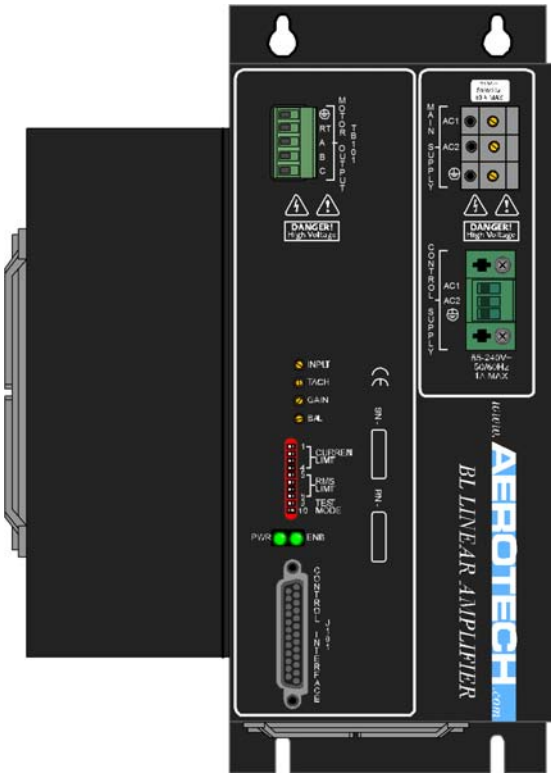
BL
Hardware Manual
(Revision 2.02.00)



Dedicated to the Science of Motion

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This product is intended for light industrial manufacturing or laboratory use.
Product names mentioned herein are used for identification purposes only and may be trademarks of their respective companies.

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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
2011/65/EU	RoHS 2 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.

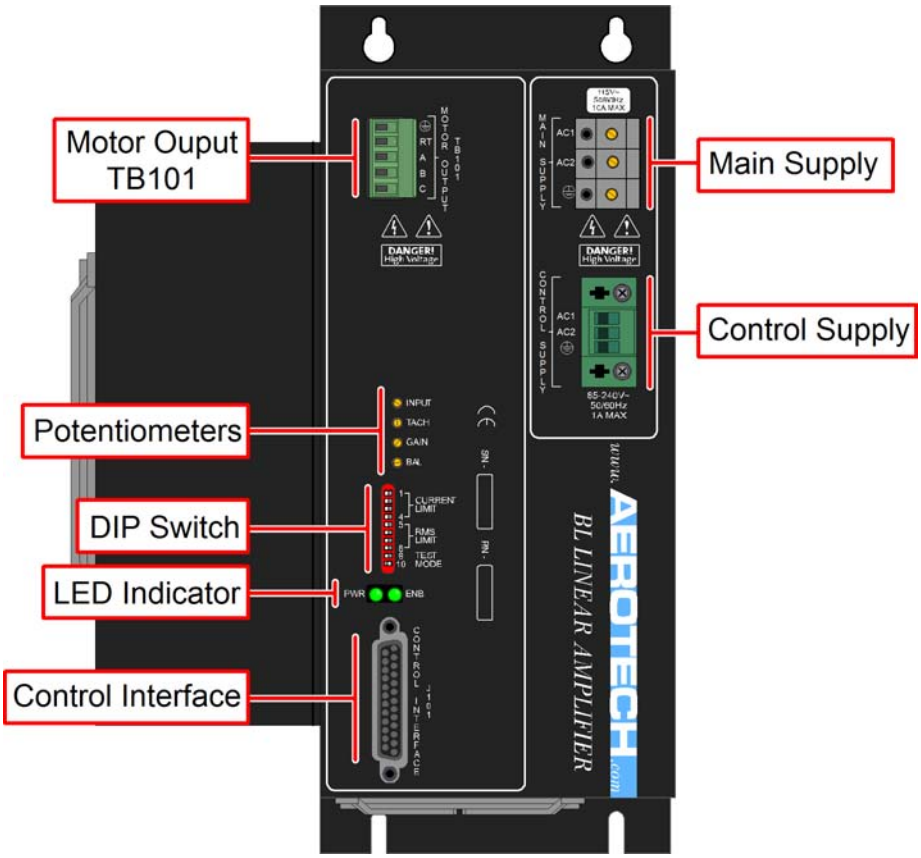


Figure 1-1: BL Linear Amplifier Connection Overview

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)

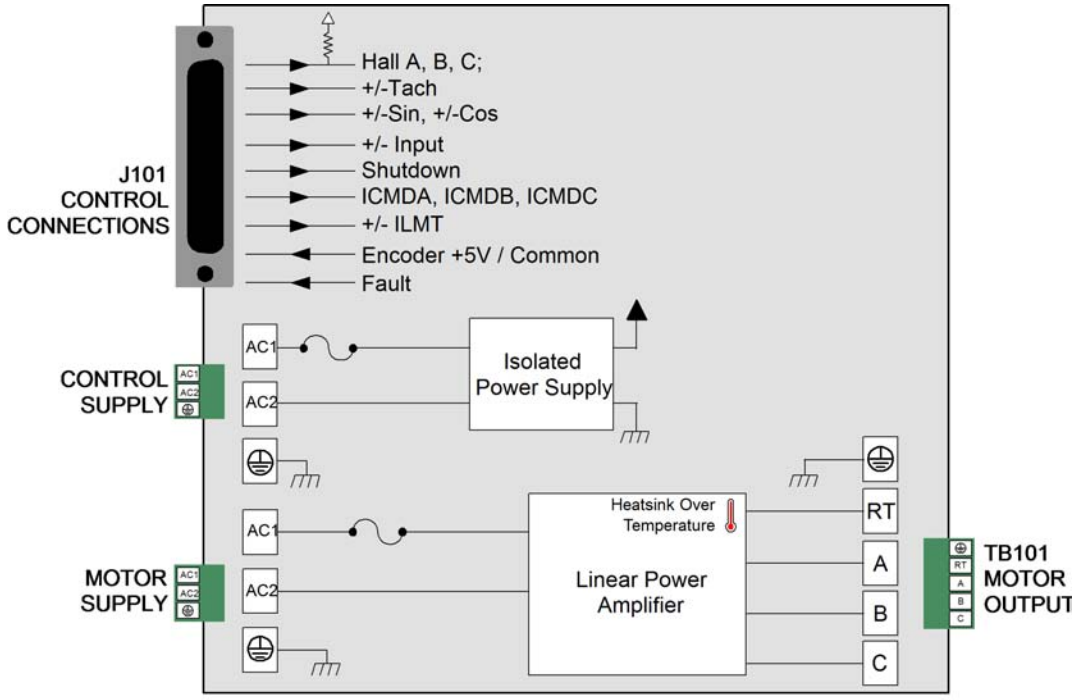


Figure 1-2: Functional Diagram

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				

1.2. Mechanical Design

Each unit should be separated from other drives and surrounded by 50 mm (2") of free air space. A space of 100 mm (4") should be allowed along the front of the unit for cable connections.

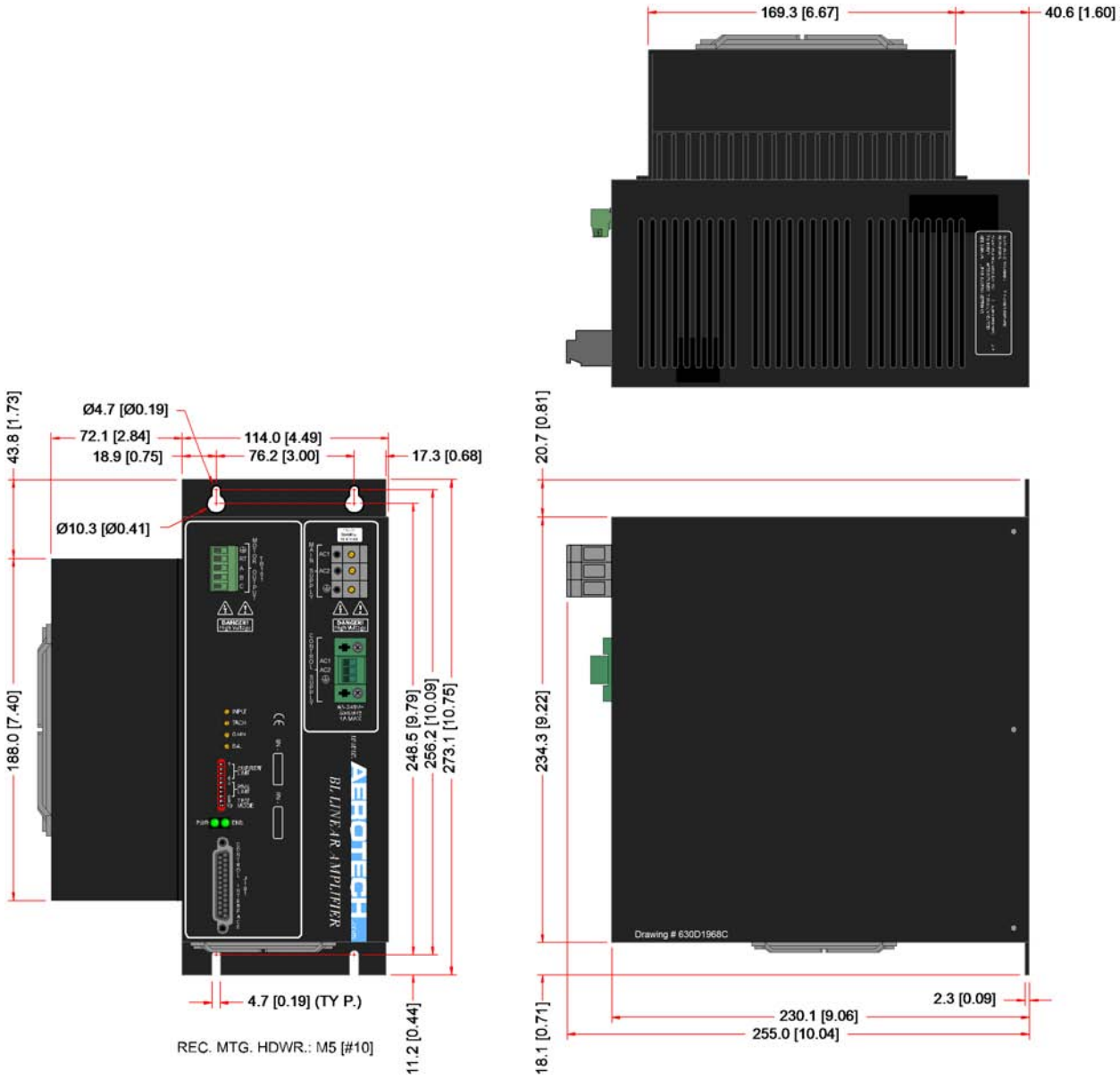


Figure 1-3: Dimensions

Table 1-3: Physical Specifications

Model	Weight
BL	8.5 kg [18.8 lb]

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.

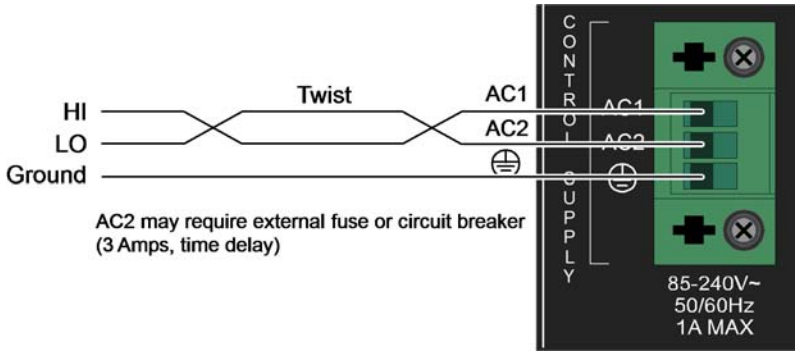


Figure 2-1: Control Supply Connections

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.

WARNING

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.

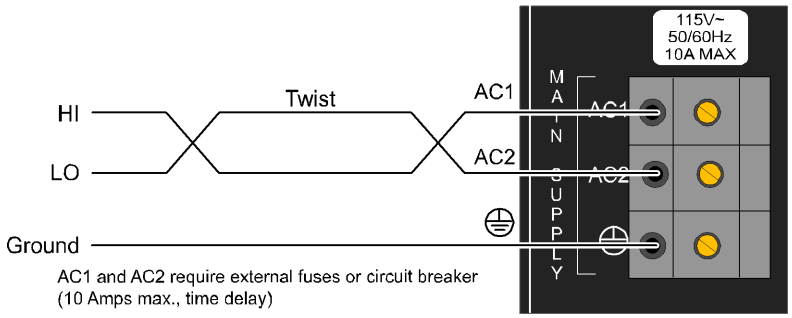


Figure 2-2: Motor Bus Input Connections

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)

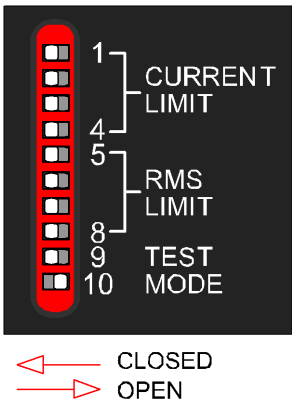
Table 2-5: Control Supply Terminal Block Mating Connector

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 Ipeak	
	2	Closed	Peak is 13% of Ipeak	
	3	Closed	Peak is 27% of Ipeak	
	4	Closed	Peak is 54% of Ipeak	
	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	Icont is 3% of Ipeak	
	6	Closed	Icont is 7% of Ipeak	
	7	Closed	Icont is 14% of Ipeak	
	8	Closed	Icont is 27% of Ipeak	
	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

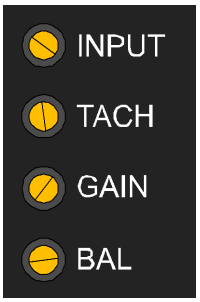
(7.8A continuous peak/20A max peak) x 100 = 39%.

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.	

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

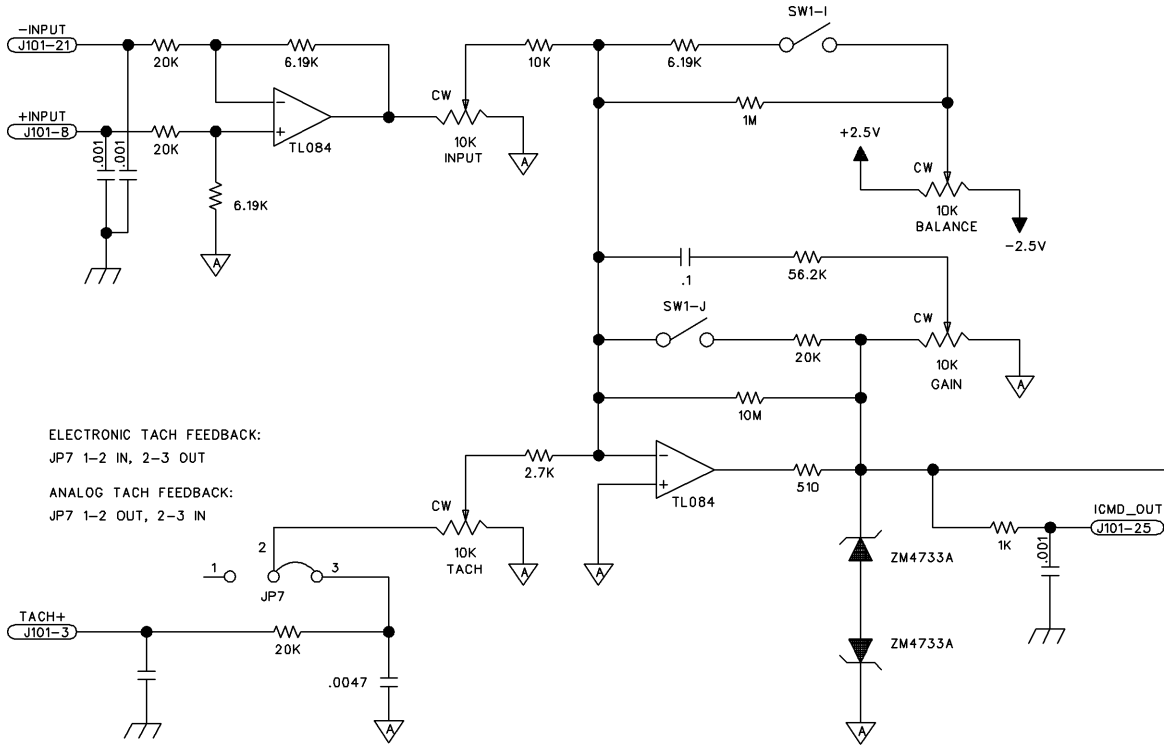
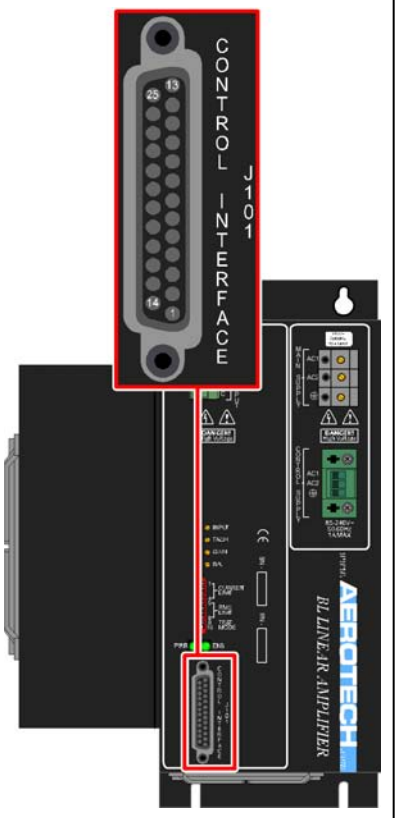


Figure 2-3: Command Signal Adjustment of the Pre-Amplifier Circuit

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

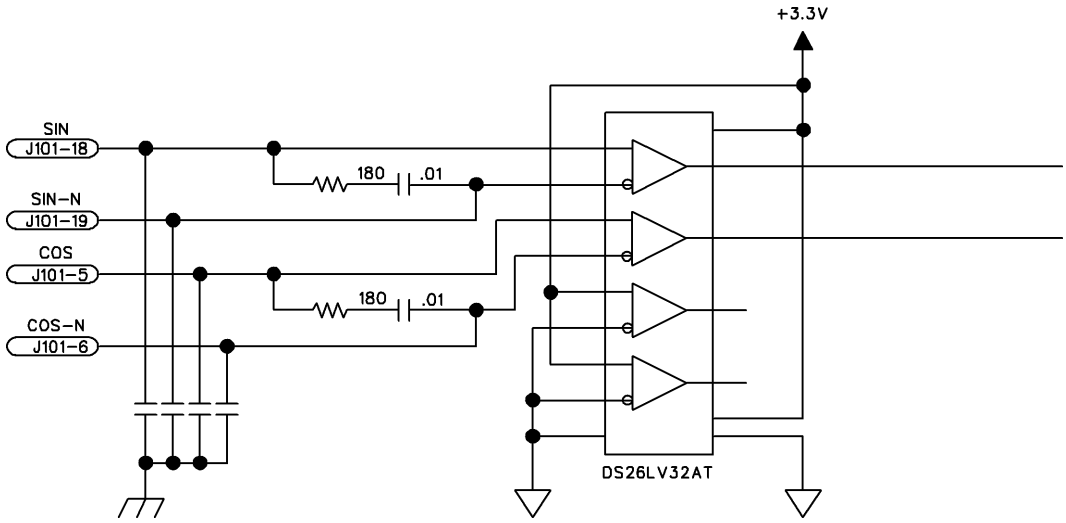


Figure 2-4: Encoder Inputs

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.

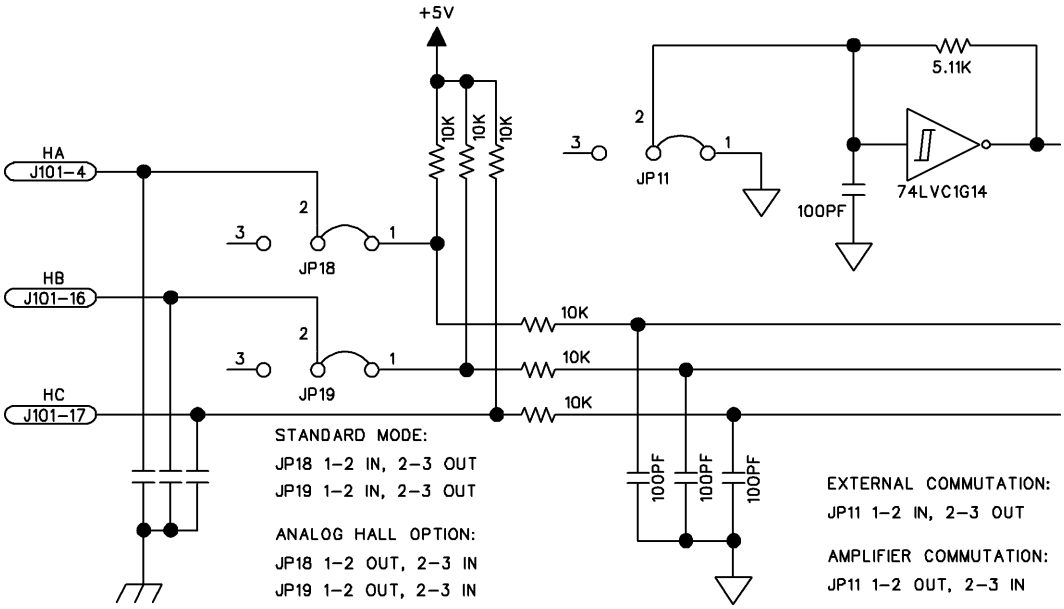


Figure 2-5: Hall-Effect Inputs

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.

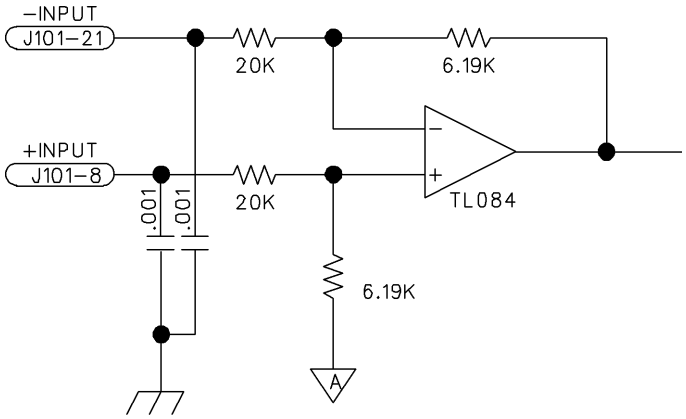


Figure 2-6: ±Input

2.6.4. Limit Inputs (J101)

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

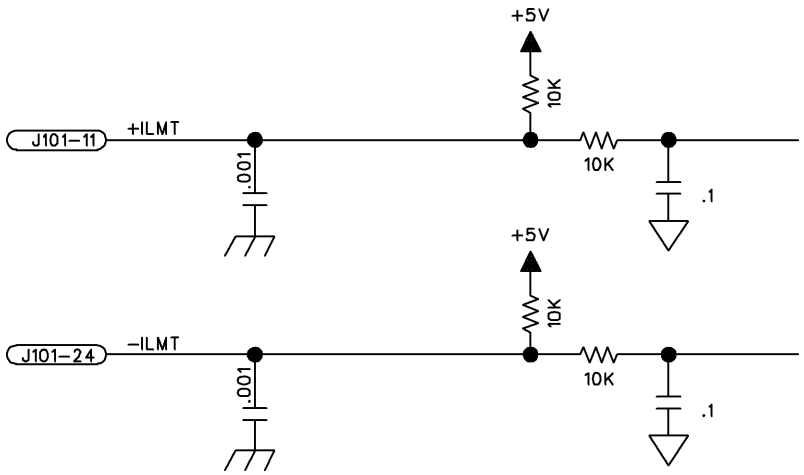


Figure 2-7: Limit Inputs

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.

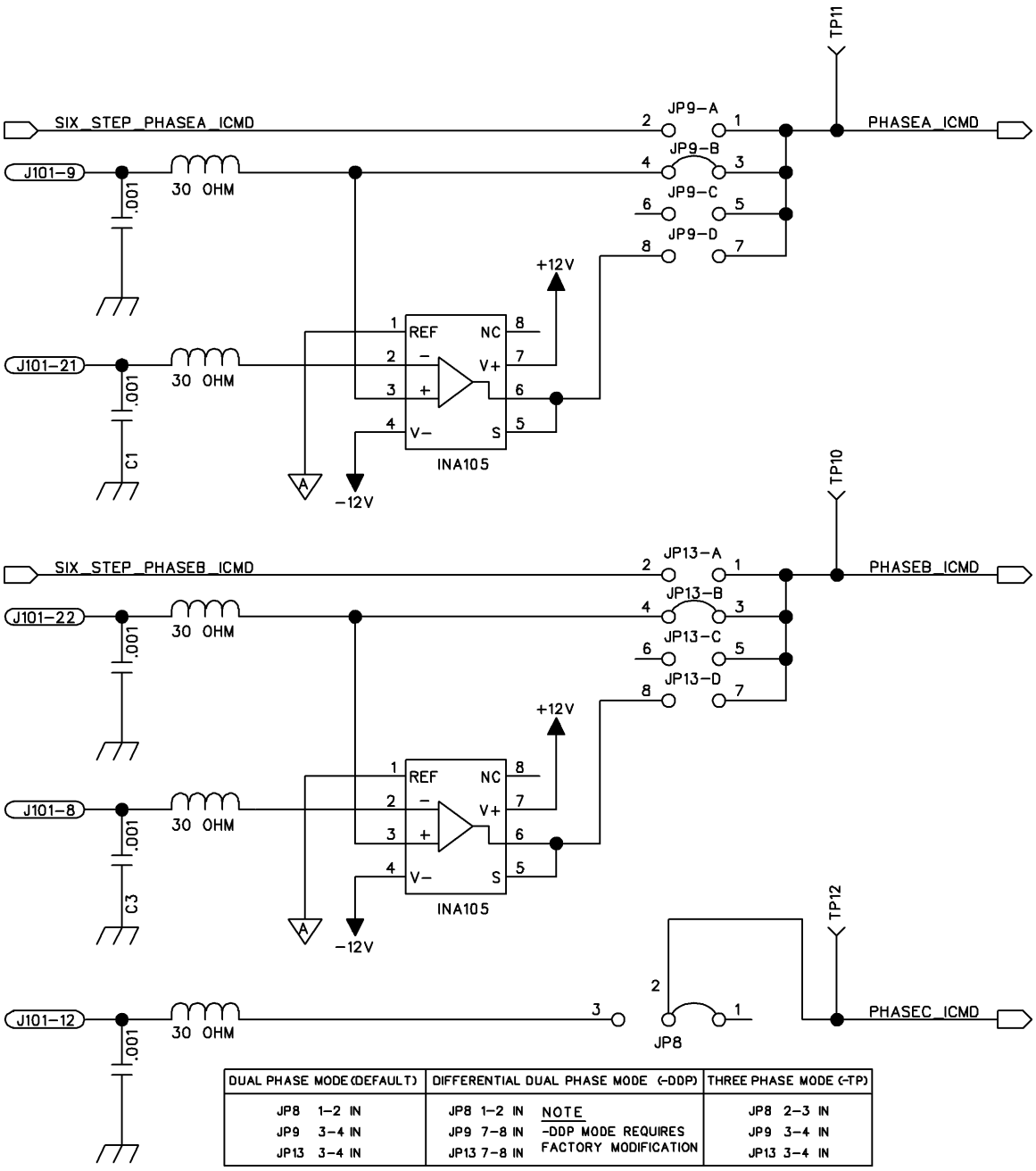


Figure 2-8: Current Command Inputs

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).

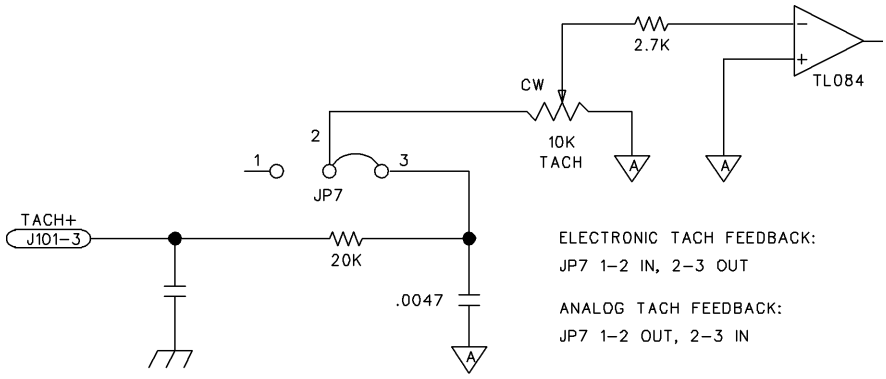


Figure 2-9: Tach Input

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.

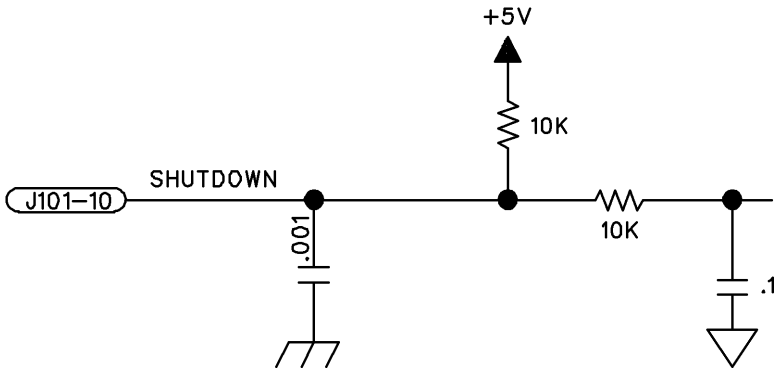


Figure 2-10: Shutdown Input

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.

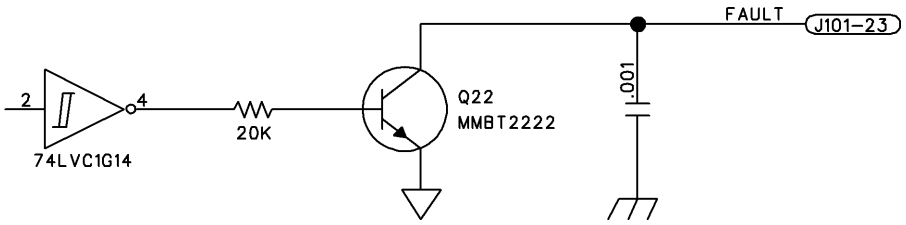


Figure 2-11: Fault Output

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.

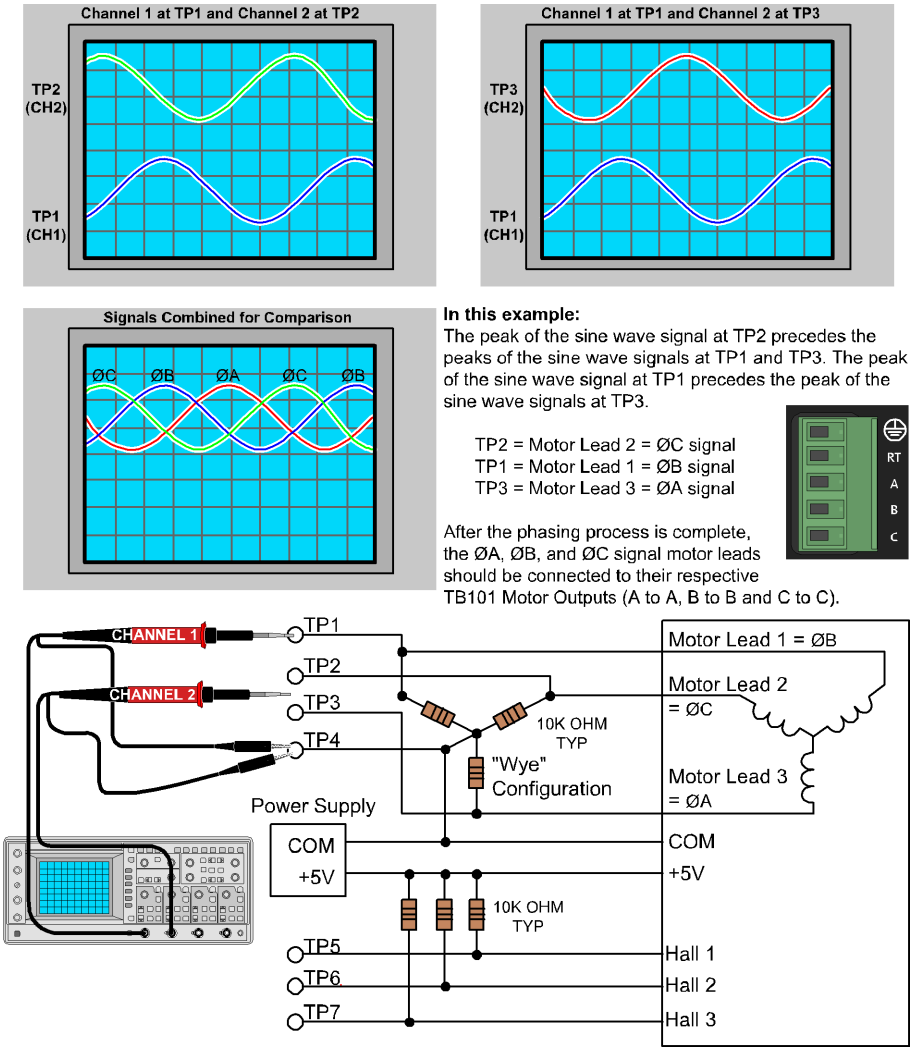


Figure 2-12: Motor Phasing Oscilloscope Example

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.

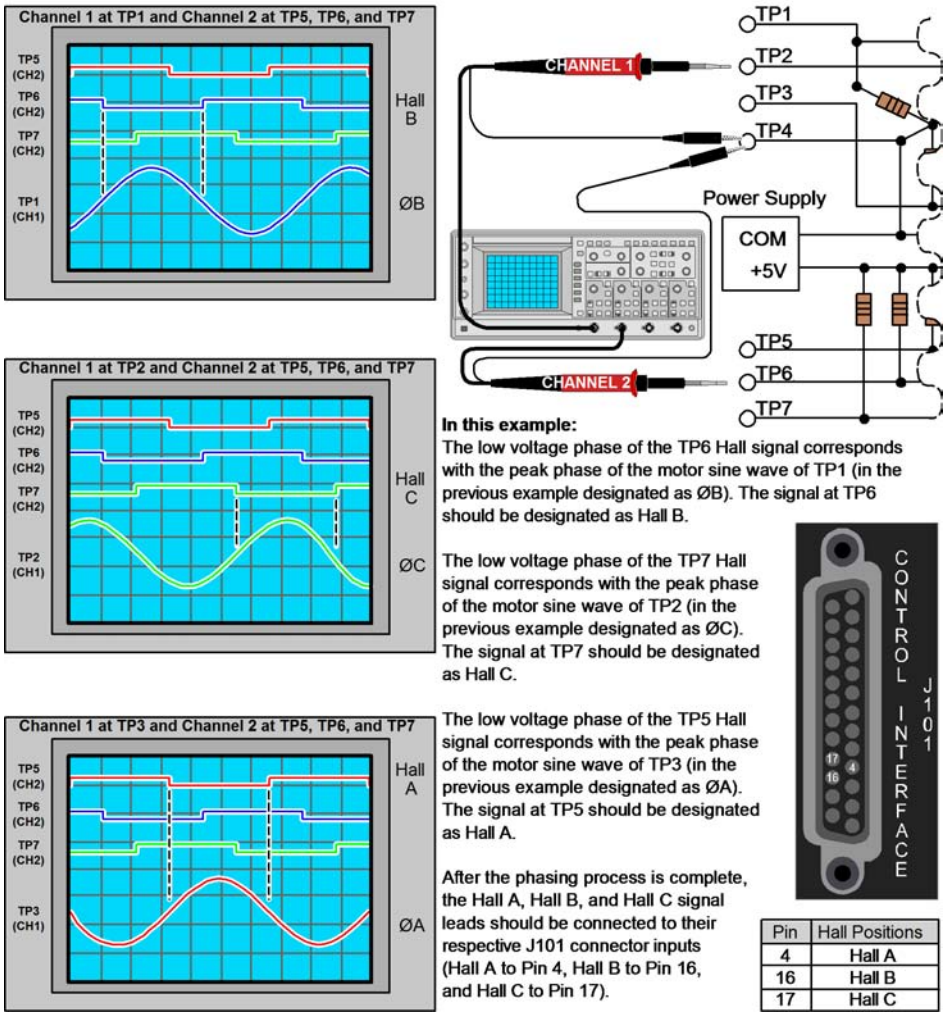
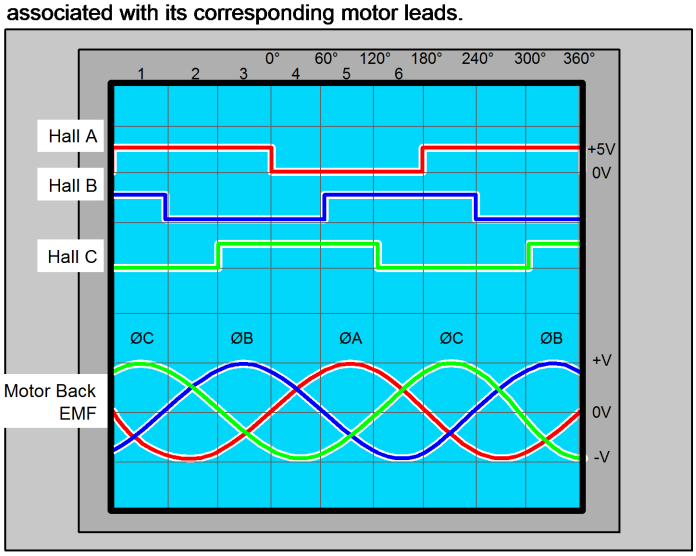


Figure 2-13: Hall Phasing with Oscilloscope

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 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 anglesThe Hall signal leads must be associated with its corresponding motor leads.



Motor Feedback Connector	Hall Positions	Corresponding Motor Lead	Motor Output Connector
Pin 4	Hall A	→	ØA
Pin 16	Hall B	→	ØB
Pin 17	Hall C	→	ØC

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.

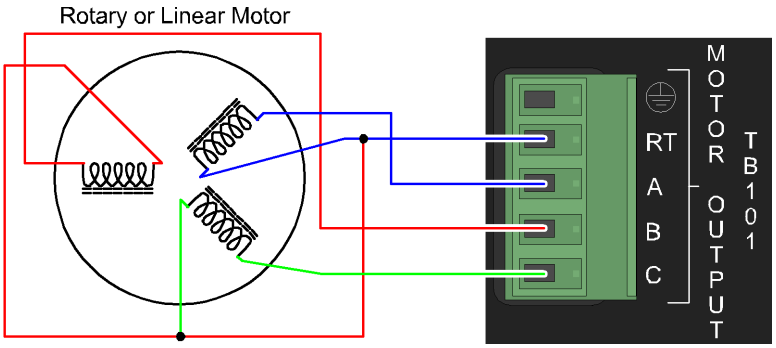


Figure 3-1: Connection of Six Wire Motors to BL Series Amplifiers

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.

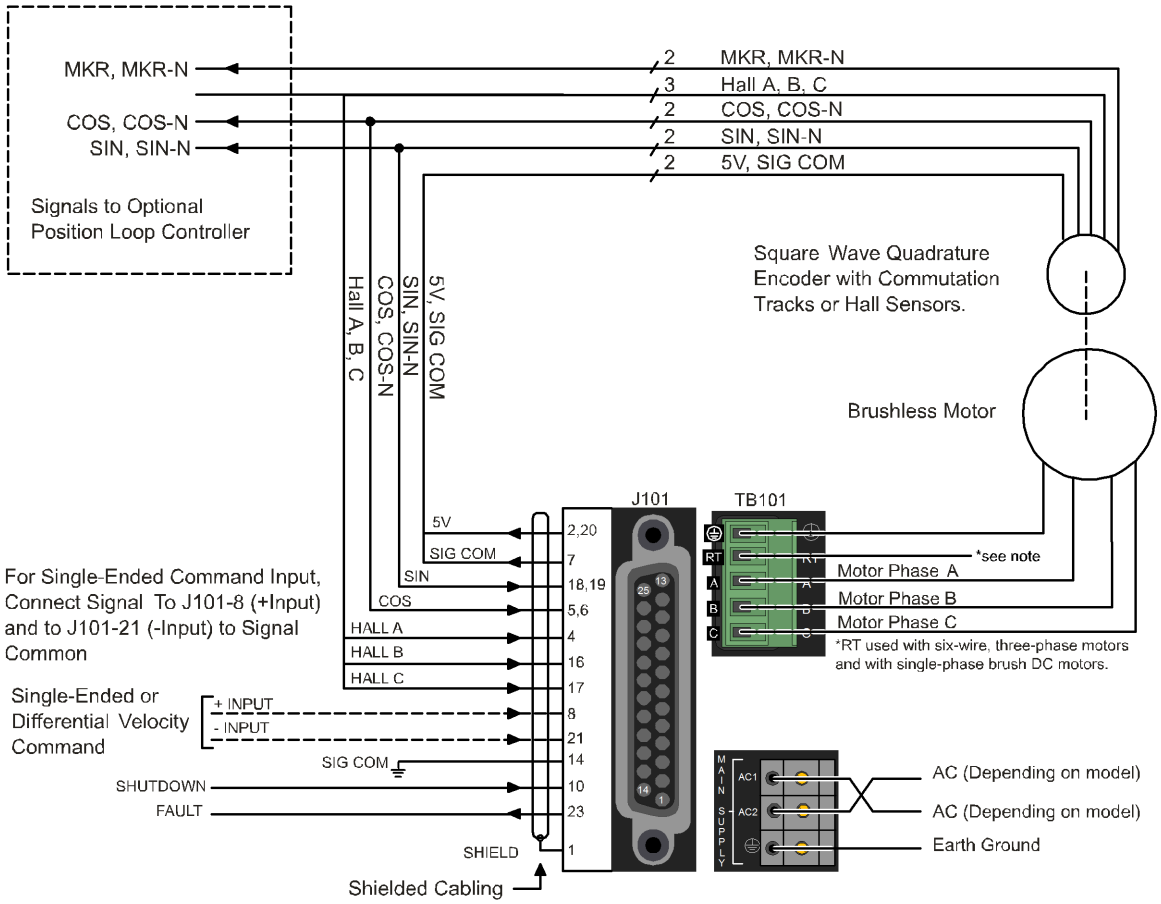


Figure 3-2: Velocity Command Configuration

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 IN[5]**	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 OUT[5]**	Brushless mode
	1-2 out, 2-3 in	Brush mode
JP4, JP10, JP12	**JP4: 1-2 IN, 2-3 OUT[5]**	0° Commutation
	JP10: 1-2 OUT, 2-3 IN [5]	Half Step AC Commutation
	JP12: 1-2 OUT, 2-3 IN [5]	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 OUT[5]**	Standard Mode

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.
2. For more information about the DIP Switch, refer to Section 2.4. DIP Switch.
3. For more information about the Potentiometer, refer to Section 2.5. Potentiometers (POTs).
4. Refer to Section 4.1. Control Board Assembly for jumper locations.
5. Default

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.

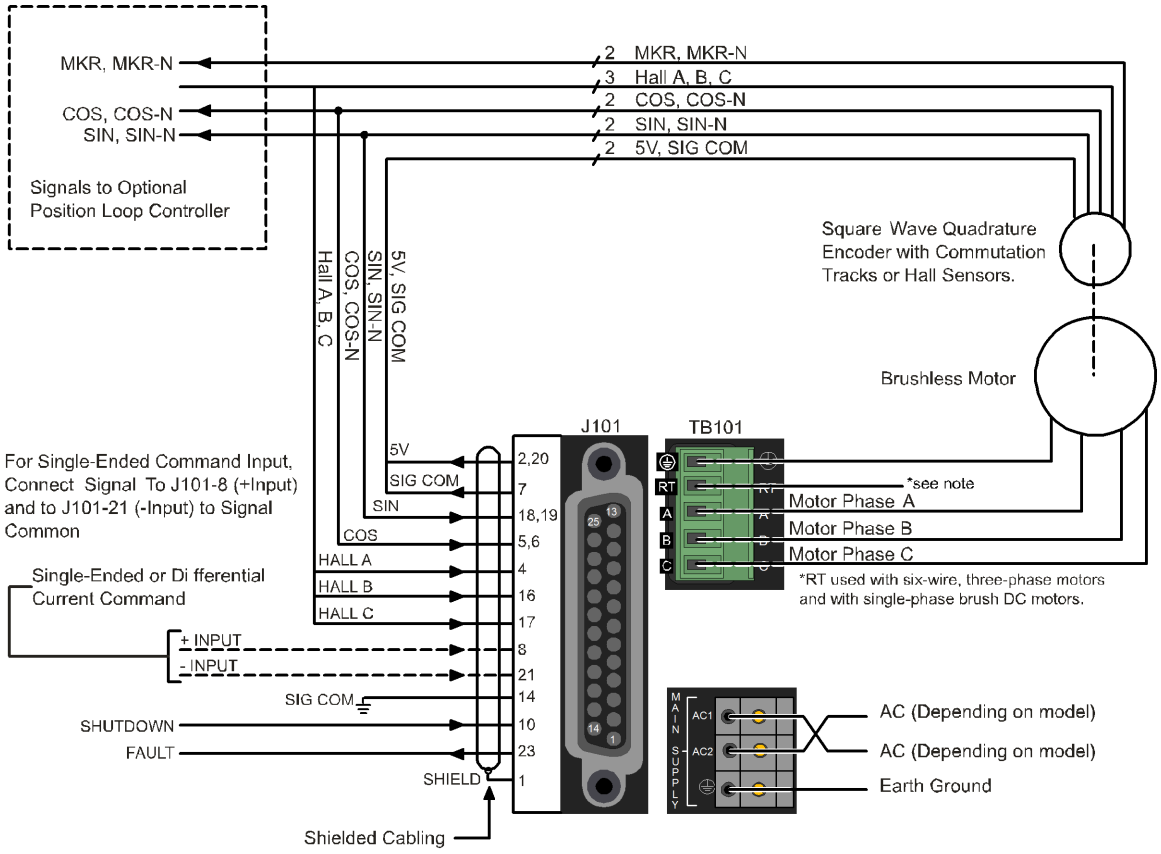


Figure 3-3: Torque (Current) Command Configuration

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

1. This setting provides a transconductance gain of ±10 volts for full current output
2. For Multiple Brush Motor Mode jumper settings, refer to Section 3.7. Multiple Brush Motor (requires -TP Option) .
3. For more information about the DIP Switch, refer to Section 2.4. DIP Switch.
4. For more information about the Potentiometer, refer to Section 2.5. Potentiometers (POTs).
5. Refer to Section 4.1. Control Board Assembly for jumper locations
6. Default

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.

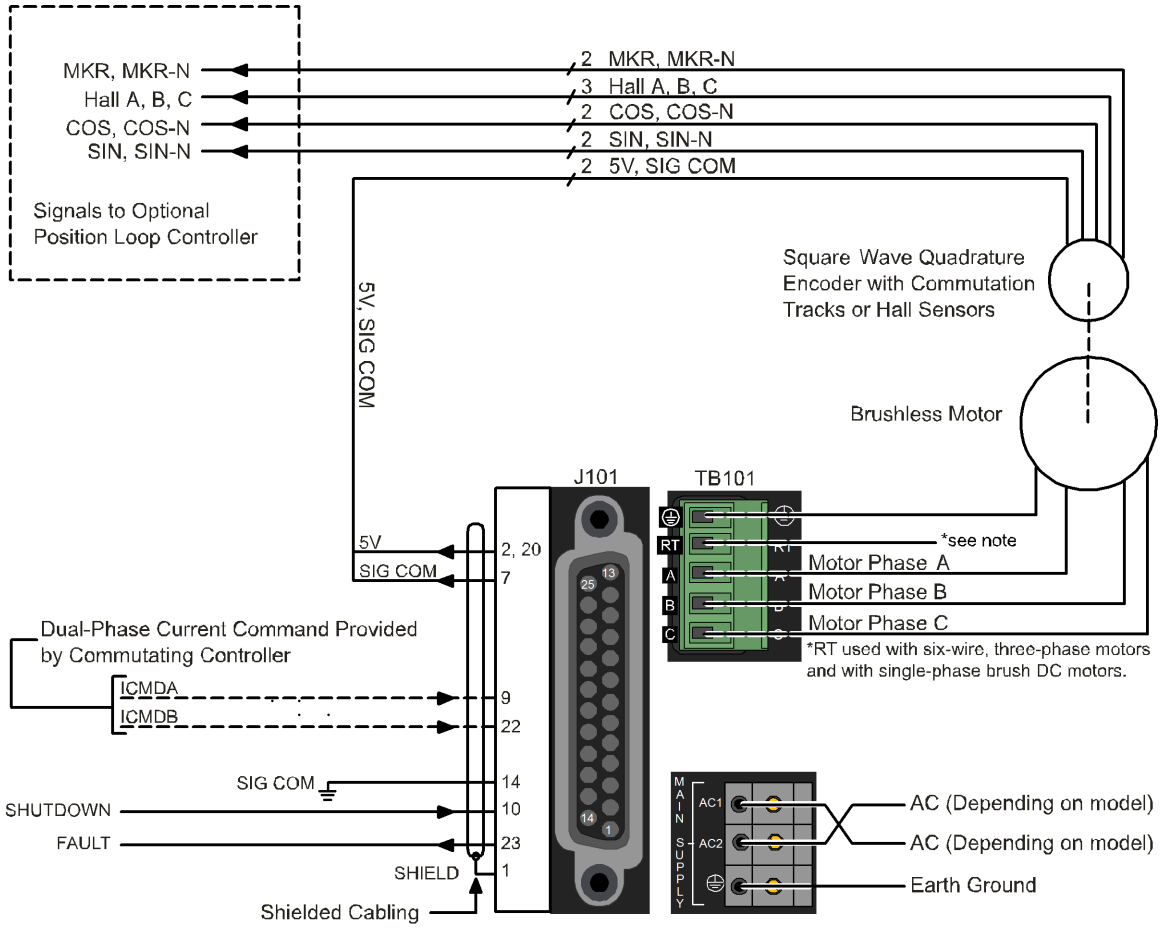


Figure 3-4: Dual-Phase Command Configuration

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.

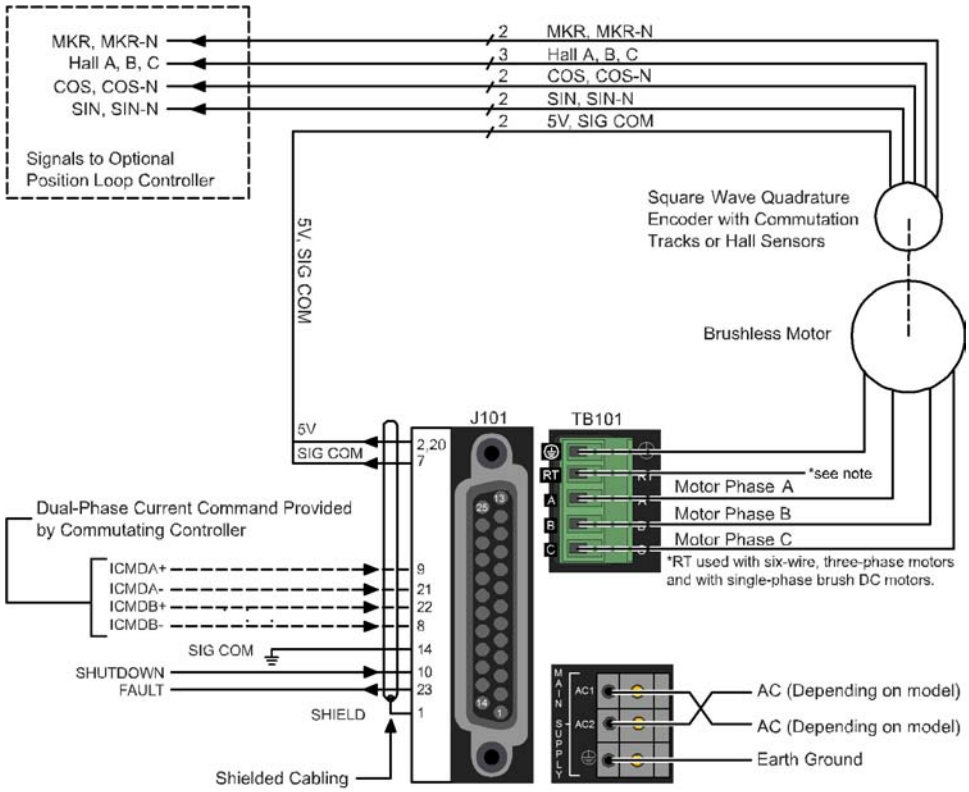


Figure 3-5: Differential Dual-Phase Command Configuration

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).

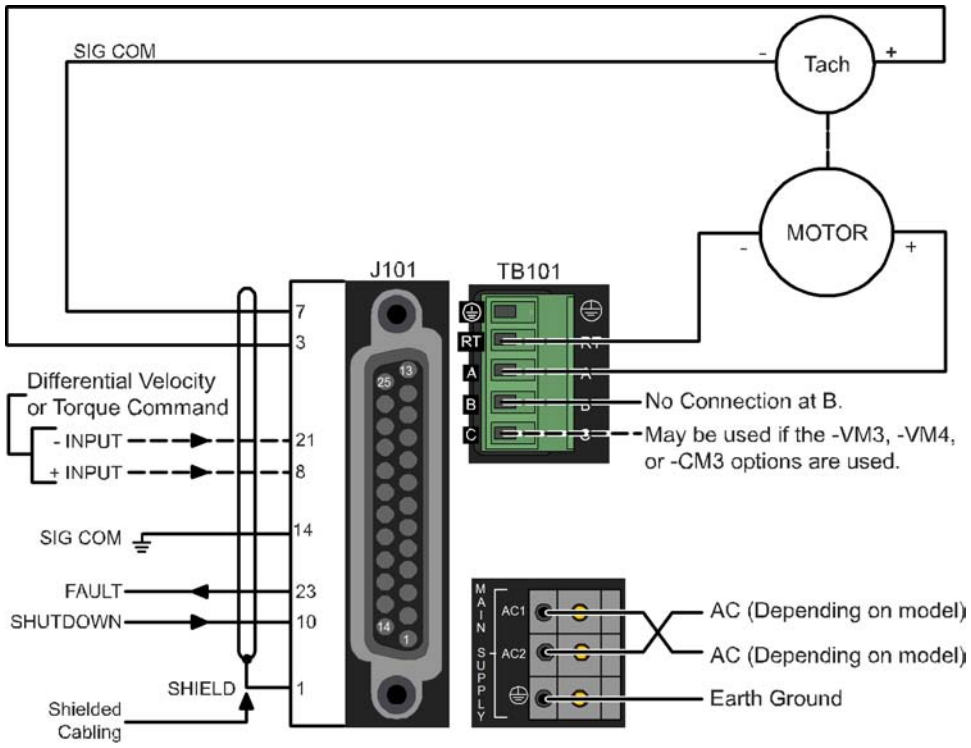


Figure 3-6: Single Brush Motor Configuration with Tachometer

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.

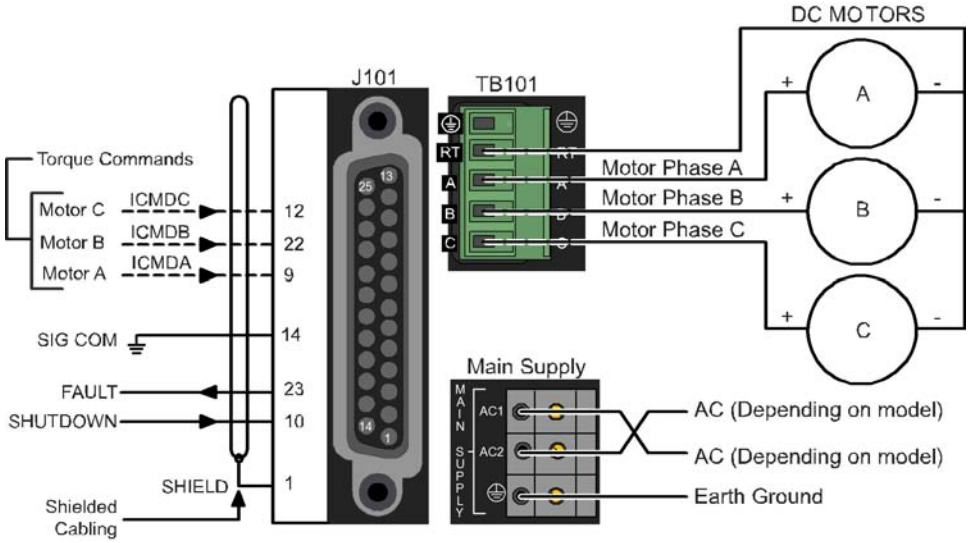


Figure 3-7: Multiple Brush Motor Configuration

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

		Standard		Hi-Flex	
Linear Stage	Options	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
ANTlx		C18982		C18983	C18984
ATS50	Stepper	C20251			
	Brushless	C18982		C18983	C18984
ATS100	50smb2	C20251			
	1035msof	BADC-MSOHF			
	BMS60	C19363	C19364	C21031	

		Standard		Hi-Flex	
Linear Stage	**Options**	**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

		Standard		Hi-Flex	
Rotary Stage	Options	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

		Standard		Hi-Flex	
Rotary Stage	Options	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.	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 (±) signals are improperly connected. Swap connections to change polarity of feedback.
Motor runs erratic in velocity mode using encoder for velocity feedback.	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).	• 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.

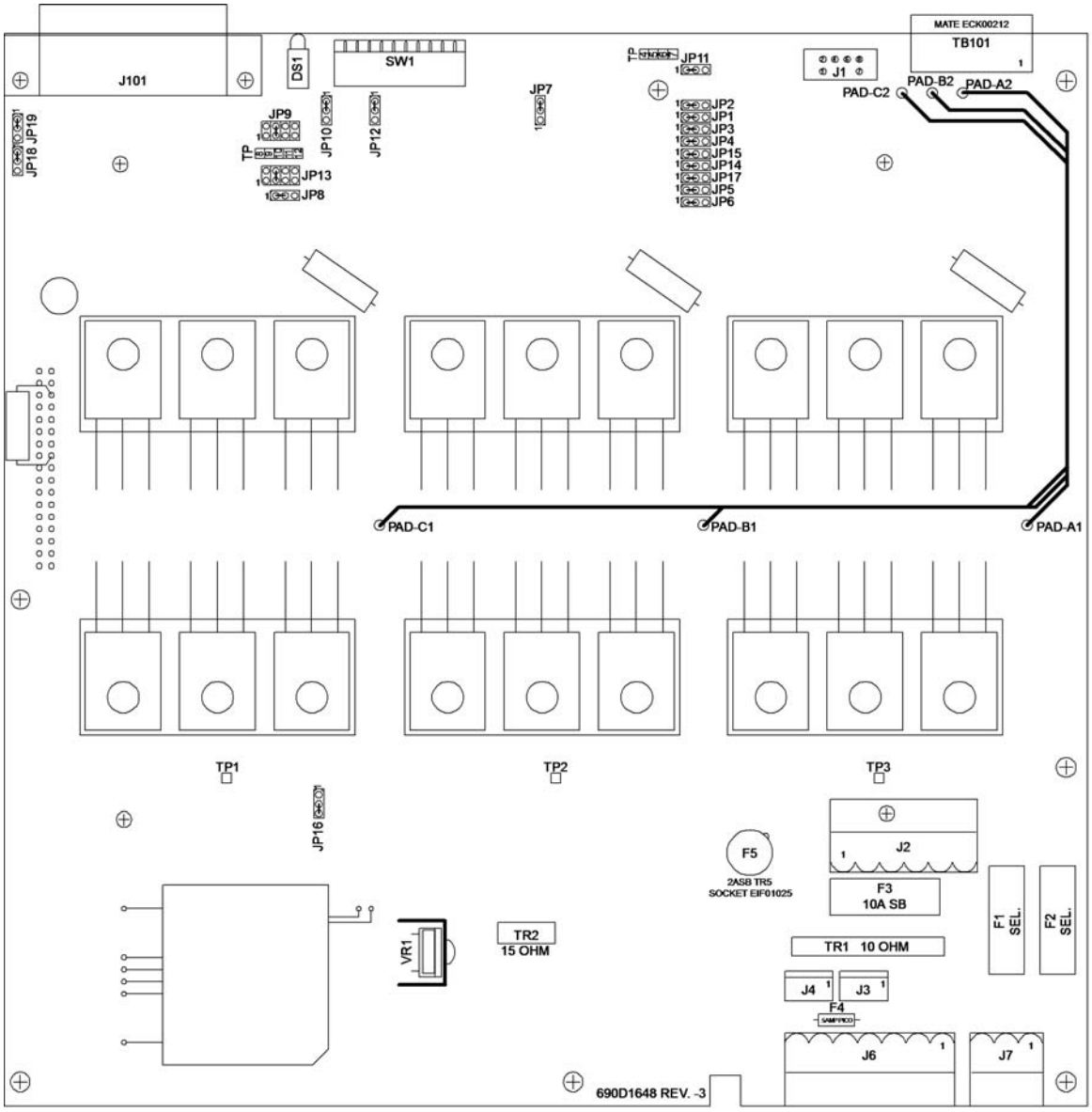


Figure 4-1: BL Control Board Assembly

DANGER

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, F2	10-40	5A S.B.	EIF01023	LittelFuse 215005.P
	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.  DANGER **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.

Laser Products

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.

Return Procedure

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.

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

Returned Product Non-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.

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 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: • ICMDA pin numbers corrected • Jumper settings corrected	Section 3.5. Differential Dual-Phase Command Configuration

Index

Reader's Comments

BL Hardware Manual
P/N: EDA144, 11/11/10
Revision: 2.02.00

Please answer the questions below and add any suggestions for improving this document.

Is this manual

	YES	NO
Adequate to the subject		
Well organized		
Clearly presented		
Well illustrated		

How do you use this document in your job? Does it meet your needs? What improvements, if any, would you like to see? Please be specific or cite examples.

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