

# MMS-201

## Multimode Scrambler

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## User Guide

Version: 1.1  
Date: August 25, 2020

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### SAFETY CONSIDERATIONS

The following safety precautions must be observed during operation of this product. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the product. General Photonics assumes no liability for customers' failure to comply with these requirements.

**Before operation, the user should inspect the product and review the manual carefully.**

Use only in a safe work environment in terms of temperature, humidity, electrical power and risk of fire or shock. The product is designed for indoor use. Avoid exposure to liquids or water condensation. Provide adequate ventilation for cooling.

Operate the product on a stable surface. Avoid excess vibration.

Standard laser safety procedures should be followed during operation.

***Never look into the light source fiber connector when the light source is turned on. THE OUTPUT LIGHT FROM A HIGH POWER LASER IS HARMFUL TO HUMAN EYES. Follow industry standard procedures when operating a high power laser source.***

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## Section 1.0 Overview

The MMS-201 is a mode scrambler specially designed for applications that require a uniform beam profile in multimode fiber. It uses a specialized General Photonics technology to perform random polarization spatial mode scrambling inside the multimode fiber to enhance the uniformity of the output beam profile.

Figure 1 shows the MMS-201. The optical input and output fiber pigtailed and electrical power connector are on the front panel. Once the electrical power (24V) is connected, the module will immediately begin mode scrambling. If the optional enable/disable input is not used, it will continue scrambling as long as the power supply is connected.



Figure 1 MMS-201 multimode scrambler

## Section 2.0 Features

### 2.1 Optical Features

The MMS-201 has two fiber pigtails to accommodate the input and output optical beams. The external fiber pigtails have 3mm protective jacketing and are about 1-meter long. The optical connectors are standard FC/PC or FC/APC connectors. The external fiber connectors should be cleaned using industry standard cleaning methods before connection to the MMS-201.

Since the optical fiber used in the MMS-201 is multimode fiber (MMF), the bending radius requirement should be more than 30 mm to avoid any additional insertion loss. When the module is not in use (connected), protection caps should be placed on the input and output connectors.

### 2.2 Electrical Features

The MMS-201 uses a +24-V DC power supply connected via a 3-pin connector (labeled "POWER" on the front panel). The connector description and pin definitions are listed below.

	Manufacturer Part #	Description
MMS Power Connector	Molex 0436450300	3 Position Rectangular Housing Connector Receptacle Black 0.118" (3.00mm)
Mating Connector	Molex 0436400301	3 Position Rectangular Housing Connector Plug Black 0.118" (3.00mm)

#### Electrical connector pin definition:

Pin #	Definition
1	+24 VDC
2	Power Supply Ground
3	Chassis Ground

The front panel of the MMS-201 is shown in Figure 2. The power supply input, the input and output optical fibers, the power indicator LED (red) and the enable/disable indicator LED (green) are mounted on the front panel. A BNC connector for scrambling enable/disable control and a cooling fan are mounted on the rear of the module, as shown in Figure 3.

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Figure 2 Front Panel

Front panel description:

POWER: 3-pin power connector (24V)

Power indicator: red LED next to power connector  
(on = power connected)

INPUT: Input pigtail

OUTPUT: Output pigtail

SCRAMBLING STATUS: scrambler enable/disable status indicator LED (green)  
(on = enabled, off = disabled)



Figure 3 Rear Panel

Rear panel description:

BNC INPUT: Scrambler enable/disable input signal

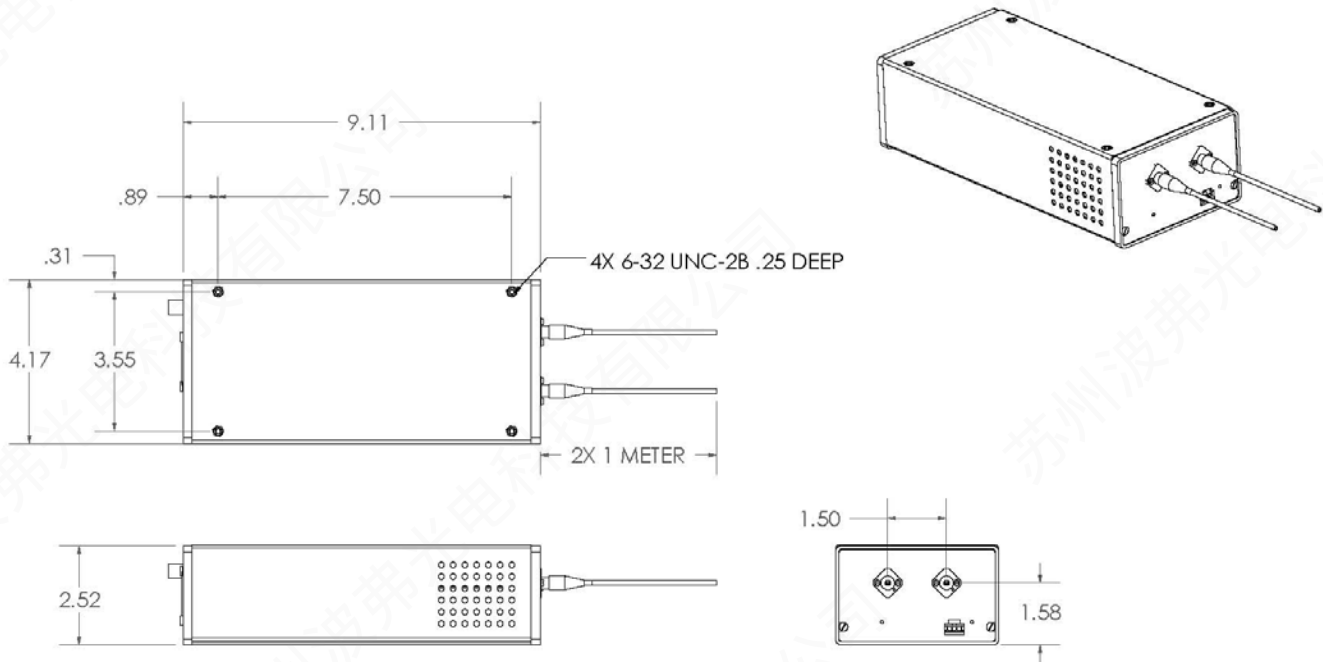
TTL high/open = enabled

TTL low/shorted to ground = disabled



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## 2.3 Mechanical Dimensions



**Figure 4 Mechanical Dimensions (in inches)**

Figure 4 shows the mechanical dimensions of the MMS-201, including the size and locations of mounting holes. The MMS-201 has 4 mounting holes on the bottom, one at each corner. 6-32 screws can be used to mount it to a surface.

## Section 3.0 Operation Instructions

### 3.1 Unpacking

Inspect MMS-201 for any physical damage due to shipping and transportation. Contact carrier if any damage is found. Check the packing list to see if any parts or accessories are missing.

Be careful when removing the product from the packing material and when handling the fiber pigtails. Do not apply any stress to the fiber or allow any sharp bends or kinks. Do not drop the connectors or allow them to hang, unsupported, from the pigtails.

#### Packing List

Item #	Description
1	MMS-201
2	Electrical connection cable
3	User guide

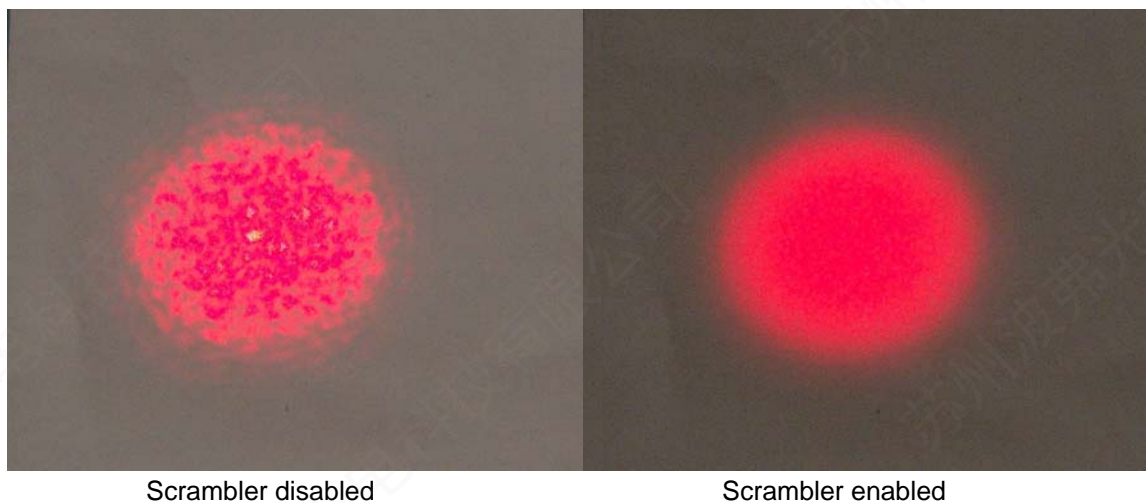
### 3.2 Operation

1. Make sure the 3-pin power connector is in good shape. If not, do not proceed. Contact General Photonics immediately.
2. Connect the power cable to the 3-pin connector. Make sure the ground pin of the power cord is also connected.
3. Connect input and output fibers to MMS-201. Clean the fiber connectors using industry standard procedures before connecting them. Turn off the light source before connector cleaning.
4. Connect the other end of the power cable to the 24-Volt power supply.
5. The module will begin scrambling as soon as the power supply is connected.
6. The BNC connector on the rear panel can be used to enable/disable scrambling without disconnecting the power supply. The default condition with no input is enabled.

TTL high/open/no input	scrambling enabled
TTL low/shorted to ground	scrambling disabled
7. The green SCRAMBLING STATUS LED indicates the scrambling enable/disable status. The LED turns on when scrambling is enabled.

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The effect of the mode scrambling can be observed by projecting the far-field illumination pattern from the fiber onto a flat surface such as a piece of paper.



**Figure 5 Illumination patterns with scrambler disabled and enabled.**

As shown in Figure 5, the illumination pattern projected from a multimode fiber is typically very uneven. Once the scrambler is enabled, the spot becomes much more uniform.

## Section 4.0 Specifications

### Optical

Operating Wavelength range	530 nm to 1630 nm
Maximum Insertion Loss at 635nm	1.0 dB including connectors
Return Loss	>50 dB (PC connector) >55 dB (APC connector)
Dynamic Mode Scrambling Efficiency <sup>1,2</sup>	>80% (effective power)
Flatness <sup>3</sup>	< 20% typical
Ripple <sup>4</sup>	< 10% typical
Optical Power Handling	400 mW
Connector Type	FC/APC or FC/PC
Fiber Core Diameter	50 μm (step index)
Fiber NA	0.22
Pigtail Length	1 m each side

### Electrical

Power Supply Voltage	24±2V
Current Consumption	0.75A typical, 1A maximum
Drive Frequency	150±5 kHz
Drive Voltage	50-65 V peak-to-peak
Electrical Enable/Disable	TTL levels <div style="display: flex; justify-content: space-around; width: 100%;"> <span>TTL high/open</span> <span>Enabled</span> </div> <div style="display: flex; justify-content: space-around; width: 100%;"> <span>TTL low/shorted</span> <span>Disabled</span> </div>

### Physical and Environmental

Operating Temperature	10 to 40°C
Operating Humidity	20 to 80% RH (non-condensing)
Operating Pressure	Atmospheric
Storage Temperature	-20 to 70°C
Dimensions	23 (L) × 10.5 (W) × 6.5 (H) cm
Weight	1.1 kg

Notes:

1. Scrambling efficiency is defined as (Light energy ≥ 80% of maximum intensity/Total energy)\* (area over which intensity is ≥ 80% of maximum intensity /total core area).
2. Measured over 80 ms integration time at 635 nm.

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3. Flatness is defined as (maximum intensity - minimum intensity) expressed as a percentage of maximum intensity, where the maximum and minimum are defined over the center 80% of the fiber core area.
4. Ripple is defined as the maximum peak-to valley difference of intensity fluctuations, expressed as a percentage of maximum intensity, where the fluctuation differences and maximum intensity are measured within the center 80% of the fiber core area.

A note on flatness and ripple definitions:

The illumination pattern intensity distribution will in general have high frequency fluctuations superposed over a more gradual spatial variation. The flatness is a measure of the maximum intensity variation over the region of interest, including the effects of both the high frequency fluctuations and the gradual variation. By contrast, the ripple is a measure of the amplitude of the high frequency fluctuations.

These definitions are illustrated below on a generic 3D surface plot provided for illustration purposes only. If the area shown in the plot is the area of interest, the maximum z value occurs at point A and the minimum at point B, so the flatness would be  $z(A) - z(B)$ , expressed as a percentage of  $z(A)$ .

However, the ripple might be  $z(C) - z(B)$ , expressed as a percentage of  $z(A)$ , if the z distance between points C and B is the largest difference between adjacent peaks and valleys.

