do not use both relays at the same time.

Refer to Section 2.6. for more information on using the brake output with the solid-state relay.

Refer to Section 3.6. for more information on using the brake output with the mechanical relay.

Table 2-20: Brake Output Pin Assignment (J103)

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

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2.4. Emergency Stop Sense Input (TB101)

The ESTOP sense input (TB101) 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 AC motor power input (Motor Supply). Refer to Figure 2-34 for interconnection details

TB101 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.

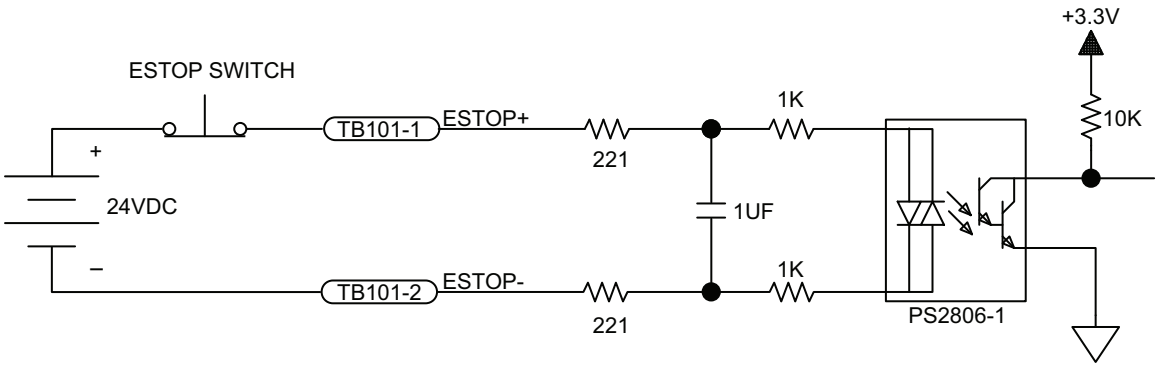


Figure 2-33: ESTOP Sense Input (TB101)

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: TB101 Mating Connector

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
2-Pin Terminal Block	ECK01250	1803578	0.22 - 0.25	0.14 - 1.5 [26-16]

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2.4.1. Typical ESTOP Interface

The user can connect an external emergency stop relay circuit to the Soloist CP's motor power supply input. This will remove power to the motor while maintaining control power, as shown in the Figure 2-34.

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

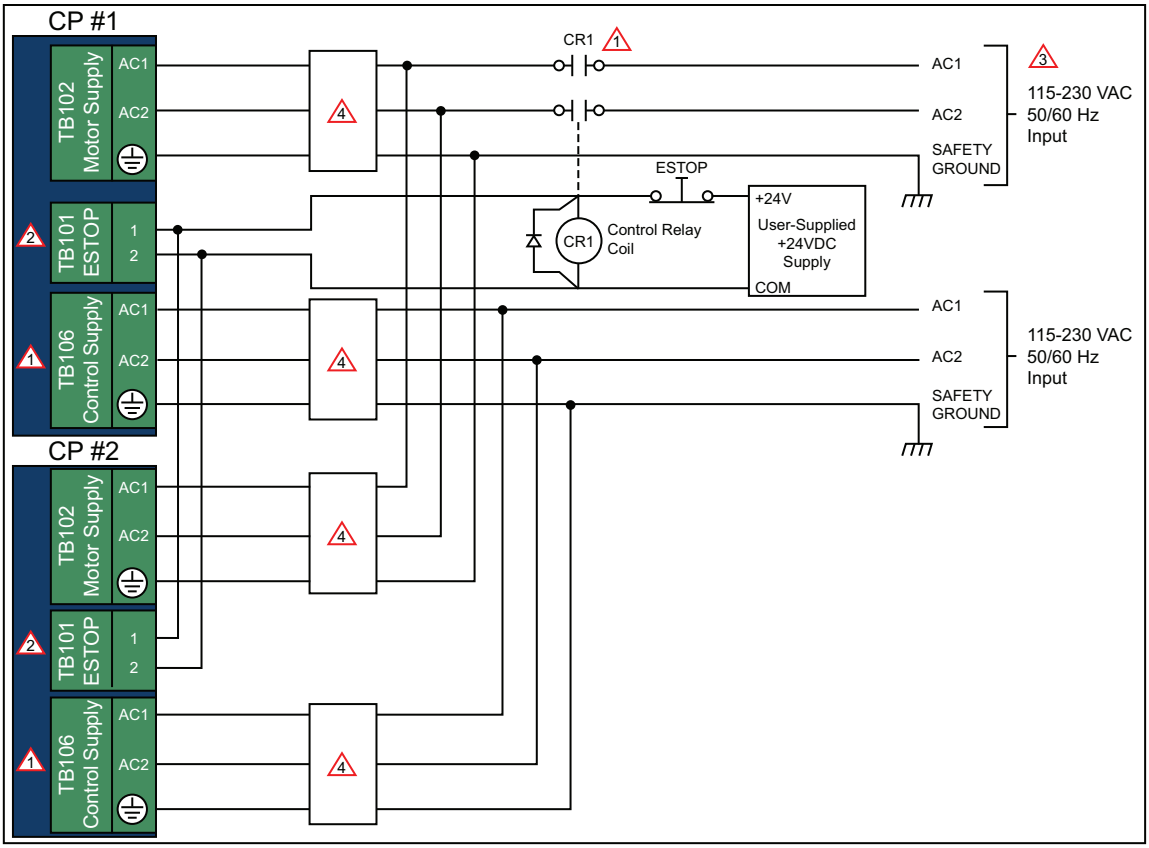


Figure 2-34: Typical Emergency Stop Circuit

Table 2-24: Typical ESTOP Relay Ratings

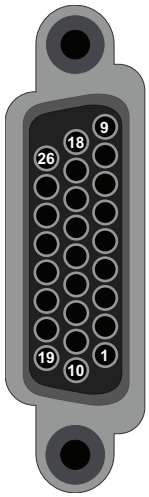
Axes	AC1	AC3	Aerotech P/N	Third Party P/N
1	32	16	ECW1018	Sprecher & Schuh CA7-16C-xx-xxx
2 to 5	85	43	ECW1019	Sprecher & Schuh CA7-43C-xx-xxx

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2.5. Auxiliary I/O Connector (J104)

The Auxiliary I/O connector (J104) provides 1 analog and 6 digital inputs, 1 analog and 4 digital outputs, and a secondary RS-422 line driver encoder input.

Table 2-25: Auxiliary I/O Connector Pin Assignment (J104)

Pin#	Description	In/Out/Bi	Connector
1	Auxiliary Sine+	Bidirectional	
2	Auxiliary Sine-	Bidirectional	
3	High Speed Input 4 + user interrupt	Input	
4	High Speed Input 4 - user interrupt	Input	
5	High Speed Input 5 + user interrupt	Input	
6	High Speed Input 5 - user interrupt	Input	
7	Opto-Isolated Output 0	Output	
8	Opto-Isolated Output 1	Output	
9	Opto-Isolated Output 2	Output	
10	Auxiliary Cosine+	Bidirectional	
11	Auxiliary Cosine-	Bidirectional	
12	+5 Volt (500 mA max)	Output	
13	Analog Input 0 + (Differential)	Input	
14	Analog Input 0- (Differential)	Input	
15	Output Common	-	
16	Opto-Isolated Output 3	Output	
17	Opto-Isolated Input 0 / CCW EOT Input (1)	Input	
18	Opto-Isolated Input 1 / CW EOT Input (1)	Input	
19	Auxiliary Marker- / PSO output (2)	Bidirectional	
20	Auxiliary Marker+ / PSO output (2)	Bidirectional	
21	Common (+5 Volt User Supply, 500 mA max)	-	
22	Analog Output 0	Output	
23	Analog Common	-	
24	Input Common	-	
25	Opto-Isolated Input 2 / Home Input (1)	Input	
26	Opto-Isolated Input 3	Input	

(1) Software configured option
(2) For PSO, see Section 2.5.2.

Mating Connector	Aerotech P/N	Third Party P/N
Connector	ECK01259	Kycon K86-AA-26P
Backshell	ECK01022	Amphenol 17-1725-2

NOTE: These items are provided as a set under the Aerotech P/N: MCK-26HDD.

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2.5.1. Auxiliary Encoder Channel (J104)

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 2.5.2.) 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 CP with the -MXU option.

Table 2-26: Auxiliary Encoder Channel Pin Assignment (J104)

Pin#	Description	In/Out/Bi
1	Auxiliary Sine+	Bidirectional
2	Auxiliary Sine-	Bidirectional
10	Auxiliary Cosine+	Bidirectional
11	Auxiliary Cosine-	Bidirectional
12	+5 Volt (500 mA max)	Output
19	Auxiliary Marker- / PSO output (2)	Bidirectional
20	Auxiliary Marker+ / PSO output (2)	Bidirectional
21	Common (+5 Volt User Supply, 500 mA max)	-
(2) For PSO, see Section 2.5.2.		

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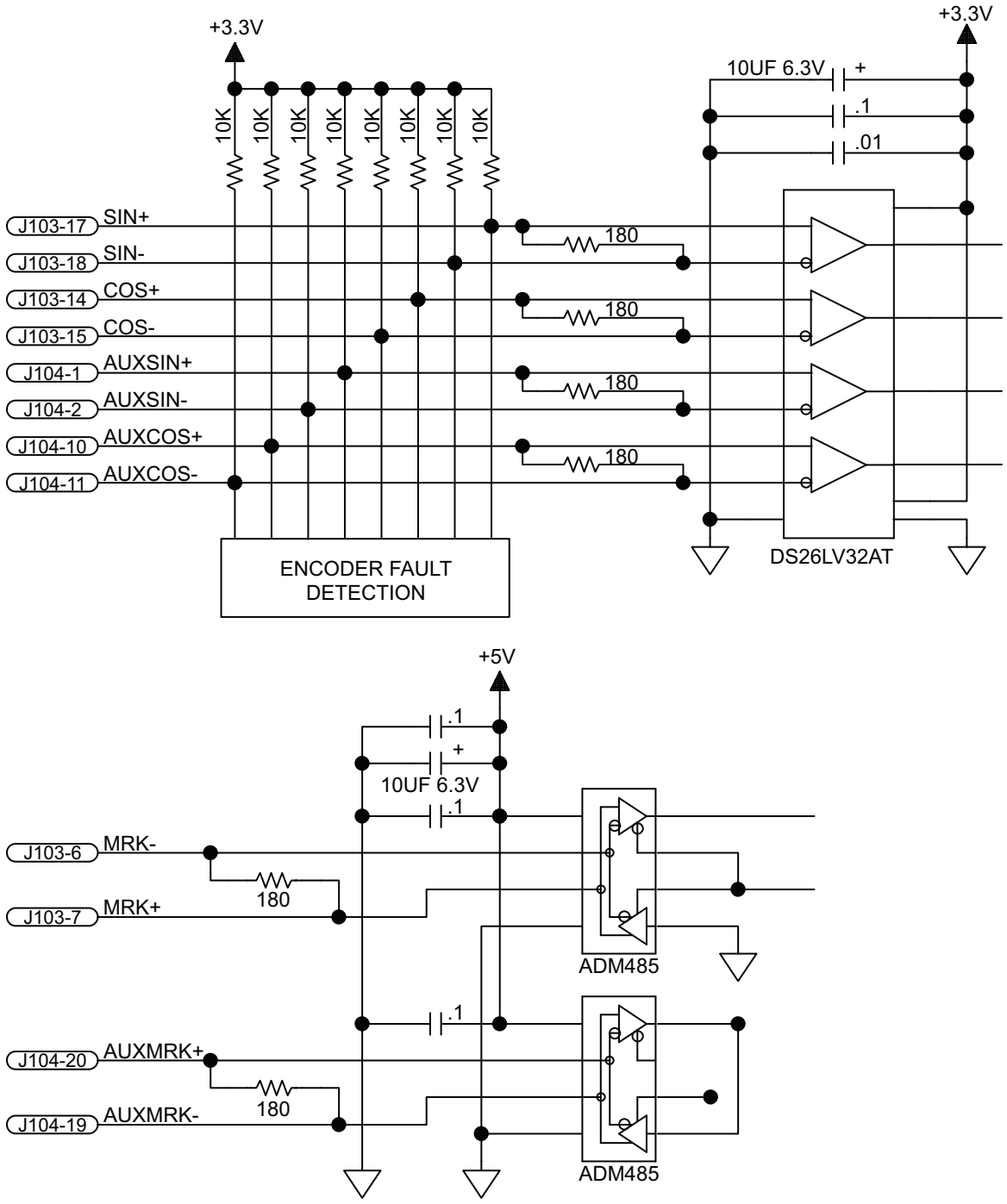


Figure 2-35: Auxiliary Encoder Channel (J104)

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2.5.2. Position Synchronized Output (PSO)/Laser Firing (J104)

The Soloist CP 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.

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.

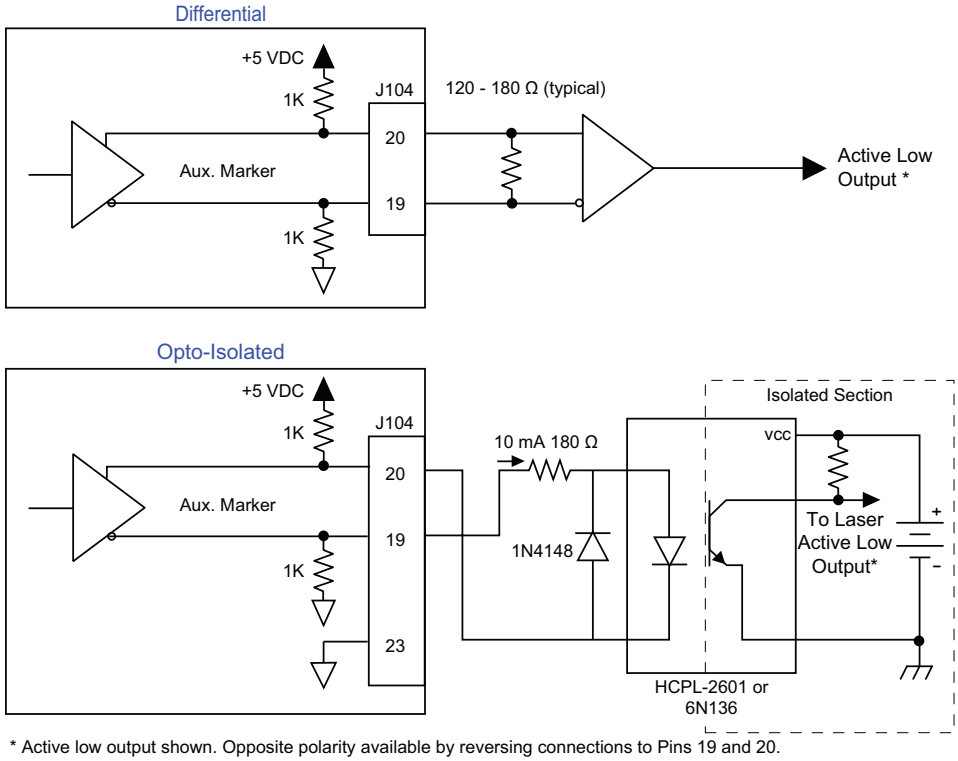
Table 2-27: PSO Output Pin Assignment (J104)

Pin#	Description	In/Out/Bi
19	Auxiliary Marker- / PSO output	Bidirectional
20	Auxiliary Marker+ / PSO output	Bidirectional
23	Analog Common	-

Table 2-28: PSO Output Sources

PSO Output Type	Max Frequency	See Also
RS-422 Marker (1)	12.5 MHz	Section 2.5.1.
(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 19 and 20.

Figure 2-36: PSO Interface

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2.5.3. Opto-Isolated Outputs (J104)

All outputs are rated for 24 VDC and 80 mA per output. The outputs are software configurable as current sinking (see Figure 2-37) or current sourcing (see Figure 2-38) .

Table 2-29: Port 0 Digital Output Connector Pin Assignment (J104)

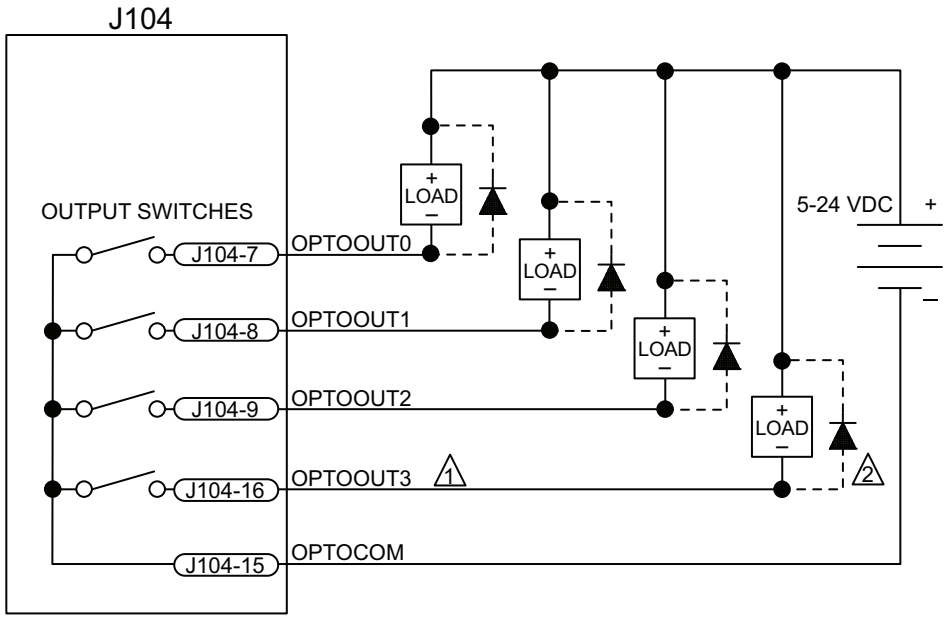
Pin#	Description	In/Out/Bi
7	Opto-Isolated Output 0	Output
8	Opto-Isolated Output 1	Output
9	Opto-Isolated Output 2	Output
15	Output Common	-
16	Opto-Isolated Output 3	Output

Table 2-30: Digital Output Specifications

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.

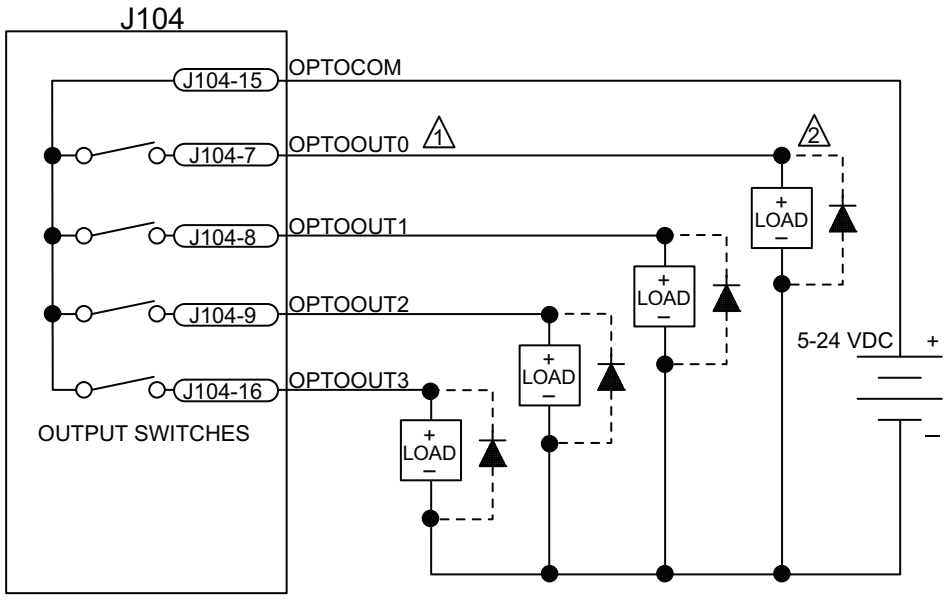
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1 EACH OUTPUT 80 mA MAXIMUM

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

Figure 2-37: Outputs Connected in Current Sinking Mode (J104)



1 EACH OUTPUT 80 mA MAXIMUM

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

Figure 2-38: Outputs Connected in Current Sourcing Mode (J104)

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2.5.4. Opto-Isolated Inputs (J104)

User inputs are scaled for an input voltage of 5-24 VDC. Figure 2-39 and Figure 2-40, respectively, illustrate how to connect a device in current sinking and sourcing current modes.

Table 2-31: Port 0 Digital Input Connector Pin Assignment (J104)

Pin#	Description	In/Out/Bi
17	Opto-Isolated Input 0 / CCW EOT Input (1)	Input
18	Opto-Isolated Input 1 / CW EOT Input (1)	Input
24	Input Common	-
25	Opto-Isolated Input 2 / Home Input (1)	Input
26	Opto-Isolated Input 3	Input
(1) Software configured option		

Table 2-32: 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

NOTE: Each bank of 8 Inputs must be connected in the all sourcing or all sinking configuration.

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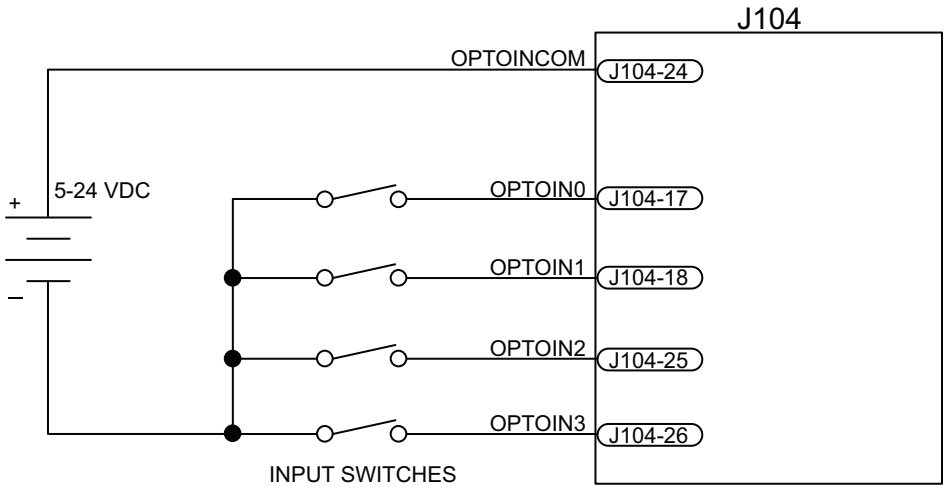


Figure 2-39: Inputs Connected in Current Sinking Mode (J104)

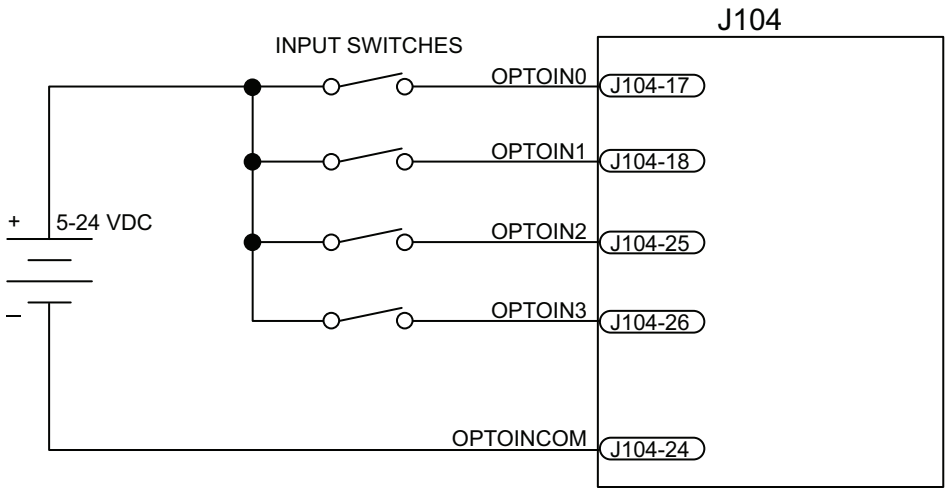


Figure 2-40: Inputs Connected in Current Sourcing Mode (J104)

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2.5.5. High Speed User Inputs 4-5 (J104)

The high-speed inputs are scaled for 5 V or 24 V input voltages based on a jumper setting (Table 2-34). A higher input voltage requires adding external series resistors to limit the current to 10 mA. The high-speed inputs are isolated by an HCPL-0630 and have a typical delay of 50 nanoseconds.

Table 2-33: Port 0 High Speed Digital Input Connector Pin Assignment (J104)

Pin#	Description	In/Out/Bi
3	High Speed Input 4 + user interrupt	Input
4	High Speed Input 4 - user interrupt	Input
5	High Speed Input 5 + user interrupt	Input
6	High Speed Input 5 - user interrupt	Input

Table 2-34: Input Voltage Jumper Configuration

Jumper	Setting	Description
JP6	1-2 (1)	24 V operation (High Speed Input 4)
	2-3	5 V operation (High Speed Input 4)
JP7	1-2 (1)	24 V operation (High Speed Input 5)
	2-3	5 V operation (High Speed Input 5)
(1) Default		

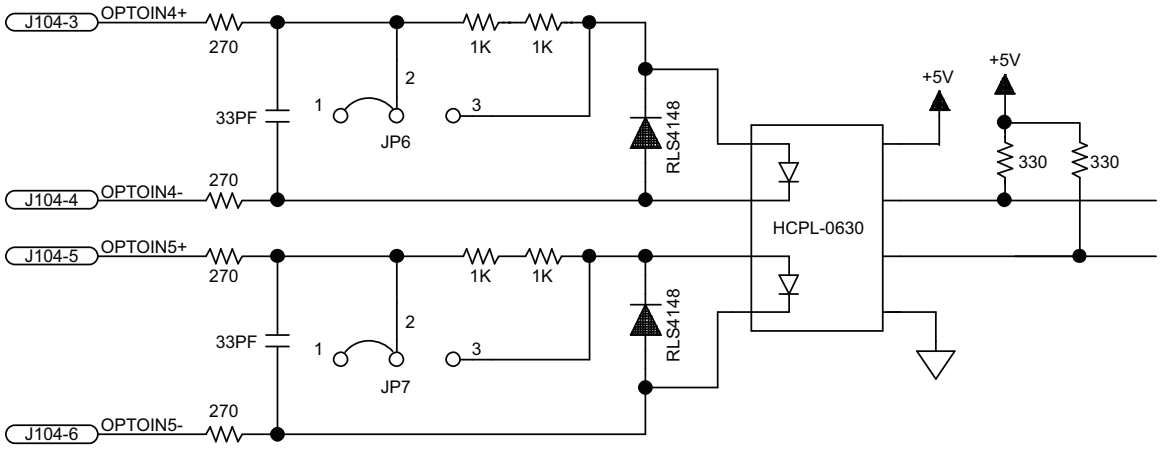


Figure 2-41: High Speed User Inputs (J104)

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2.5.6. Analog Output 0 (J104)

Analog Output 0 produces a single ended output in the range of ±10 volts with a resolution of 305 µV (16-bit). The maximum recommended output current is 5 mA (2 k Ohm load). The analog output voltage is referenced to J104-23.

Table 2-35: Analog Output Connector Pin Assignment (J104)

Pin#	Description	In/Out/Bi
22	Analog Output 0	Output
23	Analog Common	-

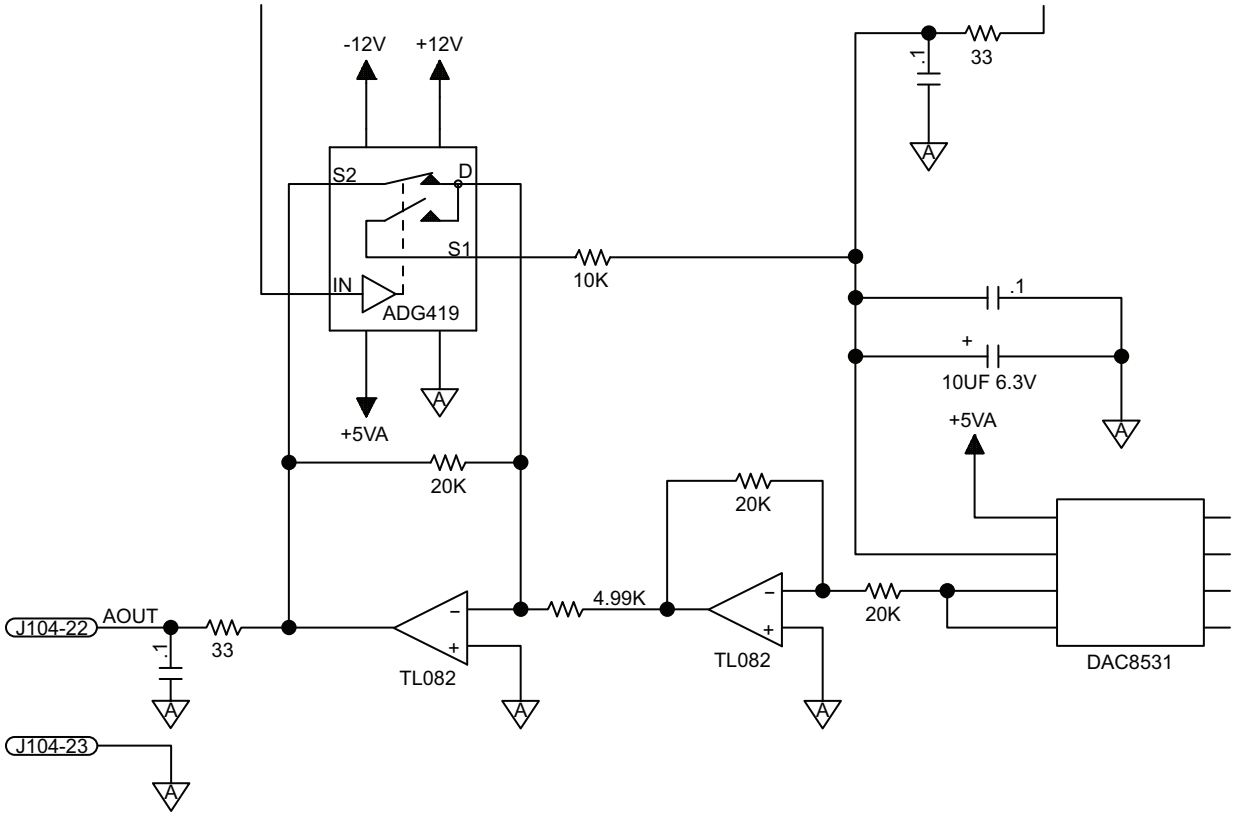


Figure 2-42: Analog Output 0 (J104)

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2.5.7. Analog Input 0 (J104)

Analog Input 0 is a 16-bit differential input that accepts a voltage in the range of ±10 V with a resolution of 305 µV. 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 14, ANALOG_IN-) and the analog source signal to the positive input (pin 13, ANALOG_IN+). A floating signal source should be referenced to the signal common (pin 23, AGND) as shown in Figure 2-43.

Table 2-36: Analog Input Connector Pin Assignment (J104)

Pin#	Description	In/Out/Bi
13	Analog Input 0 + (Differential)	Input
14	Analog Input 0- (Differential)	Input
23	Analog Common	-

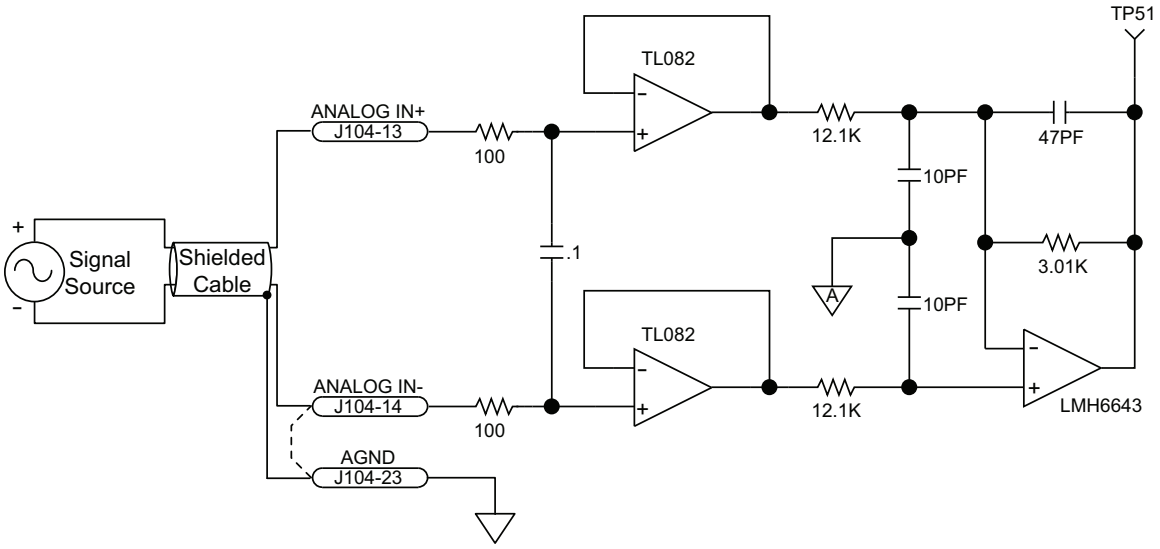


Figure 2-43: Analog Input 0 (J104)

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2.6. Brake Power Supply (TB103)

TB103 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 TB103. This is shown in Figure 2-44. The brake may also be connected in series with the Brake Power Supply and interlocked using Motor Feedback (J103) brake pins (Table 2-39 and Figure 2-45).

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).

When TB103 is used to power the solid state brake control relay, the mechanical brake control relay present on the I/O board should not be used.

NOTE: The brake power supply must be externally fused.

Table 2-37: Brake Output Connector Pin Assignment (TB103)

Pin#	Description	In/Out/Bi
5	Brake Power Supply (-)	Input
6	Brake Power Supply (+)	Input

Table 2-38: Mating Connector (TB103)

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
6-Pin Terminal Block	ECK01364	1881367	N/A	0.5 - 0.080 [20-28]

Table 2-39: 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 2-44 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 TB103.

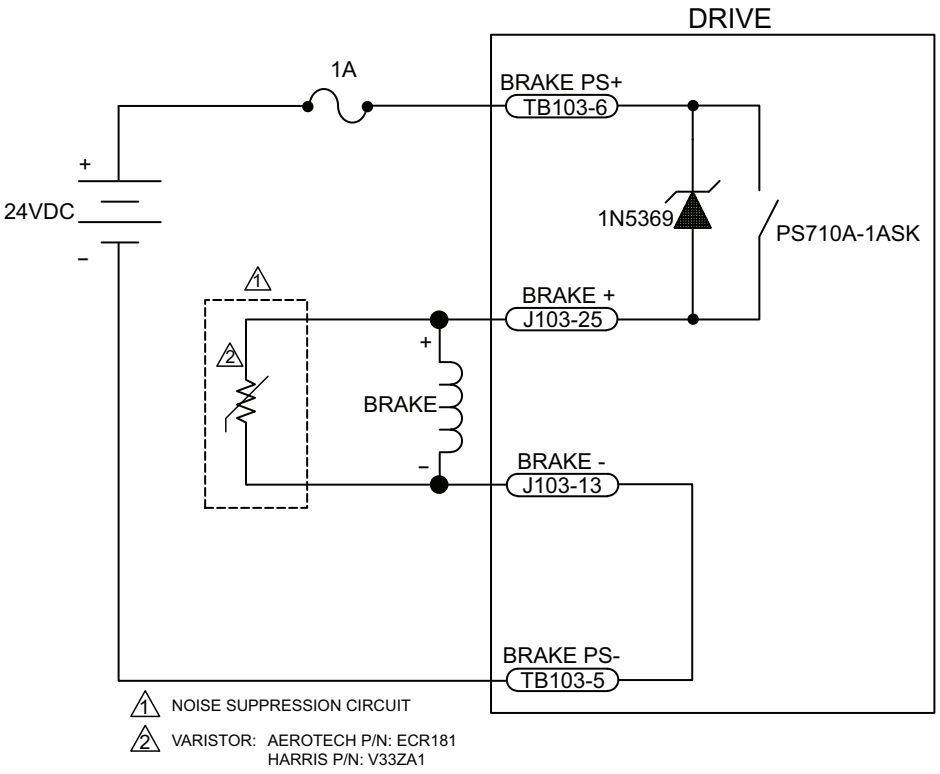


Figure 2-44: Brake Connected to J103

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

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Figure 2-45 is an example of a 24 VDC Brake connected to TB103. 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.

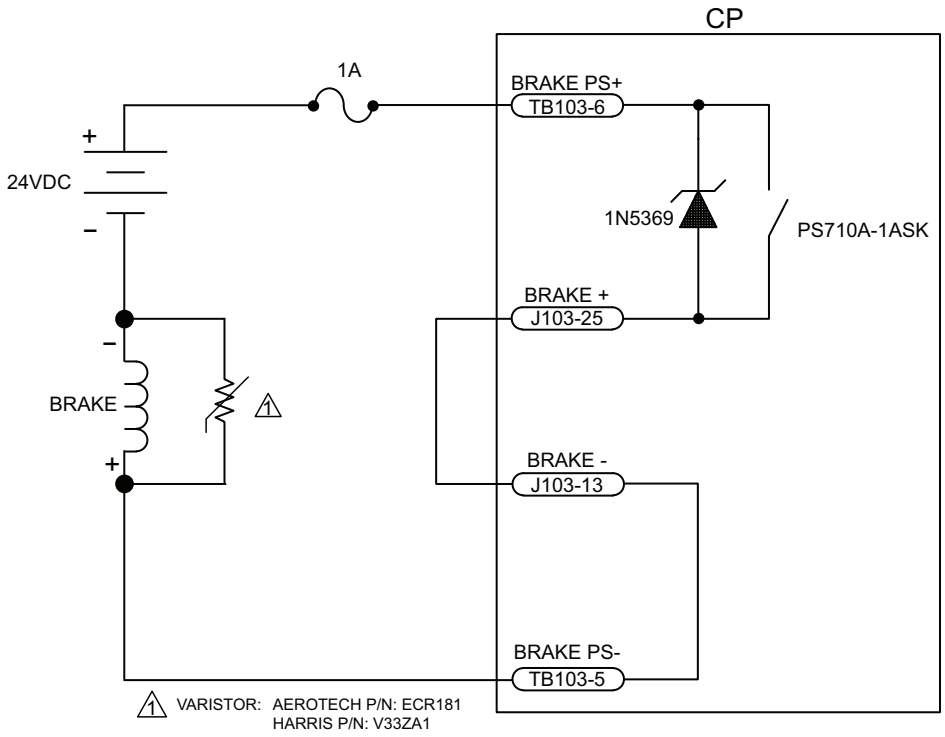


Figure 2-45: Brake Connected to TB103

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2.6.1. Solid State Relay Specifications (TB103)

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

Table 2-40: 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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2.7. RS-232 Interface (TB103)

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

Table 2-41: RS-232 Connector Pin Assignment (TB103)

Pin#	Description	In/Out/Bi
1	+5 Volt Power Output (1)	Output
2	RS-232 Transmit	Output
3	RS-232 Receive	Input
4	Signal Common	N/A
5	Brake Power Supply -	Output
6	Brake Power Supply +	Output
(1) Total user +5 V power is limited to 500 mA.		

Table 2-42: RS-232 Port Connector Mating Connector (TB103)

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
6-Pin Terminal Block	ECK01364	1881367	N/A	0.5 - 0.080 [20-28]

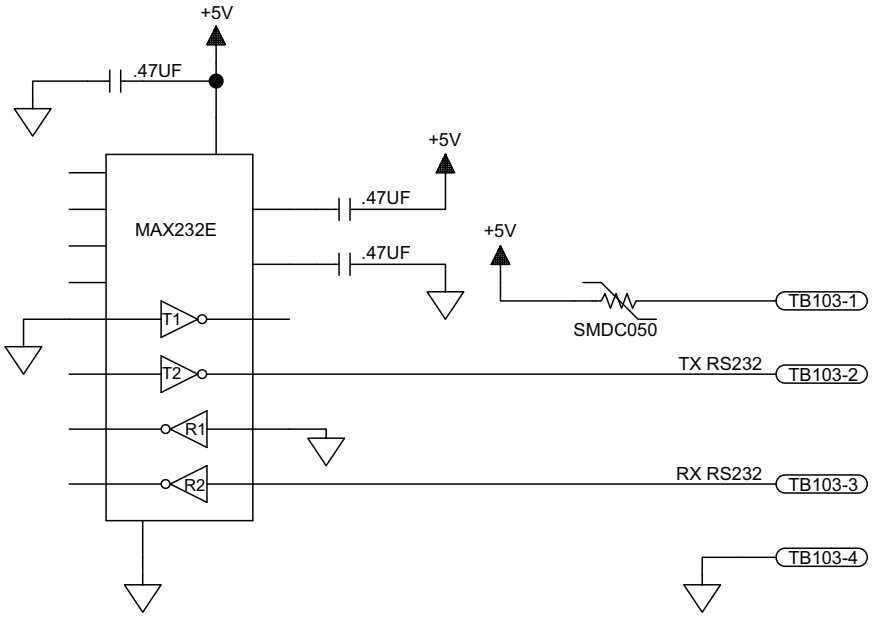


Figure 2-46: RS-232 Interface (TB103)

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2.8. -EXTSHUNT Option (TB104)

While decelerating a mechanical load, the mechanical energy is converted into electrical energy. This energy charges the internal bus filter capacitor in the amplifier. A shunt circuit prevents the bus voltage from rising too high and causing damage to the amplifier.

The Soloist CP provides an external shunt option for high-energy systems. Internally, the shunt is fused with an 8A slow-blow type fuse. The purpose of the fuse is to protect the electronic switching device and the traces on the circuit board.

Table 2-43: Recommended Shunt Resistors and Wire Gauge

Component	Recommendation	Recommended Wire Size
Power Resistor	Milwaukee Resistor Corporation's rib wound resistors	1.3 mm^2 (#16 AWG)

Table 2-44: External Shunt Mating Connector

Type	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: mm^2 [AWG]
2-Pin Terminal Block	ECK001110	1754449	0.5 - 0.6	3.3 - 0.516 [12-30]

The following is a list of parameters required to calculate the external shunt resistor value:

V_M = point at which the shunt circuit turns on - 380 V
V_{HYS} = approximately 10 V
Bus capacitance = 1,200 uF

The first step in sizing the external shunt resistor is to calculate the kinetic energy of the system. Use **Equation 1** to calculate the kinetic energy minus system losses.

Equation 1:

$$E_M = \left[\frac{1.356}{2}\right]\left[J_M + J_L\right]\omega_m^{\,2} - 3I_M^{\,2}\left[\frac{R_M}{2}\right]t_D - \left[\frac{1.356}{2}\right]T_F\omega_m t_D$$

J_M = rotor inertia (lb-ft-sec^2)
J_L = load inertia (lb-ft-sec^2)
ω_m = motor speed before deceleration (radians/sec) = RPM/9.55
I_M = motor current during deceleration (A_{RMS} per phase)
R_M = motor resistance (Ω line-to-line)
t_D = time to deceleration (seconds)
t_F = friction torque (lb-ft)

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A shunt resistor is required if the calculated energy is more than the internal bus capacitor can store. Use **Equation 2** to perform this calculation.

Equation 2:

$$E_M < \frac{1}{2} C(V_M^2 - V_{NOM}^2)$$

C = Bus capacitor (Farads) (= 1,200 uF)
V_M = turn on voltage for shunt circuit (V) (=380 V)
V_{NOM} = nominal Bus voltage (V) (160 V or 320 V Typical)

For a standard Soloist CP, the maximum energy the internal bus capacitor can store without requiring a shunt resistor is indicated in Table 2-45.

Table 2-45: Maximum Storage Energy

Bus Voltage	Maximum Energy
160 V	71.3 J
320 V	25.2 J

If a shunt resistor is required, the next step is to calculate the value of resistance necessary to remove the energy. Use **Equations 3**, **4**, and **5** to calculate the size of the shunt resistor.

Equation 3:

$$R_{MAX} = \frac{V_M^2}{P_{PEAK}} \ (\Omega)$$

V_M = turn on voltage for shunt circuit (V) (= 380 V)
P_{PEAK} = peak power that the regeneration circuit must accommodate (W)

Equation 4:

$$P_{PEAK} = \frac{E_M - \frac{1}{2} C(V_M^2 - V_{NOM}^2)}{t_D} \ (\text{W})$$

E_M = kinetic energy of load minus system losses (Joules)
C = Bus capacitor (Farads)
V_M = turn on voltage for shunt circuit (V) (=380 V)
V_{NOM} = nominal Bus voltage (V) (160 V or 320 V Typical)
t_D = time to deceleration (seconds)

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Equation 5:

$$P_{AV} = \frac{E_M - \frac{1}{2}C\left(V_M^2 - V_{HYS}^2\right)}{t_{CYCLE}} \text{ (Watts)}$$

t_{CYCLE} = time between decelerations + time to deceleration (seconds)
V_{HYS} = hysteresis point of regeneration circuit (=10 V)

Additional useful equations:

1 lb-ft = 1.356 Nm

$$t_D = \frac{\left[J_n + J_l\right]\omega_m}{K_T * I_M} \text{ (Useful as an estimate if the deceleration time is unknown)}$$

Angular Acceleration $\alpha = \frac{d\omega}{dt} * 2\pi$ (radians / revolution)

Torque $T = K_t * I_m$

Load Inertia $J_L = \frac{T}{\alpha}$

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2.9. PC Configuration and Operation Information

For additional information about Soloist CP 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 16 digital opto-inputs, 16 digital opto-outputs, 1 analog input, 1 analog output, and a brake/relay output.

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

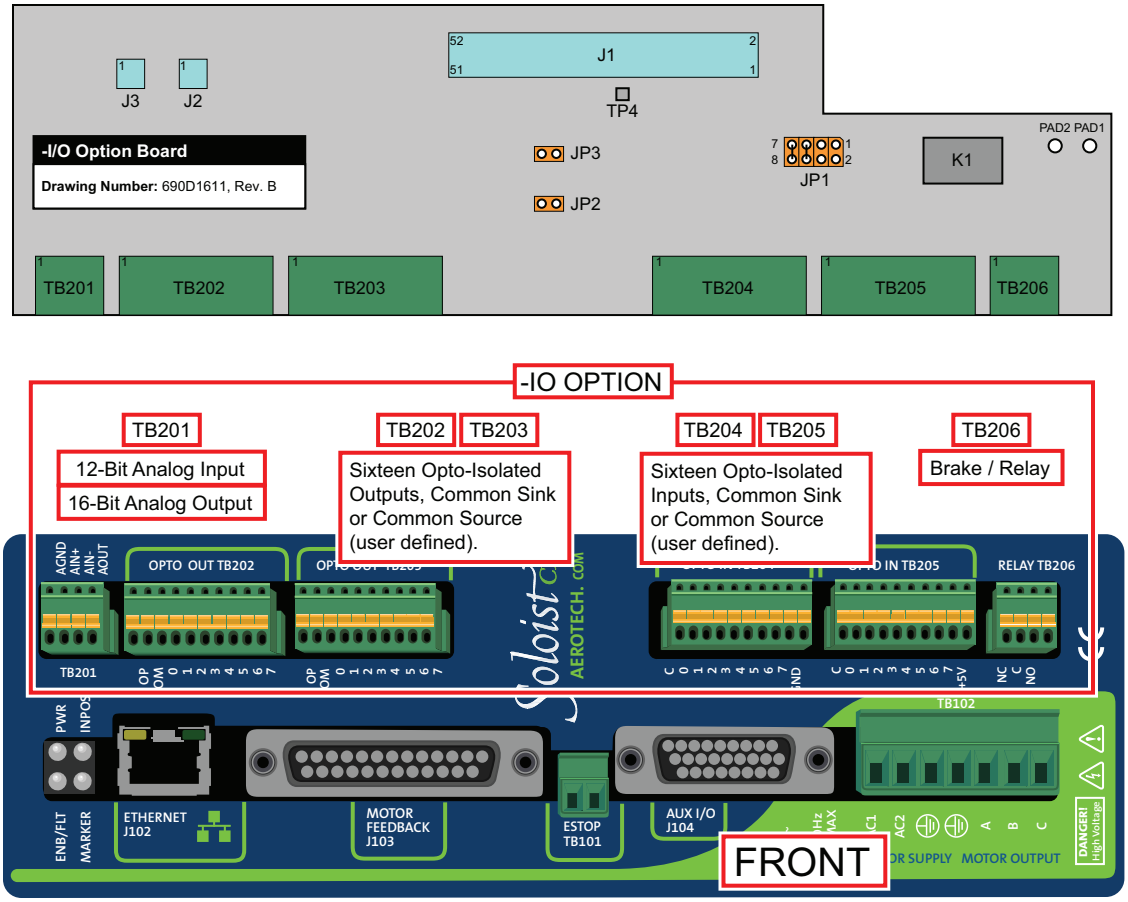


Figure 3-1: Soloist CP with -IO Option Board

Table 3-1: -IO Expansion Board Jumper Configuration

Jumper	Setting	Description
JP1	1-2, 3-4	Switch Brake +
	5-6, 7-8 (1)	Switch Brake -
	1-3	Relay Only
(1) default		

Table 3-2: -IO Option Board Fuse Information

Fuse	Description	Size	Aerotech P/N	Manufacturer's P/N
F1	+5 VDC User Power	3 A, resettable	EIF01001	Raychem RGE300

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3.1. Analog Output (TB201)

The 16-bit analog output produces a single-ended output voltage in the range of ±10 V with a resolution of 305 µV. The maximum recommended output current is 5 mA. Analog outputs are referenced to TB201-1. The analog output is set to zero when the system is powered-up or during a system reset.

NOTE: Analog Output 0 is available on J104 (see Section 2.5.7.).

Table 3-3: Analog Output Connector Pin Assignment (TB201)

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

Table 3-4: 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]

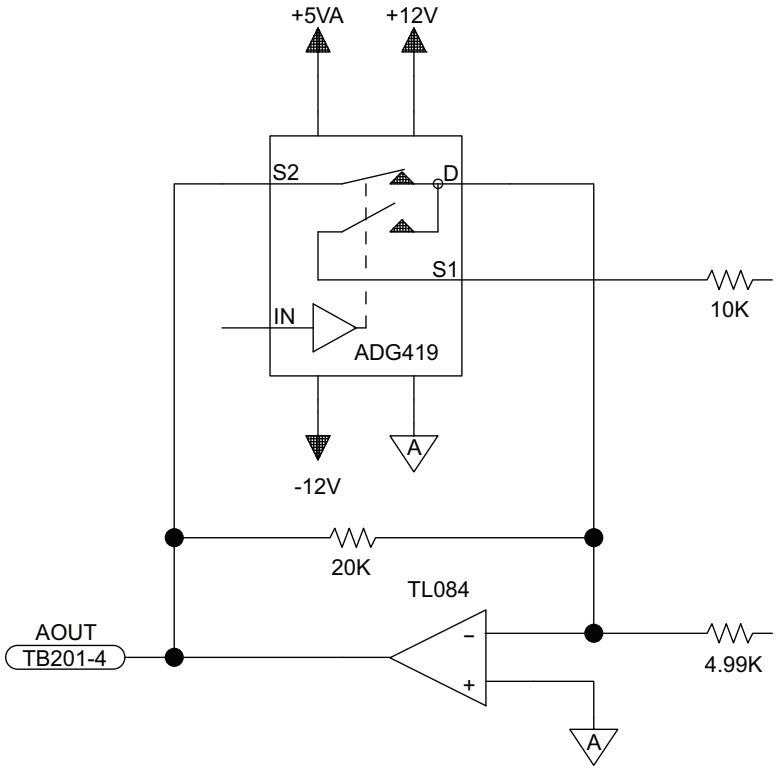


Figure 3-2: Analog Output 1 Connector (TB201)

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3.2. Analog Input (TB201)

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 3-3.

NOTE: Analog Input 0 is available on J104 (see Section 2.5.7.).

Table 3-5: Analog Inputs Connector Pin Assignment (TB201)

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

Table 3-6: 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]

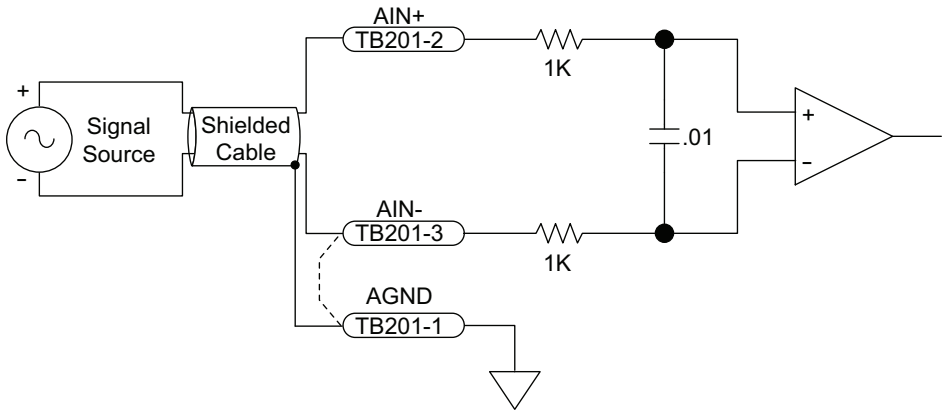


Figure 3-3: Analog Input Typical Connection (TB201)

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3.3. Opto-Isolated Inputs (TB204, TB205)

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 3-5 and Figure 3-6. See Section 2.3.5. for opto-isolated EOT limits.

Port 1 and Port 2 inputs have separate common inputs, pin 1 on TB204 and TB205, respectively. Each port can be referenced independently.

Table 3-7: 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 3-8: Port 1 Opto-Isolated Input Connector Pin Assignment (TB204)

Pin#	Description	In/Out/Bi
1	Input Common for inputs 0 - 7	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	Signal Common	N/A

Table 3-9: Port 2 Opto-Isolated Input Connector Pin Assignment (TB205)

Pin#	Description	In/Out/Bi
1	Input Common for inputs 0 - 7	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	Internal +5 Volt Power Supply (0.5 A max)	N/A

Table 3-10: 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]

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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: Each bank of 8 Inputs must be connected in the all sourcing or all sinking configuration.

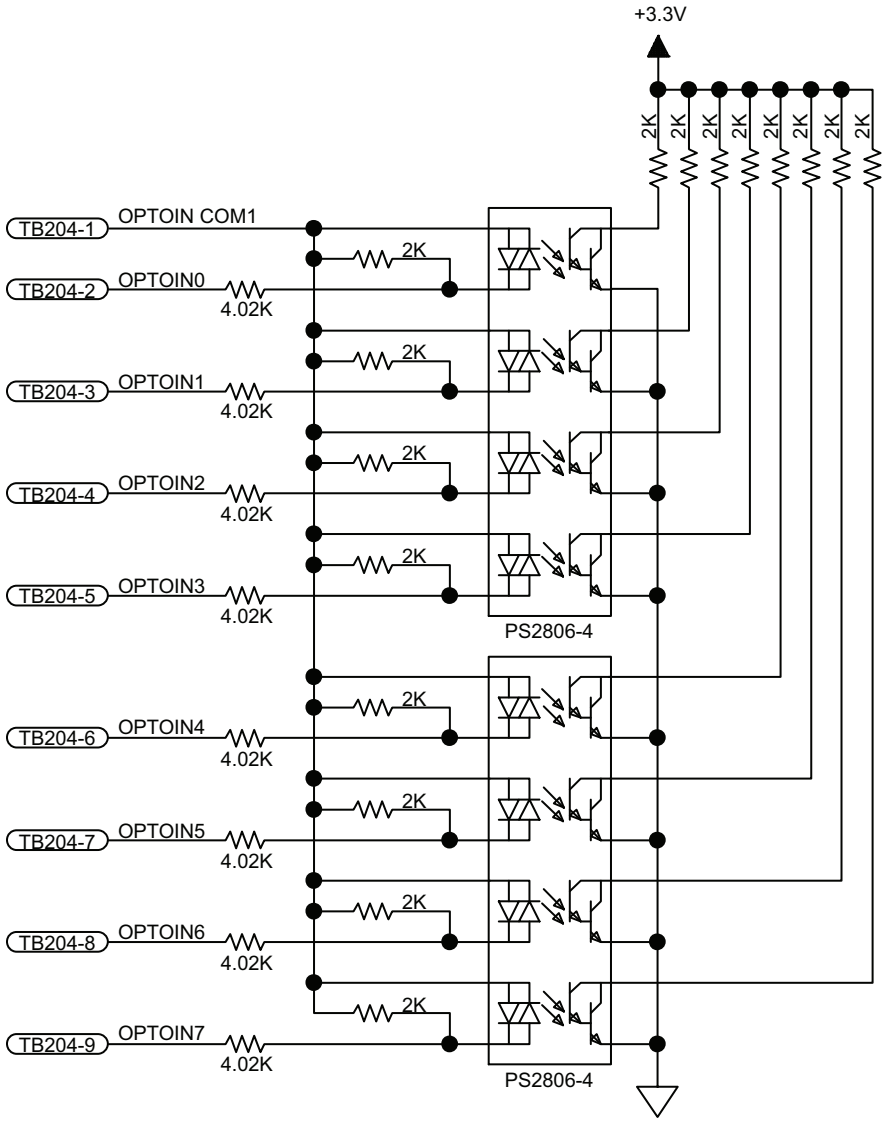


Figure 3-4: Opto-Isolated Inputs

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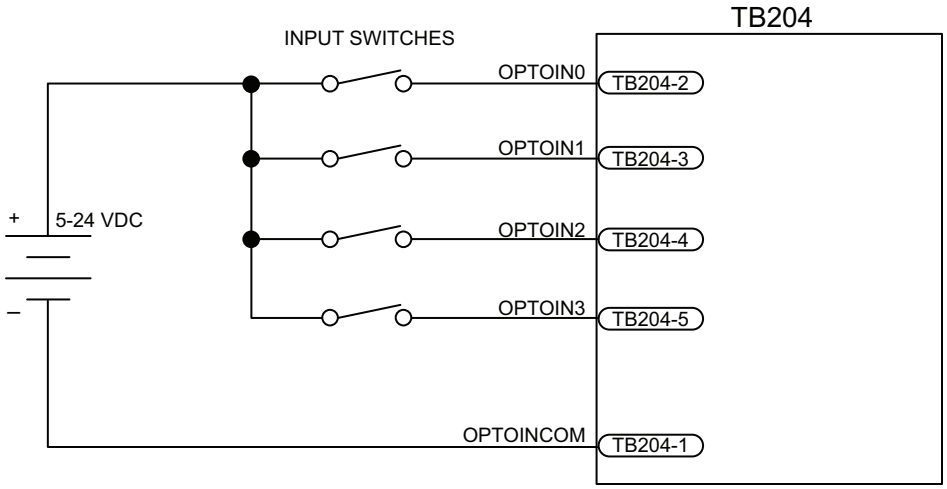


Figure 3-5: Inputs Connected to a Current Sourcing Device

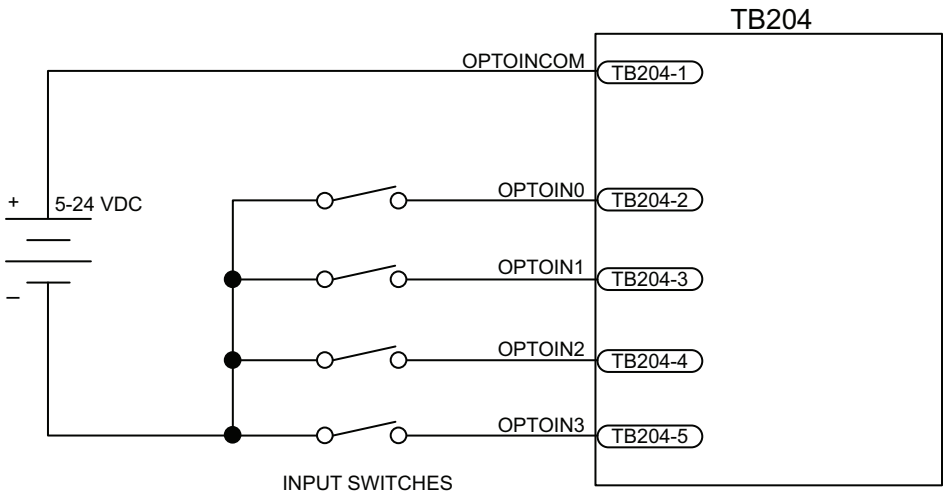


Figure 3-6: Inputs Connected to a Current Sinking Device

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3.4. Opto-Isolated Outputs (TB202, TB203)

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 3-8 and Figure 3-9 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 3-8 and Figure 3-9.

Table 3-11: Port 1 Opto-Isolated Output Connector Pin Assignment (TB202)

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 3-12: Port 2 Opto-Isolated Output Connector Pin Assignment (TB203)

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 3-13: 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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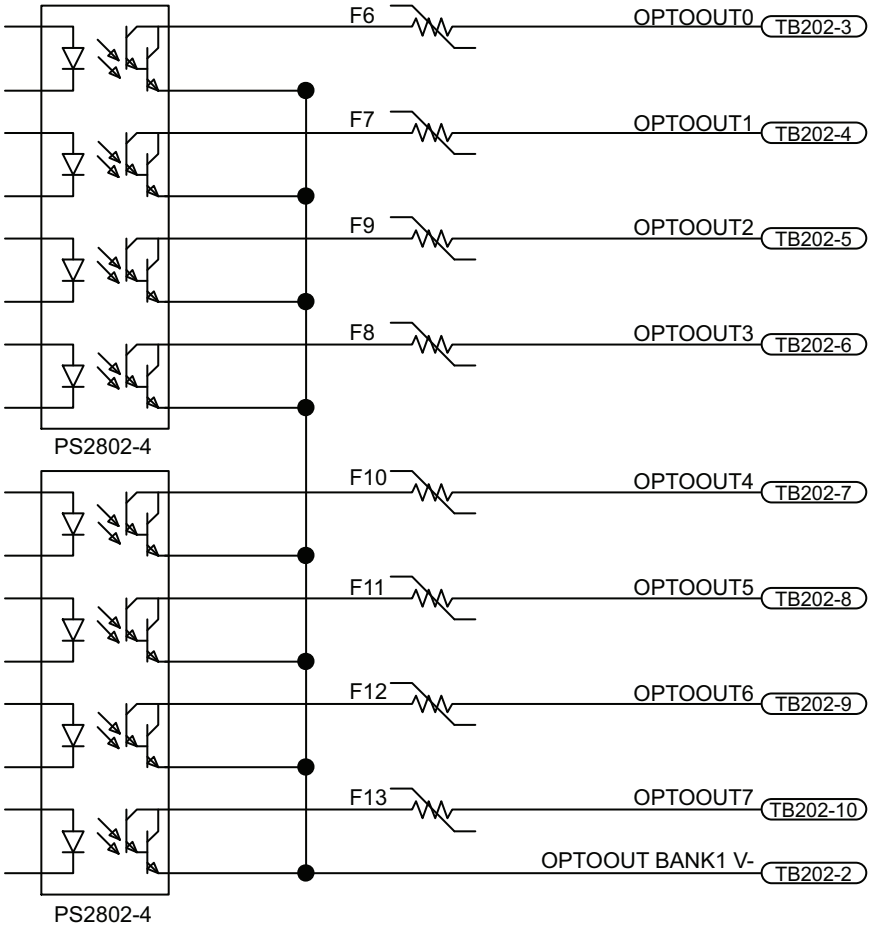


Figure 3-7: Opto-Isolated Outputs (-IO Board)

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Table 3-14: Output Specifications (TB202, TB203)

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.

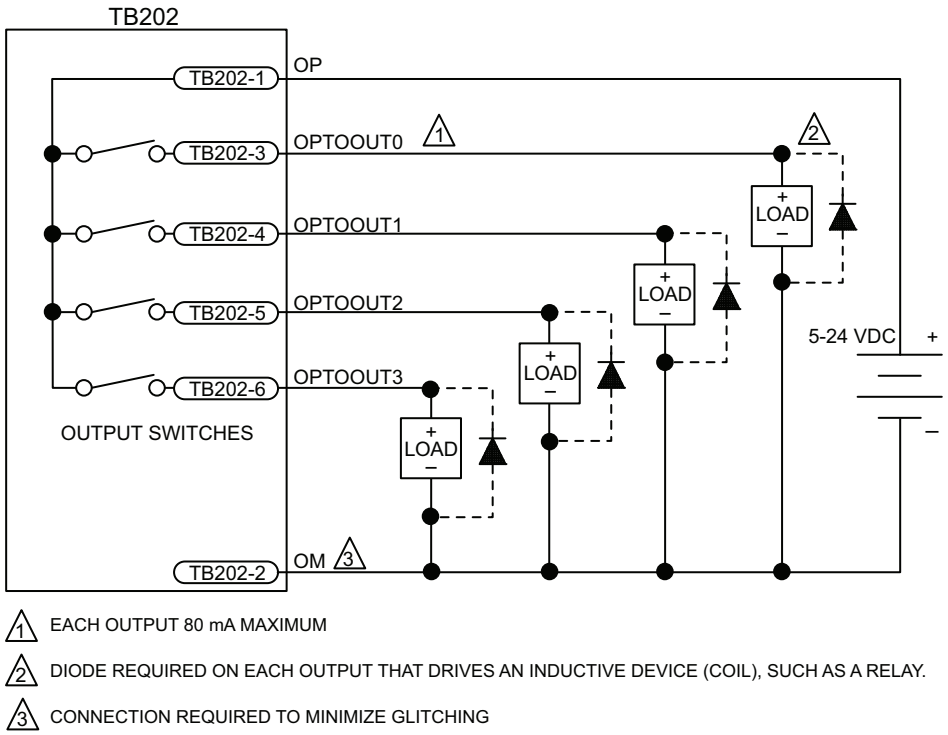


Figure 3-8: Outputs Connected in Current Sourcing Mode

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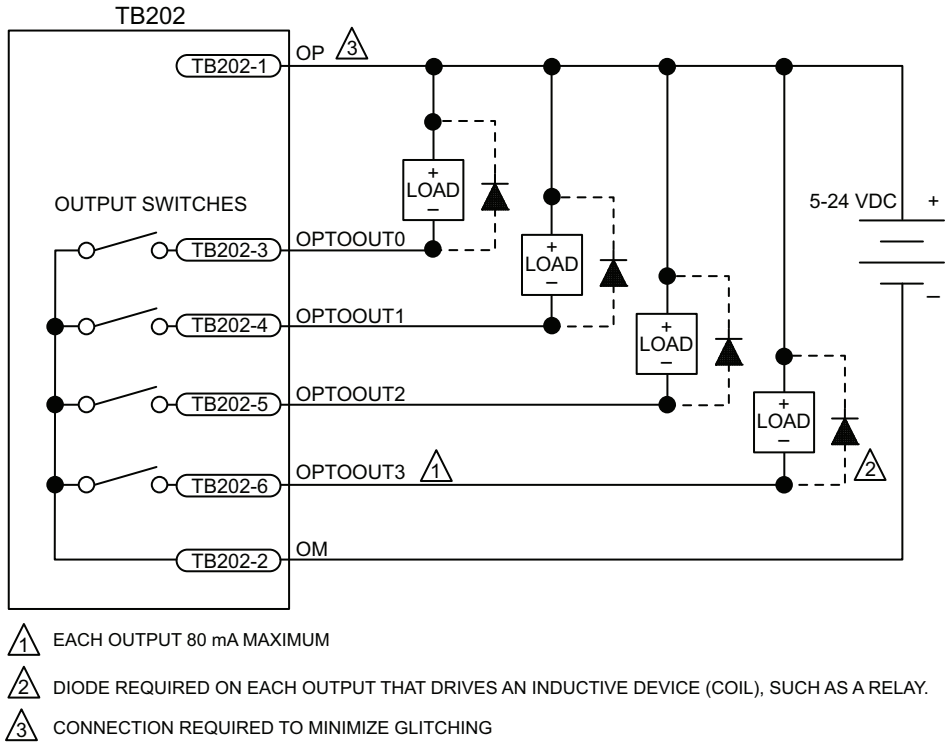


Figure 3-9: Outputs Connected in Current Sinking Mode

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 3-9 for an example of a current sinking output with diode suppression and Figure 3-8 for an example of a current sourcing output with diode suppression.

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3.5. User Power (TB204, TB205)

A user accessible power supply (+5V at 0.5 A) is available between the TB205 +5V terminal and TB204 GND terminal.

Table 3-15: User Common Connector Pin Assignment (TB204)

Pin#	Description	In/Out/Bi
10	Signal Common	N/A

Table 3-16: +5 Volt Power Connector Pin Assignment (TB205)

Pin#	Description	In/Out/Bi
10	Internal +5 Volt Power Supply (0.5 A max)	N/A

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3.6. Brake / Mechanical Relay (TB206)

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

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).

When TB206 is used to power the mechanical brake control relay, the solid state brake control relay (TB103) should not be used.

3.6.1. Brake Configuration Jumpers

The configuration of JP1 (Table 3-17) allows either the Brake + or the Brake - output to be switched by the relay and connected at the Motor Feedback connector (J103), or for the brake to be connected at TB206. Refer to Section 3.6.3. for more information.

JP1 is located on the -IO board (refer to Chapter 3).

Table 3-17: -IO Expansion Board Brake Jumper Configuration

Jumper	Setting	Description
JP1	1-2, 3-4	Switch Brake +
	5-6, 7-8 (1)	Switch Brake -
	1-3	Relay Only
(1) default		

3.6.2. Mechanical Relay Specifications

The user must verify that the application will be within the specifications of the Brake/Relay contacts. These specifications are provided below in Table 3-18.

Table 3-18: Voltage and Current Specifications (TB206)

Relay K1 Contact Ratings	
Maximum Switched Voltage	150 VDC, 125 VAC
Maximum Switched Current	1A
Maximum Carrying Current	1A
Maximum Switched Power	30 W (DC), 60 VA (AC)
NOTE: The maximum power that may be switched is voltage dependent.	
Initial Contact Resistance	50 milliohms max @ 10 mA, 6 VDC

NOTE: Do not exceed Maximum Current or Maximum Power specifications.

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

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3.6.3. Brake / Mechanical Relay Interface Connector

The normally-open relay contacts are accessible through TB206 and the Motor Feedback connector (J103). The normally-closed relay contact is only accessible through TB206 (see Figure 3-11). The Motor Feedback connector allows the brake wires to be included in the motor feedback cable and eliminate the need for a separate brake cable.

Table 3-19: Brake / Mechanical Relay Connector Pin Assignment (TB206)

Pin#	Description	In/Out/Bi
1	Brake Relay Output Normally Closed Contact	Output
2	Brake Relay Output Common Contact	Output
3	Brake Relay Output Normally Open Contact (1)	Output
(1) For JP1 jumper configuration, refer to Table 3-17		

Table 3-20: 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]

Table 3-21: Brake / Mechanical Relay Connector Pin Assignment (J103)

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

Figure 3-10 is an example of a +24 VDC Brake connected to J103, the Motor Feedback connector. In this example the external +24 power source is connected to TB206. Note that JP1 is set 1-2 and 3-4 with all others removed.

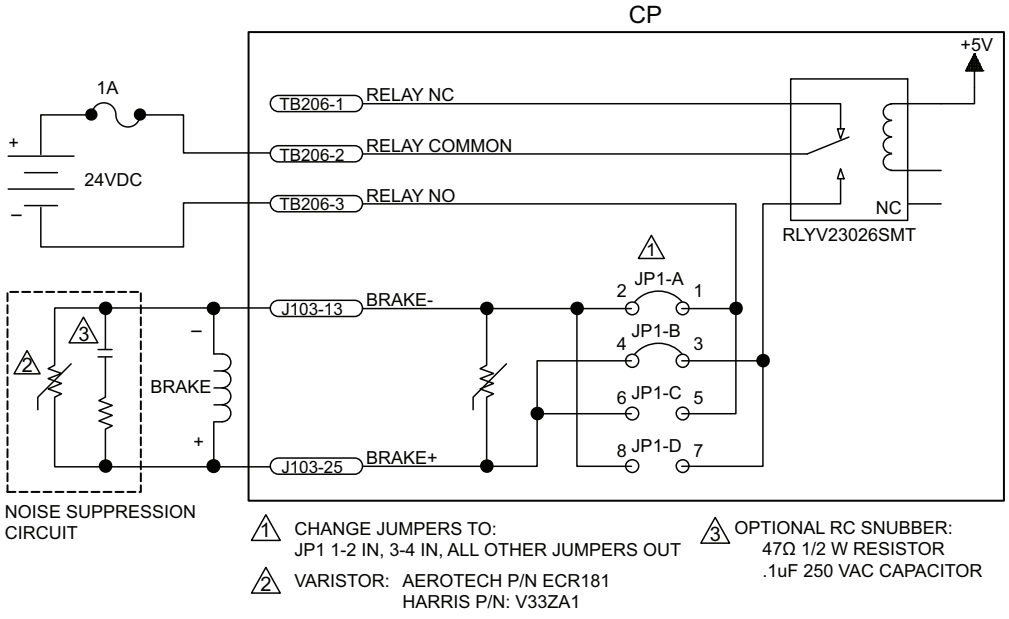


Figure 3-10: Brake Connected to J103

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

Figure 3-11 is an example of a +24 VDC Brake connected to TB206. In this example, JP1 must be set 1-3 and all other jumpers removed. Otherwise, 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.

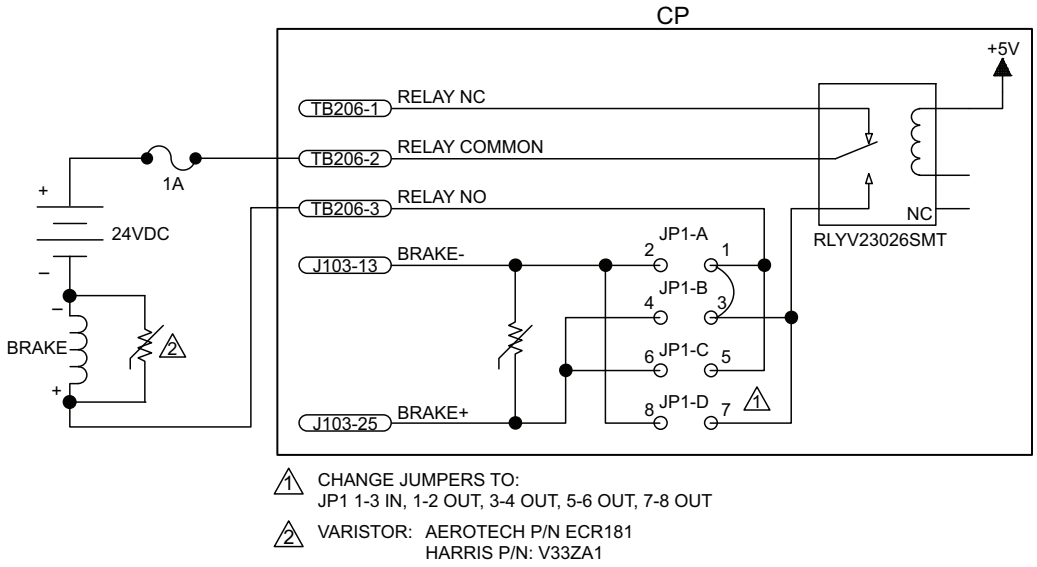


Figure 3-11: Brake Connected to TB206

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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 CPs). For cable details refer to Table 4-2.

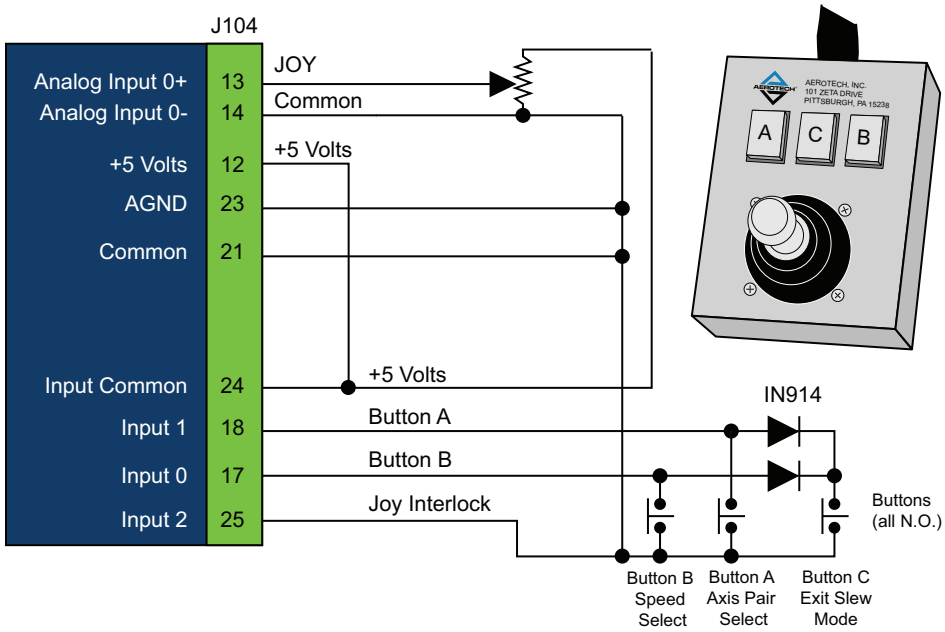


Figure 4-1: Single Axis Joystick Interface (to Aux I/O)

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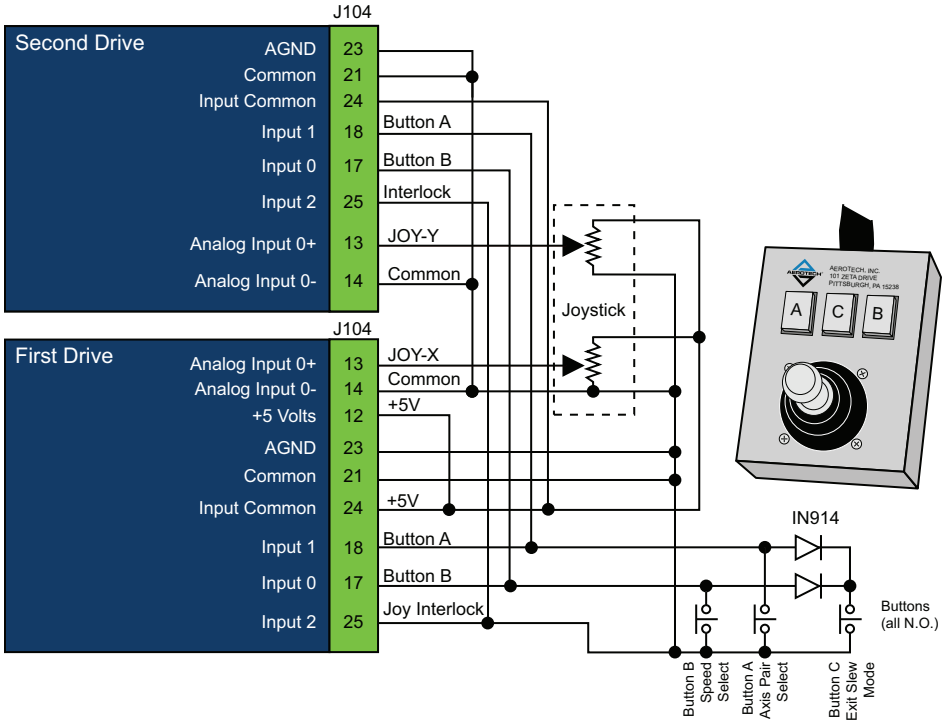


Figure 4-2: Two Axis Joystick Interface (to the Aux I/O of two drives)

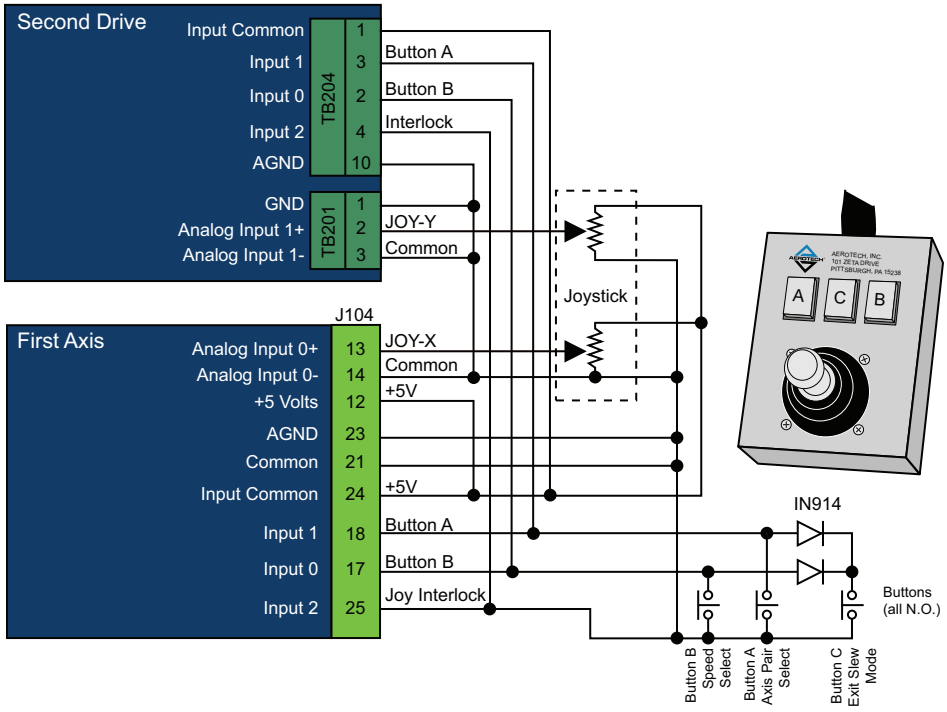


Figure 4-3: Two Axis Joystick Interface (to the Aux I/O and I/O Board)

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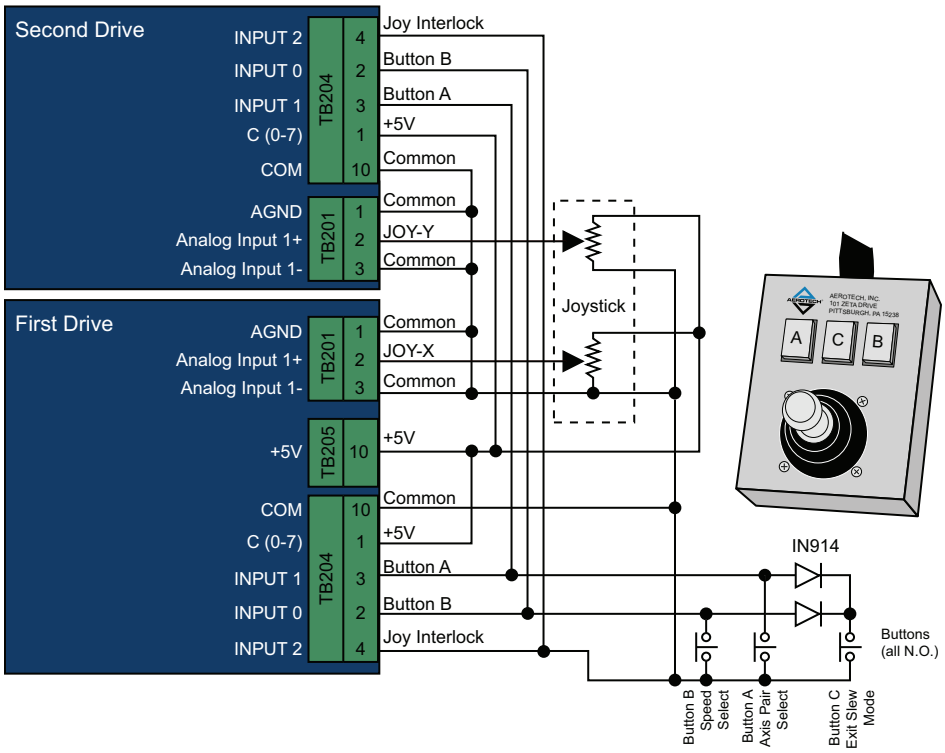


Figure 4-4: Two Axis Joystick Interface (to the I/O board of two drives)

Table 4-2: Cable Part Numbers

Part #	Cable Description	UPC #
C22763-XX	JSXT-FLY 26HD-15DU-MAX300DM SOLOISTCP DUAL AXIS	630B2276-3
C22764-XX	JSXT-26HD-15DU-MAX300DM SOLOISTCP SINGLE AXIS	630B2276-4
C22765-XX	JSXT-26HD 26HD-15DU-MAX300DM SOLOISTCP DUAL AXIS	630B2276-5
C227617XX	JSXT-FLY FLY-15DU-MAX300DM SOLOISTCP DUAL AXIS	630B2276-17

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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 CP.

A handwheel can be connected to the Aux I/O as shown in Figure 4-5 or Figure 4-6.

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

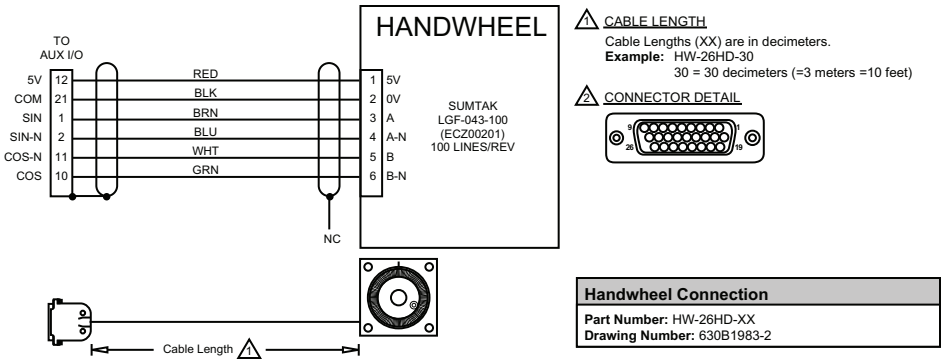


Figure 4-5: Handwheel Interconnection (to Aux I/O)

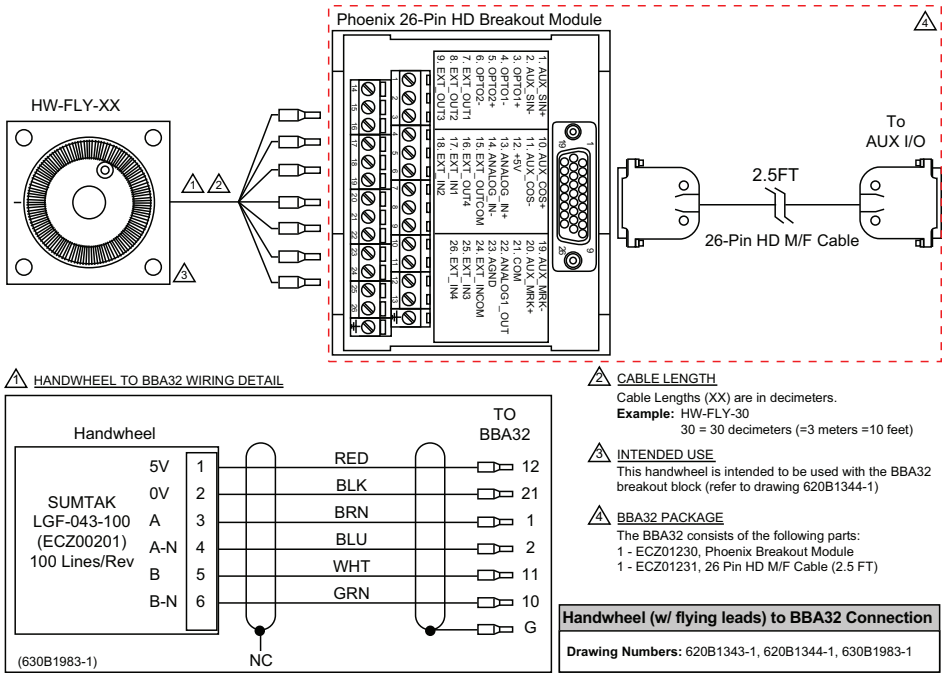


Figure 4-6: Handwheel Interconnection (to Aux I/O via a BBA32 Module)

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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 CP 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.
PWR*	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.

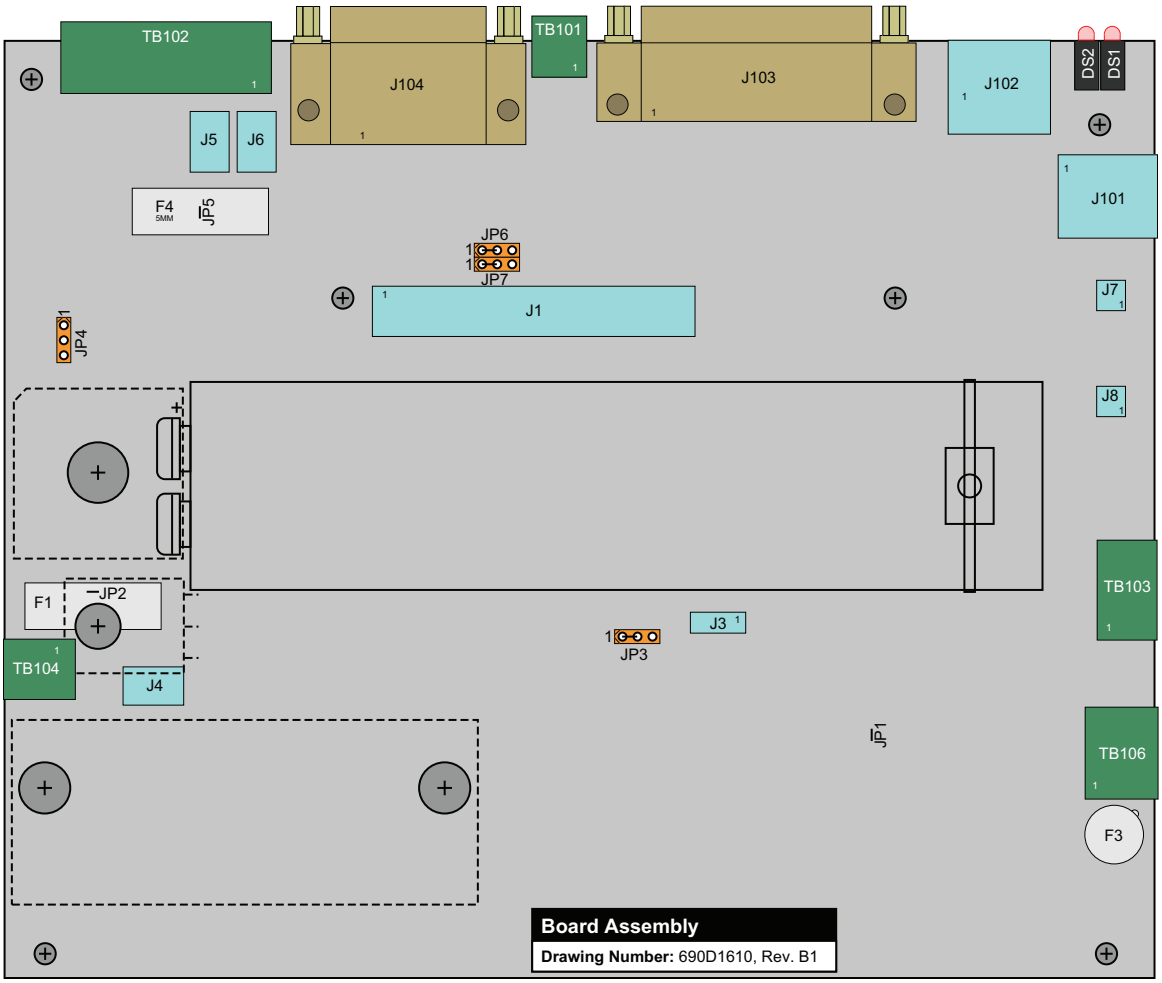


Figure 5-1: Control Board Assembly

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

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Table 5-2: Control Board Jumper Configuration

Jumper	Setting	Description
JP3	1-2 (1)	No shunt option present
	2-3	Shunt option present
JP5	1-2 (1)	Watchdog enabled
	2-3	Watchdog disabled
JP6	1-2 (1)	24 V operation (High Speed Input 4)
	2-3	5 V operation (High Speed Input 4)
JP7	1-2 (1)	24 V operation (High Speed Input 5)
	2-3	5 V operation (High Speed Input 5)
(1) Default		

Table 5-3: Control Board Fuse Information

Fuse	Description	Size	Aerotech P/N	Manufacturer's P/N
F1	Optional Shunt Fuse	2 A S.B. (5 mm)	EIF01019	LittelFuse 215002
F3	Control Power Fuse	2 A S.B.	EIF01029	LittelFuse 3721200041
F4	Soloist CP 10; VAC Input at TB102-1	5 A S.B. (5 mm)	EIF00179	Wickman 1951500
	SoloistCP 20; VAC Input at TB102-1	10 A S.B. (5 mm)	EIF01006	LittelFuse 218010
	SoloistCP 30; VAC Input at TB102-1	10 A S.B. (5 mm)	EIF01006	LittelFuse 218010

Table 5-4: 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.
PWR*	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 CP 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 5-5: Preventative Maintenance

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

Cleaning

The Soloist CP 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 CP 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 CP while cleaning. Do not allow cleaning substances or other fluids to enter the Soloist CP 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. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870	Aerotech China Full-Service Subsidiary Phone: +86 (21) 3319 7715	Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720

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

Have your customer order number ready before calling.

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Appendix B: Revision History

Revision	Date	Description
4.05.00	July 9, 2015	• Added TUV certification information: Agency Approvals • Added RoHS statement to Declaration of Conformity • Updated the Electrical Specifications (Input Power and related equation): Section 1.2. • Updated PSO maximum frequency specification: Table 2-28
4.04.00	September 7, 2012	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
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4.00.00	September 03, 2009	
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2.01.00	September 04, 2007	
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1.09	January 13, 2006	
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1.07	December 19, 2005	
1.06	December 01, 2005	
1.05	April 18, 2005	
1.04	April 12, 2005	
1.03	February 28, 2005	
1.02	December 23, 2004	
1.01	December 08, 2004	
1.00	October 12, 2004	

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Index

-

-EXTSHUNT Option 68

-I/O Expansion Board 73

-IO Board Fuse Information 73

-IO Expansion Board Brake Jumper Configuration 84

-IO Expansion Board Jumper Configuration 73

-IO Option Board 73

-IO Options 73

-MXU Option 35,38

+

+5 Volt Power Connector Pin Assignment 83

1

160 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 19

2

2006/95/EC ix

4

40 VDC Motor Power with a TV0.3-28-56-ST Transformer 15

40 Volt DC Bus from 115 and 230 VAC Source 17

8

80 VDC Motor Power with a TV0.3-28-56-ST Transformer 16

80 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 18

A

AC Line Filter 13,21

Altitude 10

Ambient Temperature 10

amplifier power dissipation 8

Analog Encoder Phasing Reference Diagram 38

Analog Encoder Specifications 38

Analog Input 62

Analog Input (I/O Board) 75

Analog Input 1 Connector 75

Analog Input Connector Pin Assignment 62

Analog Inputs Connector Pin Assignment 75

Analog Output 61

Analog Output 1 Connector 74

Analog Output 1 Connector Pin Assignment 74

Analog Outputs (I/O Board) 74

Auxiliary Encoder Channel 52-53

Auxiliary Encoder Channel Pin Assignment 52,54

Auxiliary I/O Connector 51

Auxiliary I/O Connector Pin Assignment 51

B

Brake / Mechanical Relay 84

Brake / Mechanical Relay Connector Pin Assignment 85

Brake / Mechanical Relay Interface Connector 85

Brake Configuration Jumpers 84

Brake Connected to J103 85

Brake Connected to J207 64

Brake Connected to TB20 65

Brake Connected to TB206 86

Brake Output 48

Brake Output Connector Pin Assignment 63

Brake Output Pin Assignment 48

Brake Power Supply 63

Brushless Motor Connections 23

Brushless Motor Phasing Goal 28

C

Check chassis for loose or damaged parts / hardware 96

Check for fluids or electrically conductive material exposure 96

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Cleaning 96
Continuous Output Current specifications 6
Control and Motor Power Wiring using a TM3 or TM5 Transformer 20
Control Board 94
Control Board Assembly 94
Control Board Fuse Information 95
Control Board Jumper Configuration 95
Control Supply AC Input Wiring 12
Control Supply Connections 12
Control Supply Mating Connector 12
Control Supply specifications 6

D

DC Brush Motor Connections 29
DC Brush Motor Phasing 30
Declaration of Conformity ix
Digital Input Connector Pin Assignment 58
Digital Input Specifications 76
Digital Output Connector Pin Assignment 56
Digital Output Specifications 56
dimensions 9
Drive and Software Compatibility 5

E

Efficiency of Power Amplifier specifications 6
Electrical Noise Suppression Devices 49
Electrical Specifications 6
Emergency Stop Sense Input 49
EN 61010-1 ix
encoder
absolute 36-37
Encoder and Hall Signal Diagnostics 25
Encoder Fault Interface (J207) 44
Encoder Fault Interface Input 44
Encoder Fault Interface Pin Assignment 44
Encoder Interface (J207) 34
Encoder Interface Pin Assignment 34
Encoder Phasing 24,40
Encoder Phasing Reference Diagram 40
End of Travel Limit Input Connections 45
End Of Travel Limit Input Interface (J207) 45
End of Travel Limit Input Interface Pin Assignment 45
End of Travel Limit Interface Input 46
End Of Travel Limit Phasing 47
EnDat Encoder Interface 36
Environmental Specifications 10
ESTOP sense input 49
external emergency stop relay circuit 50

F

Feedback Monitoring 24

H

Hall-Effect Feedback Interface Pin Assignment 42-43
Hall-Effect Inputs 42
Hall-Effect Interface 42
Hall Signal Phasing 24
Handwheel Interconnection 91
Handwheel Interface 91
High Speed Digital Input Connector Pin Assignment 60
High Speed User Inputs 60
Humidity 10

I

I/O board analog inputs 75
Input Voltage Jumper Configuration 60
Inputs Connected in Current Sinking Mode 59
Inputs Connected in Current Sourcing Mode 59

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Inputs Connected to a Current Sinking Device 78
Inputs Connected to a Current Sourcing Device 78
inspect all cables and connections 96
Inspect cooling vents 96
Inspection 96
Installation and Configuration 11
Isolation 6

J

J103 24,33-37,39,42-45,45-46,48,63-65,84-86
J104 51-52,54,56-62
Joystick Interface 88

L

Limit Input Diagnostic Display 47
Line Driver Encoder Interface 35

M

Mating Connector 63
Maximum Storage Energy 69
Mechanical Design 9
Mechanical Relay Specifications 84
Minimizing Conducted, Radiated, and System Noise 21
Minimum Load Inductance specifications 6
Modes of Operation 6
Motor Feedback Connections 33
Motor Feedback Connector Pin Assignment 33
Motor Phasing Oscilloscope Example 26
Motor Supply Connections 13
Motor Supply Input Wiring 21
Motor Supply specifications 6
Multi-axis PSO 54

N

Nominal Motor Operating Voltages / Required AC Voltages 14

O

optional joysticks 88
Options 2
Opto-Isolated Input Connector Pin Assignment 76
Opto-Isolated Inputs 58,76-77
Opto-Isolated Output Connector Pin Assignment 79
Opto-Isolated Outputs 56,79
Opto-Isolated Outputs (-IO Board) 80
Output Specifications 81
Output Voltage specifications 6
Outputs Connected in Current Sinking Mode 57,82
Outputs Connected in Current Sourcing Mode 57,81

P

PC Configuration and Operation Information 71
Peak Output Current specifications 6
Pollution 10
Position Feedback in the Diagnostic Display 41
Position Synchronized Output (PSO) feature 54
Position Synchronized Output (PSO)/Laser Firing 54
Power Amplifier Bandwidth specifications 6
Power Dissipation 8
Powered Motor Phasing 24
Preventative Maintenance 96
Protective Features 6
PS2802-4 opto-isolators 79
PS2806-4 device 76
PS2806-4 Opto-Device Specifications 58
PSO 54
PSO Interface 55
PSO Output Sources 54
PWM Switching Frequency specifications 6

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Q

Quick Installation Guide xiii

R

Recommended Shunt Resistors & Wire Gauge 68

relative phasing/order 26

Relay Specifications 66

Resolute Encoder Interface 37

RS-232 Connector Pin Assignment 67

RS-232 Interface 67

RS-232 Port Connector Mating Connector 67

RS-422 Line Driver Encoder (Standard) 35

S

serial data stream 36-37

Single Axis Joystick Interface 88

solid state brake control relay 63

Solid State Relay Rating 66

Solid State Relay Specifications 66

Standard Features 2

Stepper Motor Connections 31

Stepper Motor Phasing 32

T

TB101 49

TB102 13,22

TB103 63-67,84

TB104 68

TB106 12

TB201 74-75

TB202 79,81

TB203 79,81

TB204 76,83

TB205 76,83

TB206 84-86

Thermistor Interface 43

Thermistor Interface Input 43

Transformer Examples 14

Transformer Options 14

TV0.3-28-56-ST Transformer 16

TV0.3-56 19

two-axis joystick 88

Two Axis Joystick Interface 89

Typical Emergency Stop Circuit 50

Typical ESTOP Interface 50

U

UFM-ST 21

unit separation 9

unit weight 9

Unpowered Motor and Feedback Phasing 26

Use 10

User Common Connector Pin Assignment 83

User Power 83

User Power Supply specifications 6

V

verifying motor connections 23

Voltage and Current Specifications 84

W

Wire Colors for Supplied Cables 23,29,31

Wiring

Control Supply 12

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