

GSI Lumonics

VM500, VM1000 & VM1500 User's Manual



COMPONENT PRODUCTS GROUP

39 Manning Road
Billerica, Massachusetts 01821

TABLE OF CONTENTS

| | | |
|----------|--------------------------------------|-----------|
| 1 | INTRODUCTION | 3 |
| 1.1 | ESD WARNING | 3 |
| 1.2 | CUSTOMER SUPPORT | 4 |
| 1.3 | WARRANTY INFORMATION | 4 |
| 2 | SCANNER/DRIVER CONFIGURATIONS | 5 |
| 2.1 | FLEX CABLES AND ACCESSORIES | 6 |
| 3 | MIRRORS | 7 |
| 3.1 | CUSTOM MIRROR/LOAD DESIGN | 7 |
| 3.2 | MOUNTING MIRROR ASSEMBLY | 8 |
| 3.3 | MIRROR CLEANING/MAINTENANCE | 9 |
| 4 | MECHANICAL STOP ADJUSTMENT | 10 |
| 5 | GALVANOMETER MOUNTING | 11 |
| 5.1 | GROUNDING | 11 |
| 5.2 | THERMAL CONTROL | 11 |
| 6 | LIFETIME | 12 |
| 7 | APPENDIX A: OUTLINE DRAWINGS | 13 |

1 INTRODUCTION

The VM500, VM1000, VM15000 Optical Scanners are members of GSI Lumonics' High Performance VM family of Galvanometers. They offer high dynamic performance along with high accuracy and instrument grade performance. The VM Series Scanners are optimized for both large and small signal applications. They provide improved drift, noise, and linearity. The newly patented capacitive position detector used in these scanners offers superior accuracy. This manual provides the user with suggestions on proper operation and handling techniques to ensure optimum galvanometer performance and longevity. Highest performance is achieved when the VM Galvanometer is mated with GSI Lumonics' newly designed mirror assemblies and an optimized GSI servo controller.

1.1 ESD WARNING



The OEM electronics that *GSI Lumonics* manufactures - including galvanometers and servo controllers - are electrostatic discharge (ESD) sensitive. 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 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.



CALL

North America

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

Europe

Einsteinstrasse 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
oed-sales@gsilumonics.co.jp

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

1.3 Warranty Information

The Customer shall examine each shipment within 10 days of receipt and inform GSI Lumonics of any shortage or damage. 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.

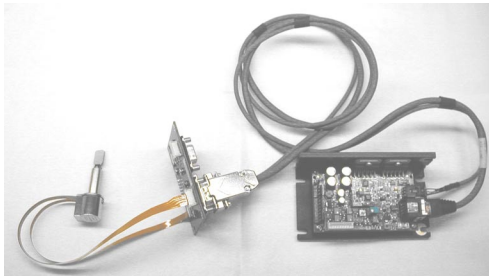
Contact Customer Service to obtain a Return Materials Authorization number *before returning any product for repair*.

All orders are subject to the GSIL Terms and Conditions and Limited Warranty. Visit www.gsilumonics.com/opticalscanning/ for the latest version of these documents and other useful information.

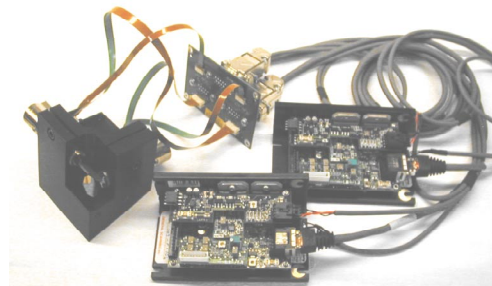
IMPORTANT: Line Scan Engines are normally tuned, serialized and warranted as a matched set for optimized performance. Mismatched components negatively affect performance and void the warranty. A matched set typically consists of galvanometer motor, mirror load, electronic driver board and interface cable.

2 SCANNER/DRIVER CONFIGURATIONS

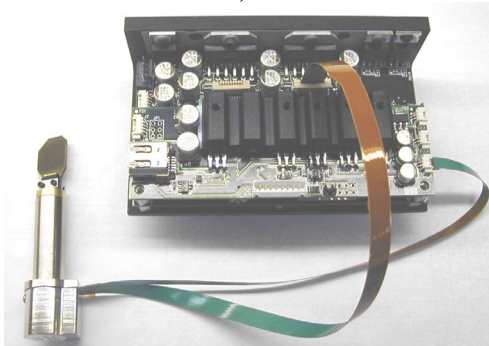
The VM500, VM1000, VM1500 are available in single axis or dual axis configurations and can be driven by either the Miniature Single Axis (MiniSAX) servo amplifier or the dual axis Intelligent Servo Driver (ISD). XY brackets are available for two axis systems and are used to mount and align the scanners. For accuracy dependent applications, VM Series Scanners are available with a thermal control to maintain temperature stability of the position detector. Maintaining a stable position detector temperature minimizes gain and offset drift due to fluctuating environmental temperatures. Since the Scanners are a component of a larger system there is a multitude of available configurations to suit OEM needs. Standard available configurations are pictured below. All configurations are available with or without thermal control.



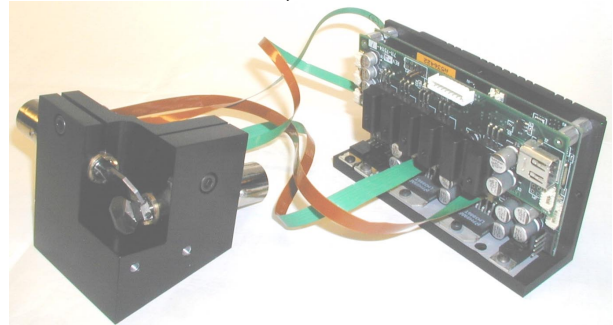
Single axis VM500 with MiniSAX servo amplifier and interconnect board. (Thermal controller not shown)



Two Axis VM1000 XY head with MiniSAX servo amplifiers and interconnect board (shown with thermal controllers)



Single Axis VM1000 with the Intelligent Servo Driver



Two Axis VM1000 XY head with the Intelligent Servo Driver

2.1 FLEX CABLES and ACCESSORIES

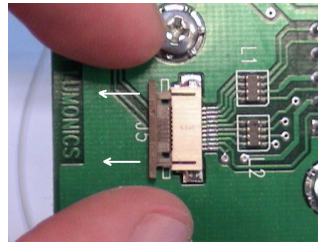
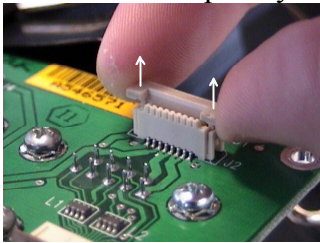
The VM Series Scanners use flat flex circuit cables to connect the drive, position and thermal control signals to the servo amplifier. The cables are connected to the servo board using ZIF (zero insertion force) connectors for flat flex cables.

WARNING: The flat flex cables and connectors are not designed to withstand the wear and tear of repetitive connecting and disconnecting. Excessive stress and strain resulting from bending and folding the cables can lead to intermittent failures.

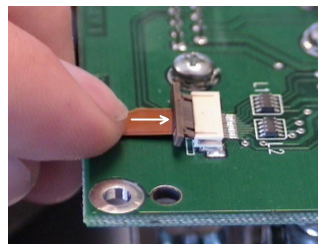
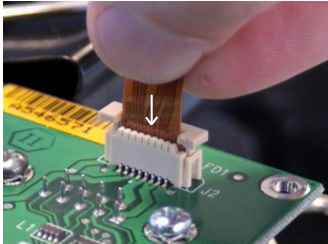
Attention MiniSAX users: For situations requiring repetitive connecting and disconnecting of the galvo from the servo, GSI Lumonics has provided a connector interface that converts the ZIF input connections to 9 pin, D-style output connectors. This interface should be securely fastened to the workspace before connecting the cables so as to minimize movement and prevent damage to the cables and connectors.

To insert the cables into their connectors:

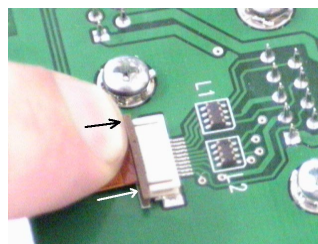
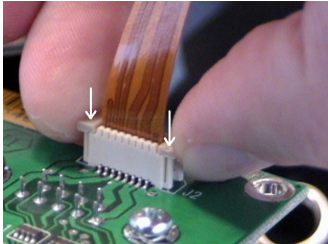
- 1) Gently lift up/out the locking mechanism or actuator on the connectors. Take precautions as to avoid completely dislodging the actuator from the base.



- 2) Insert the cables so that the exposed leads contact the pins of the connectors. Be sure that the cables are sitting square in the connectors.



- 3) Push the actuator in securing the connection.



Note: Depending on which servo amplifier you are using, the actual ZIF connectors and their locations may differ from the ones pictured. Please consult the hardware manual of the servo for more specific information.

3 MIRRORS

For best results, we recommend using standard GSI Lumonics mirrors when possible. GSI Lumonics offers a full line of mirrors designed specifically to optimize scanning performance and galvo lifetime. All GSIL mirrors are available with our standard mirror coatings. Custom mirror coatings are available for OEM applications. Please contact the GSI Lumonics Technical Services department for more information on available mirror coatings. Standard mirrors and their angular specifications for each scanner are listed below.

GSI Lumonics VM500 Mirrors:

| <u>Clear Aperture</u> | <u>Maximum Scan Angle</u> |
|-----------------------|---------------------------|
| 4mm | +/- 30° optical |
| 5mm | +/- 25° optical |
| 6mm | +/- 20° optical |

GSI Lumonics VM1000 Mirrors:

| <u>Clear Aperture</u> | <u>Maximum Scan Angle</u> |
|-----------------------|---------------------------|
| 8mm | +/- 20° optical |

GSI Lumonics VM1500 Mirrors:

| <u>Clear Aperture</u> | <u>Maximum Scan Angle</u> |
|-----------------------|---------------------------|
| 10mm | +/- 20° optical |
| 12mm | +/- 15° optical |

3.1 Custom Mirror/Load Design

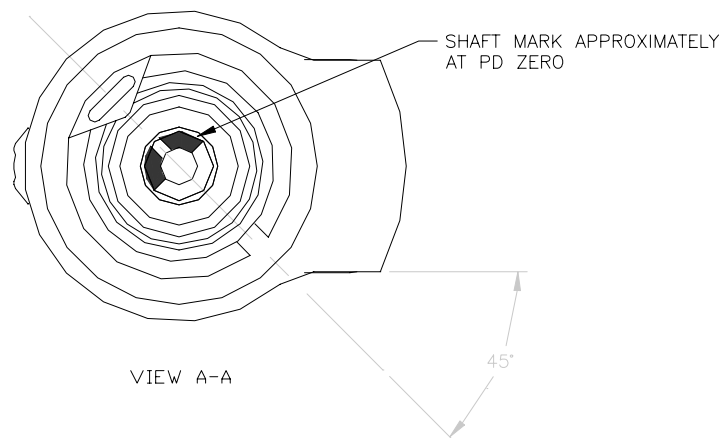
When designing a custom load, several factors that must be considered. A common oversight is to disregard the adverse effect of an improperly balanced mirror/load. An unbalanced mirror/load can shorten the life span of the galvo as it causes cross-axis excitation of the mirror rotor assembly, leading to premature bearing failure. In the event that standard GSI Lumonics mirrors do not meet your application's requirement, the following mirror design guidelines should be observed:

- 1) The mirror mass and inertia should be minimized
- 2) The mirror should be mounted as close as possible to the top bearing of the scanner.
- 3) The mirror/load's center of gravity must be on the axis of rotation.
- 4) The principal axis of the mirror/load and mount must be aligned with the scanner axis as closely as possible.

3.2 Mounting Mirror Assembly

If the VM series scanner has already been mounted in an open frame XY bracket this section does not apply. Do not remove or realign mirrors or mechanical stops as they have been set specifically at the factory to avoid mirror collision. If the mirror needs cleaning or is damaged please contact [customer service](#) to have the unit repaired.

If the VM scanner is being used single axis or custom multi-axis systems, this section may apply if the entire galvo can only be mounted in one position. Before mounting the mirror assembly to the rotor shaft, or realigning the mirror position, it is helpful to find the scanner's electrical zero position to give reference when it is used in a system. The top of the rotor shaft on each VM scanner has a scribed mark. The mark is offset with a blackened half moon to give it higher visibility (see figure below). When the mark aligned 45° from the flex cable, the position detector is approximately in its electrical zero position. This means when a GSIL servo connected to the scanner is commanded to zero the rotor shaft will be in the described position.



Alternatively, you may command the rotor to electrical zero by applying power and a 0 V DC command signal to the servo driver connected to the galvo. This will cause the rotor to torque to its zero position as described above. **If the servo amplifier was factory tuned, it may be necessary to slightly de-tune the servo to avoid any destructive oscillations that may occur when the mirror is removed.** (See the servo amplifier user's manual for information on tuning.)

When mounting the mirror, take special precautions to prevent damage the mirrors. If possible use latex gloves or finger cots, to avoid fingerprints on the mirror. It may be helpful to put a piece of tack-free tape over the mirror during any mounting procedures to guard against nicks and scratches. If the mirror does become dirty refer to the cleaning procedure in the following section.

Mirror mounting procedure:

- 1) Verify mechanical stop is in place, it can be rotated after mirror is mounted. If the stop is not in place refer to section 4 for insertion procedure.
- 2) With the rotor in its zero position, mount and align the mirror as necessary making sure the mirror is as far down as possible without rubbing the mechanical stop.
- 3) When mirror location is as desired, tighten the screws evenly to a torque spec of 1 oz/in.
- 4) Once the mirror has been mounted and aligned, retune the servo amplifier by following the instructions in the servo amplifier user's manual, if necessary.
- 3) Adjust the mechanical stop for the desired maximum scan angle as described in section 4.

3.3 Mirror Cleaning/Maintenance

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. 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. Cleaning 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.

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 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.

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

4 MECHANICAL STOP ADJUSTMENT

The VM500, VM1000 and VM1500 use an adjustable mechanical stopping device similar to the one shown here to limit the maximum angular excursion of the mirror. On the VM500, the stop is pressed down into the top inner diameter of the galvo. On the VM1000 and VM1500 the stop is slipped around the outer diameter of the top galvanometer body. Below on the right, the picture displays each scanner with the mechanical stop in place. Both stops are designed to allow a maximum scan angle of 120° optical, peak-to-peak.

Should the scanner become unstable during operation, or be commanded to excessively large scan angles, the mirror mount will hit the stop, thus preventing the rotor from spinning all the way around. The "C" ring provides enough friction to keep the stop in place, yet still allows the user to adjust its position relative to the mirror mount and therefore adjust the maximum angular peak excursion of the mirror. The stop is required in two axis applications to prevent the mirrors of an XY system from crashing into each other. In single axis applications, the stop helps keep the position detector within the necessary range of operation, for proper servo control.



Mechanical stop insertion procedure:

- 1) Remove the mirror and press the stop ring into the top of the galvo such that it rests flush against the edge of the galvo. Be sure the ring sits as far down into the galvo as possible.
- 2) Mount the mirror/load by carefully following the instructions in section 3.2.
- 3) To adjust the stop, insert a 1/8th inch or 3mm flat-head screwdriver into the slot and rotate clockwise or counterclockwise. The stop can be adjusted with or without the scanner enabled. It may be helpful to have the mirror in its zero or maximum deflection angle for reference. Recheck that the stop is still flush with the galvo and the mirror mount is not rubbing against it.



VM500



VM1000

5 GALVANOMETER MOUNTING

Before designing a scanner mount, one should consider several things that are discussed in the following sections. Initially, rigidity of the mounting surface is important in minimizing scanner vibrations and unwanted oscillations or beam movement. Rigidity becomes even more critical when operating the scanner with high inertial loads. Sources of structural vibration should be investigated so that they do not include significant relative displacement between the scanner and the target.

Clamping force on the galvo should be tight enough to prevent the galvo from moving or turning within the mounting hole. Excessive or uneven (pinching) clamping force may induce stress on the ball bearings of the galvo, thus hindering performance and significantly reducing the lifetime of the scanner. Regardless of the mounting method chosen, the following sections on electrical isolation and heatsinking should be reviewed.

5.1 Grounding

The position detector of the VM scanners is electrically isolated from the scanner body. Performance testing of both galvos has shown that electrical noise on the position signal is minimized when the body of the galvo is well grounded to servo controller ground. Therefore to achieve optimum performance, GSI Lumonics strongly recommends that the scanners be in good electrical contact with the scanner mount and that the mount be securely connected to servo controller ground.

5.2 Thermal Control

Using the thermal control option of the VM series scanners minimizes scanner offset and gain drift. The set point for temperature regulated scanners (galvos ordered with a thermal controller) must be above the highest expected ambient temperature but not above 50° C. For maximum stability, temperature controlled scanners may require thermal isolation from the scanner mount so that heat sinking by the mount does not interfere with temperature regulation. Refer to the corresponding servo driver documentation on how to set the temperature.

In most vector applications, power dissipation in the scanner is minimal, and therefore the scanner requires little heat sinking. In raster or other high duty cycle applications, Optimum heat sinking is desired to maximize the scan frequency and prevent damage to the scanner caused by overheating. When mounting a VM series scanner in your system, the thermal relationship between the scanner and its environment should be considered. **Caution: Insufficient heat sinking can cause irreparable damage to the scanner. The internal temperature of the galvo should never exceed 100° C. When using a static heatsink, this corresponds to an external case temperature of 70°C.**

To maximize heat flow from the motor case to the heat sink, the surface area of the mount should contact as much of the galvo as possible. Surface finishes should not exceed 0.8um or 32 microinches in roughness. If the mounting surface is too rough thermal grease between the two surfaces should be used.

6 LIFETIME

Scanner lifetime will vary depending on many conditions, and is limited in most cases by bearing wear. Environment, command waveform, load inertia, load balance, and required resolution among other things will all play a role in dictating the number of usable cycles. Although difficult to predict, experience has provided us with some basic guidelines that can help the user maximize scanner lifetime.

Maximum lifetime of the VM Scanners will be achieved if:

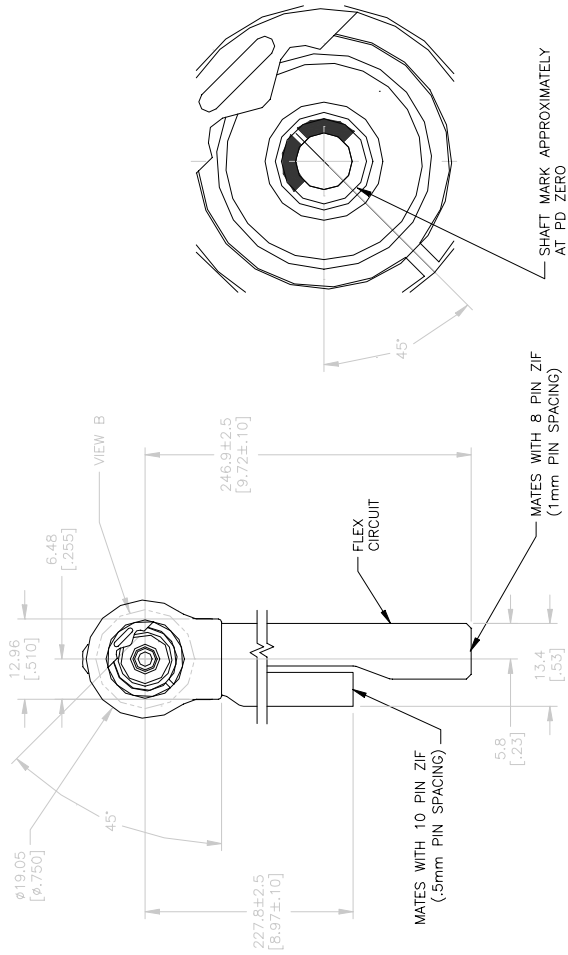
- a. The scanner is operated such that it makes random moves over the full scan field. Commanding repetitive, small angle rotations of any ball bearing device will likely lower the usable lifetime because bearing lubrication is not adequately distributed.
- b. Mirror/load inertia and mass are minimized.
- c. Large signal commands are structured to limit acceleration and cross-axis wobble.
- d. Storage and operation are in a low humidity, dust free environment. The output shaft should not be cleaned with solvents that could flow into the bearings and remove lubrication.

7 APPENDIX A: OUTLINE DRAWINGS

- ◆ [VM500 with Mechanical Stop](#)
- ◆ [VM1000 with Mechanical Stop](#)
- ◆ [VM1500 with Mechanical Stop](#)
- ◆ [VM500 4mm XY Mount](#)
- ◆ [VM500 5mm XY Mount](#)
- ◆ [VM500 6mm XY Mount](#)
- ◆ [VM1000 8mm XY Mount](#)

VM1000 with Mechanical Stop

| REVISIONS | | DATE | APPROVED |
|-----------|-----------------------|------|----------|
| ZONE/REV | DESCRIPTION | | |
| - C | REVISED PER EGD 2001- | | |



VIEW B
SCALE 8/1

VIEW A-A

NOTES:



gsi Lumonics
 100 Cambridge Drive, Bedford, Massachusetts, USA, 01730

PROPERTY OF GSI LUMONICS
 THIS DOCUMENT IS AND SHALL REMAIN AN UNCLASSIFIED AND UNCONTROLLED DOCUMENT
 PROTECTED BY COPYRIGHT. IS LOANED FOR YOUR USE ONLY. IT IS NOT TO BE REPRODUCED, COPIED, OR DISCLOSED TO ANYONE WITHOUT THE WRITTEN CONSENT OF GSI LUMONICS.

INTERPRET DRAWING IN ACCORDANCE WITH DD-20-100, ANSI Y14.5M

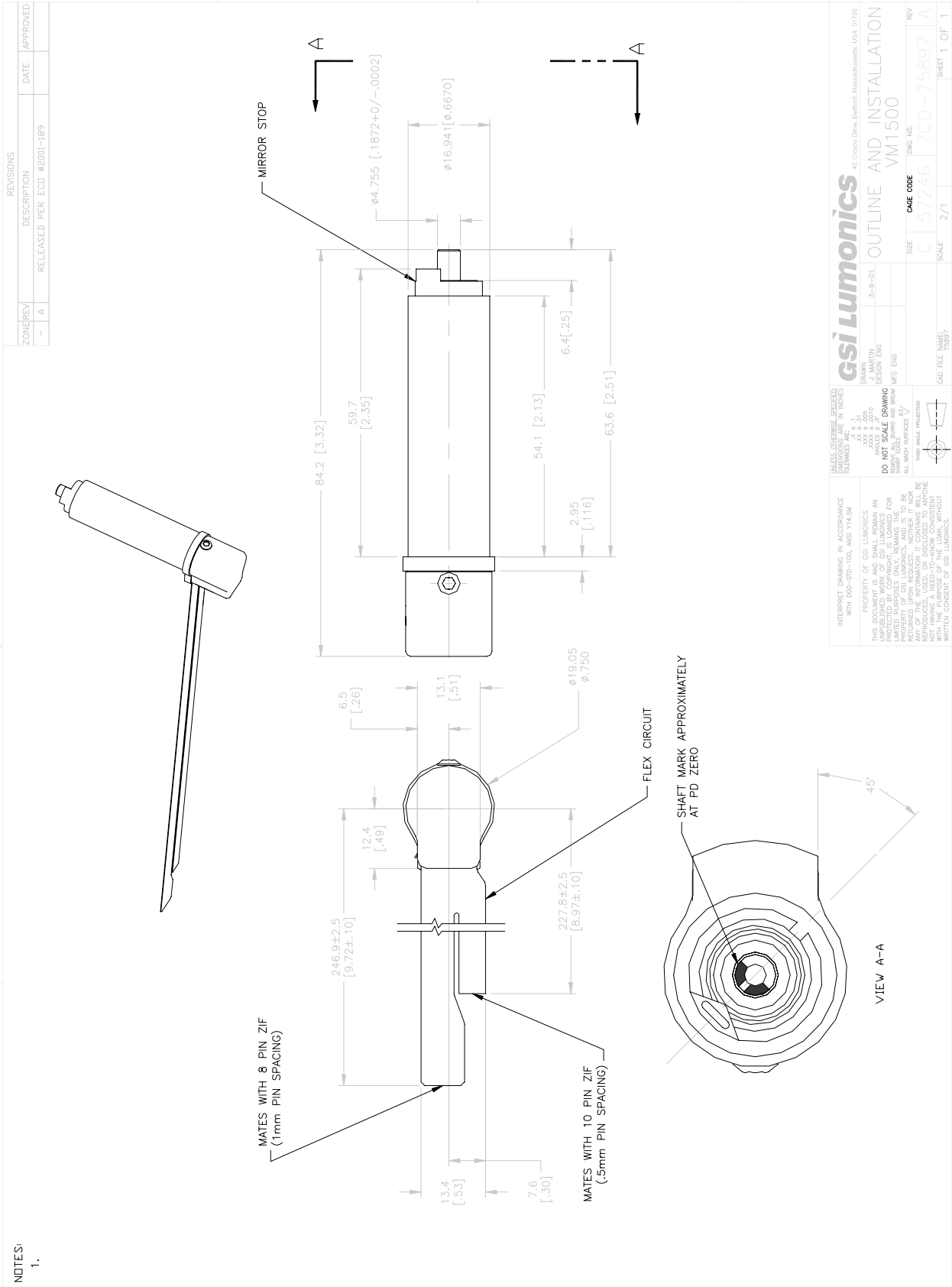
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

DRAWN BY: J. STAVISKY
 DESIGN ENG
 05-29-01
 CHECKED BY: S. HASEBEK
 05-30-01

DO NOT SCALE DRAWING
 DIMENSIONS SHALL BE TAKEN FROM ORIGINAL DRAWING

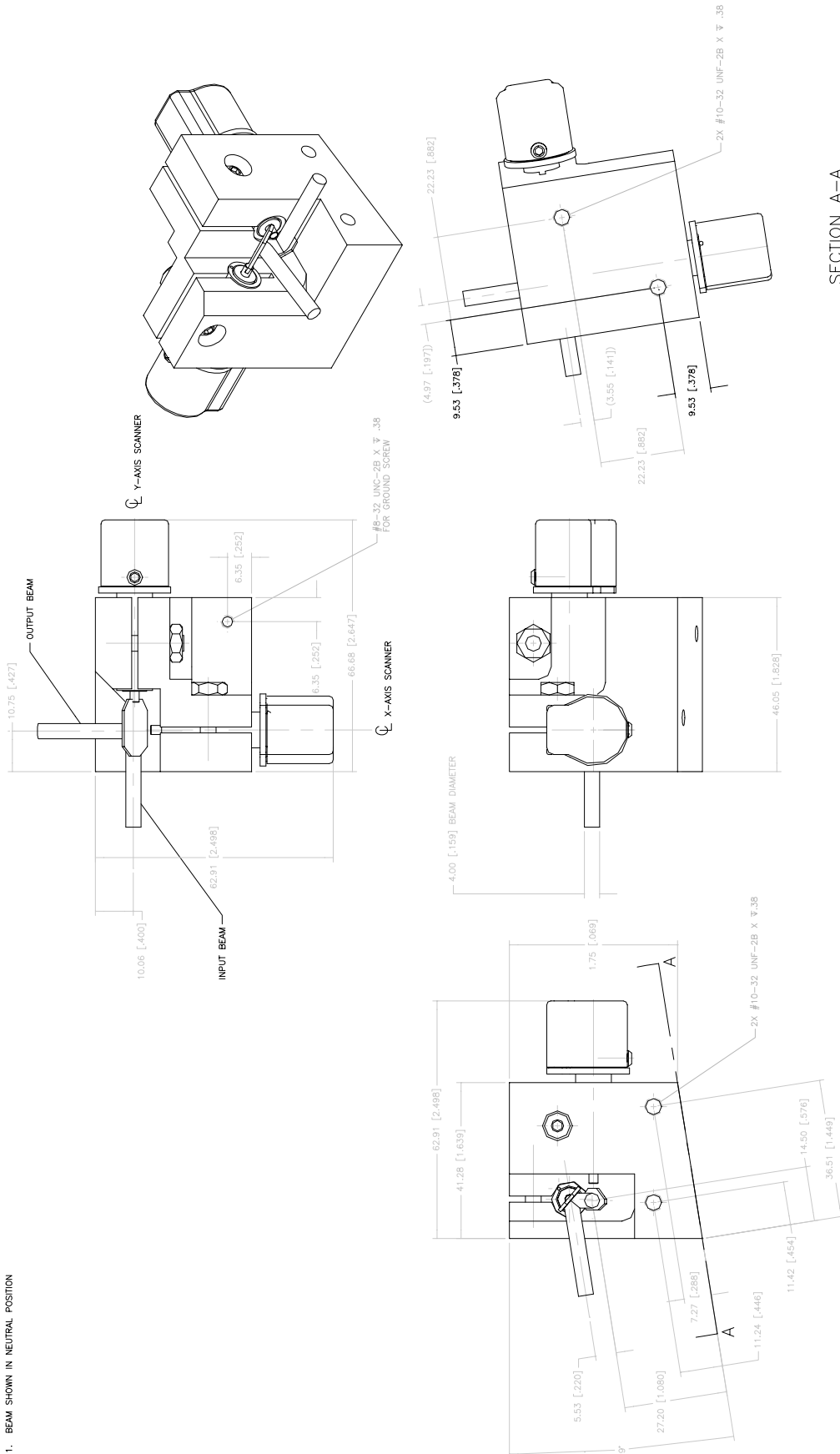
DATE: 05-29-01
 SIZE: C
 DWG NO.: 57246
 SCALE: 2/1
 SHEET NO.: 75649
 REV: C

VM1500 with Mechanical Stop



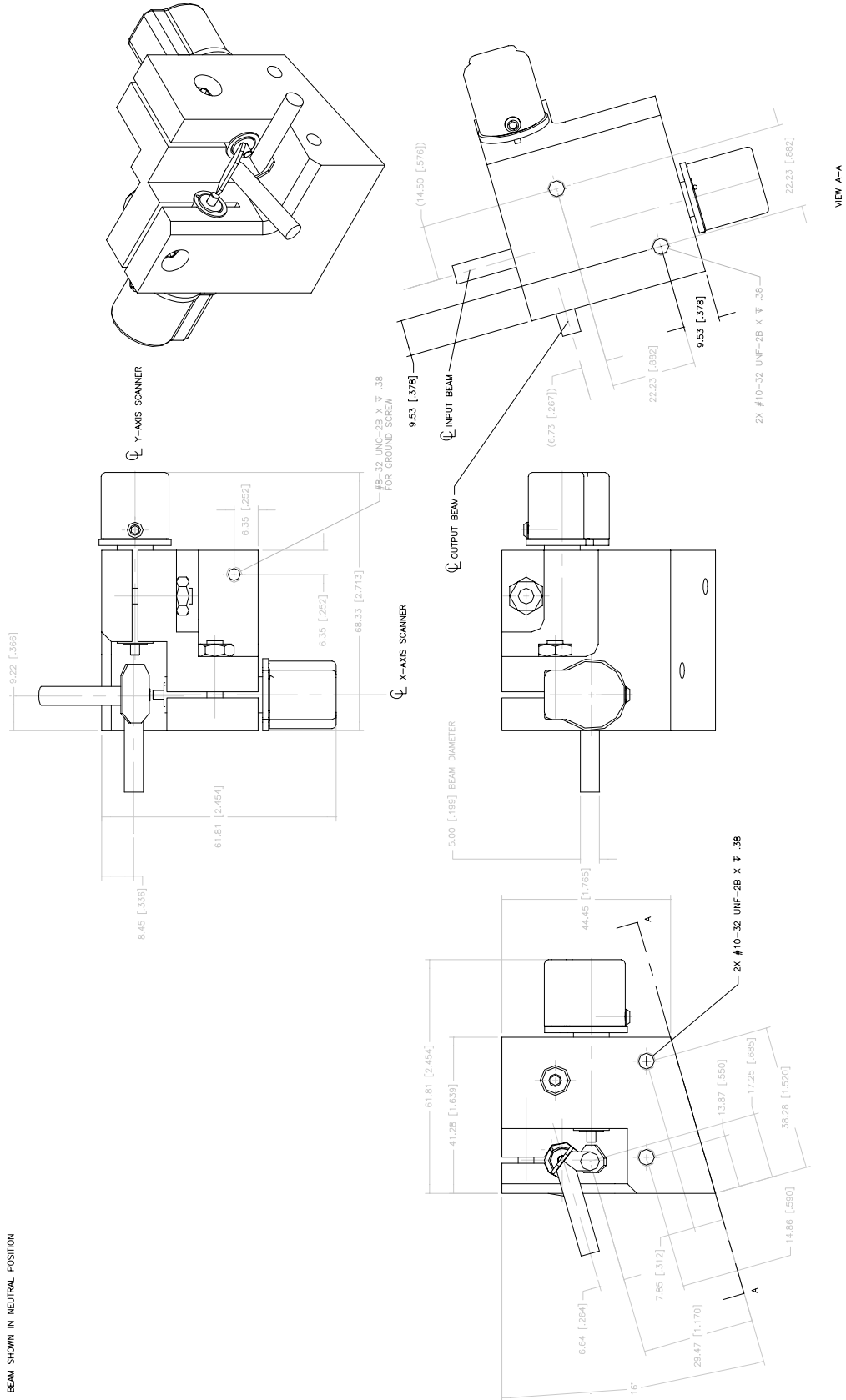
VM500 4mm XY Mount

NOTES:
1. BEAM SHOWN IN NEUTRAL POSITION

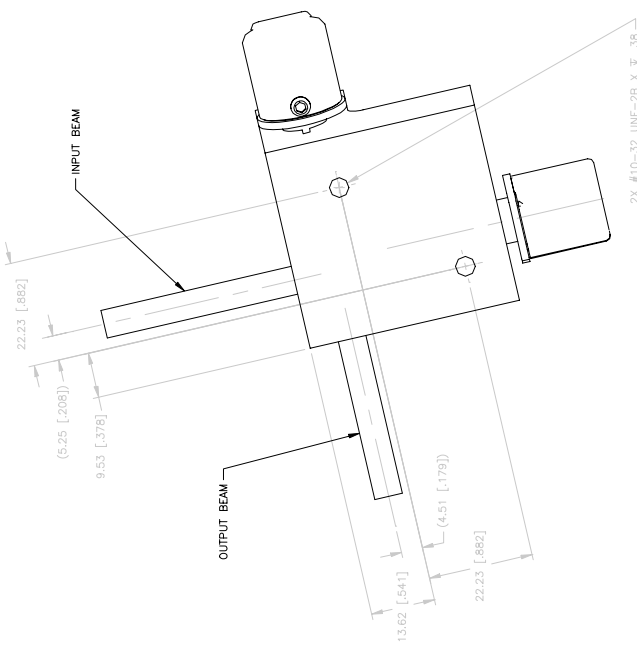
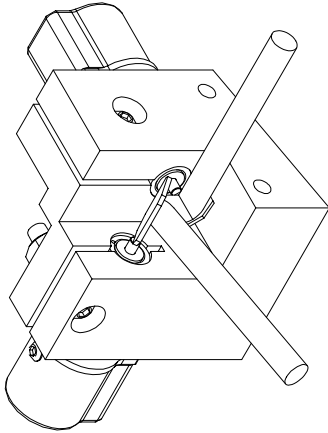
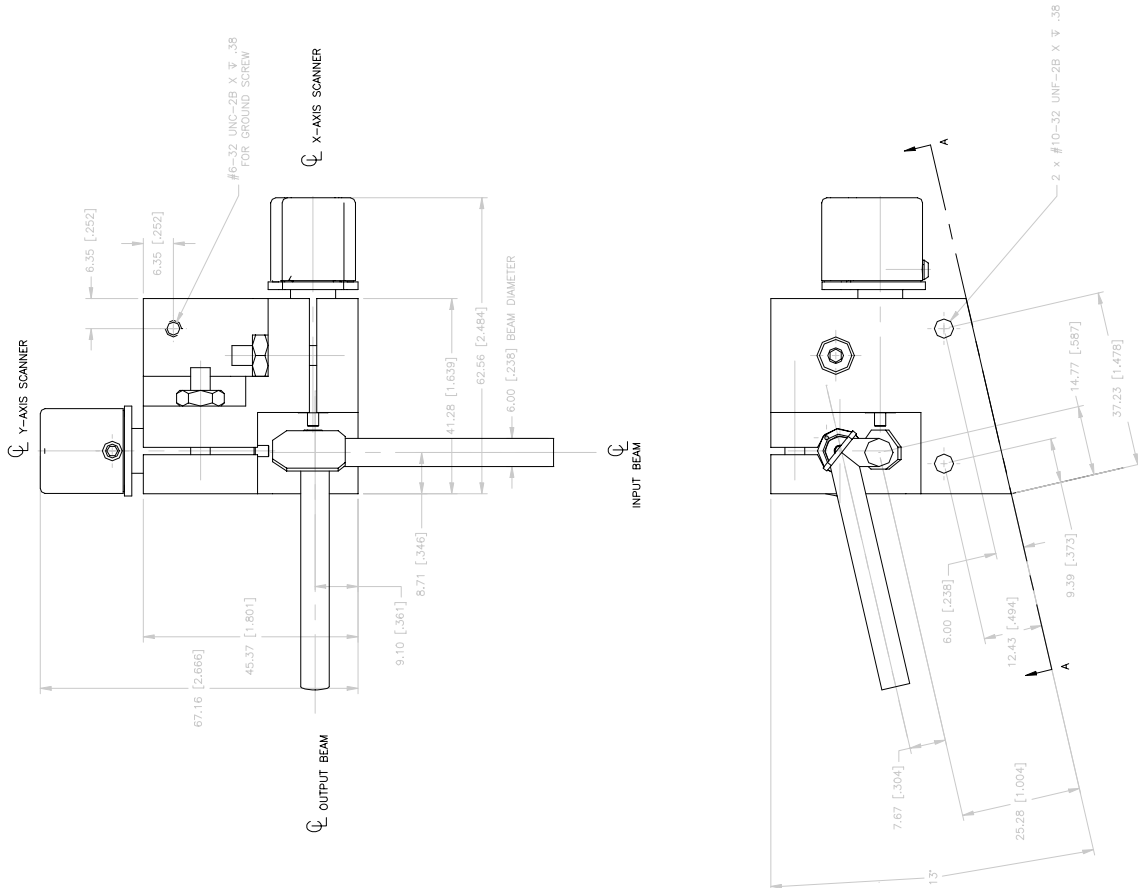


VM500 5mm XY Mount

NOTES:
1. BEAM SHOWN IN NEUTRAL POSITION



VM500 6mm XY Mount



VIEW A-A

NOTES:
1. BEAM SHOWN IN NEUTRAL POSITION

