HB™X-10
User's Manual

References found in this document to prior company and division names such as General Scanning Inc., GSI Lumonics, and GMAX now refer to General Scanning Optical Scanners, a member of GSI Group Inc.

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1 IMPORTANT INFORMATION

1.1 ESD WARNING

The OEM electronics that *General Scanning* manufactures - including galvanometers and servo controllers - 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.

Customers assume all responsibility for maintaining a laser-safe working environment. OEM customers must assume all responsibility for CDRH (Center for Devices and Radiological Health) certification.

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.

IMPORTANT: Line Scan Engines are normally tuned, serialized and warranted as a matched set for optimum performance. Mismatched components diminishes performance and void the warranty. A matched set typically consists of galvanometer motor, mirror load, electronic driver board and interface cable.

1.4 Unpacking

The package you receive includes those items listed in the packing list.

1. Carefully unpack the contents from the box.
2. Save shipping container and packaging material in case you need to return unit for service.
3. Check contents of the box against the packing list to ensure all parts were received.
4. Inspect each item to ensure it was not damaged during shipment.

The HB™ X-10 Scan Head is pictured below without additional control components. The lens shown may differ from what was received. If the Digital Interface configuration of HB™ X-10 was ordered, refer to HC/2(GSIL P/N: 176-25003) and HC/3(GSIL P/N: 7OM-034) manuals for additional product identification.

2 INTRODUCTION

The HB™ X-10 Scan Head integrates high bandwidth servo technology with high speed, high accuracy galvanometers into a small, manageable package. The HB™ X-10 Scan Head with 10mm clear aperture is one of a series of HB™ Scan Heads. This manual details how to install and operate **hardware** of the HB™ X-10 Scan Head. Descriptions of the three system configurations available lead the user to proper complementary documentation for commanding/controlling the Scan Head. The HB™ X-10 has analog, digital, and ScribeSmart™ control interface configurations available.

Be careful to observe the information in the Safety and Warnings section that alerts you to laser hazards you may encounter while running the HB™ X-10. The HB™ X-10 Scan Head consists of galvanometers and attached mirrors that reflect a laser beam whose operation can be hazardous if certain precautions are not taken. Please be alert to the safety considerations and specific procedures regarding the HB™ X-10 Scan Head and the laser you are using.

Figure 1.0: Example of a HB™ X-10 Scan Head with optional F160 YAG optional Lens Kit Assembly.

2.1 Theory of Operation

GSI Lumonics' 2-axis galvanometric Scan Heads provide the capability of deflecting optical beams in a XY plane for all possible laser applications. The synchronized actions of two galvanometer servo-controlled mirrors direct the laser beam to specific locations on a target in both the X and Y directions. The HB™ X-10 Scan Head Module is a multi-purpose dual-axis beam steering unit. The Scan Head contains two VM1000 galvanometer scanners (X and Y), Intelligent Servo Driver (ISD), and optional Lens Kit Assembly. The lens kit consists of a field flattening lens and a lens holder that screws onto the Scan Head. There are three types of electronic interfaces to the HB™ X-10 Scan Head: Analog, Digital, and ScribeSmart™ control. The analog version requires a customer supplied analog signal to command the individual axes of the Scan Head.

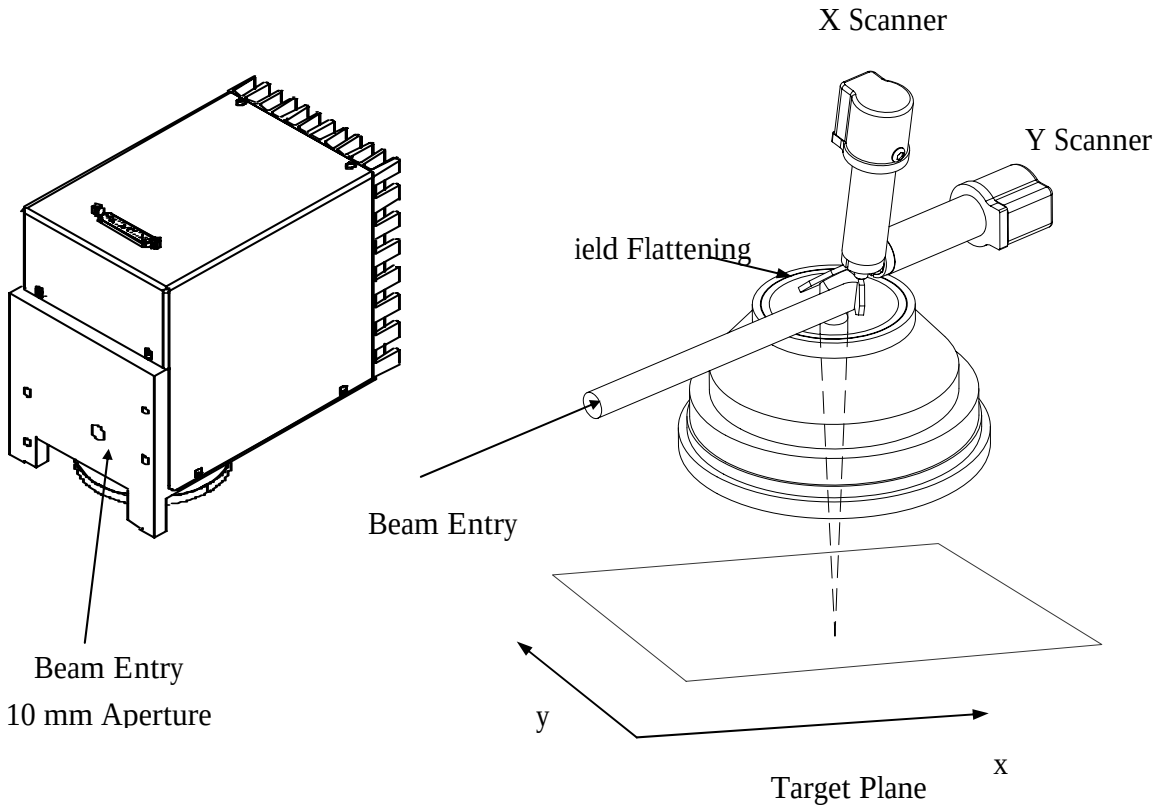


Figure 2.1: Simple beam path description through HB™ Scan Head.

The Digital Interface HB™, contains an additional Digital to Analog Receiver (DAR) board that interfaces with the HC/3 card. The HC/3 is a PCI card that fits internal to a PC and can be used with GSIL software to easily control the Hummingbird scan head as well as provide laser control. PC-MARK

MT™ and WinMCL Plus™ are developer-level control software modules that work with the HC/3 card. This software solution allows a user to command up to four HB™ Heads from a single PC.

The ScribeSmart™ control HB™ configuration is the definitive standalone solution. Like the Digital Interface solution, the ScribeSmart™ control requires software commands to steer the galvanometers and control the laser. The SC2000*Li* is contained within the HB™ Head and programs containing position and laser control commands are uploaded via Serial Link. The HB™ head can then be disconnected from the PC and run standalone. A single program may be run on start-up or programs can be triggered using the *Binning Port* on the Head. The Laser Interface of the ScribeSmart™ controlled HB, internal to the scanhead, allows control to all types of common lasers. The features of the Laser Interface are listed below:

- General purpose 8-bit parallel output (mostly needed for controlling lamp and diode pumped lasers)
- RS232 or RS485 Serial Port (for lasers controlled via a serial communications port)
- Mark-on-the-Fly ready, with position encoder inputs (Accepts bidirectional A/B quadrature signals or unidirectional single channel pulse train).
- Marking Serialization ready, for automatic increment of a serial number being marked.
- Binning ready: while marking, the user can select one of 64 different user defined patterns or "bins" (e.g. logos, lots or serial number sequences).
- Generates Pulse-width modulated (PWM) signal (0 to 100% duty cycle) for laser output control.
- Generates Tickle pulses for CO_2 and other gas lasers for quick turn-on times.
- Generates variable First Pulse Suppression (FPS) pulses for YAG and other crystal lasers for flexible regulation of "giant" first pulses from the laser.
- Laser control signals are user selectable active high or active low.
- User definable Analog Output (0 to 10 volts, 8-bit resolution) for power control or general purpose use.
- Internal Relay switch for shutter control.
- Four dedicated control inputs (Begin Mark, Abort Mark, Flag input and Shutter input)
- Three dedicated control outputs (Mark In Progress, Remote Execute, Mark Error)
- Supplies isolated 5 volts (100 mA) for customer's use and convenience (e.g. pull-up resistors, signaling, etc.)
- All inputs and outputs are optoisolated for critical noise immunity and to avoid ground loops.

Refer to *ScribeSmart™ User Manual* (GSIL P/N: 7OM-1117) and *SC2000Li Laser Interface User Manual* (GSIL P/N: 7OM-1017) for further details on functionality of the above features.

2.2 Specifications – All Configurations

Laser Type	YAG	YAG	YAG	YAG
Wavelength λ (nm)	1064	1064	1064	1064
Objective (f in mm)	100	160	163	254
Input Aperture (mm)	10	10	10	10
Spot Size TEM_{00} (µm)	19	32	32	50
Scan Angle	±20°	±20°	±20°	±20°
Standard Field Size (mm^2) [1]	70 x 70	99 x 99	114 x 114	157 x 157
Working Distance (mm^2) [2]	212	210	233	355
Relative Positional Repeatability[3] (µm)	10	16	16	25
Dither (µm)	5	8	8	13
Writing Speed (m/s)	2.8	4.5	4.5	7.1
Idle Stability [3] (µm)	48	70	70	110
Active Stability [4] (µm)	80	128	128	203
Long Term Stability (µm in 8 hours)	42	68	68	108
Linearity[5]	0.3%	0.3%	0.3%	0.3%
Geometric Distortion [5]	0.4%	0.4%	0.4%	0.4%
Laser Power Capability, CW (W/cm^2)	500	500	500	500
Laser Power Capability, 100 ns pulsed (MW/cm^2)	100	100	100	100
Laser Power Loss, Including Lens[6]	<11%	<11%	<11%	<11%
Operating Temperature (°C)	25 +/- 10			
Weight (Kg. without objective lens)	2.87			

[1] Grid Corrected Field Size; note: the fields may be increased but with a decrease of spot size and field flatness.
[2] From surface facing target to target plane, see Figure 3.1.
[3] Thermal drift due to idling
[4] Thermal drift due to most aggressive operation in worst environment
[5] Grid corrected, Geometric Distortion includes lens distortion, while linearity does not
[6] Includes lens and mirror losses

Specifications and outline drawings defined in the user manual represent standard product, and may vary by model. Contact technical support for specifications and drawings relating to custom configurations.

Laser Type	**CO_2**	**CO_2**	**CO_2**
Wavelength λ (nm)	10600	10600	10600
Objective (f in mm)	100	200	300
Input Aperture (mm)	10	10	10
Spot Size TEM_{00} (µm)	230	380	570
Scan Angle	±20°	±20°	±20°
Standard Field Size (mm^2) [1]	70 x 70	140 x 140	210 x 210
Working Distance (mm^2) [2]	94	196	294
Relative Positional Repeatability[3] (µm)	10	20	30
Dither (µm)	5	10	15
Writing Speed (m/s)	3.2	6.4	9.5
Idle Stability [3] (µm)	44	87	131
Active Stability [4] (µm)	80	160	240
Long Term Stability (µm in 8 hours)	43	85	128
Linearity[5]	0.3%	0.3%	0.3%
Geometric Distortion [5]	0.4%	0.4%	0.4%
Laser Power Capability, CW (W/cm^2)	500	500	500
Laser Power Capability, 100 ns pulsed (MW/cm^2)	400	400	400
Laser Power Loss, Including Lens[6]	<3%	<3%	<3%
Operating Temperature (°C)	25 +/- 10		
Weight (Kg. without objective lens)	2.87		

[2] From surface facing target to target plane, see Figure 3.1.
[3] Thermal drift due to idling
[4] Thermal drift due to most aggressive operation in worst environment
[5] Grid corrected, Geometric Distortion includes lens distortion, while linearity does not
[6] Includes lens and mirror losses

Storage Temperature:	-10°C – 60°C
Ambient Operation Temperature:	0°C – 50°C
Humidity:	Non-condensing
Voltage Input	±15V – ±18V
Quiescent Current	+500mA, -300mA
Peak Current	4 Amps
Ripple	100 mV
Noise	≤ 0.5% DC to 30MHz

Mirrors:

	YAG	DG	DS
Wavelength	1,064 nm	2000-16,000 nm	450-700 nm
Coating	Dielectric	Durable Au	Durable Ag
Reflection (min.) @ Wavelength (nm)	99.5% @ 1,064 >80.0% @ 450-650	>98.8%	>98.0%
Flatness @ 633 nm	λ/4	λ/4	λ/4
Power Capability, CW (W/cm²) MAX	500	500	500
Power Capability, 100 ns pulsed (MW/cm²) MAX	400	400	100
Surface Quality (Scratch/Dig)	40/20	40/20	40/20

2.3 System Description – Analog Interface

The Analog Interface HB™ system configuration includes the head itself and optional field flattening lens kit. This configuration requires the user to supply analog voltages to command the galvanometers within the head. A differential input signal of ±3V will command a maximum deflection of ±20° optical. The user must supply power (power supply specifications provided in section 2.2 Specifications – All Configurations) and cabling for both 25-pin Analog I/O Connection and 9-pin Power Connection. Pin-outs are provided on following page. A functional description of each pin is provided in section 2.3.2 Analog Pin-Out Description. Below Figure 2.2 shows the physical layout of Analog Interface HB.

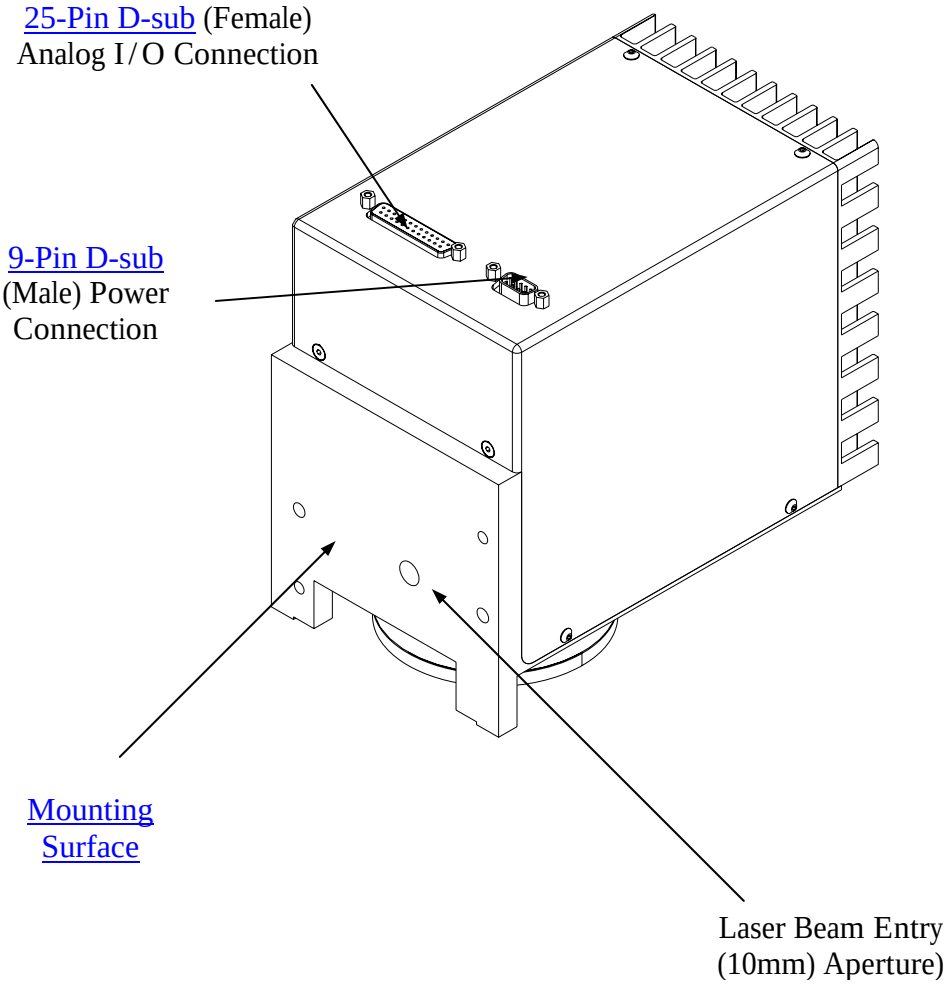
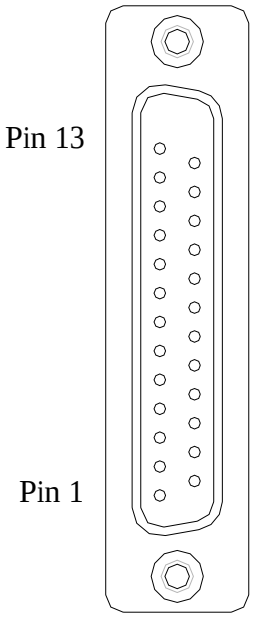
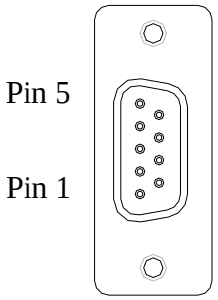


Figure 2.2: Analog HB™ configuration, points of interest with links to further information about those points. Optional YAG 160 Lens Assembly shown. General physical characteristics; for exact dimensions see Appendix B: Outline Drawings.

2.3.1 Analog Interface – Pin-Outs

INTERFACE	PIN	ASSIGNMENT
 25-Pin D-sub (Male) Analog I/O Connection	 13 25 11 20 23 9 7 12 24 10 21 22 8 6 19 18 16 15 3 1,2,4,5, 14,17	***X Axis Connections*** +X COMMAND -X COMMAND SIGNAL GROUND SERVO ENABLE SERVO READY +X POSITION READBACK -X POSITION READBACK ***Y Axis Connections*** +Y COMMAND -Y COMMAND SIGNAL GROUND SERVO ENABLE SERVO READY +Y POSITION READBACK -Y POSITION READBACK ***Sync Connections*** SYNC 1 SYNC 2 SYNC 3 SYNC 4 SYNC GND ***Reserved Pins*** NC

INTERFACE	PIN	ASSIGNMENT
 9-Pin D-sub (Male) Power Connection	 4, 5, 9 3, 7, 8 1, 2, 6	 +Vin GND -Vin

2.3.2 Analog Pin-Out Description

Each control signal interface 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 Table 3.2.

Command Input

The command input to the servo is a true differential input of ±3V. The maximum input voltage (before triggering over-voltage protection) is ±3.25. The input impedance looking into one of the command input pins while having the opposite grounded is 17.8kΩ.

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-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.

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.

Scanner Position

A full-scale signal voltage of ±3V corresponding to the position of the scanner is provided at pins 7 and 8 for each axis at the given 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.

Sync Input

The sync input pins are 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. A multiple tune configuration is considered a non-standard feature and is only implemented on request. For further information contact Customer Support.

2.4 System Description – Digital Interface

The Digital Interface HB™ configuration has the same physical layout as the Analog configuration. Refer to Figure 2.2 as needed; note that the Analog I/O Connection is Digital for this configuration. Below is a diagram displaying how a typical Digital Interface HB™ system interconnects to control electronics. The female 25-pin connection on HB™ corresponds to the pin-outs of the HC/3 card that resides in a PC. The Digital Interface Cable connects the HC/3 to the HB™ head. Pin-outs for both signal and power connections are provided on following page. The communication between the HC/3 card and HB™ scan head is the GSI Lumonics developed, industry standard GSI Protocol, as called XY2-100. A functional description of the pins can be found in the corresponding HC/3 Manual (see APPENDIX A: Additional Resources). The HC/3 has additional I/O to control a laser as well as trigger and read-in external events.

GSI Lumonics offers two software options for PC control of Digital Interface heads. PC-MARK MT is a DOS based software allowing vector commands to control a scan head. Also available is a Graphical User Interface called Job Editor that links with PC-MARK MT allowing graphic image on-screen to translate to an image produced on the target plane by the scan head. WinMCL Plus is a Microsoft Windows NT® family based software (including 2000 and XP) providing driver libraries that can be developed by the user. Refer to corresponding PC MARK MT or WinMCL Plus software manual for more information. Part numbers are provided in APPENDIX A: Additional Resources.

A Typical Digital Interface HB™ system includes:

- HB™ Scan Head – Digital Interface and optional Field Flattening Lens
- HC/3
- Digital Interface Cable (available as an option in 3m and 10m lengths)
- Software package WinMCL Plus or PC-MARK MT with optional Job Editor front-end

The user must supply power (power supply specifications provided in section 2.5 Specifications – All Configurations) and cabling for 9-pin Power Connection and for Laser Control.

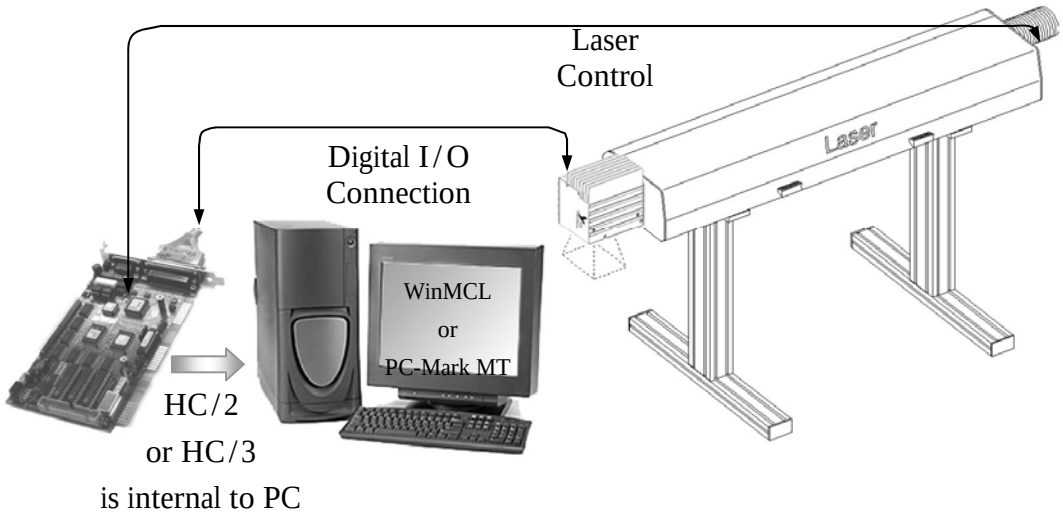
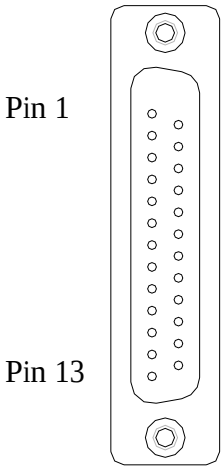
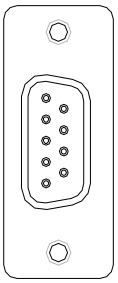
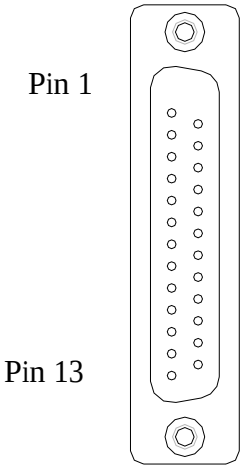


Figure 2.3: Descriptive Diagram of a Typical Digital Interface HB™ System

2.4.1 Digital Interface (Dual Connector Option) – Pin-Out

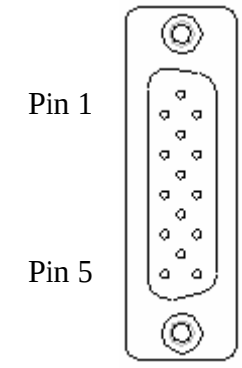
INTERFACE	PIN	ASSIGNMENT
 25-Pin D-sub (Female) Digital I/O Connection	 1 14 2 15 3 16 4 17 5 18 6 19 7 – 13 20 – 25	***HC/3 Connections*** SENDCK - SENDCK + SYNC - SYNC + CHANNEL X - CHANNEL X + CHANNEL Y - CHANNEL Y + RESERVED FOR Z AXIS RESERVED FOR Z AXIS STATUS - STATUS + ***Reserved Pins*** NC NC
INTERFACE	**PIN**	**ASSIGNMENT**
 9-Pin D-sub (Male) Power Connection	 4, 5, 9 3, 7, 8 1, 2, 6	 +Vin GND -Vin

2.4.2 Digital Interface (Single Connector Option) – Pin-Out

INTERFACE	PIN	ASSIGNMENT
 25-Pin D-sub (Female) Digital I/O Connection		***HC/x Connections***
	1	SENDCK -
	14	SENDCK +
	2	SYNC -
	15	SYNC +
	3	CHANNEL X -
	16	CHANNEL X +
	4	CHANNEL Y -
	17	CHANNEL Y +
	5	RESERVED FOR Z AXIS
	18	RESERVED FOR Z AXIS
	6	STATUS -
	19	STATUS +
		Power Supply Connections
	9, 10, 22	+Vin
	11, 23, 24	Gnd
	12, 13, 25	-Vin

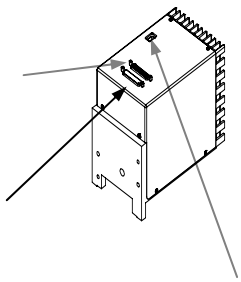
Note:
If the system has a power source not accessible through the single 25-pin connector, an adaptor cable needs to be created converting the single connector pinout above to the two separate connectors pinout described in section **Error! Reference source not found.** above.

2.4.3 TuneMaster™ Interface (Relevant heads) – Pin-Out

INTERFACE	PIN	ASSIGNMENT
 15-Pin HDB (Male) Communication & Probes Connection		***HC/x Connections***
	1	[Reserved]
	6	[Reserved]
	11	D-GND 2
	2	TXD
	7	-CTS
	12	[Reserved]
	3	RXD
	8	-RTS
	13	[Reserved]
	4	Probe 1
	9	Probe 2
	14	D-GND 1
	5	Y Position
	10	A-GND
	15	X Position

2.5 System Description – ScribeSmart™ with Laser Interface

The ScribeSmart™ control interface HB™ configuration has the ability to connect directly to a laser, not requiring a permanent attachment to a PC. The ScribeSmart™ control configuration includes one male 9-pin and one female 37-pin D-sub style connectors, while all other physical aspects remain the same as the Analog Interface head. Below is a diagram describing interconnections between components of a ScribeSmart™ interface HB™ system. The male 9-pin connection contains power, while the female 25-pin connection is the Laser Interface including RS232, 8-bit digital port, signals to support features of all types of lasers, binning ports, and user control signals. To maintain maximum flexibility within the multitude of system configurations, users must provide cabling for both connections to the head. Pin-outs of the connections are provided on the following page. Further description of each pin's function is provided in the ScribeSmart™ manual.



When the head is connected properly, the ScribeSmart™ software package can be used to create programs that command the movement of the galvanometers in addition to controlling laser parameters. Programs can be uploaded from a PC to the head via the Serial Link Cable and saved into flash memory. Once the head has been programmed the PC connection is no longer necessary. All operations of the HB™ head can be triggered externally. Refer to corresponding ScribeSmart™ Software manuals listed in APPENDIX A: Additional Resources.

The ScribeSmart™ Interface HB™ system includes:

- HB™ Scan Head and optional Field Flattening Lens
- Serial Link Cable
- ScribeSmart™ Software package

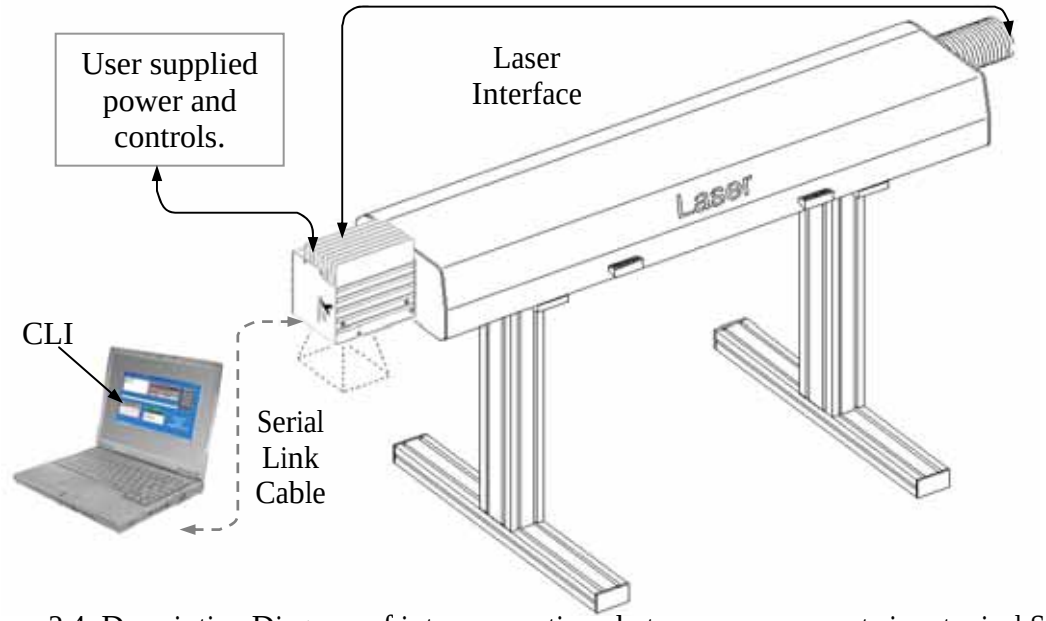
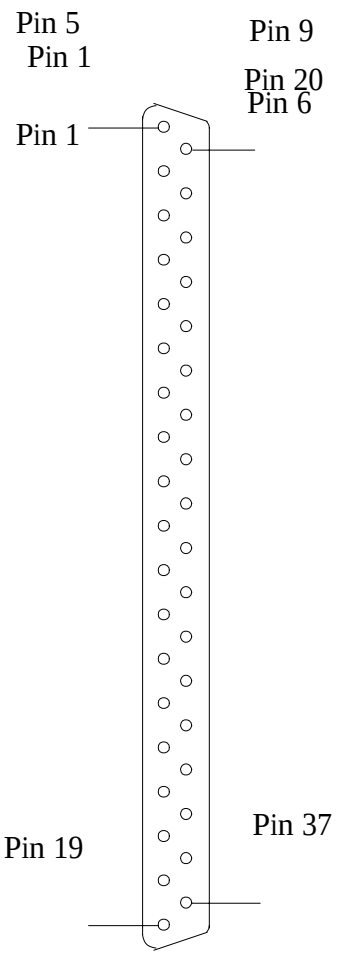
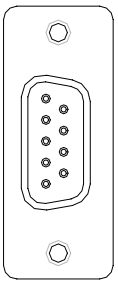


Figure 2.4: Descriptive Diagram of interconnections between components in a typical ScribeSmart™ Interface HB™ System

2.5.1 SC2000 Interface – Pin-Out

INTERFACE	PIN	ASSIGNMENT
 37 Pin D-sub (Female) User's I/O Connection	1 20 2 21 3 22 4 23 5 24 6 25 7 26 8 27 9 28 10 29 11 30 12 31 13 32 14 33 15 34 16 35 17 36 18 37 19	Position Encoder B (input) Position Encoder A (input) +5 V isolated (output) Ground (Isolated) Mark_In_Progress (output) Mark_Error (output) Remote_Execute (output) Flag_Input (input) Abort_Mark (input) Begin_Mark (input) Binning 5 (input) Binning 4 (input) Binning 3 (input) Binning 2 (input) Binning 1 (input) Binning 0 (input) Shutter Relay 1 (output) Shutter Relay 2 (output) Ground (chassis) Shutter Input (input) Ground (isolated) FPS (output) +5 V isolated (output) PWM LM (output) RS232 (TXD) (output) RS232 (-CTS) (input) RS232 (RXD) (input) RS232 (-CTS) (output) Laser Power +10V DAC (output) 8-Bit Digital Port 7 (output) 8-Bit Digital Port 6 (output) 8-Bit Digital Port 5 (output) 8-Bit Digital Port 4 (output) 8-Bit Digital Port 3 (output) 8-Bit Digital Port 2 (output) 8-Bit Digital Port 1 (output) 8-Bit Digital Port 0 (output)
INTERFACE	**PIN**	**ASSIGNMENT**
 9-Pin D-sub (Male) Power Connection	4, 5, 9 3, 7, 8 1, 2, 6	+ Voltage GND -Voltage

3 INSTALLATION

GSI Lumonics recommends that you fully enclose and interlock the zone of hazard for your application to prevent possible opening while the laser is energized. If laser radiation exceeding Class 1 levels may exit the enclosure, you must have available suitable protection for your eyes.

3.1 Mounting HB™ X-10 Scan Head

The scan head has two holes to receive dowel pins for head alignment in addition to two M6 (metric) threaded holes for mounting. GSIL recommends creating a mounting flange that will match the mounting holes on the beam input side of the assembly, shown below in Figure 3.1. Use the outline drawings in Appendix B Technical Outline Drawings to determine the dimensions for the manufacture of a mounting flange.

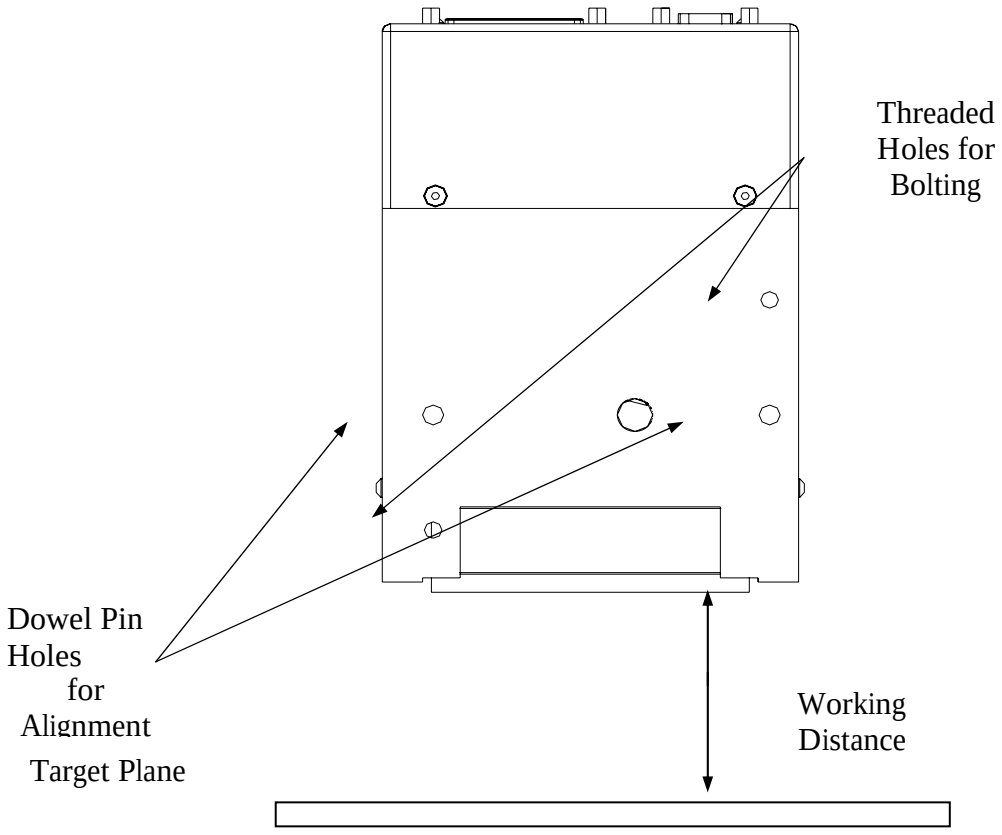


Figure 3.1: The mounting holes are located on the Beam Input side of the HB™ assembly. General locations of the two types of mounting holes are described. For exact dimensions see APPENDIX B: Outline Drawings.

4 SAFETY AND WARNINGS

The United States Food and Drug Administration, through the Center for Devices and Radiological Health (CDRH), has promulgated regulations (21 CFR parts 1000 and 1040) controlling the safety of lasers and laser products for sale or manufacture in the United States.

This section is a guide to the specific areas of this product where laser safety should be addressed. GSI Lumonics Scan Heads are designed to provide maximum flexibility and ease of use. Such a design inherently requires the user to assure the overall safety of the configuration in use.

Note: Prior to operating any configuration of the GSI Lumonics Scan Heads, you must make a thorough analysis of system safety. Key information for this purpose is contained in this manual. You should become familiar with all this information before proceeding.

A full description of laser hazard analysis is beyond the scope of this manual. A technical survey of laser safety requirements can be found in **ANSI Z136.1**, **"American National Standard For the Safe Use of Lasers"**. This is available from:

American National Standards Institute, Inc.
1430 Broadway
New York, New York 10018
www.ansi.org

Among the many other sources of laser safety information, the following institution offers several excellent publications:

The Laser Institute of America
5151 Monroe Street, Suite 118W
Toledo, Ohio 43623
www.laserinstitute.org

Your Laser Safety Officer or a competent specialist in this field should make final analysis of all safety features. The first consideration in a safety analysis is the laser mated to the GSI Lumonics Scan Heads. The Laser Class label on the device indicates the approximate hazard level of the laser. Refer to **ANSI Z136.1** for definitions of laser classes and labeling information. Note that, besides radiation, lasers may present other hazards, e.g. electric shock or creation of poisonous fumes.

Note: The GSI Lumonics Scan Heads provide you with the ability to aim the laser beam over a roughly pyramidal volume. The divergence of the focused beam beyond the focal point, which is a function of the lenses selected and their position, can cause radiation to exit the pyramid. When analyzing safety, you must consider all regions within this aiming pyramid, the divergent beam, and the effects of all focal possibilities in the zone of hazard. Reflections must also be considered.

4.1 Laser Shutter Installation

The laser attenuator (shutter) is not included with the Scan Head. Because each laser is unique, it is the user's responsibility to insure that such a device is incorporated as required.

CFR 1040.10 [f] [6] states:

> "A beam attenuator is required on Class II, IIIa, IIIb and IV laser systems. The beam attenuator is a mechanical or electrical device such as a shutter or attenuator that blocks emission. The beam attenuator blocks bodily access to laser radiation above Class I limits without the need to turn off the laser. The beam attenuator must be available for use at all times during operation. Power switches and key controls do not satisfy the attenuator requirement."

Refer to CFR 1040.10 for more information.

The beam shutter should be installed between the laser head and the Scan Head. The following figure shows the recommended location of the shutter.

We strongly recommend that you specify a laser with a vendor-supplied shutter mechanism. If this is not possible, consult the laser vendor to design a proper safety shutter.

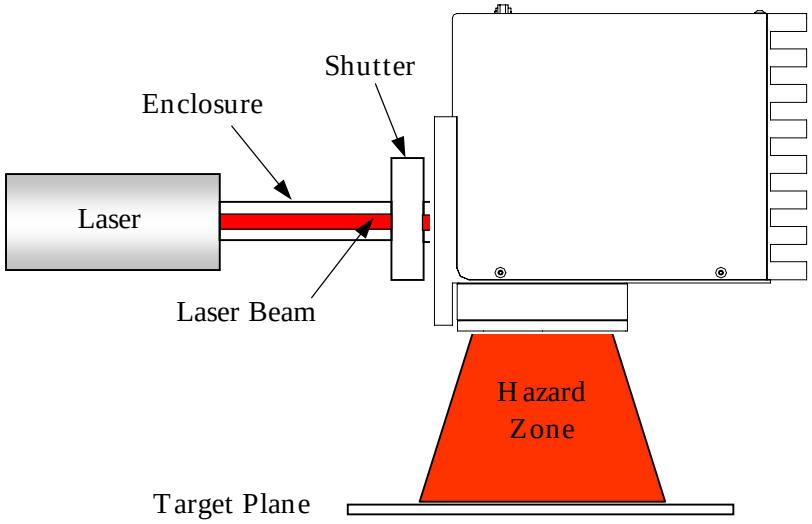


Figure 4.1: The laser's internal and external optical path towards the target plane, specifically where the hazard zones are located as the optical beam passes through the HB™ Scan Head.

Final analysis of the system should be performed by a Laser Safety Officer, or a competent specialist in this field.

4.2 Installation Safety Requirements

For the Digital and SC2000 interfaces of the HB™ Scan Head, the head should be inter connected for software shut down of the laser. This will ensure safety during operation, error or recovery of the Scan Head. The SC2000 Interface provides two Shutter Relay control signals as well as a sensor input to feedback shutter status. Refer to SC2000 user manual for connection specifications and software commands.

In all cases, we recommend that you fully enclose and interlock the zone of hazard for your application to prevent possible beam deflections while the laser is energized. Refer to ANSI Z136.1 to determine what protective equipment is required.

At no time should you stare into the beam, place any parts of your body in the beam path, or expose yourself to reflections of powerful beams. You should use only a Class 1 HeNe Laser for alignment. If this is not possible, you should use the available laser's lowest power
Using optical instruments with this product increases eye hazard.

Additional Safety requirements may be applicable during initial alignment of the optical system. Refer to Section 4 Safety and Warnings.

5 HANDLING / MAINTENANCE

GSI Lumonics XY Scan Heads do not contain any user serviceable or user maintainable parts. However, you should visually inspect all optical surfaces each time lenses and alignment mirrors are handled.

All contamination on optical surfaces must be removed prior to operation or serious damage and/or hazard may result. The Scan Head must be protected from airborne contaminates. Dust attaching through impact or vapors condensing on the optical surfaces reduces the mirror's reflectivity. Furthermore, avoid scanner exposure to dust, condensation or cleaning fluids.

- **Make sure that the laser is off before performing any inspections! Wear finger cots or cotton gloves when handling optics.**
- **You must be extremely careful not to allow contaminates from entering the galvanometer itself. Serious scanner damage may result.**

If you feel that cleaning or service is necessary, contact the customer service group at GSI Lumonics for information regarding service.

5.1 Handling and Mounting a Lens

If the user has purchased a Lens Kit, it will come mounted to the Scan Head.
If you have not purchased a lens kit with your Scan Head, and you are installing your own lens, or you are removing a lens, follow the steps outlined below for handling and installing a lens.

Make sure that the laser is off before performing any inspections! Wear finger cots or cotton gloves when handling optics for inspection.

Below in Figure 5.1, an exploded Lens Kit Assembly and Scan Head drawing indicate how the Lens, Lens Holder and Scan Head attach to one another. The Lens Kit shown is an example of a YAG lens assembly. For a single element lens, a separate threaded ring screws in to hold the lens in place. Drawings of the Lens Kit Assemblies can be found in Appendix B: Outline Drawings.

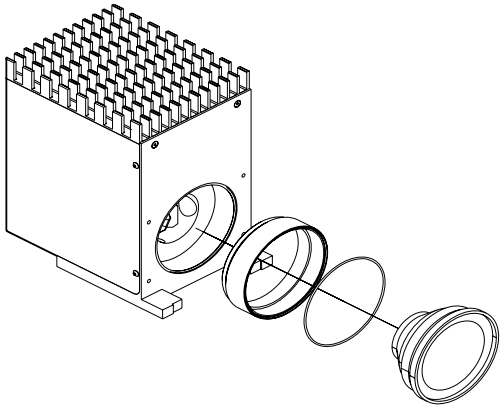


Figure 5.1: Exploded view of the lens mount assembly with optional F/160 YAG lens.

5.2 Mirror Cleaning

Although the user can replace the mirrors, we **do not recommend** you do so. Furthermore, GSI Lumonics **does not recommend cleaning front surface mirrors.** Mirrors damaged by cleaning are **not included under the warranty**. The surface of these mirrors damage easily. Prevention of hard dust particles from being entrained in the process and causing scratches is difficult. In many cases, small defects in the mirror's surface may be less harmful than the surface damage resulting from continued cleaning. Cleaning requires special equipment typically not available to typical users.

There are times, however, when cleaning the mirror becomes a necessity, e.g. stains such as fingerprints must be removed immediately to prevent permanent etching of the reflective surface. The information below includes general recommendations for those special occasions when mirrors must be cleaned.

Remove lint from mirrors with a jet of low pressure clean air or nitrogen. Blowing on front surface of mirrors with mouth deposits moisture that may stain the finish.

A thin overcoating of silicon monoxide protects most mirrors from oxidation. Like many optical coatings, it is easily damaged when attempts are made to clean the mirror surface with a dry tissue.

The safest method of cleaning is to place a piece of lens tissue wet with reagent grade (highly pure) alcohol. Lay the wet tissue over the surface of the mirror, gently agitate it, then slide the tissue off. If an uneven film remains when dry, repeat the process, but use a jet of low pressure clean air or nitrogen to quickly spread remaining liquid. This should remove the problem blemishes.

- Note that the mirror is not rubbed.
- Do not let solvent enter the bonded zone of the mirror.
- Do not let solvent enter the scanner bearings. When wetting the mirror's surface, hold the Scan Head at an angle so that the liquid does not wet the scanner. If any solvent is found in the bearings of the scanner, the warranty is voided.

6 TROUBLESHOOTING

If you encounter problems with a HB™ Scan Head, check the following matrix. If you cannot solve the problem, contact GSI Lumonics technical support for further assistance.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
1. Decrease in marking quality.	1. Dirty or Damage lens or protection glass.	1. Clean glass per instructions in Maintenance Section. 2. Replace protection glass
	2. Drop in output power.	1. Check laser power.
2. Laser will not mark when ordered by computer.	1. Laser modulation malfunction.	1. Check connections between laser controller and laser.
	2. No power to galvanometers.	1. Check power connections to scanning head.

7 GLOSSARY

Galvanometer: Extremely linear limited rotation magnetic torque motor. The galvanometer (galvo) rotates a mirror to direct the laser beam.

CLI: Command Line Interface is the front-end software used to compile and deliver vector commands to the SC2000.

DAR: Digital to Analog Receiver converts digital sequences from the HC/2 or HC/3 card and converts them to analog signals for commanding each galvanometer within a scan head.

HC/3: A PCI card internal to a PC providing the hardware link between software commands and a scan head. Optoisolation and I/O for laser control and parts handling are additional features. The HC/3 is fully compatible with PC-MARK MT (multitasking) software and WinMCL.

HPGL: HP® Graphics Language, a graphics format which PC-MARK MT or WinMCL can translate into vector data for scanning.

PC-MARK MT: A front-end macro command language. PC-MARK MT accepts application commands to place text and graphics in the marking field and translates them into the appropriate lists of vectors. Users may also write their own PC-MARK MT programs in any one of many popular software languages. The sub-language of PC-MARK, MMCL is utilized as the link to the HC/2 card.

JOB EDITOR: A menu-driven application program of PC-MARK MT that provides a graphics user interface and file management. It allows the user to manipulate HPGL based graphics with an accurate real preview of one's job.

SC2000: Scan Controller built into the SC2000 Interface HB™ that can command two galvanometers in response to real-time software commands or programs stored in its flash memory. In addition, the Laser Interface attached to the SC2000 can control parameters of all types of lasers using CLI software commands.

WinMCL Plus: Developer level, Windows© NT based macro command language. Programs can be written in a Visual C++ environment to invoke positioning. The language also supports some laser control features. It interfaces with both the HC/2 and HC/3 card.

8 APPENDIX A: ADDITIONAL RESOURCES

Digital Interface:

PC-MARK MT™ / PC-MARK Command Reference: GSIL P/N: 176-25008

PC-MARK MT Programmer's Manual: GSIL P/N: 176-25015

HC/3™ and HC/3 M-S [HelperCard III] PC Hardware Controller Reference Manual: GSIL P/N: 7OM-034

WinMCL32 Technical Reference: GSIL P/N: 7OM-033

ScribeSmart™ Interface:

SC2000 Command Reference: GSIL P/N: 7OM-029

SC2000 Support Programs Manual: GSIL P/N: 7OM-030

SC2000Li Laser Interface User Manual : GSIL P/N: 7OM-1017

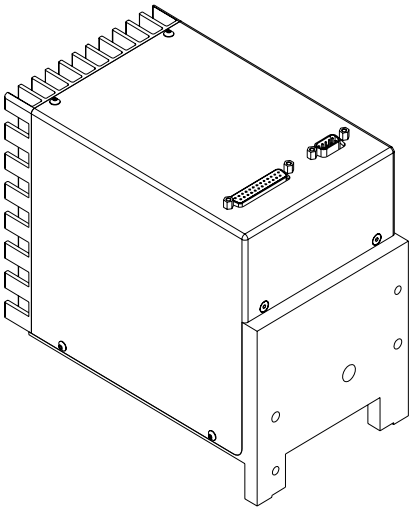
ScribeSmart™ User Manual : GSIL P/N: 7OM-1117

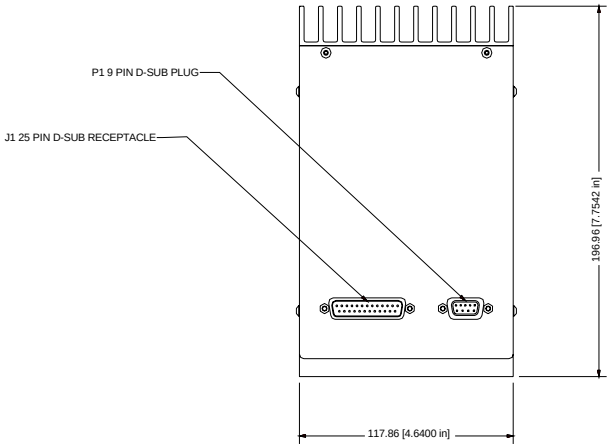
9 APPENDIX B: OUTLINE DRAWINGS

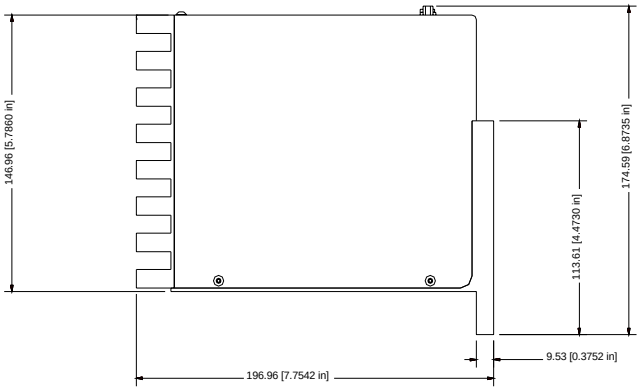
Specifications and outline drawings defined in this user manual represent standard product, and may vary by model. Contact customer support for specifications and drawings related to customer configurations.

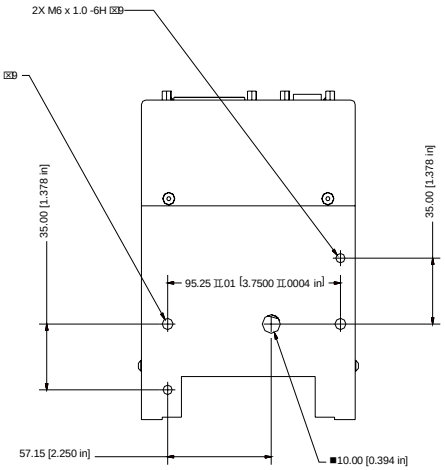
- HB™ X-10 Analog/Dual-Connector DAR Interface Scan Head
- HB™ X-10 Single DAR Interface Scan Head & ScribeSmart™ Interface Scan Head
- YAG F/160 Lens Kit 98mm Field
- YAG F/254 Lens Kit 156mm Field
- CO2 F/100, F/200, and F/300 Lens Kit. 70mm, 140mm, and 210mm Fields

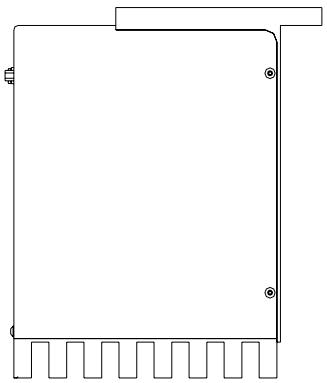
9.1 HB™X-10 Analog or Dual-Connector Digital Interface Scan Head

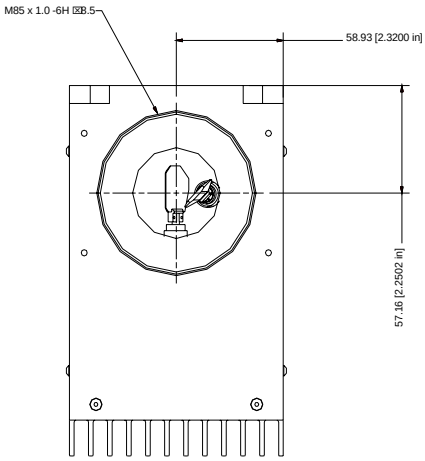






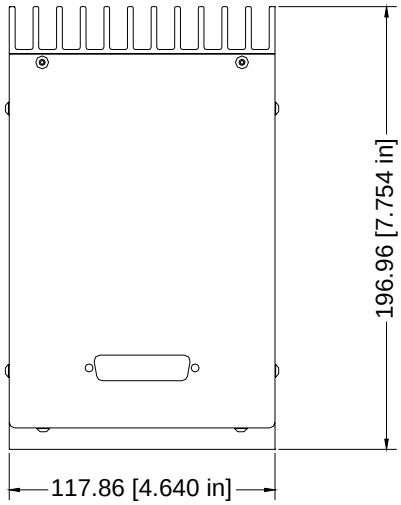




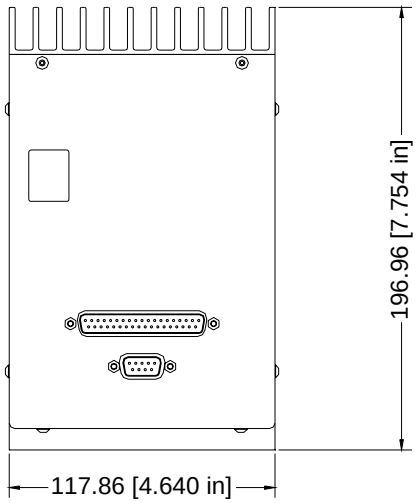


All standard HB™ X-10 Scan Heads have the same dimensions, except for differences in electrical connector locations. Please see Section 2.5 System Description - SC2000 Interface or contact Technical Support if you require more information.

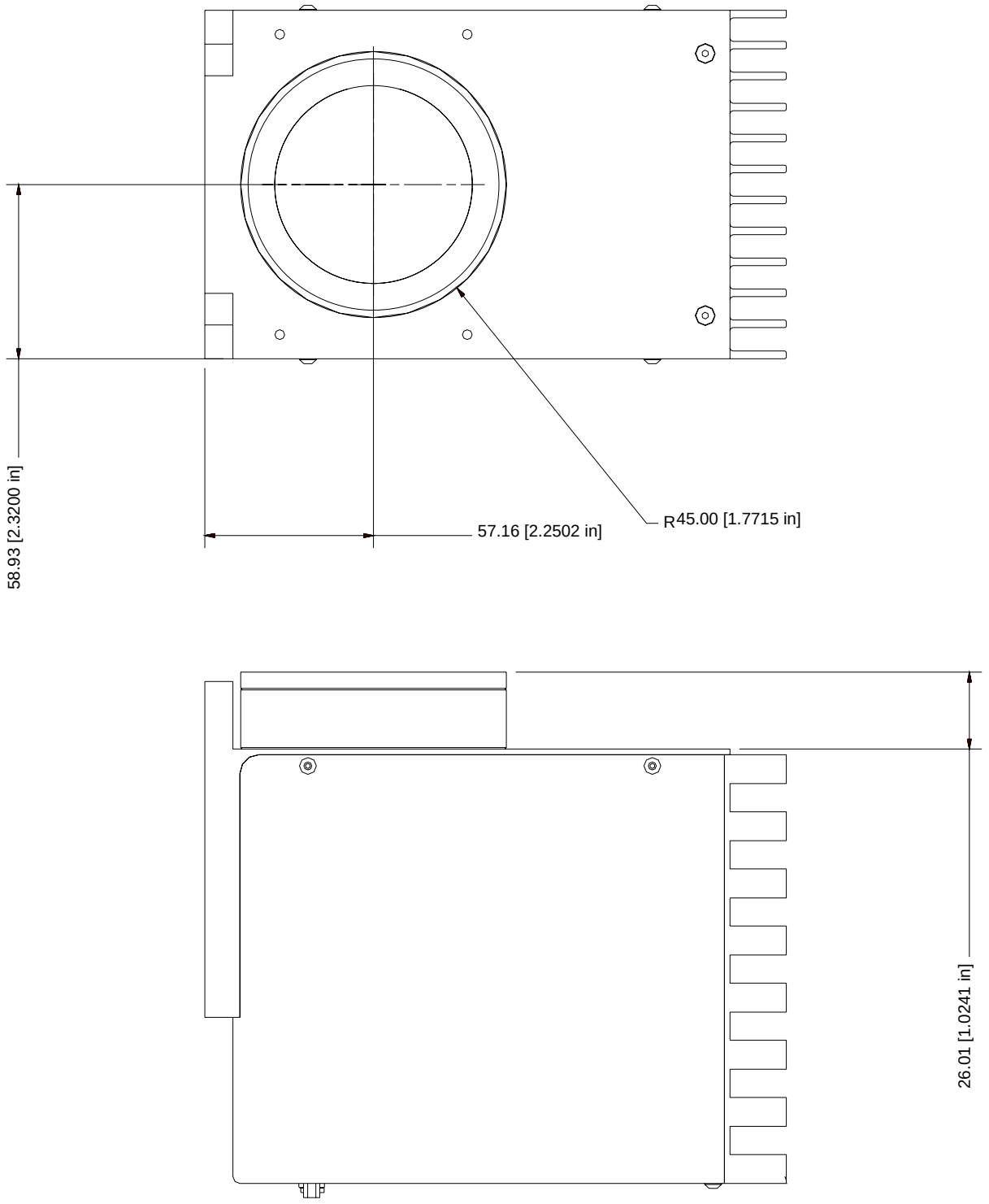
HB™ X-10 Single Connector Digital Interface Scan Head



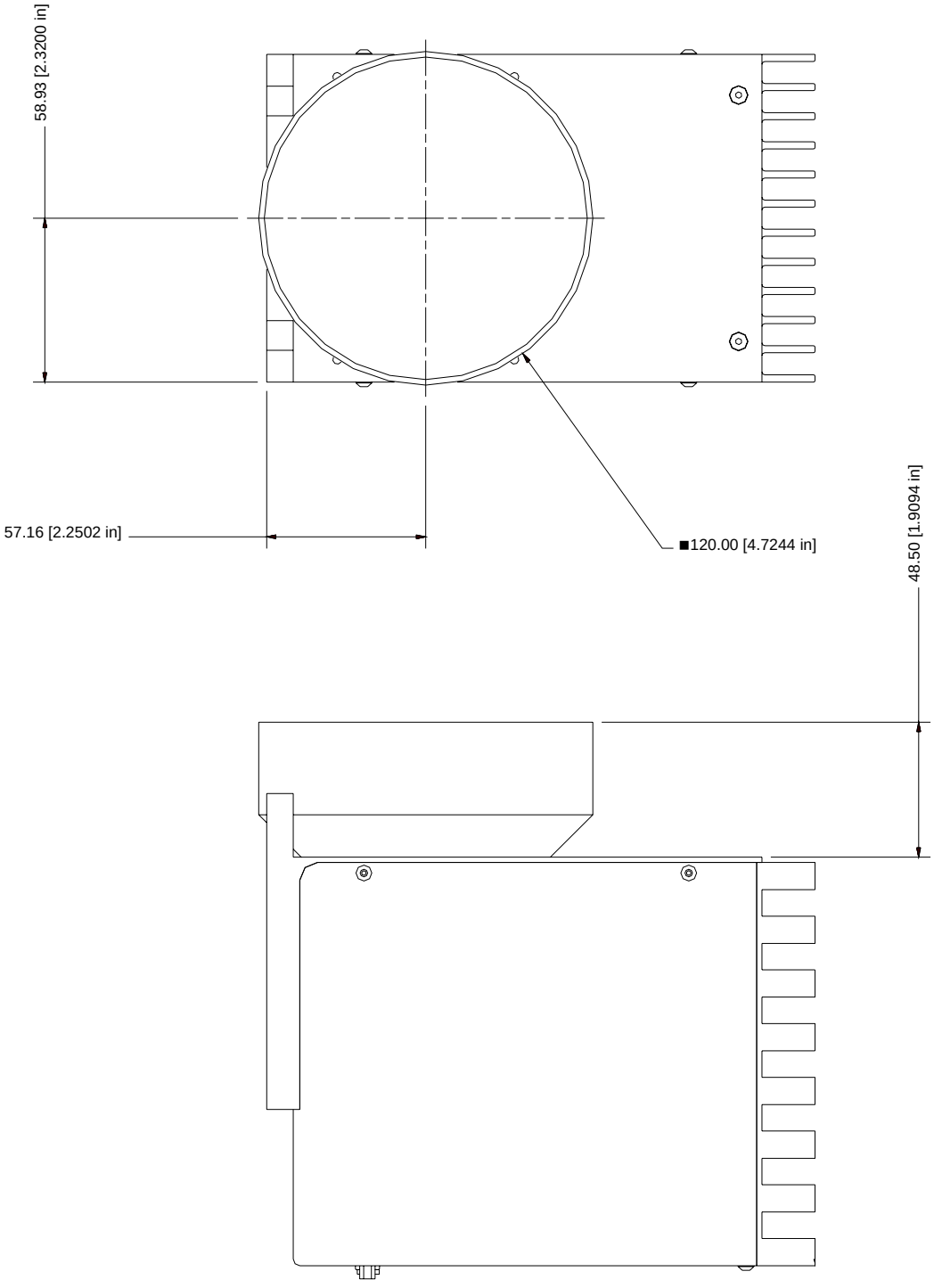
HB™ X-10 ScribeSmart™ Interface Scan Head



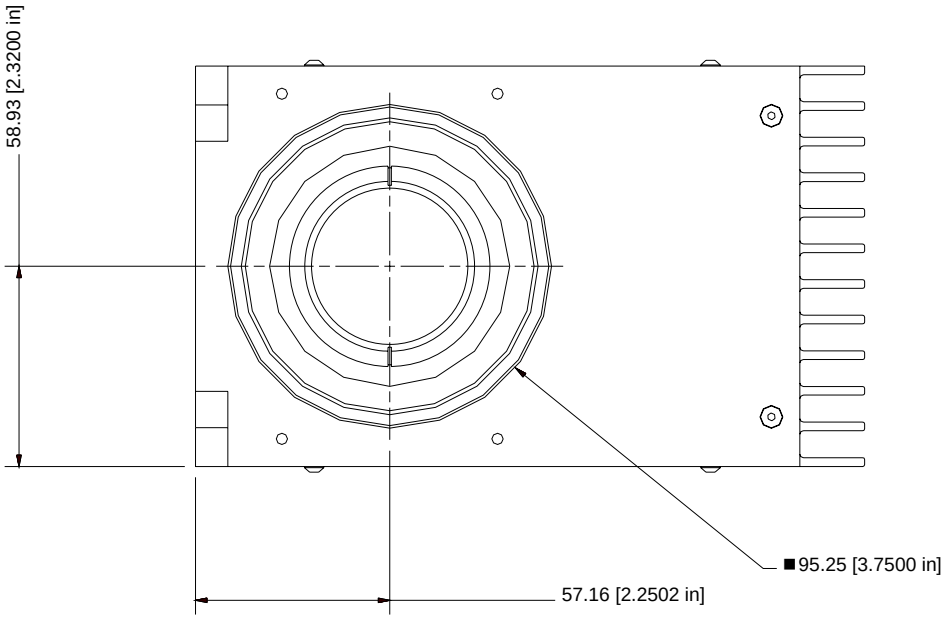
9.2 YAG F/160 Lens Kit 98mm Field

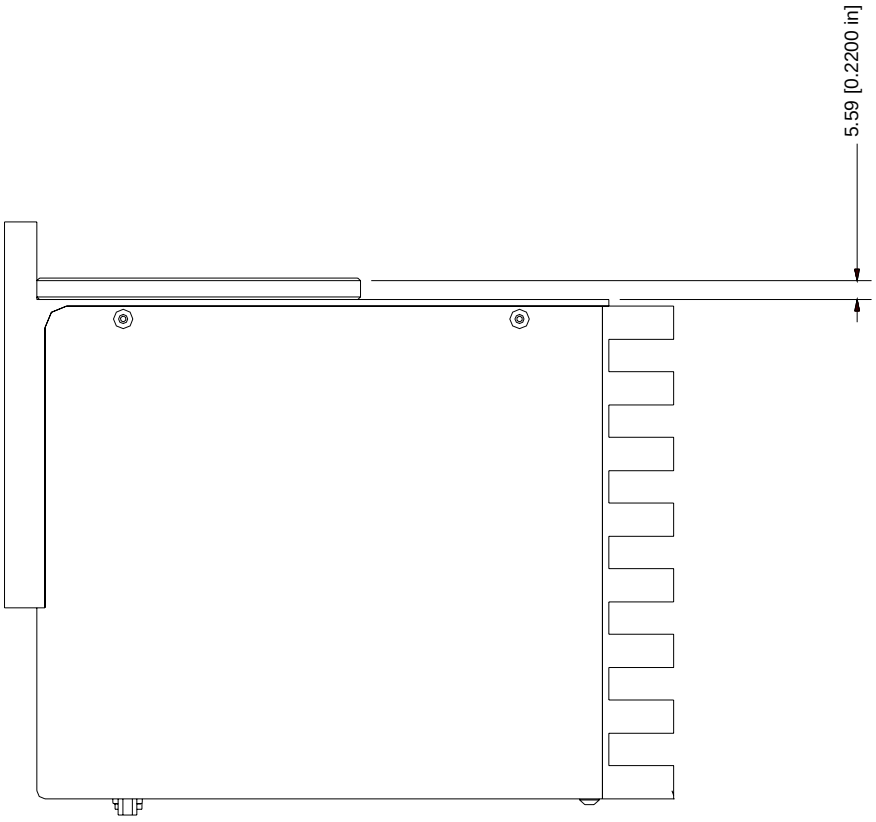


9.3 YAG F/254 Lens Kit 156mm Field



9.4 CO2 F/100, F/200, and F/300 Lens Kit. 70mm, 140mm, and 210mm Fields





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