# FSM75-P01 Fast Steering Mirror

## FEATURES

- Simultaneous Two-Axis Frictionless Steering on a Single Pivot Point
- Fast and Accurate X and Y Rotation
- Large 3” Mirror Replacing 2 Single-Axis Mirrors
- High Reflection Coating
- Efficient Voice Coil Drive by Segmented Actuators
- High-Power Current Drive
- Digital Position Control
- Analog X,Y User Interface (Target / Position / Position Difference)




## APPLICATIONS

- Rapid Prototyping
- Plastic Welding
- Steel Cutting and Welding with Beam Deflection
- Fast Optical Near Field Communication
- High Resolution Surface Scans with Defined Angle in two Axis

## DESCRIPTION OF MODELS

The FSM75-P01 Fast Steering Mirror is a fully motorized 3" single point mirror that provides high-speed beam deflection in two axes simultaneously. Together with the included control box, the FSM75-P01 excels in applications that require a scanning speed of down to 3 ms per step for high power lasers. The large mirror, supported by a flexure suspension system, is driven by specially designed voice-coils allowing large tilt ranges and fast acceleration. The included digital controller offers an analog user interface and provides high linearity and millisecond settling at sub-microradian resolution and stability. The FSM75-P01 can be mounted on metric or imperial tables.

- **FSM75-P01** — Fast Steering Mirror System, FSM75-P01 Mirror Head, Step Response 3 ms, Protected Silver Coating, 75 mm Clear Aperture, Wavelength Range 450 nm to 2 µm, FSM75-P01 Controller, Power Supply


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# ABSOLUTE MAXIMUM RATINGS

All specifications are valid at 23 ± 5 °C and 45 ± 15% rel. humidity (non condensing)

| Item # | FSM75-P01 |
|---|---|
| **Damage Threshold CW** | 4 W/cm (450 nm to 2 µm) |
| **Damage Threshold Pulsed** | 1 J/cm$^2$ (1064 nm, 10 ns, 10 Hz, Ø10 mm) |

# OPERATING CONDITIONS

All technical data are valid at 23 ± 5 °C and 45 ± 15% rel. humidity (non condensing)

| Item # | FSM75-P01 |
|---|---|
| **Operating Temperature[a]** | 0° C to 40° C |
| **Storage Temperature[a]** | -40° C to 70° C |

[a]) non-condensing

# SPECIFICATIONS

All technical data are valid at 23 ± 5 °C and 45 ± 15% rel. humidity (non condensing)

| Item # | FSM75-P01 |
|---|---|
| **Number of Axes** | 2 (Tip Tilt) |
| **Angular Range** | +/- 6° (Mechanical) |
| **Repeatability (for <2°)** | < 0.5 µrad (1σ) (Mechanical) |
| **Stability (for <2°)** | < 0.5 µrad (1σ) (Mechanical) |
| **Repeatability (for <6°)** | < 1.8 µrad (1σ) (Mechanical) |
| **Stability (for <6°)** | < 1.8 µrad (1σ) (Mechanical) |
| **Step Response (up to ±1.2° mechanical)** | 3 ms (99%) |
| **Linearity, +/- 4°, mechanical** | 99.8% |
| **Linearity, +/- 6°, mechanical** | 99.5% |
| **Resolution of Local Monitoring Position Sensitive Detector** | 0.1 µrad |
| **Thermal Drift** | ≤ 20 µrad/K |
| **Interconnect Cable Length** | 1.5 m |
| **Active Area** | Ø75.0 mm |
| **Pivot Point of Axes** | 11.6 mm Behind Mirror Surface |
| **Coating** | Silver, Protected (other Coatings on Request) |
| **Average Reflectance** | ≥ 97% (450 nm to 2 µm) |
| **Surface Flatness (RMS)** | ≤ λ/4 (633 nm) |
| **Command Input** | +/- 10 V ($R_{in}$ = 15 kΩ; Differential) |
| **Position, Position Difference Outputs** | +/- 10 V (1 mA Max) |
| **Thermal Protection** | 60° C (Mirror Head Temperature) |
| **Digital Signal Input** | Low: 0.0 V to 1.0 V, High: 2.3 V to 3.3 V, 10 kΩ pull up to 3.3 V |
| **Digital Signal Output** | Low: 0.0 V to 0.4 V, High: 2.9 V to 3.3 V, $I_{out}$ ≤ 8 mA |


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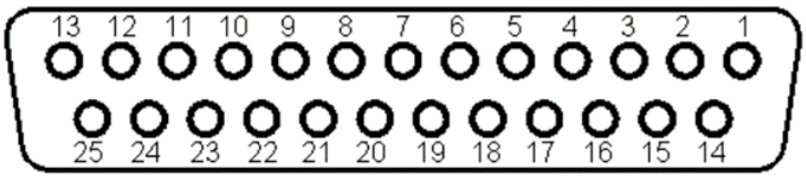
# MECHANICAL SPECIFICATIONS

| Item # | FSM75-P01 |
|---|---|
| **Dimensions Mirror Head (W x H x D)** | 110.0 mm x 140.0 mm x 51.2 mm (4.33" x 5.51" x 2.01") |
| **Dimensions Controller (W x H x D)** | 199.8 mm x 104.9 mm x 323.8 mm (7.87" x 4.13" x 12.75") |
| **Weight Mirror Head** | 910 g |
| **Weight Controller** | 3.46 kg |

All technical data are valid at 23 ± 5 °C and 45 ± 15% rel. humidity (non condensing)

# PIN-OUT DIAGRAM

The table below shows the pin assignment of the I/O port of the FSM75-P01 controller.




*D-SUB 25 FSM75-P01 Controller*

| PIN | Description | PIN | Description |
|---|---|---|---|
| **1** | A/I: Target Mirror Position X+ Differential Input, ±10 V | **14** | A/I: Target Mirror Position X- Differential Input, ±10 V |
| **2** | Ground | **15** | Ground |
| **3** | A/I: Target Mirror Position Y+ Differential Input, ±10 V | **16** | A/I: Target Mirror Position Y- Differential Input, ±10 V |
| **4** | Ground | **17** | Ground |
| **5** | A/O: Actual Mirror Position X, ±10 V | **18** | A/O: Actual Mirror Position Y, ±10 V |
| **6** | A/O: Position Difference X , ±10 V | **19** | A/O: Position Difference Y , ±10 V |
| **7** | Ground | **20** | Ground |
| **8** | Reserve, Do Not Connect | **21** | Reserve, Do Not Connect |
| **9** | D/I: Control Enable, Low Active | **22** | Reserve, Do Not Connect |
| **10** | Reserve, Do Not Connect | **23** | Ground |
| **11** | D/O: Controller Active, High Active | **24** | D/O: Current Warning, High Active |
| **12** | D/O: Current Error, High Active | **25** | D/O: Temperature Warning, High Active |
| **13** | D/O: Temperature Error, High Active | | |

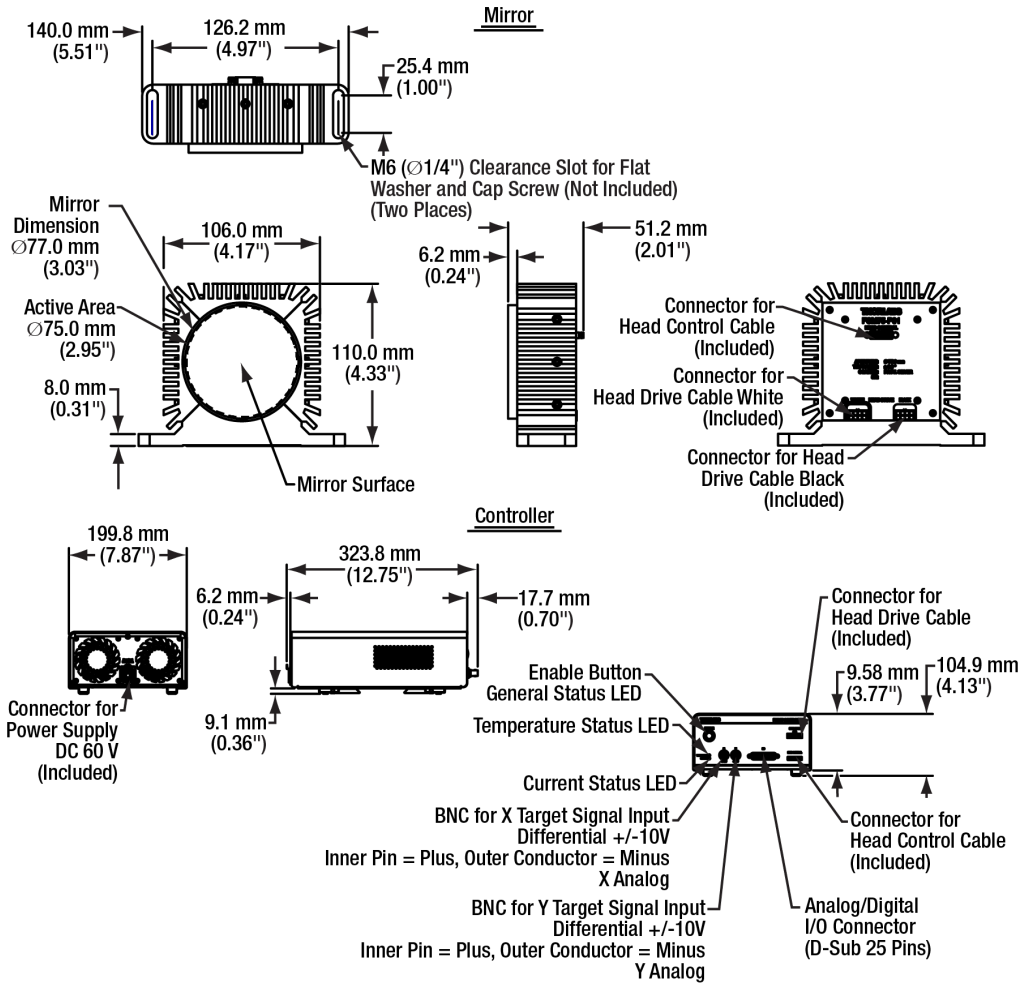
A/O: Analog Output

D/O: Digital Output

D/I: Digital Input


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# MECHANICAL DRAWING

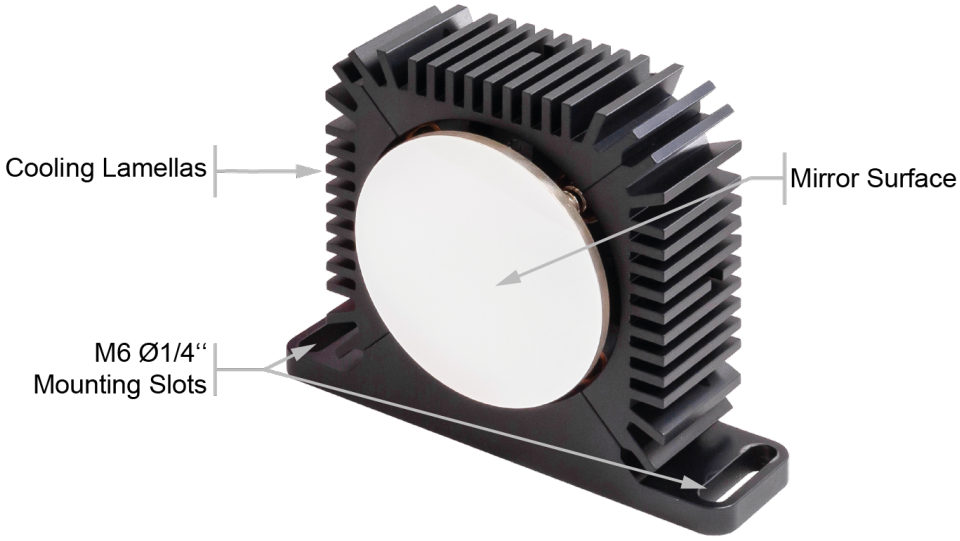




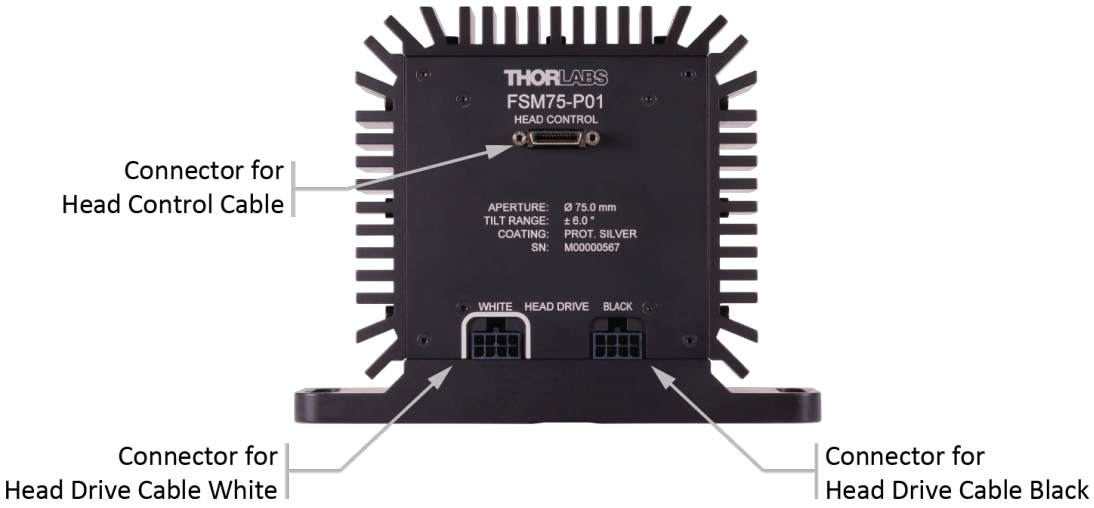
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# OPERATING ELEMENTS

FSM75-P01 Mirror Head




FSM75-P01 Mirror Head Rear





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FSM75-P01 Controller




FSM75-P01 Controller Rear




# OPERATING GUIDE

The FSM75-P01 steering mirror consists of a mirror head, a control box, and a power supply (included). The scanning movement of the optical mirror is controlled by a user-supplied input voltage, such as the output from a frequency generator. This signal is sent to the mirror via the controller box. Both X and Y axes are completely independent and can follow different waveforms. For example, to drill a hole, a laser beam might be deflected using a sine signal in X and a cosine signal in Y to draw a circle. The controller box not only converts the analog signal voltage input into a digital drive signal to control the mirror's motion, but also monitors all parameters aside from the main steering function, such as the temperature of the mirror head and the mirror position with a local position sensitive detector (PSD). If the mirror head temperature is too high, the status LEDs will warn the user, and the system will reduce its performance or automatically shut off to protect itself.

**Attention** Please be aware that the FSM75-P01 is a free space system. Please ensure laser safety according to the specifications of the used light source.

## Mounting

The FSM75-P01 consists of two parts: the actual mirror head and the controller. Please mount the FSM75-P01 steering mirror head on an optical table or stable object which can also serve as a heat sink, using M6 screws or, for imperial bread boards, 1/4" screws (both not included).
The FSM75-P01 controller can be placed on any table as far as 150 cm away from the mirror, only limited by the cable length. Please place the FSM75-P01 controller such that the power cable can easily connected and disconnected.


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# Operational Sequence

Once the FSM75-P01 is mounted, proceed as follows:

1. Connect the controller box to the mirror unit using the provided cables (head control and head drive).
2. Connect the controller box to the provided power supply.
3. Connect the power supply to the power network.
4. Remove the transport clamps.
5. Switch on the power supply.
6. The general status LED around the Enable Button will be white. In case of Errors, it will be red (i.e. when a cable has not been connected). To activate the position control, press the enable putton. The general status LED will be green.
7. The Controller Box can now drive the mirror head. To steer the mirror, the FSM75-P01 controller box features analog input BNC ports labeled X and Y on the front panel of the controller to feed signal from a voltage source (e.g. frequency generator, not included) into the controller box which then addresses the mirror.
8. Use the I/O port for additional signal input/output.

**Monitoring the scan**

The controller box also monitors the mirror head and electronics temperature and additional limitations.
Status LEDs indicate the following:

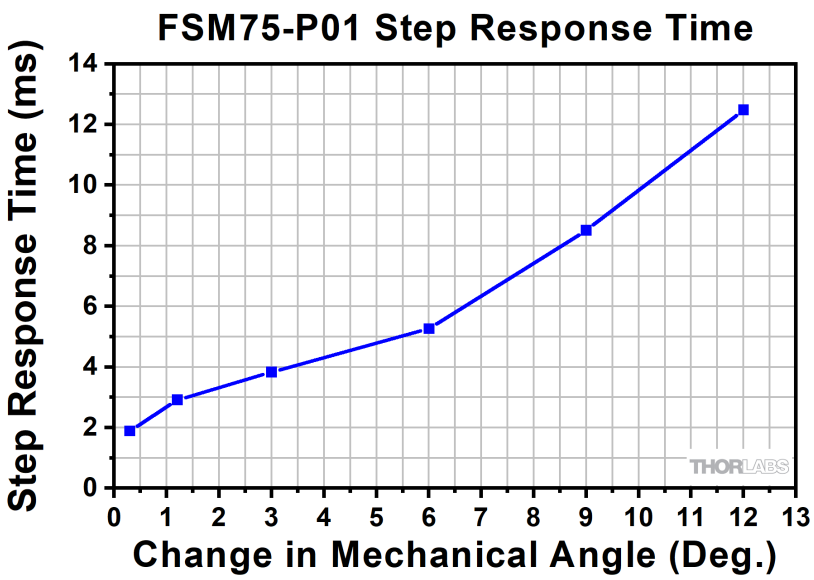
| **Item #** | **FSM75-P01** |
|---|---|
| **Color** | **Control Status** |
| **ENABLE Button** | |
| (off) | Power Supply not Connected or Switched Off |
| Red Blinking | Head – Controller Mismatch of SN |
| White | Ready to Start |
| Yellow | Soft Start Procedure Running, Coil Wire Connection Test, Takes ≈ 0.5 sec. |
| Green | Position Control is Active |
| Red | An Error Occurred, Needs to be Acknowledged to Return to 'Ready' State |
| **Temperature Status LED** | |
| Green | OK |
| Orange | Temperature is Getting too High, Please Reduce Drive Speed or Amplitude |
| Red | Temperature too High, Drive is Stopped for Protection. Please Reduce Drive Speed or Amplitude. |
| **Current Status LED** | |
| Green | OK |
| Orange | Current Close to Limits |
| Red | Current Limited, Performance is Reduced |

**Note** All status signals are also available at the I/O connector.

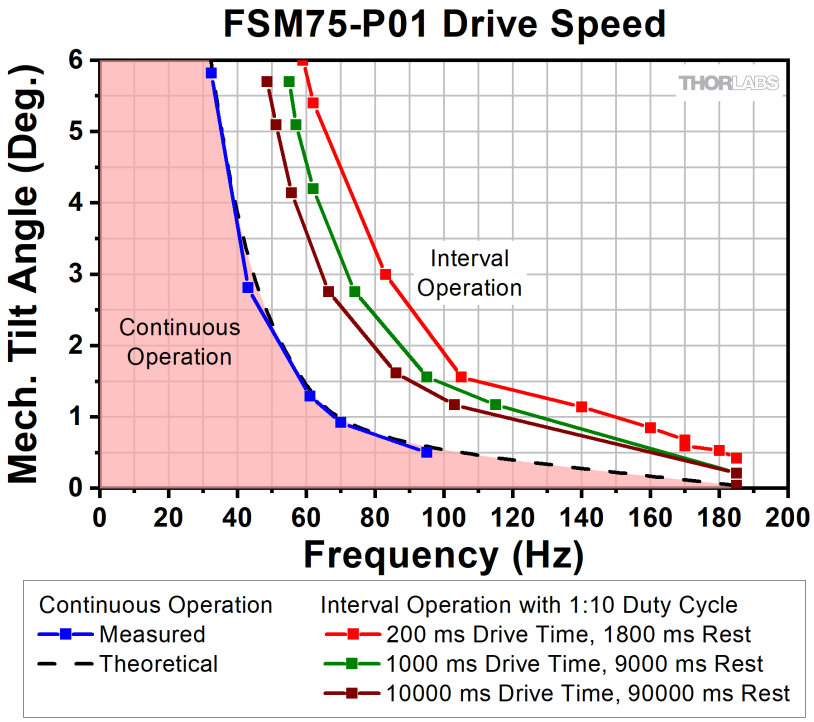

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# TYPICAL PERFORMANCE GRAPHS

**Step Response**




**Drive Speed as a Function of the Operation Mode**




*The performance measurements were done with a sinusoidal signal.*
*Mirror oscillates 10% of the period time in 1:10 Duty Cycle. The curves with "200ms", "1000ms" and "10000ms" have oscillation times of 200ms, 1000ms and 10000ms, respectively, and period times of 2000ms, 10000ms and 100000ms.*
*The dotted line marks the boundary between performance values as in continuous mode and interval mode.*

For angular velocities below the dotted line the FSM75-P01 can be operated in continuous mode. To achieve angular velocities beyond this, please use interval operation.

Further, the angular velocity increases for shorter operation periods.


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# PRECAUTIONS

**Attention**

Please remove the transport clamps from the mirror prior to operation. Failure to do so will damage the mirror.

Protect the FSM75-P01 from adverse weather conditions. The FSM75-P01 is not water resistant.

To avoid damage to the instrument, do not expose it to spray, liquids or solvents!

The unit does not need a regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please contact Thorlabs for return instructions.

Do not remove any covers of the instrument!

**Laser Safety Warning**

Lasers used with the FSM75-P01 may emit harmful energy levels. When operated incorrectly, this can cause severe damage to your eyes and health! Be sure to pay strict attention to the safety recommendations of the appropriate laser safety class, as stated for the used light source. Safety is the responsibility of the user for any system assembled by the user. Please ensure appropriate laser safety measures

**Attention**

The safety of any system incorporating the equipment is the responsibility of the assembler of the system. This is in particular true for systems assembled by the user which involve harmful laser light.

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.

The FSM75-P01 must not be operated in explosion endangered environments!

Do not open the cabinet. There are no user-serviceable parts inside!

This precision device is only serviceable if returned and properly packed into the complete original packaging including the cardboard inserts. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

Changes to this device cannot be made nor may components not supplied by Thorlabs be used without written consent from Thorlabs.

**Attention**

Prior to applying power to the FSM75-P01, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

All modules must only be operated with duly shielded connection cables.

**Attention**

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

# MANUFACTURING AND COMPLIANCE

Manufactured by: Thorlabs GmbH, Münchner Weg 1, 85232 Bergkirchen, Germany

All specifications are subject to change without notice.

UK Importer Address: Thorlabs LTD., 204 Lancaster Way Business Park, Ely CB6 3NX, United Kingdom



# CERTIFICATIONS

## EU Declaration of Conformity

*in accordance with EN ISO 17050-1:2010*

*We:* Thorlabs GmbH

*Of:* Münchner Weg 1, 85232 Bergkirchen, Deutschland

*in accordance with the following Directive(s):*

| | |
|---|---|
| 2014/35/EU | Low Voltage Directive (LVD) |
| 2014/30/EU | Electromagnetic Compatibility (EMC) Directive |
| 2011/65/EU | Restriction of Use of Certain Hazardous Substances (RoHS) |

*hereby declare that:*

*Model:* ***FSM75-P01***

*Equipment:* ***Fast Steering Mirror System, 2 axes, 3 Inch, AG coated***

*is/are in conformity with the applicable requirements of the following documents:*

| | | |
|---|---|---|
| EN 61010-1 | Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use. | 2010 + A1:2019 + AC:2019. |
| EN 61326-1 | Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements | 2013 |

*and which, issued under the sole responsibility of Thorlabs, is/are in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:*

contains no substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

*I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.*

*Signed:* *On:* 24 November 2022

*Name:* Dr. Bruno Gross

*Position:* General Manager

*EDC - FSM75-P01 -2022-11-24*

CE


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