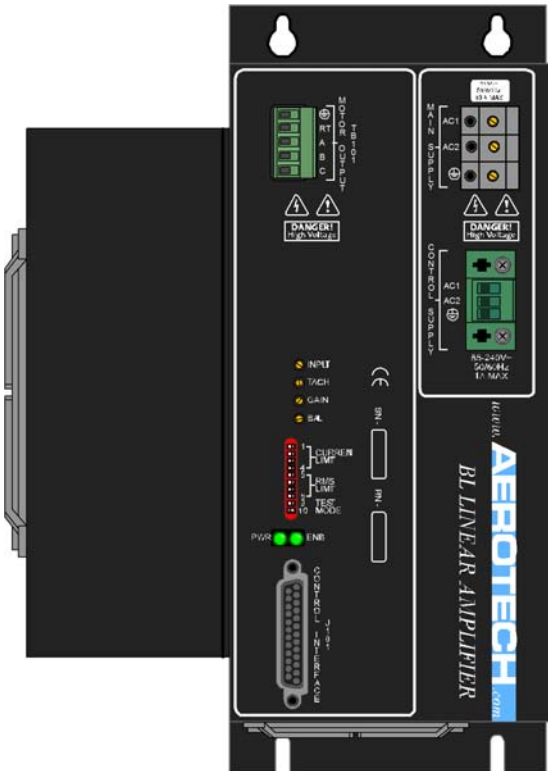


BL Hardware Manual

P/N: EDA144 (Revision 2.02.00)



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Revision History

| | |
|---------|----------|
| 2.02.00 | 11/11/10 |
| 2.01.00 | 6/22/10 |
| 2.00.00 | 3/16/10 |
| 1.08 | 8/11/09 |
| 1.07 | 12/4/06 |
| 1.06 | 2/27/06 |
| 1.05 | 12/12/05 |
| 1.04 | 11/1/04 |
| 1.03 | 8/6/04 |
| 1.02 | 6/7/04 |
| 1.01 | 11/4/03 |
| 1.00 | 1/7/03 |

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EC Declaration of Conformity

Manufacturer Aerotech, Inc.
Address 101 Zeta Drive
Pittsburgh, PA 15238
USA
Product BL
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 |

and is in conformity with the applicable requirements of the following documents when installed and used in accordance with the manufacturer's supplied installation instructions.

| | |
|-----------------|--|
| EN 61010-1:2001 | Safety requirements for electrical equipment |
|-----------------|--|

| | |
|-----------------|---|
| Name |  / Alex Weibel |
| Position | Engineer Verifying Compliance |
| Location | Pittsburgh, PA |
| Date | September 2010 |

Chapter 1: Introduction

The BL Series amplifiers are highly reliable linear brushless servo amplifiers that are easily adaptable to drive brush or brushless servomotors. The BL amplifier package is a complete modular unit that includes heat sink, metal cover, control and bus power supplies that operate at ± 40 VDC (@ 20 amps peak) or ± 80 VDC (@ 10 amps peak).

The BL drives feature self commutation with analog or digital Hall-effect feedback signals and include a 5 VDC, 250 mA supply to power encoders and Hall-effect devices (HEDs). Each model is jumper selectable, providing the capability to drive both brush and brushless motors. Complete electrical isolation is provided between the control stage and the power stage for all models of the BL. This is accomplished with a transformer isolated control voltage power supply and opto-isolation of the drive signals, current command signals and fault signal between the control and power stages.

Operating modes include current command, velocity command or dual-phase command (for brushless modes of operation only). For brush modes of operation, the available operating modes are current command and velocity command. Differential inputs are used for better noise immunity. Velocity feedback is from either an encoder or tachometer and logic inputs include directional current limits and shutdown. Fault, current, and velocity outputs simplify monitoring drive status. In addition, there is an option to drive three brush motors in torque mode.

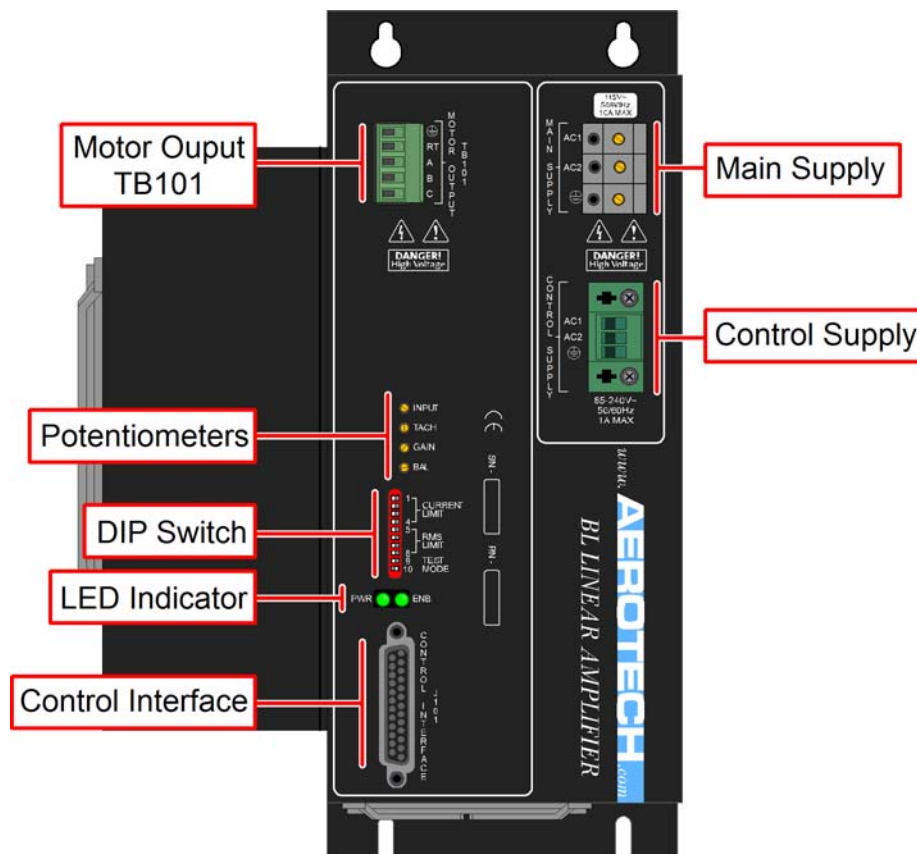


Figure 1-1: BL Linear Amplifier Connection Overview

Table 1-1: Amplifier Options

| BL Series Linear Amplifiers | |
|-----------------------------|---|
| BL10-40-x | ±40 V output (80 V bus) and 10 A peak current, with cooling fan and isolation transformer. |
| BL10-80-x | ±80 V output (160 V bus) and 10 A peak current, with cooling fan and autotransformer. |
| BL20-40-x | ±40 V output (80 V bus) and 20 A peak current, with cooling fan and isolation transformer. |
| | x = A for 115 VAC single phase input power (standard) x = B for 230 VAC single phase input power x = C for 100 VAC single phase input power x = D for 200 VAC single phase input power |
| Options | |
| -VM1 | Brushless motor, electronic Tachometer, 0° commutation offset (Aerotech standard) |
| -VM2 | Brushless motor, electronic Tachometer, 30° commutation offset |
| -VM3 | Brush motor, analog Tachometer |
| -VM4 | Brush motor, electronic Tachometer |
| -CM1 | Brushless motor, 0° commutation offset (Aerotech Standard) |
| -CM2 | Brushless motor, 30° commutation offset |
| -CM3 | Brush motor |
| -AH | Analog Hall |
| -TP | Three independent current regulators (one enable/fault) |
| -DDP | Brushless motor, differential dual phase current commands |
| -PK n | Peak current output $n\%$ of max (where n can equal 6, 13, 19, 27, 33, 40, 46, 54, 60, 67, 73, 81, 87, 94, 100) |
| -CC n | Continuous current output before automatic shutdown $n\%$ of max (where n can equal 3, 7, 10, 14, 17, 21, 24, 27, 30, 34, 37, 41, 44, 47, 50) |

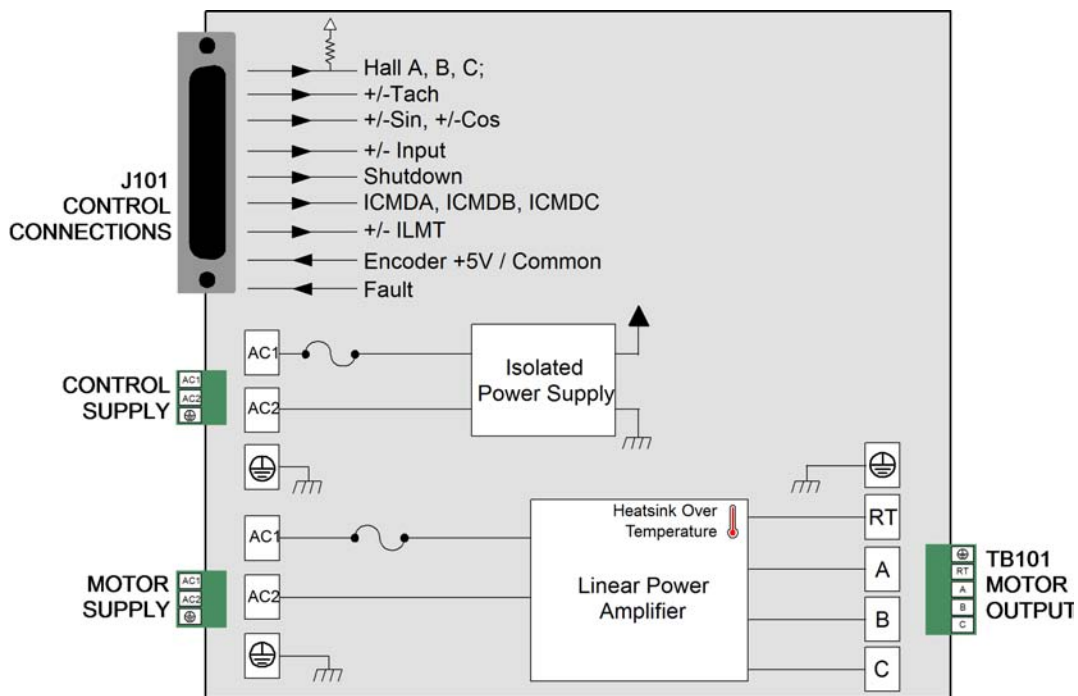


Figure 1-2: Functional Diagram

1.1. Electrical Specifications

The electrical specifications for the BL are listed below.

Table 1-2: Electrical Specifications

| Description | | BL 20-40 | BL 10-40 | BL 10-80 |
|-------------------------------|----------------------------------|--|-----------------------|-----------------------|
| Motor Supply | Input Voltage | 100, 115, 200, 230 VAC (model dependent) | | |
| | Input Frequency | 50-60 Hz | | |
| | Inrush Current | 10, 11.5, 20, 23 A (model dependent) | | |
| | Maximum Continuous Input Current | 5.66 A _{rms} | 2.83 A _{rms} | 5.66 A _{rms} |
| Control Supply | Input Voltage | 85-240 VAC | | |
| | Input Frequency | 50-60 Hz | | |
| | Inrush Current | 16 A | | |
| | Input Current | .25 A max | | |
| Output Voltage ⁽¹⁾ | | ±36V @ 20A | ±38V @ 20A | ±78V @ 10A |
| Peak Output Current | | 20 | 10 | 10 |
| Continuous Output Current | | 10 | 5 | 5 |
| Power Amplifier Bandwidth | | 2 kHz | | |
| Minimum Load Resistance | | 0.5 Ω | | |
| Output Impedance | | 0.2 Ω (each phase) | | |
| User Power Supply Output | | 5 VDC (@ 500 mA) | | |
| Modes of Operation | | Brushless; Brush; Stepper | | |
| Protective Features | | Peak current limit; Over temperature; RMS current limit; Dynamic power dissipation limit; Designed to EN61010/UL3101 | | |
| Isolation | | Optical and transformer isolation between control and power stages. | | |
| (1) Load Dependent | | | | |

1.3. Environmental Specifications

The environmental specifications for the BL are listed below.

| | |
|---------------------|---|
| Ambient Temperature | Operating: 5° to 40°C (41° to 104° F) |
| | Storage: -20° to 70°C (-4° to 158° F) |
| Humidity | Maximum relative humidity is 80% for temperatures up to 31°C. Decreasing linearly to 50% relative humidity at 40°C. Non condensing. |
| Altitude | Up to 2000 meters. |
| Pollution | Pollution degree 2 (normally only non-conductive pollution). |
| Use | Indoor use only. |

Chapter 2: Installation and Configuration

This section covers the hardware configurations using the switches, jumpers, connectors, and power hook-ups when used with a brush or brushless DC motor. Wiring, grounding, and shielding techniques, an explanation of the current regulator adjustment and the motor phasing process are also covered in this section.

NOTE: Aerotech brushless motors should be configured for 0° Hall commutation shift. Motors from other manufacturers may require a 30° Hall commutation offset. Consult the motor manufacturer for details.

The BL amplifier must be installed inside an enclosure with construction compliant for use with unlimited circuits. The BL amplifier can be lifted and transported using both hands to hold and support the case of the amplifier. The BL amplifier must be mounted with at least 2 inches of ventilation space around all sides the amplifier. Additional ventilation and cooling requirements are determined by the application. See Section 1.2. Mechanical Design for the BL amplifier and mounting dimensions.



Do not hold the BL amplifier by the connectors, and be careful of all sharp edges and hardware to prevent bodily injury and damage to amplifier.

2.1. 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. Operators should be trained before operating this equipment.

NOTE: The BL (all Aerotech equipment) is not to be used in a manner not specified by Aerotech, Inc.



To minimize the possibility of bodily injury and electrical shock, make certain that electrical power is disconnected (Mains disconnect) from amplifier before performing system maintenance or wiring.



Risk of injury during operation due to moving parts connected to the BL.



Residual voltages greater than 60V can be present inside and at the terminals of the BL amplifier for longer than 5 seconds after power has been disconnected.



All service and maintenance must be performed by qualified personnel.



Improper operation of this equipment may result in personal injury. The user must read this manual and related documentation thoroughly before operating the equipment.



Use of this product in a manner other than its intended use may result in bodily injury and/or damage to the equipment.



The BL case temperature may exceed 75°C in some applications.

NOTE: All drawings and illustrations are for reference only and were complete and accurate as of this manual's release. The most recent system drawings and schematics can be found on your software CD ROM.

2.2. Power Connections

The BL 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 1.1.

2.2.1. Control Supply Connections

The control power supply input allows the BL 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 (at 3 A). AC2 may require an external fuse or circuit breaker (3 A, time delay). The figure below shows the required connections to the control power input.

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

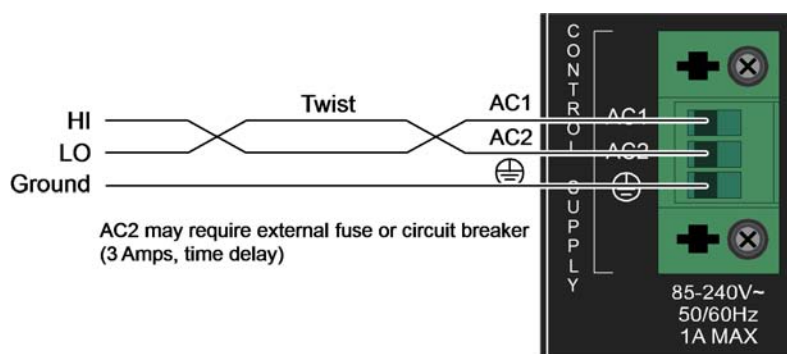


Figure 2-1: Control Supply Connections

Table 2-1: Control Supply AC Input Wiring

| Pin | Description | Recommended Wire Size |
|-----|---|--------------------------------|
| AC1 | 85-240 VAC Control Power Input | 2.00 mm ² (#14 AWG) |
| AC2 | 85-240 VAC Control Power Input | 2.00 mm ² (#14 AWG) |
| ⊕ | Protective Ground (Required for Safety) | 2.00 mm ² (#14 AWG) |

Table 2-2: Control Supply Terminal Block Mating Connector

| Type | Aerotech P/N | Phoenix P/N | Wire Size: AWG [mm ²] |
|----------------------|--------------|-------------|-----------------------------------|
| 3-Pin Terminal Block | ECK00213 | 1754465 | 12-30 [3.3 - 0.0516] |

2.2.2. Motor Supply Connections

Motor power is applied at the three terminals of the MAIN SUPPLY connector.

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



External fuses or a circuit breaker (10 A maximum, time delay type) are required for the AC1 and AC2 inputs for branch protection. The protective device should be located near the drive.

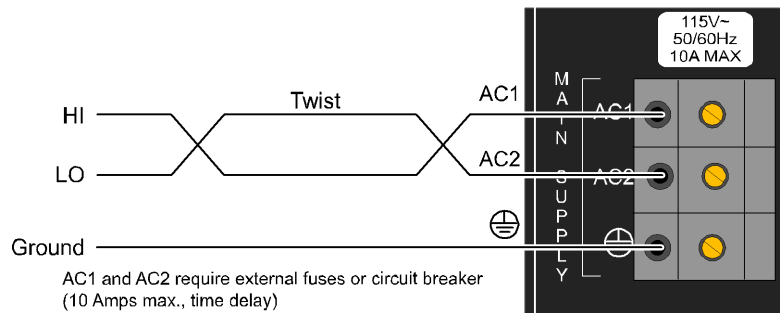



Figure 2-2: Motor Bus Input Connections

Table 2-3: Motor Supply Input Wiring

| Pin | Description | Wire Size |
|---|---|-------------------------------|
| AC1 | 115/100/208/230 Volt AC Input | 2.0 mm ² (#14 AWG) |
| AC2 | 115/100/208/230 Volt AC Input | 2.0 mm ² (#14 AWG) |
|  | Protective Ground (Required for Safety) | 2.0 mm ² (#14 AWG) |

2.3. Motor Output Connections (TB101)

The three-phase motor terminal connections are made at the A, B, C, and RT (Return) terminals, as designated on the amplifier. A protective ground connection is provided at the motor connector for the motor frame and shield wires. The motor frame and shield must be connected to (⊕) ground as well.

See Wiring Configurations for information on connecting each of the supported motor types.

Table 2-4: Motor Output Connection

| Pin | Description | Recommended Wire Size |
|-----|---|-------------------------------|
| ØA | Phase A Motor Lead | 2.0 mm ² (#14 AWG) |
| ØB | Phase B Motor Lead | 2.0 mm ² (#14 AWG) |
| ØC | Phase C Motor Lead | 2.0 mm ² (#14 AWG) |
| RT | Brushless Motors with Wye connection only | 2.0 mm ² (#14 AWG) |
| ⊕ | Earth Ground to Motor (required for safety) | 2.0 mm ² (#14 AWG) |

Table 2-5: Control Supply Terminal Block Mating Connector

| Type | Aerotech P/N | Phoenix P/N | Wire Size: AWG [mm ²] |
|----------------------|--------------|-------------|-----------------------------------|
| 5-Pin Terminal Block | ECK00212 | 1754504 | 12-30 [3.3 - 0.0516] |

2.4. DIP Switch

There is a 10-position DIP switch on the BL drive that provides four discrete functions. The switch permits the user to control maximum allowable current to the motor, continuous output current, velocity or current operational mode, and test mode.

Table 2-6: DIP Switch Functions

| | Switches | Position | Function | |
|--------------------------------|--|----------|--|--|
| Current Peak Limit | 1 | Closed | Peak is 6% of I _{peak} | |
| | 2 | Closed | Peak is 13% of I _{peak} | |
| | 3 | Closed | Peak is 27% of I _{peak} | |
| | 4 | Closed | Peak is 54% of I _{peak} | |
| | Switches 1 through 4 affect the GAIN adjustment of the velocity loop; closing switches 1 through 4 produces maximum gain adjustment. | | | |
| Continuous Current Peak | 5 | Closed | I _{cont} is 3% of I _{peak} | |
| | 6 | Closed | I _{cont} is 7% of I _{peak} | |
| | 7 | Closed | I _{cont} is 14% of I _{peak} | |
| | 8 | Closed | I _{cont} is 27% of I _{peak} | |
| | Closing switches 5 through 8 will allow 50% peak continuous current for two seconds. | | | |
| Test | 9 | Closed | Closing this position allows the BAL pot to manually control motor velocity or torque without the need of an input signal depending upon the setting of switch 10. | |
| Mode | 10 | | Velocity/Current mode - closing this position enables the current mode. | |

Switches 1-4 affect the full-scale current output range of the amplifier when in current (and in velocity) mode. When all four switches are closed, the peak current range is not limited. Closing each switch effectively limits the output range of the amplifier by a factor associated with that switch. For example closing only SW1-4 (54%) on a BL10 limits the output current to 5.4 A. Therefore, a 10 V input signal would produce a 5.4 A output; similarly, a 5 V input would produce a 2.7 A output ($5V / 10V * 5.4A$). It should be noted that switches 1-4 have no effect in dual-phase mode.

Switches 5 through 8 determine the level where the continuous output current will produce a fault. This type of protection is known as an electronic fuse.



Failure to set these switches can result in damage to the amplifier.

Example: Setting Continuous Current Switch Equation

$$I_{CLAMP} = \frac{(V_{BUS} - V_{BEMF}) - \sqrt{(V_{BUS} - V_{BEMF})^2 - 768 * R_{LN}}}{2 * R_{LN}}$$

V_{BUS} = Amplifier Bus Voltage (Units = Volts)

V_{BEMF} = Voltage due to Back-Emf of motor (Units = Volts)

$$= \frac{K_{BEMF} * MaximumVelocity}{\sqrt{3}} = \text{Brushless}$$

$$= \frac{K_{BEMF} * MaximumVelocity}{2} = \text{Brush}$$

R_{LN} = Line-to-line neutral motor resistance (Units = Ohms)

Example: Setting Continuous Current Limits (BL20)

To set the continuous current limit to 5.5A:

5.5A Continuous RMS x 1.414 = 7.8A continuous peak

(7.8A continuous peak/20A max peak) x 100 = 39%.

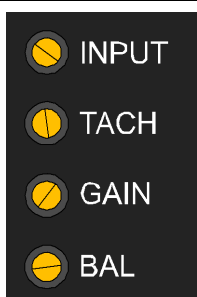
Open switches 1 and 4; close switches 2 and 3.

2.5. Potentiometers (POTs)

Potentiometers INPUT, TACH, GAIN, and BAL (balance) are associated with the pre amplifier circuit contained in the amplifier. These potentiometers are used to adjust the pre-amplifier gain when the MODE switch is set for velocity control using an external DC tachometer or incremental encoder for velocity feedback.

Table 2-7: Potentiometer Functions

| Potentiometer | CW | CCW | Function |
|---------------|----------|----------|--|
| INPUT | Increase | Decrease | This pot adjusts the DC gain of the input command present at J101 Pins 8 & 21. |
| TACH | Increase | Decrease | This pot adjusts the DC gain of the tach or encoder derived velocity feedback input present at J101-Pin 3. |
| GAIN | Decrease | Increase | This pot adjusts the AC gain of the pre-amplifier. |
| BAL | | | Provides the means of canceling small DC offsets that may be present in the pre amplifier circuit. |



- INPUT
- TACH
- GAIN
- BAL

This figure illustrates a portion of the pre-amplifier circuit that is accessible to the user for adjusting command signal gains.

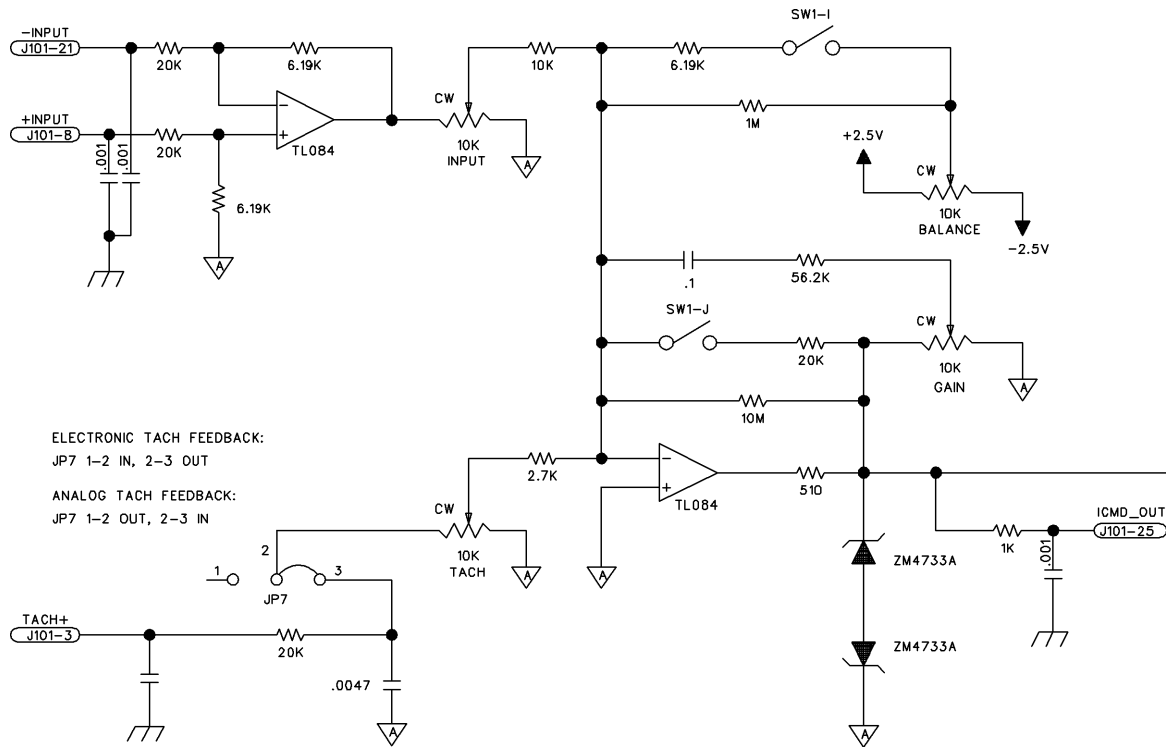
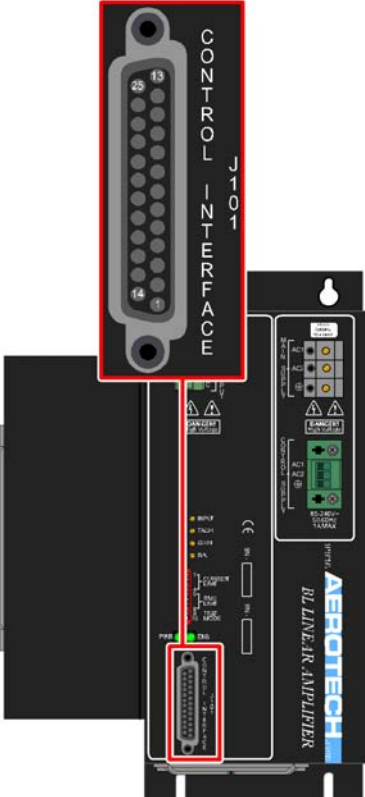


Figure 2-3: Command Signal Adjustment of the Pre-Amplifier Circuit

2.6. Control Interface Connector (J101)

Connector J101 (25-pin “D” type, female) provides the interface for input and output control connections.

Table 2-8: Connector J101 Pin Assignment

| Pin | Signal | Function | I/O | Location |
|-----|----------|---|--------------------|--|
| 1 | SHIELD | Chassis frame ground | Input |  |
| 2 | POWER | +5V Power for Encoder (250 mA max) | Output | |
| 3 | TACH+ | Tachometer input for velocity feedback (encoder vs. tach velocity feedback is jumper selectable). | Input | |
| 4 | HA | Hall-Effect Sensor A (brushless motors only) | Input ¹ | |
| 5 | COS | Encoder Cosine + | Input | |
| 6 | COS-N | Encoder Cosine - | Input | |
| 7 | GROUND | Signal common. Electrical reference for all control circuitry on amplifier. | Input | |
| 8 | +INPUT | Non-inverting input of differential input circuit. | Input | |
| 9 | ICMDA | Current Command A | Input | |
| 10 | SHUTDOWN | Shut off power stage (and remove all power to the motor). | Input ¹ | |
| 11 | +ILMT | CW directional current limit input. | Input ¹ | |
| 12 | ICMDC | Current Command C | Input | |
| 13 | -- | -- | -- | |
| 14 | GROUND | Signal common of an encoder | N/A | |
| 15 | TACH- | Recommended reference input for tachometer. This point is identical to signal common. | Input | |
| 16 | HB | Hall-Effect Sensor B (brushless motors only) | Input ¹ | |
| 17 | HC | Hall-Effect Sensor C (brushless motors only) | Input ¹ | |
| 18 | SIN | Encoder Sine + | Input | |
| 19 | SIN-N | Encoder Sine - | Input | |
| 20 | Power | +5V Power for Encoder (250 mA max) | Output | |
| 21 | -INPUT | Inverting input of differential input circuit. | Input | |
| 22 | ICMDB | Current Command B | Input | |
| 23 | FAULT | Indicates the status of the power stage (amplifier enabled or faulted). | Output | |
| 24 | -ILMT | CCW directional current limit input. | Input ¹ | |
| 25 | -ICMD | Current command monitor. Representative of the current command (self commutating modes only). | Output | |

1. Denotes input pull up to internal +5 VDC through a 10K resistor

2.6.1. Encoder Inputs (J101)

The Encoder input signals provide encoder position information to the amplifier. The encoder inputs can also be used to derive an electronic tachometer signal

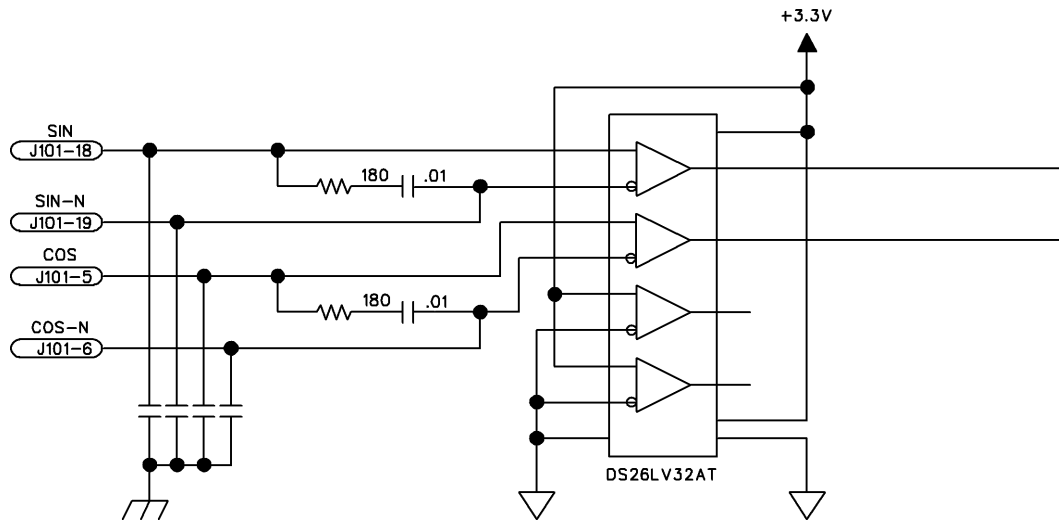


Figure 2-4: Encoder Inputs

2.6.2. Hall-Effect Inputs (J101)

The Hall-effect input signals provide motor rotor position information to the amplifier. Hall-effect input signals are recommended for AC brushless motor commutation but not absolutely required.

The Hall-effect inputs accept 5-24 VDC level signals.

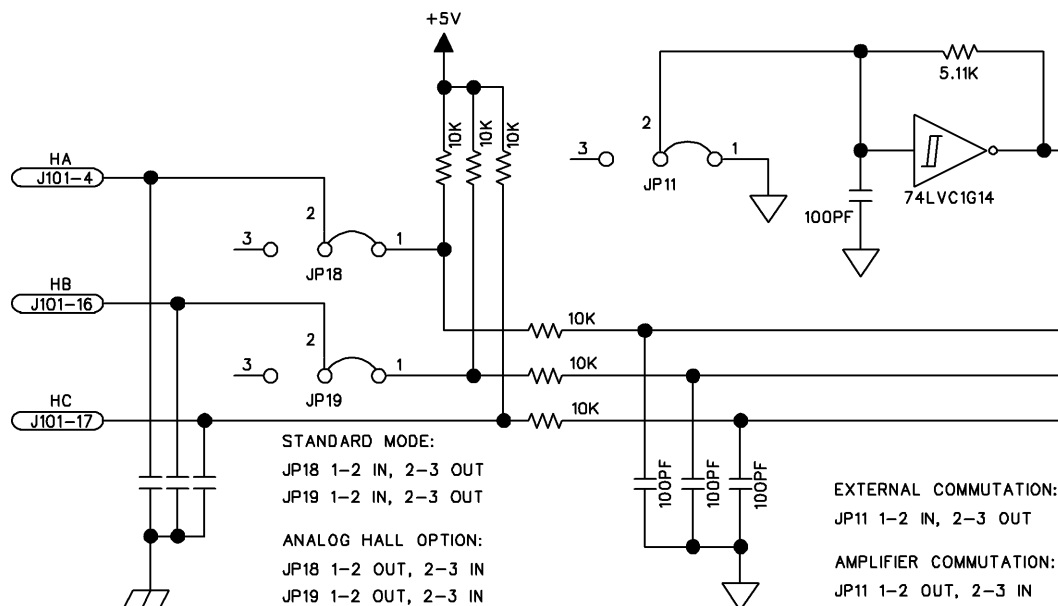


Figure 2-5: Hall-Effect Inputs

2.6.3. +/- Input

A positive voltage on J101-8 causes CCW motor rotation (torque or velocity mode). For single ended operation, connect command to this input and ground (Pin 21 of J101).

A positive voltage on J101-21 causes CW motor rotation (torque or velocity mode). For single ended command operation, ground this connection and connect signal to Pin 8 of J101.

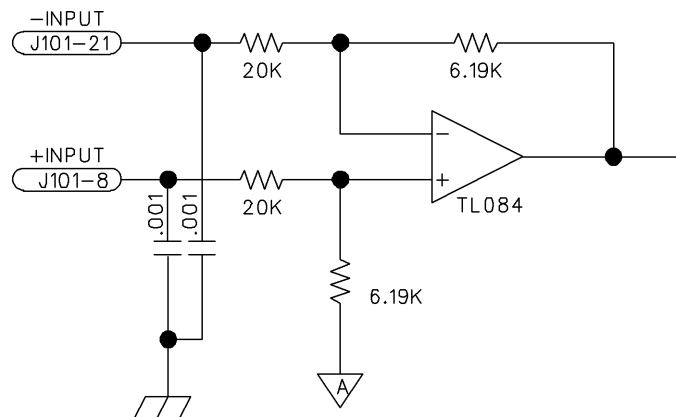


Figure 2-6: \pm Input

2.6.4. Limit Inputs (J101)

When pulled to its active state, motion is inhibited (jumper selectable).

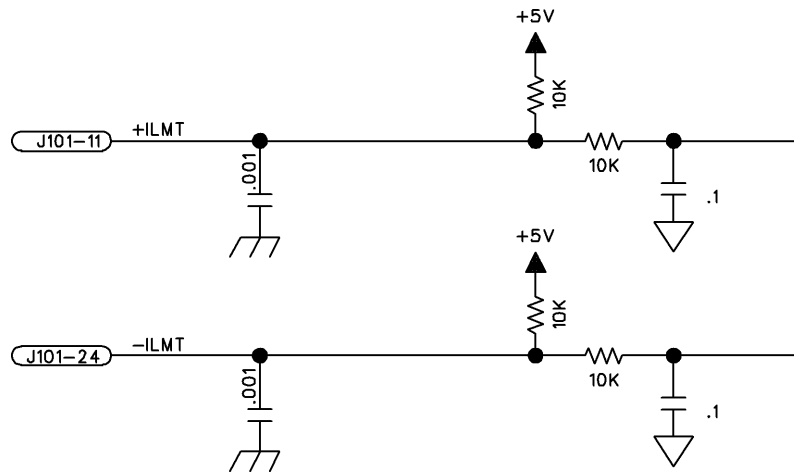


Figure 2-7: Limit Inputs

2.6.5. Current Command Inputs (J101)

These signals provide external velocity loop and commutation control. They are jumper selectable current command inputs that bypass differential input, pre-amplifier, and self-commutation circuits.

J101-12 allows control of phase C current when jumper JP8 is set to 2-3. Normally, phase C current is derived internally from phase A and B currents.

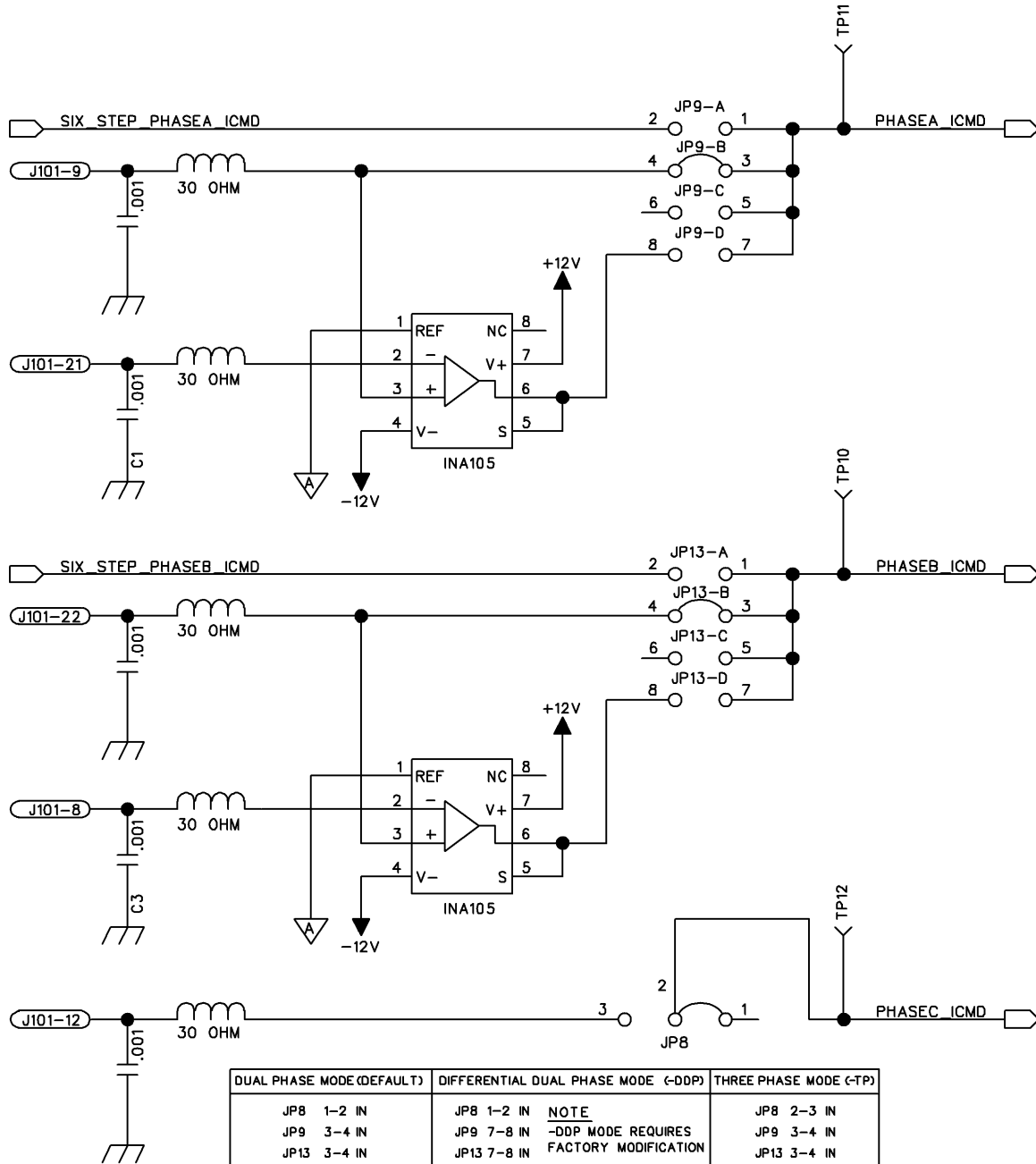


Figure 2-8: Current Command Inputs

NOTE: Refer to Section 3.2. Velocity Command Configuration and Section 3.3. Torque Command Configuration (Current) for Six Step Phase ICMD.

2.6.6. Tach Input (J101)

A tachometer can be used in the velocity loop configuration to provide negative feedback to the amplifier. This allows the amplifier to close the servo loop and control the stability of the loop. If an encoder is used for velocity feedback, this pin serves as an output for monitoring velocity (approx. 1V/KRPM).

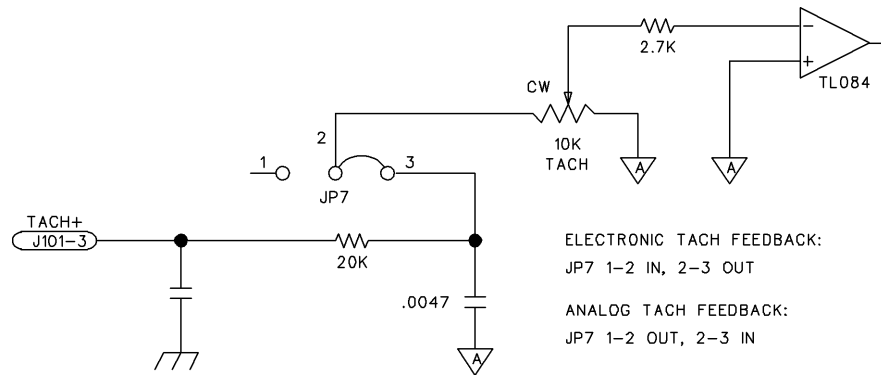


Figure 2-9: Tach Input

2.6.7. Shutdown Input (J101)

Jumper selectable active high or active low input. It is used to shut off power stage and therefore remove all power to the motor.

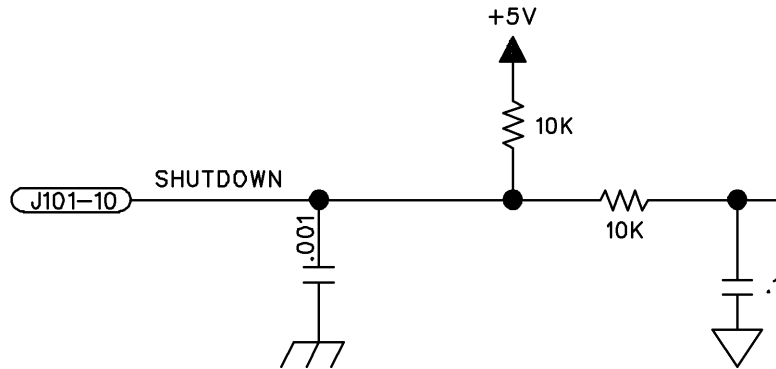


Figure 2-10: Shutdown Input

2.6.8. Fault Output (J101)

Jumper selectable active high or active low (open collector) output. It is used to indicate the status of the power stage (amplifier enabled or faulted). The output device (Q22) can sink up to 160 mA of current.

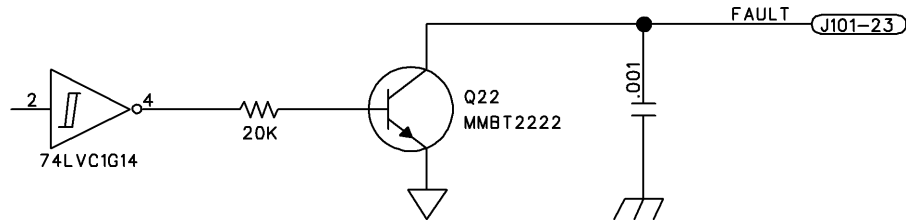


Figure 2-11: Fault Output

2.7. Motor and Feedback Phasing

When configuring the BL amplifier to run a brushless motor, the commutation signal input connections (labeled HALL A, B, C on connector J101 in velocity or torque command mode pins 4, 16, and 17) are necessary. Two sequences of 30° or 0° (default) signal shift can be used, depending on the setting of jumpers JP4, JP10, and JP12. These sequences and the generated output motor phase voltages (motor output connections A, B, and C with respect to a real or pseudo neutral connection) are shown in Figure 2-12. The voltages generated are made under the conditions of a positive signal placed at +INPUT with respect to -INPUT at control signal input/output connector J101. A 0 for the given HALL input indicates zero voltage or logic low, where a 1 indicates five volts or logic high.

NOTE: If an Aerotech brushless motor is used with the BL amplifier, motor phase and HALL connections can be determined by referring to the system interconnection drawings in Figure 3-2, Figure 3-3, and Figure 3-4.

Disconnect the motor from the controller and connect the motor in the test configuration shown in Figure 2-12. 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 2-12).

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

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

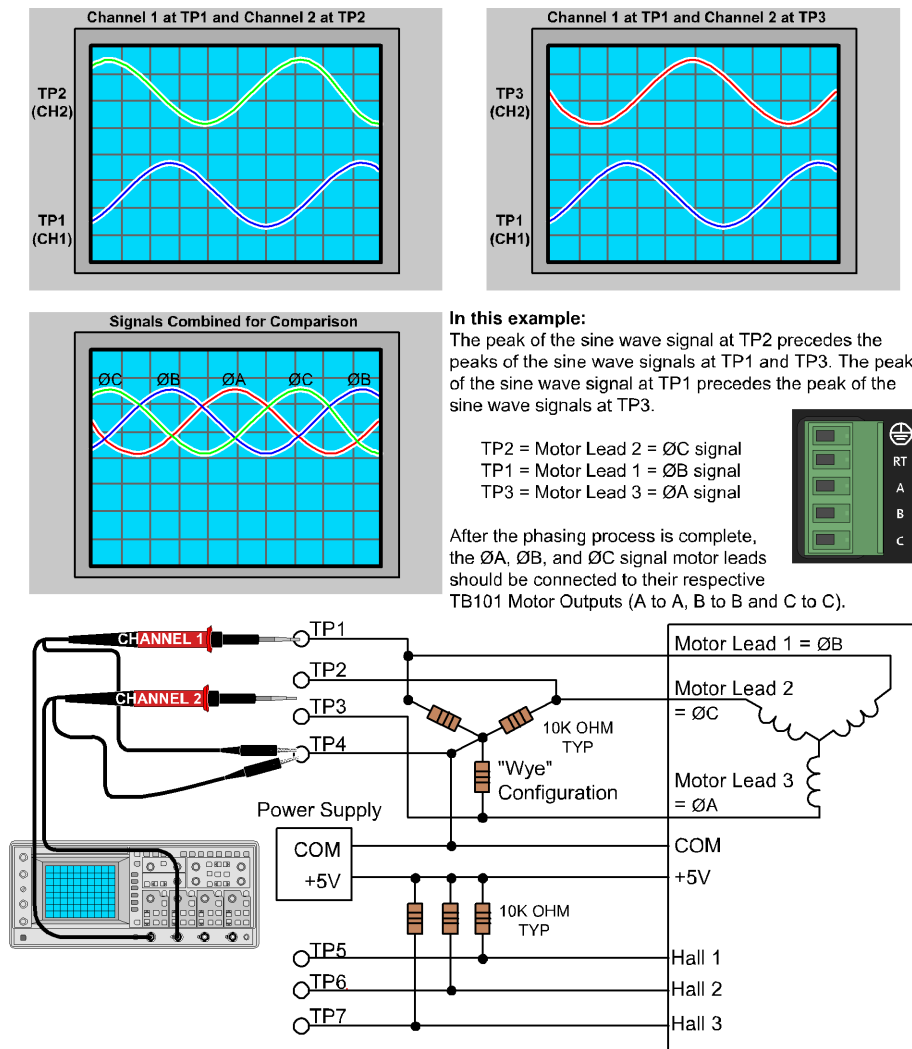


Figure 2-12: Motor Phasing Oscilloscope Example

After the motor leads have been tested, the next step is to determine the phase of the Hall signals. The required (by an Aerotech system) relationship between motor and Hall leads is that the peak of a motor lead signal should correspond to the low voltage phase of the Hall signal (the relationship is shown in Figure 2-13).

With channel 1 still connected to one of the motor leads, connect channel 2 of the oscilloscope to TP5, TP6, and then TP7, while advancing the motor in the positive direction after each connection. Note which of the three Hall signals has the complimentary phase relationship to the motor lead that channel 1 is connected to (as shown in Figure 2-13).

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

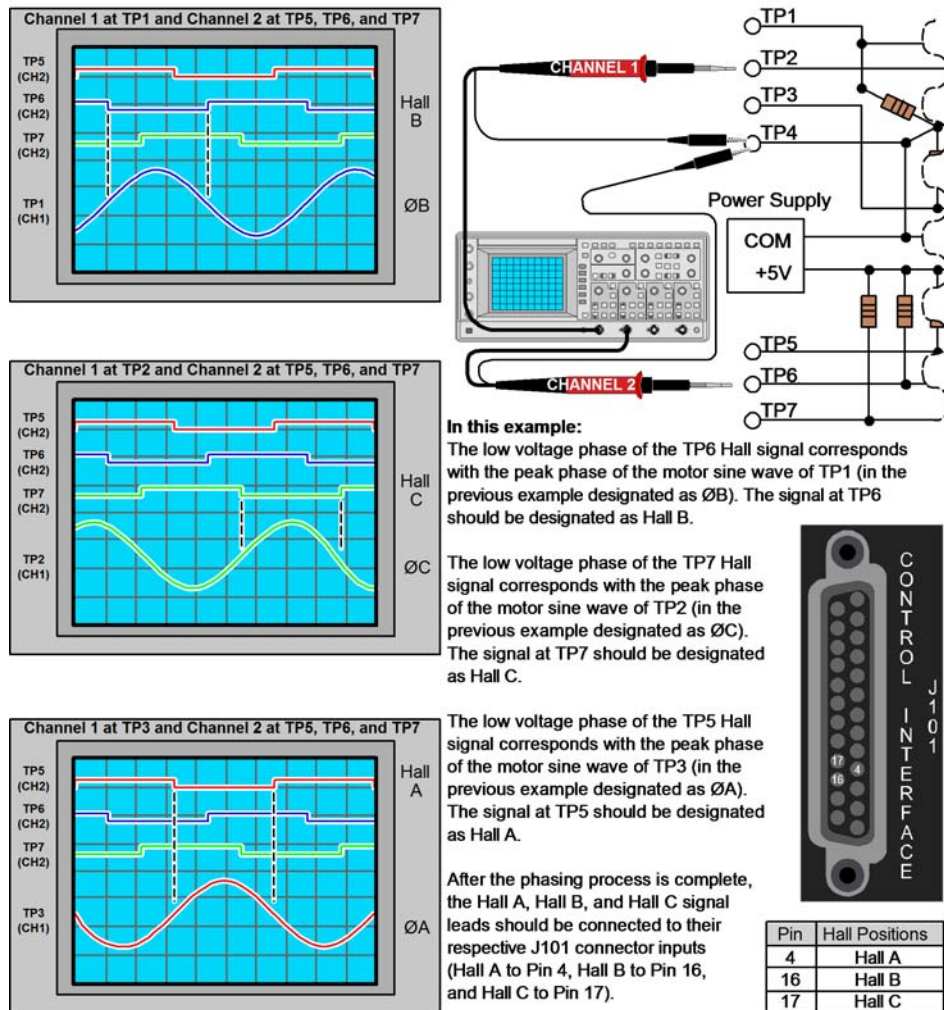


Figure 2-13: Hall Phasing with Oscilloscope

With the designations of the motor and Hall leads of a third party motor determined, the motor can now be connected to an Aerotech system. Connect motor lead A to motor connector A, motor lead B to motor connector B, and motor lead C to motor connector C. Connect Hall lead A to Pin 4 of the feedback connector. Hall lead B should be connected to Pin 16 and Hall lead C should connect to Pin 17 of the feedback connector.

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

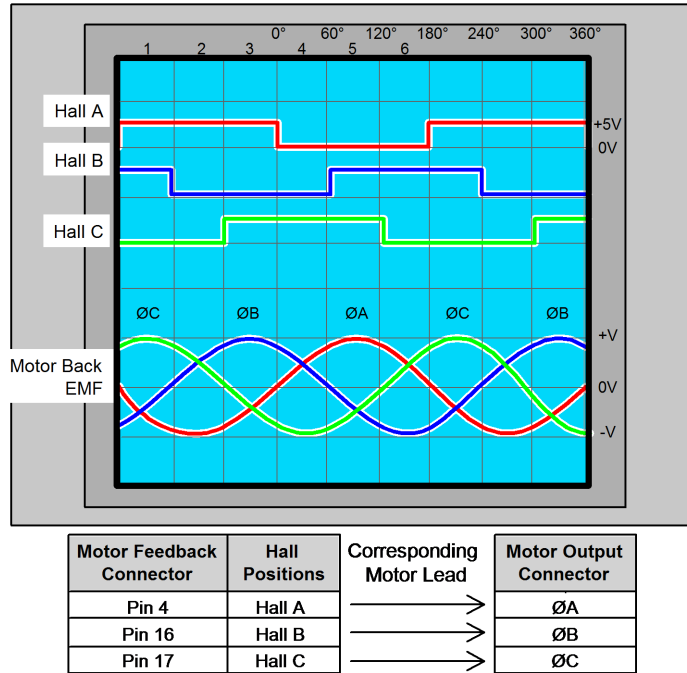


Figure 2-14: Brushless Motor Phasing Goal

Chapter 3: Wiring Configurations

BL drives can be wired into a system in one of two modes (brush or brushless). For a list of motor and feedback cables, refer to Section 3.8. Cables.

3.1. Three-Phase Brushless Motors with Unconnected Phases

Most three phase brushless motors require only three connections between the servo amplifier and the motor. This is due to the motor phases being internally connected in a Wye or Delta style. This form of connection simplifies wiring, ensuring that the servo amplifier only controls and monitors two phase currents, since the third phase current is always the sum of the first two phase currents.

However, this simplicity has one drawback. This drawback is phase winding imbalances that can cause torque ripple and make it difficult to compensate, since the servo amplifier only controls two of the three phase currents. The BL Series amplifier overcomes this problem by providing the RT (return) connection for six wire motors, like the Aerotech BLM Series linear motors.

Since the BL Series amplifier independently controls current in each of its three phases, six wire motors can be connected as shown in Figure 3-1. In this configuration, offset and/or gain adjustments of current made in one phase do not affect those set in the other two phases.

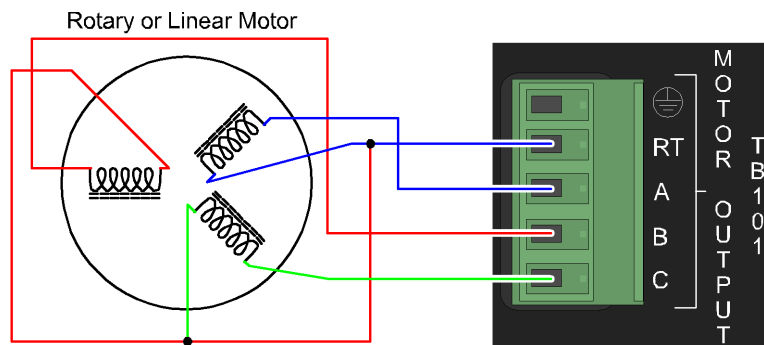


Figure 3-1: Connection of Six Wire Motors to BL Series Amplifiers

3.2. Velocity Command Configuration

The speed of the motor is controlled by the amplifier in velocity command mode. In this mode, a velocity feedback signal is required. The feedback signal can be derived from an analog DC tachometer connected to the +TACH pin, or from an incremental encoder that is connected to the sine and cosine pins (refer to Figure 3-2). From this signal, the amplifier adjusts the velocity of the motor accordingly depending upon the velocity command from the external controller. In this configuration, the amplifier closes and controls the velocity loop.

This configuration can drive both brush and brushless DC motors.

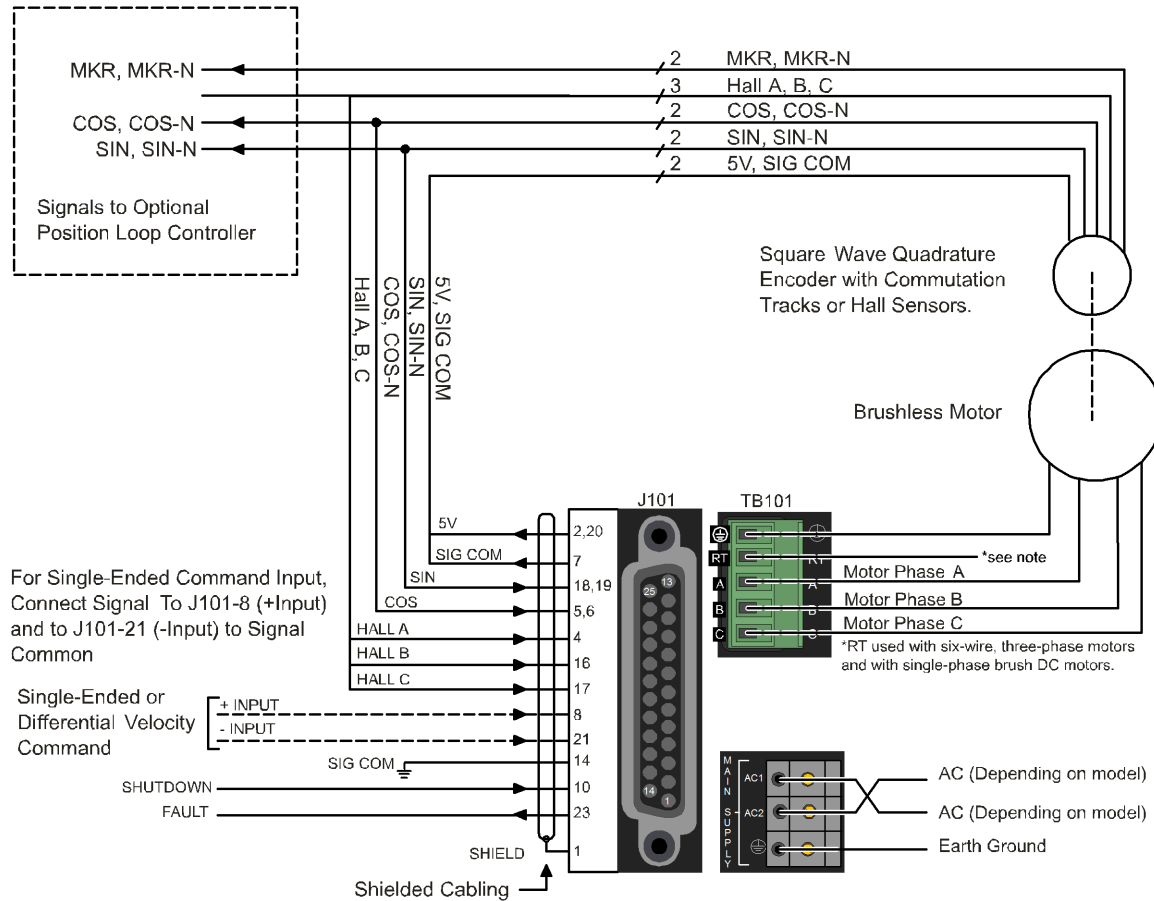


Figure 3-2: Velocity Command Configuration

Table 3-1: Velocity Command Mode BL Configuration

| DIP Switch | Setting ² | |
|---|---|--|
| 1 through 4 | Select peak current limit | |
| 5 through 8 | Select continuous current limit | |
| 9 (Test) | Open ⁵ | |
| 10 (Mode) | Open ⁵ | |
| Potentiometer ₁ | Setting ³ | |
| INPUT | 1/3 CW from full CCW (recommended starting point) | |
| GAIN | Full CW (recommended starting point) | |
| TACH | Full CW (recommended starting point) | |
| BAL | N/A | |
| Jumpers | Setting ⁴ | Description |
| JP7 | 1-2 OUT, 2-3 IN⁵ | Analog Tachometer Feedback |
| | 1-2 in, 2-3 out | Electronic (encoder) Tachometer Feedback |
| JP9 | 1-2 in, 3-4 out, 5-6 out, 7-8 out | Six-step mode |
| JP13 | 1-2 in, 3-4 out, 5-6 out, 7-8 out | Six-step mode |
| JP3 | 1-2 IN, 2-3 OUT⁵ | Brushless mode |
| | 1-2 out, 2-3 in | Brush mode |
| JP4, JP10, JP12 | JP4: 1-2 IN, 2-3 OUT⁵ | 0° Commutation |
| | JP10: 1-2 OUT, 2-3 IN⁵ | Half Step AC Commutation |
| | JP12: 1-2 OUT, 2-3 IN⁵ | Half Step AC Commutation |
| JP4, JP10, JP12 | JP4: 1-2 out, 2-3 in | 30° Commutation Offset |
| | JP10: 1-2 in, 2-3 out | Full Step AC Commutation |
| | JP12: 1-2 in, 2-3 out | Full Step AC Commutation |
| JP8 | 1-2 IN, 2-3 OUT⁵ | Standard Mode |
| <p>1. These initial settings will usually generate a stable system under the assumption that the tachometer feedback gain is around 6 volts/Krpm, or, if an encoder is used and the line resolution is between 1,000 and 1,500 per revolution.</p> <p>2. For more information about the DIP Switch, refer to Section 2.4. DIP Switch.</p> <p>3. For more information about the Potentiometer, refer to Section 2.5. Potentiometers (POTs).</p> <p>4. Refer to Section 4.1. Control Board Assembly for jumper locations.</p> <p>5. Default</p> | | |

To minimize the possibility of electrical shock and bodily injury, decouple the motor from the mechanical system to avoid injury if the motor begins to spin.

Starting with a zero input command signal, apply power to the amplifier. If the motor spins uncontrollably, remove power and switch the polarity of the tachometer input signal. If an encoder is being used, switch the sine and cosine input signals. Verify compliment signals (Sin & Sin-N, Cos & Cos-N) are of correct phasing.

Again, apply power to the amplifier. If the motor begins to oscillate, turn the TACH pot CCW until the oscillation stops. The GAIN and TACH potentiometers can be adjusted to provide maximum stiffness on the motor shaft.

Use the BAL pot to cancel any bias in the internal or external control circuit that would cause the motor to rotate when the input command signal is zero. If the TEST switch is closed, the effects of the BAL pot will be magnified. This is useful when applying a test bias signal (for velocity or torque modes) to the amplifier without introducing an external command signal.

3.3. Torque Command Configuration (Current)

In this configuration, the output current to the motor is proportional to the current command input. The advantage to this configuration is that the sine and cosine signals to the amplifier and a tachometer are not required.

This configuration will drive both brush and brushless DC motors.

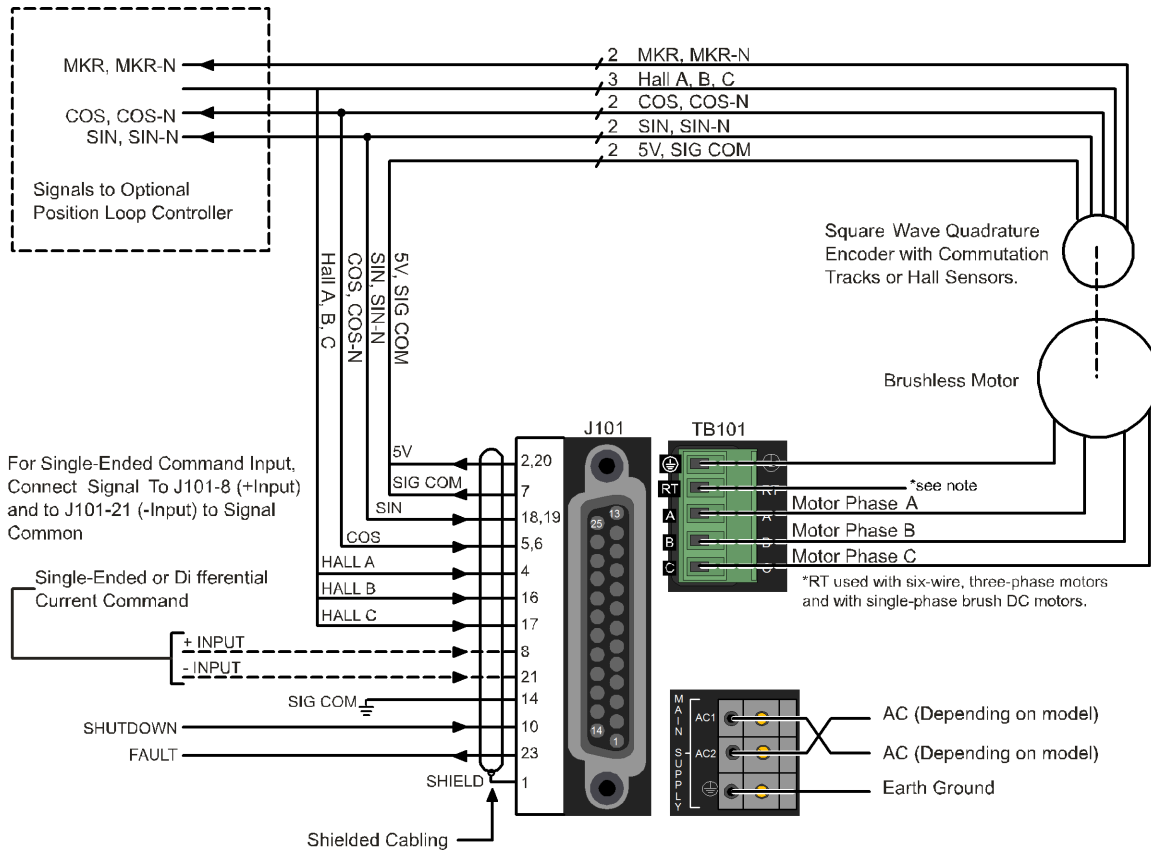


Figure 3-3: Torque (Current) Command Configuration

Table 3-2: Torque Command Mode (Current) BL Configuration

| DIP Switch | Setting ³ | |
|--|--|----------------------------|
| 1 through 4 | Select peak current limit | |
| 5 through 8 | Select continuous current limit | |
| 9 (Test) | Open ⁶ | |
| 10 (Mode) | Closed | |
| Potentiometer | Setting ⁴ | |
| INPUT ¹ | Full CW | |
| GAIN ¹ | Full CCW | |
| TACH | Setting has no effect on torque command mode setup | |
| BAL | Setting has no effect on torque command mode setup | |
| Jumpers | Setting ⁵ | Description |
| JP7 | 1-2 OUT, 2-3 IN ⁶ | Analog Tachometer Feedback |
| JP9 ² | 1-2 in, 3-4 out, 5-6 out, 7-8 out | Six-step mode |
| JP13 ² | 1-2 in, 3-4 out, 5-6 out, 7-8 out | Six-step mode |
| JP3 ² | 1-2 IN, 2-3 OUT ⁶ | Brushless mode |
| | 1-2 out, 2-3 in | Brush mode |
| JP4, JP10, JP12 | JP10: 1-2 OUT, 2-3 IN ⁶ | Half Step AC Commutation |
| | JP12: 1-2 OUT, 2-3 IN ⁶ | Half Step AC Commutation |
| | JP4: 1-2 IN, 2-3 OUT ⁶ | 0° Commutation |
| JP4, JP10, JP12 | JP10: 1-2 in, 2-3 out | Full Step AC Commutation |
| | JP12: 1-2 in, 2-3 out | Full Step AC Commutation |
| | JP4: 1-2 out, 2-3 in | 30° Commutation Offset |
| JP8 ² | 1-2 IN, 2-3 OUT ⁶ | Standard Mode |
| <p>1. This setting provides a transconductance gain of ± 10 volts for full current output</p> <p>2. For Multiple Brush Motor Mode jumper settings, refer to Section 3.7. Multiple Brush Motor (requires -TP Option) .</p> <p>3. For more information about the DIP Switch, refer to Section 2.4. DIP Switch.</p> <p>4. For more information about the Potentiometer, refer to Section 2.5. Potentiometers (POTs).</p> <p>5. Refer to Section 4.1. Control Board Assembly for jumper locations</p> <p>6. Default</p> | | |

With this configuration, an input signal of ± 10 volts to pins +INPUT and INPUT will produce the maximum current output signal (viewed at J101 pin 25 ICMD) of ± 6 volts. DIP switch positions 1 through 4 are used to scale this ± 6 volt signal from zero to maximum current.

3.4. Dual-Phase Command Configuration

In this configuration, the differential input, pre-amplifier, and self-commutation circuits are bypassed. The dual-phase inputs are sinusoidal and are 120° out of phase from each other. The third phase is internally generated by the amplifier. The advantage of this configuration is that it provides the smoothest possible motion.

This mode is used with a brushless motor only.

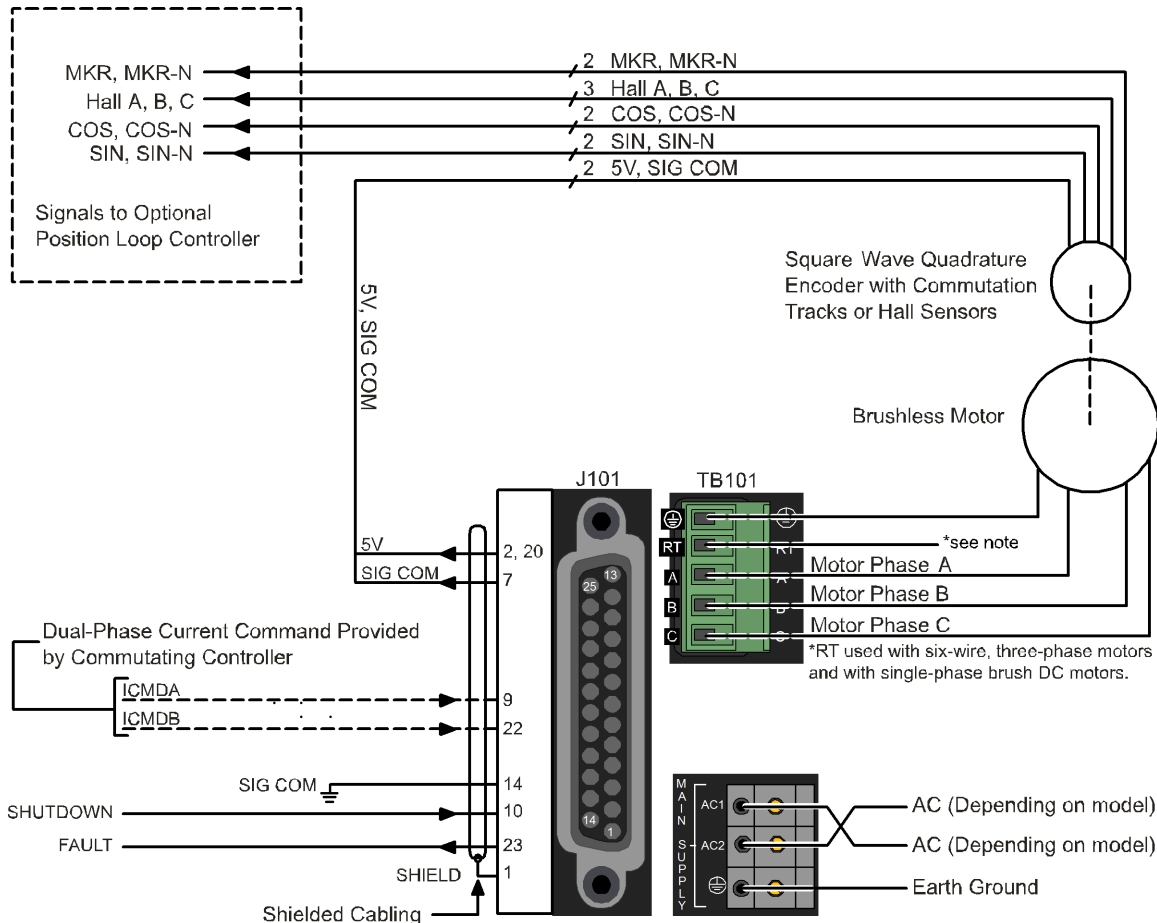


Figure 3-4: Dual-Phase Command Configuration

Table 3-3: Dual-Phase Mode BL Configuration

| Jumpers ¹ | Setting | Description |
|----------------------|--|-----------------|
| JP9 | 1-2 OUT, 3-4 IN, 5-6 OUT, 7-8 OUT ² | Dual phase mode |
| JP13 | 1-2 OUT, 3-4 IN, 5-6 OUT, 7-8 OUT ² | Dual phase mode |

1. Refer to Section 4.1. Control Board Assembly for jumper locations
 2. Default

Refer to Table 3-1 for complete Velocity Mode settings and Table 3-2 for complete Torque Mode settings.

3.5. Differential Dual-Phase Command Configuration

In this configuration, the differential input, pre-amplifier, and self-commutation circuits are bypassed. The dual-phase inputs are differential, sinusoidal, and are 120° out of phase from each other. The third phase is internally generated by the amplifier. The advantage to this configuration is that it provides the smoothest possible motion.

This mode is used with a brushless motor only.

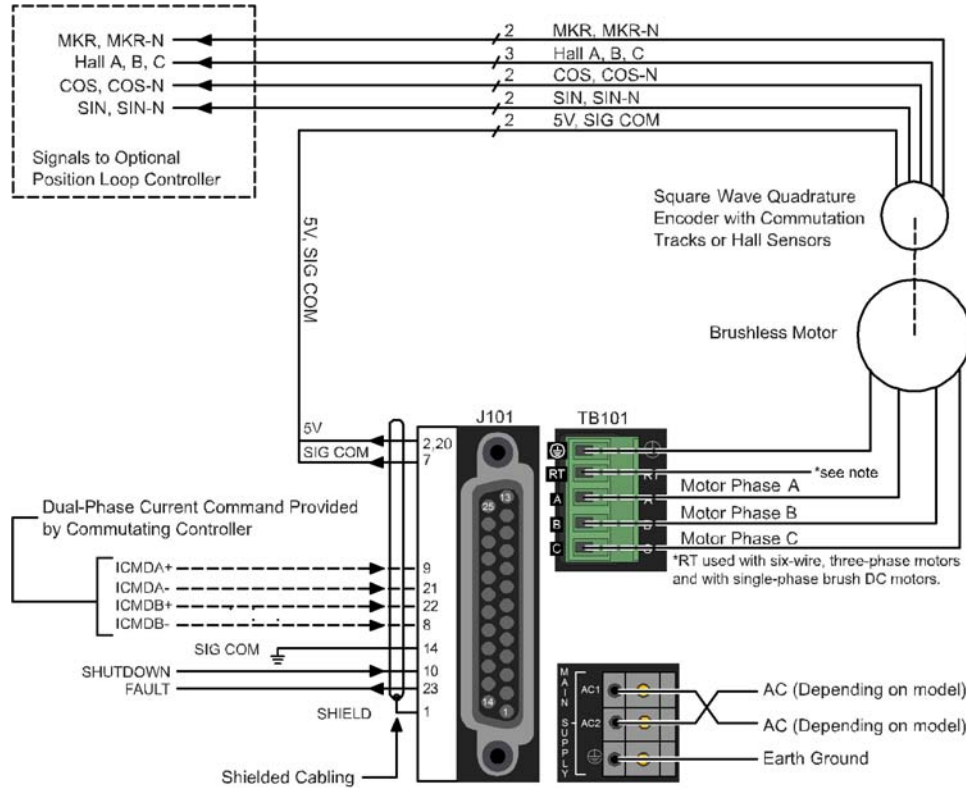


Figure 3-5: Differential Dual-Phase Command Configuration

Table 3-4: Differential Dual Phase Mode BL Configuration

| Jumpers | Setting | Description |
|---------|-----------------------------------|------------------------------|
| JP9 | 1-2 Out, 3-4 Out, 5-6 Out, 7-8 IN | Differential Dual phase mode |
| JP13 | 1-2 Out, 3-4 Out, 5-6 Out, 7-8 IN | Differential Dual phase mode |

Refer to Section 4.1. Control Board Assembly for jumper locations

Refer to Table 3-1 for complete Velocity Mode settings and Table 3-2 for complete Torque Mode settings.

3.6. Single Brush Motor

In this mode, a brush motor can be controlled in either velocity mode or current mode. It may be connected in two ways as described below.

Connecting the + side of the motor to A and - to the RT (Return) allows the motor to operate in a single-ended mode. This means that the A terminal will swing plus and minus with respect to RT. For a BL10-40, the motor will only see +40V or -40V maximum; not 80V. This permits lower voltage DC motors to be used safely with BL.

Connecting the motor to the amplifier at the phase A and phase C connections, allows the motor to see the entire bus. Meaning, if a BL10-40 is the amplifier, then the brush motor will have 80 volts across its terminals and a BL10-80 will put 160 volts across the motor terminals (differential at full speed).

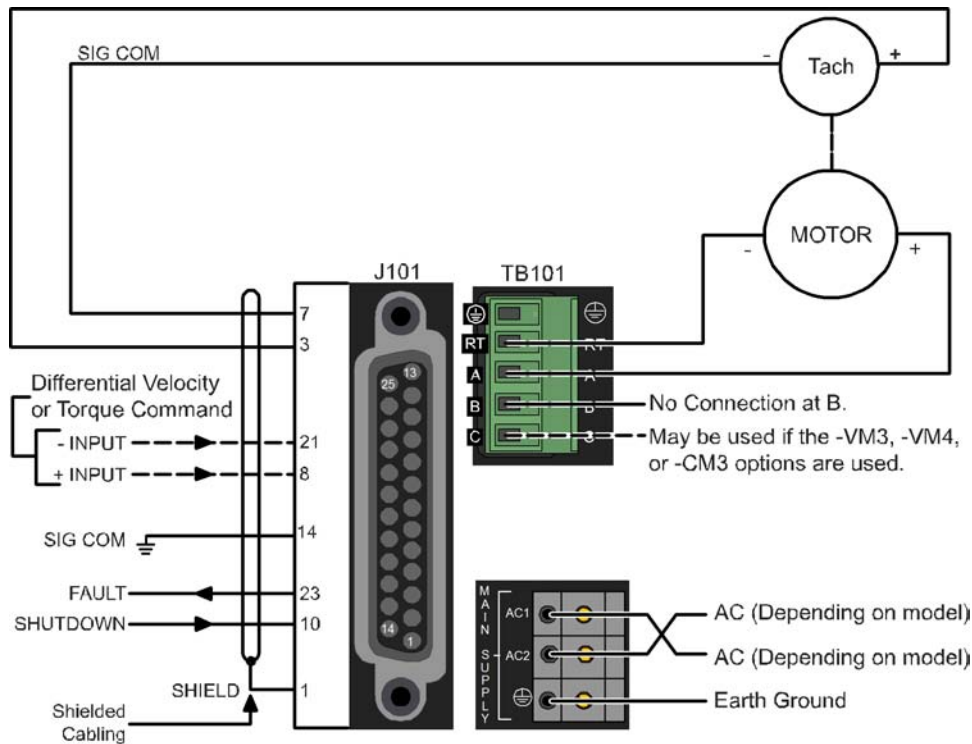


Figure 3-6: Single Brush Motor Configuration with Tachometer

Table 3-5: Single Brush Motor Mode BL Configuration

| Jumpers | Setting | Description |
|---|-----------------|-------------|
| JP3 | 1-2 Out, 2-3 IN | Brush mode |
| Refer to Section 4.1. Control Board Assembly for jumper locations | | |

Refer to Table 3-1 for complete Velocity Mode settings and Table 3-2 for complete Torque Mode settings.

3.7. Multiple Brush Motor (requires -TP Option)

The BL amplifier can control up to three brush motors in torque mode. In this mode, motor + of each motor connects to the appropriate phase on the amplifier and the motor - connects to the return (RT). While operating in this mode, each motor can only see half of the bus. Meaning, the BL10-40 drives each motor with 40 volts and a BL10-80 drives each motor with 80 volts.

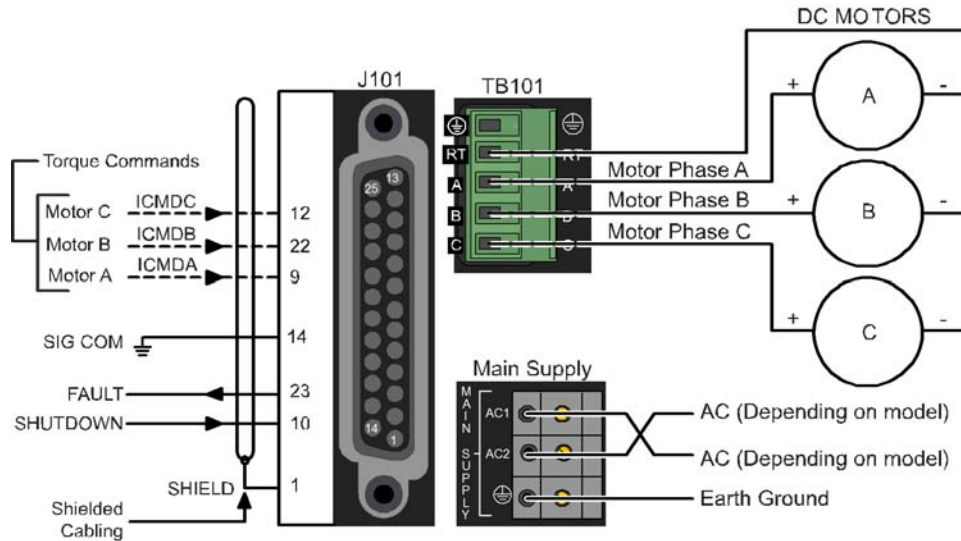


Figure 3-7: Multiple Brush Motor Configuration

Table 3-6: Multiple Brush/Torque Command Mode BL Configuration

| Jumpers ¹ | Setting | Description |
|----------------------|--|-----------------|
| JP9 | 1-2 OUT, 3-4 IN, 5-6 OUT, 7-8 OUT ² | Dual phase mode |
| JP13 | 1-2 OUT, 3-4 IN, 5-6 OUT, 7-8 OUT ² | Dual phase mode |
| JP3 | 1-2 out, 2-3 in | Brush mode |
| JP8 | 1-2 out, 2-3 in | TP Mode |
| JP16 | 1-2 in, 2-3 out | TP Mode |

1. Refer to Section 4.1. Control Board Assembly for jumper locations
 2. Default

Refer to Table 3-2 for complete Torque Mode settings.

3.8. Cables

NOTE: For a complete list of cables, a wiring/assembly drawing, or to identify a cable, see an Aerotech Documentation-CD or your software CD ROM.

Table 3-7: Motor Cables for Linear Stages

| Linear Stage | Options | Standard | | Hi-Flex | |
|--------------|-----------|------------|---------------------------|---------|--------------|
| | | Typical | Configured ⁽¹⁾ | Typical | Gore <107 dm |
| ABG10000 | | C19360 | | C19851 | |
| ABL1000 | | C18982 | | C18983 | C18984 |
| ABL1500 | | C19363 | C19364 | C21031 | |
| ABL2000 | | C19363 | C19364 | C19851 | |
| ABL3600 | | C19363 | C19364 | C21031 | |
| ABL8000 | BLM-142A | C19363 | C19364 | C21031 | |
| | BLM-264A | C19360 | | C19851 | |
| ABL9000 | BLM-142A | C21151 | | | |
| | BLMH262A | C21151 | | | |
| | BLM-325A | C21151 | | | |
| AHL9000 | | C19360 | | C19851 | |
| ALS130 | -25du | C18982 | | C18983 | C18984 |
| | -4du-25du | C19363 | C19364 | C21031 | |
| ALS130H | -25du | C18982 | | C18983 | C18984 |
| ALS135 | -25du | C18982 | | C18983 | C18984 |
| | -4du-25du | C19363 | C19364 | C21031 | |
| ALS1000 | | C19363 | C19364 | C21031 | |
| ALS3600 | | C19363 | C19364 | C21031 | |
| ALS5000 | Standard | C19360 | | C21031 | |
| ALS5000WB | Wide Body | C19360 | | C19851 | |
| ALS20000 | | C19363 | C19364 | C21031 | |
| ALS25000 | | C19363 | C19364 | C21031 | |
| ANT25/50 | | C18982 | | C18983 | C18984 |
| ANTix | | C18982 | | C18983 | C18984 |
| ATS50 | Stepper | C20251 | | | |
| | Brushless | C18982 | | C18983 | C18984 |
| ATS100 | 50smb2 | C20251 | | | |
| | 1035msof | BADC-MSOHF | | | |
| | BMS60 | C19363 | C19364 | C21031 | |

| Linear Stage | Options | Standard | | Hi-Flex | |
|--------------|-----------|------------|---------------------------|---------|--------------|
| | | Typical | Configured ⁽¹⁾ | Typical | Gore <107 dm |
| ATS150 | 101smb2 | C20251 | | | |
| | BMS60 | C19363 | C19364 | C21031 | |
| ATS0300 | 50smb2 | C20251 | | | |
| | BMS60 | C19363 | C19364 | C21031 | |
| ATS1000 | 1050msof | BADC-MSOHF | | | |
| | 101smb2 | C20251 | | | |
| | BM200 | C19360 | | C19851 | |
| | BMS60 | C19363 | C19364 | C21031 | |
| ATS1100H | | C19363 | C19364 | C21031 | |
| ATS1500 | 101smb2 | C20251 | | | |
| | BMS60 | C19363 | C19364 | C21031 | |
| ATS2000 | 101smb2 | C20251 | | | |
| | BMS60 | C19363 | C19364 | C21031 | |
| ATS3600 | 1050msof | BADC-MSOHF | | | |
| | 101smb2 | C20251 | | | |
| | BMS60 | C19363 | C19364 | C21031 | |
| ATS5000 | Standard | C15805 | | C21663 | |
| ATS5000WB | Wide Body | C15805 | | C21663 | |
| ATS6200 | 310smb3 | | | | |
| | BM250 | C15805 | | C21663 | |
| | BMS280 | C15806 | | C21661 | |
| LMA142 | | C19363 | C19364 | C19851 | |
| LMA264 | | C19360 | | C19851 | |
| LMAC-095 | | C19363 | C19364 | C19851 | |
| LMAC-143 | | C19363 | C19364 | C19851 | |
| MaskAlign | | C21151 | | | |
| PRO115 | BMS60 | C19363 | C19364 | C21031 | |
| | BM75 | C19360 | | C21032 | |
| PRO165 | BMS100 | C19363 | C19364 | C21031 | |

(1) These cables can be configured for length, backshell, and cable exit direction (45° or 90°, left or right).

Table 3-8: Motor Cables for Combination Stages

| Stage | Options | Typical | Configured ⁽¹⁾ | Hi-Flex |
|-------------|------------|---------|---------------------------|---------|
| LaserTurn 1 | Linear | C19363 | C19364 | C19851 |
| | Rotary | C19363 | C19364 | C19851 |
| LaserTurn 2 | Linear | C19363 | C19364 | C19851 |
| | Rotary | C19360 | | C19851 |
| LaserTurn 5 | ASR Linear | C19360 | | C19851 |
| | ASR Rotary | C19360 | | C19851 |
| | ACS Linear | C19363 | C19364 | C19851 |
| | ACS Rotary | C19363 | C19364 | C19851 |
| VascuLathe | ASR Linear | C19360 | | C19851 |
| | ASR Rotary | C19360 | | C19851 |
| | ACS Linear | C19360 | | C19851 |
| | ACS Rotary | C19363 | C19364 | C19851 |

(1) These cables can be configured for length, backshell, and cable exit direction (45° or 90°, left or right).

Table 3-9: Motor Cables for Rotary Stages

| Rotary Stage | Options | Standard | | Hi-Flex | |
|----------------|-------------------|----------|---------------------------|---------|--------------|
| | | Typical | Configured ⁽¹⁾ | Typical | Gore <107 dm |
| ABRS | -150 | C18982 | | C18983 | C18984 |
| | All others | C19363 | C19364 | C19851 | |
| ABRT | -150 | C18982 | | C18983 | C18984 |
| | All others | C19363 | C19364 | C19851 | |
| ACS and ACS-LP | | C19363 | C19364 | C19851 | |
| ADR | | C19363 | C19364 | C19851 | |
| ADRH | | | | | |
| ADRS | | C19363 | C19364 | C19851 | |
| ADRT | | C19363 | C19364 | C19851 | |
| ALA1000 | | C19363 | C19364 | C19851 | |
| ALAR | | C19363 | C19364 | C19851 | |
| AMG | -A | C19363 | C19364 | C19851 | |
| | -B | C19360 | | C19851 | |
| ANT20RA | | C18982 | | C18983 | C18984 |
| ANT-4V-20RA | | C18982 | | C18983 | C18984 |
| AOM130 | 50smb2 | C20251 | | | |
| | BMS60 w/o limits | C19363 | C19364 | C19851 | |
| | BMS60 with limits | C19363 | C19364 | C19851 | |
| AOM300 | 50smb2 | C20251 | | | |
| | DC | C13803 | | | |
| | BMS60 w/o limits | C19363 | C19364 | C19851 | |
| | BMS60 with limits | C19363 | C19364 | C19851 | |
| AOM360 | | | | | |
| ARA125 | | C19363 | C19364 | C19851 | |
| ARA1000 | | C19363 | C19364 | C19851 | |
| ARMS | | C19363 | C19364 | C19851 | |
| ART50 | Stepper | C20251 | | | |
| | Brushless | C18982 | | C18983 | C18984 |
| ART100 | Stepper | C20251 | | | |
| | Brushless | C18982 | | C18983 | C18984 |

| Rotary Stage | Options | Standard | | Hi-Flex | |
|--------------|----------|------------|---------------------------|---------|--------------|
| | | Typical | Configured ⁽¹⁾ | Typical | Gore <107 dm |
| ART310,15,20 | 50smb2 | C20251 | | | |
| | 1035msof | BADC-MSOHF | | | |
| | BMS60 | C19363 | C19364 | C19851 | |
| | BM | C15805 | | C21663 | |
| ART330 | BMS280 | C15805 | | C21663 | |
| | 310smb3 | | | | |
| | BM250 | C19360 | | C19851 | |
| ASR1000 | | C19360 | | C19851 | |
| ASR1100 | | C19360 | | C19851 | |
| ASR1200 | | C19360 | | C19851 | |
| ASR2000 | | C19363 | C19364 | C19851 | |
| AVL112 | | C19363 | C19364 | C19851 | |
| AVL125 | | C18982 | | C18983 | C18984 |
| AVL1000 | | C19363 | C19364 | C19851 | |
| AVS10x | 50smb2 | C20251 | | | |
| | BMS60 | C19363 | C19364 | C19851 | |
| AVSI100 | BMS60 | C19363 | C19364 | C19851 | |
| WaferMax T | | C19363 | C19364 | C19851 | |
| WaferMax Z | | C19363 | C19364 | C19851 | |

(1) These cables can be configured for length, backshell, and cable exit direction (45° or 90°, left or right).

Chapter 4: Maintenance

This section covers symptoms, probable causes and solutions related to BL amplifier operation. Table 4-1 lists the most common symptoms of irregular operation and the possible causes and solutions for these faults.



Always disconnect the Mains power connection before opening the BL chassis.



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 4-1: Troubleshooting

| Symptom | Possible Cause and Solution |
|--|--|
| ENABLE LED fails to energize when AC input power is applied. | <ol style="list-style-type: none"> 1. Insufficient input voltage. Use voltmeter to check voltages at “AC1” and “AC2” AC input terminals. 2. Shutdown, J101-10 is not at active state for running amplifier. |
| Brushless motor will not spin in open loop current mode. | Motor phases A, B, and C connected incorrectly relative to HA, HB, and HC Hall inputs. See Section 2.7. Motor and Feedback Phasing for motor phasing information. |
| Motor spins uncontrollably in velocity mode configuration. | Encoder (sine and cosine) signals or tach (\pm) signals are improperly connected. Swap connections to change polarity of feedback. |
| Motor runs erratic in velocity mode using encoder for velocity feedback. | <ol style="list-style-type: none"> 1. The phase of the sine and cosine signal of the encoder is not separated by 90°. The encoder must be adjusted on the motor. 2. Noise on the sine and cosine signals of the encoder. Use a shield or twisted pair (signal common wrapped around sine and cosine wires) cable between the motor and the BL amplifier. |
| Amplifier Faults (Enable LED de-energizes). | <ul style="list-style-type: none"> • RMS current exceeded: Turn off and then back on, run at lower current. • Over temperature condition: Turn off and let amplifier cool down. Provide better ventilation. • Defective on board power supply: Return for repair. • Over loaded logic power supply: Remove device(s) being powered from the BL 5 V supply. |

Table 4-2: LED Description

| LED | Description |
|------|--|
| ENB | Turns green to indicate that the axis is enabled. Turns red to indicate a fault condition. |
| PWR* | Turns green when power is applied. |

* 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.

4.1. Control Board Assembly

The BL Series amplifiers are jumper selectable providing the user with reconfiguration capability of operating modes. Table 4-3 lists the jumpers and the default configurations for the amplifiers. Figure 4-1 highlights where the jumpers are located on the board.

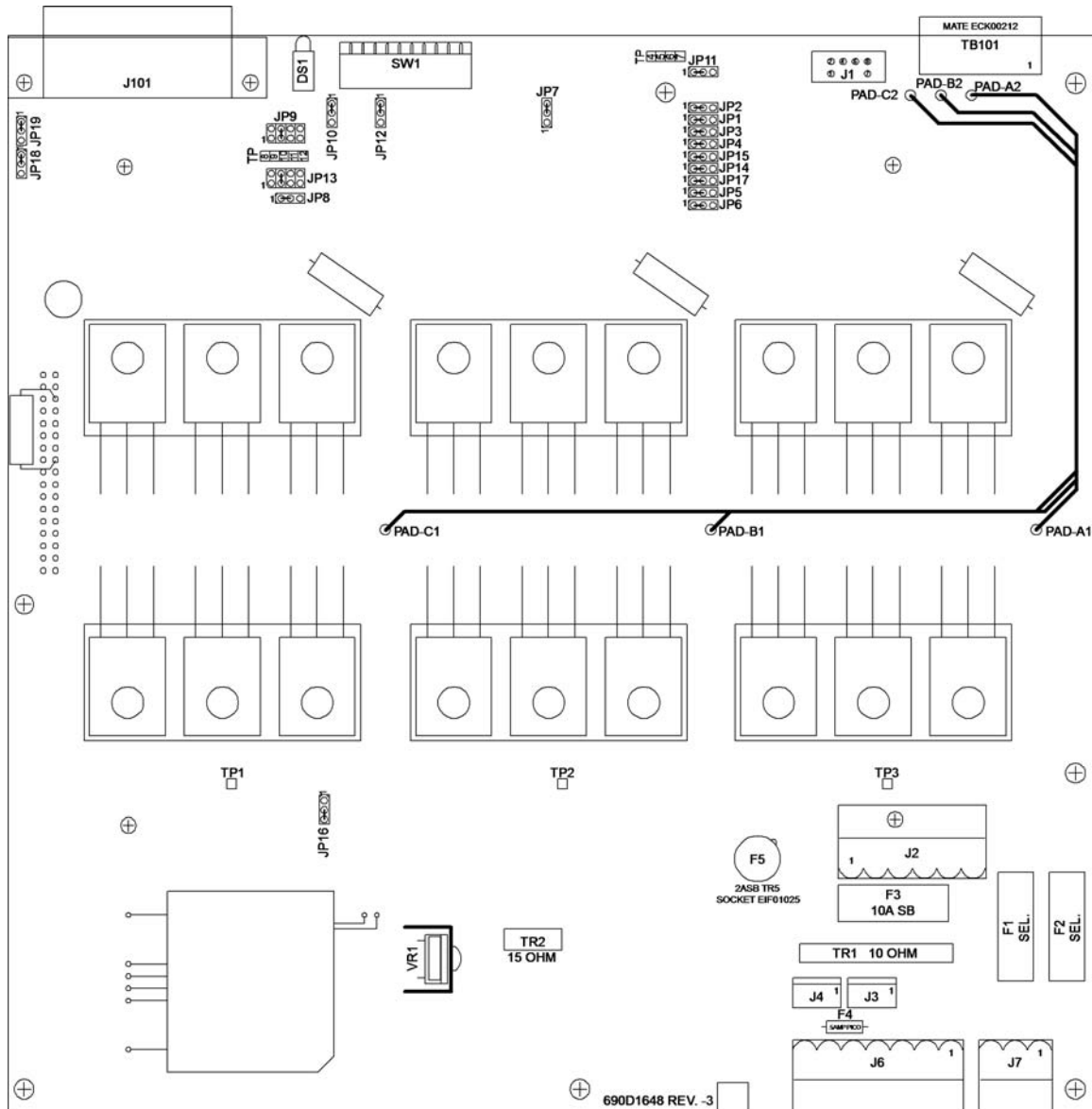


Figure 4-1: BL Control Board Assembly



Always disconnect the Mains power connection before opening the BL chassis.

Table 4-3: Control Board Jumper Selections

| Jumper | Selection | Description |
|------------------|---|---|
| JP1 | 1-2 IN, 2-3 OUT* | Active Low +ILMT |
| | 1-2 out, 2-3 in | Active High +ILMT |
| JP2 | 1-2 IN, 2-3 OUT* | Active Low -ILMT |
| | 1-2 out, 2-3 in | Active High -ILMT |
| JP3 | 1-2 IN, 2-3 OUT* | Brushless Mode |
| | 1-2 out, 2-3 in | Brush Mode |
| JP4 | 1-2 IN, 2-3 OUT* | 0° Commutation |
| | 1-2 out, 2-3 in | 30° Commutation |
| JP5 | 1-2 IN, 2-3 OUT* | Active High Fault Output |
| | 1-2 out, 2-3 in | Active Low Fault Output |
| JP6 | 1-2 IN, 2-3 OUT* | Active High Shutdown |
| | 1-2 out, 2-3 in | Active Low Shutdown |
| JP7 | 1-2 in, 2-3 out | Electronic Tachometer Feedback |
| | 1-2 OUT, 2-3 IN* | Analog Tachometer Feedback |
| JP8 | 1-2 IN, 2-3 OUT* | Standard Mode |
| | 1-2 out, 2-3 in | TP Mode |
| JP9 | A 1-2 in, 3-4 out, 5-6 out, 7-8 out | Six Step Mode |
| | B 1-2 OUT, 3-4 IN, 5-6 OUT, 7-8 OUT* | Dual Phase Mode |
| | C 1-2 out, 3-4 out, 5-6 in, 7-8 out | Analog Hall Mode |
| | D 1-2 out, 3-4 out, 5-6 out, 7-8 in | Differential Dual Phase Mode |
| JP10 | 1-2 in, 2-3 out | Full Step AC Commutation |
| | 1-2 OUT, 2-3 IN* | Half Step AC Commutation |
| JP11 | 1-2 IN, 2-3 OUT* | External Commutation |
| | 1-2 out, 2-3 in | Amplifier Commutation |
| JP12 | 1-2 in, 2-3 out | Full Step AC Commutation |
| | 1-2 OUT, 2-3 IN* | Half Step AC Commutation |
| JP13 | A 1-2 in, 3-4 out, 5-6 out, 7-8 out | Six Step Mode |
| | B 1-2 OUT, 3-4 IN, 5-6 OUT, 7-8 OUT* | Dual Phase Mode |
| | C 1-2 out, 3-4 out, 5-6 in, 7-8 out | Analog Hall Mode |
| | D 1-2 out, 3-4 out, 5-6 out, 7-8 in | Differential Dual Phase Mode |
| JP14 | 1-2 IN, 2-3 OUT* | Current Command Mode |
| | 1-2 out, 2-3 in | Voltage Command Mode |
| JP15 | 1-2 IN, 2-3 OUT* | Current Command Mode |
| | 1-2 out, 2-3 in | Voltage Command Mode |
| JP16 | 1-2 in, 2-3 out | TP Mode |
| | 1-2 OUT, 2-3 IN* | Standard Mode |
| JP17 | 1-2 IN, 2-3 OUT* | Current Command Mode |
| | 1-2 out, 2-3 in | Voltage Command Mode |
| JP18 | 1-2 IN, 2-3 OUT* | Square Wave Logic Hall-Effect Inputs (Hall A) |
| | 1-2 out, 2-3 in | Analog Hall-Effect Inputs (Hall A) |
| JP19 | 1-2 IN, 2-3 OUT* | Square Wave Logic Hall-Effect Inputs (Hall B) |
| | 1-2 out, 2-3 in | Analog Hall-Effect Inputs (Hall B) |
| * Default | | |

Table 4-4: Control Board Test Points

| Test Point | Description |
|------------|-------------------|
| TP1 | - |
| TP2 | - |
| TP3 | - |
| TP4 | Common |
| TP5 | +12V |
| TP6 | -12V |
| TP7 | +5V |
| TP8 | Analog Hall A |
| TP9 | Analog Hall B |
| TP10 | Current Command B |
| TP11 | Current Command A |
| TP12 | Current Command C |

4.1.1. Fuse Replacement

Table 4-5 lists the manufacturer and Aerotech's part number for typical replacement fuses. Additional fuse information can be found on the system drawing supplied with the unit.



Always disconnect the Mains power connection before opening the BL chassis.

Table 4-5: BL Fuse Replacement Part Numbers

| Fuse | Drive | Size | Aerotech P/N | Manufacturer's P/N |
|------|-----------------------------------|----------|----------------------|---------------------|
| F1, | 10-40 | 5A S.B. | EIF01023 | Littelfuse 215005.P |
| F2 | 20-40 | 10A S.B. | EIF01020 | Littelfuse 215010.P |
| | 10-80 | 5A S.B. | EIF01023 | Littelfuse 215005.P |
| F3 | Line voltage dependent, see 4.1.1 | | EIF01023 (5 A Fuse) | Littelfuse 215005.P |
| | | | EIF01020 (10 A Fuse) | Littelfuse 215010.P |


Table 4-6: Line Voltage Fuse Information

| Line Voltage | Fuse F3 Value |
|--------------|---------------|
| 100V (C) | 10A SB |
| 115V (A) | 10A SB |
| 200V (D) | 5A SB |
| 230V (B) | 5A SB |

4.2. Preventative Maintenance

The BL and external wiring should be inspected monthly. Inspections may be required at more frequent intervals, depending on the environment and use of the system. The table below lists the recommended checks that should be made during these inspections.

Table 4-7: 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 BL.  WARNING: Disconnect power to avoid shock hazard. |
| Visually inspect all cables and connections. | Tighten or re-secure any loose connections. Replace worn or frayed cables. Replace broken connectors. |

Cleaning

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

Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from 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, where 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 or 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.

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures. Laser Products

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. 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. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. 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 (30) days after the issuance of a return authorization number will be subject to review. Return Procedure

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 airfreight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period. Returned Product Warranty Determination

After Aerotech's examination, 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 (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment. Returned Product Non-warranty Determination

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. Rush Service

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 service 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.

Company Address

Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA
15238-2897

Phone: (412)963-7470

Fax: (412) 963-7459

Appendix B: Current Changes

Table B-1: Revision 2.02.00 Manual Changes

| Section | Description |
|-----------|---|
| Chapter 2 | Added supported wire gauges for quick connect terminal blocks |

Table B-2: Recent Manual Changes

| Revision # | Description | Section |
|------------|--|---|
| 2.01.00 | Section 1.1. Electrical Specifications | Updated Output Voltages |
| | Table 4-5 | Updated fuse replacement part table (removed 10-60 drive) |
| | Section 2.2.1. Control Supply Connections | The Aux Supply has been renamed Control Supply (and AL1 and AL2 have been renamed AC1 and AC2). |
| | Figure 2-8 | Figure updated. |
| 2.00.00 | All | Full Revision |
| | Section 4.1. Control Board Assembly | Power board removed/Control board revised |
| 1.08.00 | Load table removed. | Related to Table 2-6 |
| | Dip switch equation example added. | Section 2.4. DIP Switch |
| 1.07.00 | Differential Dual Phase Mode: <ul style="list-style-type: none"> • ICMDA pin numbers corrected • Jumper settings corrected | Section 3.5. Differential Dual-Phase Command Configuration |

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