

GSI Lumonics

Intelligent Servo Driver Hardware Manual



COMPONENT PRODUCTS GROUP
39 Manning Road
Billerica, Massachusetts 01821

TABLE OF CONTENTS

TABLE OF CONTENTS	1
1 IMPORTANT INFORMATION	2
1.1 ESD WARNING	2
1.2 WARRANTY INFORMATION	2
1.3 CUSTOMER SUPPORT	3
2 INTRODUCTION	4
3 SPECIFICATIONS	5
4 CONFIGURATIONS	6
5 MOUNTING	7
5.1 GROUNDING	7
5.1.1 <i>Grounding with a Heatsink / Bracket Assembly</i>	7
5.1.2 <i>Grounding without a Heatsink / Bracket Assembly</i>	8
5.2 HEATSINKING	8
6 CONNECTORS AND CABLES	9
6.1 ZIF CONNECTOR INSTRUCTIONS	9
6.2 CONNECTOR IDENTIFICATION	10
6.3 SERVO BOARD CONNECTORS	11
6.3.1 <i>Galvanometer Drive</i>	11
6.3.2 <i>Position Detector</i>	11
6.3.3 <i>Power</i>	11
6.3.4 <i>X Axis and Y Axis Control Signal Interface</i>	11
6.3.4.1 <i>Command Input</i>	12
6.3.4.2 <i>Servo Enable</i>	12
6.3.4.3 <i>Servo Ready</i>	12
6.3.4.4 <i>Scanner Position</i>	12
6.3.5 <i>Sync Input</i>	13
6.3.6 <i>Test Interface Connection</i>	13
6.3.7 <i>RS232 Connection</i>	13
6.4 REPLACEMENT CONNECTOR PART NUMBERS	14
6.5 CABLE KIT	14
APPENDIX A	15
FULL ASSEMBLY DIMENSIONS	16
MAINBOARD DIMENSIONS	17
DAUGHTERBOARD MOUNTING ASSEMBLY	18

1 IMPORTANT INFORMATION

1.1 ESD Warning



The OEM electronics that *GSI Lumonics* manufactures - including galvanometers and servo controllers - are sensitive to electrostatic discharge (ESD). Improper handling could therefore damage these electronics. *GSI Lumonics* 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 of any shortage or damage within that period. If no discrepancies are reported, *GSIL* shall assume the shipment was delivered complete and defect free. *GSIL* warrants 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 *GSIL* Terms and Conditions and Limited Warranty. Visit <http://www.gsilumonics.com/cpg> for the latest version of these documents and other useful information.

IMPORTANT: Line Scan Engines 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

GSI Lumonics 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 GSI Lumonics' 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.



**CONTACT
Us!**

North America

39 Manning Rd.
Billerica, MA 01821
U.S.A.
TEL: (978) 439-5511
FAX: (978) 663-0044
scanning@gsilumonics.com

Europe

Eisstenstrasse 2
D-85716 Unterschleissheim
Germany
TEL: (089) 31707 0
FAX: (089) 31707 250
sales.components@gsilumonics.com

Asia

Technoport Kamata, 16-1
Minami-Kamata 2-Chome
Ohta-Ku Tokyo 144-0035
Japan
TEL: (81) 3 5714 0380
FAX: (81) 3 5714 0335
oad-sales@gsilumonics.co.jp

Website: <http://www.gsilumonics.com/cpg>

2 INTRODUCTION

The Intelligent Servo Driver is *GSI Lumonics'* most recent development in galvanometric servo control technology. Opening the door to new possibilities for the laser system manufacturer, the Intelligent Servo brings a level of performance and flexibility 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
- Sync Input ports available for switching between multiple tunes
- Software tunable (available with optional tuning kit)

The Intelligent Servo uses a modular design, providing the ability to readily configure the driver for specific applications. The Intelligent Servo heatsink / mounting bracket provides a safe and convenient mounting surface. An optional thermal control module is available to reduce galvanometer drift by taking advantage of GSIL's thermally regulated scanners.

The Intelligent Servo is designed to run in high bandwidth applications (allowing for minimum step times when driving galvanometers) 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 scanner applications, with a 2nd order / 3rd order servo control loop. Online tuning may be accomplished using a “knobs on the screen” host interface package (the “DISH” software) via a RS232 communications link offered as part of the optional tuning kit package. Tuning features include continuously variable field size from 10° to 100° for variable resolution applications. Multiple tunes may be permanently stored on-board and switched instantly (<15 μ s) via Sync Input pins. 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.

The purpose of this manual is to familiarize the user with the functionality of the Intelligent Servo. When buying a complete line scan engine (scanner, driver, and mirror) the servo should arrive with a factory tune. An additional test / tuning kit may be purchased that will allow the user to customize the servo tuning for a specific application. This kit includes a serial interface module, test interface board and tuning software. Please contact the sales representative in your area for additional information.

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

3 SPECIFICATIONS

Command Input Characteristics

- Differential Voltage Range Differential command voltage selectable between: ± 3 volts (standard), ± 5 volts, ± 8 volts, and ± 10 volts. (Selectable with DISH software or factory preset; Consult customer service for desired setting)

Position Readback

- Position Signal ± 3 volts

Power Input

- Voltage ± 15 to ± 28 volts DC
 $\pm 12V$ Available (consult customer service)
- Quiescent Current $+500mA$, $-300mA$ (servo enabled, galvo resting without error, no thermal controller)
- Peak Current 4 Amps

Motor Drive Power

- Max. Average (100ms) 2.5A RMS (Galvanometer dependant and adjustable)
- Peak Current 10 Amps

Control I/O Characteristics

- Servo Ready Open Collector, Active Low (50mA max. Output)
- Servo Enable TTL/CMOS Compatible, Active Low (Input)
- Temp OK Open Collector, Active Low (50mA max. Output)

Protection

- Auto recovery Over-position
 - Automatic Shutoff Over-current – 2.5A Average over 100ms
Over-temperature
 - Galvo case: 85° C
 - Galvo coil: 105° C
 - Servo: 75° C
- Supply Under-voltage
Position Detector Inactive

Size

- | | |
|----------------------------------|--|
| (Not including bracket/heatsink) | W x L x H
2.4" x 4.6" x 1.2" (62mm x 117mm x 30mm) |
| (Including bracket/heatsink) | 2.7" x 4.7" x 2.0" (69mm x 119mm x 50mm) |

Weight

- | | |
|----------------------------------|------|
| Main Board (only) | 68g |
| Thermal Control Board (only) | 70g |
| Heatsink/Mounting Bracket (only) | 222g |

- Operating Temperature Range** 0°C to 50°C

4 CONFIGURATIONS

The Intelligent Servo is sold in various configurations. Refer to Figure 4.0 and the table below to easily identify and verify the available configurations. The table provides part numbers for all purchasable items along with descriptions of the parts included within those part numbers. Please verify the proper components were received in accordance with our warranty policy. In most cases the servo arrives assembled and you need only verify it is intact. When the servo is ordered without the heatsink, parts for mounting are included.

Description/Included Parts	Part Number (As Listed on Invoice)
Mainboard (1), Heatsink (7) (assembled)	002-3005107
Mainboard (1), Daughterboard (8), Heatsink (7) (assembled)	002-3005108
Mainboard (1), Mounting Kit ¹	002-3005109
Mainboard (1), Daughterboard (8), Mounting Kit ²	002-3005110
Daughterboard (8) [With two Standoffs (5) and two 13/16" 4-40 Phillips Head Screws (9)]	002-3005056

¹ Mounting Kit Includes five 3/16" 4-40 Screws (3), four Shoulder Washers (2), two 1/2" 4-40 Phillips Head Screws (9), two #4 3/16OD x 9/32" Standoffs (5).

² Same as mounting kit above except with four Standoffs rather than two and with 13/16" rather than 1/2" Phillips Head Screws (9) for mounting the Daughterboard assembly.

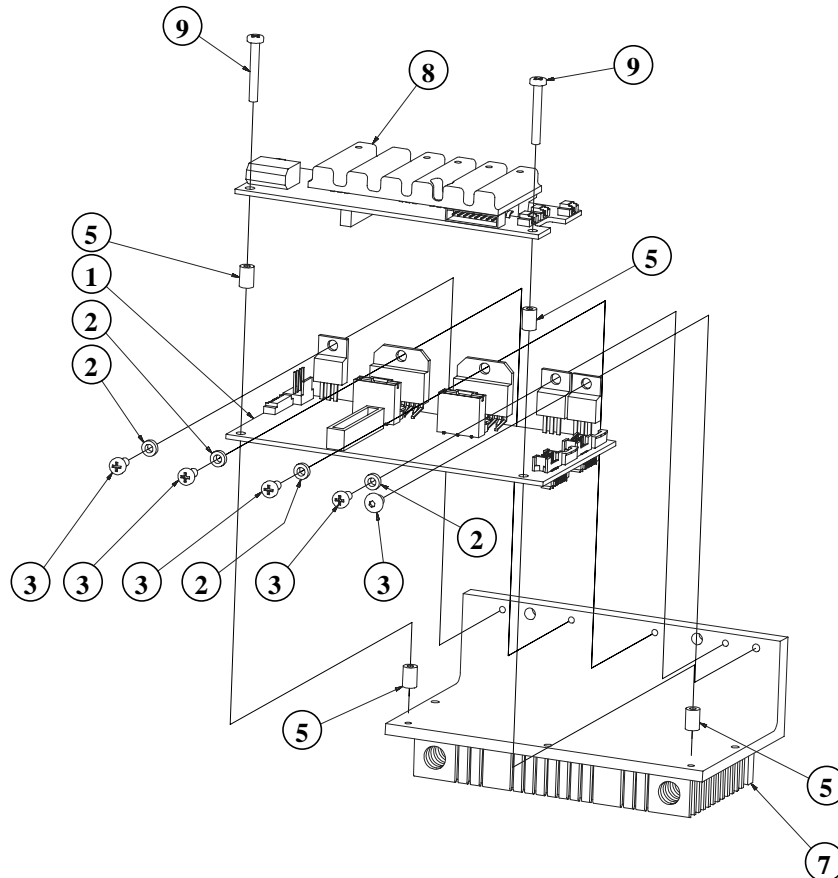


Figure 4.0: Exploded Assembly Drawing

5 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 “power up”.

5.1 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.

5.1.1 Grounding with a Heatsink / Bracket Assembly

With the servo assembled on the standard heatsink, you need only use non-insulating screws in the mounting holes (Figure 5.0) of the heatsink / bracket to effectively ground the system. (See outline drawings in Appendix A for more details).

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

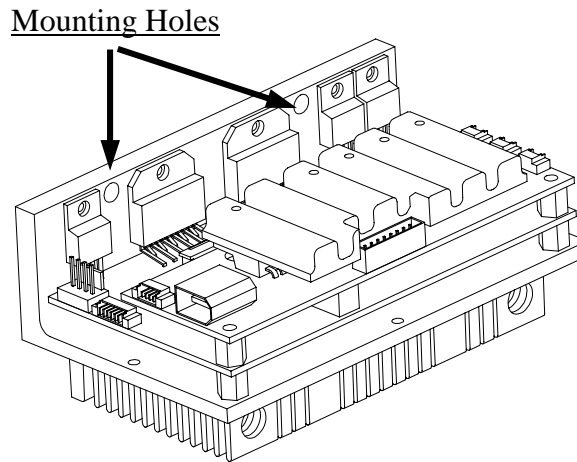


Figure 5.0: Mounting

5.1.2 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 5.1. Insert isolating washers (2) as shown and note that the device farthest from the power connector (or closest to the front 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 four 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.

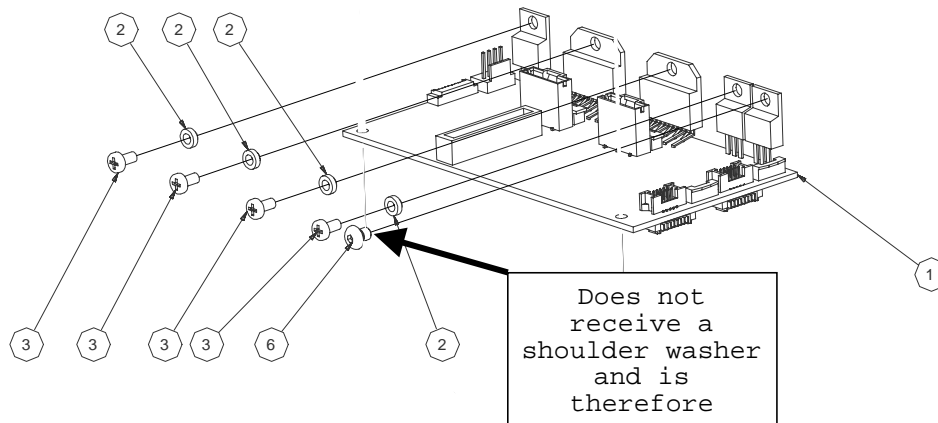


Figure 5.1: Mainboard Assembly Mounting

5.2 Heatsinking

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

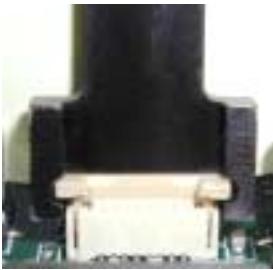
If the servo is mounted without the heatsink, make certain that the mounting surface can dissipate at least 50 Watts. If the temperature of the servo rises above $75^{\circ}C$ the servo will shutdown. Follow the mounting instructions in section 5.1.1 to ensure proper operation. Also, refer to outline drawings in Appendix A to assist in mount design.

6 CONNECTORS AND CABLES

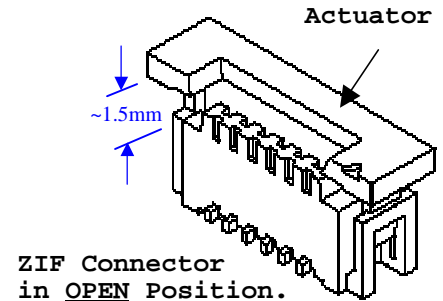
This section provides information pertaining to the servo board connections. Included you will find identification of the location and function of each connector on the servo, instructions for connecting the zero input force (ZIF) connectors, pinouts for specific connectors, and power considerations associated with input and output pins of the servo.

6.1 ZIF Connector Instructions

The following procedure gives further insight into the proper way of using ZIF connectors:

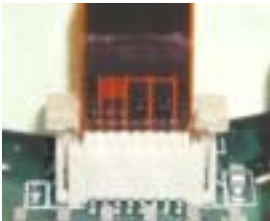


Using the wide end of the supplied ZIF tool, fit the claws around the edges of the actuator (left picture), then pull gently until it is approximately one-eighth inch (1.5mm) above the base. You can feel the actuator become loose.



Note: Actuator should not dislodge from base.

The actuator should not completely dislodge from the base.

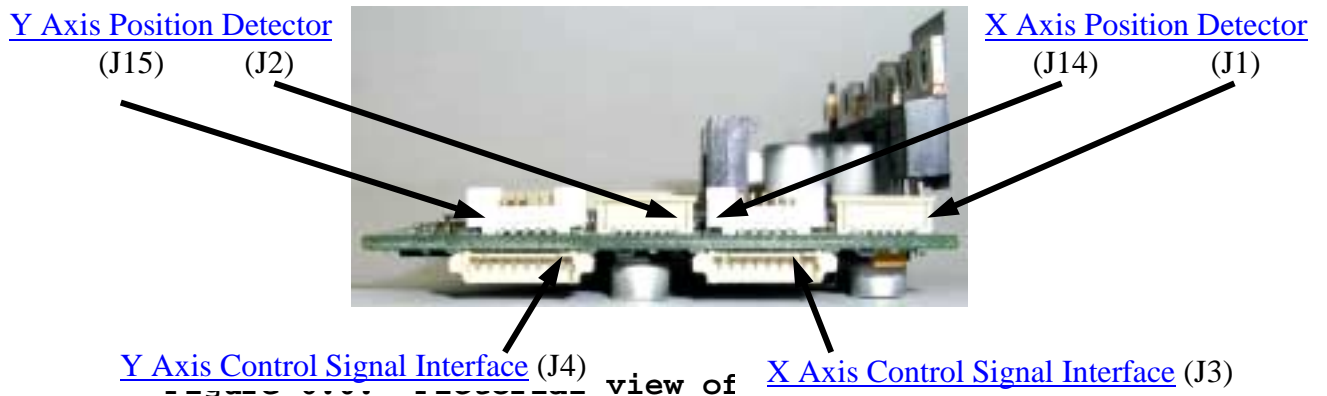
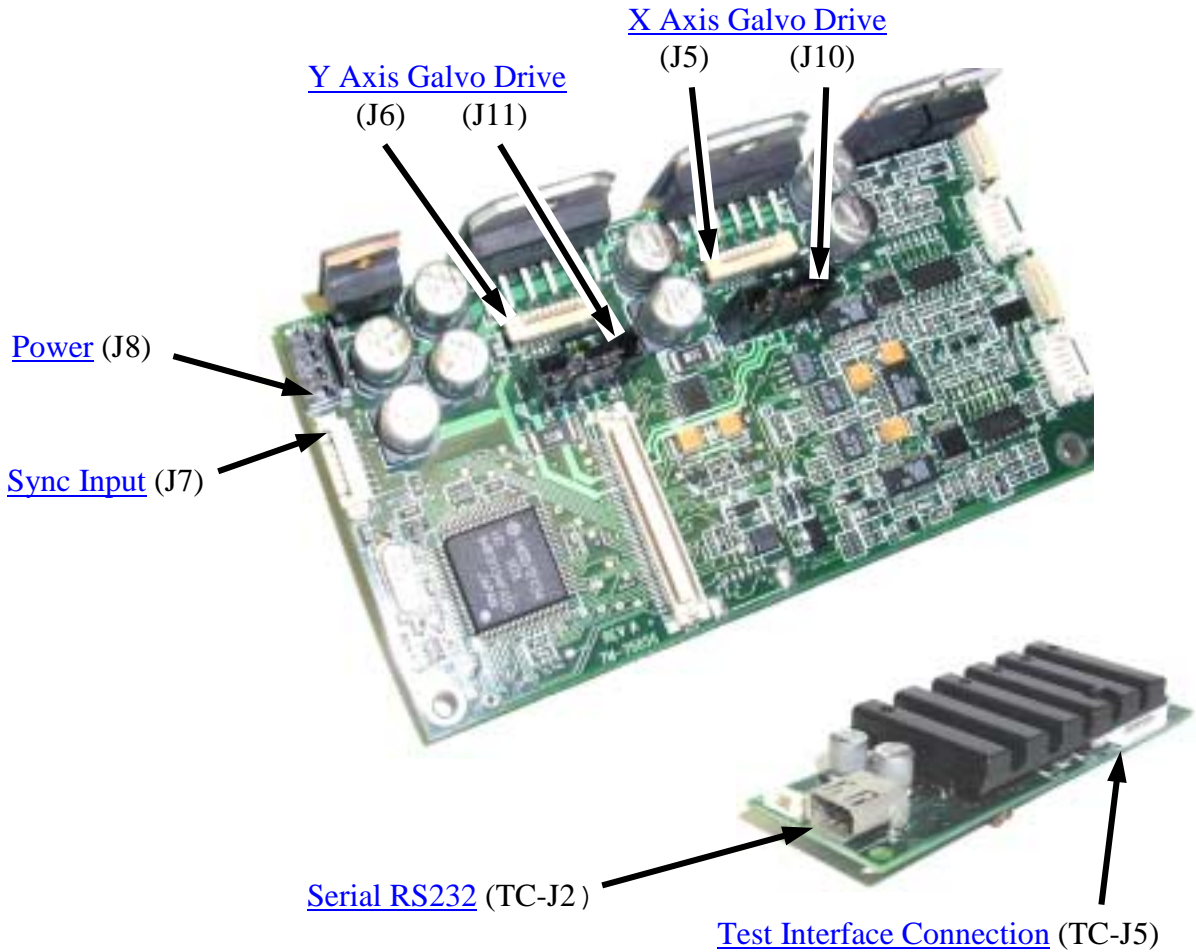


Insert the edge of the flex cable from the galvanometer into the ZIF connector with the contacts of the cable facing away from the actuator. Make sure the cable is square and well seated in the connector base. While holding the cable square to the connector, use the tool to press the actuator down until it is flush with the base.

Note: ZIF connectors and flex cabling are designed for a limited number of insertions. Repeated disconnection and reconnection as well as extreme bending of the flex cable can degrade performance and cause intermittent failures within the servo-galvo system. A reasonable level of care should be exercised when handling the cables.

6.2 Connector Identification

The following pictures indicate relevant connectors' location and their designation:
(The arrow-heads point to the location of pin one of each connector)



Note: The arrow tip points to the approximate location of pin 1 on each connector.

6.3 Servo Board Connectors

6.3.1 Galvanometer Drive

The Galvanometer Drive connectors on the mainboard supply drive and heater power to each galvanometer (both Flex and wire cable types are supported). The axis of the connector is labeled on the printed circuit board next to the given connector. If in doubt, refer back to Figure 6.0 for connector identification.

6.3.2 Position Detector

The Position Detector connections supply the position read-back from each galvanometer to the servo (both Flex and wire cable types are supported). The ZIF option of these connections is similar to the galvanometer drive ones, but much smaller. Use the smaller end of the ZIF tool and perform the same procedure as with the galvanometer drive connection, taking special precautions not to completely dislodge the actuator from the base. The exposed leads or traces on the flex cable should always face away from the actuator.

6.3.3 Power

The servo power supply can range from $\pm 15\text{V}$ to $\pm 28\text{V}$ DC. The power supply voltage requirements of the servo 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, 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	Lead Color (See "6.5 Cable Kit" below)
1	Reserved	N/A
2	+ Supply (+15 to +28 V)	Red
3	Ground	Green/Yellow
4	- Supply (-15 to -28 V)	Black

6.3.4 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' galvanometer. The interface includes the command input, position output, status feedback and enable.

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

Pin	Function	Lead Color / Letter (See "6.5 Cable Kit" below)
1	+ Command	Black
2	- Command	Brown
3	Ground	Red
4	Reserved	Orange
5	Servo Enable	Black
6	Servo Ready	Brown
7	+ Scanner Position	Red
8	- Scanner Position (Ground)	Orange

6.3.4.1 Command Input

The command input to the servo is a true differential input with a selectable range that can be preset at the factory to $\pm 3\text{V}$, $\pm 5\text{V}$, $\pm 8\text{V}$, or $\pm 10\text{V}$ when ordered. In addition, if you have purchased the optional tuning kit, the range can be selected within the DISH software (Please consult DISH software manual for further details).

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	15.6k Ω
± 8	± 8.34	16.0k Ω
± 5	± 5.11	17.8k Ω
± 3	± 3.25	23.3k Ω

* Measured on one terminal, with the other terminal grounded

6.3.4.2 Servo Enable

Servo enable is a falling edge triggered TTL/CMOS-compatible input with a 10k Ω 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 when the daughterboard is present and enable / disable functionality is handled by DISH software via serial communications. **If at any time the optional daughterboard is not present, *servo enable* must be low for the servo axis to operate.**

6.3.4.3 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.

6.3.4.4 Scanner Position

A full-scale signal voltage of $\pm 3\text{V}$ 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.

6.3.5 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 servo will arrive from the factory with a set of preprogrammed tunes. If the optional tuning package was ordered, customized tunes can be downloaded to the servo and activated through the sync pins. 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	Lead Color/Letter (See “6.5 Cable Kit” below)	
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	Red	
8	+LED (+5V)	Orange	

6.3.6 Test Interface Connection

The test interface connection is only available with the optional tuning kit. The connection allows the user to directly access internal signals of the servo. Accessing this port is considered an advanced option, used with the DISH software package 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 controller 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	Signal
1	Reserved
2	Ground
3	+X Position
4	+Y Position
5	Probe 1
6	Probe 2
7	+12V
8	- 12V

6.3.7 RS232 Connection

The RS232 serial port connection allows communication between a host computer and the servo for users who have purchased the DISH software package.

6.4 Replacement Connector Part Numbers

In the event of connector damage or a desire to build your own cables, the following Table supplies the necessary connector part numbers. The *base* connector refers to the connector on the PCB.

Mainboard Connectors

Connector	Base Connector	Mating Connector	Terminal/Pins
J1	Molex 52559-1092	N/A	N/A
J2	Molex 52559-1092	N/A	N/A
J3	Molex 53261-0890	Molex 51021-0800	Molex 50058-8000
J4	Molex 53261-0890	Molex 51021-0800	Molex 50058-8000
J5	Molex 52610-0890	N/A	N/A
J6	Molex 52610-0890	N/A	N/A
J7	Molex 53261-0890	Molex 51021-0800	Molex 50058-8000
J8	AMP 647047-4	Molex 22-01-3047	Molex 08-52-0123
J10	AMP 1375549-4	AMP 104257-4	AMP 104481-2
J11	AMP 1375549-4	AMP 104257-4	AMP 104481-2
J13	Not Used	N/A	N/A
J14	Hirose DF13A-10DP-1.25V	Hirose DF13-2630SCFA	DF13-10DS-1.25C
J15	Hirose DF13A-10DP-1.25V	Hirose DF13-2630SCFA	DF13-10DS-1.25C

Daughterboard Connectors

Connector	Base Connector	Mating Connector	Terminal/Pins
J2-TC	Molex 53462-0611	N/A	N/A
J3-TC	Not Used	N/A	N/A
J4-TC	Not Used	N/A	N/A
J5-TC	Molex 53325-0810	Molex 51090-0810	Molex 50212 -0810
J6-TC	Not Used	N/A	Molex 50058-0290
J7-TC	Not Used	N/A	Molex 50058-0290

6.5 Cable Kit

The cable kit shown on the right is an optional, but recommended, purchase to quickly get the servo up and running. If applicable, verify all Cable Kit items were received.

Cable Kit (P/N 006-3006024):

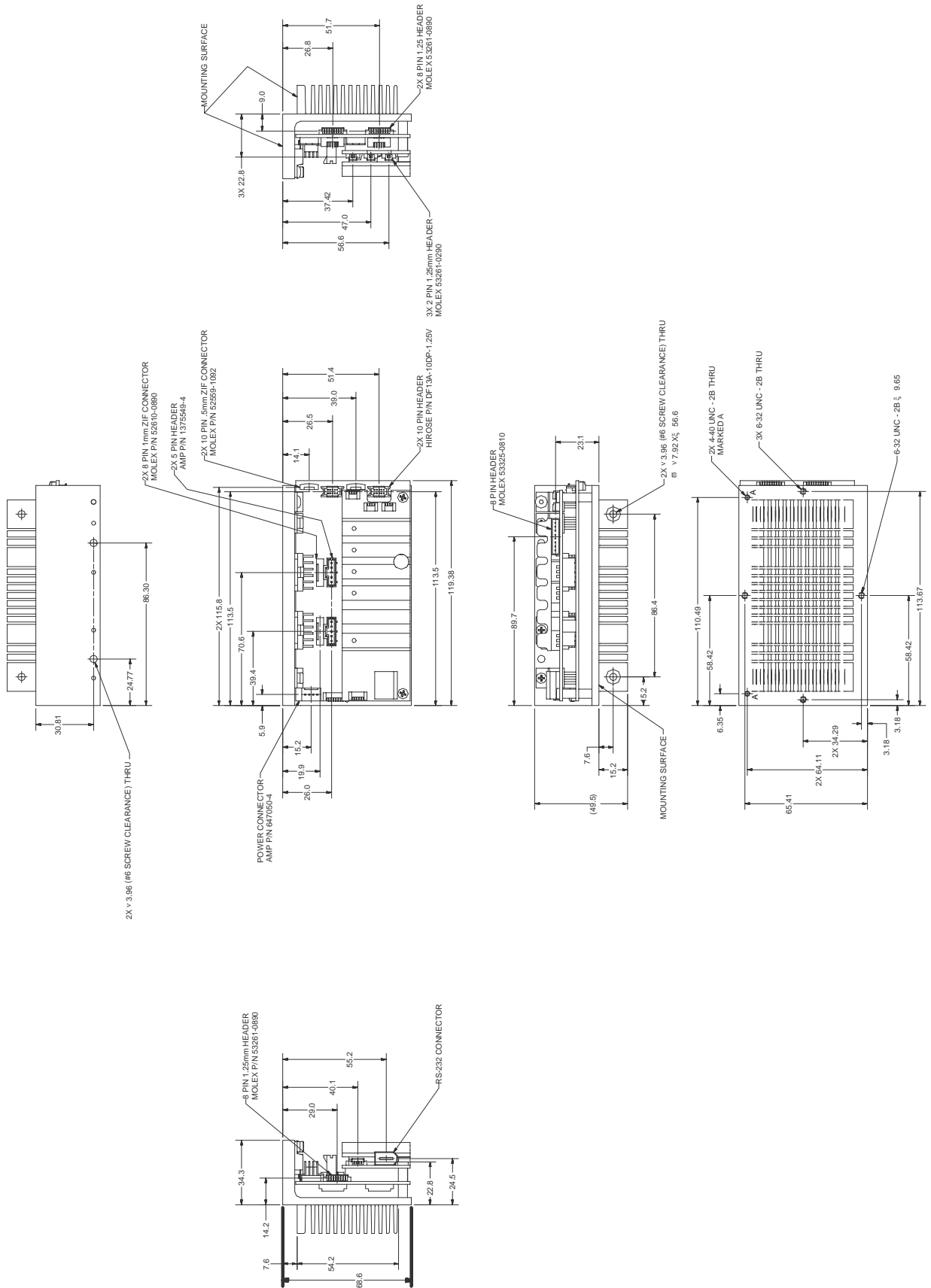
- ✦ 2 Flying-lead Command Cables
- ✦ 1 Flying-lead Sync Cable
- ✦ Twisted 3 lead Power Cable
- ✦ ZIF Tool



APPENDIX A

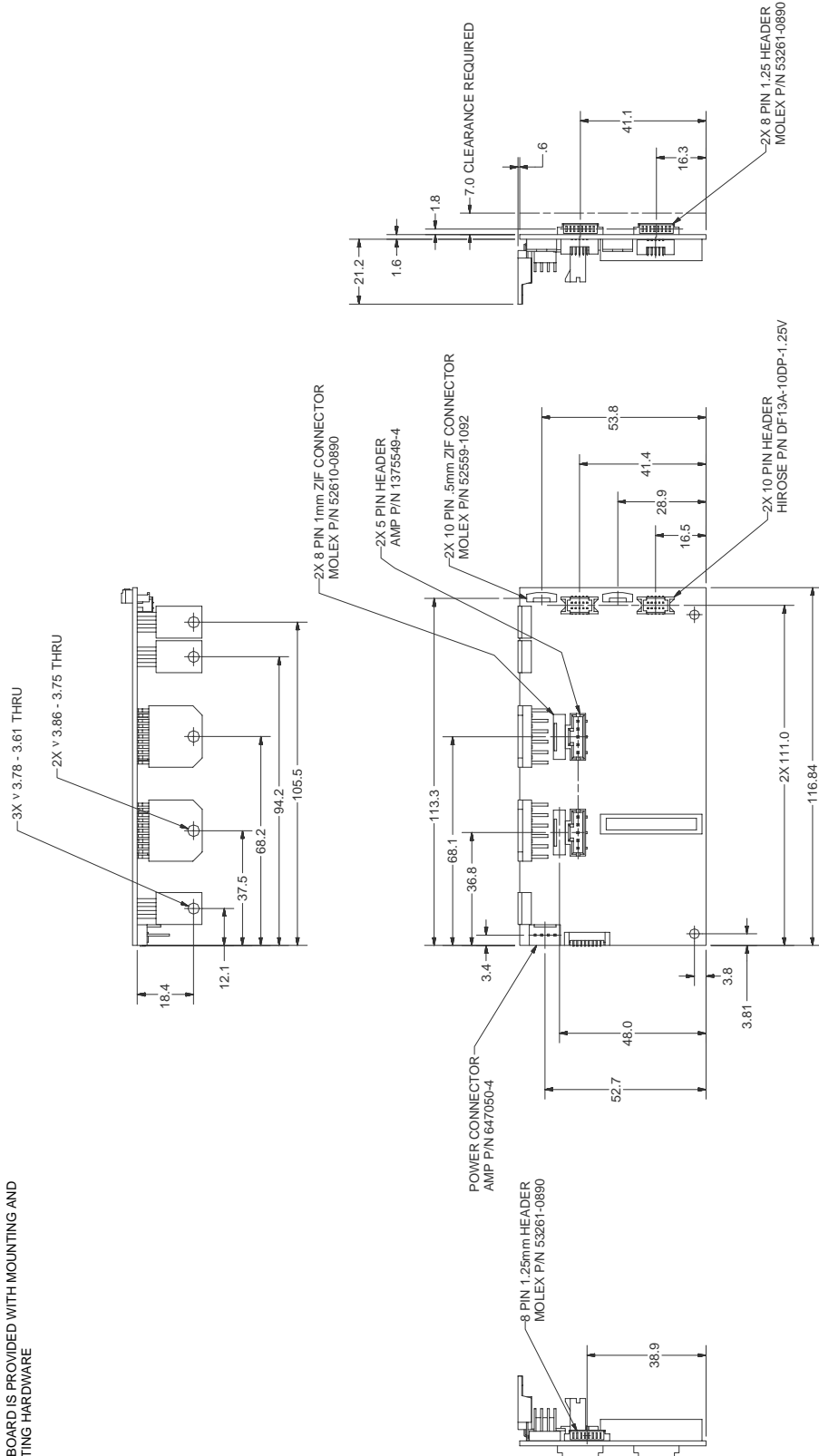
- [Full Assembly Dimensions](#)
- [Mainboard Dimensions](#)
- [Daughterboard Mounting Assembly](#)

Full Assembly Dimensions



Mainboard Dimensions

NOTE:
1. SERVO BOARD IS PROVIDED WITH MOUNTING AND INSULATING HARDWARE



Daughterboard Mounting Assembly

If the daughterboard is received as an add-on component, follow the steps below that describe the attachment process. (Refer to Figure 4.0 on page 7 and the figure below for parts identification).

- Remove original short screws (“A” below) from mainboard (1) assembly.
- Mount daughterboard (8) into connector
- Add two standoffs (5) between the mainboard and the daughterboard.
- Secure both boards using long screws (9).

