Lightning™ Digital Servo Driver User's Manual

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Revision b

www.gsig.com/scanners

Contact Information

Americas

39 Manning Road
Billerica, MA 01821
U.S.A.
TEL: +1 (978) 439-5511
FAX: +1 (978) 663-0131
E-mail:
ScannerSales-Americas@gsig.com
Toll Free: +1 (800) 342-3757

Europe

Einsteinstrasse 2
D-85716 Unterschleissheim
Germany
TEL: +49 (89) 31707-0
FAX: +49 (89) 31707-250
E-mail:
ScannerSales-Europe@gsig.com

Asia

Technoport Kamata, 16-1
Minami-Kamata 2-Chome,
Ohta-Ku Tokyo 144-0035, Japan
TEL: +81 (3) 5425-7733 [Sales]
+81 (3) 5714-0557 [Service]
FAX: +81 (3) 5425-7738 [Sales]
+81 (3) 5714-0566 [Service]
E-mail:
ScannerSales-Asia@gsig.com

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1 IMPORTANT INFORMATION

1.1 ESD WARNING

The OEM electronics that *General Scanning* manufactures - including scanner motors and servo drivers - are electrostatic discharge (ESD) sensitive. Improper handling could therefore damage these electronics. *General Scanning* has implemented procedures and precautions for handling these devices and we encourage our customers to do the same. Upon receiving your components, you should note that it is packaged in an ESD-protected container with the appropriate ESD warning labels. The equipment should remain sealed until the user is located at a proper static control station*.

Note: Any equipment returned to the factory must be shipped in anti-static packaging.

(*) A proper static control station **should** include:

1. A soft grounded conductive tabletop or grounded conductive mat on the tabletop.
2. A grounded wrist strap with the appropriate (1 Meg) series resistor connected to the tabletop mat and ground.
3. An adequate earth ground connection such as a water pipe or AC ground.
4. Conductive bags, trays, totes, racks or other containers used for storage.
5. Properly grounded power tools.
6. Personnel handling ESD items should wear ESD protective garments and ground straps.

1.2 Warranty Information

The Customer shall examine each shipment within 10 days of receipt and inform General Scanning of any shortage or damage. If no discrepancies are reported, General Scanning shall assume the shipment was delivered complete and defect free. General Scanning warrantees products against defects up to 1 year from manufacture date, barring unauthorized modifications or misuse. Repaired product is warranted 90 days after the repair is made, or one year after manufacture date - whichever is longer.

Contact Customer Service to obtain a Return Materials Authorization number *before returning any product for repair*.

All orders are subject to the General Scanning Terms and Conditions and Limited Warranty. Visit our website for the latest version of these documents and other useful information.

IMPORTANT: Optical Scanners are normally tuned, serialized and warranted as a matched set for optimized performance. Mismatched components negatively affect performance and void the warranty. A matched set typically consists of galvanometer motor, mirror load, electronic driver board and interface cable.

1.3 Customer Support

General Scanning has support services to address your questions or concerns with either the product or manual you are using. Before calling for assistance, be sure to refer to any appropriate sections in the manual that may answer your questions. Call General Scanning's Customer Service Department Monday through Friday between 8 A.M. and 5 P.M. local time (GMT –05:00 Eastern Time (US & Canada)).

The customer service personnel will be able to give you direct assistance and answers to your questions.

2 INTRODUCTION

The Lightning Servo Driver is *General Scanning*'s next generation digital servo controller, supporting a family of performance scanners, applied to a variety of applications. Opening the door to new possibilities for the laser system manufacturer, the Lightning Servo Driver brings a level of performance, consistency, flexibility and value unattainable with traditional analog servo controllers. Some of its key features include:

- Independent servo control of two axis systems
- Improved bandwidth and filtering control
- Protection circuitry with automatic recovery and selectable default actions
- Integrated thermal control and compensation for improved position stability
- Interface with the TuneMaster™ software toolset

The Lightning Servo Driver uses a modular design, providing the ability to readily configure the driver for specific applications. Accessories include a fanned heatsink, providing a convenient mounting and cooling surface for the Lightning Servo Driver, and a cable for serial communication and probe access, allowing the user to tune and conveniently monitor servo parameters.

The Lightning Servo Driver is designed to run in high bandwidth applications (allowing for minimum step times when driving optical scanners) with low gain and offset drift over time and temperature. It is a 2-axis analog-input / digital-processing programmable servo controller for both large and small angle scanning applications, with a 2^{nd} order / 3^{rd} order servo control loop. Automatic tuning may be accomplished using the TuneMaster software toolset. Tuning features include continuously variable field size from 10° to 100° PTP optical for variable resolution applications. The input range and maximum optical deflection can be set via the optional tuning software or as part of the factory tune (contact customer service for more information). For assured reliability, monitoring capabilities include analog position readback and real-time scanner* and controller temperature reporting and protection.

* Not available for all scanner motor models

The purpose of this manual is to familiarize the user with the functionality of the Lightning Servo Driver. An additional test / tuning kit may be purchased that will allow the user to monitor the servo driver performance while customizing the tuning for a specific application. Please contact the sales representative in your area for additional information.

This manual accounts for all available servo driver configurations. Please read carefully to identify all sections that apply to your situation.

3 CONFIGURATIONS

The Lightning Servo Driver is sold in various configurations. Refer to Appendix A "Full Assembly Drawing" and the tables below to easily identify various items.

The tables provide descriptions of the parts included in each configuration. (Please verify the proper components were received in accordance with our warranty policy. In most cases the servo driver arrives assembled and you need only verify it is intact. When the servo is ordered without the heatsink, parts for mounting are included).

Lightning Servo Driver Configurations
Mainboard with Mounting Kit [1]
Mainboard with assembled Heatsink
Mainboard with assembled Heatsink and Fan

Item	**Description of Miscellaneous Assembly Hardware**	**Quantity**
1	Screw, Pan Head, Phillips, M3 x 7mm lg.	7
2	Washer, Shoulder Glass-filled	6
3	Spacer, 3/16" DIA. x 5/16"	2
4	Screw, Pan Head, Phillips, M3 x 16mm lg.	2
5	Washer, Flat #4	2
6 [2]	Screw, Pan Head, Phillips, M3 x 40mm lg.	4

1 Mounting Kit includes items 1 thru 5 of the following table.

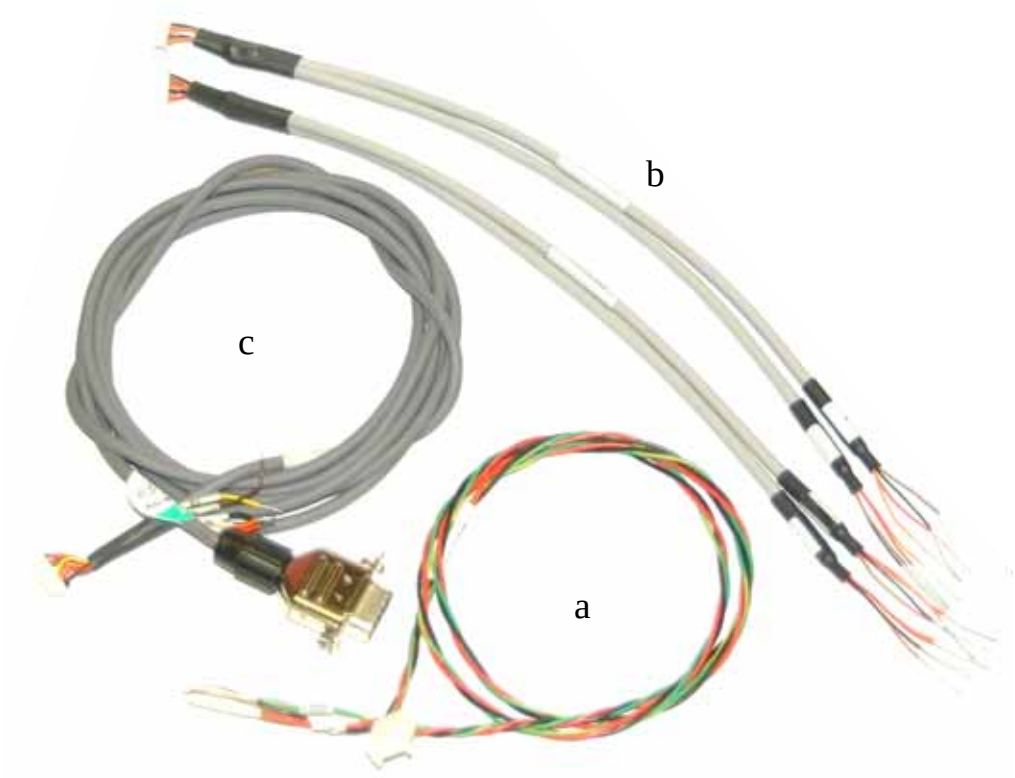
2 Item 6 is only used with the fanned heat sink assembly

3.1 Accessories

There are two cable kits available for Lightning Servo Driver –

Basic Kit
a. Power Cable (x1)
b. Command Cable (x2)

Full Kit
a. Power Cable (x1)
b. Command Cable (x2)
c. Communication Cable (x1)



4 MOUNTING

Setup of the servo is simple. The following sections provide necessary information to properly integrate and operate the servo within a given system. If the application requires setup outside the scope of this manual, please contact technical services before proceeding or applying power to the driver.

4.1 Grounding

The effects of noise on servo operation are highly application dependent. In most cases the servo should be grounded for lowest noise operation. The following two sections explain grounding with and without the Heatsink Assembly.

4.1.1 Grounding *with* a Heatsink / Bracket Assembly

With the servo driver assembled on the standard heatsink, you need only use non-insulating screws in one of the unmasked mounting hole (Figure 1) of the heatsink / bracket to effectively ground the system.

The current servo design ensures that the XY head or galvanometer casing is on the same ground plane as the servo.

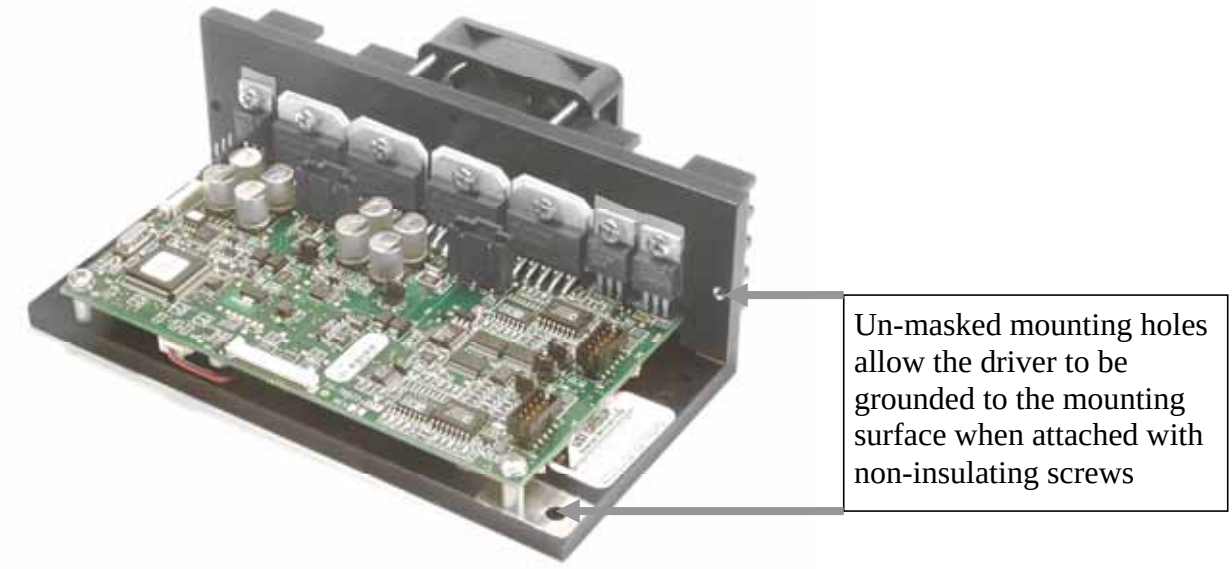


Figure 1: Mounted Assembly

4.1.2 Grounding *without* a Heatsink / Bracket Assembly

The mainboard assembly has insulating pads attached to the power devices. Attach the mainboard to the heatsinking / mounting surface with the screws provided as shown in Figure 2. Insert isolating washers as shown and note that the device farthest from the power connector (or the right-most in this view) should not have an isolating washer and thus will be electrically connected to the (grounded) mounting surface. Be sure that the exposed metal of the six devices receiving shoulder washers do not make direct contact with any conducting surfaces. When mounting, screws should be tightened to a torque of 16 in·lb (1.8 N·M) to ensure good thermal contact without damage to the insulating washers.

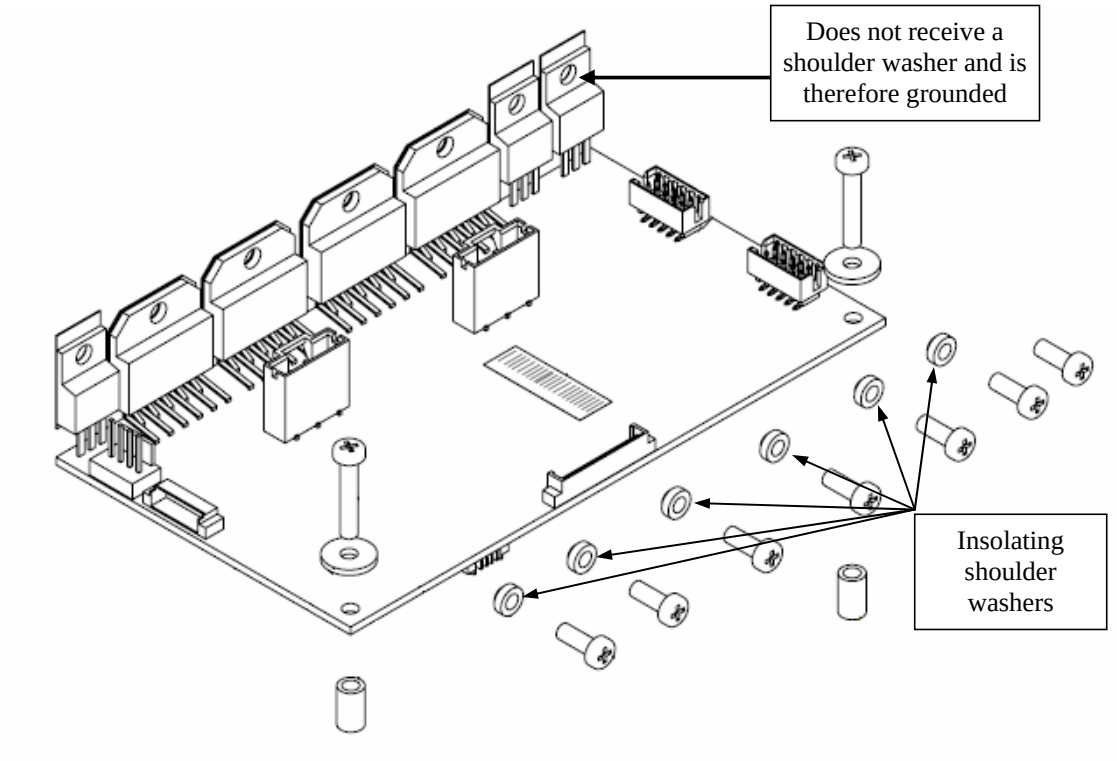


Figure 2: Mainboard Assembly Mounting

4.2 Heatsinking

This section applies to configurations with and without the standard heatsink. Power dissipation is highly application dependent. High bandwidth applications with larger scanner motors will generally require larger voltage supplies (up to ±28V), thus increasing standby power. Aggressive waveforms dominated by large accelerations will place further demands on heatsinking.

If the servo is mounted without the heatsink, make certain that the mounting surface can dissipate at least 50 Watts. If the temperature of the servo rises above 75°C the servo will set a warning flag and shutdown if so configured. Follow the mounting instructions to ensure proper operation. Also, refer to outline drawings (available on www.gsig.com/scanners) to assist in mount design.

5 CONNECTORS AND JUMPERS

This section provides information pertaining to the servo driver connections. Included you will find identification of the location and function of each connector on the servo driver, pinouts for specific connectors, and power considerations associated with input and output pins of the servo driver.

5.1 Connector Identification

The following pictures indicate relevant connectors' location and their designation:

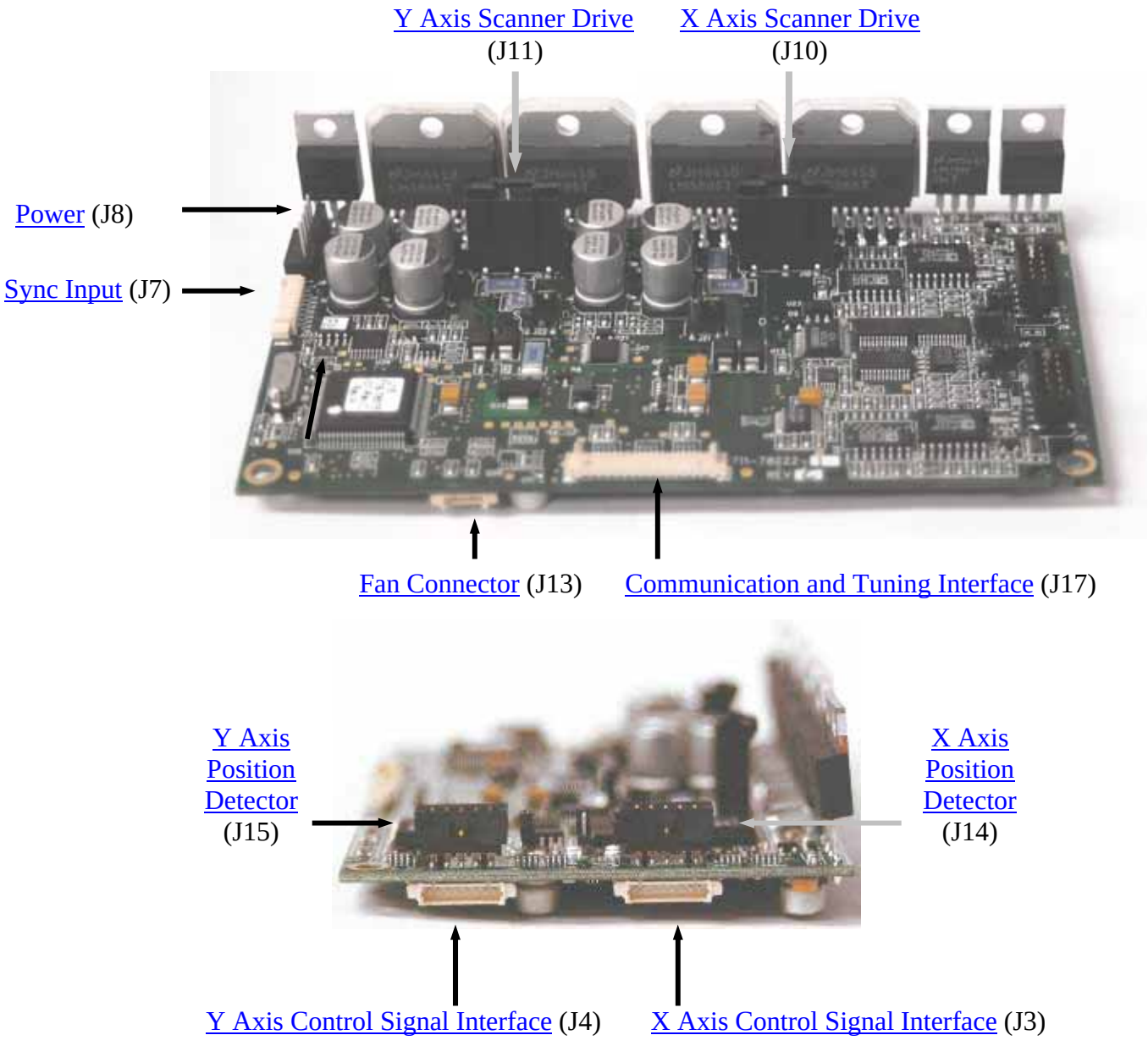


Figure 3: Pictorial view of connector locations

5.2 Servo Board Connectors

5.2.1 Scanner Motor Drive

The Scanner Motor Drive connectors on the mainboard supply drive power to each scanner motor. The axis of the connector is labeled on the printed circuit board next to the given connector. If in doubt, refer back to Figure 3 for connector identification.

5.2.2 Position Detector

The Position Detector connections supply the position read-back from each scanner motor to the servo driver.

5.2.3 Power

The servo driver power supply can range from ±15V to ±28V DC. The power supply voltage requirements of the servo driver are application dependent. In many cases, supplying more voltage can provide improved control and faster response, at the expense of greater power dissipation. To fully utilize the capabilities of the servo driver, the power supply should be able to withstand a peak current draw of 4A from each rail.

The pin functions and corresponding lead designations are provided in the following table:

Pin	Function	Power Cable Lead Color
1	Reserved	N/A
2	Supply Voltage [+]	Red
3	Ground	Green/Yellow
4	Supply Voltage [-]	Black

5.2.4 X Axis and Y Axis Control Signal Interface

Each control signal interface connector allows access to both input and output signals associated with each axis' scanner motor. The interface includes the command input, position output, status feedback and enable command.

The pin functions and corresponding lead designations are provided in the following table:

Pin	Function	Cable Lead Color / Letter	
1	Command [+]	Black	Cable "A"
2	Command [-]	Brown	
3	Ground	Red	
4	Servo Status	Orange	
5	Servo Enable	Black	Cable "B"
6	Servo Ready	Brown	
7	Scanner Position [+] (+/-3V)	Red	
8	Scanner Position [-] (Ground)	Orange	

5.2.4.1. Command Input

The command input to the servo driver is a true differential input with a selectable range that can be preset at the factory to ±3V, ±5V, ±8V, or ±10V when ordered. In addition, the range can be selected within the TuneMaster software.

The following table shows maximum voltages (before triggering over-voltage protection) and input impedance for the various nominal voltages:

Nominal Input Voltage	Maximum Input Voltage	Input Impedance*
±10	±10.2	15.6kΩ
±8	±8.34	16.0kΩ
±5	±5.11	17.8kΩ
±3	±3.25	23.3kΩ

* Measured on one terminal, with the other terminal grounded

5.2.4.2. Servo Status

Servo Status is defined to have an active low output when the following conditions are met:

- Calculated Coil temperature is within limits,
- Coil current is within limits,
- Servo board temperature is within limits.
- Scanner Motor Case is within limits and in regulation (±1°) if heater is available and in use*

This is an open drain output, capable of sinking 50mA at a maximum of 25V. An external pull up resistor is required.

* Not relevant with some models

5.2.4.3. Servo Enable

Servo enable is a falling edge triggered TTL/CMOS-compatible input with a 10kΩ pull-up resistor allowing independent control of each axis. The associated servo axis is disabled when servo enable is high and is enabled by a high-to-low transition. If a servo axis has become disabled due to an over-current or over-temperature condition, it may be re-enabled by strobing the servo enable line. For applications not requiring this function, servo enable should be tied directly to ground. By default, the servo is configured to ignore the servo enable inputs through software.

5.2.4.4. Servo Ready

Servo ready is an active low output that indicates the given axis scanner is enabled and no fault conditions are detected. This is an open drain output, capable of sinking 50mA at a maximum of 25V. An external pull up resistor is required.

5.2.4.5. Scanner Position

A full-scale signal voltage of ±3V corresponding to the position of the scanner is provided for each axis at pins 7 and 8 of the corresponding interface connector. This signal is a real-time analog representation of the mechanical position of the rotor. The signal is buffered and can be referenced for triggering of other events.

5.2.5 Sync Input

The sync input connector has four TTL/CMOS compatible sync inputs, allowing the user to change tunes "on-the-fly"(*). Each tune in the servo's memory is assigned a unique sync configuration to allow selective activation. The set of preprogrammed tunes need to be loaded in advance. The sync pins are debounced inputs, sampled every 120ns and latched to an internal register if no pin has changed state since the last sample. This register is read every 6.72 µs for the X & Y servos, alternately. Additionally, an LED can be connected across pins 7 and 8 to indicate error events and download completion.

The pin functions and corresponding lead designations are provided in the following table:

Pin	Function	Cable Lead Color/Letter	
1	Sync 1 (TTL/CMOS)	Black	Cable "A"
2	Sync 2 (TTL/CMOS)	Brown	
3	Sync 3 (TTL/CMOS)	Red	
4	Sync 4 (TTL/CMOS)	Orange	
5	Probe Trace Input Trigger (TTL/CMOS)	Black	Cable "B"
6	Ground	Brown	
7	LED [-] (GND)	Red	
8	LED [+] (+5V)	Orange	

* Note:

The ability to change tunes "on-the-fly" is currently not supported by the TuneMaster software. The information in this section is provided to explain existing hardware that will be available to support future capabilities of the TuneMaster software.

5.2.6 Communication and Tuning Interface Connection

The communication and tuning interface connection allows the user to directly access internal signals of the servo driver. Accessing this port is considered an advanced option, used with the TuneMaster software to create and edit tunes as well as access other advanced features. A Test Interface Board can be purchased for easy attachment to an oscilloscope. The signals available on the test interface connector are not buffered or isolated. If these signals are to be used in your laser system, we strongly recommend that they be buffered as close as possible to the servo driver and that care be taken not to introduce electrical noise into these lines.

The signal locations for the test interface connector are provided in the following table:

Pin	Function	
1	Bound A out	Position Acknowledge/ Bounds Testing
2	Bound B out	
3	Digital Ground	
4	~RTS out	RS-232
5	TXD out	
6	~CTS in	
7	RXD in	
8	Digital Ground	
9	-12V out	Test Interface Board Connection
10	+12V out	
11	Probe 2 out	
12	Probe 1 out	
13	Y Position out	
14	X Position out	
15	Analog Ground	

5.2.6.1. Position Acknowledge / Bounds Testing

'Bound' is an active low 3.3V TTL/CMOS output, which indicates that a selected internal servo state has remained below a programmable value for a programmable period of time. When position error is the selected state this is referred to as Position Acknowledge. Bound B can either be the negation of Bound A, or independently monitor a second internal state. *Note: Bounds testing is not yet implemented.*

5.2.6.2. RS-232 Communication

A 115kBaud RS-232 serial port connection is used for communication between a host computer and the servo driver during configuration and tuning, and may be used for status monitoring and "on-the-fly" tune selection during operation.

5.2.6.3. Position Out

These are the same signals that are present on the Control Interface, with independent +/-3V outputs representing the position signal for the X and Y-axis scanner.

5.2.6.4. Probes

Probes are configurable to represent internal states of the servo as ±2.5V output signals and viewed on an oscilloscope for troubleshooting and tuning.

Each of the probes can be set to display any one the following signals of either axis:

Description	Output Range or Conversion Factor	Comments
▪ Position	+/-2.5V	
▪ Command	+/-2.5V	
▪ Low Resolution Error	+/-2.5V	Low res. - NOT for tuning
▪ 5x Error	+/-2.5V	High res. - useful for tuning
▪ Integrated Error	+/-2.5V	Avoid saturation
▪ Damping, Low Pass	+/-2.5V	Avoid saturation
▪ Damping, High Pass	+/-2.5V	Avoid saturation
▪ Command FeedForward	Currently not implemented	
▪ DAC out	+/-2.5V	Avoid saturation
▪ Delta Position	Currently not implemented	
▪ Delta Command	Currently not implemented	
▪ Velocity	84 x scan field	In mechanical degrees
▪ Coil Current	2.7A/V	
▪ Case Temperature	20mV/°C	Thermistor readback
▪ Coil Temperature	20mV/°C	Case temp + I^2R model

Reporting measured values inevitably involves some delay as the signal is sampled, processed, and converted back to an analog signal and filtered. In addition, the interleaved nature of sampling and converting in the driver makes these latencies non-uniform. The table below gives the approximate delays from measurement to reporting.

Signal	Probe 1	Probe 2
X Command & Position	20µs	13µs
X 5x Error & Coil Current	10µs	17µs
Y Command & Position	13µs	20µs
Y 5x Error & Coil Current	17µs	10µs

5.2.7 Fan Connector

The fan connector is primarily used for running the small cooling fan option attached to the heatsink.

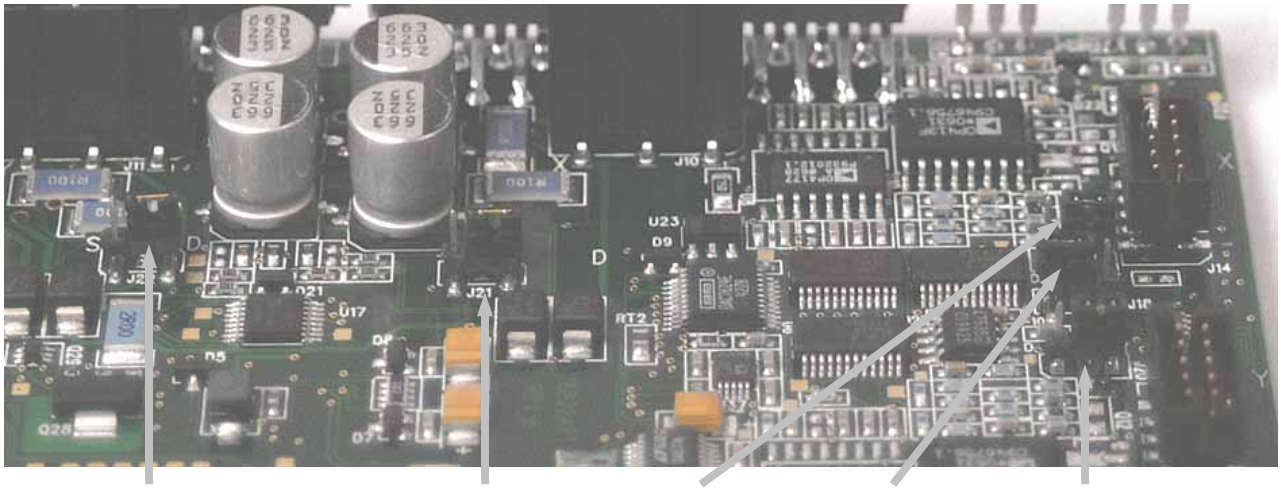
Pin	Function
1	-12V out, filtered
2	Digital Ground
3	+12V out, filtered
4	NA

5.3 Jumper Configuration

The Lightning Servo Driver has five jumpers that are used for setting three of the board functionalities, as described in the table below –

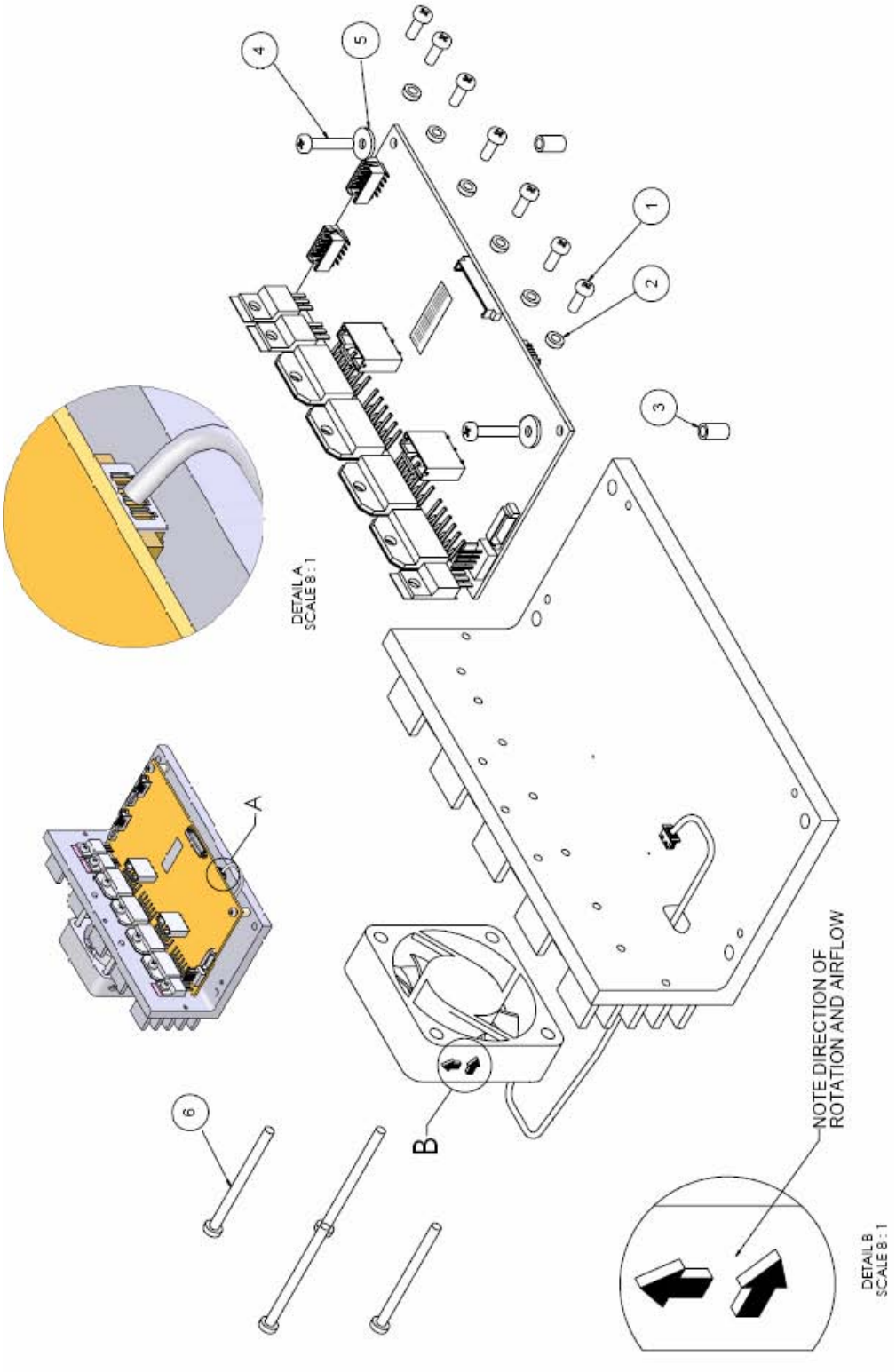
Jumper	Setting Type	Jumper Position	Operation Mode
J18	PD Reference Voltage	Left	-10V
		Right	Ground
J19	Thermal Sensing [X]	Left	Diode Sense
J20	Thermal Sensing [Y]	Right	Thermistor Sense
J21	Output Stage Drive [X]	Left	Single-Ended
J22	Output Stage Drive [Y]	Right	Differential

Users should NOT change jumpers' position when the driver is part of a Lightning system!



J22 J21 J18 J19 J20

APPENDIX A - FULL ASSEMBLY DRAWING



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