

GSI Lumonics

**XY10M2T Open Frame
With DAE
Hardware Manual**

XY10M2T Open Frame Scan Head

**GMAX™ SYSTEMS
MULTI-AXIS BEAM HANDLING**

P/N E80-21477

Rev. C

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1. INTRODUCTION

This manual details the instructions on how to install and operate hardware of the High Performance Laser Scanning Module (**XY10M2T Open Frame**). Included is information on setting up the hardware in preparation for your software commands, at which point you can refer to the proper software manual.

Be careful to observe the information in the Environmental Requirements section that alert you to the hazards and the laser beam path you can expect while running the **XY10M2T**.

Many of the details in this manual refer to the **XY10M2T** Open Frame Scan Head used within the **XY10M2T** module. This is because the **XY10M2T** Open Frame head is **extremely intricate**, and since it consists of the galvanometers that reflect the laser beam, it can be hazardous if certain precautions are not taken. Please be alert to the safety considerations and specific procedures regarding the **XY10M2T** head and the laser you are using.

Conventions

Throughout the manual you will see graphic icons representing pertinent information in the text. The purpose of these icons is to provide a visual convention to alert you of a stop in the flow of the manual, where an important note or safety hazard alert is posted.

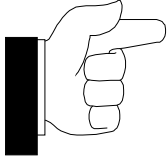

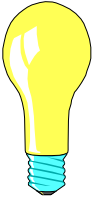
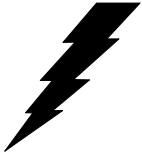

NOTE is an important procedure you should be aware of before proceeding.

CAUTION alerts you of a potential danger to equipment or the user.

WARNING indicates an imminent danger to the user.

TIP and **REMINDER** are helpful hints to procedures listed in the text.

The conventions are listed as follows, showing both the text and the picture you will see.

NOTE	CAUTION	TIP	WARNING	REMINDER
				

GMAX,HC/2,HCI,PC-MARK MT, HPM and HPLK are trademarks of GSI Lumonics, Microsoft, MS-DOS and Windows are registered trademarks of Microsoft Corporation.

HP is a trademark of Hewlett-Packard Company.

1.1 Warranty

GSI Lumonics (GSLI) warrants this product to be free from defects in materials and workmanship for 12 months from the date of shipment. GSLI will, at its option, repair or replace the product if it is defective within the warranty period and returned, freight pre-paid, to a service center designated by GSLI.

GSI Lumonics requests that customers obtain a Return Authorization Number prior to returning units, and that they carefully pack units in their original packing or equivalent.

Under warranty, GSLI is not obligated to repair damage to any units resulting from the following conditions (customers are responsible for defining which conditions are applicable to their product):

- a) Personnel other than GSLI representatives attempting to repair or service the product.
- b) Improper use of the equipment.
- c) Connecting the product to incompatible equipment.
- d) Personnel other than GSLI representatives modifying the product.
- e) Scratches and chips on any optical surface after three weeks from the date of receipt.
- f) Damage to any optical surface from improper handling or cleaning procedures. This applies specifically to those items subjected to excess laser radiation, contaminated environments, extreme temperature or abrasive cleaning.

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.



NOTE

There is no implied warranty of fitness for a particular purpose, and GSLI is not responsible for consequential damages. Individual components manufactured by GSLI or others may be covered by their own warranties. Refer to the appropriate manuals for this information.

1.2 Customer Support

GSI Lumonics has support services available to you concerning problems with either the product or manual you are using.

Before calling for assistance, please make sure you refer to any appropriate sections in the manual that may answer your questions. The “Outline Drawings / Data Sheets” in Appendix B may be particularly helpful. If you need further assistance:

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



U.S. (Massachusetts):	(781)-275-1300 +01 978-661-4300 (outside the U.S.)
Germany (Munich):	+49 89 8989 91340
Italy (Monza):	+39 39 2025387
UK (Banbury):	+44 132 787 2424
Japan (Tokyo):	+81-3-3406-7990

... ask for the Customer Service Department

1.3 Unpacking

The package you receive will include those items mentioned in the packing list is included in the shipment that details the exact items shipped.

- a) CAREFULLY unpack the contents from the box.
- b) Save shipping container and packaging material in case you need to return unit for service.
- c) Check contents of the box against the packing list to assure all parts have been received.
- d) Inspect each item to assure it is not damaged.

2. GENERAL DESCRIPTION

2.1 Theory of Operation

The High Performance Open Frame Laser Scanning Module (**XY10M2T**) is a multi-purpose-designed module. The module consists of 2 galvanometer scanners (X and Y), and external Dual Axis Digital Driver Electronics.

GSI Lumonics' 2-mirror, 2-axis galvanometer Scan Heads provide the capability of deflecting optical beams in an XY manner for all possible laser applications. The synchronized actions of two galvanometer servo-controlled turning mirrors direct the laser beam to specific locations on a target material surface in both the X and Y directions, based on user supplied analog command signals.

2.2 General Description

The **XY10M2T Scan Head (Analog Interface)** is a basic building block for the construction of a laser beam positioning system, It is intended for use by OEM customers, integrators, and sophisticated end-users.

The ± 3 V analog interface has separate signal inputs for X- and Y-axis. Status signals provide indications of a fault of the X- or Y-axis.

± 15 V Input: 9 pin D sub connector male, mounted on the **DAE driver board**

Interface Connector : 25 pin D sub connector male, mounted on the **DAE Driver board**

GSI Lumonics provides the following items that make up the full XY10M2T package:

- **XY10M2T** Open Frame Scan Head with 2 galvanometer scanners and optics.
- External Dual Axis Analog Driver Electronics.
- Documentation.

The Customer must provide:

- A laser.
- A computer (optional)
- A method of mounting the **XY10M2T** Scan Head
- An analog interface cable
- Power supply with the following specifications:

Power Supply Specifications

Voltage V1/V2	± 15 V +60%-20%
Current	2A
Ripple	$\leq 0.2\%$
Noise	$\leq 0.5\%$ DC to 30MHz

2.3 Specifications

Environmental Requirements

Storage Temperature: -10°C to $+60^{\circ}\text{C}$
Minimum Operation Temperature: $+15^{\circ}\text{C}$
Maximum Operating Temperature: $+34^{\circ}\text{C}$
Humidity: Non-condensing

XY10M2 Scan Head

Specifications and Pin Configurations are located in "8. APPENDIX A: SPECIFICATIONS , 8.1 XY10M2T Scan Head".

Mirrors

Specifications are located in "8. APPENDIX A: SPECIFICATIONS , 8.2 XY10M2T Scan Head Mirror"

3. 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. GSI Lumonics **XY Scan Heads** are regulated by the CDRH.

This section is a guide to the specific areas of this product and to the manual(s). Pay particular attention to CDRH compliance information.

*User
Responsibilities*

GSI Lumonics **XY Scan Head** 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.

It is the user's responsibility to insure that:

- 1) Only lasers certified to comply to CDRH regulations are used with GSI Lumonics **XY Scan Heads**.
- 2) Certified lasers contain features to assist in their safe usage. These protective features and the protective features within the GSI Lumonics **XY Scan Heads** should not be defeated.



CAUTION

Prior to operating any configuration of the GSI Lumonics XY Scan Heads, you must make a through analysis of system safety. Key information for this purpose is contained in this manual. You would thoroughly familiarize yourself with all this information before proceeding.

Laser Hazard Analysis

A full description of laser hazard analysis is beyond the scope of this manual. A good 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*

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*

Final analysis of all safety features should be made by your Laser Safety Officer or a competent specialist in this field.

The first consideration in a safety analysis is the laser mated to the GSI Lumonics **XY Scan Head**. The hazard level of the laser is roughly indicated by the Laser Class label that is on the device. A brief description of the radiation classes are shown in the following table.

Note that, besides radiation, lasers may present other hazards, e.g.; electric shock or creation of poisonous fumes.

Classes and Characteristics of Lasers

LASER CLASS	DESCRIPTION
Class I	Lasers are not considered to be hazardous.
Class IIa	Lasers are hazardous if viewed for periods greater than one thousand seconds.
Class II	Lasers are chronic viewing hazards.
Class IIIa	Lasers may represent acute, intrabeam viewing or chronic or acute viewing hazards when viewed with optical instruments.
Class IIIb	Lasers are an acute hazard to skin and eyes from direct radiation.
Class IV	Lasers are an acute hazard to skin and eyes from direct or scattered radiation.



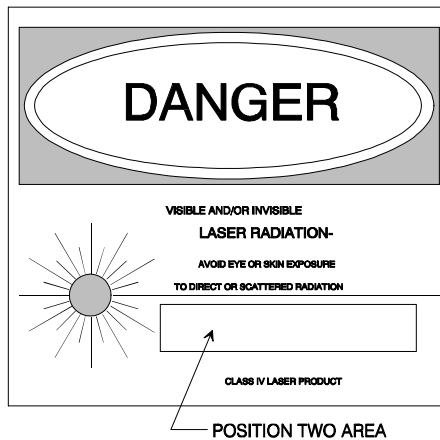
CAUTION

Do not use equipment outside of these ranges, as additional hazards may result.

Because we do not determine the laser used with our product, all GSI Lumonics end-user **XY Scan Heads** are labeled at the highest hazard level (Class IV). You should obtain information on output power or energy, wavelength(s) of output, duration of pulse, beam size and beam divergence from the manufacturer of the laser you are using.

The wavelength and power of the laser actually used should be written on the warning logo type label, Position 2. (See Section page 33699 and 33700 of the Federal Register, Appendix B). Be sure to use a permanent, indelible ink.

Class IV Warning Label



The Federal Register Rules and Regulations, Vol. 50, No. 161, dated Tuesday, August 20, 1985, contains the performance standards adopted by the Food and Drug Administration (FDA) which gives detailed information regarding the determination of laser classification and labeling. The ANSI and the FDA classifications are not the same. For purposes of labeling, use only the FDA classifications. If your laser falls in a classification below Class 4, replace the warning label type with the correct label and appropriate classification. The factory provides alternate labels upon request.



REMINDER

The GSI Lumonics **XY 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.

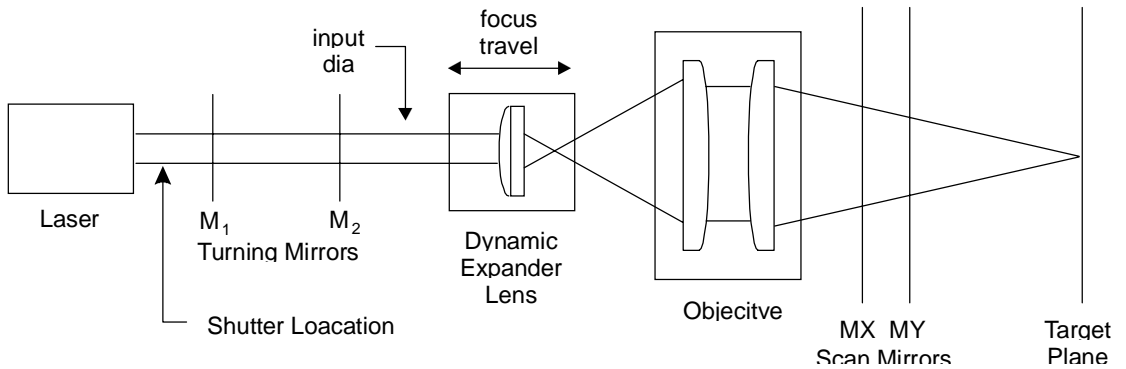
3.1 Laser Shutter Installation



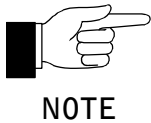
The laser attenuator (shutter) is not included with the **XY Scan Head**. Because each laser is unique, it is the user's responsibility to insure that such a device is incorporated in the installation in conformance with CFR regulations (1040.10[f][6]), which reads as follows:

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.

Example of Laser Shutter Location in a HPLK System

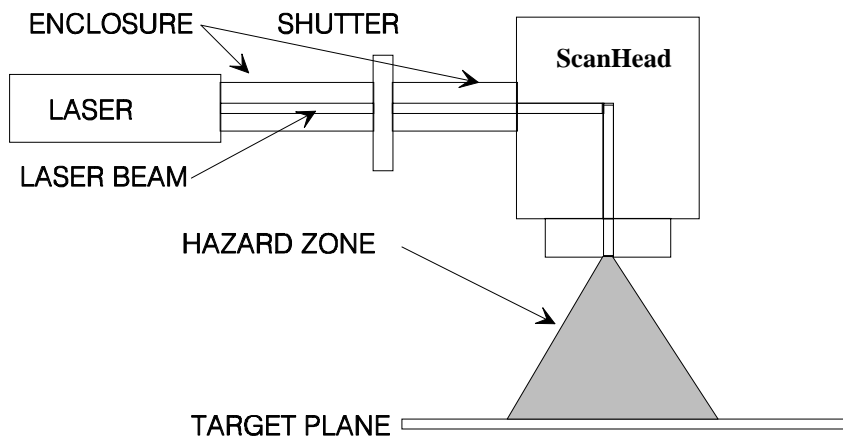


The beam shutter should be installed between the laser head and the Scan Head. The following figure shows the recommended location of the shutter.



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.

Laser Scanner Hazard Zones of an HPM Scan Head



The figure shows 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 **XYM2T Scan Head**

3.2 Installation Safety Requirements

Because of the possible hazard increase of scanning stopping or slowing to an unsafe velocity, it is required that the controller software shuts down the laser power (a scanning safeguard).

In all cases, we recommend that you fully enclose and interlock the zone of hazard for your application to prevent possible opening while the laser is energized. When laser radiation exceeding Class 1 levels may exit the enclosure, you must have suitable protection for eyes available.



NOTE

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 setting and remote beam sensing technique.



CAUTION

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, “Safety and Warnings”, Section 3.

GSI Lumonics XY Scan Heads are labeled in conformance to the requirements of 21 CFR parts 1000 and 1040.

4. INSTALLATION

Installation of the XY Scan Head and Driver Electronics are relatively simple.

Scan Head Installation

Three holes that will accept 1/4" screws have been provided in the baseplate. Additionally, two dowel pins have been placed in the baseplate, allowing repeatable alignment of the XY Scan Head to its mounting surface. Refer to outline drawings in the appendix for exact locations of these features.

Driver Electronics

Four holes that will accept M4 screws have been provided in the baseplate. Refer to outline drawings in the appendix for exact locations of these features.

5. 5. HANDLING / MAINTENANCE

The GSI Lumonics XY Scan Head does 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.



NOTE

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

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 contaminants. Dust attaching through impact or heating and vapors condensing on the optical surfaces reduces the mirror's reflectivity. Furthermore, avoid scanner exposure to dust, condensation or cleaning fluids in the exposed bearing area.



CAUTION

You must be extremely careful not to allow contamination from entering the galvanometer through its exposed bearing. 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 Mirror Cleaning

Although the mirrors can be replaced by the user, 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 damages easily. It is difficult to prevent hard dust particles from being entrained in the process and causing scratches. In many cases, small defects in the mirror's surface may be less harmful than the surface damage resulting from continued cleaning. It requires special equipment typically not available to customers.

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.

Removing Dust

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

Removing Stains

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 on the mirror surface and wet it with reagent grade (highly pure) alcohol or acetone (If you use acetone, take precautions regarding possible health and fire hazards). Grasp an overhanging corner of the tissue and gently agitate it several times, then slide the tissue off. This should remove the problem blemishes.



CAUTION

Do not let solvent enter the bonding zone of the mirror.



NOTE

Note that the mirror is not rubbed.

If the mirror surface is still contaminated, use a highly pure solvent such as alcohol or acetone and generously wet the mirror surface with a **sterile** cotton swab or lens tissue. Gently wipe the dirty areas. Turn your cotton swab or tissue with each stroke so that a clean area is exposed.



CAUTION

Do not let solvent enter the scanner bearings. When wetting the mirror's surface, hold the scanner 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 your **XY10M2T**, you can check the following matrix. If you cannot solve the problem, contact **GSI Lumonics** for further assistance.

PROBLEM	PROBABLE CAUSE	POSSIBLE SOLUTION
1. Decrease in marking quality.	1. Dirty protection glass.	1. Clean glass per instructions in Maintenance Section.
	2. Marking parameters changed.	1. Check PC-MARK MT and JOB EDITOR parameters.
	3. 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 and laser controller. 2. Check connections between laser controller and laser.
	2. No power to galvanometers.	1. Check power connections to scanning head.
	3. HC/2 malfunction.	1. Verify that HC/2 connections and installation are correct.

7. GLOSSARY

- Galvanometer:* A scanner with limited rotation magnetic torque motor with position feedback. The galvanometer (galvo) rotates a mirror to direct the laser beam.
- HC/2:* A PC based board that provides the hardware link between your PC and the XY Industrial Scan Head. I/O for laser control and parts handling are additional features. The HC/2 is fully compatible with PC-MARM MT (multitasking) software.
- HPGL:* HP® Graphics Language, a graphics format which PC-MARK MT can translate into vector data for scanning.
- HPM:* (High Performance Modules) Complete beam position packages consisting of the XY Industrial Scan Head, Driver Electronics, PC resident HC/2 card, PC-MARK MT software and interconnects.
- I/O-2:* An add-on board available as an option to the HC/2 card. Features include opto-isolated programmable I/O ports, analog laser power control and first pulse suppression.
- PC-MARK MT:* (multitasking) A powerful 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. MMCL is utilized as the link to the HC/2 card.
- JOB EDITOR:* A menu-driven application program of PC-MARK MT that provides an extensive graphics user interface and file management. It allows the user to manipulate HPGL based graphics with an accurate real preview of one's job.

8. APPENDIX A: SPECIFICATIONS

8.1 XY10M2T Scan Head

The specification are not defined yet.

Laser Type					
Wavelength					
Objective (f in mm)					
Standard Field Size (mm²)					
Maximum Practical Field Size (mm²)					
Spot Size TEM₀₀ (μm)					
Working Distance (mm)					
Resolution (μm)					
Writing Speed (m/s)					
Uncalibrated Non-Linearity (maximum %)					
Temperature Drift (maximum μm/°C)					
Aperture (mm)					
Scan Angle (maximum)					
Power Capability, cw (W/cm²)					
Power Capability, 100 ns pulsed (MW/cm²)					
Scan Head Size (height x length x with in mm)					
Weight (kg)					

8.2 XY10M2T Scan Head Mirrors

	LASER TYPE					
	YAG	CO2	ARGON	ARGON (HP)	UV	VISIBLE
Wavelength	1,064 nm	10,600 nm	488-514 nm	488-514 nm	325-360 nm	450-700 nm
Coating	Dielectric	Dielectric on Metal	Dielectric	Dielectric	Dielectric	Durable Ag
Reflection (min.) @ Wavelength (nm)	99.5% @ 1,064 80.0% @ 450-650	99.5%	98.0% @ 480-514 50.0% @ 633	99.5%	98.0% @ 325-350 95.0% @ 350-360 45.0% @ 633	96.0%
Flatness @ 633 nm	$\lambda/4$	$\lambda/4$	$\lambda/4$	$\lambda/4$	$\lambda/4$	$\lambda/4$
Power Capability, cw (W/cm²)	500	500	100	5 MW/cm ²		10
Power Capability, 100 ns pulsed (MW/cm²)	100	400	80	2 GW/cm ² (10 ns pulsed)		N/A
Surface Quality (Scratch/Dig)	40/20	40/20	40/20	40/20	40/20	40/20

See your GSI Lumonics sales representative for more details.

9. APPENDIX B: TECHNICAL OUTLINE DRAWINGS

1. **M2/M2T scanner data sheet**
2. **Outline drawing ECD-20324**

M2 Series Optical Scanners

Features

- ▶ Repeatability to 5μ radians optical
- ▶ Non-linearity as low as 0.05%
- ▶ Low sensor thermal drift
- ▶ Low wobble and jitter
- ▶ Rugged moving-magnet rotor design
- ▶ Higher precision writing speeds
- ▶ Angles up to ± 30 degrees optical
- ▶ Lightweight 210 g

The new M2 optical scanners offer an innovative motor design coupled with an advanced capacitive position detector. This new design offers higher speeds, wider angles, lower linearity error and improved operational stability over existing scanner technology.

Using moving-magnet technology, this scanner incorporates the more familiar characteristics of both moving-coil and moving-iron torque

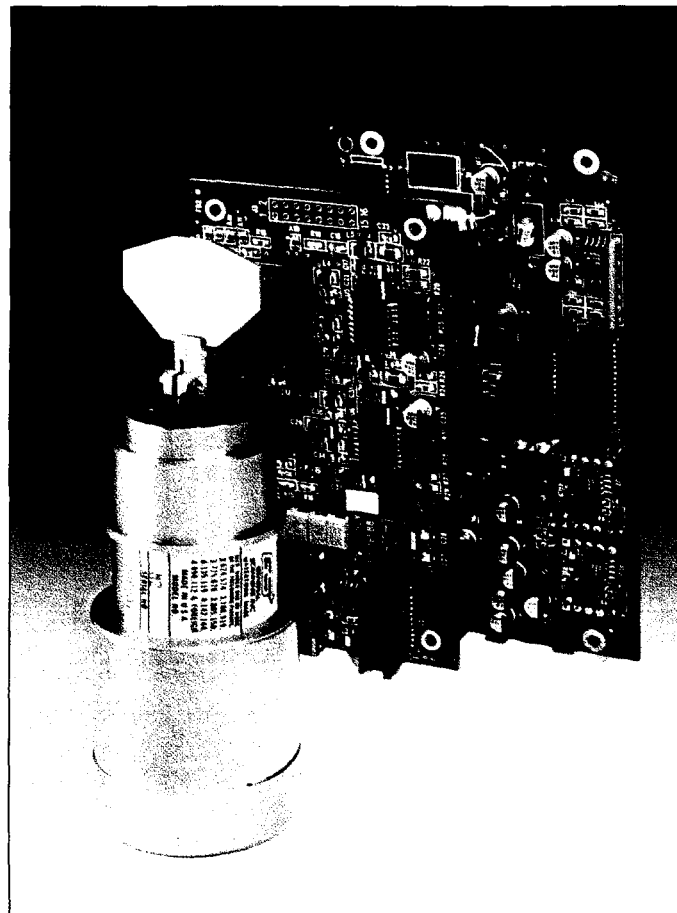
transducers. The M2 has the low inertia rigidity and low temperature control of moving-iron devices as well as the low inductance of moving-coil units. This new scanner, however, is smaller and lighter than either moving-coil or moving-iron models.

Our rugged M2 is available in two configurations. The M2T is our high performance unit, the M2 the standard. Both the M2T and M2, when used with GSI's innovative servo-loop, achieve higher bandwidth, faster mirror settling, and lower drift than other designs.

The M2T is designed to provide a higher degree of gain and offset stability in environments where moderate ambient temperature changes are anticipated.

High-speed laser beam positioning now meets the absolute accuracy requirements for stereolithography, micromachining, imaging, and communications.

Customization is available for OEM's.



OPTICAL SCANNERS

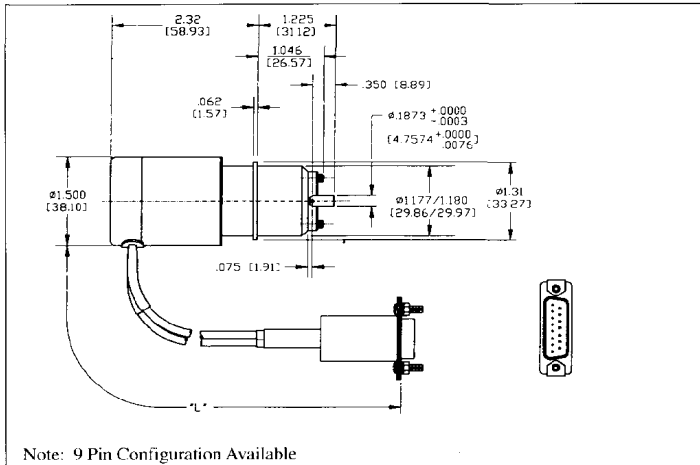
M2 Series Optical Scanners

Specifications¹

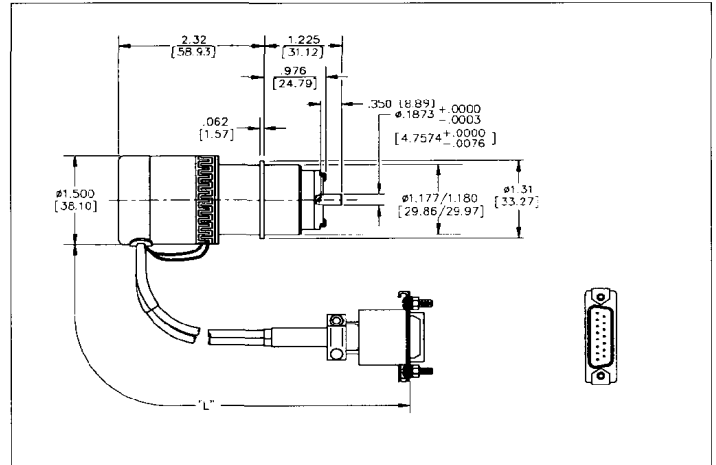
Parameters	Units	M2	M2T
Rated Excursions, max.	degrees optical	± 30	±30
Rotor Inertia	g-cm ²	1.7	1.7
Wobble ^{2,4}	μrad	1.5	1.5
Jitter ^{2,4}	μrad	6	6
Repeatability ²	μrad	12	12
Magnetic Driver			
Coil Resistance	Ohms	4.5	4.5
Coil Inductance	mH, 1 kHz	0.62	0.62
Torque Constant	Nm/A	.023	.023
Peak Current/Instantaneous	A	25	25
Thermal Conductivity (Coil to Case)	°C/W	2.5	2.5
Position Sensor¹			
Angular Sensitivity	μA/° optical	11	11
Non-Linearity	% max.	0.05	0.05
Typical Zero Drift ²	μ radian/° C	18	1.5
Typical Gain Drift ³	ppm/° C	-60	-10

Notes: 1. Angular specifications in terms of optical deflection.
2. STD deviation.

3. Distribution STD deviation is 27 ppm/°C and 3 ppm/°C for M2 and M2T respectively.
4. Depends strongly on mirror size and operational speed.

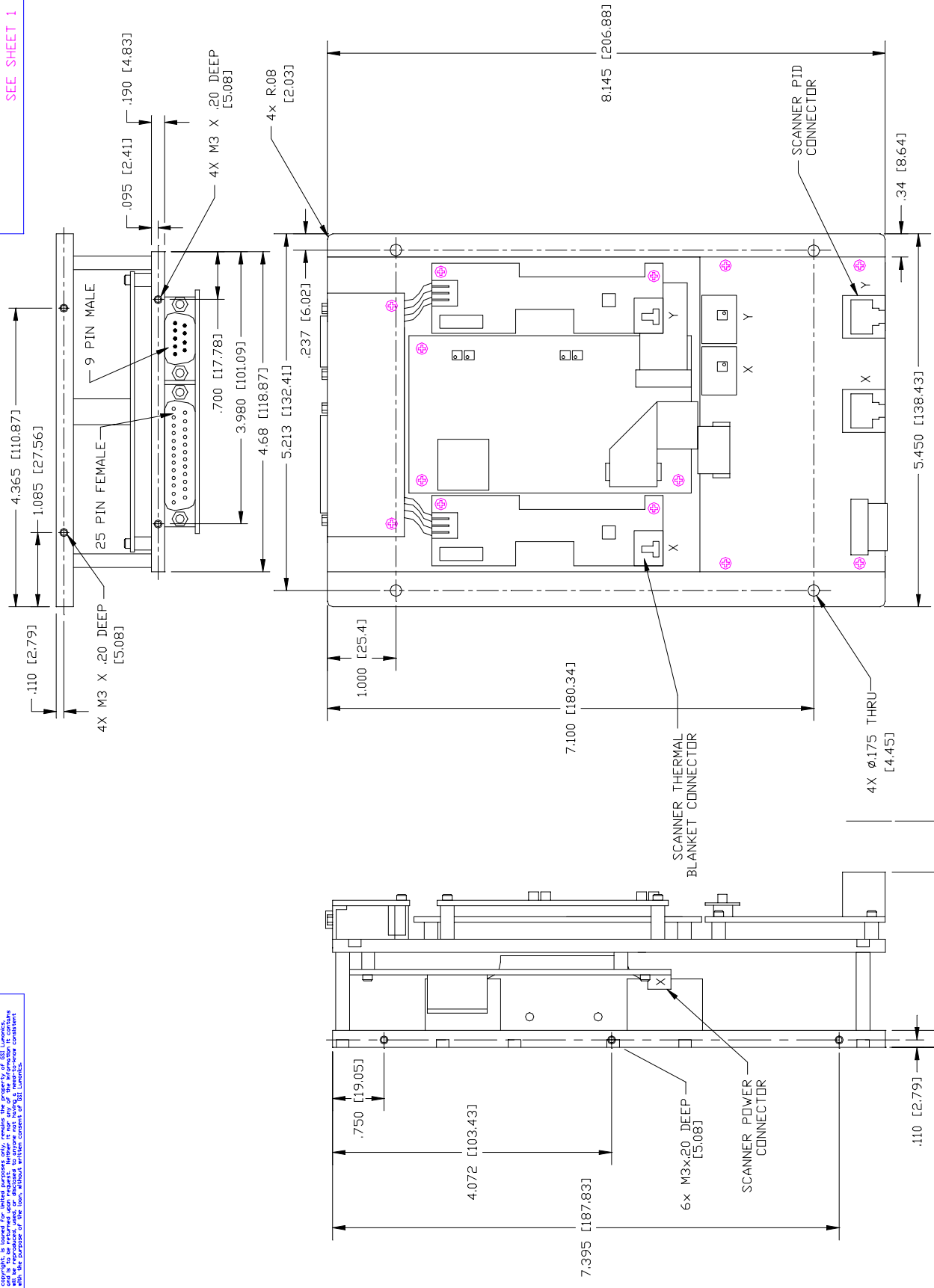


M2 Outline Drawing



M2T Outline Drawing

PROPERTY OF GSI LUMINICS
 This drawing is the property of GSI LUMINICS and is not to be reproduced, copied, or used in any way without the written consent of GSI LUMINICS. All dimensions are in inches unless otherwise noted. GSI LUMINICS is not responsible for any errors or omissions in this drawing.



SCALE	CAD FILE No.	GMAX 20324-00	FSCM No.	REV
1=1				D
		gsi luminics	SIZE	DRAWING NUMBER
		WILMINGTON, MA	C	ECD-20324

REQUIRED SPACE WITH SCANNER CONNECTORS PLUGGED IN