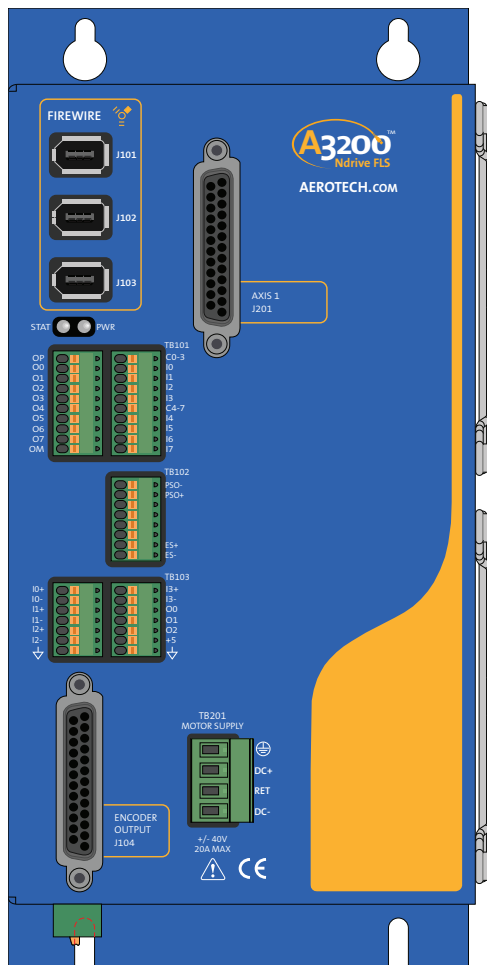




Ndrive FLS Hardware Manual

Revision: 1.01.00



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EC Declaration of Conformity

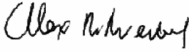
Manufacturer Aerotech, Inc.
Address 101 Zeta Drive
 Pittsburgh, PA 15238-2897
 USA
Product Ndrive FLS
Model/Types All

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

- | | |
|-------------|---|
| 2006/95/EC | Low Voltage Directive |
| 2004/108/EC | Electromagnetic Compatibility Directive |
| 2011/65/EU | RoHS 2 Directive |

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

- | | |
|--------------|---|
| EN 61010-1 | Safety requirements for electrical equipment |
| EN 61800-3 | Adjustable speed electric power drive systems EMC |
| EN 61000-6-2 | EMC immunity for industrial environments |
| EN 61000-6-4 | EMC emission standard for industrial environments |

Name  / Alex Weibel
Position Engineer Verifying Compliance
Location Pittsburgh, PA
Date April 22, 2015

Agency Approvals

Aerotech, Inc. Model Ndrive FLS 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 12 10 68995 008 |
| File / Report #: | 092-1209216-000 |
| Standards: | UL 61010-1; CAN/CSA-C22.2 No. 61010-1 |

Safety Procedures and Warnings

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.

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: 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 Ndrive FLS 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 Ndrive FLS inside a rack or enclosure.
6. Do not connect or disconnect any electrical components or connecting cables while connected to a power source.
7. Make sure the Ndrive FLS and all components are properly grounded in accordance with local electrical safety requirements.
8. Operator safeguarding requirements must be addressed during final integration of the product.



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

1. Use of this equipment in ways other than described by this manual can cause personal injury or equipment damage.
2. Moving parts can cause crushing or shearing injuries. Access to all stage and motor parts must be restricted while connected to a power source.
3. Cables can pose a tripping hazard. Securely mount and position all system cables to avoid potential hazards.
4. Do not expose the Ndrive FLS to environments or conditions outside of the listed specifications. Exceeding environmental or operating specifications can cause damage to the equipment.
5. If the Ndrive FLS is used in a manner not specified by the manufacturer, the protection provided by the Ndrive FLS can be impaired and result in damage, shock, injury, or death.
6. Operators must be trained before operating this equipment.
7. All service and maintenance must be performed by qualified personnel.
8. The Ndrive FLS is intended for light industrial manufacturing or laboratory use. Use of the Ndrive FLS for unintended applications can result in injury and damage to the equipment.

Quick Installation Guide

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

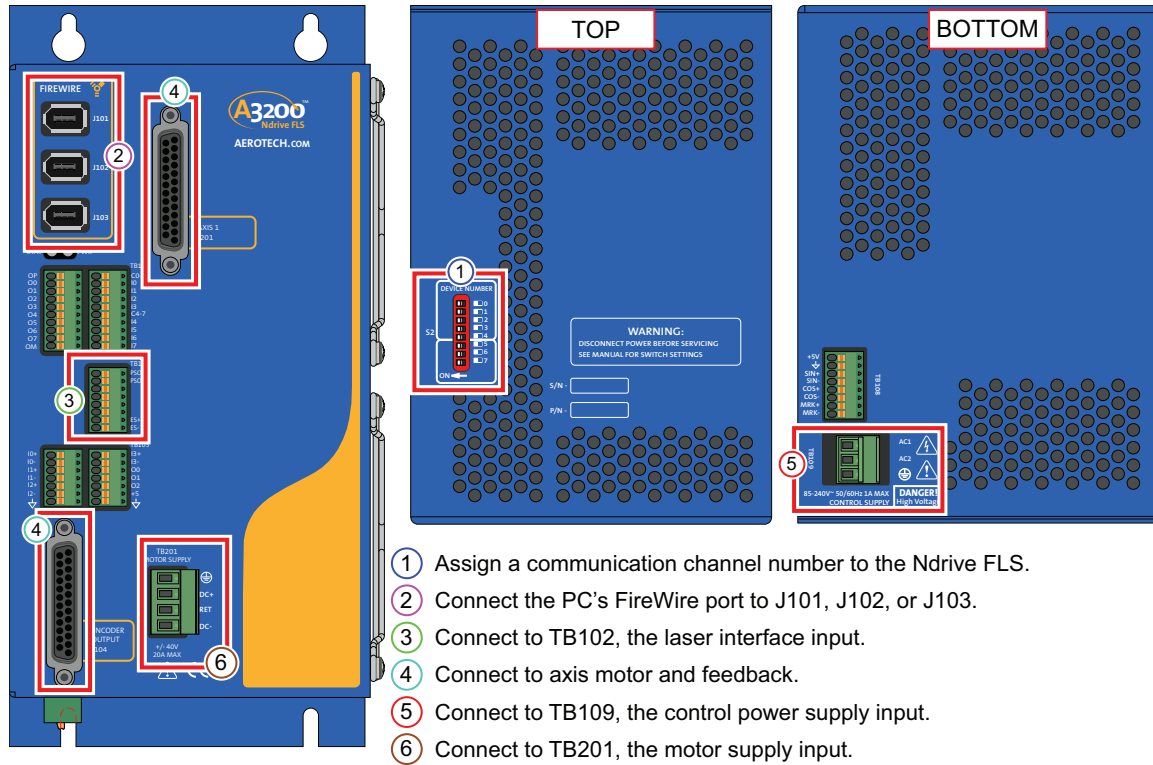


Figure 1: Quick Start Connections

Quick Start Summary

| Topic | Section |
|-------------------------------|---|
| Set the Device Number | Section 2.1. |
| Connect the FireWire | Section 2.3. |
| Connect the ESTOP/PSO | Section 2.5. and Section 2.6. |
| Connect to the Control Supply | Section 2.2.1. |

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Chapter 1: Introduction

Aerotech’s Ndrive FLS (Fast Linear Servo) network digital drive is a high-performance linear amplifier designed to eliminate the non-linearities common with PWM amplifiers. The drive provides deterministic behavior, auto-identification, and easy software setup. The Ndrive FLS’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 Ndrive FLS has an encoder interpolation feature, dedicated analog and digital I/O, and separate power connections for motor and control supply voltages

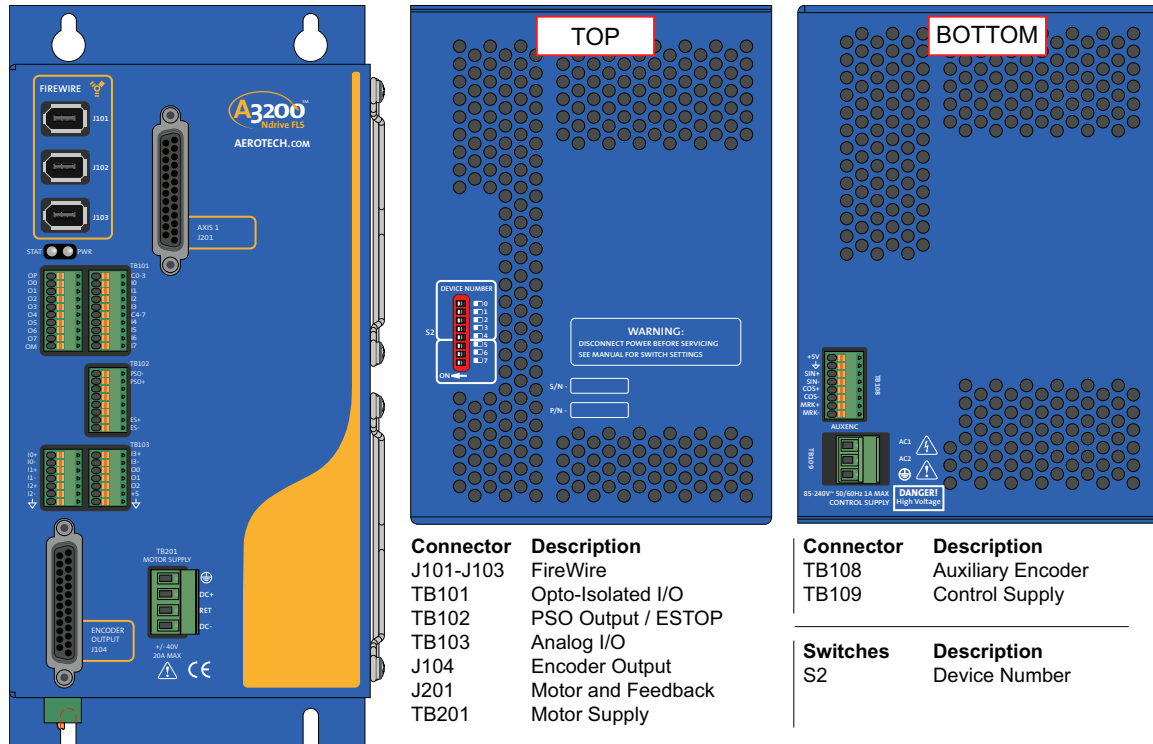


Figure 1-1: Ndrive FLS Controller

Table 1-1: Feature Summary

| Standard Features | |
|--|---|
| <ul style="list-style-type: none"> • One auxiliary channel of 40 MHz line driver quadrature encoder inputs. • Eight optically-isolated digital inputs; 5-24V • Eight optically-isolated digital outputs sinking or sourcing; 5-24V • Four 16-bit differential analog inputs • Three 16-bit analog outputs • Three FireWire ports • Dedicated 5-24V Emergency Stop sense input • Internal power supply • 5 VDC, 500 mA user output power for encoder | |
| Cables | |
| FireWire | See Section 2.3. FireWire Interface . |

The following block diagram shows a connection summary (refer to Chapter 2 and Chapter 3 for more detailed connection information).

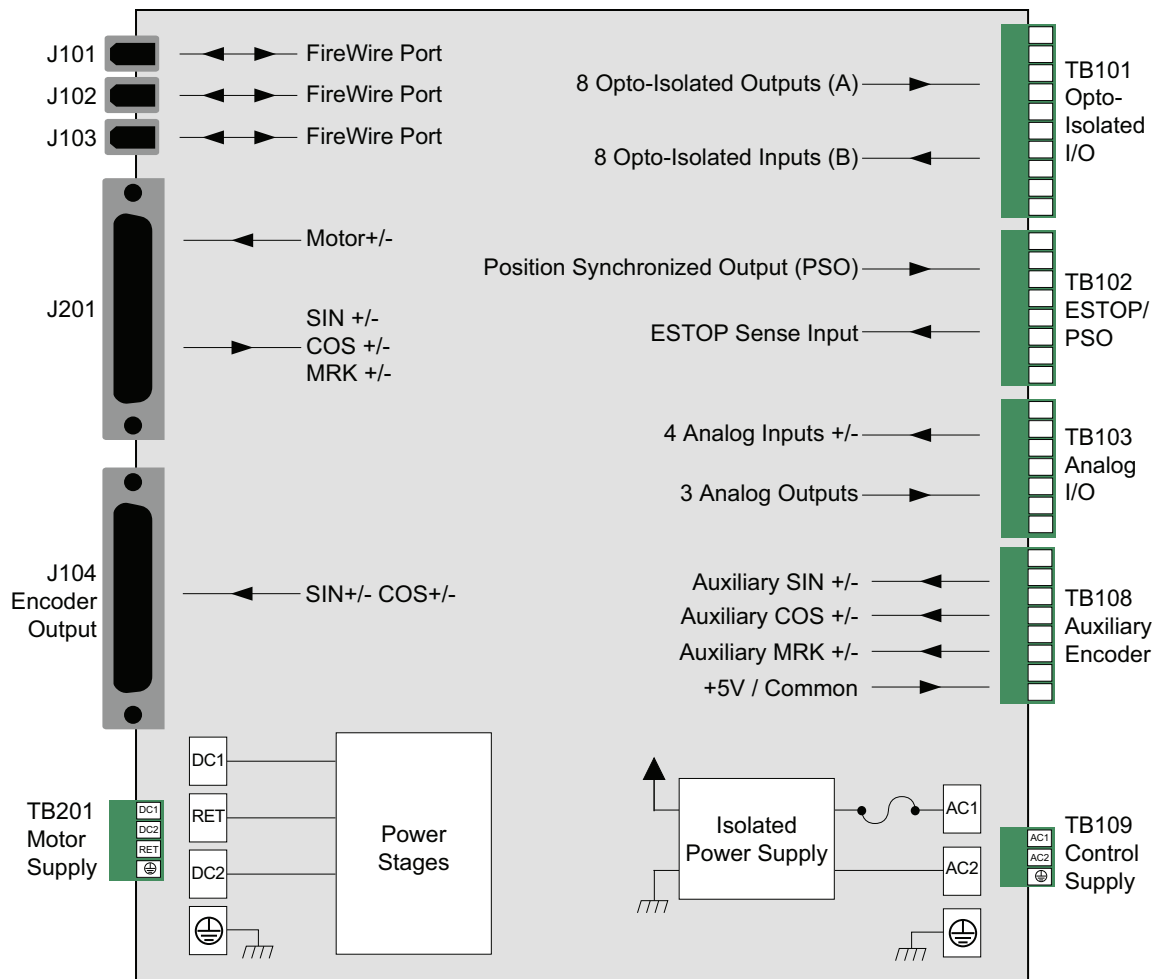


Figure 1-2: Functional Diagram

1.1. Electrical Specifications

The electrical specifications for the Ndrive FLS are listed below.

Table 1-2: Electrical Specifications

| Description | | Ndrive FLS |
|--|----------------------------|------------------|
| Motor Supply | Input Voltage | ±40 VDC (max) |
| | Input Current (continuous) | 7 A |
| | Input Current (peak) | 20 A |
| Control Supply | Input Voltage | 85-240 VAC |
| | Input Frequency | 50-60 Hz |
| | Inrush Current | 16 A |
| | Input Current | 0.25 A (max) |
| Output Voltage ⁽¹⁾ | | ±35 V @ 20 A |
| Peak Output Current ⁽¹⁾ | | 20 A |
| Continuous Output Current ⁽¹⁾ | | 7 A |
| Power Amplifier Bandwidth ⁽¹⁾ | | 6 kHz |
| Minimum Load Resistance | | 0.5 Ω |
| Output Impedance | | 0.25 Ω |
| User Power Supply Output | | 5 VDC (@ 500 mA) |
| Mode of Operation | | Brush |
| ⁽¹⁾ Load Dependent | | |

1.2. Mechanical Design

The following figure shows the Ndrive FLS package dimension as well as the typical mounting orientation. Refer to Section 2.3. for FireWire interconnection cable options.

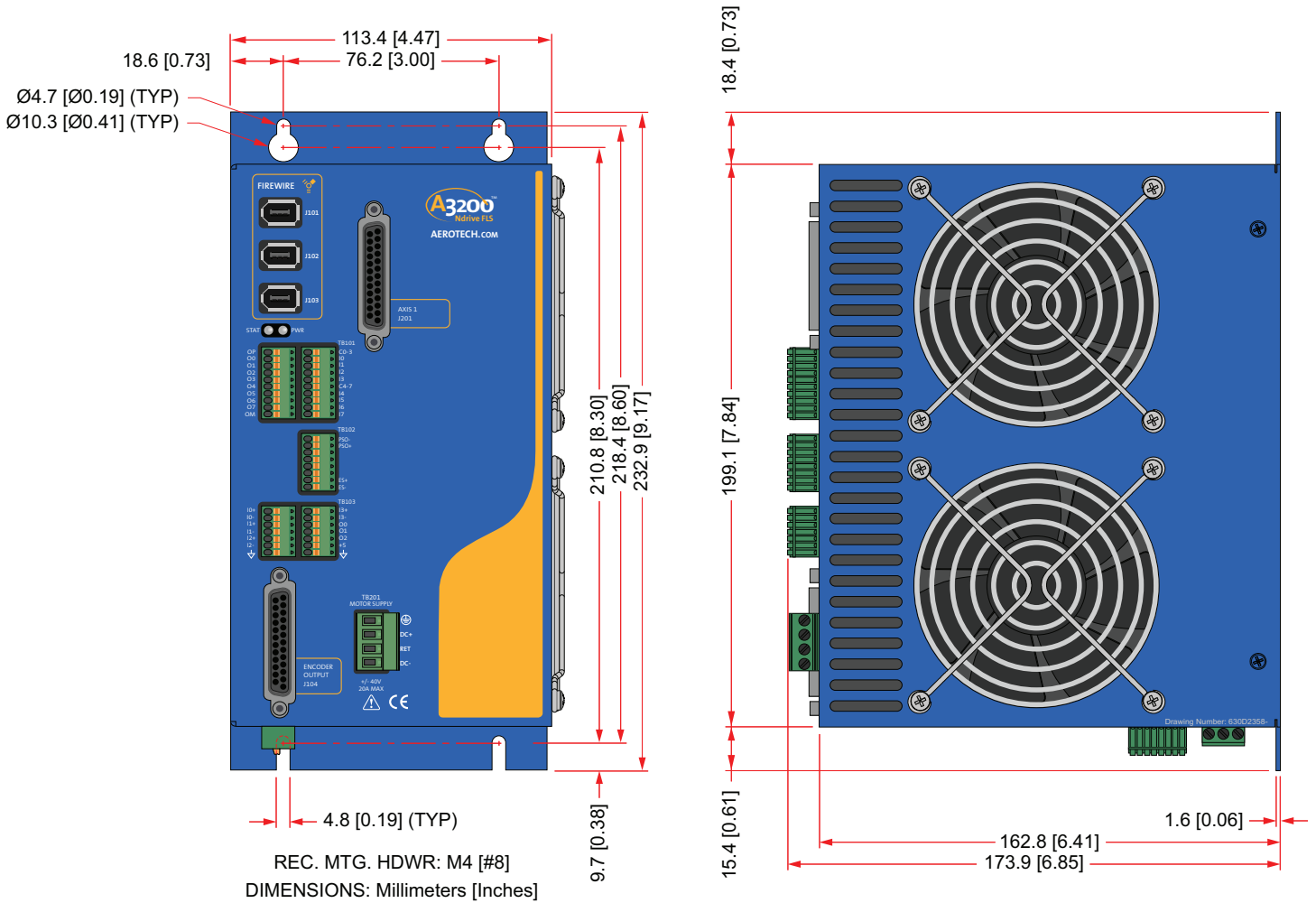


Figure 1-3: Dimensions

1.3. Environmental Specifications

The environmental specifications for the Ndrive FLS 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. |

1.4. Drive and Software Compatibility

The following table lists the available A3200 drives and which version of the A3200 software first provided support for a given drive. Drives that list a specific version number in the **Last Software Version** column will not be supported after the listed version.

Table 1-3: A3200 Drive and Software Compatibility

| Drive Type | Firmware Revision | First Software Version | Last Software Version |
|---------------------|-------------------|------------------------|-----------------------|
| CL | - | 2.18 | Current |
| | A | 2.55 | Current |
| CP | - | 2.03 | 2.55 |
| | A | 2.10 | Current |
| | B | 2.19 | Current |
| FLS | - | 4.03 | Current |
| FLS | A | 4.06.001 | Current |
| HL | - | 1.01 | 2.55 |
| HLe | - | 2.22 | Current |
| HP | - | 1.01 | 2.55 |
| | A | 1.08 | 2.55 |
| HPe | - | 2.22 | Current |
| ML | - | 3.00 | Current |
| MP | - | 2.14 | Current |
| Nmark CLS | - | 4.02 | Current |
| Nmark CLS | A | 4.06.001 | Current |
| Nmark SSaM | - | 2.21 | Current |
| Nmark SSaM | A | 4.06.001 | Current |
| Npaq ⁽¹⁾ | - | 1.07 | 2.55 |
| | A | 2.09 | Current |
| Nservo | - | 2.08 | Current |
| Nstep | - | 2.14 | Current |
| QL/QLe | - | 5.01 | Current |

(1) This section does not apply to the Npaq MR. The Npaq MR contains multiple ML or MP drives. Refer to either the ML or MP drive type to determine the value for your Npaq MR.

Chapter 2: Installation and Configuration

2.1. Communication Channel Settings

Use the Device Number switches of S2 to assign a communication channel number to the Ndrive FLS. If you are using multiple drives, each drive must be assigned a unique communication channel. Multiple drives are typically configured using sequential communication channels.

Table 2-1: Device Number Switch Settings (S2)

| Device # | Switch Settings (Off is indicated by "-") | | | | | Switch Location |
|----------|---|----|----|----|----|-----------------|
| | 4 | 3 | 2 | 1 | 0 | |
| 1 | ON | ON | ON | ON | ON | |
| 2 | ON | ON | ON | ON | - | |
| 3 | ON | ON | ON | - | ON | |
| 4 | ON | ON | ON | - | - | |
| 5 | ON | ON | - | ON | ON | |
| 6 | ON | ON | - | ON | - | |
| 7 | ON | ON | - | - | ON | |
| 8 | ON | ON | - | - | - | |
| 9 | ON | - | ON | ON | ON | |
| 10 | ON | - | ON | ON | - | |
| 11 | ON | - | ON | - | ON | |
| 12 | ON | - | ON | - | - | |
| 13 | ON | - | - | ON | ON | |
| 14 | ON | - | - | ON | - | |
| 15 | ON | - | - | - | ON | |
| 16 | ON | - | - | - | - | |
| 17 | - | ON | ON | ON | ON | |
| 18 | - | ON | ON | ON | - | |
| 19 | - | ON | ON | - | ON | |
| 20 | - | ON | ON | - | - | |
| 21 | - | ON | - | ON | ON | |
| 22 | - | ON | - | ON | - | |
| 23 | - | ON | - | - | ON | |
| 24 | - | ON | - | - | - | |
| 25 | - | - | ON | ON | ON | |
| 26 | - | - | ON | ON | - | |
| 27 | - | - | ON | - | ON | |
| 28 | - | - | ON | - | - | |
| 29 | - | - | - | ON | ON | |
| 30 | - | - | - | ON | - | |
| 31 | - | - | - | - | ON | |
| 32 | - | - | - | - | - | |

2.2. Power Connections

The Ndrive FLS has two input power connectors; one for control power (AC) and a second for motor power (DC). For a complete list of electrical specifications, refer to [Section 1.1. Electrical Specifications](#).

2.2.1. Control Supply Connections (TB109)

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 Ndrive FLS 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 Ndrive FLS may be required for CE compliance (Aerotech recommends Schaffner FN2080).

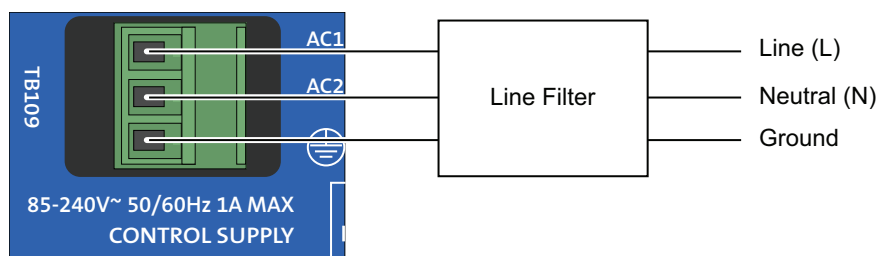


Figure 2-1: Control Supply Connections

Table 2-2: Control Supply Input Wiring (TB109)

| Pin | Description | Recommended Wire Size |
|-----|---|-------------------------------|
| AC1 | Line: 85 - 240 Volt AC Input Range | 1.3 mm ² (#16 AWG) |
| AC2 | Neutral (0V) or 85 - 240 Volt AC Input Range with external fuse | 1.3 mm ² (#16 AWG) |
| ⊕ | Protective Ground (Required for Safety) | 1.3 mm ² (#16 AWG) |

NOTE: Wire insulation rated for 300 V.

Table 2-3: Control Supply Mating Connector (TB109)

| 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] |

2.2.2. Motor Supply Connections (TB201)

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 Ndrive FLS at the four terminals of the Motor Supply connector (TB201). The DC+ and DC- inputs are internally fused.



WARNING: Do not operate the Ndrive FLS without the safety ground connection in place.

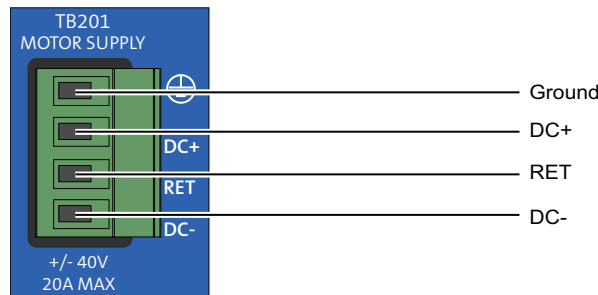



Figure 2-2: Motor Bus Input Connections

Table 2-4: Motor Supply Input Wiring

| Pin | Description | Recommended Wire Size |
|---|---|-------------------------------|
| DC+ | 0 to +40 Volt DC Input Range | 2.1 mm ² (#14 AWG) |
| RET | Return for DC Input | 2.1 mm ² (#14 AWG) |
| DC- | 0 to -40 Volt DC Input Range | 2.1 mm ² (#14 AWG) |
|  | Protective Ground (Required for Safety) | 2.1 mm ² (#14 AWG) |

NOTE: Wire insulation rated for 300 V.

Table 2-5: Motor Supply Mating Connector (TB201)

| Type | Aerotech P/N | Phoenix P/N | Screw Torque Value: Nm | Wire Size: mm ² [AWG] |
|----------------------|--------------|-------------|------------------------|----------------------------------|
| 4-Pin Terminal Block | ECK01581 | 1757035 | 0.5 - 0.6 | 3.3 - 0.0516 [12-30] |

2.2.3. External Power Supply Options

Aerotech's TM3 can be used to power up to 4 drives, providing 300 watts of power (refer to [Figure 2-3](#)).

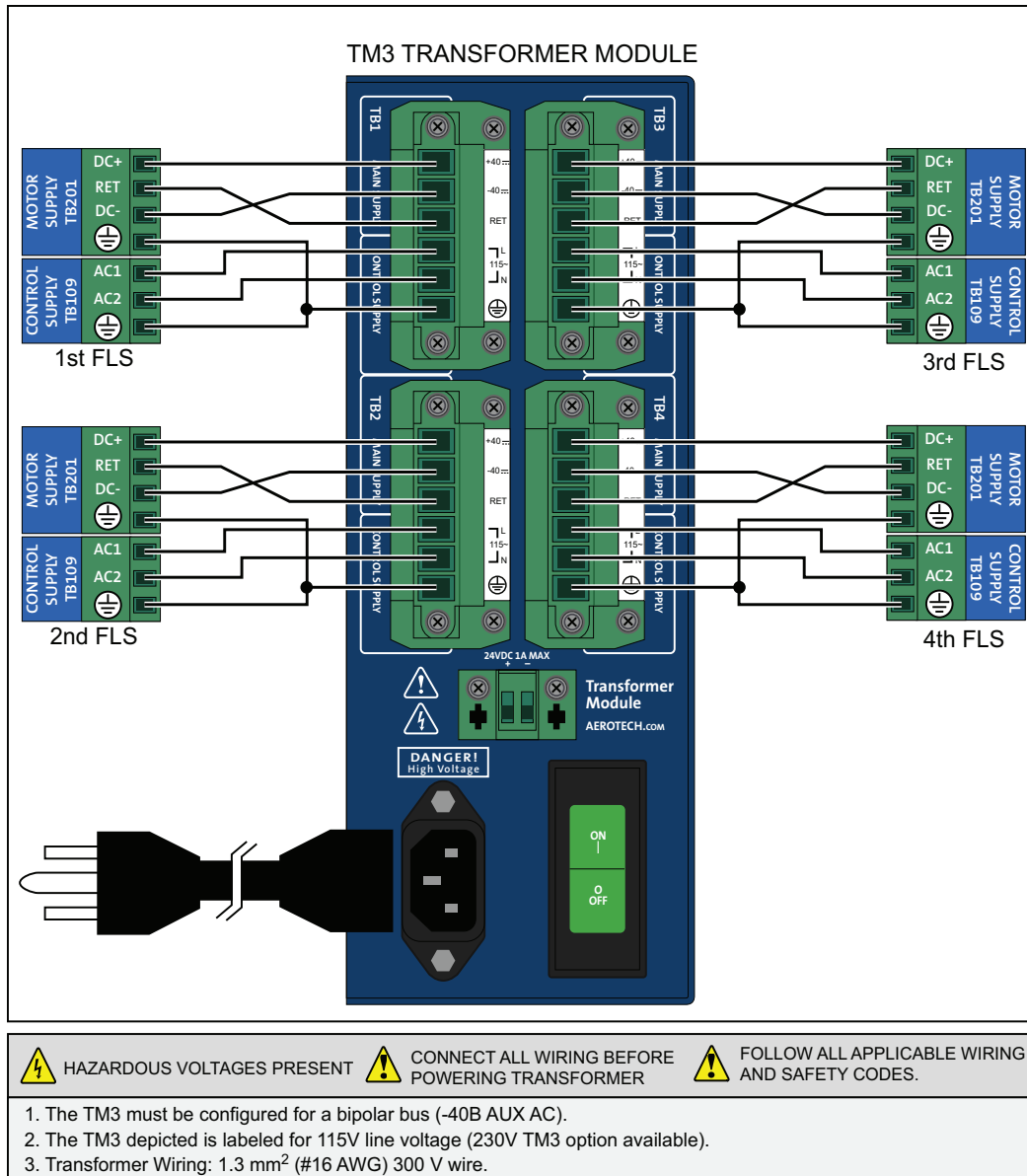


Figure 2-3: Control and Motor Power Wiring using a TM3 Transformer

2.2.4. Minimizing Conducted Radiated and System Noise

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

User connections to the product must be made using shielded cables with metal D-style connectors and back shells. The shield of the cables must be connected to the metal back shell in order for the product to conform to the radiated emission standards.

The Ndrive FLS 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.

2.3. FireWire Interface

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

Table 2-6: FireWire Card Part Numbers

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

Table 2-7: FireWire Repeaters (for cables exceeding 4.5 m (15 ft) specification)

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

Table 2-8: FireWire Cables (copper and glass fiber)

| Part Number | Description |
|--------------------|--|
| NCONNECT-4500-66 | 4.5 m (15 ft) long, 6 pin to 6 pin |
| NCONNECT-3000-66 | 3 m (10 ft) long, 6 pin to 6 pin |
| NCONNECT-1800-66 | 1.8 m (6 ft) long, 6 pin to 6 pin |
| NCONNECT-900-66 | 900 mm (3 ft) long, 6 pin to 6 pin |
| NCONNECT-500-66 | 500 mm (19 in) long, 6 pin to 6 pin |
| NCONNECT-228-66 | 228 mm (9 in) long, 6 pin to 6 pin |
| NCONNECT-10000-GOF | 10 m (32.8 ft), glass fiber Optical cable |
| NCONNECT-15000-GOF | 15 m (49.2 ft), glass fiber Optical cable |
| NCONNECT-20000-GOF | 20 m (65.6 ft), glass fiber Optical cable |
| NCONNECT-30000-GOF | 30 m (101.7 ft), glass fiber Optical cable |

2.4. Motor and Feedback Connections (J201)

The Ndrive FLS is capable of controlling a DC Brush motor only.

The Motor and Feedback connector (a 25-pin, D-style connector) has an analog encoder input, 5 volt encoder power, and motor connections.

Table 2-9: Motor and Feedback Connector Pin Assignment (J201)

| Pin | Description | In/Out/Bi | Pin Location |
|-----|---------------------|-----------|--------------|
| 1 | Sine + | Input | |
| 2 | Cosine + | Input | |
| 3 | Encoder Ground | N/A | |
| 4 | Reserved | -- | |
| 5 | Reserved | -- | |
| 6 | Reserved | -- | |
| 7 | Marker + | Input | |
| 8 | Encoder Power (+5V) | N/A | |
| 9 | Reserved | -- | |
| 10 | Reserved | -- | |
| 11 | Shield | N/A | |
| 12 | Motor + | Output | |
| 13 | Motor + | Output | |
| 14 | Sine - | Input | |
| 15 | Cosine - | Input | |
| 16 | Encoder Ground | N/A | |
| 17 | Reserved | -- | |
| 18 | Reserved | -- | |
| 19 | Reserved | -- | |
| 20 | Marker - | Input | |
| 21 | Encoder Ground | N/A | |
| 22 | Reserved | -- | |
| 23 | Shield | N/A | |
| 24 | Motor - | Output | |
| 25 | Motor - | Output | |

Table 2-10: Motor and Feedback Mating Connector (J201)

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

2.4.1. Analog Encoder Inputs (J201)

The Ndrive FLS will accept an analog encoder input signal. The multiplication (interpolation) factor is determined by the EncoderMultiplicationFactor parameter.

Table 2-11: Analog Encoder Specifications

| Specification | Description |
|--|---------------------|
| Input Frequency (max) | 500 kHz |
| Input Amplitude | 0.6 to 2.25 Vpk-Vpk |
| Interpolation Factor (software selectable) | 262, 144 |

The gain, offset, and phase balance of the analog Sine and Cosine encoder input signals can be adjusted by controller parameters. Encoder signals should be adjusted using the Feedback Tuning tab of the Digital Scope Utility.

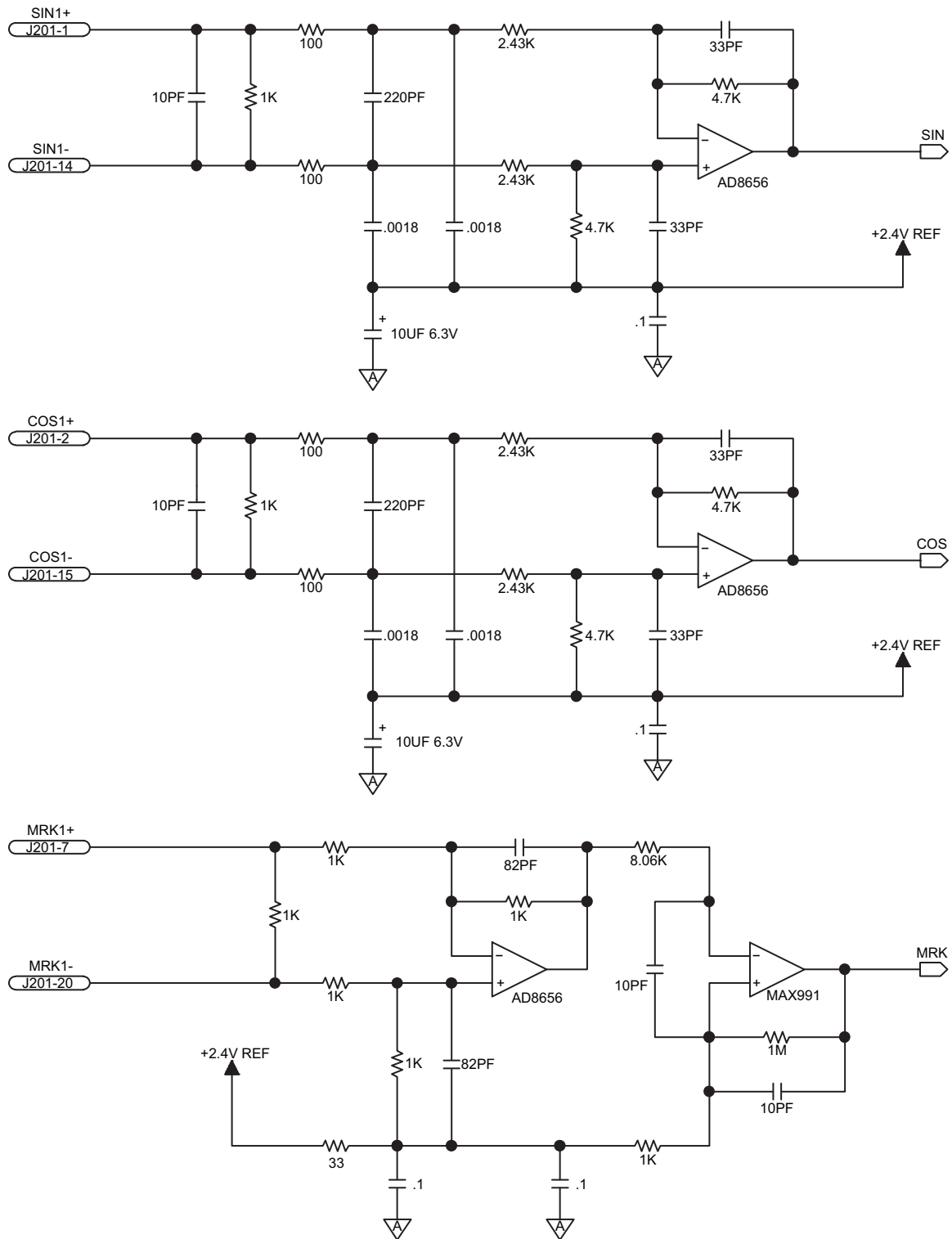


Figure 2-4: Analog Encoder Input Schematic

2.5. Emergency Stop Sense Input (TB102)

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.



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

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

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

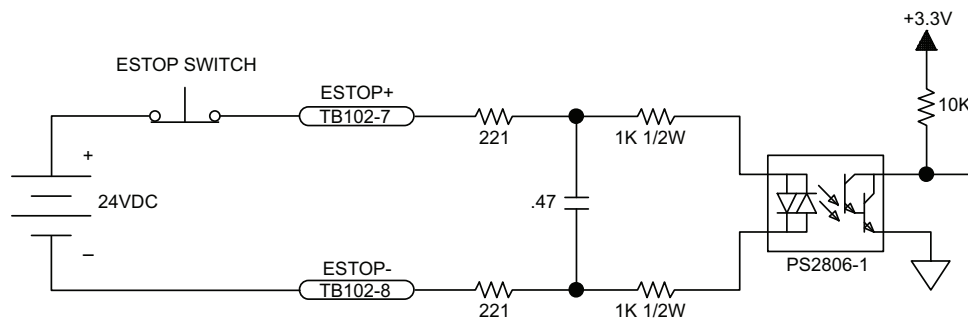


Figure 2-5: ESTOP Sense Input (TB102)

Table 2-12: ESTOP Pin Assignment (TB102)

| Pin | Description | In/Out/Bi |
|-----|--------------------------------------|-----------|
| 7 | Emergency Stop Opto-Isolated Input + | Input |
| 8 | Emergency Stop Opto-Isolated Input - | Input |

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 2-13](#). These devices are applied across the switched coil to suppress transient voltages.

Table 2-13: 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 |

2.6. Position Synchronized Output (PSO) (TB102)

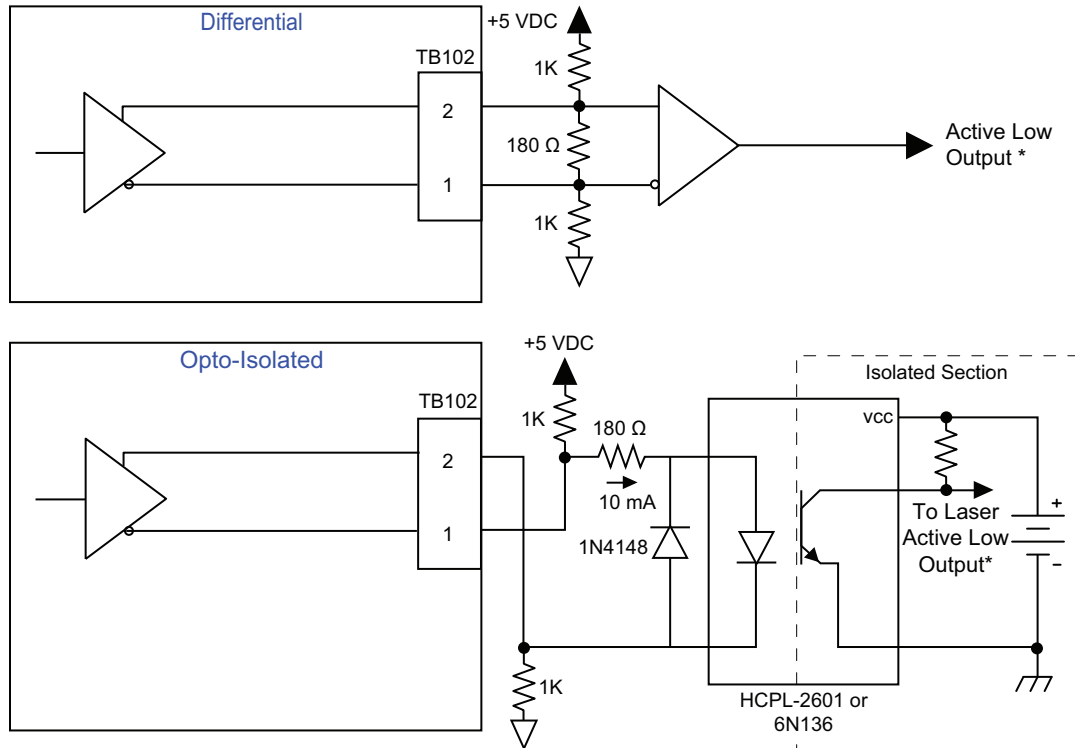
The Ndrive FLS includes a Position Synchronized Output (PSO) feature.

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

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

Table 2-14: PSO Output Pin Assignment (TB102)

| Pin | Description | In/Out/Bi |
|-----|--------------|-----------|
| 1 | PSO Output - | Output |
| 2 | PSO Output + | Output |



* Active low output shown. Opposite polarity available by reversing connections to Pins 1 and 2.

Figure 2-6: PSO Outputs (TB102)

Table 2-15: PSO Output Sources

| PSO Output Type | Max Frequency | Pins |
|-----------------|---------------|------------------|
| RS-422 Marker | 12.5 MHz | TB102-1, TB102-2 |

2.7. Opto-Isolated Outputs (TB101 A)

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

Outputs must be connected in either all sinking or all sourcing mode. All outputs are rated for 24 VDC and 80 mA per output. [Figure 2-8](#) and [Figure 2-9](#) illustrate how to connect to an output in current sinking and current sourcing modes, respectively.

NOTE: Power supply connections must always be made to both the Output Common Plus (OP) and Output Common Minus (OM) pins as shown in [Figure 2-8](#) and [Figure 2-9](#).

Table 2-16: Opto-Isolated Outputs Pin Assignment (TB101 A)

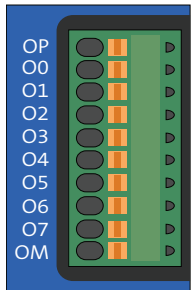
| Pin | Description | In/Out/Bi | Connector |
|-----|-------------------------------|-----------|---|
| 1 | Output Common Plus | Input |  |
| 2 | Output 0 (Optically-Isolated) | Output | |
| 3 | Output 1 (Optically-Isolated) | Output | |
| 4 | Output 2 (Optically-Isolated) | Output | |
| 5 | Output 3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

Table 2-17: Opto-Isolated Output Connector Mating Connector (TB101 A/B)

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

Table 2-18: Opto-Isolated Output Specifications (TB101)

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



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

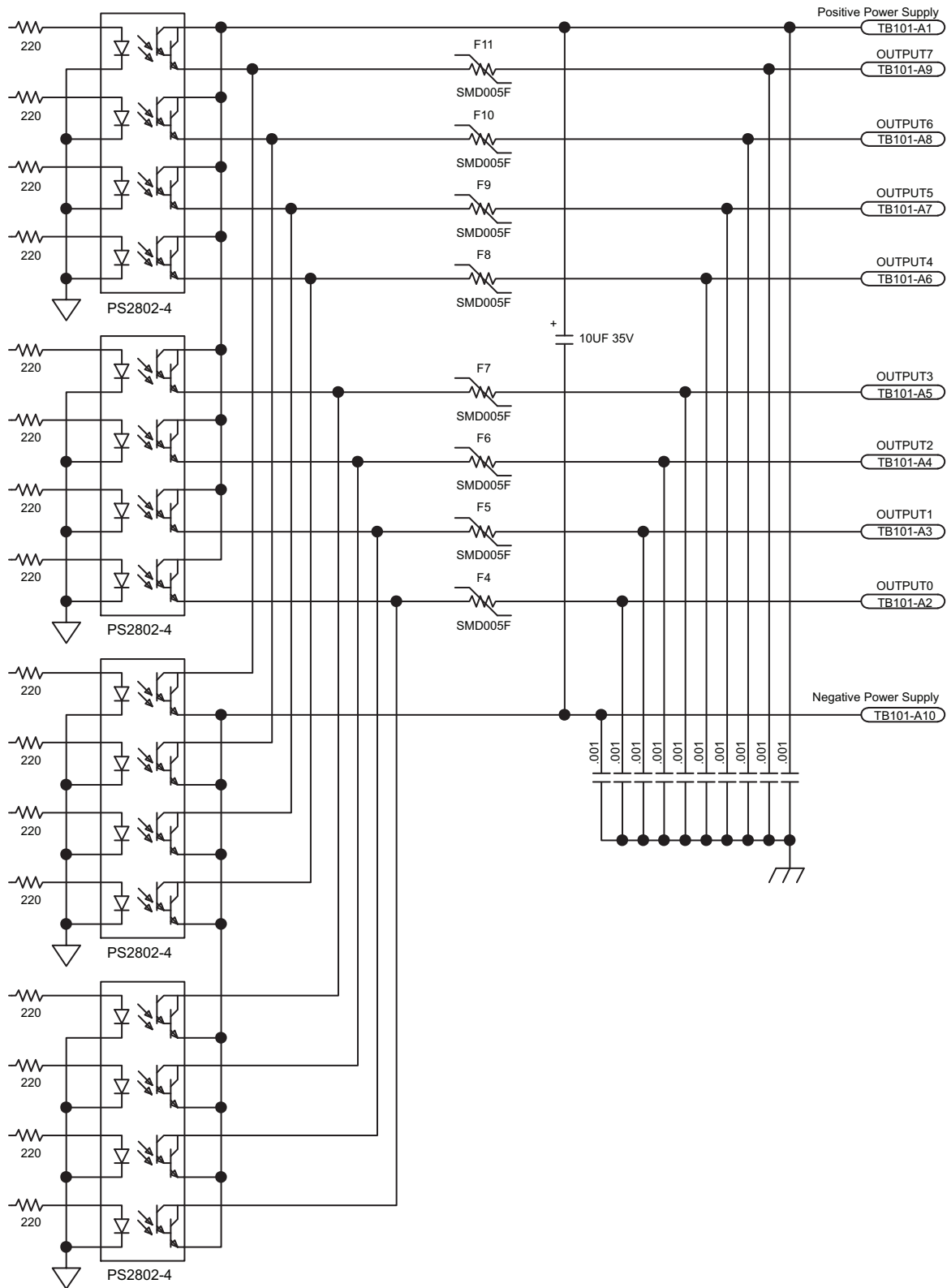


Figure 2-7: Opto-Isolated Outputs (TB101 A)

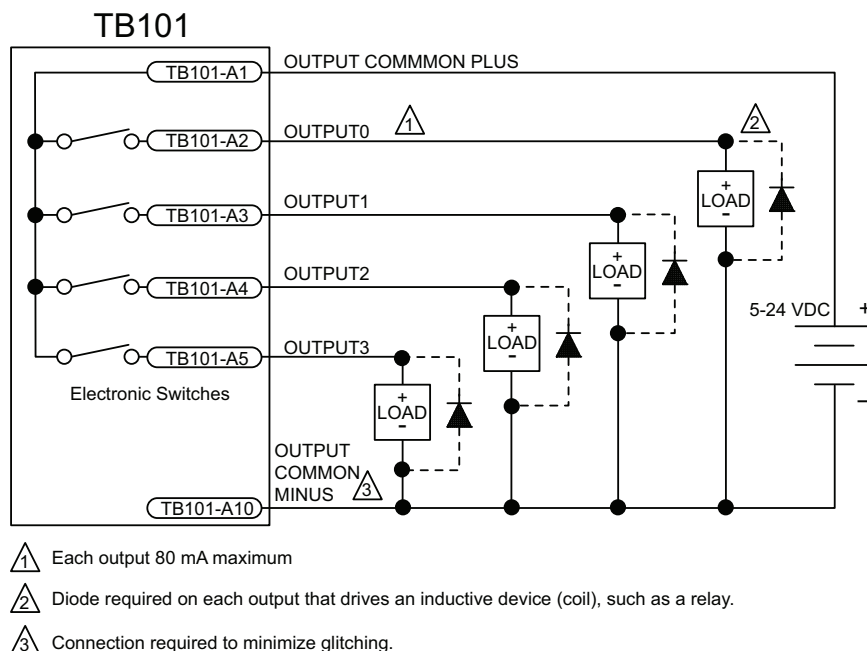


Figure 2-8: Outputs Connected in Current Sourcing Mode

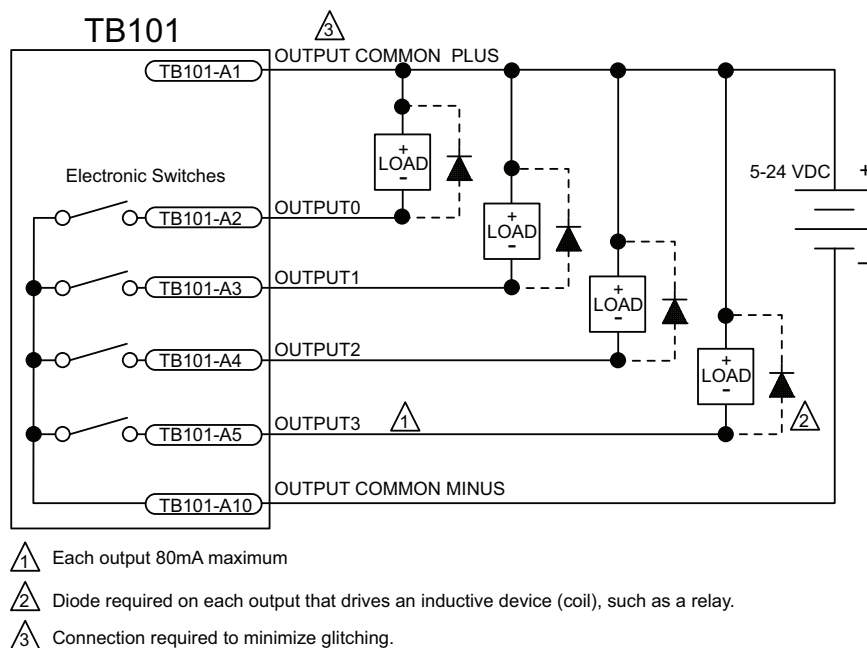


Figure 2-9: Outputs Connected in Current Sinking Mode

Suppression diodes must be installed on outputs driving relays or other inductive devices. This protects the outputs from damage caused by inductive spikes. Suppressor diodes, such as the 1N914, can be installed on all outputs to provide protection. It is important that the diode be installed correctly (normally reversed biased). Refer to [Figure 2-9](#) for an example of a current sinking output with diode suppression and [Figure 2-8](#) for an example of a current sourcing output with diode suppression.

2.8. Opto-Isolated Inputs (TB101 B)

The opto-isolated inputs use a PS2806-4 device and are configured for 5-24 volt input levels. The inputs may be connected to current sourcing or current sinking devices, as shown in [Figure 2-11](#) and [Figure 2-12](#).

Inputs 0-3 and inputs 4-7 have separate common inputs, pin 1 and pin 6, respectively. Each 4-bit bank of inputs must be connected in the same configuration (sinking or sourcing).

Table 2-19: PS2806-4 Opto-Device Specifications

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

Table 2-20: Opto-Isolated Inputs Pin Assignment (TB101 B)

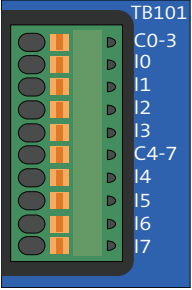
| Pin | Description | In/Out/Bi | Connector |
|-----|-----------------------------|-----------|--|
| 1 | Input Common for Inputs 0-3 | Input |  |
| 2 | Input 0 | Input | |
| 3 | Input 1 | Input | |
| 4 | Input 2 | Input | |
| 5 | Input 3 | Input | |
| 6 | Input Common for Inputs 4-7 | Input | |
| 7 | Input 4 | Input | |
| 8 | Input 5 | Input | |
| 9 | Input 6 | Input | |
| 10 | Input 7 | Input | |

Table 2-21: Opto-Isolated I/O Connector Mating Connector (TB101 A/B)

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



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

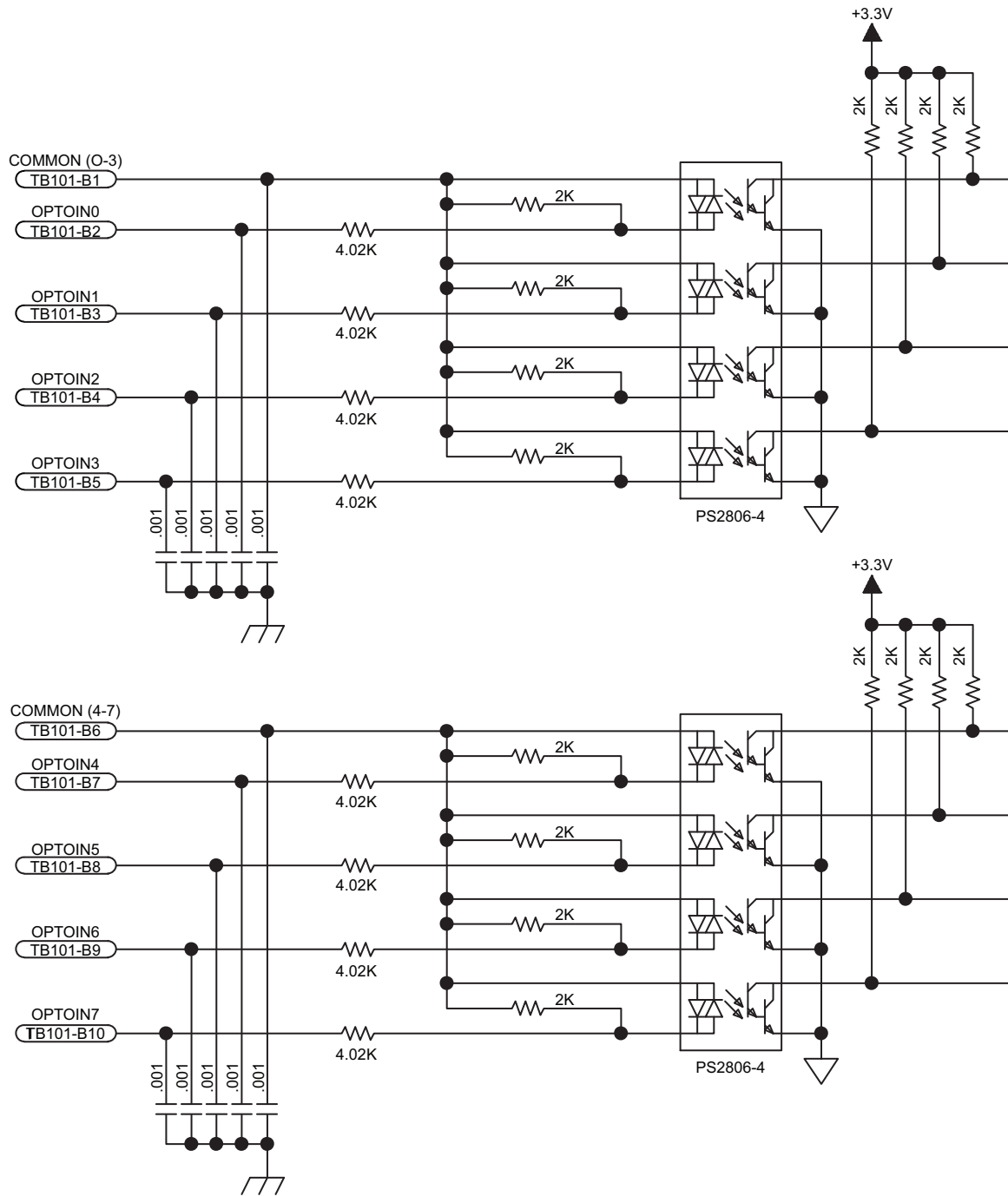


Figure 2-10: Opto-Isolated Inputs (TB101 B)

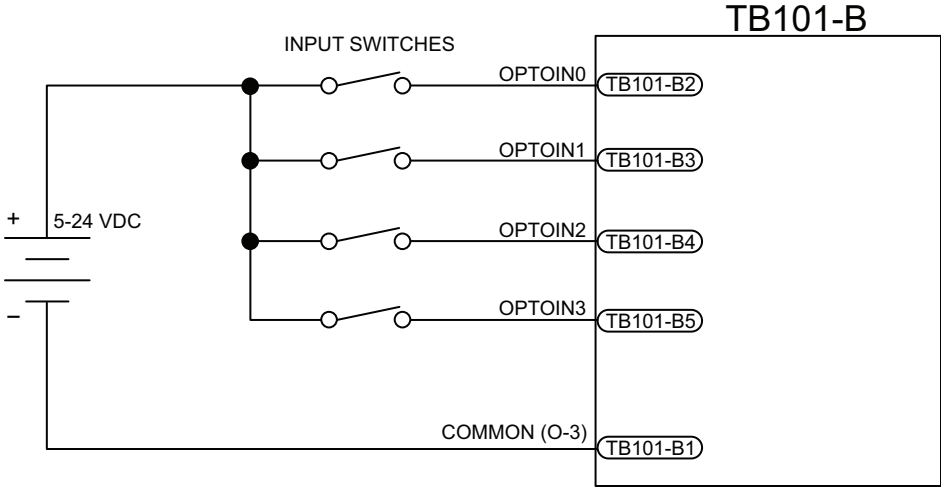


Figure 2-11: Inputs Connected to a Current Sourcing Device

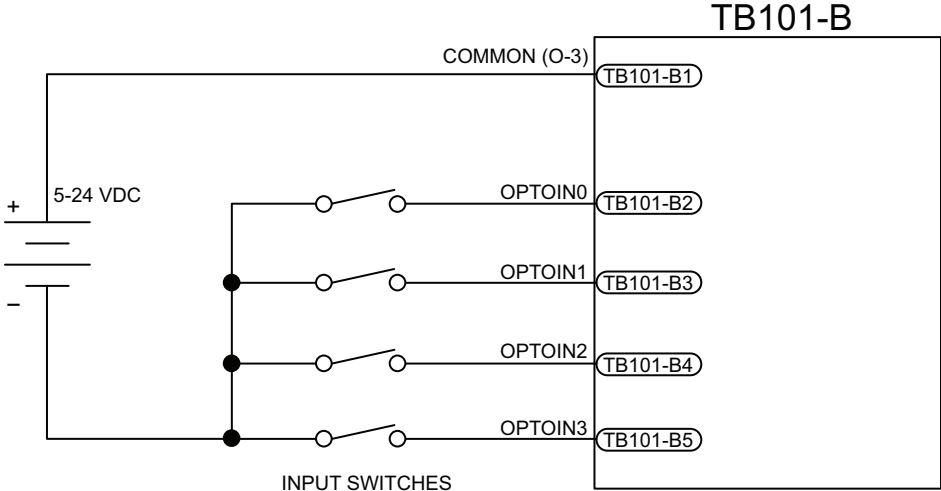


Figure 2-12: Inputs Connected to a Current Sinking Device

2.9. Analog I/O Interface (TB103 A/B)

The analog inputs are 16-bit differential inputs that accept a voltage in the range of ± 10 volts with a resolution of $305 \mu\text{V}$. Signals outside of this range may damage the input. To interface to a single-ended (non-differential) voltage source, connect the signal common of the source to the negative input and the analog source signal to the positive input. A floating signal source should be referenced to the analog common as shown in [Figure 2-13](#).

The 16-bit analog outputs produce a single ended output in the range of ± 10 VDC with a resolution of $305 \mu\text{V}$. The maximum recommended output current is 5 mA (2 k Ω load). Analog outputs are referenced to the analog common (TB103B, pin 7). The analog outputs are set to zero when the system is powered up or during a system reset.

Table 2-22: Analog I/O Pin Assignment (TB103 A)

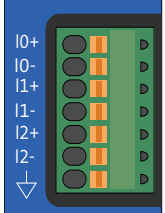
| Pin | Description | In/Out/Bi | Connector |
|-----|-----------------|-----------|---|
| 1 | Analog Input 0+ | Input |  |
| 2 | Analog Input 0- | Input | |
| 3 | Analog Input 1+ | Input | |
| 4 | Analog Input 1- | Input | |
| 5 | Analog Input 2+ | Input | |
| 6 | Analog Input 2- | Input | |
| 7 | Analog Common | N/A | |

Table 2-23: Analog I/O Pin Assignment (TB103 B)

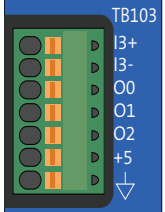
| Pin | Description | In/Out/Bi | Connector |
|-----|------------------|-----------|---|
| 1 | Analog Input 3+ | Input |  |
| 2 | Analog Input 3- | Input | |
| 3 | Analog Output 0 | Output | |
| 4 | Analog Output 1 | Output | |
| 5 | Analog Output 2 | Output | |
| 6 | +5V Output Power | Output | |
| 7 | Analog Common | N/A | |

Table 2-24: Analog I/O Connector Mating Connector (TB103 A/B)

| Type | Aerotech P/N | Phoenix P/N | Wire Size: mm ² [AWG] |
|----------------------|--------------|-------------|----------------------------------|
| 7-Pin Terminal Block | ECK01631 | 1881370 | 0.5 - 0.080 [20-28] |

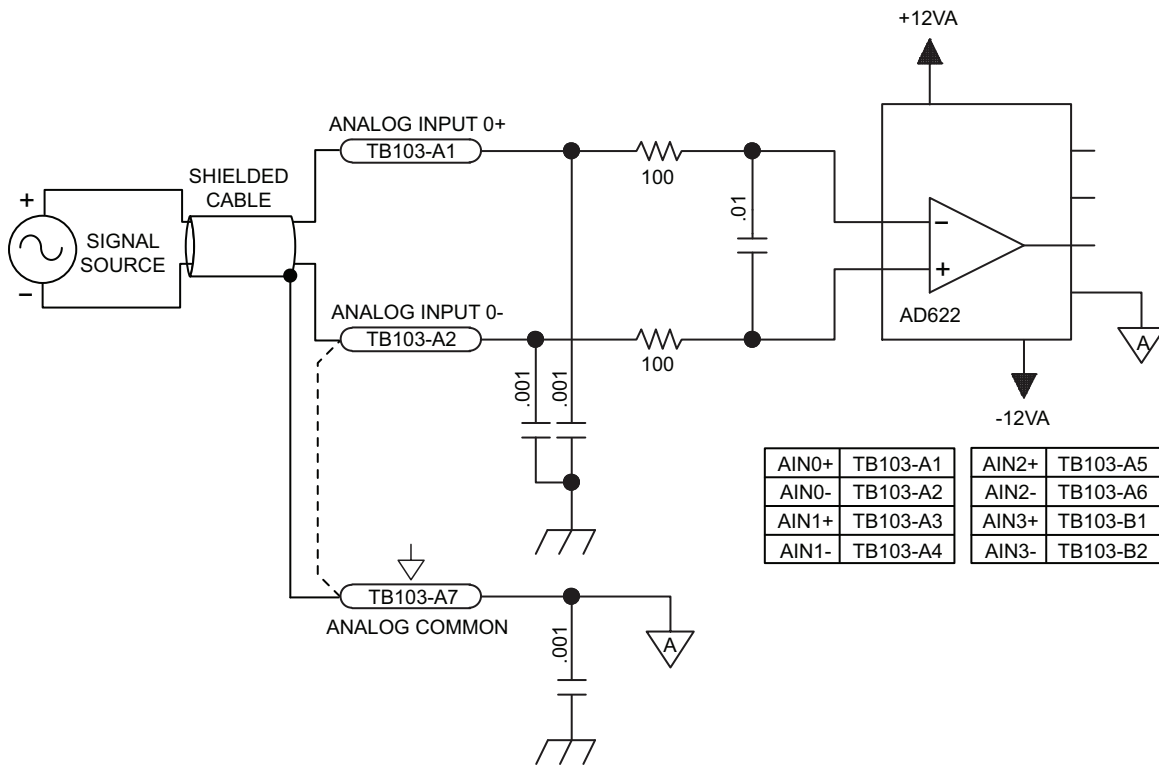


Figure 2-13: Analog Inputs (TB103)

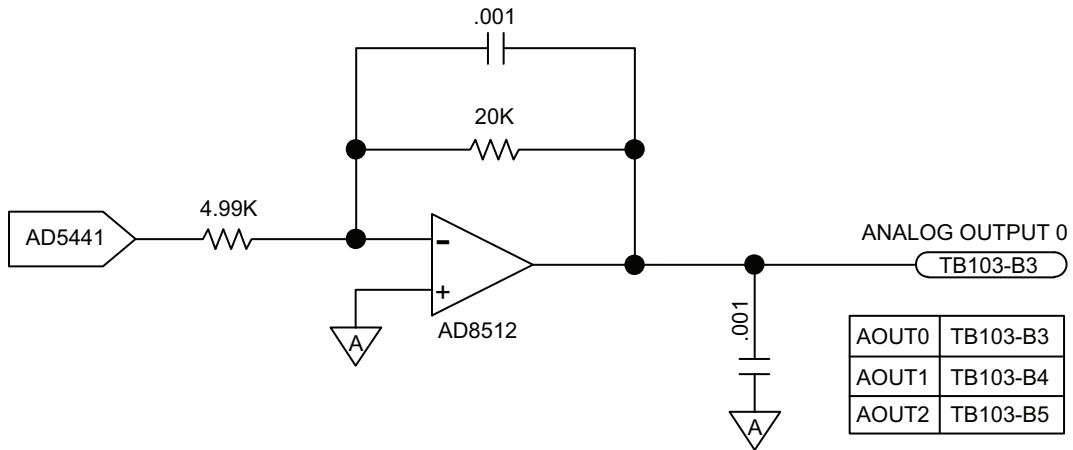


Figure 2-14: Analog Outputs (TB103)

2.10. Auxiliary Encoder Interface (TB108)

The Ndrive FLS is equipped with an auxiliary encoder input channel. The encoder interface accepts an RS-422 differential line driver input in the range of 0 to 5V. TB108 accepts a 10 MHz (max) encoder signal frequency (25 nsec edge separation), producing 40 million counts per second after times four (x4) quadrature decoding.

Table 2-25: Auxiliary Encoder Interface Pin Assignment (TB108)

| Pin | Description | In/Out/Bi |
|-----|--------------------|-----------|
| 1 | +5V Encoder Power | Output |
| 2 | Ground | N/A |
| 3 | Encoder SIN+ Input | Input |
| 4 | Encoder SIN- Input | Input |
| 5 | Encoder COS+ Input | Input |
| 6 | Encoder COS- Input | Input |
| 7 | Encoder MRK+ Input | Input |
| 8 | Encoder MRK- Input | Input |

Table 2-26: Auxiliary Encoder Interface Mating Connector (TB108)

| Mating Connector | Aerotech P/N | Phoenix P/N | Wire Size: mm ² [AWG] |
|----------------------|--------------|-------------|----------------------------------|
| 8-Pin Terminal Block | ECK01386 | 1881383 | 0.5 - 0.080 [20-28] |

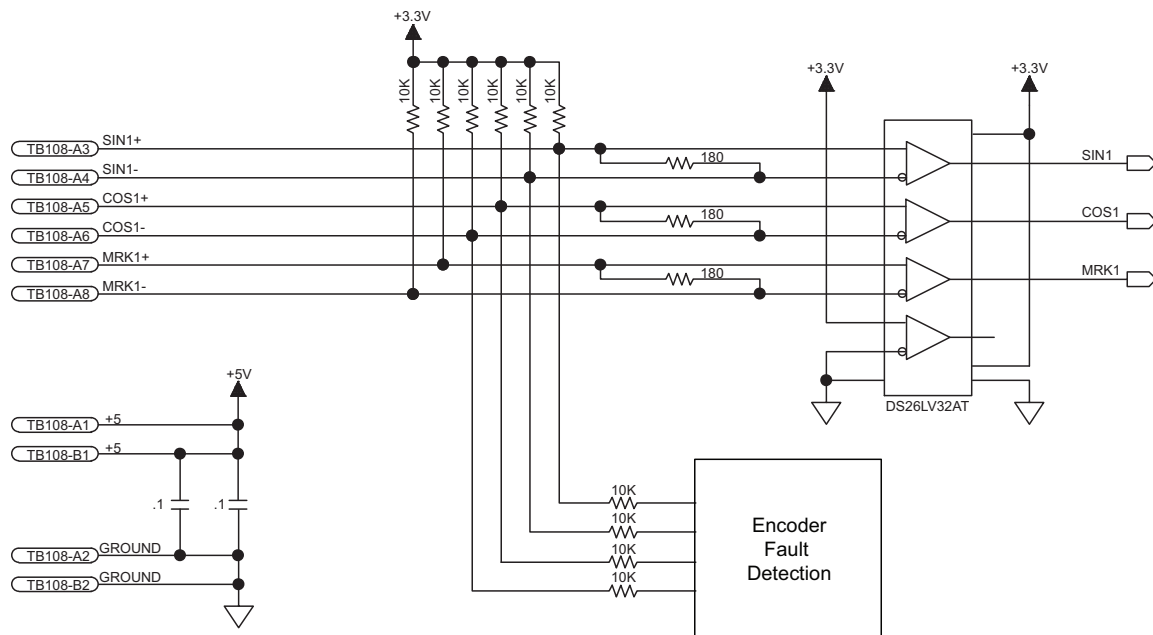


Figure 2-15: Encoder Connections (TB108)

2.11. PC Configuration and Operation Information

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

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Chapter 3: Maintenance

Except for S2, the Ndrive FLS does not have any user-configurable switches or jumpers.



DANGER: Always disconnect the Mains power connection before opening the Ndrive FLS 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 3-1: LED Description

| LED | Description |
|--|--|
| PWR* | Turns green when power is applied. |
| STAT | Turns red to indicate a fault condition on any axis. |
| * 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. | |

3.1. Preventative Maintenance

The Ndrive FLS 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: Always disconnect the Mains power connection before opening the Ndrive FLS chassis.

Table 3-2: Preventative Maintenance

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

Cleaning

The Ndrive FLS 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 Ndrive FLS 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 Ndrive FLS while cleaning. Do not allow cleaning substances or other fluids to enter the Ndrive FLS or to get on to any of the connectors. Avoid cleaning labels to prevent removing the label information.

3.2. Board Assembly

Figure 3-1 highlights the important components located on the control board. Table 3-3 lists the jumpers and the default configurations and Table 3-4 lists the fuse information for the control board. Refer to Figure 3-2 for Power Board fuse location and Table 3-5 for fuse information.



DANGER: Always disconnect the Mains power connection before opening the Ndrive FLS chassis.

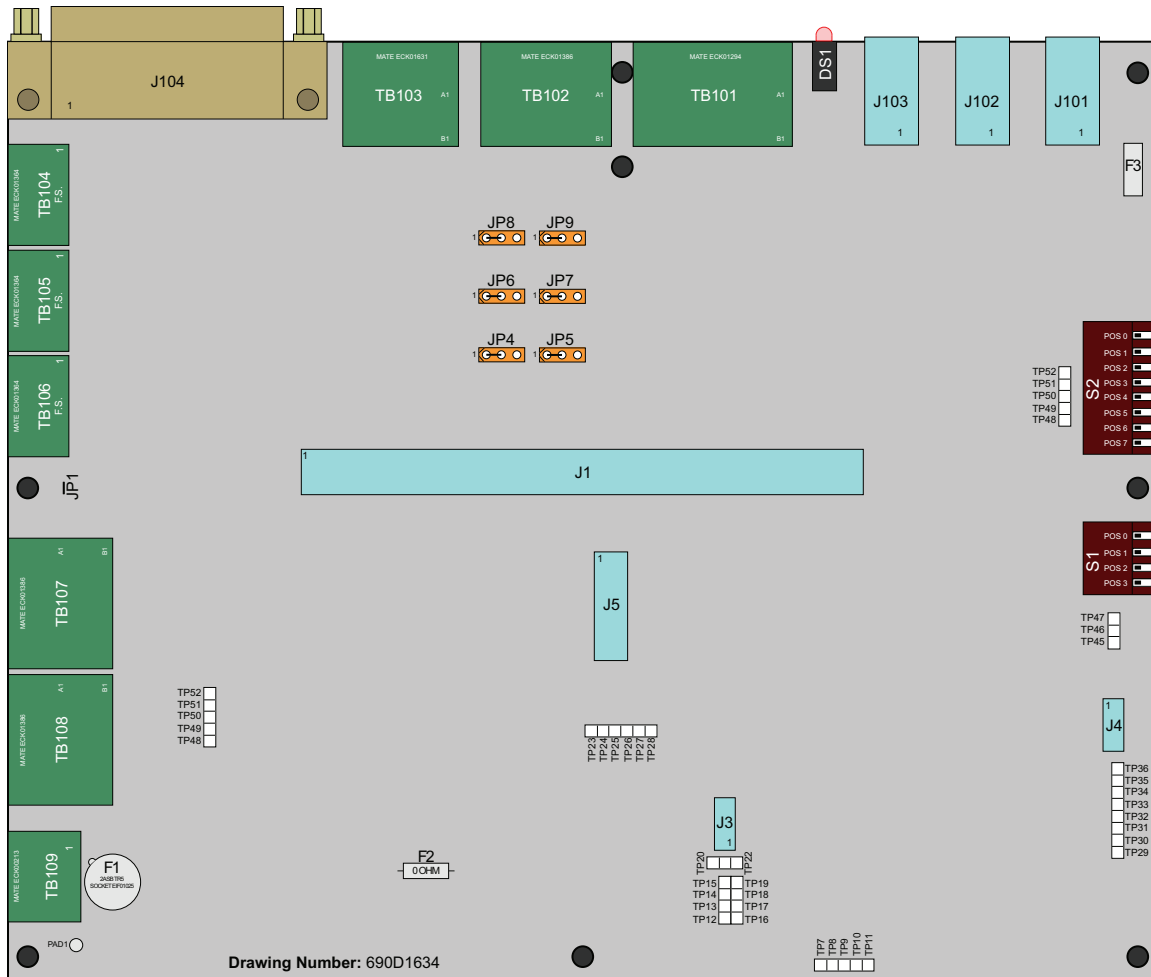


Figure 3-1: Control Board Assembly

Table 3-3: Jumper Selections

| Jumpers | Positions | Function |
|---------|--------------------|------------------------------|
| JP4-JP5 | 1-2 ⁽¹⁾ | Laser Output 3 (O3) Sinking |
| | 2-3 | Laser Output 3 (O3) Sourcing |
| JP6-JP7 | 1-2 ⁽¹⁾ | Laser Output 2 (O2) Sinking |
| | 2-3 | Laser Output 2 (O2) Sourcing |
| JP8-JP9 | 1-2 ⁽¹⁾ | Laser Output 1 (O1) Sinking |
| | 2-3 | Laser Output 1 (O1) Sourcing |

(1) Default

Table 3-4: Control Board Fuse Specifications

| Fuse | Description | Size | Aerotech P/N | Manufacturer's P/N |
|------|----------------------------|----------|--------------|-----------------------|
| F1 | Control Power at TB109-1 | 2 A S.B. | EIF01029 | Littelfuse 3721200041 |
| F3 | FireWire power at J101-103 | 3 A | EIF01001 | Raychem RGE300 |

NOTE: F3 is a resettable fuse (turn off power and remove the short. F3 does not require replacement.



DANGER: Always disconnect the Mains power connection before opening the Ndrive FLS chassis.

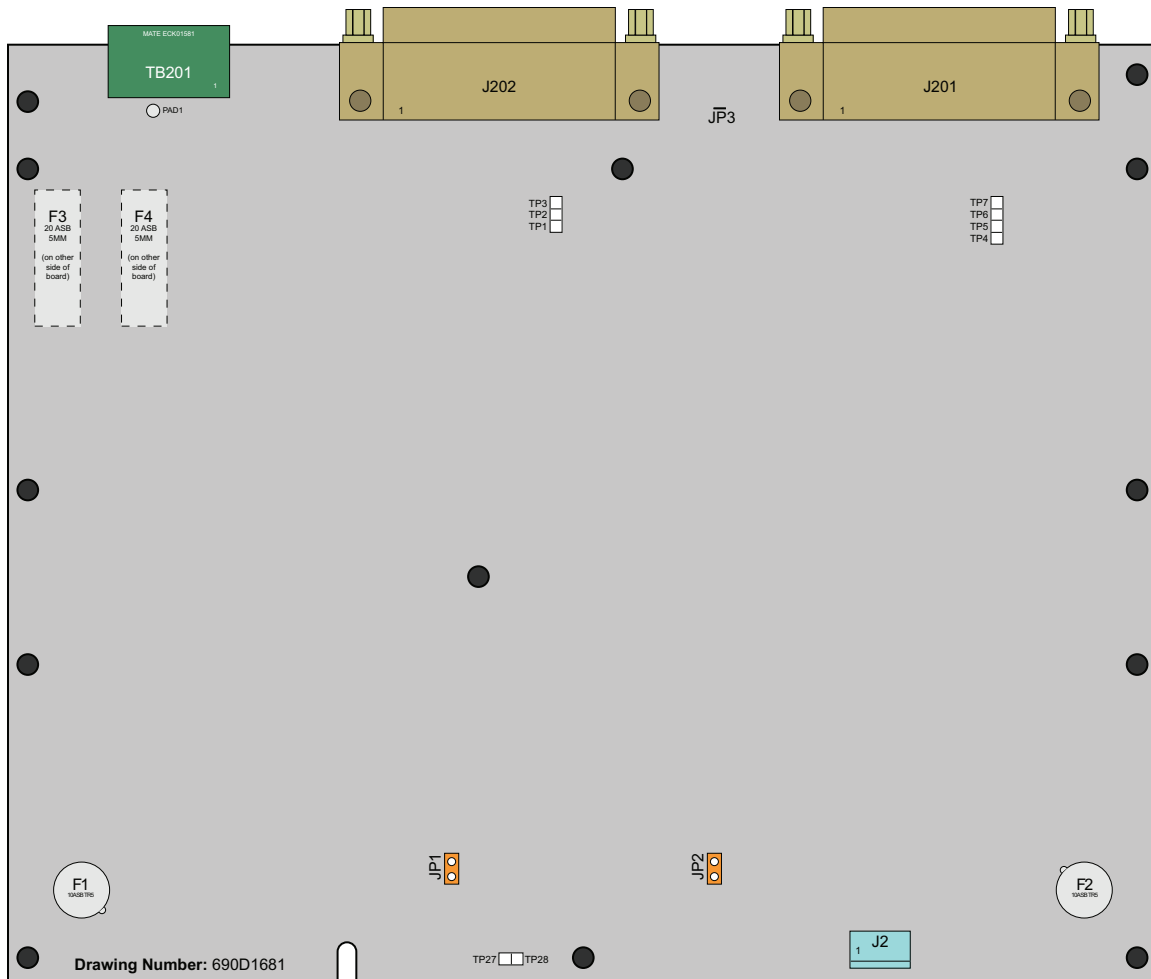


Figure 3-2: Power Board Assembly

Table 3-5: Power Board Fuses

| Fuse | Description | Size | Aerotech P/N | Manufacturer's P/N |
|------|--------------------------|-----------|--------------|---------------------|
| F1 | Motor Output (Channel 2) | 10 A S.B. | EIF01035 | Littelfuse 374210 |
| F2 | Motor Output (Channel 1) | 10 A S.B. | EIF01035 | Littelfuse 374210 |
| F3 | Motor Bus Supply (B-) | 20 A S.B. | EIF01041 | Littelfuse 215020.p |
| F4 | Motor Bus Supply (B+) | 20 A S.B. | EIF01041 | Littelfuse 215020.p |

NOTE: F3 and F4 can be located on the bottom of the board.

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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.

Rush Service

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

On-site Warranty Repair

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

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

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

On-site Non-Warranty Repair

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

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

Service Locations

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

| USA, CANADA, MEXICO | CHINA | GERMANY |
|--|--|--|
| Aerotech, Inc. Global Headquarters Phone: +1-412-967-6440 Fax: +1-412-967-6870 | Aerotech China Full-Service Subsidiary Phone: +86 (21) 3319 7715 | Aerotech Germany Full-Service Subsidiary Phone: +49 (0)911 967 9370 Fax: +49 (0)911 967 93720 |
| JAPAN | TAIWAN | UNITED KINGDOM |
| Aerotech Japan Full-Service Subsidiary Phone: +81 (0)50 5830 6814 Fax: +81 (0)43 306 3773 | Aerotech Taiwan Full-Service Subsidiary Phone: +886 (0)2 8751 6690 | Aerotech United Kingdom Full-Service Subsidiary Phone: +44 (0)1256 855055 Fax: +44 (0)1256 855649 |

Have your customer order number ready before calling.

Appendix B: Revision History

| Rev # | Date | Description |
|---------|-----------------|---|
| 1.01.00 | April 22, 2015 | <ul style="list-style-type: none">• Updated EC Declaration of Conformity• Added RoHS statement to EC Declaration of Conformity• Added Agency Approval section: Agency Approvals• Added TUV information: Section 1.1.• Added Input Power equation: Section 1.1.• Added torque tightening specifications: Table 2-3 and Table 2-5• Updated PSO specifications: Table 2-15 |
| 1.00.00 | August 23, 2012 | New Manual |

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| TB101 B | 21 |
| TB102 | 16-17 |
| TB103 | 24 |
| TB108 | 26 |
| TB109 | 8 |
| TB201 | 9 |
| U | |
| Use | 5 |