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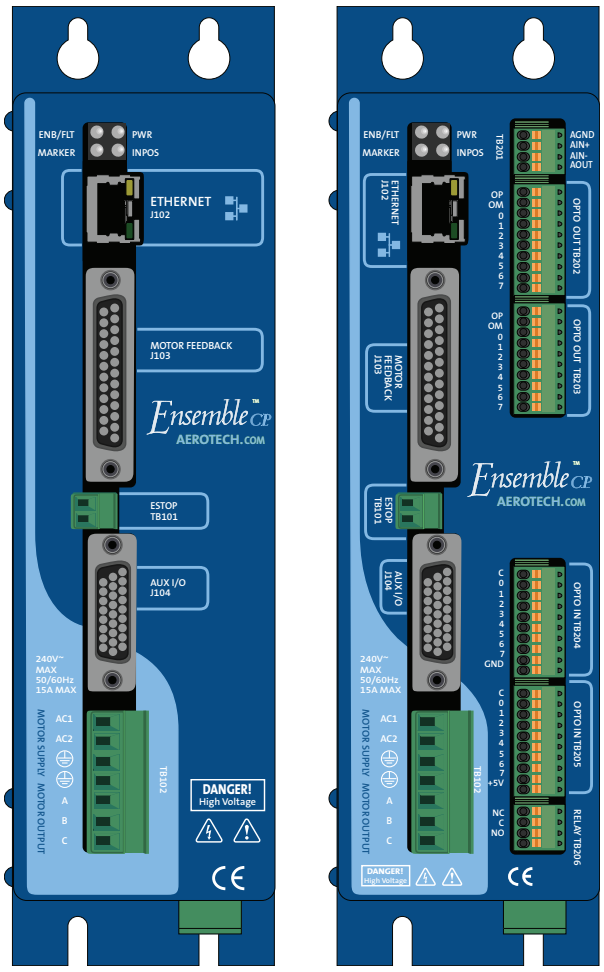
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Ensemble CP Hardware Manual

Revision: 4.07.00



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Table of Contents

Ensemble CP Hardware Manual **1**
Table of Contents 3
List of Figures 5
List of Tables 7
EU Declaration of Conformity 9
Agency Approvals 10
Safety Procedures and Warnings 11
Quick Installation Guide 13

Chapter 1: Introduction **15**
1.1. Drive and Software Compatibility 18
1.2. Electrical Specifications 19
1.2.1. System Power Requirements 20
1.2.2. Power Dissipation 21
1.3. Mechanical Design 22
1.4. Environmental Specifications 23

Chapter 2: Installation and Configuration **25**
2.1. Power Connections 25
2.1.1. Control Supply Connections (TB106) 26
2.1.2. Motor Supply Connections (TB102) 27
2.1.3. Transformer Options 28
2.1.4. Minimizing Conducted, Radiated, and System Noise 35
2.2. Motor Output Connections 36
2.2.1. Brushless Motor Connections 37
2.2.1.1. Powered Motor Phasing 38
2.2.1.2. Unpowered Motor and Feedback Phasing 39
2.2.2. DC Brush Motor Connections 40
2.2.2.1. DC Brush Motor Phasing 41
2.2.3. Stepper Motor Connections 42
2.2.3.1. Stepper Motor Phasing 43
2.3. Motor Feedback Connections (J103) 44
2.3.1. Encoder Interface (J103) 45
2.3.1.1. RS-422 Line Driver Encoder (Standard) 46
2.3.1.2. EnDat Encoder Interface (J103) 47
2.3.1.3. Resolute Encoder Interface (J103) 48
2.3.1.4. Analog Encoder Interface 49
2.3.1.5. Encoder Phasing 51
2.3.2. Hall-Effect Interface (J103) 53
2.3.3. Thermistor Interface (J103) 54
2.3.4. Encoder Fault Interface (J103) 55
2.3.5. End Of Travel Limit Input Interface (J103) 56
2.3.5.1. End Of Travel Limit Phasing 58
2.3.6. Brake Output (J103) 59
2.4. Emergency Stop Sense Input (TB101) 60
2.4.1. Typical ESTOP Interface 61
2.5. Auxiliary I/O Connector (J104) 62
2.5.1. Auxiliary Encoder Channel (J104) 63
2.5.2. Position Synchronized Output (PSO)/Laser Firing (J104) 65
2.5.3. Opto-Isolated Outputs (J104) 67
2.5.4. Opto-Isolated Inputs (J104) 69
2.5.5. High-Speed User Inputs 4-5 (J104) 71
2.5.6. Analog Output 0 (J104) 72

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2.5.7. Differential Analog Input 0 (J104) 73
2.6. Brake Power Supply (TB103) 74
2.6.1. Solid State Relay Specifications (TB103) 77
2.7. Aeronet Interface (J107/J108) 78
2.8. RS-232 Interface (TB103) 79
2.9. -EXTSHUNT Option (TB104) 80
2.10. PC Configuration and Operation Information 83

Chapter 3: -I/O Expansion Board 85
3.1. Analog Output (TB201) 86
3.2. Analog Input (TB201) 87
3.3. Opto-Isolated Inputs (TB204, TB205) 88
3.4. Opto-Isolated Outputs (TB202, TB203) 91
3.5. User Power (TB204, TB205) 95
3.6. Brake / Mechanical Relay (TB206) 96
3.6.1. Brake Configuration Jumpers 96
3.6.2. Mechanical Relay Specifications 96
3.6.3. Brake / Mechanical Relay Interface Connector 97

Chapter 4: Standard Interconnection Cables 99
4.1. Joystick Interface 100
4.2. Handwheel Interface 103

Chapter 5: Maintenance 105
5.1. Control Board 106
5.2. Preventative Maintenance 108

Appendix A: Warranty and Field Service 109

Appendix B: Revision History 111

Index 113

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List of Figures

Figure 1-1: Ensemble CP Networked Digital Drive 15
Figure 1-2: Functional Diagram 17
Figure 1-3: Power Dissipation vs. Output Current 21
Figure 1-4: Ambient Temperature vs. Power Dissipation 21
Figure 1-5: Dimensions 22
Figure 2-1: Control Supply Connections 26
Figure 2-2: Motor Bus Input Connections 27
Figure 2-3: Transformer Examples 28
Figure 2-4: 40 VDC Motor Power with a TV0.3-28-56-ST Transformer 29
Figure 2-5: 80 VDC Motor Power with a TV0.3-28-56-ST Transformer 30
Figure 2-6: 40 Volt DC Bus from 115 and 230 VAC Source 31
Figure 2-7: 80 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 32
Figure 2-8: 160 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 33
Figure 2-9: Control and Motor Power Wiring using a TM3 or TM5 Transformer 34
Figure 2-10: AC Line Filter (UFM-ST) 35
Figure 2-11: Brushless Motor Configuration 37
Figure 2-12: Encoder and Hall Signal Diagnostics 38
Figure 2-13: Motor Phasing Oscilloscope Example 39
Figure 2-14: Brushless Motor Phasing Goal 39
Figure 2-15: DC Brush Motor Configuration 40
Figure 2-16: Clockwise Motor Rotation 41
Figure 2-17: Stepper Motor Configuration 42
Figure 2-18: Clockwise Motor Rotation 43
Figure 2-19: Line Driver Encoder Interface (J103) 46
Figure 2-20: Serial Data Stream Interface 47
Figure 2-21: Serial Data Stream Interface 48
Figure 2-22: Analog Encoder Phasing Reference Diagram 49
Figure 2-23: Analog Encoder Interface (J103) 50
Figure 2-24: Encoder Phasing Reference Diagram (Standard) 51
Figure 2-25: Position Feedback in the Diagnostic Display 52
Figure 2-26: Hall-Effect Inputs (J103) 53
Figure 2-27: Thermistor Interface Input (J103) 54
Figure 2-28: Encoder Fault Interface Input (J103) 55
Figure 2-29: End of Travel Limit Input Connections 56
Figure 2-30: End of Travel Limit Interface Input (J103) 57
Figure 2-31: Limit Input Diagnostic Display 58
Figure 2-32: ESTOP Sense Input (TB101) 60
Figure 2-33: Typical Emergency Stop Circuit 61
Figure 2-34: Auxiliary Encoder Channel (J104) 64
Figure 2-35: PSO Interface 66
Figure 2-36: Outputs Connected in Current Sourcing Mode (J104) 68
Figure 2-37: Outputs Connected in Current Sinking Mode (J104) 68
Figure 2-38: Inputs Connected in Current Sourcing Mode (J104) 70
Figure 2-39: Inputs Connected in Current Sinking Mode (J104) 70
Figure 2-40: High-Speed User Inputs (J104) 71
Figure 2-41: Analog Output 0 (J104) 72
Figure 2-42: Analog Input 0 (J104) 73
Figure 2-43: Brake Connected to J103 75
Figure 2-44: Brake Connected to TB103 76
Figure 2-45: Aeronet Connection with Three Discrete Drives 78
Figure 2-46: RS-232 Interface (TB103) 79

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Figure 3-1: Ensemble CP with -IO Option Board 85
Figure 3-2: Analog Output Connector (TB201) 86
Figure 3-3: Analog Input Typical Connection (TB201) 87
Figure 3-4: Opto-Isolated Inputs 89
Figure 3-5: Inputs Connected to a Current Sourcing Device 90
Figure 3-6: Inputs Connected to a Current Sinking Device 90
Figure 3-7: Opto-Isolated Outputs (-IO Board) 93
Figure 3-8: Outputs Connected in Current Sourcing Mode 94
Figure 3-9: Outputs Connected in Current Sinking Mode 94
Figure 3-10: Brake Connected to J103 98
Figure 3-11: Brake Connected to TB206 98
Figure 4-1: Single Axis Joystick Interface (to Aux I/O) 100
Figure 4-2: Two Axis Joystick Interface (to the Aux I/O of two drives) 101
Figure 4-3: Two Axis Joystick Interface (to the Aux I/O and I/O Board) 101
Figure 4-4: Two Axis Joystick Interface (to the I/O board of two drives) 102
Figure 4-5: Handwheel Interconnection (to Aux I/O) 103
Figure 4-6: Handwheel Interconnection (to Aux I/O via a BBA32 Module) 104
Figure 5-1: Control Board Assembly 106

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List of Tables

Table 1-1: Feature Summary 16
Table 1-2: Drive and Software Compatibility 18
Table 1-3: Electrical Specifications 19
Table 1-4: Physical Specifications 22
Table 2-1: Control Supply AC Input Wiring 26
Table 2-2: Control Supply Mating Connector 26
Table 2-3: Motor Supply Mating Connector 27
Table 2-4: Nominal Motor Operating Voltages / Required AC Voltages 28
Table 2-5: Transformer Options 28
Table 2-6: Ferrite Noise Suppression Numbers 35
Table 2-7: UFM-ST Electrical Specifications 35
Table 2-8: Motor Power Output Connections (TB102) 36
Table 2-9: Motor Power Output Mating Connector 36
Table 2-10: Wire Colors for Aerotech Supplied Cables (Brushless) 37
Table 2-11: Wire Colors for Aerotech Supplied Cables (DC Brush) 40
Table 2-12: Wire Colors for Aerotech Supplied Cables (Stepper) 42
Table 2-13: Motor Feedback Connector Pin Assignment (J103) 44
Table 2-14: Encoder Interface Pin Assignment 45
Table 2-15: Encoder Specifications 46
Table 2-16: Analog Encoder Specifications 49
Table 2-17: Hall-Effect Feedback Interface Pin Assignment (J103) 53
Table 2-18: Thermistor Interface Pin Assignment (J103) 54
Table 2-19: Encoder Fault Interface Pin Assignment (J103) 55
Table 2-20: End of Travel Limit Input Interface Pin Assignment (J103) 56
Table 2-21: Brake Output Pin Assignment (J103) 59
Table 2-22: Electrical Noise Suppression Devices 60
Table 2-23: TB101 Mating Connector 60
Table 2-24: Typical ESTOP Relay Ratings 61
Table 2-25: Auxiliary I/O Connector Pin Assignment (J104) 62
Table 2-26: Auxiliary Encoder Specifications 63
Table 2-27: Auxiliary Encoder Channel Pin Assignment (J104) 63
Table 2-28: PSO Specifications 65
Table 2-29: PSO Output Pin Assignment (J104) 65
Table 2-30: Digital Output Specifications 67
Table 2-31: Port 0 Digital Output Connector Pin Assignment (J104) 67
Table 2-32: Opto-Isolated Input Specifications 69
Table 2-33: Port 0 Digital Input Connector Pin Assignment (J104) 69
Table 2-34: High-Speed Input Specifications 71
Table 2-35: Port 0 High Speed Digital Input Connector Pin Assignment (J104) 71
Table 2-36: Input Voltage Jumper Configuration 71
Table 2-37: Analog Output 0 Specifications (TB102 B) 72
Table 2-38: Analog Output Connector Pin Assignment (J104) 72
Table 2-39: Differential Analog Input 0 Specifications 73
Table 2-40: Analog Input Connector Pin Assignment (J104) 73
Table 2-41: Brake Output Connector Pin Assignment (TB103) 74
Table 2-42: Mating Connector (TB103) 74
Table 2-43: Brake Output Connector Pin Assignment (J103) 74
Table 2-44: Relay Specifications 77
Table 2-45: Aeronet Cable Part Numbers 78
Table 2-46: RS-232 Connector Pin Assignment (TB103) 79
Table 2-47: RS-232 Port Connector Mating Connector (TB103) 79

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Table 2-48: -EXTSHUNT Component Information 80
Table 2-49: Maximum Storage Energy 81
Table 3-1: -IO Expansion Board Jumper Configuration 85
Table 3-2: -IO Option Board Fuse Information 85
Table 3-3: Analog Output Specifications (TB102 B) 86
Table 3-4: Analog Output Connector Pin Assignment (TB201) 86
Table 3-5: Analog Output Mating Connector 86
Table 3-6: Differential Analog Input 1 Specifications 87
Table 3-7: Analog Inputs Connector Pin Assignment (TB201) 87
Table 3-8: Analog Input Mating Connector 87
Table 3-9: Opto-Isolated Input Device Specifications 88
Table 3-10: Port 1 Opto-Isolated Input Connector Pin Assignment (TB204) 88
Table 3-11: Port 2 Opto-Isolated Input Connector Pin Assignment (TB205) 88
Table 3-12: Opto-Isolated Input Mating Connector 88
Table 3-13: Output Specifications (TB202, TB203) 91
Table 3-14: Port 1 Opto-Isolated Output Connector Pin Assignment (TB202) 92
Table 3-15: Port 2 Opto-Isolated Output Connector Pin Assignment (TB203) 92
Table 3-16: Opto-Isolated Output Mating Connector 92
Table 3-17: User Common Connector Pin Assignment (TB204) 95
Table 3-18: +5 Volt Power Connector Pin Assignment (TB205) 95
Table 3-19: -IO Expansion Board Brake Jumper Configuration 96
Table 3-20: Voltage and Current Specifications (TB206) 96
Table 3-21: Brake / Mechanical Relay Connector Pin Assignment (TB206) 97
Table 3-22: Mating Connector for TB206 97
Table 3-23: Brake / Mechanical Relay Connector Pin Assignment (J103) 97
Table 4-1: Standard Interconnection Cables 99
Table 4-2: Cable Part Numbers 102
Table 5-1: LED Description 105
Table 5-2: Control Board Jumper Configuration 107
Table 5-3: Control Board Fuse Information 107
Table 5-4: LED Description 107
Table 5-5: Preventative Maintenance 108

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EU Declaration of Conformity

Manufacturer	Aerotech, Inc.
Address	101 Zeta Drive Pittsburgh, PA 15238-2897 USA
Product	Ensemble CP
Model/Types	All

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

2014/30/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive LVD
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 55011:1998	RFI Limits and Measurement
EN 61800-3:2004	EMC requirements for power drives
EN 61000-3-2:2000	Harmonic Current Emissions
EN 61000-3-3:1995	Voltage Fluctuation and Flicker
EN 61000-4-2:1995	ESD Immunity
EN 61000-4-3:2002	Radiated RFI/EMI Immunity
EN 61000-4-4:1995	EFT/Burst Immunity
EN 61000-4-5:1995	Surge Immunity
EN 61000-4-6:1996	Conducted Immunity
EN 61000-4-11:1994	Voltage Dips and Interruptions
EN 61010-1:2010	Safety requirements for electrical equipment

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

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Agency Approvals

Aerotech, Inc. Model Ensemble 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 17 01 68995 023
Standards:	UL 61010-1:2004; CAN/CSA-C22.2 No. 61010-1:2004; EN 61010-1:2010

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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 Ensemble 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 Ensemble CP inside a rack or enclosure.
6. The shunt resistor temperature can exceed 70°C during normal operation and contains lethal voltage on its terminals and surface. It must be properly enclosed and shielded to avoid risk of fire and operator shock.
7. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
8. All components must be properly grounded in accordance with local electrical safety requirements.
9. Operator safeguarding requirements must be addressed during final integration of the product.



DANGER: The Ensemble 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 this product to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
5. If the product is used in a manner not specified by the manufacturer, the protection provided by the product can be impaired and result in damage, shock, injury, or death.
6. Operators must be trained before operating this equipment.
7. All service and maintenance must be performed by qualified personnel.
8. This product is intended for light industrial manufacturing or laboratory use. Use of this product for unintended applications can result in injury and damage to the equipment.

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Quick Installation Guide

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

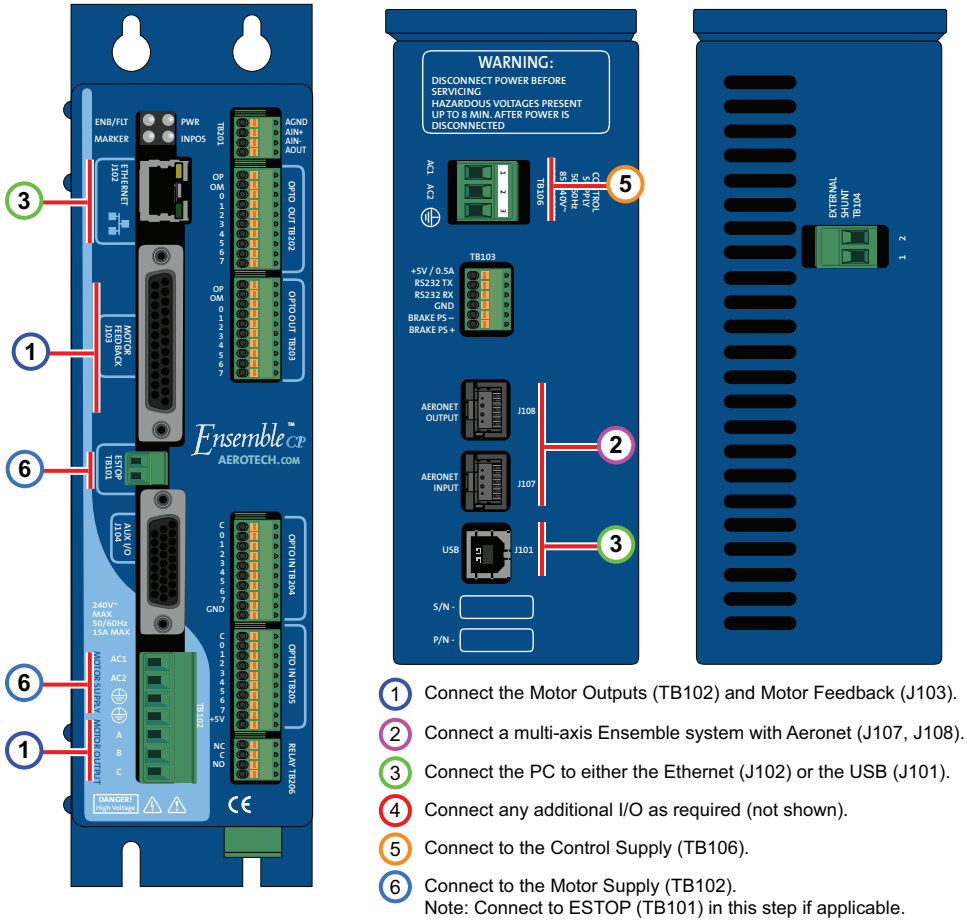


Figure 1: Quick Start Connections

Topic	Section
Motor Output	Section 2.2. Motor Output Connections
Motor Feedback	Section 2.3. Motor Feedback Connections (J103)
Aeronet	Section 2.7. Aeronet Interface (J107/J108)
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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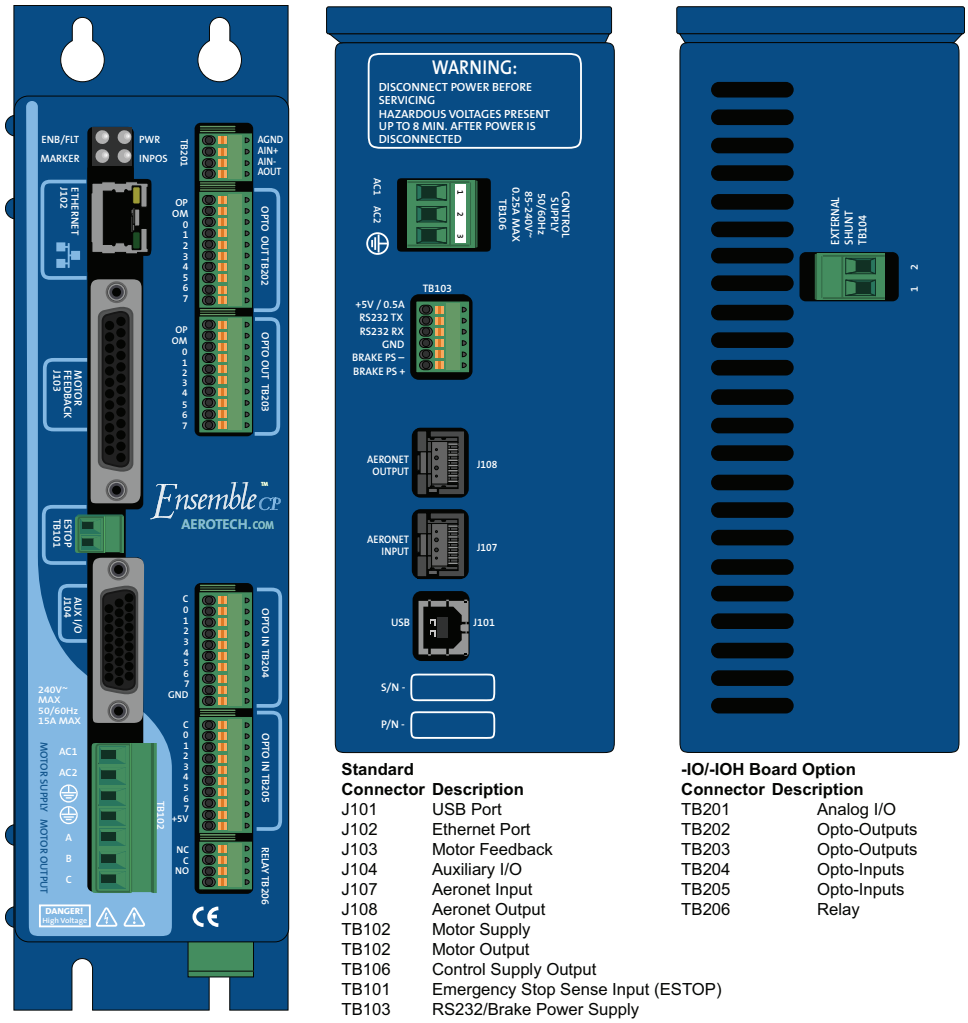
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Chapter 1: Introduction

Aerotech's Ensemble CP (Compact PWM) network digital drive is a high performance amplifier. The drive provides deterministic behavior, auto-identification, and easy software setup. The Ensemble 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 Ensemble 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
J107	Aeronet Input
J108	Aeronet Output
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: Ensemble 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 Ensemble Help file for more information) • Camming (refer to the Ensemble Help file for more information) • 10/100 BASE-T Ethernet port for use with Ethernet I/O modules	
Options	
-S	Internal shunt resistor (standard on CP 30). 50 Ohm, 40 W Continuous; 400 W Peak (5 seconds), (Manufacturer's P/N: Ohmite F40J50RE or equivalent)
-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.
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.

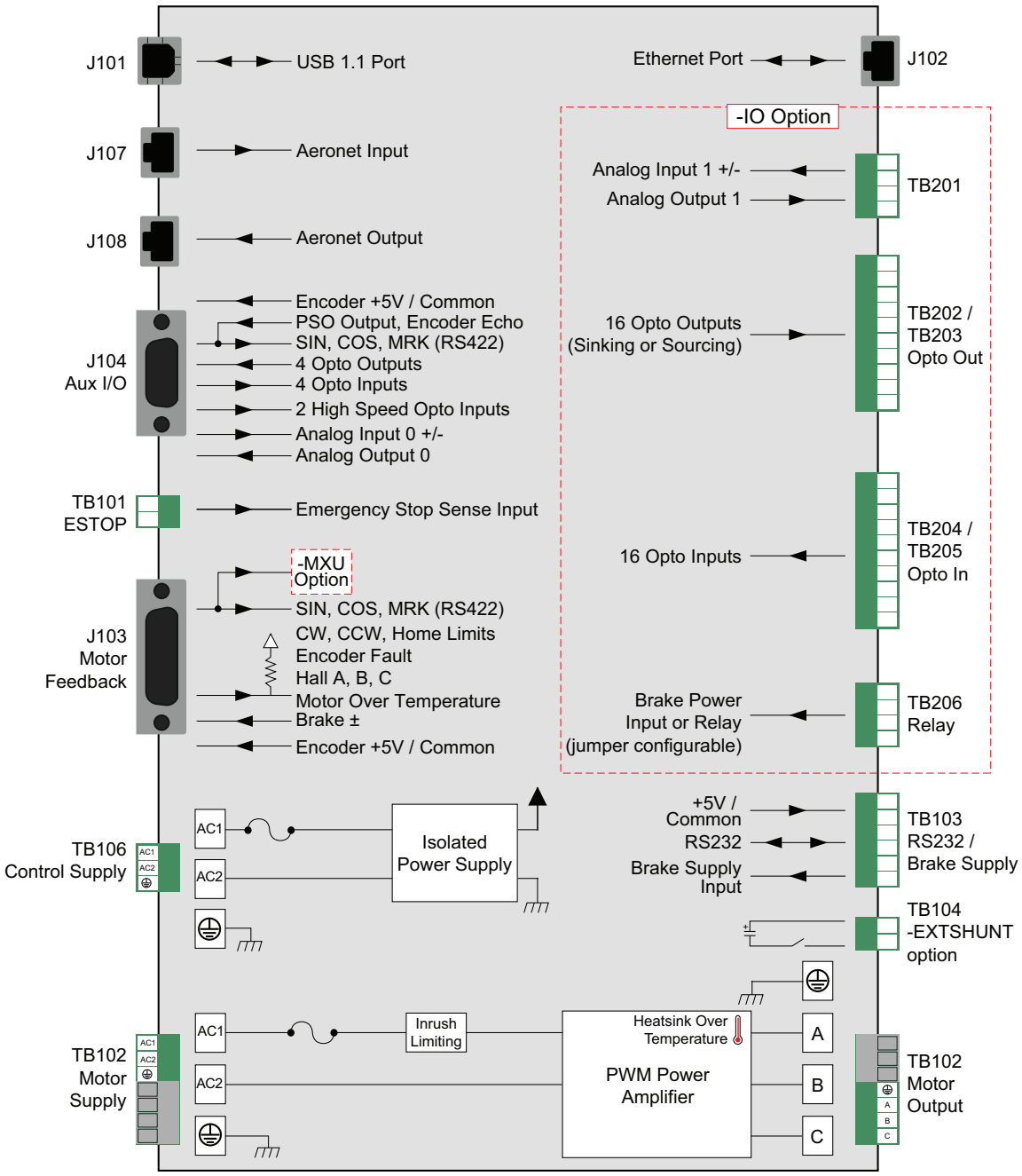


Figure 1-2: Functional Diagram

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1.1. Drive and Software Compatibility

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

Table 1-2: Drive and Software Compatibility

Drive Type	Firmware Revision	First Software Version	Last Software Version
CL	-	1.01	5.02
	A	2.55	5.02
CP	A	1.00	Current
	B	2.54	Current
Epaq	-	1.00	Current
	A	2.55	Current
Epaq MR with ML drives	-	3.00	Current
Epaq MR with MP drives	-	1.00	Current
	A	2.55	Current
HLe	-	2.51	Current
HPe	-	2.51	Current
LAB	-	4.04	Current
ML	-	3.00	Current
MP	-	1.00	Current
	A	2.55	Current
QDe/QL/QLe	-	5.01	Current
QLAB	-	4.07	Current

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1.2. Electrical Specifications

Table 1-3: 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 amplifier power dissipation under continuous power supply and output current conditions is shown in Figure 1-3. 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. Figure 1-4 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 Ensemble CP. Mounting it to a large metal plate for extra heat-sinking and providing additional fan flow are suggested.

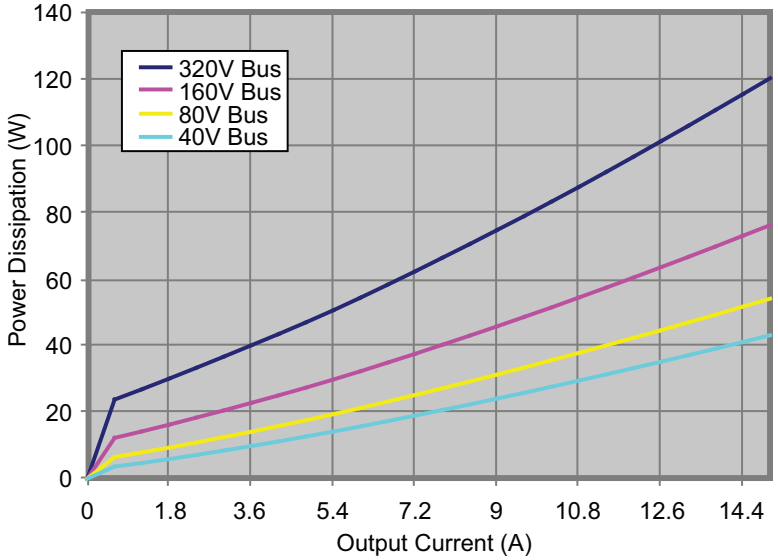


Figure 1-3: Power Dissipation vs. Output Current

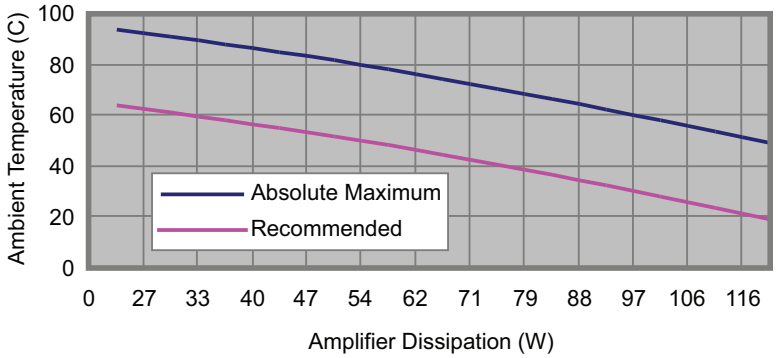


Figure 1-4: Ambient Temperature vs. Power Dissipation

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.

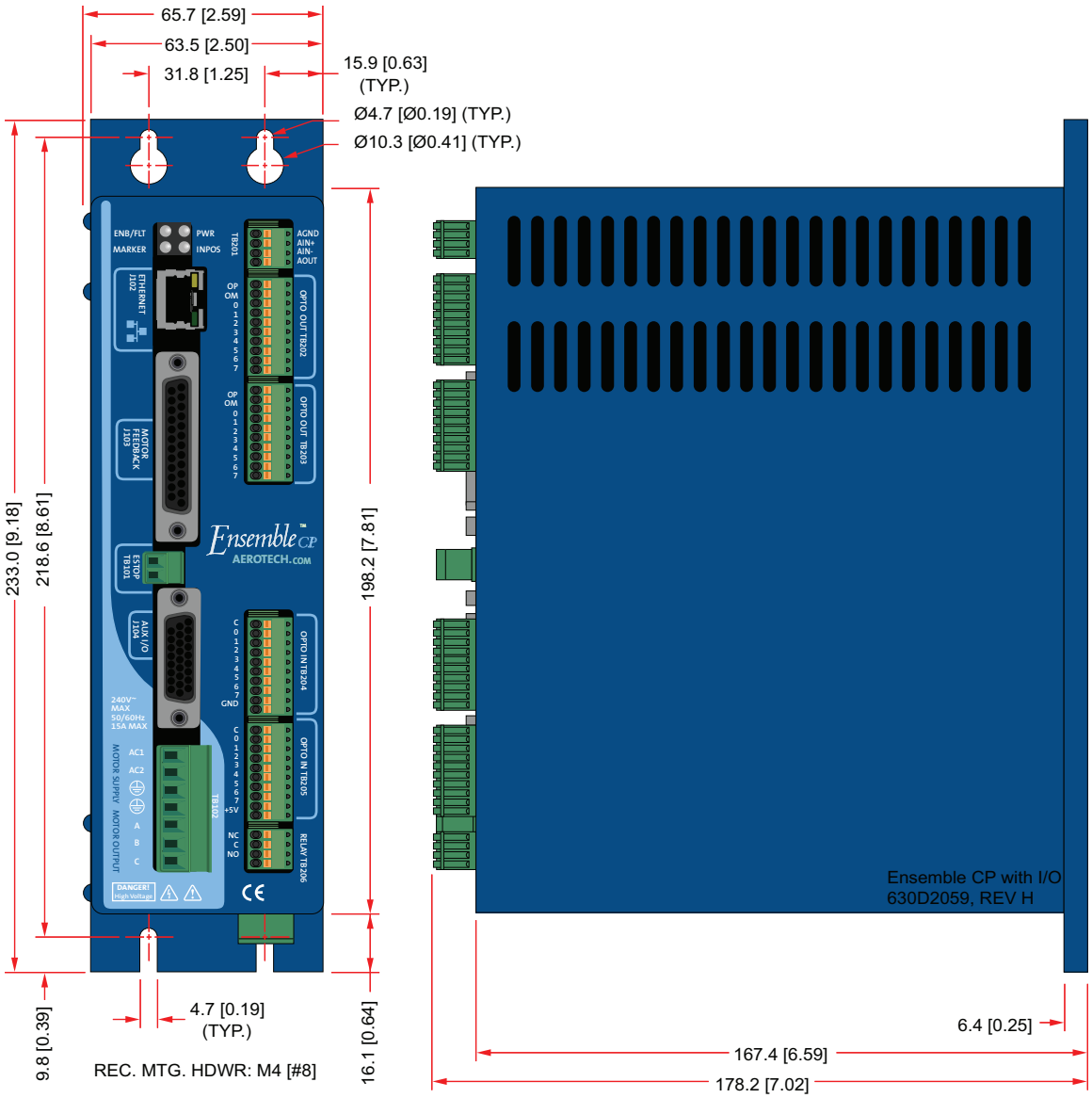


Figure 1-5: Dimensions

Table 1-4: Physical Specifications

	Weight
Standard	1.63 kg (3.6 lb)

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1.4. Environmental Specifications

The environmental specifications for the Ensemble 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 Ensemble 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 Ensemble 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 Ensemble CP may be required for CE compliance (Aerotech recommends Schaffner FN2080 or Aerotech UFM-ST).

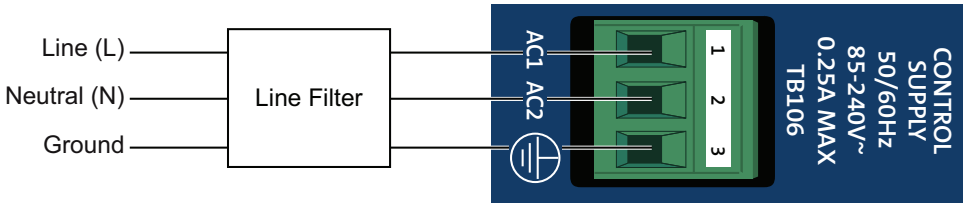


Figure 2-1: Control Supply Connections

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	Screw Torque Value: Nm	Wire Size: AWG [mm^2]
3-Pin Terminal Block	ECK00213	1754465	0.5 - 0.6	12-30 [3.3 - 0.516]

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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 Ensemble CP Motor Supply connector (refer to Figure 2-2 for locations).

Wires must be properly matched to the fuses or circuit breakers and must be sized to meet local electrical safety codes.

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.

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

WARNING: Do not operate the Ensemble 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.

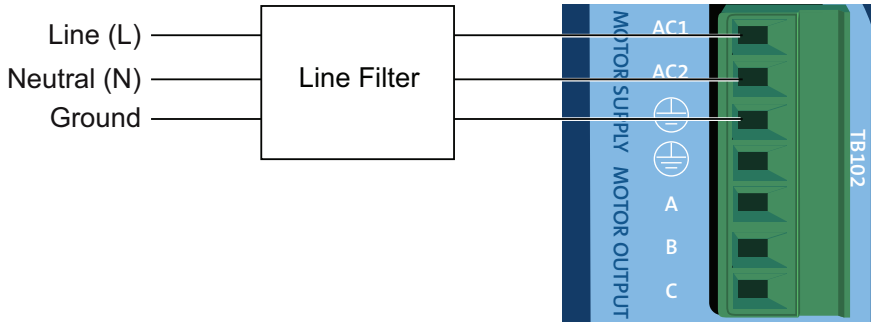


Figure 2-2: Motor Bus Input Connections

Table 2-3: Motor Supply Mating Connector

Description	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: AWG [mm^2]
7-Pin Terminal Block	ECK01114	1754546	0.5 - 0.6	3.3 - 0.516 [12-30]
1. Recommended Wire Size: 1.3 mm^2 (#16 AWG)				

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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

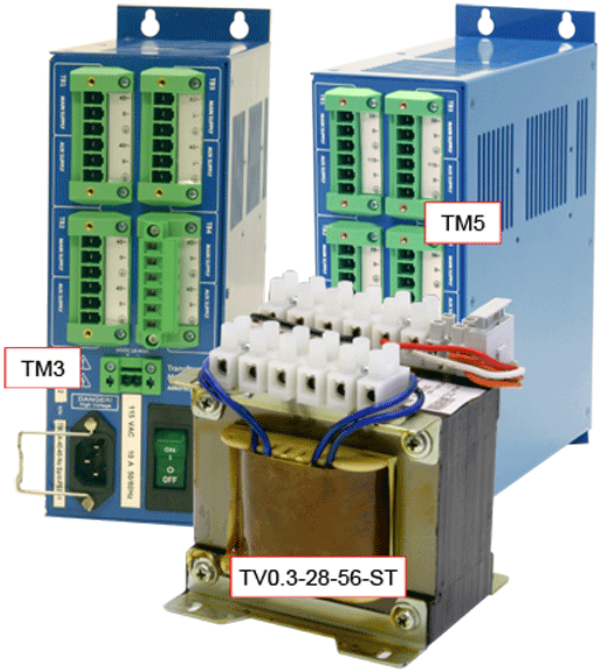


Figure 2-3: Transformer Examples

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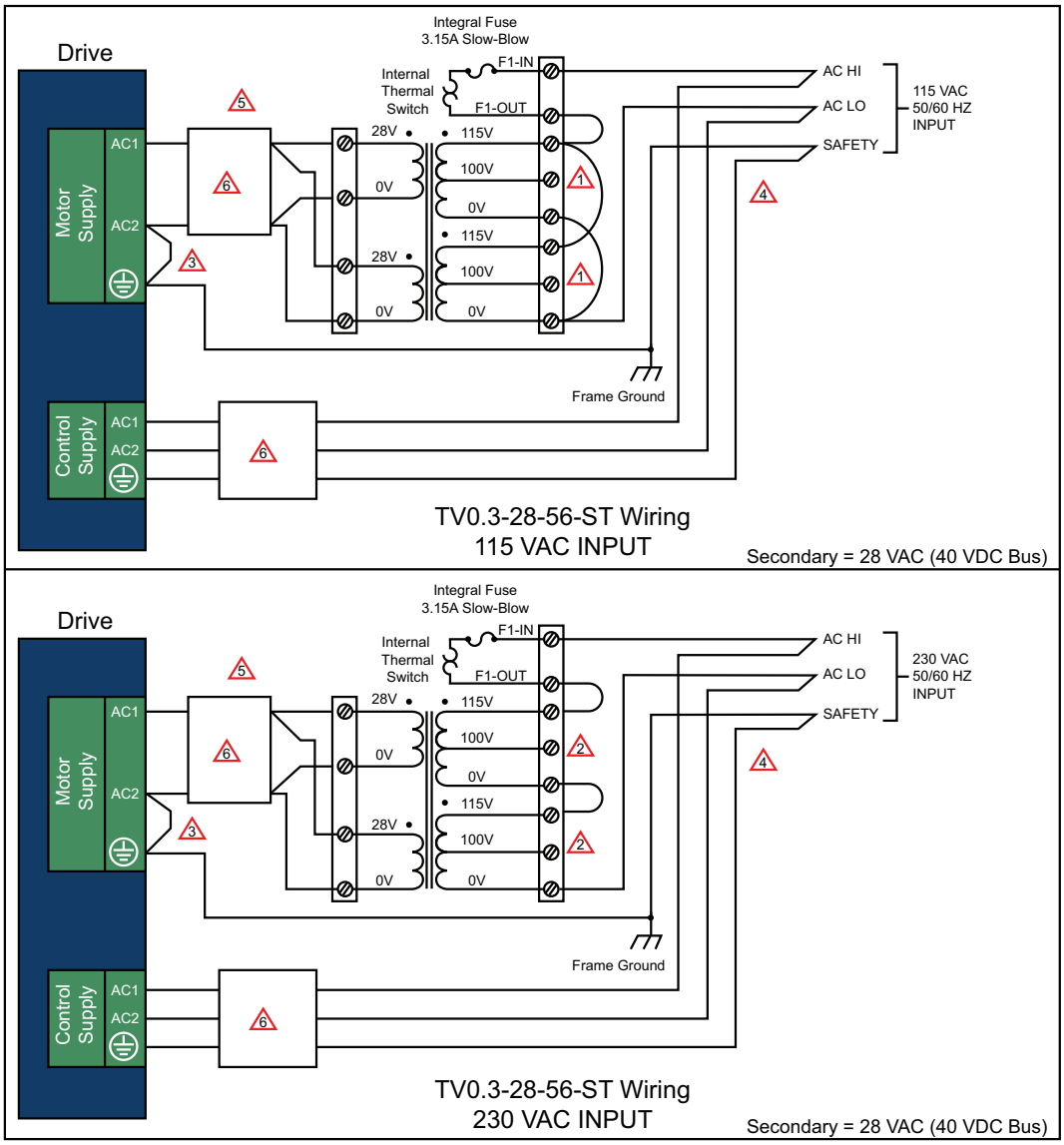


Figure 2-4: 40 VDC Motor Power with a TV0.3-28-56-ST Transformer

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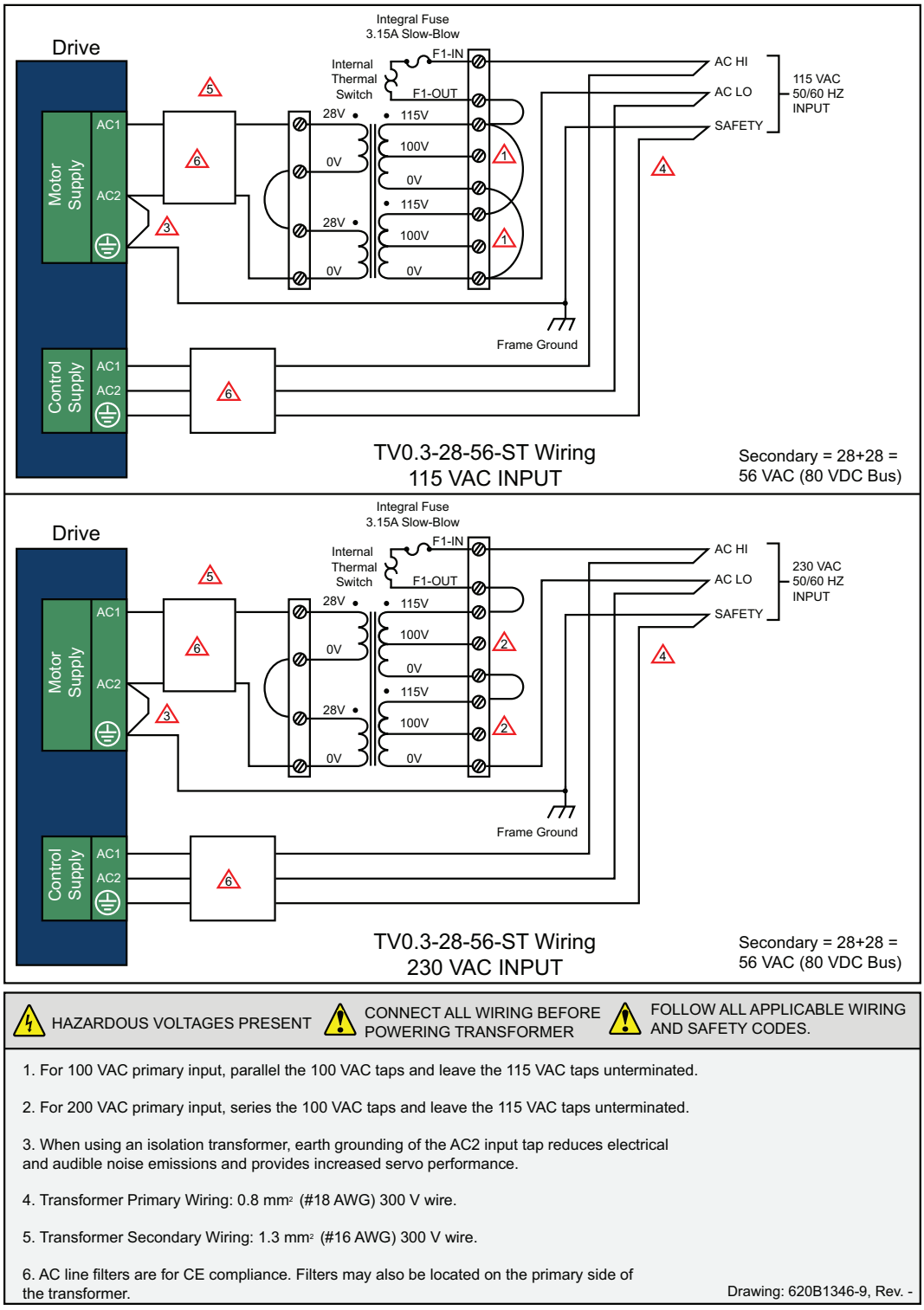
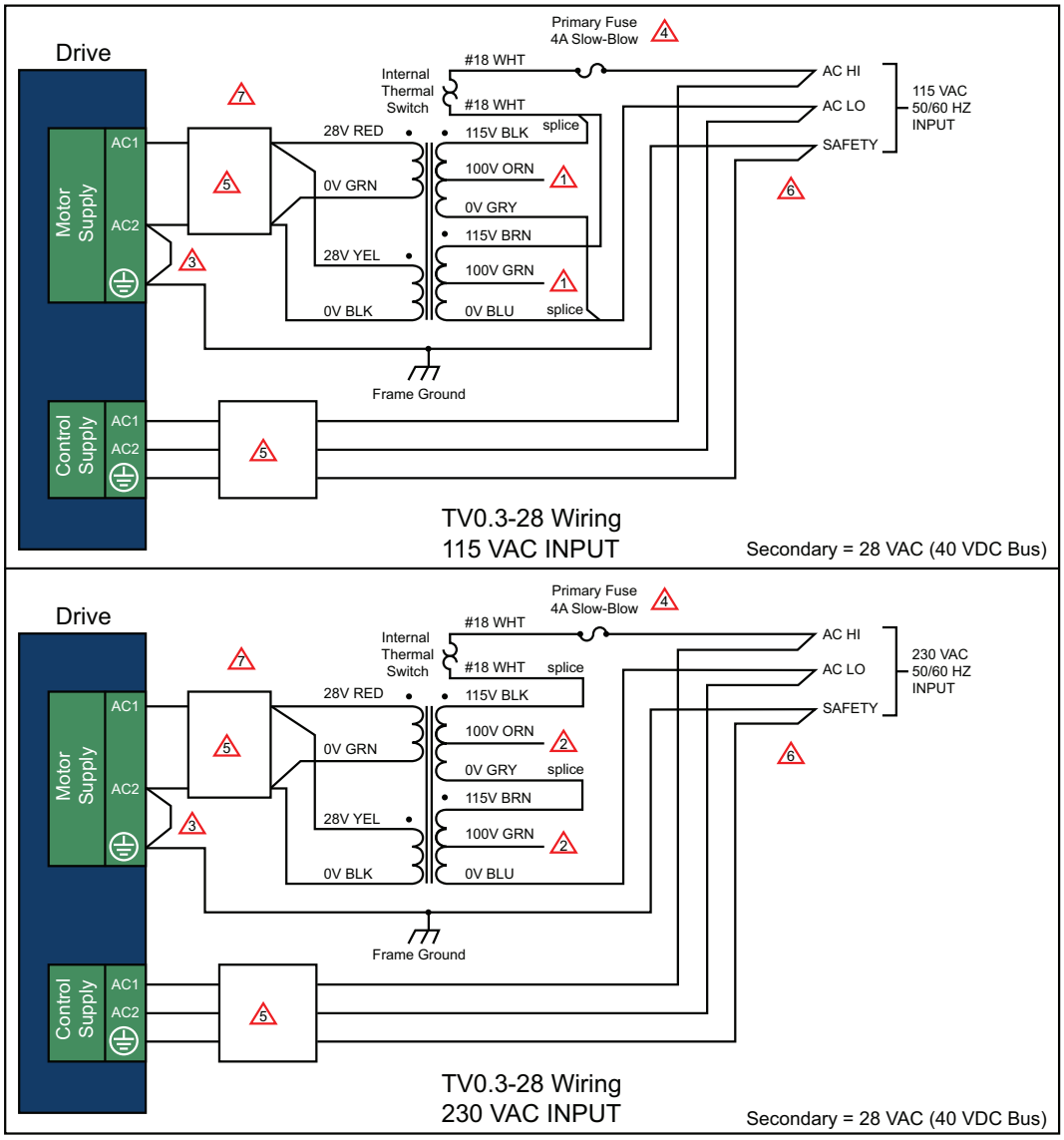


Figure 2-5: 80 VDC Motor Power with a TV0.3-28-56-ST Transformer

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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.

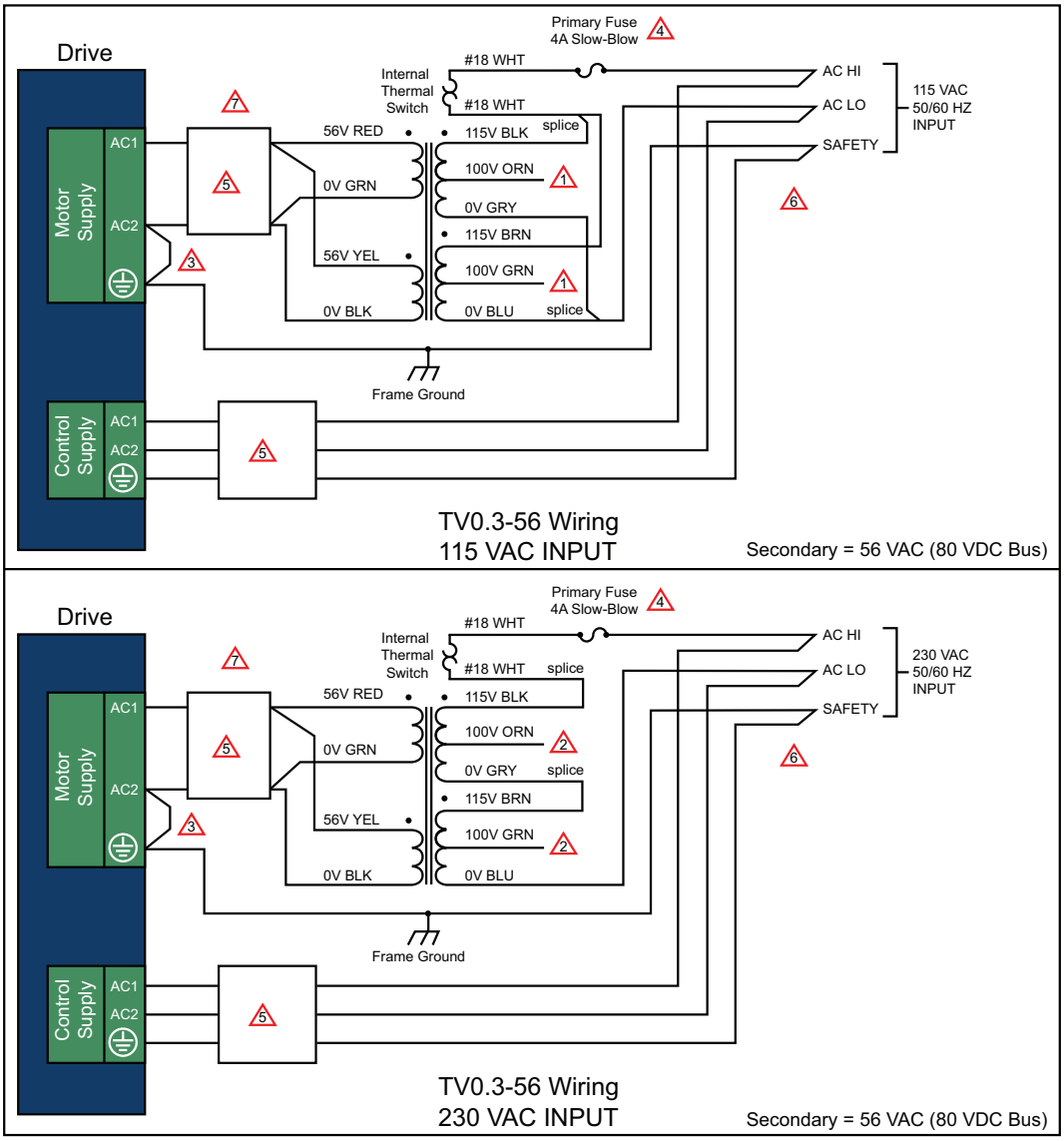
6. Transformer Primary Wiring: 0.8 mm^2 (#18 AWG) 300 V wire.

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

Drawing: 620B1346-1

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

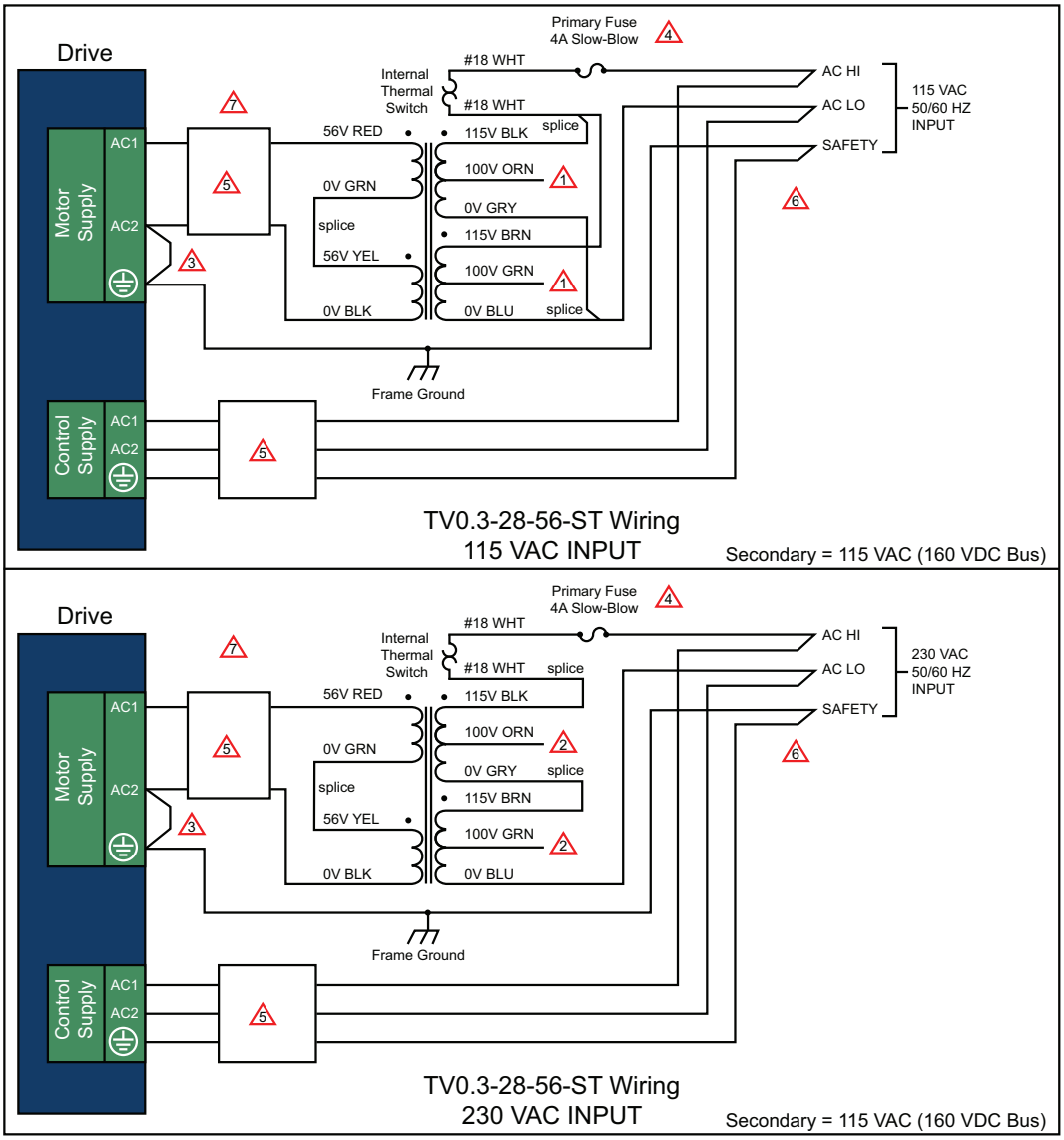
5. AC line filters are required for CE compliance. Filters may also be located on the primary side of the transformer.

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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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 for CE compliance. Filters may also be located on the primary side of the transformer.

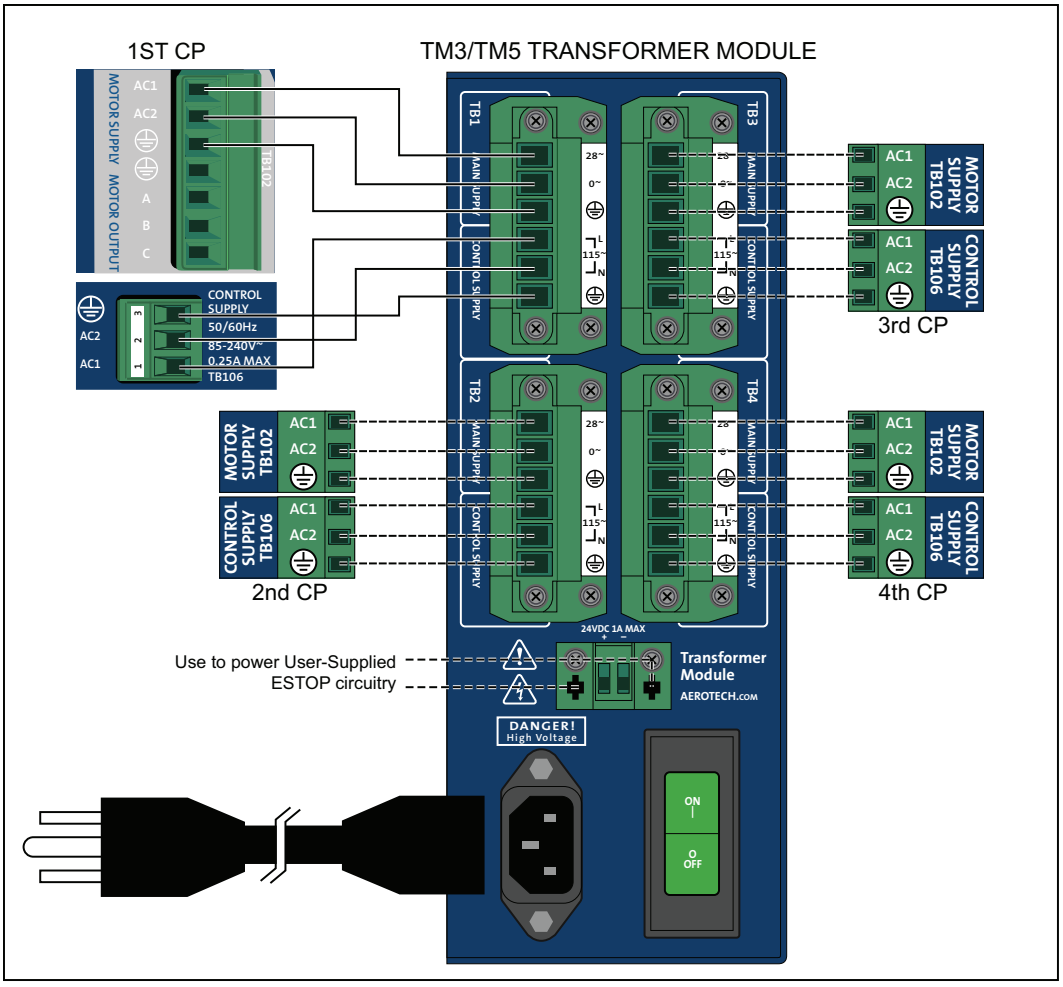
6. Transformer Primary Wiring: 0.8 mm^2 (#18 AWG) 300 V wire.

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

Drawing: 620B1346-3

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 Ensemble 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 radiated emission standards.The Ensemble CP is a component designed to be integrated with other electronics. EMC testing must be conducted on the final product configuration.

Ferrite beads can be used on the motor leads to reduce the effects of PWM noise.

Table 2-6: Ferrite Noise Suppression Numbers

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
0.5 mm^2 (#20 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

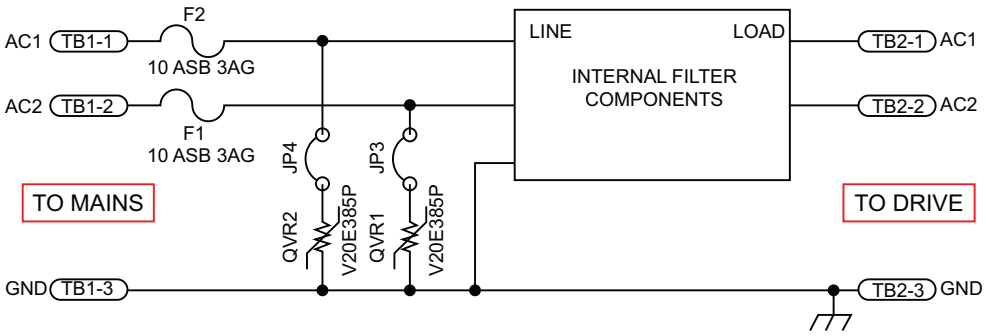


Figure 2-10: AC Line Filter (UFM-ST)

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2.2. Motor Output Connections

The Ensemble 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

Description	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: AWG [mm^2]
7-Pin Terminal Block	ECK01114	1754546	0.5 - 0.6	3.3 - 0.516 [12-30]
1. Recommended Wire Size: 1.3 mm^2 (#16 AWG)				

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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.

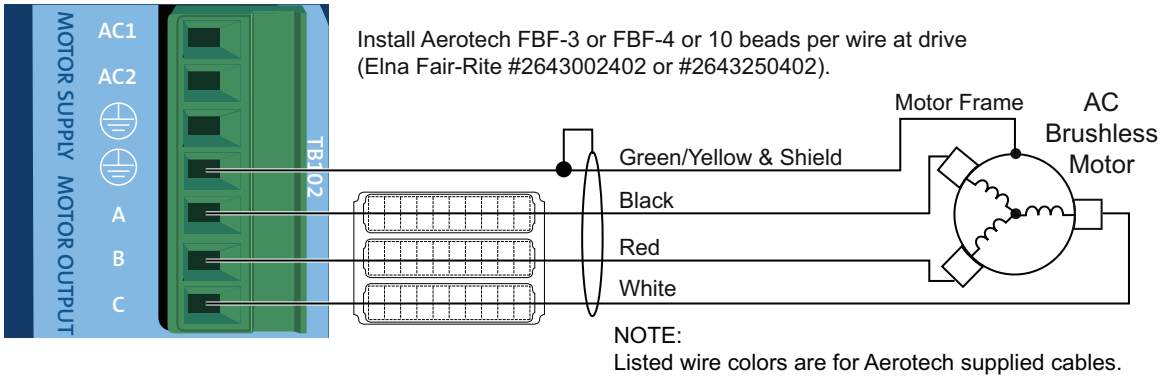


Figure 2-11: Brushless Motor Configuration

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 controller requires that the Back-EMF of each motor phase be aligned with the corresponding Hall-effect signal. To ensure proper alignment, motor, Hall, and encoder connections should be verified using one of the following methods: *powered*, through the use of a test program; or *unpowered* using an oscilloscope. Both methods will identify the A, B, and C Hall/motor lead sets and indicate the correct connections to the controller. Refer to Section 2.2.1.1. for powered motor phasing or Section 2.2.1.2. for unpowered motor and feedback phasing.

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

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

Feedback Monitoring

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

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

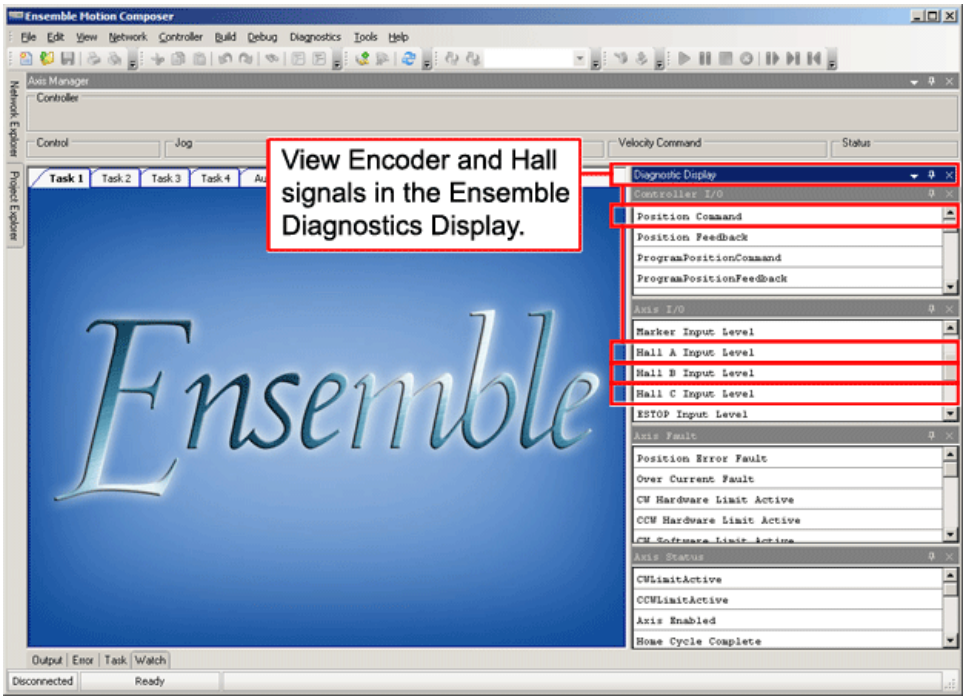


Figure 2-12: Encoder and Hall Signal Diagnostics

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

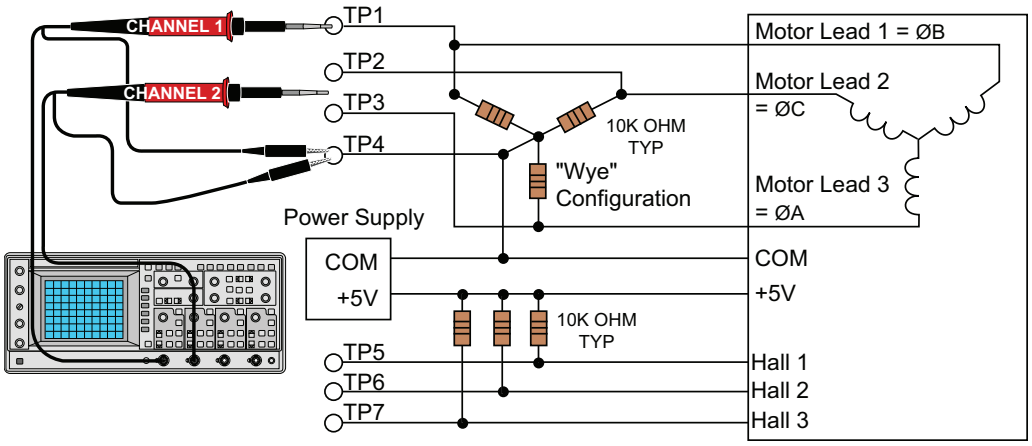


Figure 2-13: Motor Phasing Oscilloscope Example

With the designations of the motor and Hall leads of a third party motor determined, the motor can now be connected to an Aerotech system. Connect motor lead A to motor connector A, motor lead B to motor connector B, and motor lead C to motor connector C. Hall leads should also be connected to their respective feedback connector pins (Hall A lead to the Hall A feedback pin, Hall B to Hall B, and Hall C to Hall C). The motor is correctly phased when the Hall states align with the Back EMF as shown in (Figure 2-14). Use the CommutationOffset parameter to correct for Hall signal misalignment.

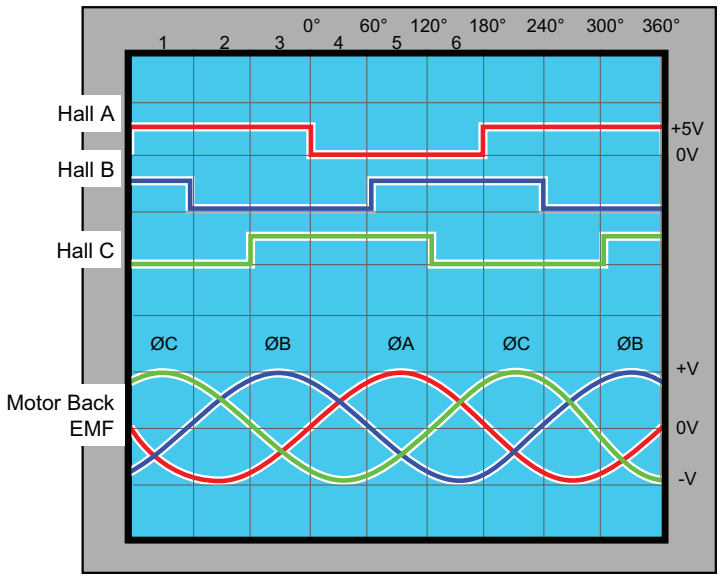


Figure 2-14: Brushless Motor Phasing Goal

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2.2.2. DC Brush Motor Connections

The configuration shown in Figure 2-15 is an example of a typical DC brush motor connection. Refer to Section 2.2.2.1. for information on motor phasing.

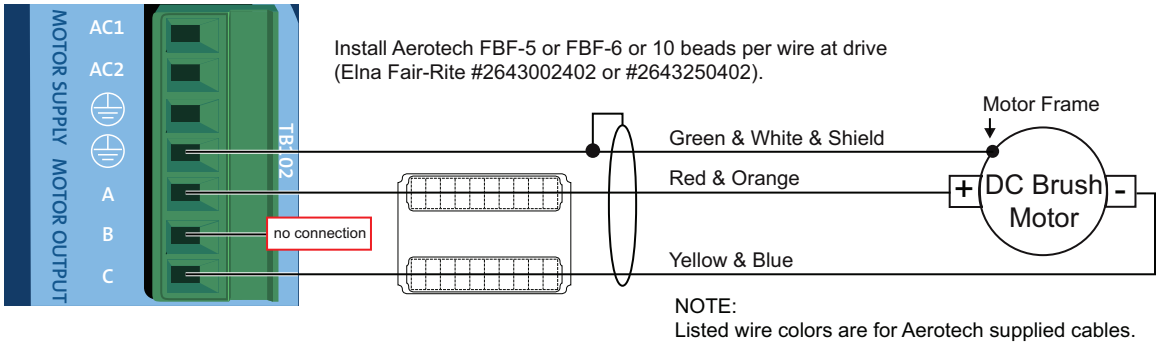


Figure 2-15: DC Brush Motor Configuration

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.

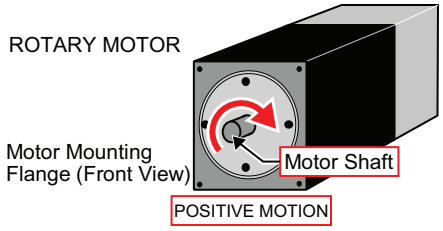


Figure 2-16: Clockwise Motor Rotation

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 Ensemble CP. Connect the motor lead from the negative lead of the voltmeter to the ØC motor terminal on the Ensemble 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 2-17 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.

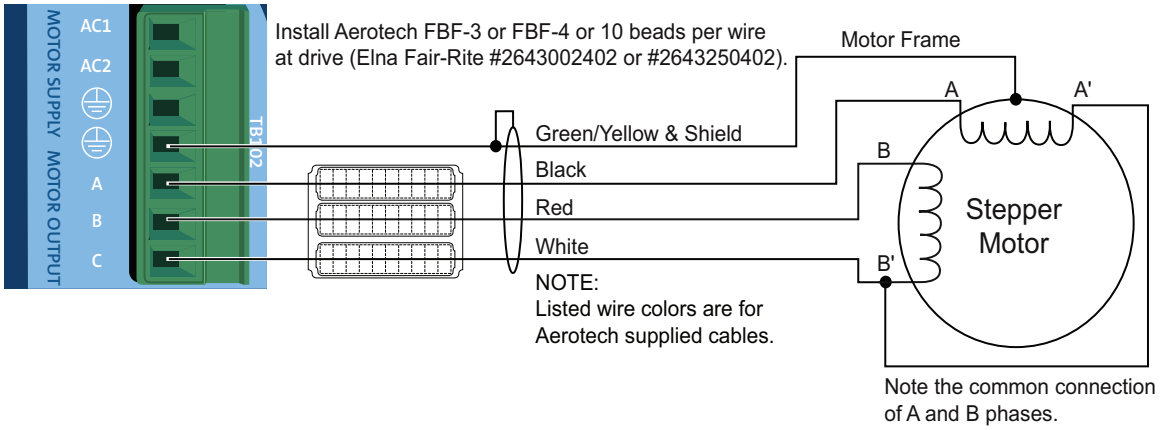


Figure 2-17: Stepper Motor Configuration

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 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.

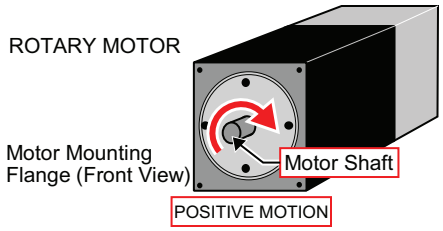


Figure 2-18: Clockwise Motor Rotation

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

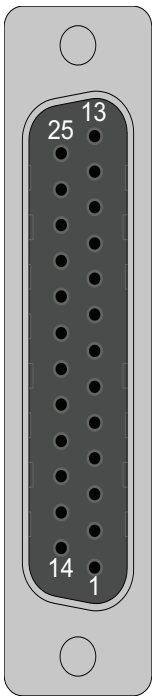
NOTE: After the motor has been phased, use the ReverseMotionDirection parameter to change the direction of “positive” motion.

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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 Ensemble 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 Ensemble CP has been purchased with the -MXU option, the standard encoder interface can 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. Invalid or missing signals will cause a feedback fault when the axis is enabled.

An analog encoder is used with the -MXU option (refer to Section 2.3.1.4. for more information).

Table 2-15: Encoder Specifications

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

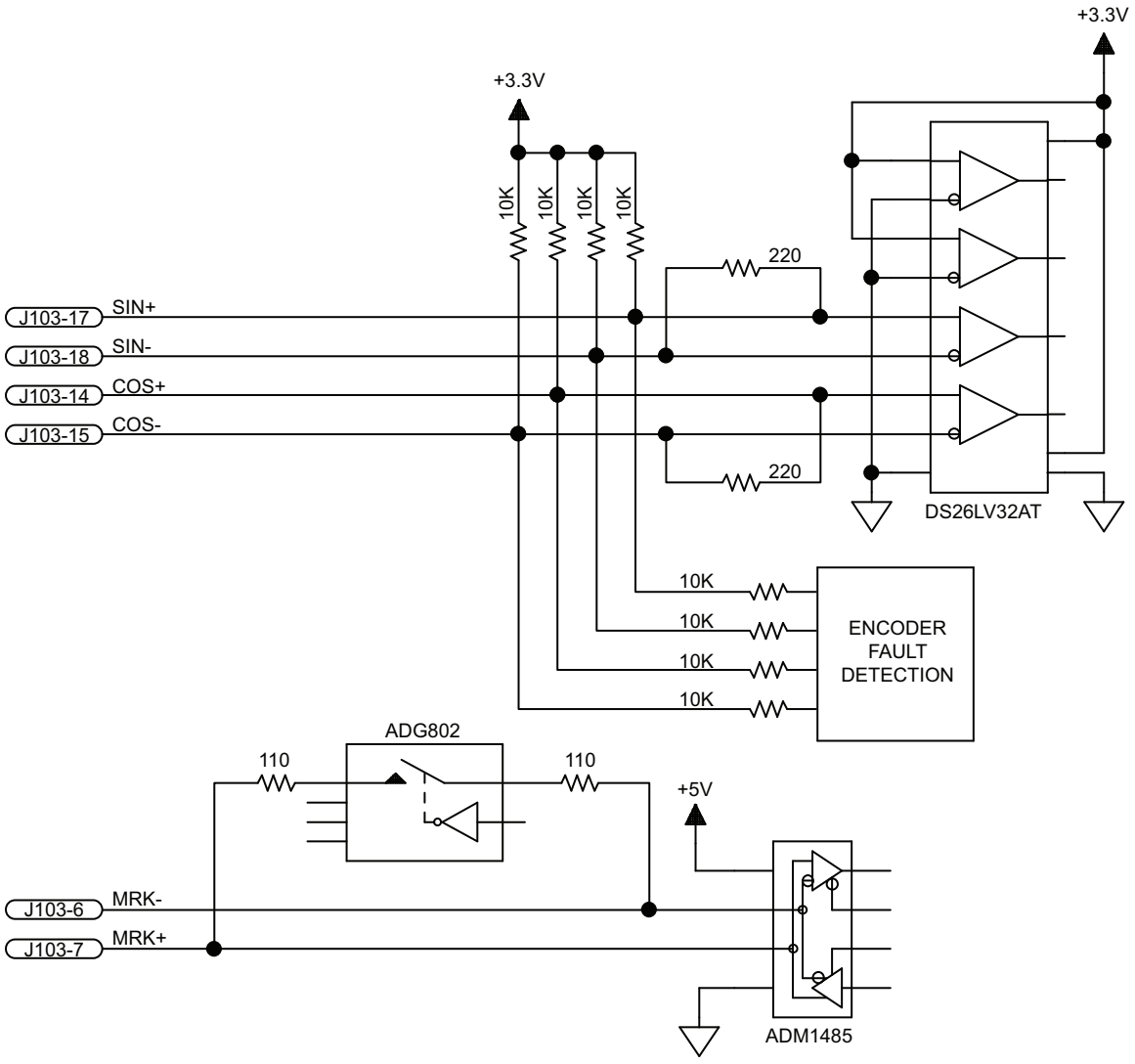


Figure 2-19: Line Driver Encoder Interface (J103)

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2.3.1.2. EnDat Encoder Interface (J103)

The Ensemble CP retrieves absolute position data along with encoder fault information via a serial data stream from the absolute encoder. See Figure 2-20 for the serial data stream interface. Set up of this interface requires setting parameters EnDatEncoderResolution, EnDatEncoderSetup, and EnDatEncoderTurns.

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.

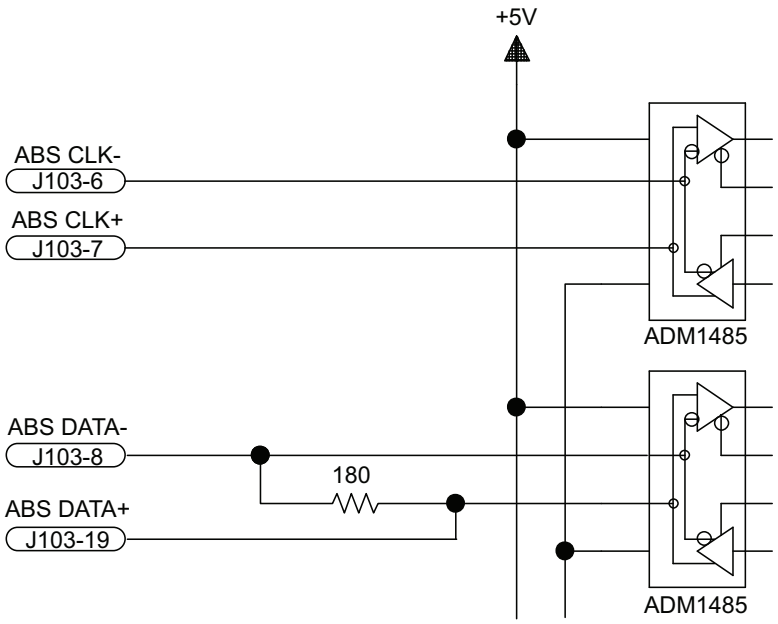


Figure 2-20: Serial Data Stream Interface

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2.3.1.3. Resolute Encoder Interface (J103)

The Ensemble CP retrieves absolute position data along with encoder fault information via a serial data stream from the resolute encoder. See Figure 2-21 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.

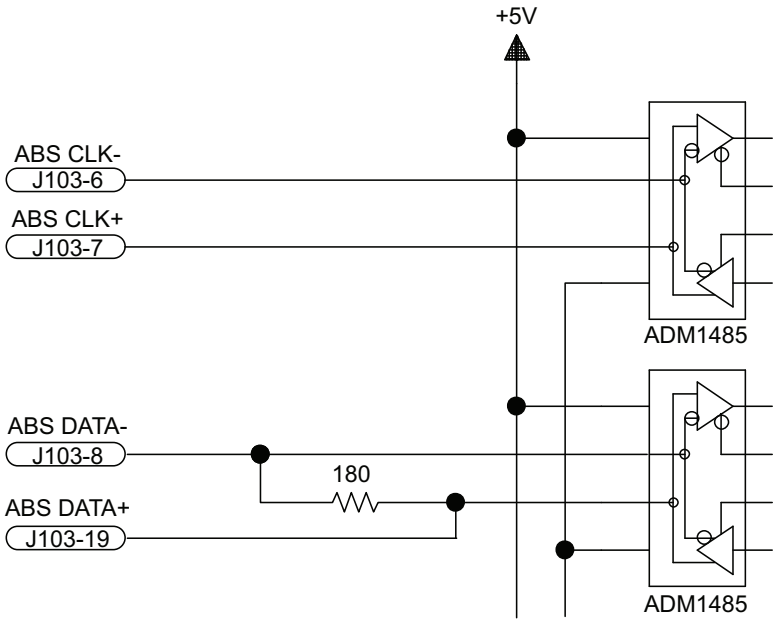


Figure 2-21: Serial Data Stream Interface

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2.3.1.4. Analog Encoder Interface

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

Table 2-16: Analog Encoder Specifications

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

Refer to Figure 2-22 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 Ensemble Help file for more information.

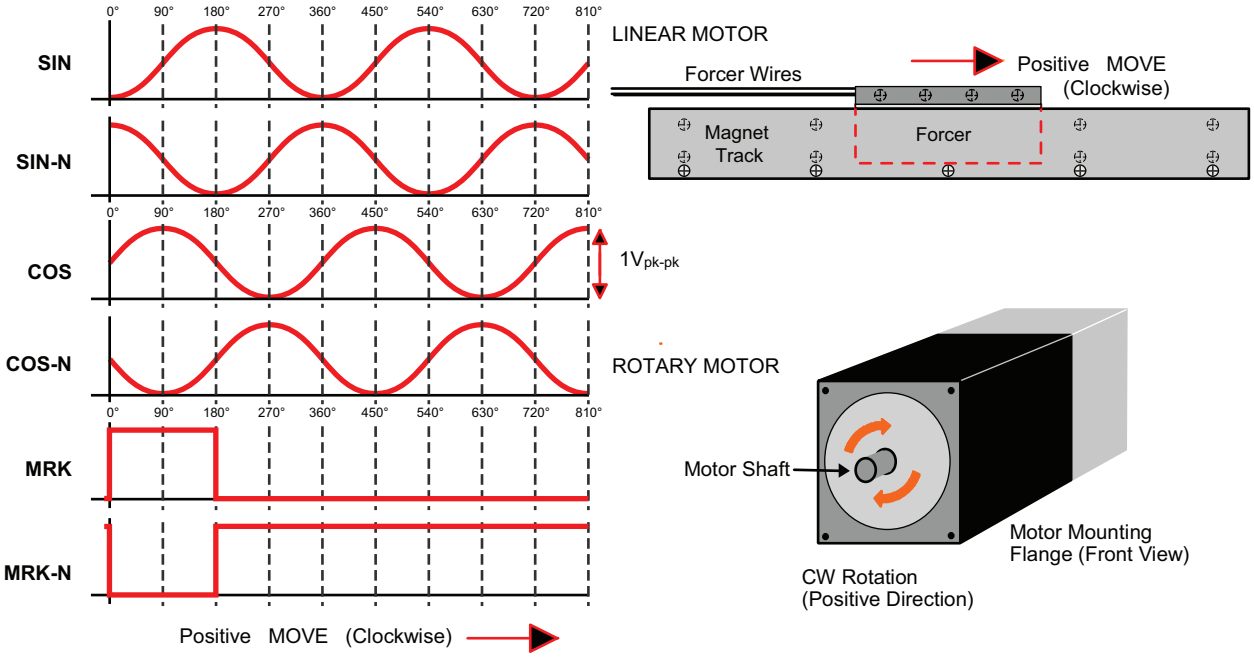


Figure 2-22: Analog Encoder Phasing Reference Diagram

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.

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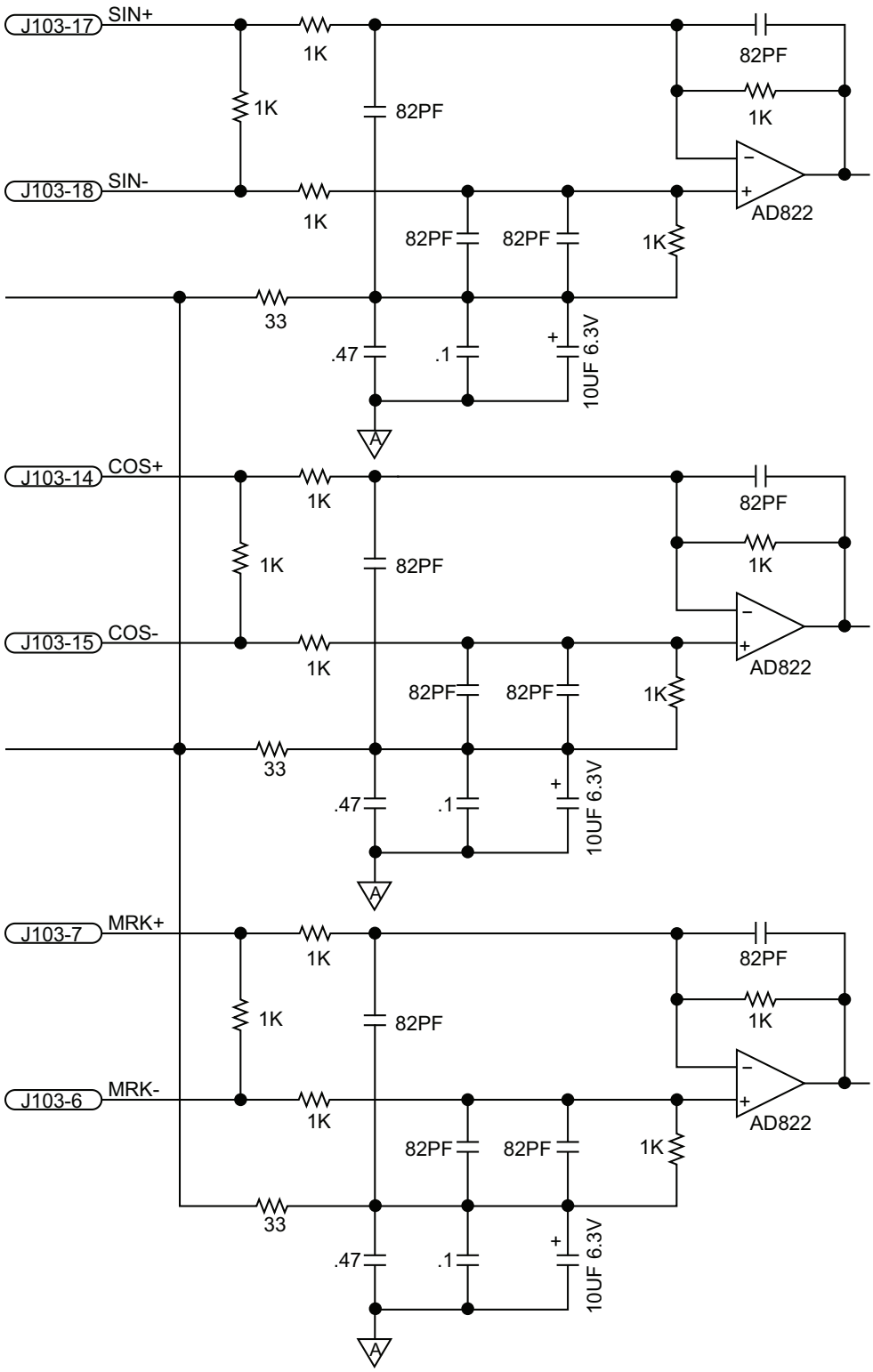


Figure 2-23: Analog Encoder Interface (J103)

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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 2-24 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 2-25). The Motor Phasing Calculator in the Configuration Manager can be used to determine proper encoder polarity.

For dual loop systems, the velocity feedback encoder is displayed in the diagnostic display (Figure 2-25).

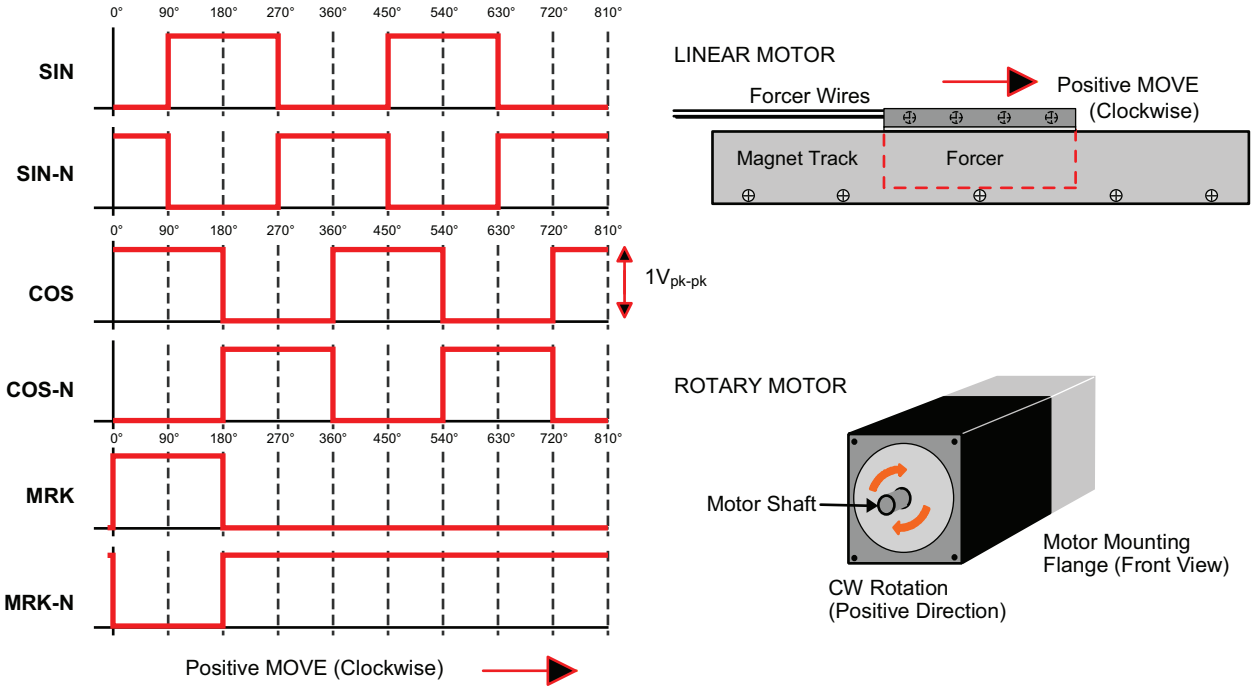


Figure 2-24: Encoder Phasing Reference Diagram (Standard)

NOTE: Encoder manufacturers may refer to the encoder signals as A, B, and Z. The proper phase relationship between signals is shown in Figure 2-24.

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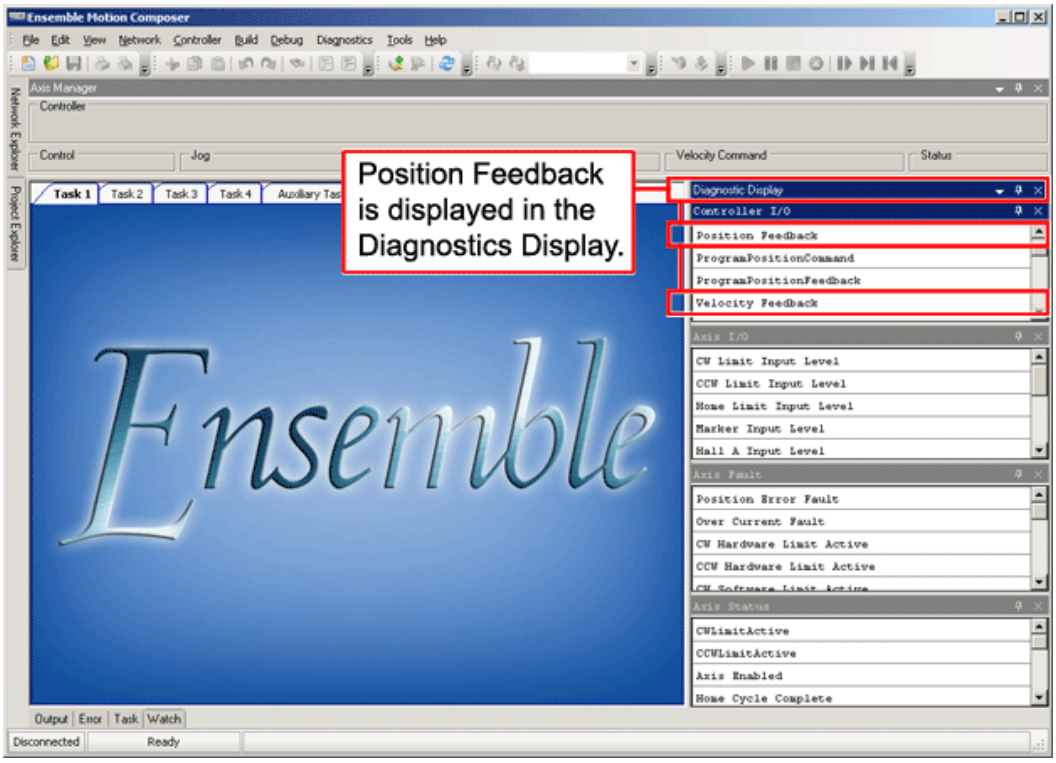


Figure 2-25: Position Feedback in the Diagnostic Display

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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. Hall states (0,0,0) or (1,1,1) are invalid and will generate a "Hall Fault" axis fault.

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

Table 2-17: 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

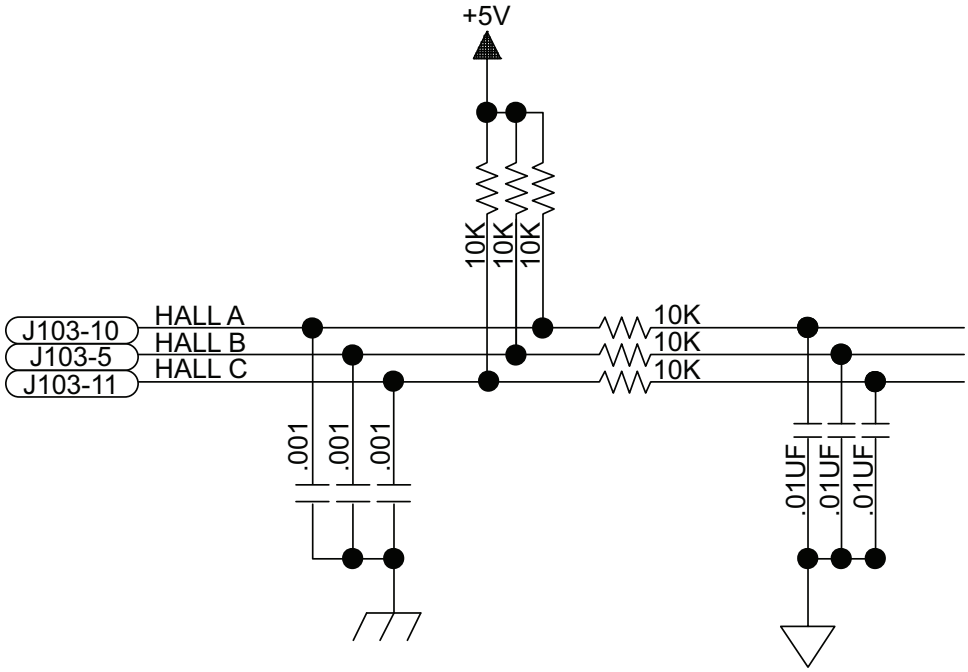


Figure 2-26: Hall-Effect Inputs (J103)

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2.3.3. Thermistor Interface (J103)

The thermistor input is used to detect a motor over temperature condition by using a positive temperature coefficient sensor. As the temperature of the sensor increases, so does the resistance. Under normal operating conditions, the resistance of the thermistor is low (i.e., 100 ohms) which will result in a low input signal. As the increasing temperature causes the thermistor's resistance to increase, the signal will be seen as a logic high triggering an over temperature fault. The nominal trip value of the sensor is 1k Ohm.

Table 2-18: Thermistor Interface Pin Assignment (J103)

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

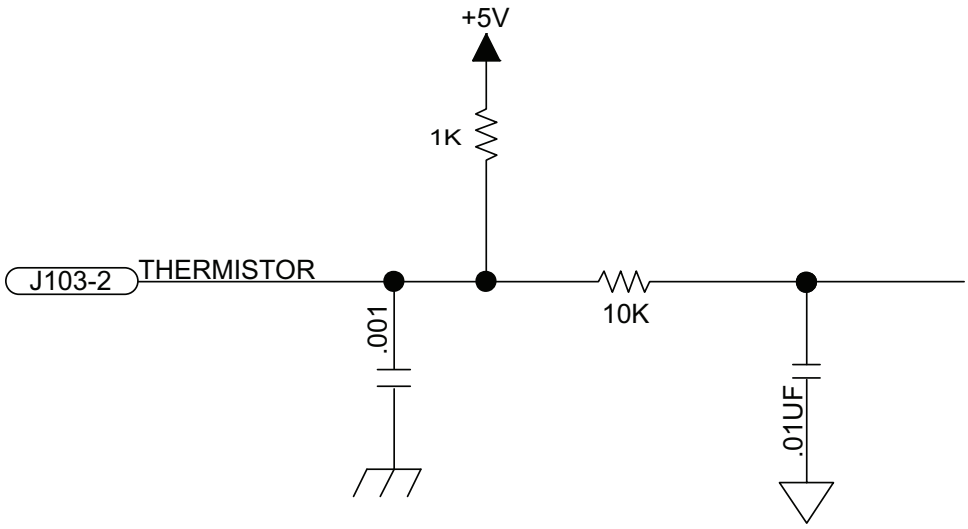


Figure 2-27: Thermistor Interface Input (J103)

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2.3.4. Encoder Fault Interface (J103)

The encoder fault input is for use with encoders that have a fault output. This is provided by some manufactures and indicates a loss of encoder function. The active state of this input is parameter configurable and the controller should be configured to disable the axis when the fault level is active.

Table 2-19: Encoder Fault Interface Pin Assignment (J103)

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

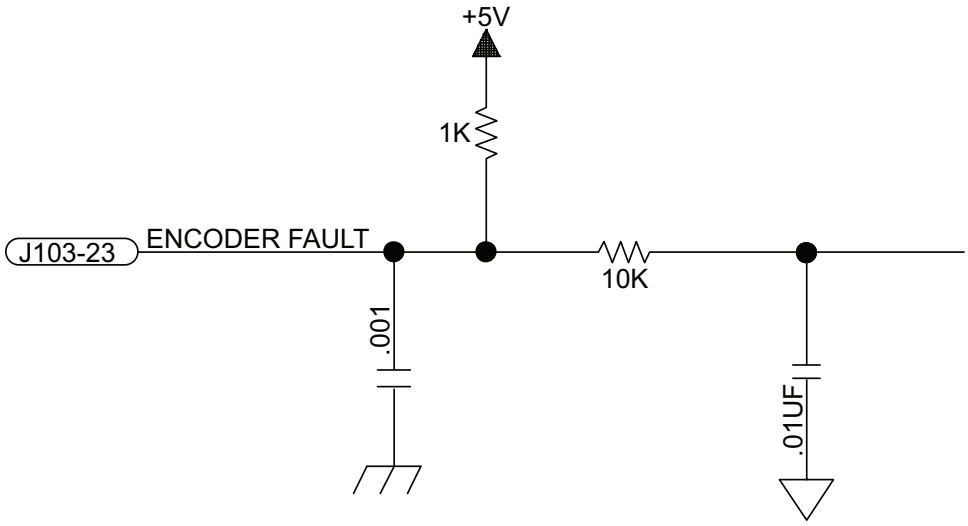


Figure 2-28: Encoder Fault Interface Input (J103)

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2.3.5. End Of Travel Limit Input Interface (J103)

End of Travel (EOT) limits are used to define the end of physical travel. The EOT limit inputs accept 5-24 VDC level signals. The active state of the EOT limits is software selectable by the EndOfTravelLimitSetup axis parameter (refer to the Ensemble Help file). Limit directions are relative to the encoder polarity in the diagnostics display (refer to Figure 2-31).

Positive motion is stopped by the clockwise (CW) end of travel limit input. Negative motion is stopped by the counterclockwise (CCW) end of travel limit input. The Home Limit switch can be parameter configured for use during the home cycle, however, the CW or CCW EOT limit is typically used instead.

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

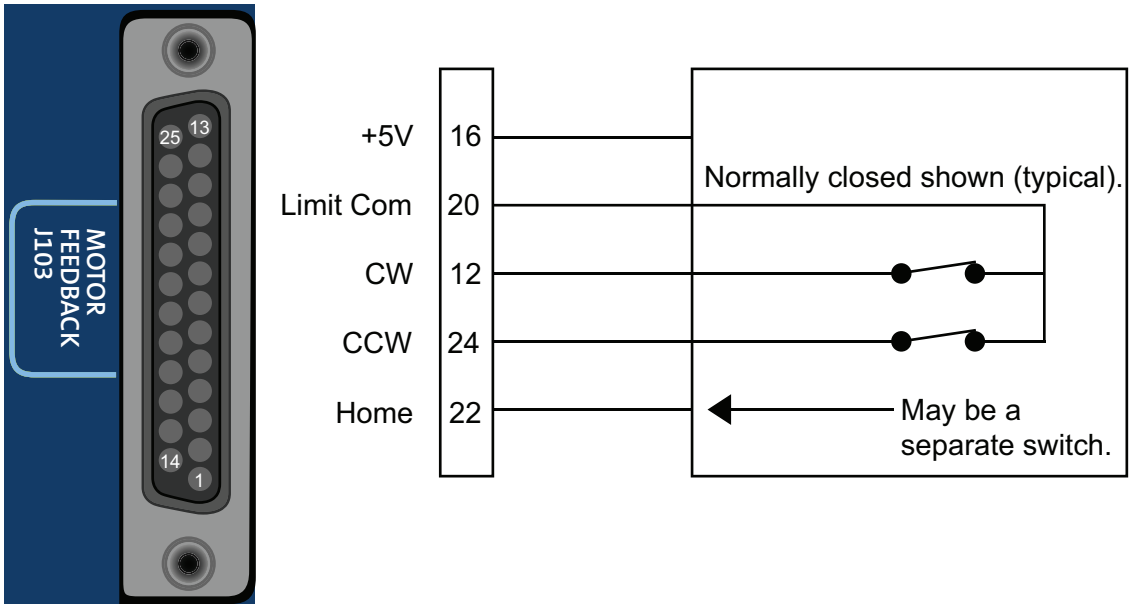


Figure 2-29: End of Travel Limit Input Connections

Table 2-20: 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

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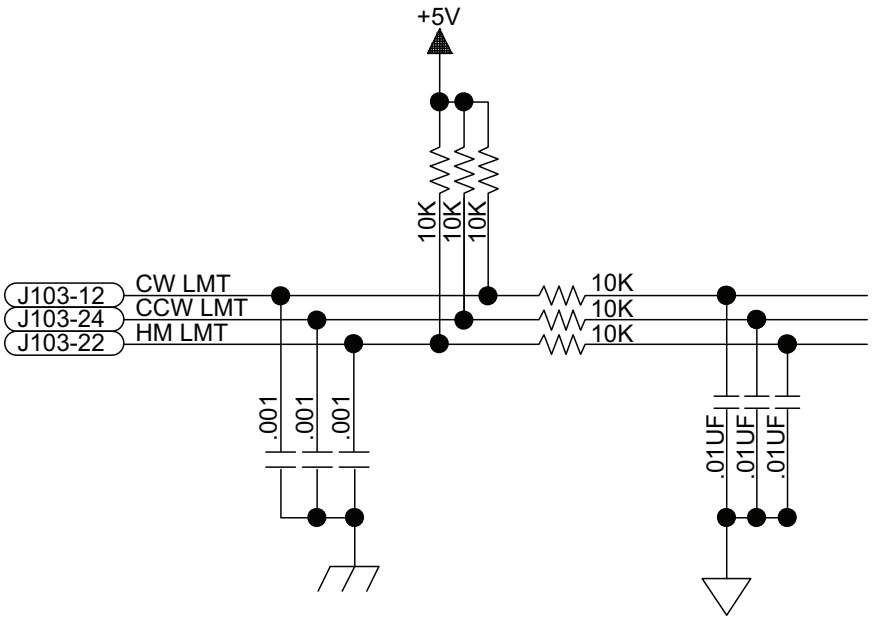


Figure 2-30: End of Travel Limit Interface Input (J103)

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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 motor feedback connector. The logic level of the EOT limit inputs may be viewed in the Diagnostic Display (shown in Figure 2-31).

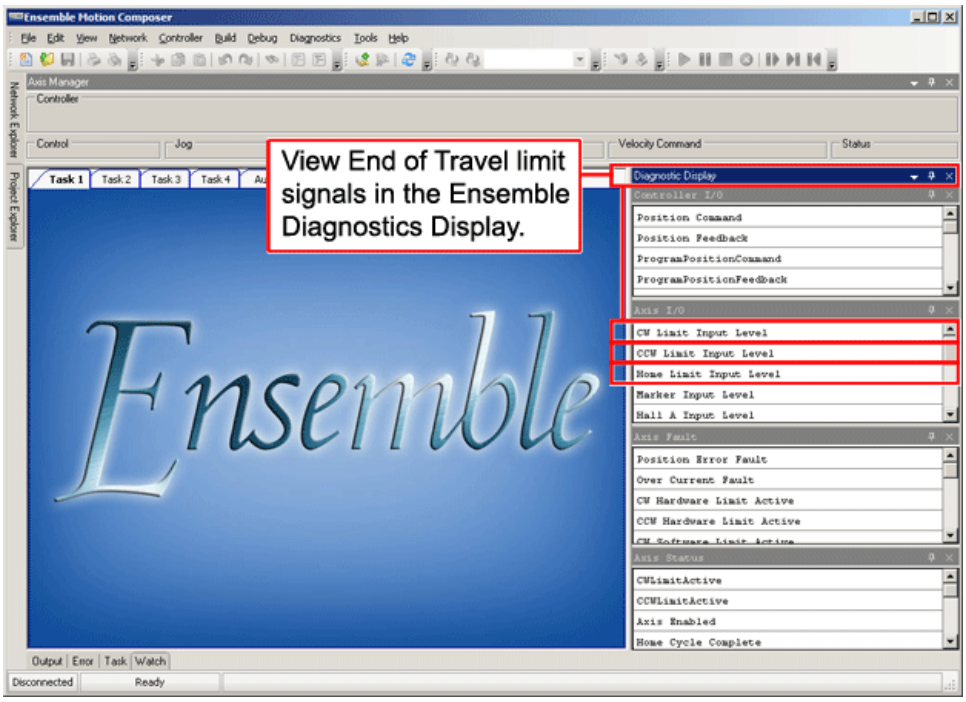


Figure 2-31: Limit Input Diagnostic Display

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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 Ensemble 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 Ensemble Help file for more information).

Use either the solid state relay on the Ensemble 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 2-21: 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 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.

Refer to Section 2.4.1. for interconnection details.

WARNING: The user is responsible for assessing 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 2-33 for interconnection details

The ESTOP input is scaled for an input voltage of 5-24 volts.

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

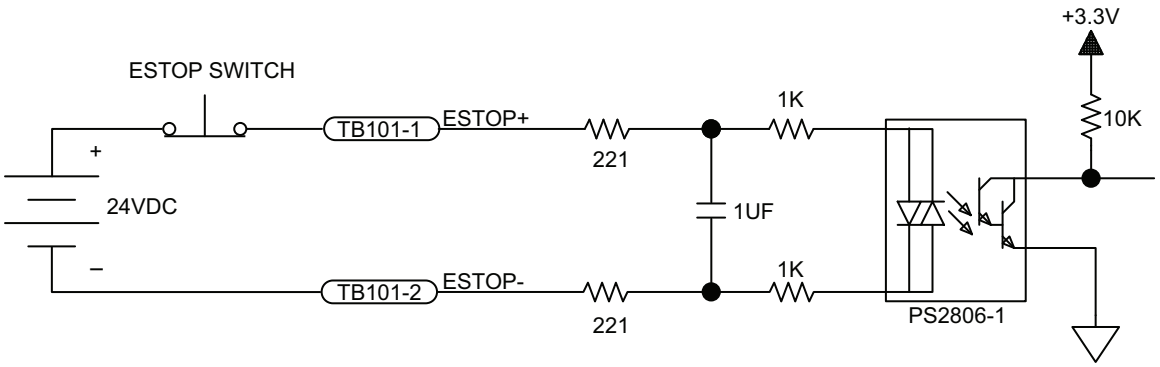


Figure 2-32: ESTOP Sense Input (TB101)

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 2-22. 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

Description	Aerotech P/N	Phoenix P/N	Tightening Torque (Nm)	Wire Size: AWG [mm^2]
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 Ensemble CP's motor power supply input. This will remove power to the motor while maintaining control power, as shown in the Figure 2-33.

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

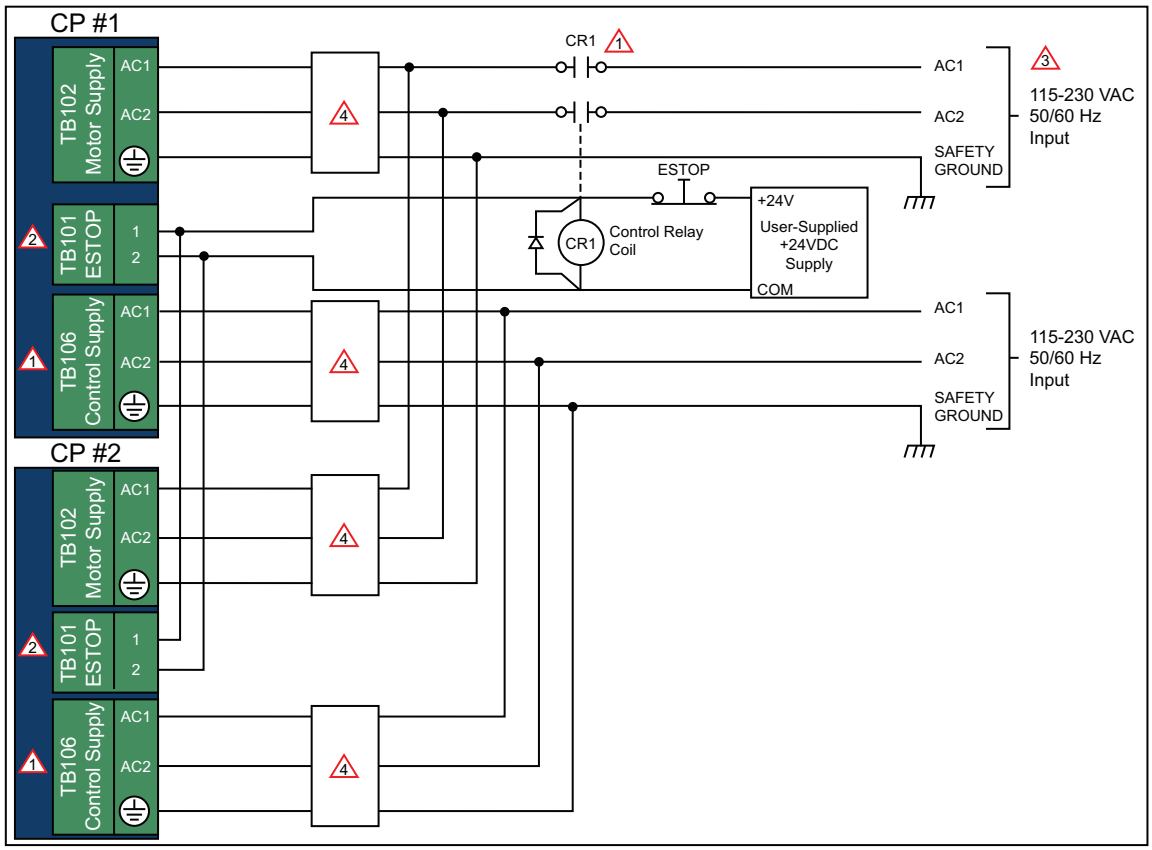


Figure 2-33: Typical Emergency Stop Circuit

Table 2-24: Typical ESTOP Relay Ratings

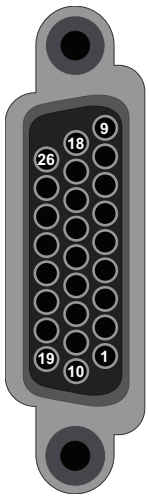
Axes	AC1	AC3	Aerotech P/N	Third Party P/N
1	32	16	ECW1018	Sprecher & Schuh CA7-16C-xx-xxx
2 to 5	85	43	ECW1019	Sprecher & Schuh CA7-43C-xx-xxx

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

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.

Table 2-26: Auxiliary Encoder Specifications

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

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 Ensemble Help file for more information.

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

Table 2-27: 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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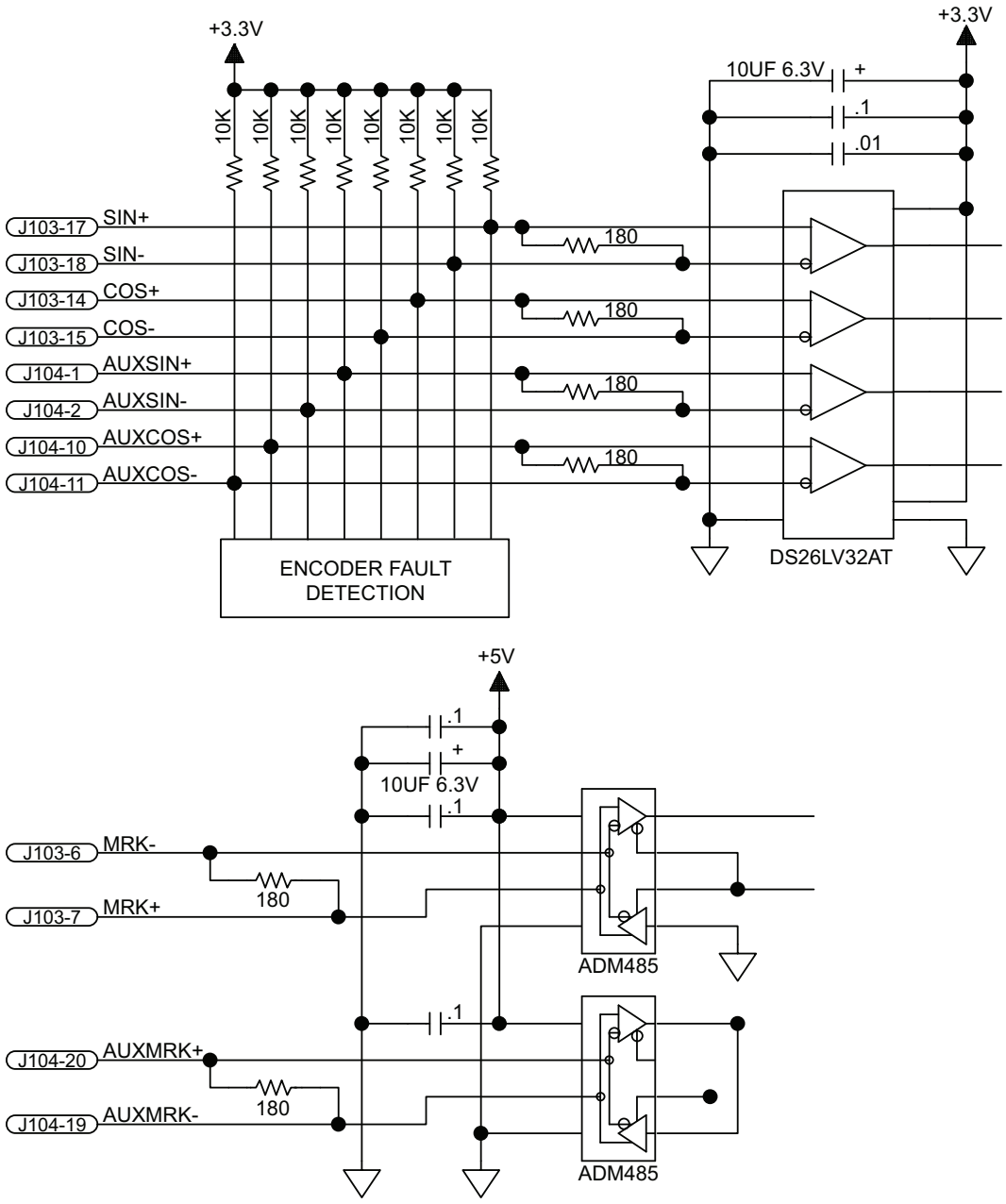


Figure 2-34: Auxiliary Encoder Channel (J104)

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

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

The PSO output is available on the dual-function AUX Marker/PSO signal lines. The auxiliary marker must be configured as an output using the PSOOUTPUT CONTROL command. Refer to the Help File for more information.

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

Table 2-28: PSO Specifications

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

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

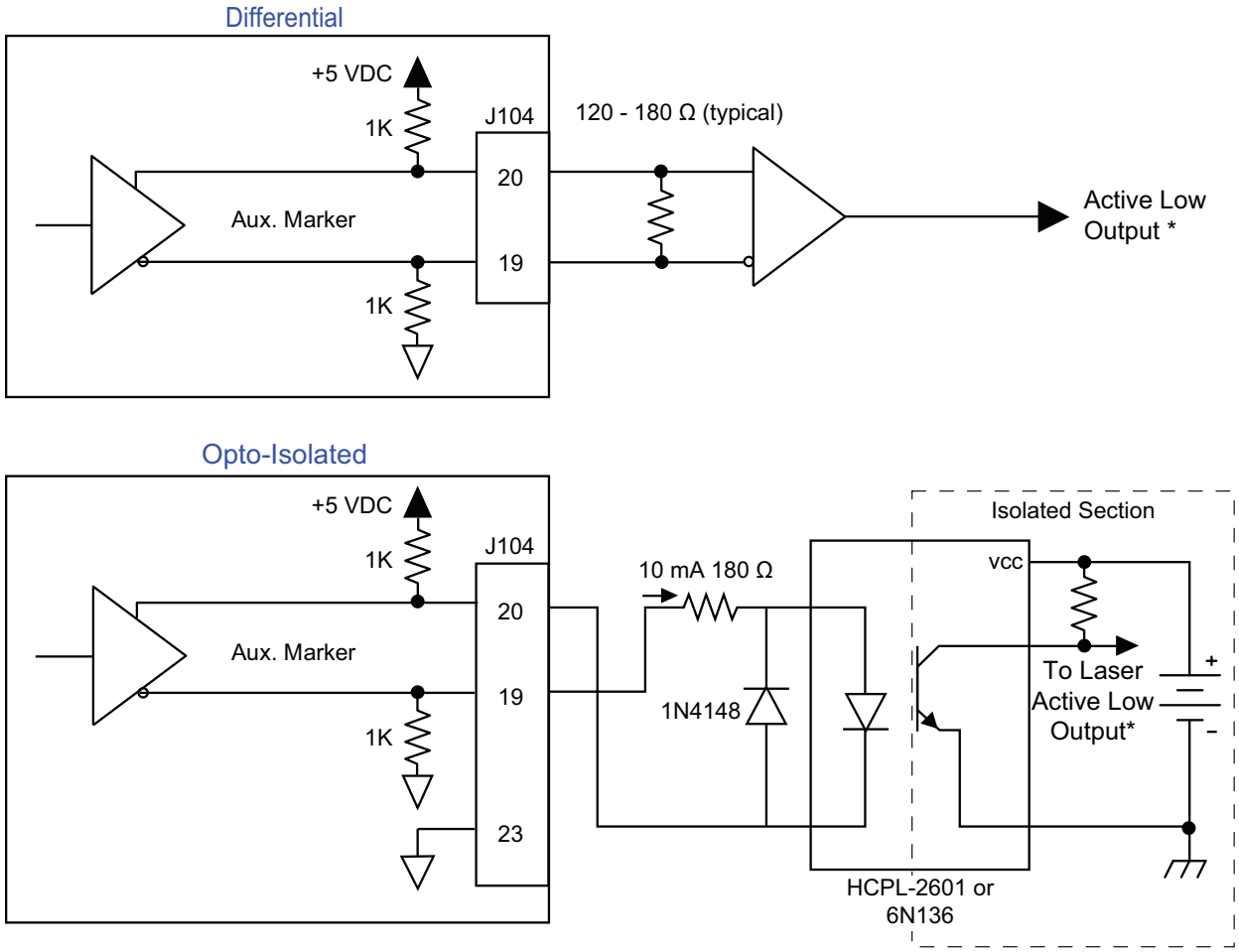
NOTE: When using the MRK± signals with single-ended systems, **do not** connect MRK+ or MRK- to GROUND (GND).

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

Table 2-29: 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	-

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* Active low output shown. Opposite polarity available by reversing connections to Pins 19 and 20.

Figure 2-35: PSO Interface

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2.5.3. Opto-Isolated Outputs (J104)

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

The outputs are software-configurable and must be connected in either all sinking or all sourcing mode. Figure 2-36 and Figure 2-37 illustrate how to connect to an output in current sourcing and current sinking modes.

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

Table 2-30: Digital Output Specifications

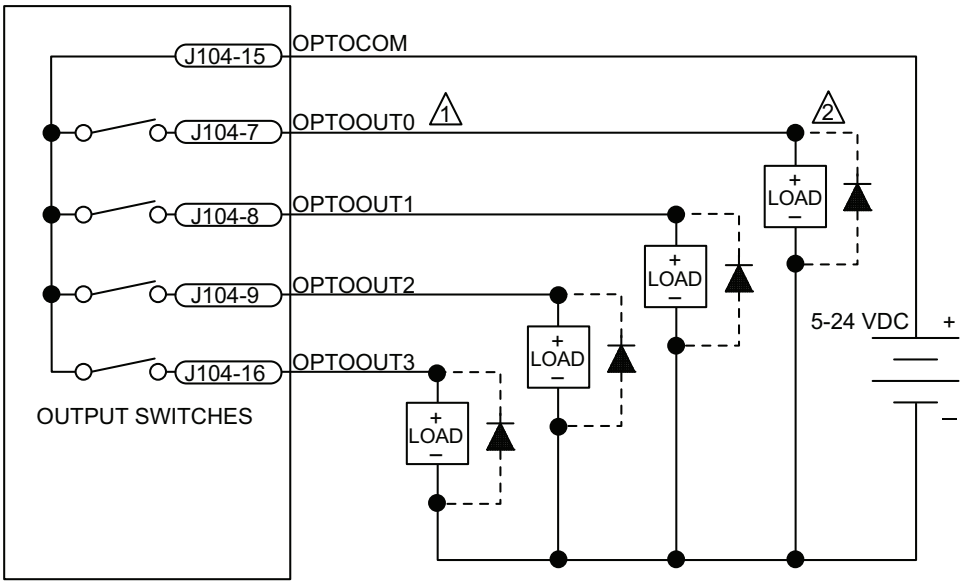
Opto Device Specifications	Value
Maximum Voltage	24 V maximum
Maximum Sink/Source Current	60 mA/channel @ 50°C
Output Saturation Voltage	2.75 V at maximum current
Output Resistance	33 Ω
Rise / Fall Time	250 usec (typical)
Reset State	Output Off (High Impedance State)

Table 2-31: 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

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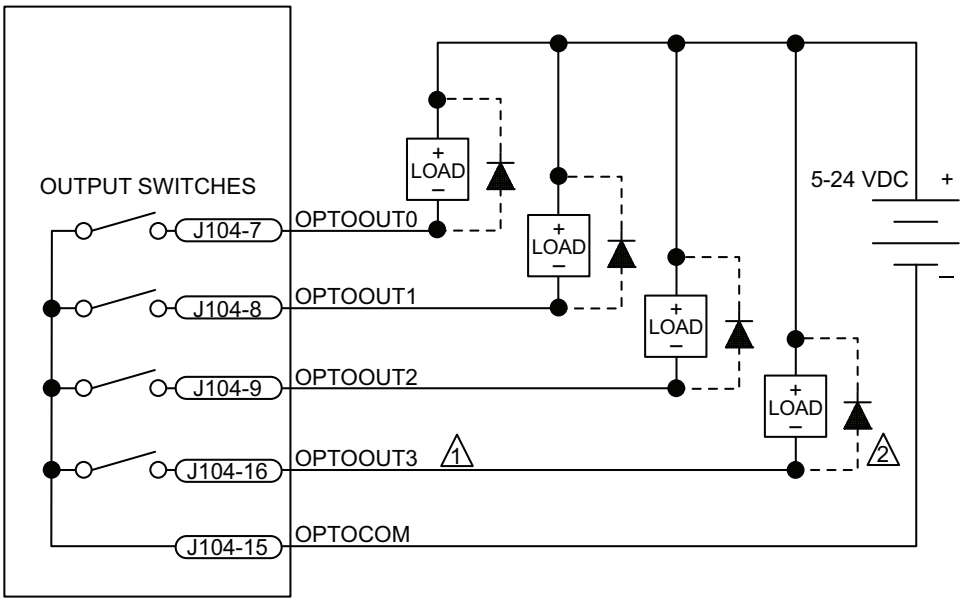
NOTE: Outputs must be connected as all sourcing or all sinking.



1 EACH OUTPUT 60 mA MAXIMUM

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

Figure 2-36: Outputs Connected in Current Sourcing Mode (J104)



1 EACH OUTPUT 60 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)

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2.5.4. Opto-Isolated Inputs (J104)

The digital inputs are opto-isolated and may be connected to current sourcing or current sinking devices, as shown in Figure 2-38 and Figure 2-39. These inputs are designed to connect to other ground-referenced circuits and are not intended for high-voltage isolation.

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

Table 2-32: Opto-Isolated Input Specifications

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

Table 2-33: 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		

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

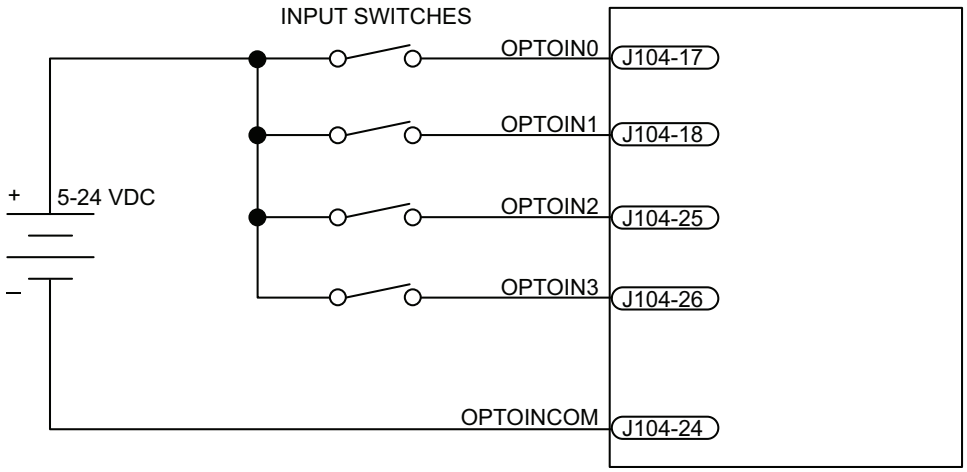


Figure 2-38: Inputs Connected in Current Sourcing Mode (J104)

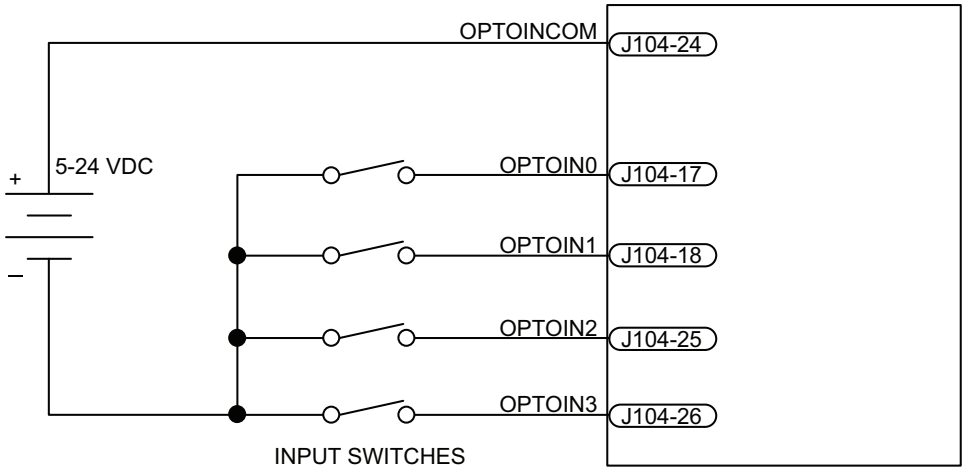


Figure 2-39: Inputs Connected in Current Sinking Mode (J104)

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

The high speed inputs 4-5 are typically used as a sample signal for data collection.

Table 2-34: High-Speed Input Specifications

Specification	Value
Input Voltage	5V or 24 V input voltages based on a jumper setting (Table 2-36)
Input Current	10 mA
Input Device	HCPL-0630
Delay	50 nsec

Table 2-35: 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 2-36: Input Voltage Jumper Configuration

Jumper	Setting	Description
JP4	1-2 (1)	No shunt option present
	2-3	Shunt option present
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

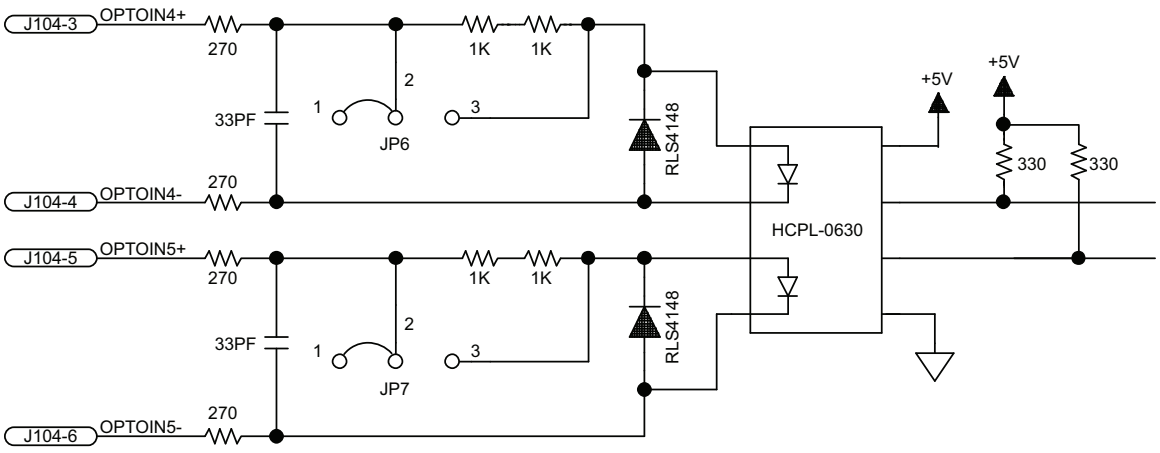


Figure 2-40: High-Speed User Inputs (J104)

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2.5.6. Analog Output 0 (J104)

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

Table 2-37: Analog Output 0 Specifications (TB102 B)

Specification	Value
Output Voltage	-10 V to +10 V
Output Current	5 mA
Resolution (bits)	16 bits
Resolution (volts)	305 µV

Table 2-38: Analog Output Connector Pin Assignment (J104)

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

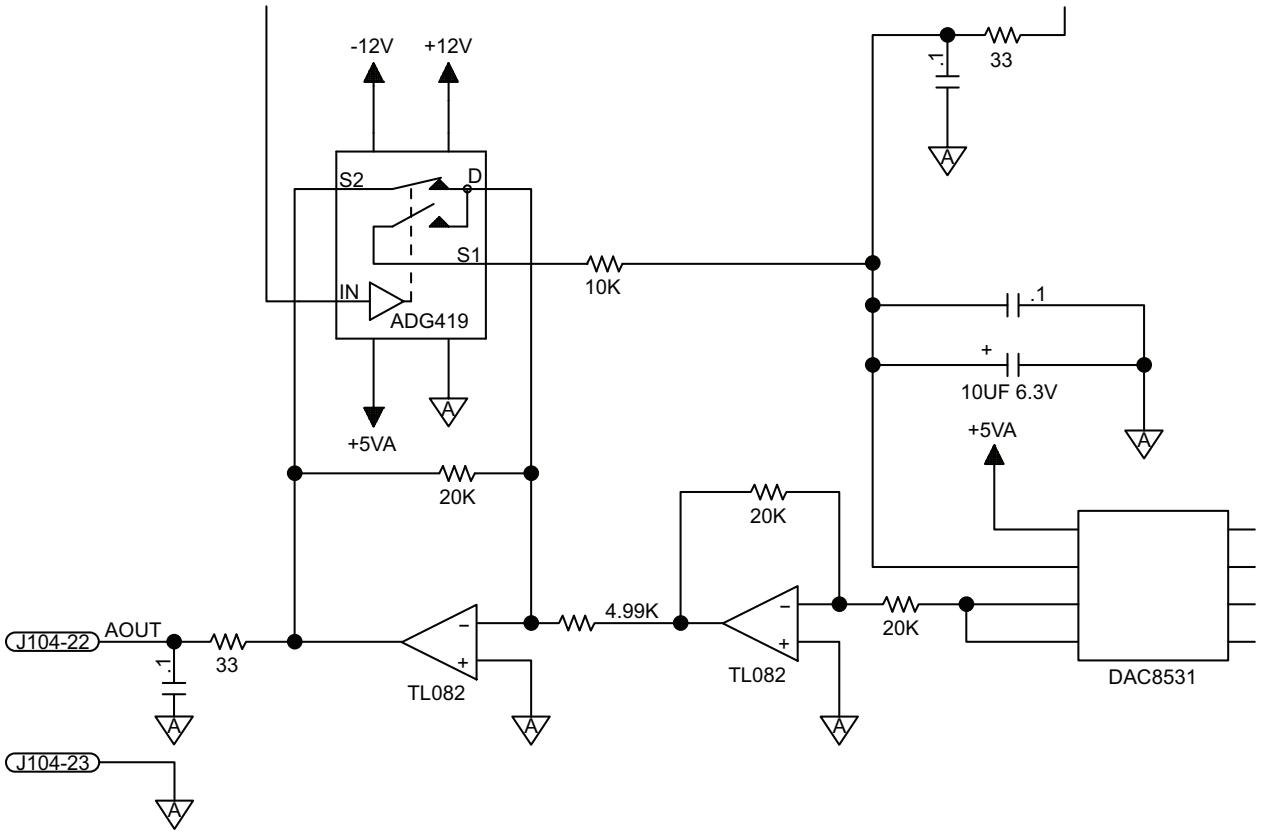


Figure 2-41: Analog Output 0 (J104)

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2.5.7. Differential Analog Input 0 (J104)

To interface to a single-ended (non-differential) voltage source, connect the signal common of the source to the negative input and the analog source signal to the positive input. A floating signal source should be referenced to the analog common as shown in Figure 2-42.

Table 2-39: Differential Analog Input 0 Specifications

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

Table 2-40: 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	-

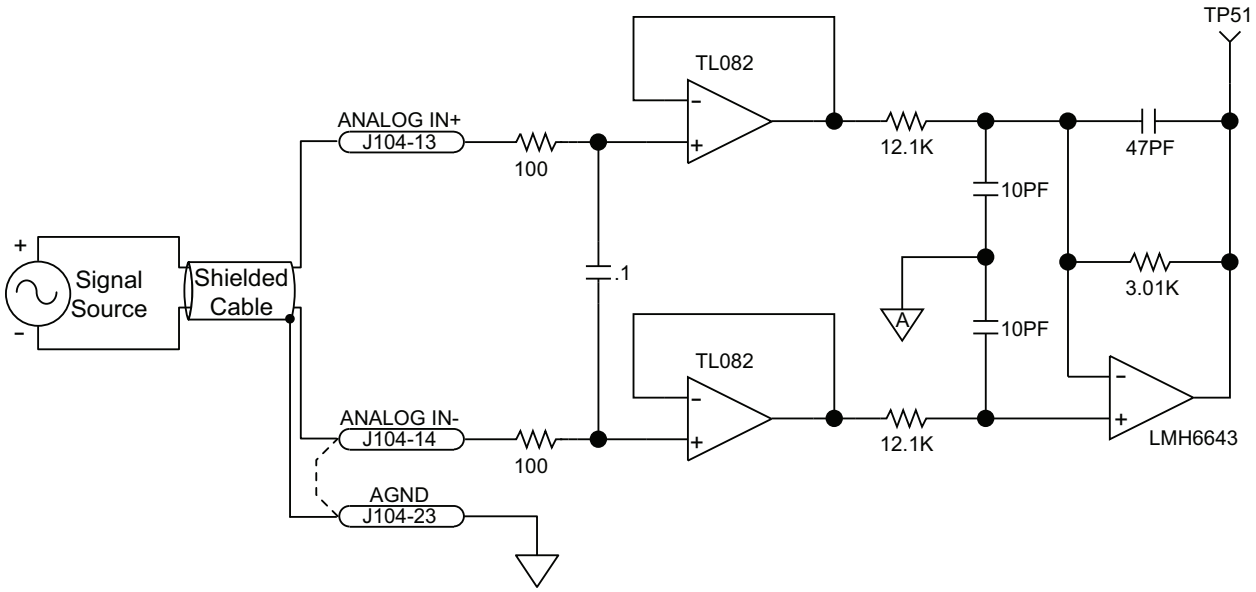


Figure 2-42: Analog Input 0 (J104)

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

The brake is typically wired directly to the Motor Feedback connector and the brake power supply is connected to TB103 (shown in Figure 2-43. The brake may also be connected in series with the Brake Power Supply and interlocked using Motor Feedback brake pins (Table 2-43 and Figure 2-44).

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

The brake output can be software configured; refer to the Ensemble Help file for more information (see topics for the EnableBrakeControl 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 2-41: Brake Output Connector Pin Assignment (TB103)

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

Table 2-42: Mating Connector (TB103)

Description	Aerotech P/N	Phoenix P/N	Wire Size: AWG [mm^2]
6-Pin Terminal Block	ECK01364	1881367	0.5 - 0.080 [20-28]

Table 2-43: Brake Output Connector Pin Assignment (J103)

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

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Figure 2-43 is an example of a +24 VDC brake connected to the Motor Feedback connector. In this example the external +24 VDC power source is connected to TB103.

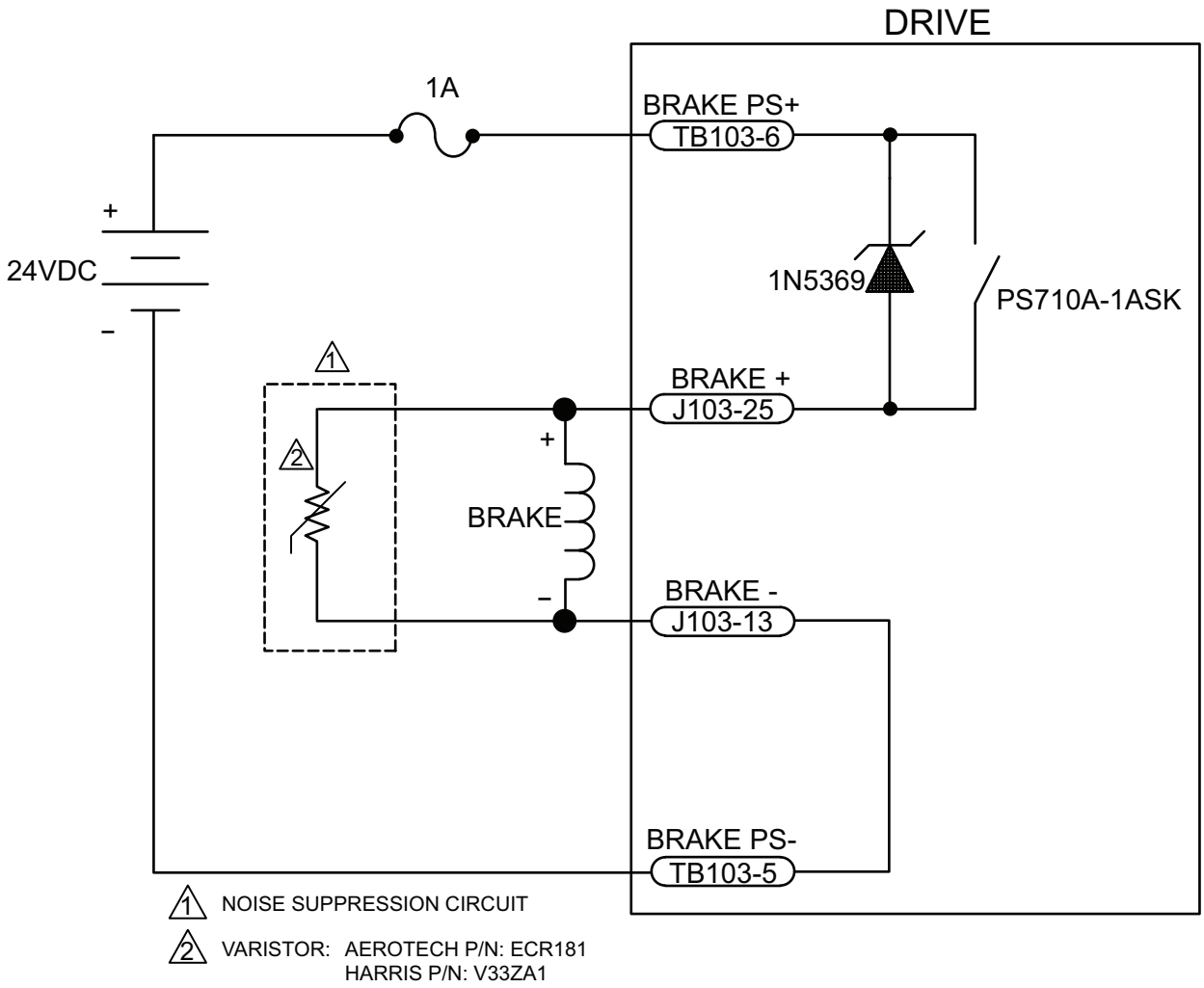


Figure 2-43: Brake Connected to J103

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

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Figure 2-44 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.

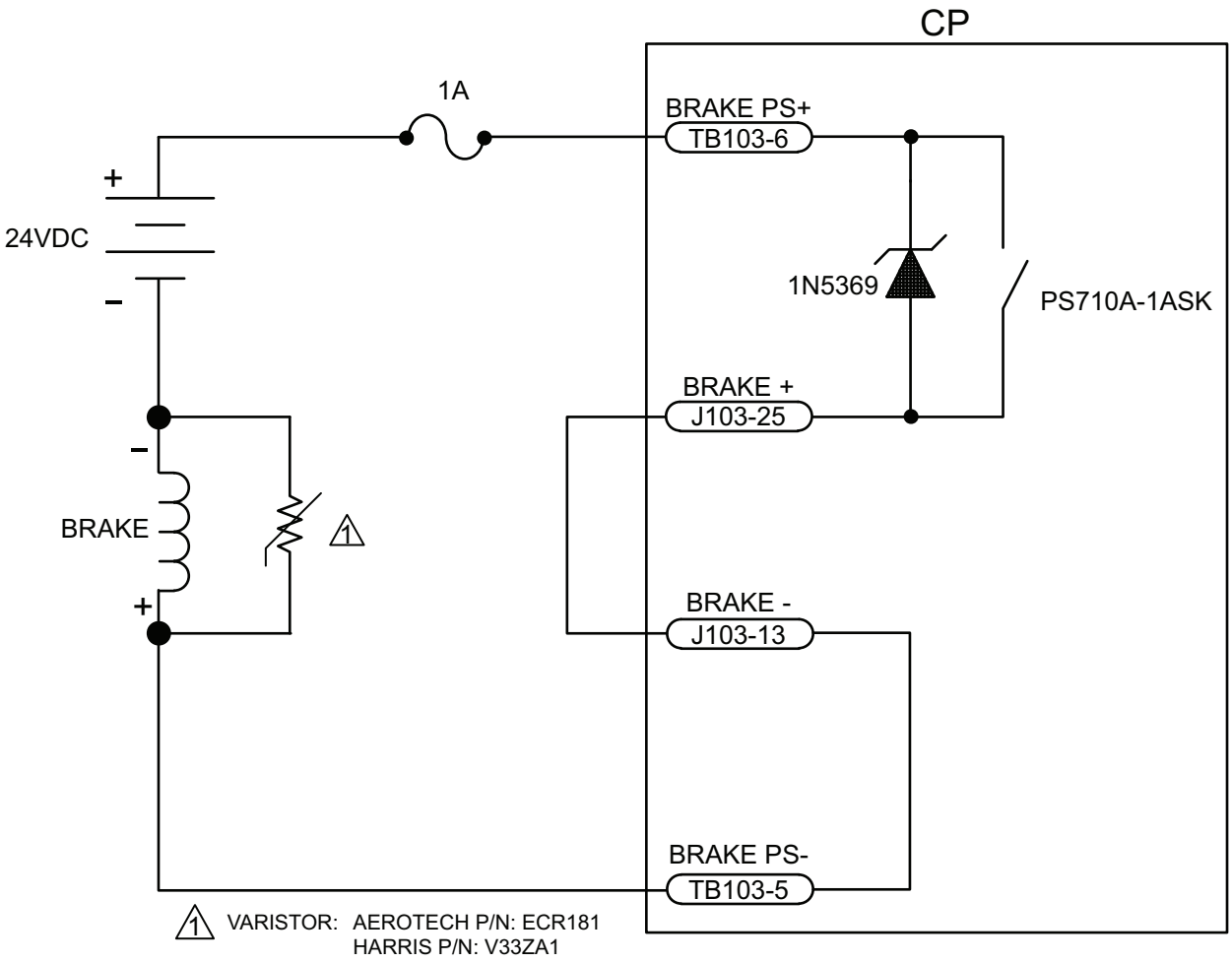


Figure 2-44: Brake Connected to TB103

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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.

Table 2-44: 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. Aeronet Interface (J107/J108)

The Aeronet interface is used to connect discrete Ensemble CPs to make a multi-axis system. The Aeronet connection requires a shielded CAT-6 Ethernet cable. If a non-shielded cable is used, communication failures will likely occur.

When connecting a PC using Ethernet or USB to a multi-axis system, you must connect the PC to the primary Ensemble CP using the standard Ethernet or USB connectors. Connecting the PC to any of the secondary units will result in a connection failure.

Any discrete unit is capable of acting as the primary Ensemble CP. The unit acting as the primary is dictated by the connection of the Aeronet. A primary drive will only act as an output. A secondary drive (in a configuration with three or more drives) will act as an input and output. The last drive connected in any configuration will only act as an input.

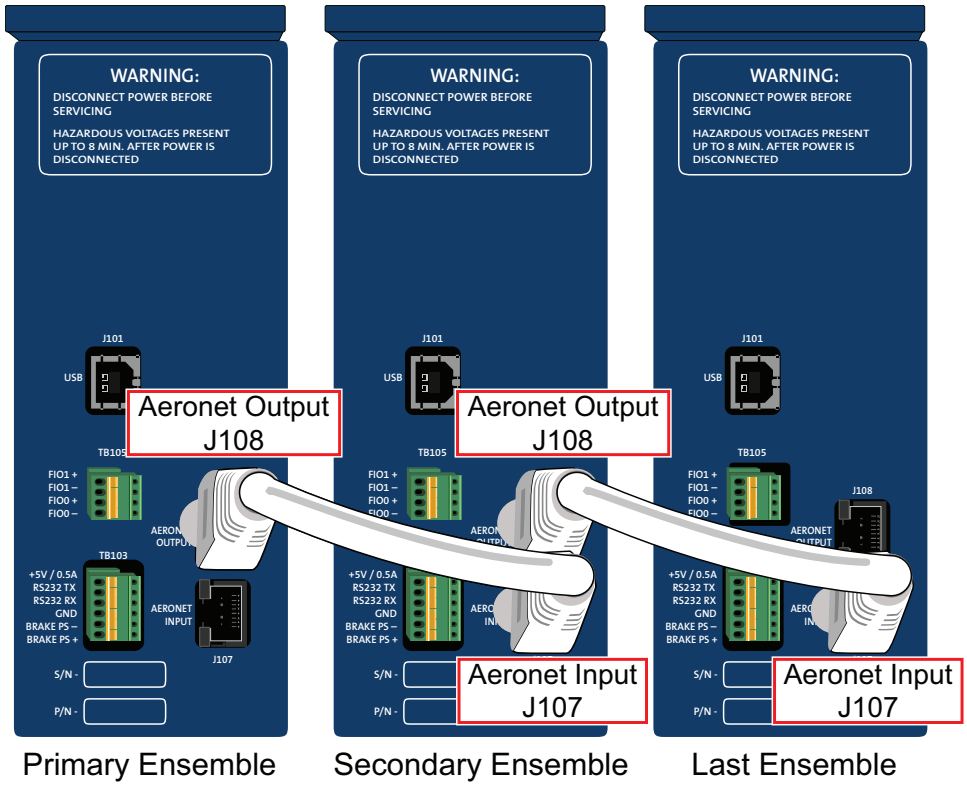


Figure 2-45: Aeronet Connection with Three Discrete Drives

Table 2-45: Aeronet Cable Part Numbers

Cable Part Number	Length
ENET-CAT6-x	A CAT6 cable; length is x decimeters
1) x = 3, 10, 20, 30, 45, 76, or 90 2) Cable lengths are in decimeters, 10dm = 1 meter = 3.28 feet	

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2.8. RS-232 Interface (TB103)

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

Table 2-46: 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 2-47: 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]

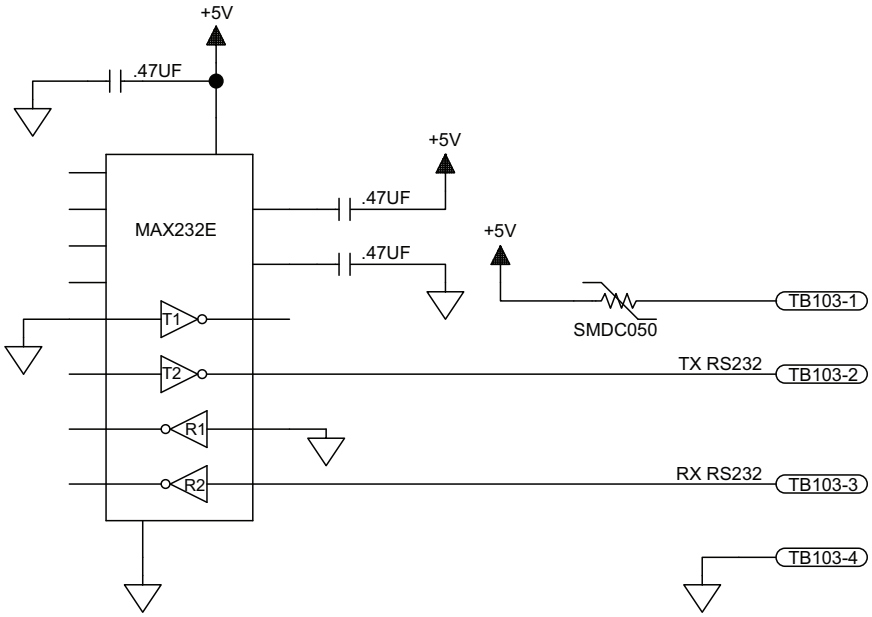


Figure 2-46: RS-232 Interface (TB103)

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2.9. -EXTSHUNT Option (TB104)

The -EXTSHUNT option provides a connection for a user-provided shunt resistor to dissipate excess energy and keep the internal drive voltage within safe levels. The drive switches this resistor "ON" when the internal bus voltage reaches approximately 380 VDC. This option is generally required for systems that have a large amount of stored mechanical energy (i.e. large rotating drums).

Proper sizing, mounting, and protection of the shunt resistor is critical due to the potentially large amounts of power dissipated.



DANGER: The shunt resistor temperature can exceed 70°C during normal operation and contains lethal voltage on its terminals and surface. It must be properly enclosed and shielded to avoid risk of fire and operator shock.

Table 2-48: -EXTSHUNT Component Information

Component	Description	Aerotech P/N
Recommended Shunt Resistor	50 Ω (min), 300 W Vishay/Dale: RBEF030050R00KFBVT	ECR01039
2-Pin Mating Connector	**Screw Torque Value**: 0.5 - 0.6 N·m **Wire Size**: 12-30 AWG [3.3 - 0.0516 mm^2] Phoenix:175449	ECK01110
Fuse (F1 on the Control Board)	2.5 A S.B. Littelfuse: 21502.5P	EIF01053
Recommended Wire Size	16 AWG (1.3 mm^2) High Temperature	--

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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)

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 Ensemble CP, the maximum energy the internal bus capacitor can store without requiring a shunt resistor is indicated in Table 2-49.

Table 2-49: 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:

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

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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)

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

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

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

$$\text{Torque } T = K_t * I_m$$

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

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2.10. PC Configuration and Operation Information

For additional information about PC configuration, hardware requirements, programming, utilities, and system operation refer to the Ensemble 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 Ensemble CP chassis.

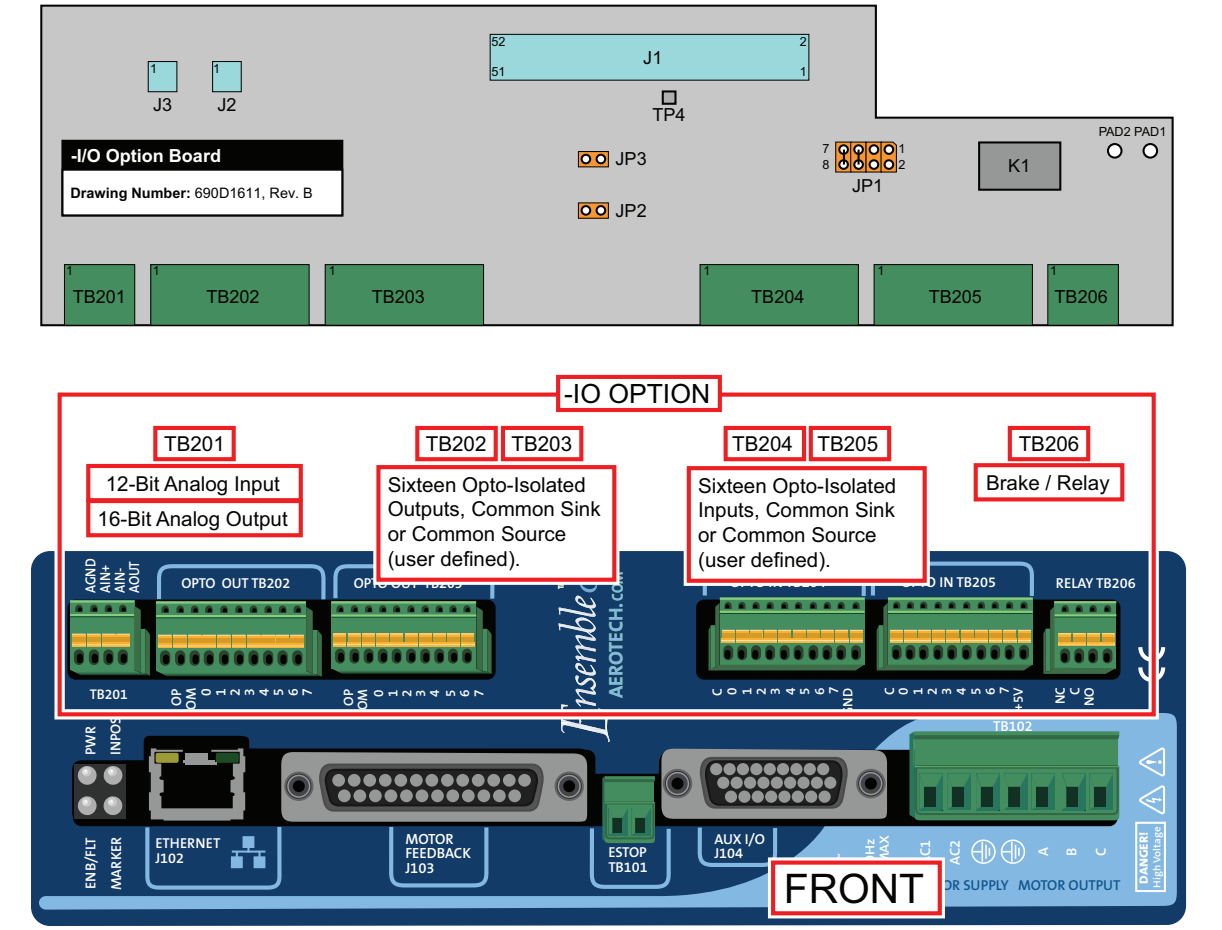


Figure 3-1: Ensemble CP with -IO Option Board

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

Table 3-3: Analog Output Specifications (TB102 B)

Specification	Value
Output Voltage	-10 V to +10 V
Output Current	5 mA
Resolution (bits)	16 bits
Resolution (volts)	305 µV

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

Table 3-4: Analog Output Connector Pin Assignment (TB201)

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

Table 3-5: Analog Output Mating Connector

Type	Aerotech P/N	Phoenix P/N	Wire Size: AWG [mm^2]
4-Pin Terminal Block	ECK01293	1881341	20-28 [0.5- 0.080]

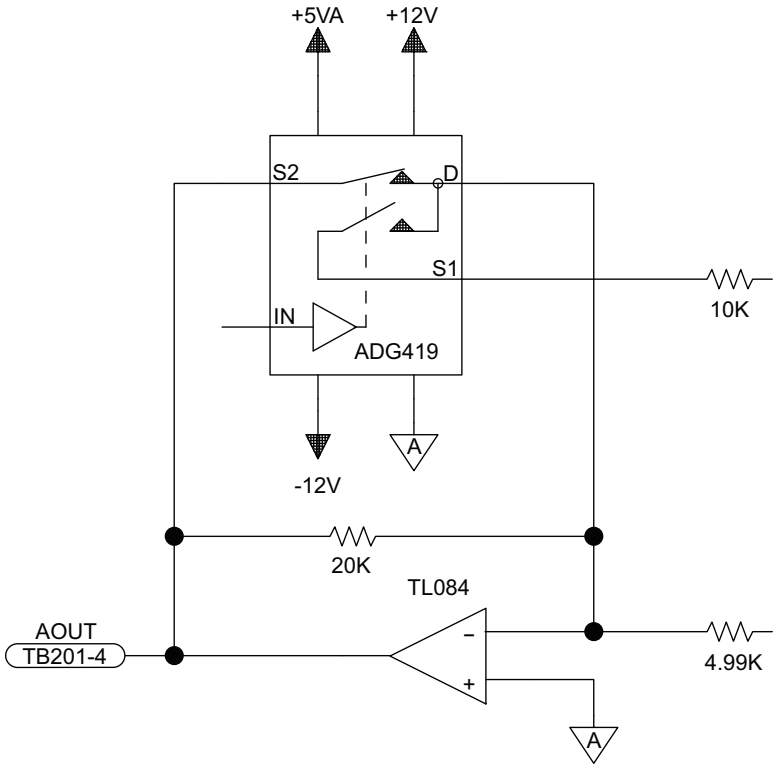


Figure 3-2: Analog Output Connector (TB201)

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3.2. Analog Input (TB201)

To interface to a single-ended (non-differential) voltage source, connect the signal common of the source to the negative input and the analog source signal to the positive input. A floating signal source should be referenced to the analog common as shown in Figure 3-3.

Table 3-6: Differential Analog Input 1 Specifications

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

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

Table 3-7: 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 3-8: Analog Input Mating Connector

Type	Aerotech P/N	Phoenix P/N	Wire Size: AWG [mm^2]
4-Pin Terminal Block	ECK01293	1881341	20-28 [0.5- 0.080]

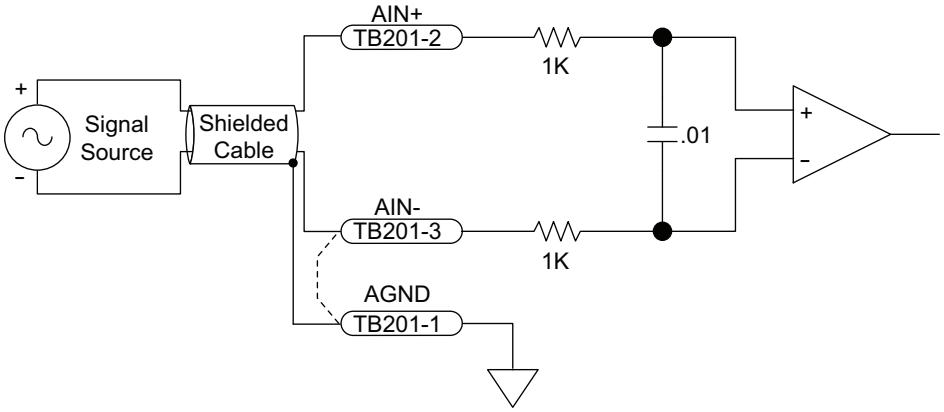


Figure 3-3: Analog Input Typical Connection (TB201)

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3.3. Opto-Isolated Inputs (TB204, TB205)

The digital inputs are opto-isolated and may be connected to current sourcing or current sinking devices, as shown in Figure 3-5 and Figure 3-6. These inputs are designed to connect to other ground-referenced circuits and are not intended for high-voltage isolation.

Port 1 and Port 2 inputs have separate common inputs (refer to Table 3-10 for TB204 and Table 3-11 for TB205). Each port can be referenced independently.

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

Table 3-9: Opto-Isolated Input 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 3-10: 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 3-11: 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 3-12: Opto-Isolated Input Mating Connector

	Aerotech P/N	Phoenix P/N	Wire Size: AWG [mm^2]
10-Pin Terminal Block	ECK01294	1881406	20-28 [0.5-0.080]

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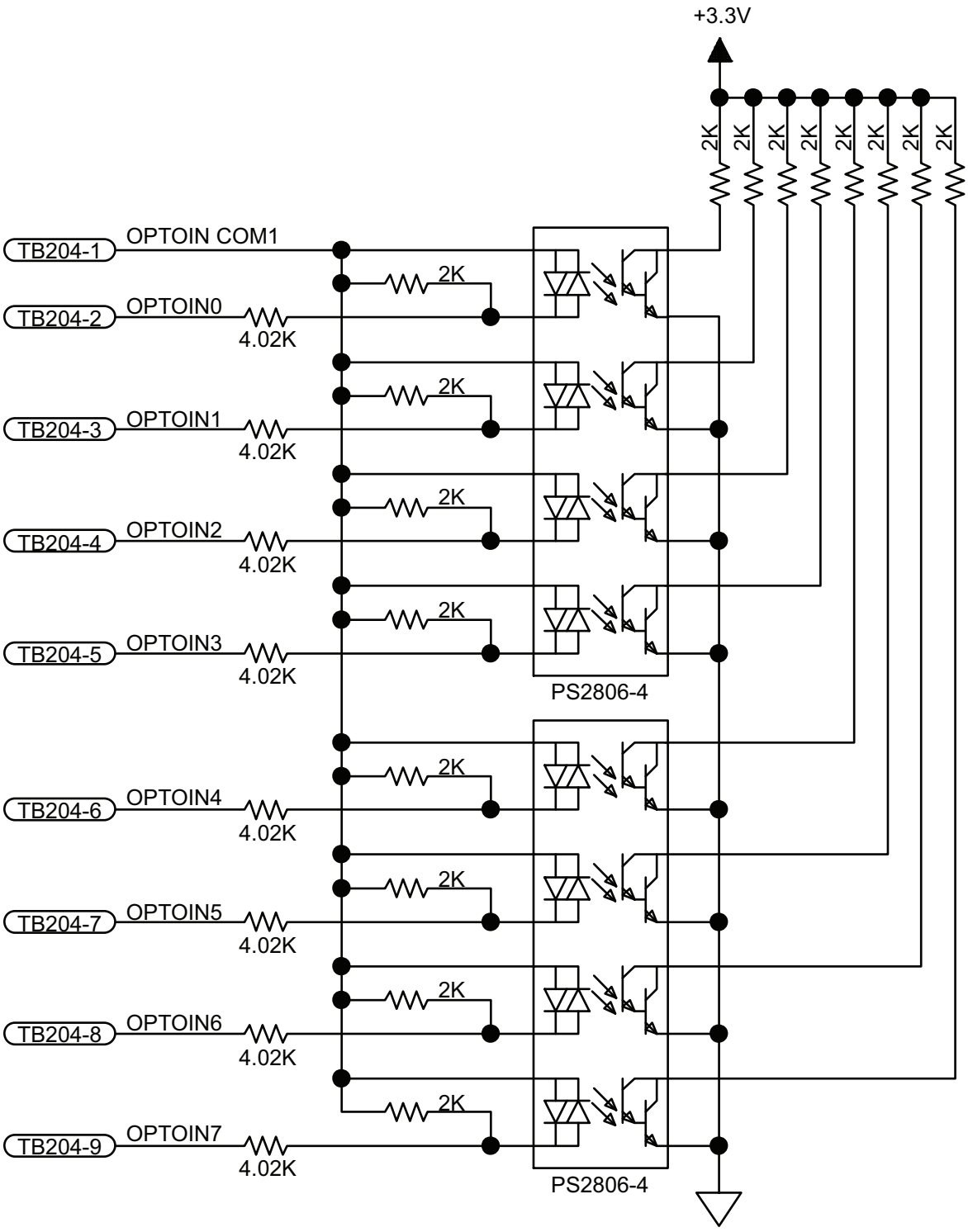


Figure 3-4: Opto-Isolated Inputs

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

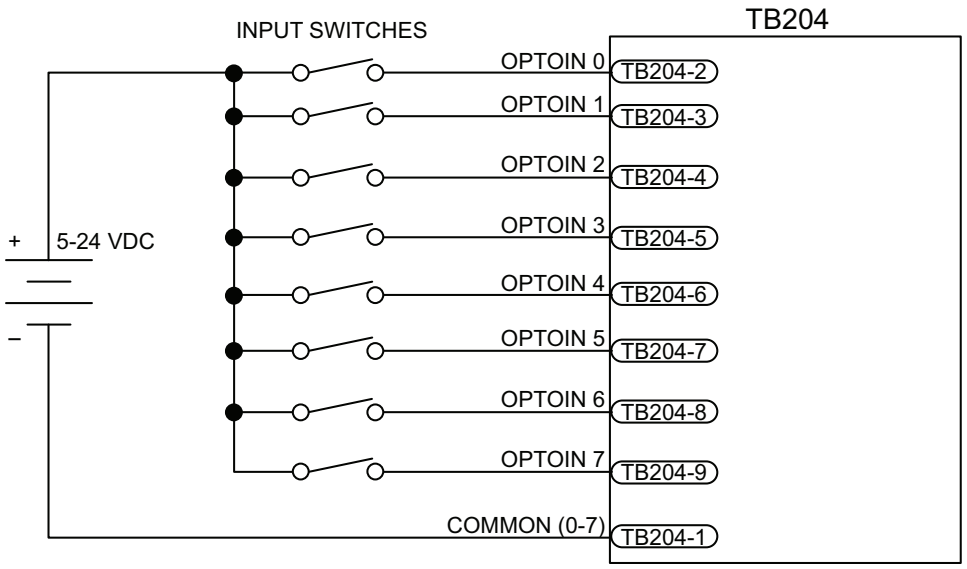


Figure 3-5: Inputs Connected to a Current Sourcing Device

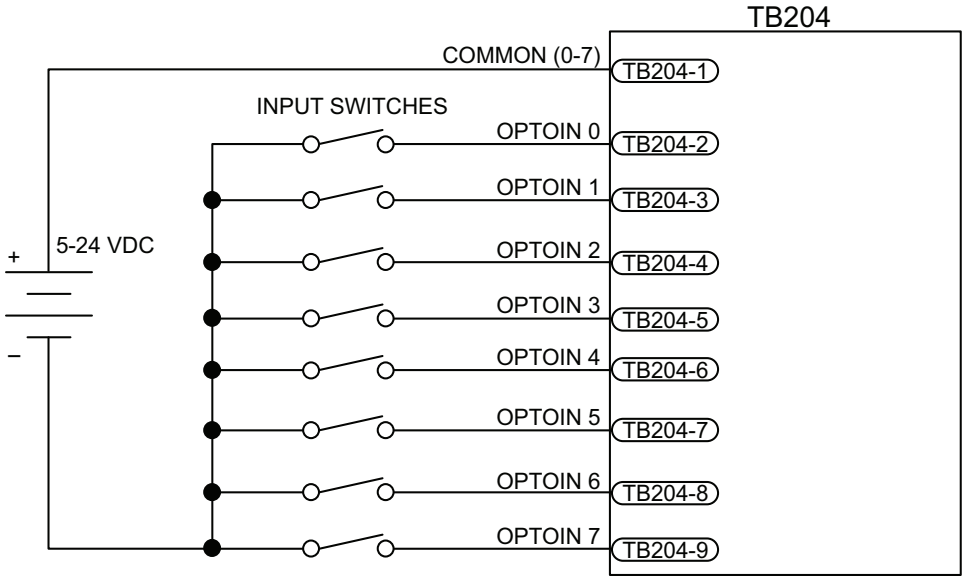


Figure 3-6: Inputs Connected to a Current Sinking Device

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3.4. Opto-Isolated Outputs (TB202, TB203)

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

The outputs are software-configurable and must be connected in either all sinking or all sourcing mode. Figure 3-8 and Figure 3-9 illustrate how to connect to an output in current sourcing and current sinking modes.

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

Table 3-13: Output Specifications (TB202, TB203)

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

Suppression diodes must be installed on outputs driving relays or other inductive devices. This protects the outputs from damage caused by inductive spikes. Suppressor diodes, such as the 1N914, can be installed on all outputs to provide protection. It is important that the diode be installed correctly (normally reversed biased). Refer to Figure 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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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.

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

Table 3-14: 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 3-15: 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 3-16: Opto-Isolated Output Mating Connector

	Aerotech P/N	Phoenix P/N	Wire Size: AWG [mm^2]
10-Pin Terminal Block	ECK01294	1881406	20-28 [0.5-0.080]

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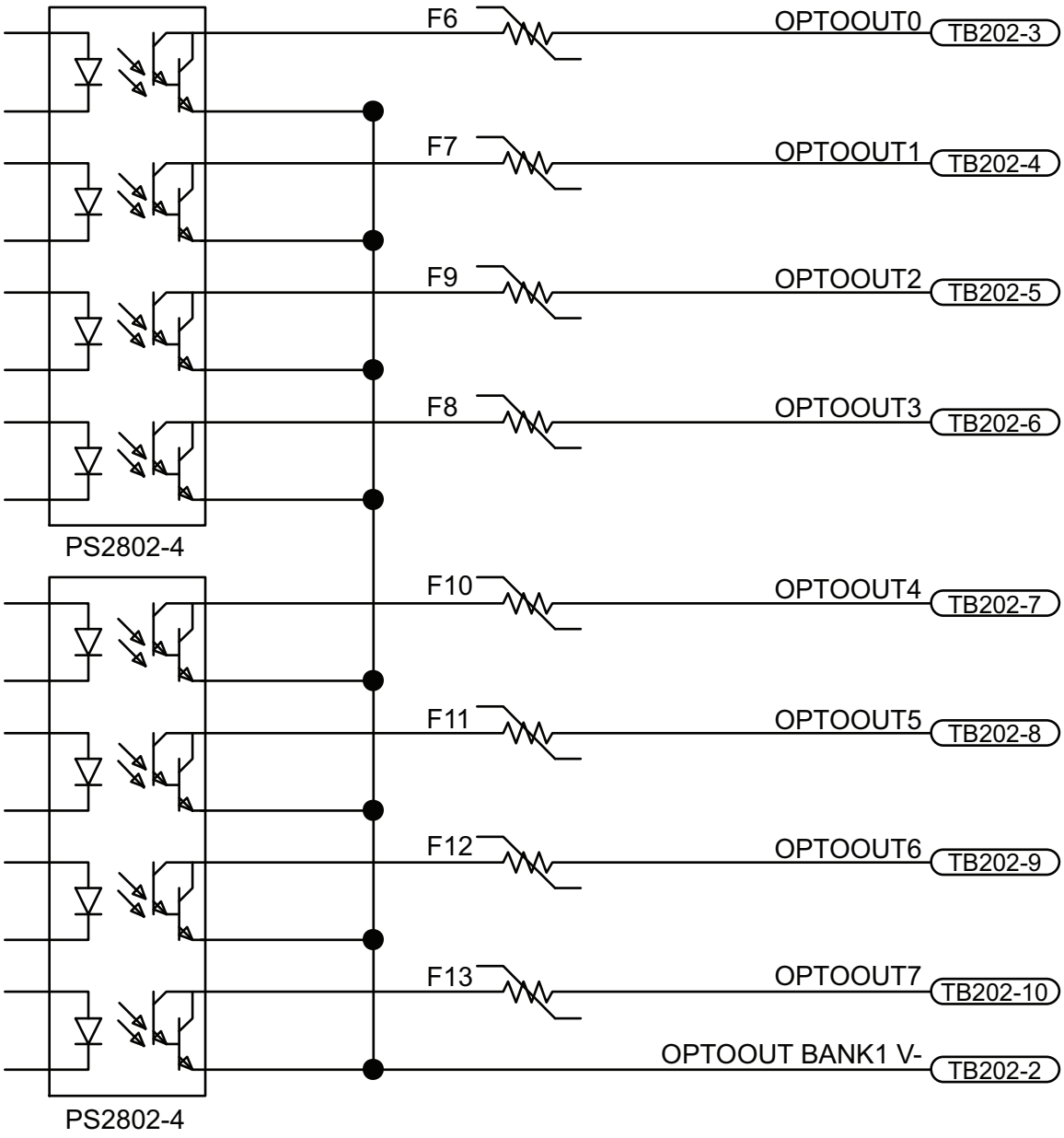


Figure 3-7: Opto-Isolated Outputs (-IO Board)

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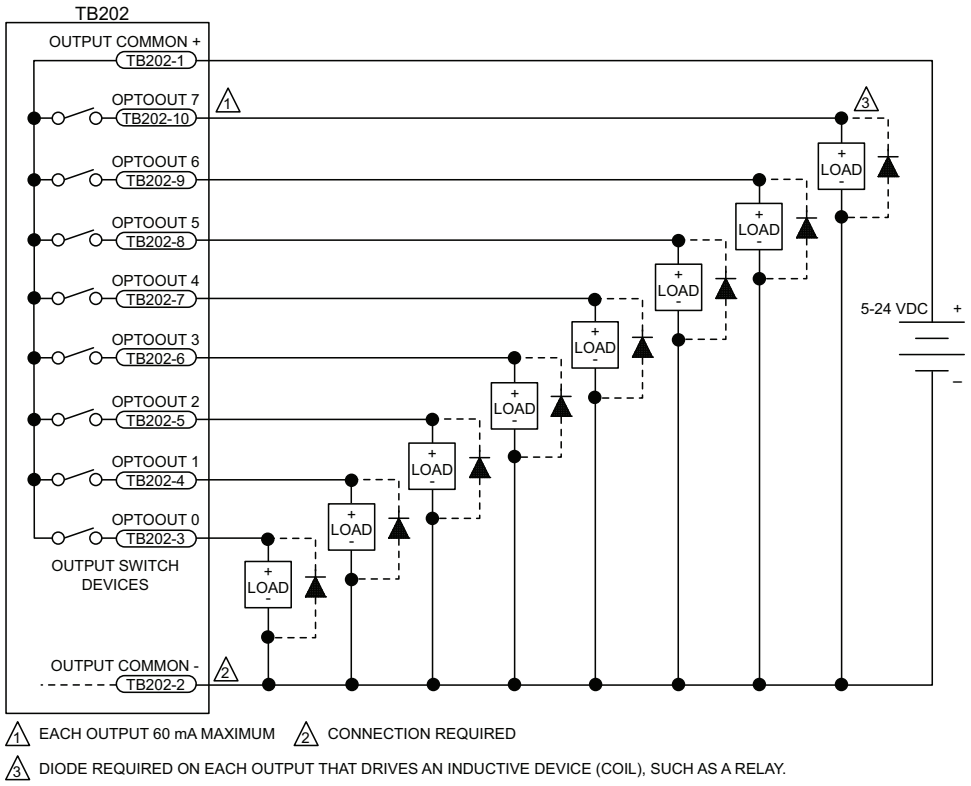


Figure 3-8: Outputs Connected in Current Sourcing Mode

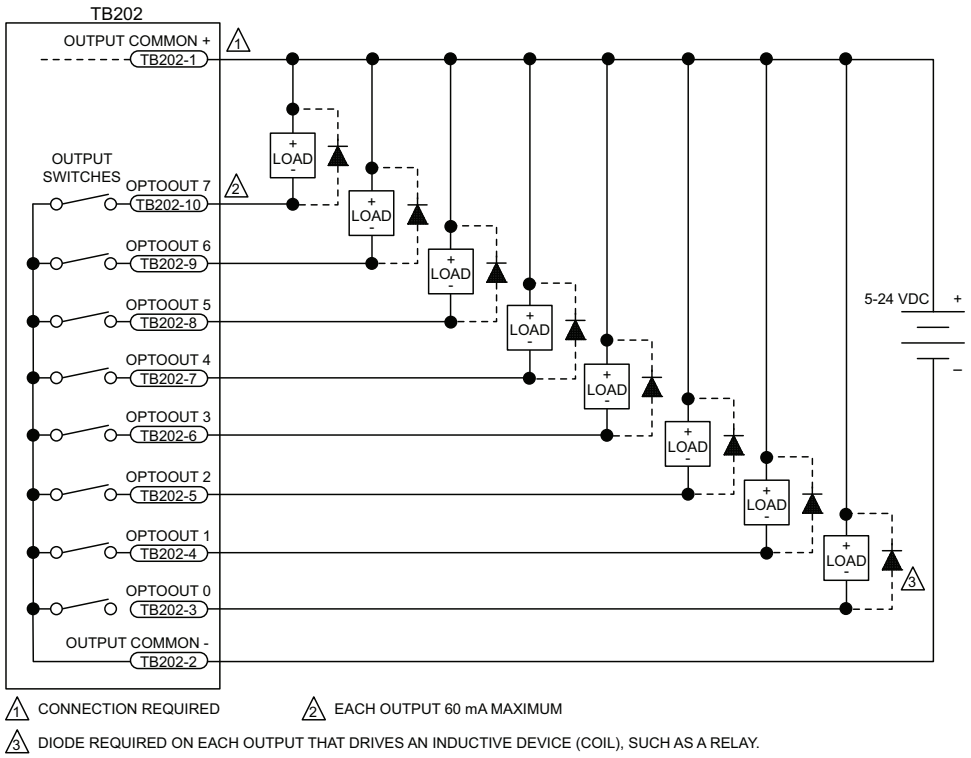


Figure 3-9: Outputs Connected in Current Sinking Mode

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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 3-17: User Common Connector Pin Assignment (TB204)

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

Table 3-18: +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 can be used to automatically control 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 Ensemble Help file for more information (see topics for the EnableBrakeControl 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 3-19) allows either the Brake + or the Brake - output to be switched by the relay and connected at the Motor Feedback connector 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 3-19: -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.

Table 3-20: 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.

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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. 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 3-21: 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 3-19		

Table 3-22: Mating Connector for TB206

Type	Aerotech P/N	Phoenix P/N	Wire Size: AWG [mm^2]
4-Pin Terminal Block	ECK01293	1881341	20-28 [0.5- 0.080]

Table 3-23: Brake / Mechanical Relay Connector Pin Assignment (J103)

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

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

Figure 3-10 is an example of a +24 VDC Brake connected to 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.

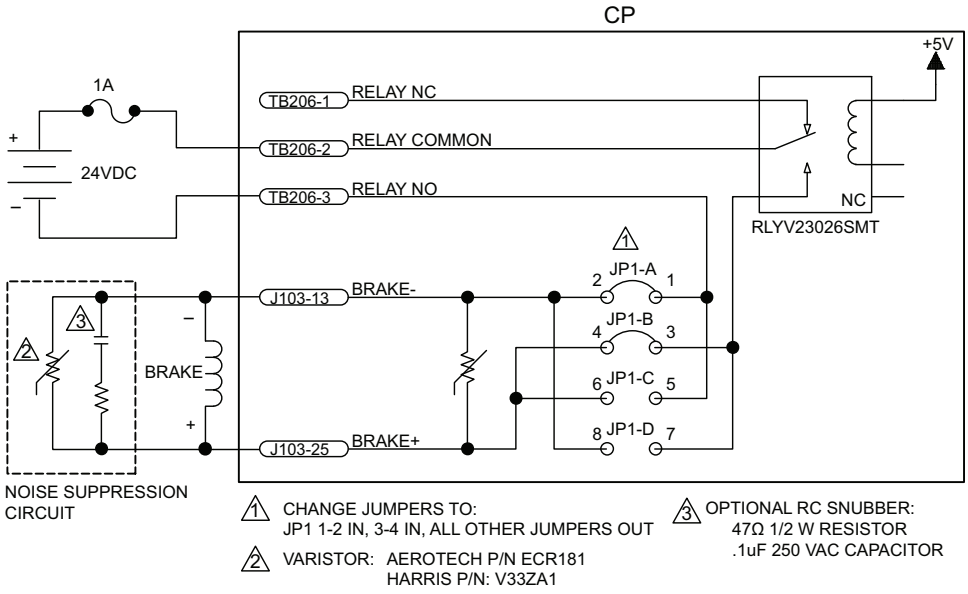


Figure 3-10: Brake Connected to J103

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.

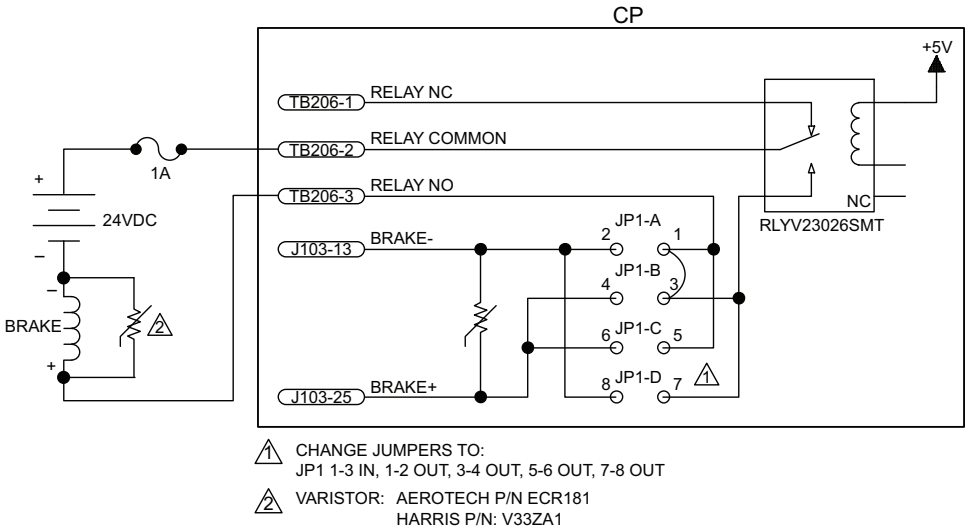


Figure 3-11: Brake Connected to TB206

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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.

The following drawings illustrate how to connect a single- or two-axis joystick . For cable details refer to Table 4-2. Refer to the Ensemble Help file for programming information about how to change joystick parameters (see the Joystick2D.ab or Joystick3D.ab examples).

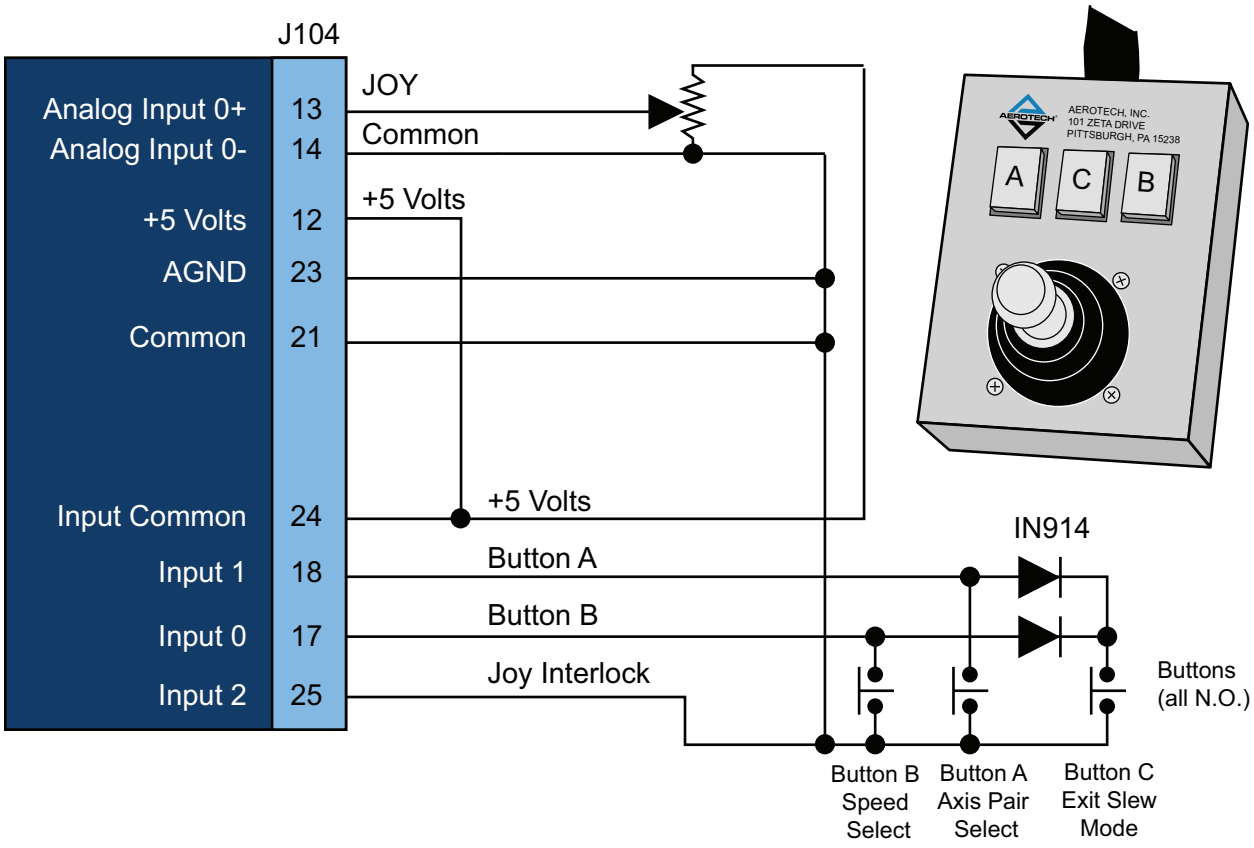


Figure 4-1: Single Axis Joystick Interface (to Aux I/O)

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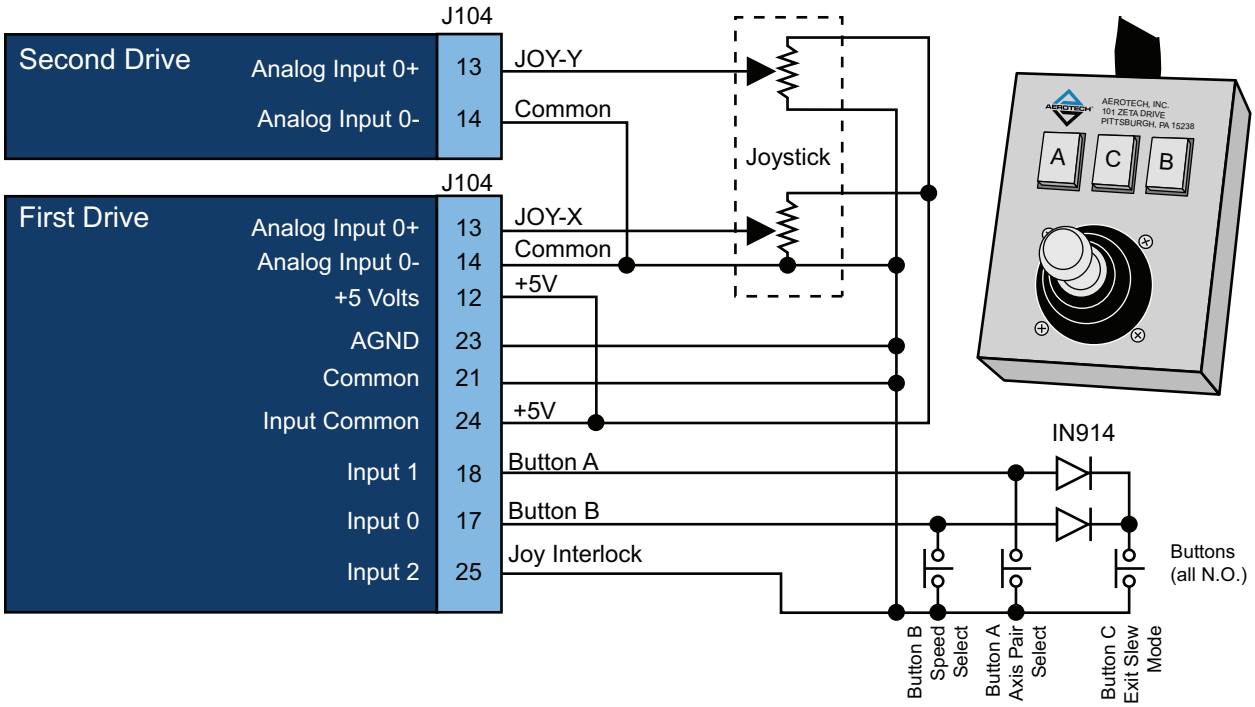


Figure 4-2: Two Axis Joystick Interface (to the Aux I/O of two drives)

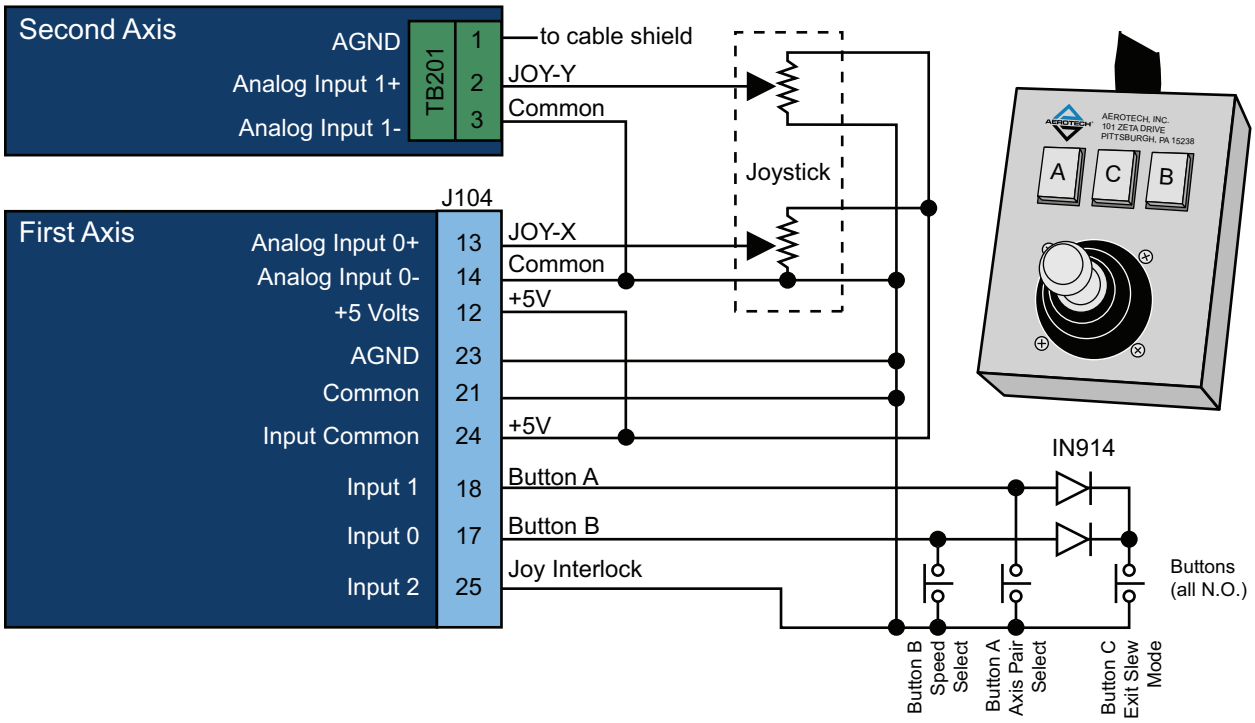


Figure 4-3: Two Axis Joystick Interface (to the Aux I/O and I/O Board)

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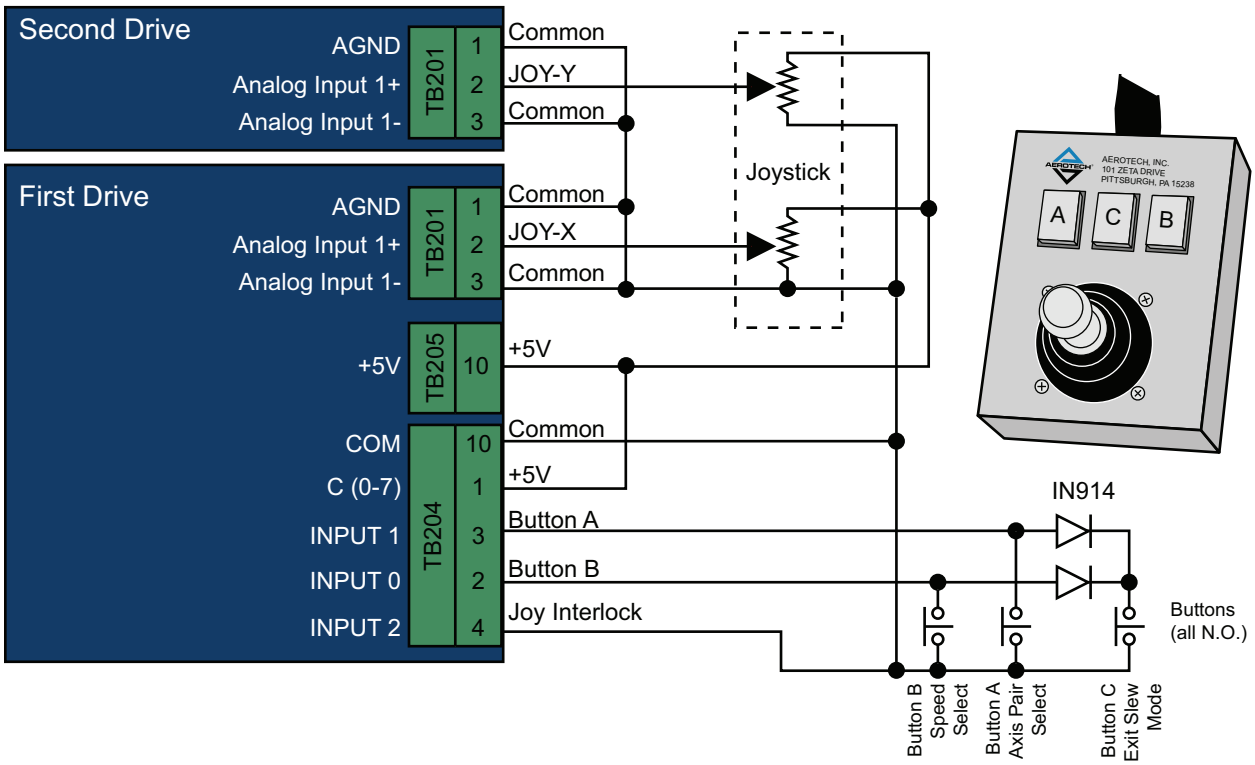


Figure 4-4: Two Axis Joystick Interface (to the I/O board of two drives)

Table 4-2: Cable Part Numbers

Part #	Cable Description	UPC #
C22773-XX	JSXT-FLY 26HD-15DU-MAX300DM ENSEMBLECP DUAL AXIS	630B2277-3
C22774-XX	JSXT-26HD-15DU-MAX300DM ENSEMBLECP SINGLE AXIS	630B2277-4
C22775-XX	JSXT-26HD 26HD-15DU-MAX300DM ENSEMBLECP DUAL AXIS	630B2277-5
C227717-XX	JSXT-FLY FLY-15DU-MAX300DM ENSEMBLECP DUAL AXIS	630B2277-17

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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 Ensemble CP.

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

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

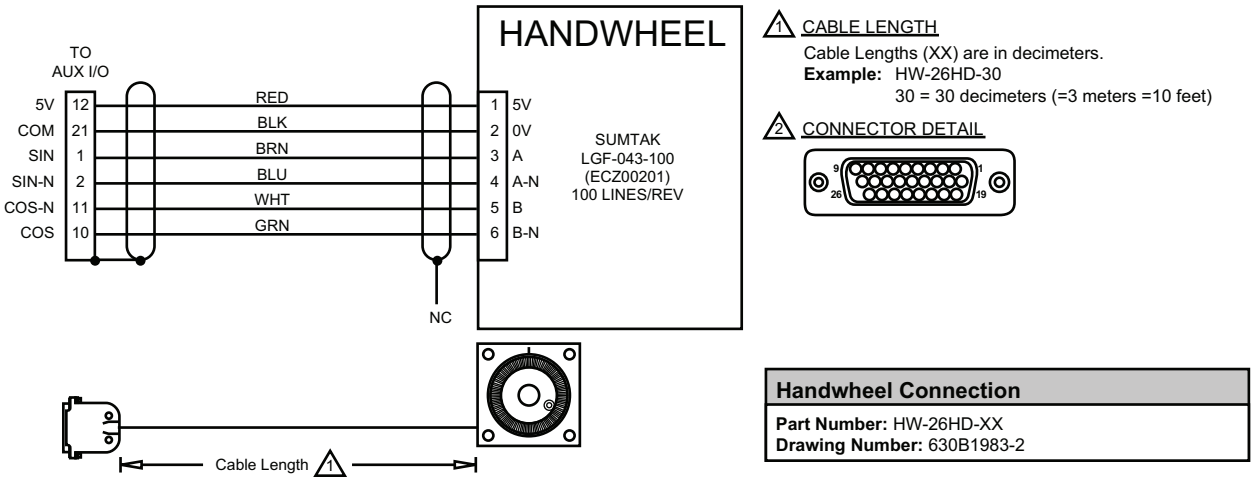


Figure 4-5: Handwheel Interconnection (to Aux I/O)

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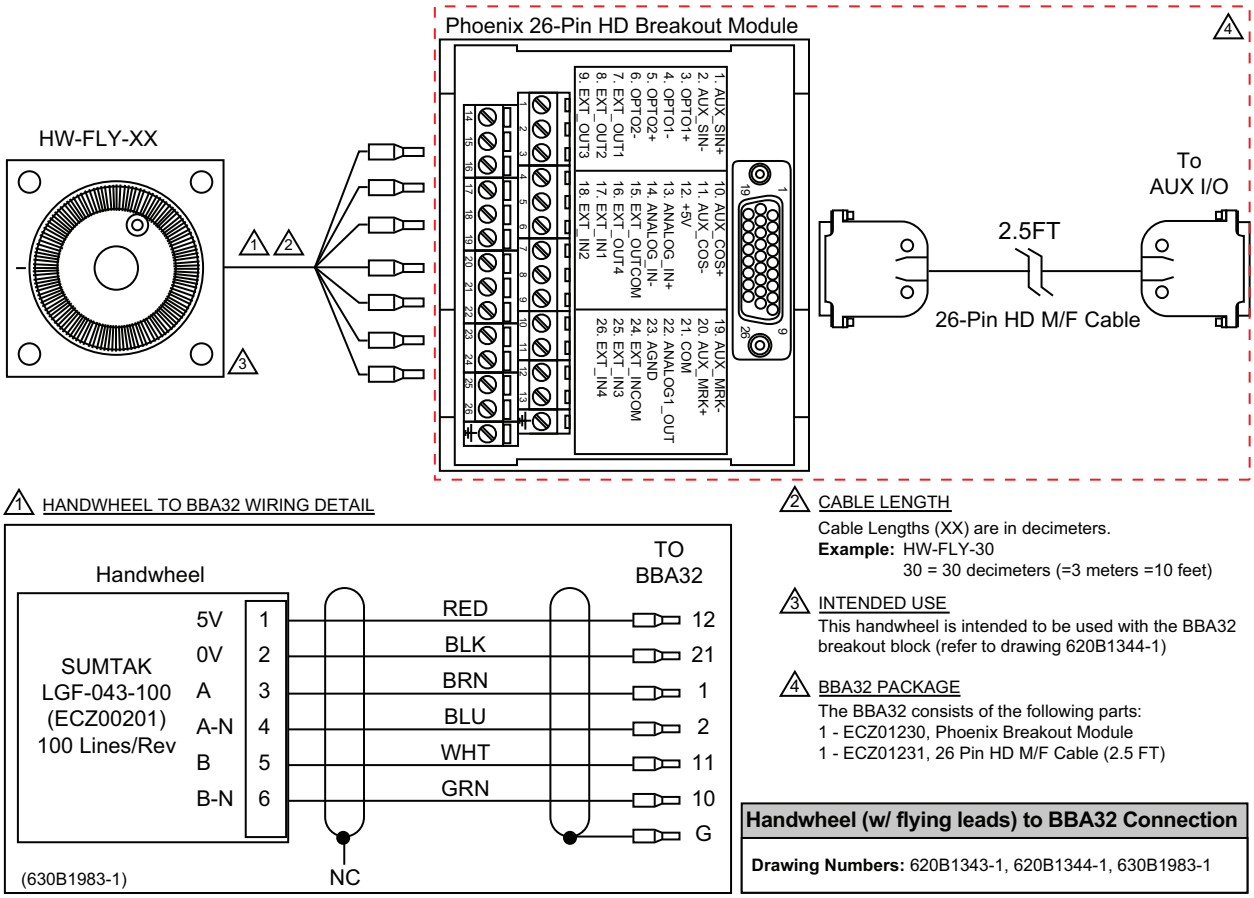


Figure 4-6: Handwheel Interconnection (to Aux I/O via a BBA32 Module)

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Chapter 5: Maintenance



DANGER: Always disconnect the Mains power connection before opening the Ensemble 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

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

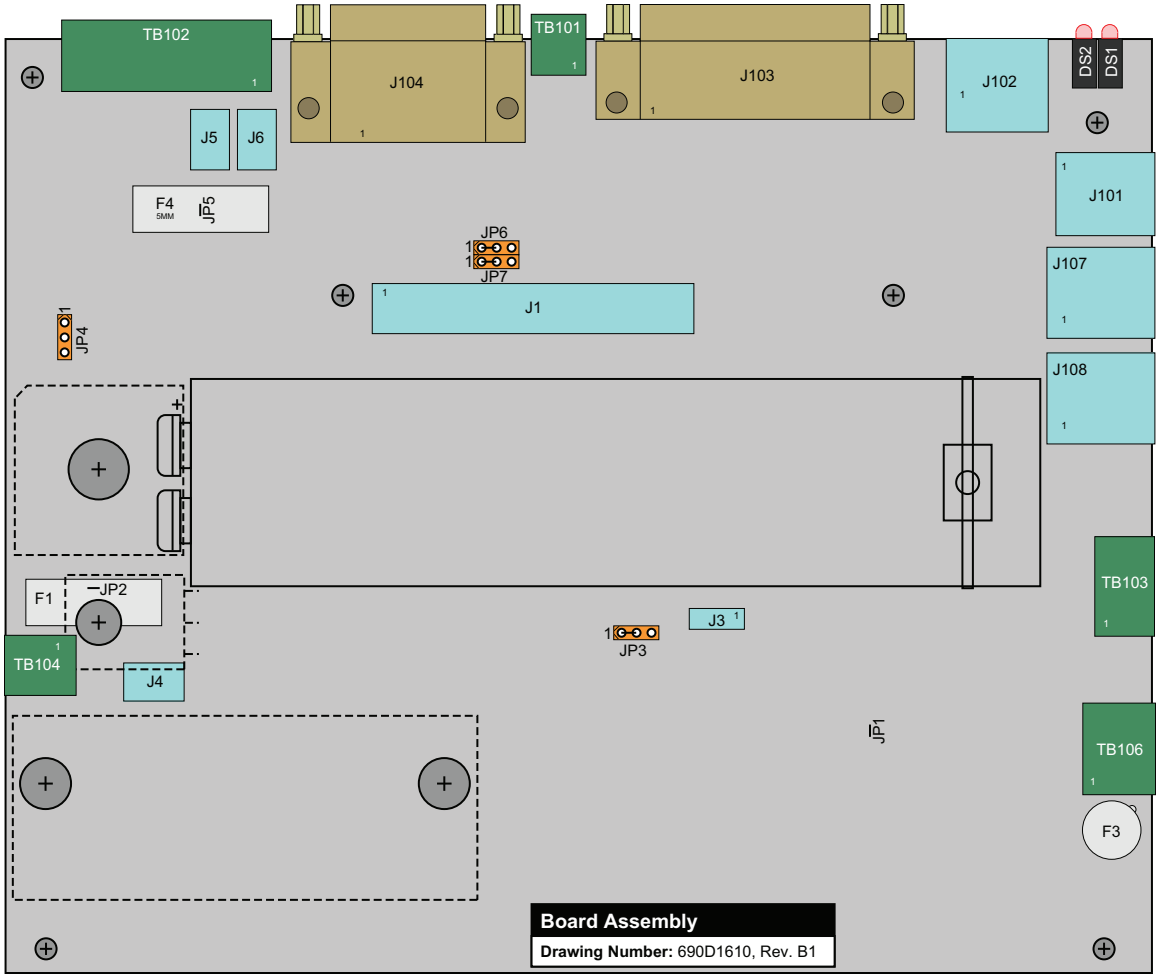


Figure 5-1: Control Board Assembly

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Table 5-2: Control Board Jumper Configuration

Jumper	Setting	Description
JP3	1-2 (1)	Watchdog enabled
	2-3	Watchdog disabled
JP4	1-2 (1)	No shunt option present
	2-3	Shunt option present
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	-S Option Shunt Fuse	1 A S.B. (5 mm)	EIF01052	Littelfuse 215001.P
	-EXTSHUNT Option Shunt Fuse	2.5 A S.B.	EIF01053	Littelfuse 21502.5P
F3	Control Power Fuse	2 A S.B.	EIF01029	Littelfuse 3721200041
F4	Ensemble CP 10; VAC Input at TB102-1	5 A S.B. (5 mm)	EIF01023	Littelfuse 215005.P
	Ensemble CP 20; VAC Input at TB102-1	10 A S.B. (5 mm)	EIF01006	Littelfuse 218010
	Ensemble CP 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 Ensemble 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 Ensemble CP.
Visually inspect all cables and connections.	Tighten or re-secure any loose connections. Replace worn or frayed cables. Replace broken connectors.

Cleaning

The Ensemble 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 Ensemble 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 Ensemble CP while cleaning. Do not allow cleaning substances or other fluids to enter the Ensemble 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	Description
4.07.00	The following sections have been updated: • EU Declaration of Conformity • Section 2.2. Motor Output Connections • Section 2.2.1.1. Powered Motor Phasing • Section 2.2.1.2. Unpowered Motor and Feedback Phasing • Section 2.3.1.1. RS-422 Line Driver Encoder (Standard) • Section 2.3.2. Hall-Effect Interface (J103) • Section 2.3.4. Encoder Fault Interface (J103) • Section 2.5.1. Auxiliary Encoder Channel (J104) • Section 2.5.2. Position Synchronized Output (PSO)/Laser Firing (J104) • Section 2.5.3. Opto-Isolated Outputs (J104) • Section 2.5.4. Opto-Isolated Inputs (J104) • Section 2.5.5. High-Speed User Inputs 4-5 (J104) • Section 2.5.6. Analog Output 0 (J104) • Section 2.5.7. Differential Analog Input 0 (J104) • Section 3.1. Analog Output (TB201) • Section 3.2. Analog Input (TB201) • Section 3.3. Opto-Isolated Inputs (TB204, TB205) • Section 3.4. Opto-Isolated Outputs (TB202, TB203) • Section 5.1. Control Board • Section 2.9. -EXTSHUNT Option (TB104) • Control board jumper configuration change: Table 5-2
4.05.00	• 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	Revision changes have been archived. If you need a copy of this revision, contact Aerotech Global Technical Support.
4.03.00	
4.02.00	
4.01.00	
4.00.00	
2.03.00	
2.02.00	
2.01.00	
2.00.02	
2.00.00	
1.00	

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Index

-

-I/O Expansion Board 85

-IO Board Fuse Information 85

-IO Expansion Board Brake Jumper Configuration 96

-IO Expansion Board Jumper Configuration 85

-IO Option Board 85

-IO Options 85

-MXU Option 46,49

-S 16

+

+5 Volt Power Connector Pin Assignment 95

1

160 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 33

2

2014/30/EU 9

2014/35/EU 9

4

40 VDC Motor Power with a TV0.3-28-56-ST Transformer 29

40 Volt DC Bus from 115 and 230 VAC Source 31

8

80 VDC Motor Power with a TV0.3-28-56-ST Transformer 30

80 Volt DC Bus from 115 and 230 VAC Source (TV0.3-56) 32

A

AC Line Filter 27,35

Aeronet Interface 78

Altitude 23

Ambient Temperature 23

amplifier power dissipation 21

Analog Encoder Phasing Reference Diagram 49

Analog Encoder Specifications 49

Analog Input 73

Analog Input (I/O Board) 87

Analog Input 1 Connector 87

Analog Input Connector Pin Assignment 73

Analog Inputs Connector Pin Assignment 87

Analog Output 72

Analog Output 1 Connector 86

Analog Output 1 Connector Pin Assignment 86

Analog Outputs (I/O Board) 86

Auxiliary Encoder Channel 63-64

Auxiliary Encoder Channel Pin Assignment 63,65

Auxiliary I/O Connector 62

Auxiliary I/O Connector Pin Assignment 62

B

Brake / Mechanical Relay 96

Brake / Mechanical Relay Connector Pin Assignment 97

Brake / Mechanical Relay Interface Connector 97

Brake Configuration Jumpers 96

Brake Connected to J103 98

Brake Connected to J207 75

Brake Connected to TB20 76

Brake Connected to TB206 98

Brake Output 59

Brake Output Connector Pin Assignment 74

Brake Output Pin Assignment 59

Brake Power Supply 74

Brushless Motor Connections 37

Brushless Motor Phasing Goal 39

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C

Check chassis for loose or damaged parts / hardware 108

Check for fluids or electrically conductive material exposure 108

Cleaning 108

Continuous Output Current specifications 19

Control and Motor Power Wiring using a TM3 or TM5 Transformer 34

Control Board 106

Control Board Assembly 106

Control Board Fuse Information 107

Control Board Jumper Configuration 107

Control Supply AC Input Wiring 26

Control Supply Connections 26

Control Supply Mating Connector 26

Control Supply specifications 19

D

DC Brush Motor Connections 40

DC Brush Motor Phasing 41

Declaration of Conformity 9

Digital Input Connector Pin Assignment 69

Digital Input Specifications 88

Digital Output Connector Pin Assignment 67

Digital Output Specifications 67

dimensions 22

Drive and Software Compatibility 18

E

Efficiency of Power Amplifier specifications 19

Electrical Specifications 19

Emergency Stop Sense Input 60

EN 55011 9

EN 61000-3-2 9

EN 61000-3-3 9

EN 61000-4-2 9

EN 61800-3 9

encoder

absolute 47-48

Encoder and Hall Signal Diagnostics 38

Encoder Fault Interface (J207) 55

Encoder Fault Interface Input 55

Encoder Fault Interface Pin Assignment 55

Encoder Interface (J207) 45

Encoder Interface Pin Assignment 45

Encoder Phasing 51

Encoder Phasing Reference Diagram 51

End of Travel Limit Input Connections 56

End Of Travel Limit Input Interface (J207) 56

End of Travel Limit Input Interface Pin Assignment 56

End of Travel Limit Interface Input 57

End Of Travel Limit Phasing 58

EnDat Encoder Interface 47

Environmental Specifications 23

external emergency stop relay circuit 61

F

Feedback Monitoring 38

G

Global Technical Support 2

H

Hall-Effect Feedback Interface Pin Assignment 53

Hall-Effect Inputs 53

Hall-Effect Interface 53

Handwheel Interconnection 103

Handwheel Interface 103

High Speed Digital Input Connector Pin Assignment 71

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High Speed User Inputs 71
Humidity 23

I

Input Voltage Jumper Configuration 71
Inputs Connected in Current Sinking Mode 70
Inputs Connected in Current Sourcing Mode 70
Inputs Connected to a Current Sinking Device 90
Inputs Connected to a Current Sourcing Device 90
inspect all cables and connections 108
Inspect cooling vents 108
Inspection 108
Installation and Configuration 25
Isolation 19

J

J103 44-48,50,53-55,55-57,59,74-76,97-98
J104 62-63,65,67-73
J107 78
J108 78
Joystick Interface 100

L

Limit Input Diagnostic Display 58
Line Driver Encoder Interface 46

M

Mating Connector 74
Maximum Storage Energy 81
Mechanical Design 22
Mechanical Relay Specifications 96
Minimizing Conducted, Radiated, and System Noise 35
Minimum Load Inductance specifications 19
Modes of Operation 19
Motor Feedback Connections 44
Motor Feedback Connector Pin Assignment 44
Motor Phasing Oscilloscope Example 39
Motor Supply Connections 27
Motor Supply Input Wiring 35
Motor Supply specifications 19

N

Nominal Motor Operating Voltages / Required AC Voltages 28

O

optional joysticks 100
Options 16
Opto-Isolated Input Connector Pin Assignment 88
Opto-Isolated Inputs 69,88-89
Opto-Isolated Output Connector Pin Assignment 92
Opto-Isolated Outputs 67,91
Opto-Isolated Outputs (-IO Board) 93
Output Specifications 91
Output Voltage specifications 19
Outputs Connected in Current Sinking Mode 68,94
Outputs Connected in Current Sourcing Mode 68,94

P

PC Configuration and Operation Information 83
Peak Output Current specifications 19
Pollution 23
Position Feedback in the Diagnostic Display 52
Position Synchronized Output (PSO)/Laser Firing 65
Power Amplifier Bandwidth specifications 19
Power Dissipation 21
Powered Motor Phasing 38
Preventative Maintenance 108
Protective Features 19
PS2806-4 Opto-Device Specifications 69
PSO Interface 66
PSO Output Sources 65

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PWM Switching Frequency specifications 19

Q

Quick Installation Guide 13

R

Relay Specifications 77
Resolute Encoder Interface 48
RS-232 Connector Pin Assignment 79
RS-232 Interface 79
RS-232 Port Connector Mating Connector 79
RS-422 Line Driver Encoder (Standard) 46

S

serial data stream 47-48
shunt resistor network 16
Single Axis Joystick Interface 100
solid state brake control relay 74
Solid State Relay Rating 77
Solid State Relay Specifications 77
Standard Features 16
Stepper Motor Connections 42
Stepper Motor Phasing 43
Support 2

T

TB101 60
TB102 27,36
TB103 74-77,79,96
TB104 80
TB106 26
TB201 86-87
TB202 91
TB203 91
TB204 88,95
TB205 88,95
TB206 96-98
Technical Support 2
Thermistor Interface 54
Thermistor Interface Input 54
Transformer Examples 28
Transformer Options 28
TV0.3-28-56-ST Transformer 30
TV0.3-56 33
Two Axis Joystick Interface 101
Typical Emergency Stop Circuit 61
Typical ESTOP Interface 61

U

UFM-ST 35
unit separation 22
unit weight 22
Unpowered Motor and Feedback Phasing 39
Use 23
User Common Connector Pin Assignment 95
User Power 95
User Power Supply specifications 19

V

Voltage and Current Specifications 96

W

Wire Colors for Supplied Cables 37,40,42
Wiring
  Control Supply 26

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