

# ***GSI Lumonics***

## **FM3 User's Manual**



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# 1 IMPORTANT INFORMATION

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## 1.1 ESD Warning

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

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

\* A proper static control station **should** include:

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

## 1.2 Warranty

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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* warrantee 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/](http://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.

## 1.3 Customer Support

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

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



**CONTACT  
Us!**

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## 2 INTRODUCTION

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### 2.1 Overview

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The FM Series galvanometer provides the innovation required to meet the growing need for extended product lifetime. This new galvanometer design replaces ball bearings and their inevitable wear, with extremely long life flexures. In addition to longevity, smooth and precise scanning gives the FM Series galvanometer a leading position in today's demanding applications.

Highest performance is achieved when the FM Galvanometer is mated with GSI Lumonics' newly designed mirror assemblies and an optimized GSI servo controller.

This manual provides the user with suggestions on proper operation and handling techniques to ensure optimum galvanometer performance and longevity.

### 2.2 Configurations

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The FM Series scanners are designed to be driven by the Miniature Single Axis (MiniSAX) wide bandwidth servo amplifier.

The FM series galvanometers are available with 12" (1ft), 1m or 2m cables for direct interconnection with the miniSAX

Open loop galvanometer models are also available.

### 2.3 Accessories

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#### **Cooling option**

The FM galvanometer is available with cooling Fins or removable Fans. See section 5.3.3 "Cooling Options" for more details.

#### **Custom Flexure Thickness**

The FM Series galvanometer provides an extremely efficient method of operation when driven by a sinusoidal command at its resonant frequency. The exact resonant frequency is a function of the flexure thickness and load. Thicker flexures and lighter loads result in higher resonant frequencies. Please contact the factory or local applications support for details.

### 3 SPECIFICATIONS

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Parameter	Units	FM3
Max Scan Angle	degrees optical	$\pm 30^\circ$
Non-Linearity (max) (Optical deviation from given command)	% (over $\pm 20^\circ$ optical)	0.1
Offset Drift (max)	$\mu$ Radians / $^\circ\text{C}$	30
Gain Drift (max)	PPM / $^\circ\text{C}$	100
Operating Temperature	$^\circ\text{C}$	0 - 50
Optimal Mirror Size	mm, clear aperture	15 - 30+
Bandwidth <sup>1,2</sup> (typical)	Hz	>700
Small Step Time <sup>1,2</sup> (typical)	$\mu\text{s}$	<900

- Notes:**
1. Dynamic specifications listed above will vary depending on mirror inertia, command waveform, and servo adjustment.
  2. When used in combination with MiniSAX servo.

## 4 MIRRORS AND LOADS

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### 4.1 Standard Mirrors

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The FM3 is fitted with a ¼" rotor and has available 20mm and 30mm aperture mirrors. These mirrors are offered in a variety of coatings. Please contact the factory for more details. GSI Lumonics strongly recommends that evaluation units be purchased with standard mirrors to accurately assess the performance limitations for each application.

### 4.2 Custom Loads

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Mirror assembly design is not trivial. A common oversight is to disregard the adverse effect that an improperly balanced mirror has on the galvanometer's performance and lifetime. A severely unbalanced mirror or load can shorten the usable life span of the galvanometer as it causes cross axis excitation of the rotor assembly, resulting in possible damage to the flexures. For best results, we recommend using standard GSI Lumonics mirrors when possible. **Custom coatings are available for OEM applications.** In the event that standard GSI Lumonics mirrors do not meet your application's requirement, the following guidelines should be kept in mind:

- The mirror mass and inertia should be minimized and the mirror should be mounted as close as possible to the top of the rotor.
- All moments of inertia with respect to the axis of rotation should be balanced in order to minimize wobble induced during angular acceleration.
- The mirror/load should be mounted symmetrically along both axes to prevent imbalance and wobble.
- Care must be exercised in the bonding process to prevent mirror distortion.

### 4.3 Mounting Mirror Assembly

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If the FM series scanner has already been mounted in an open frame XY bracket this section does not apply. Do not remove or realign mirrors 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 FM scanner is being used in single-axis or custom multi-axis systems, this section may apply if the entire galvanometer can only be mounted in a specific orientation.

As a result of the flexure design, the scanner is at its electrical zero position when not commanded. Use this position to create a reference position when it is used in a system.

When mounting the mirror, take special precautions to prevent damage to 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) With the rotor in its zero position, mount and align the mirror as necessary, making sure the mirror is as far down as possible, and clear from any mechanical interference.
- 2) When mirror location is as desired, tighten the screws evenly.
- 3) Once the mirror has been mounted and aligned, retune the servo amplifier if necessary, by following the instructions in the servo amplifier user's manual.

## 4.4 Mirror Mechanical Stops

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Mechanical Stops do not exist on the FM3 scanner. Therefore FM Series galvanometer requires a certain level of care to avoid damage to the flexures.

The use of an optical scale is strongly recommended when scanning near the angular limits of the flexures to ensure that the scanning limits are not exceeded.

## 4.5 Mirror Cleaning/Maintenance

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GSI Lumonics **does not recommend cleaning front surface mirrors**. Mirrors damaged by cleaning are **not covered by 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 over-coating 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.

# 5 MOUNTING CONSIDERATIONS

## 5.1 Mechanical

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The mounting surface of FM3 provides two untapped holes used for alignment and five tapped holes used for attachment. To avoid performance-degrading vibrations, it is important to mount the scanner using all five screws on a stiff plate. Refer to the outline drawing in Appendix A for the mounting surface details.

## 5.2 Electrical

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The FM3's cable shields are connected to the MiniSAX ground and terminated at the galvanometer's body. The mounting surface is electrically conductive, so mount design should include ground isolation to avoid possible ground loops. Line scan engines should be grounded at one point only, preferably at the servo. This means that the scanners should be electrically isolated from each other as well as any other ground path. Hard anodizing or other insulators should be used to provide electrical isolation between scanner and chassis ground.

## 5.3 Thermal

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### 5.3.1 Heatsinking

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It is important to note that the mounting surface of the FM Series galvanometer provides virtually no heatsinking. The stator is thermally isolated from the housing to allow the temperature of the position detector to be relatively independent from stator temperature.

Instead, the scanner heat dissipation is handled through static fins or powered fans as described in section 5.3.3 below.

### 5.3.2 Thermal Control

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The FM3 does not have Thermal Control option available.

### 5.3.3 Cooling Options

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The FM series comes with two options for cooling - static fins or powered fans.

- **Fin** units create a large surface area, and rely on surrounding airflow to provide cooling to the FM3 motor as air passes over the fins to remove heat generated by the coils.
- **Fan** units have two integrated fans mounted on opposite sides of the motor housing. The fans create a constant airflow disturbance directly above the heatsink's surface, providing an efficient and low noise solution to remove excess heat from the motor.

GSI Lumonics strongly recommends discussing the cooling requirements of your application (see Table 5.1 below) with the local applications support before deciding on cooling options.

<b>Table 5.1: FM Series Temperature Limits</b>	
Max allowable coil temp	100°C
Approx. case temp at max coil temp - FM Series <b>without</b> Fans	80°C
Approx. case temp at max coil temp - FM Series <b>with</b> Fans	50°C

Fan units are wired in series with the pinout definition as shown below –

<b>Table 5.2: Fan Cable Pinout</b>	
<b>Pin</b>	<b>Description</b>
1	+V
2	-V or GND
3	Unused
4	Shield

Note that Pin 2 may be connected to –V or to GND.

In either configuration, voltage between Pins 1 and 2 should be maintained between 20V and 40V.

The power supply range shown in Table 5.3 shows the appropriate voltage range when running off the same power supply as the MiniSAX driver board –

<b>Table 5.3: Fan Supply Voltage Range</b>	
<b>Pin 2 connected to –V</b>	<b>Pin 2 connected to GND</b>
+15V ≤ Pin 1 ≤ +20V -15V ≥ Pin 2 ≥ -20V	+20V ≤ Pin 1 ≤ +28V Pin 2 = GND

## 6 APPLICATION NOTES

### 6.1 Mirror Mounting

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Used properly, the FM series galvanometers are designed for extremely long life use. However, certain precautions must be taken in order to maintain flexure integrity. Since only the flexures support the rotor, forces on the rotor translate to the flexures. For this reason, careful mounting and removal of mirrors is critical to ensure flexure longevity. Observe the following practices:

- Mirror should slide on the rotor with minimal resistance. If this is not the case, remove clamps from mirror mount and inspect mirror mount for possible contamination such as machining burrs or bonding adhesive.
- Always remove or mount the mirror by pushing straight up or down, respectively. Do not 'twist' the mirror onto or off of the rotor.

### 6.2 Command Waveforms

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To avoid unnecessary stresses to the flexures, as well as improving performance, it is recommended that structured waveforms be used when running the scanner at higher frequencies and wider angles to limit the galvanometer's acceleration needs. This includes rounding the corners on triangular waveforms, creating sinusoidal retraces on saw tooth waveforms and micro-vectoring large step signals.

Structuring the command waveform will help reducing cross axis resonance (minimizing wobble), thus improving performance and increasing scanner longevity.

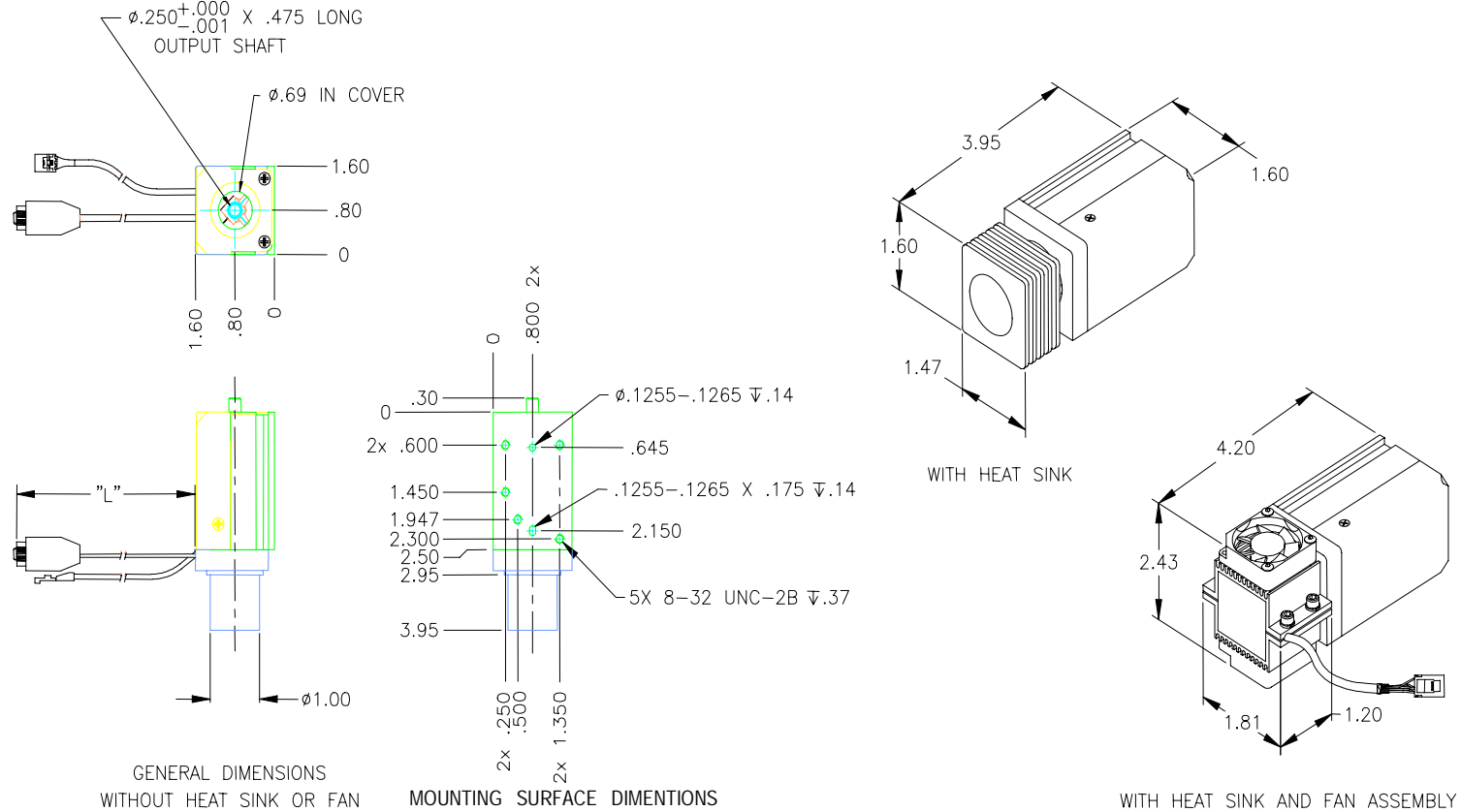
### 6.3 Maximal Angle

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Flexure based scanners should not be rotated beyond the rated scan angle even if allowed by internal structure. Flexures are designed for specific scan angles and going beyond these angles will exceed its stress limits. Though operation may not be immediately impaired, flexure lifetime is dramatically diminished in the event of over scanning. During the evaluation process of a new application, an optical scale should be used to verify that the maximum angle is never exceeded.

# APPENDIX A: OUTLINE DRAWINGS

## FM3 with and without fans



NOTES:

1. CABLE LENGTH "L" = 1ft, 1m OR 2m