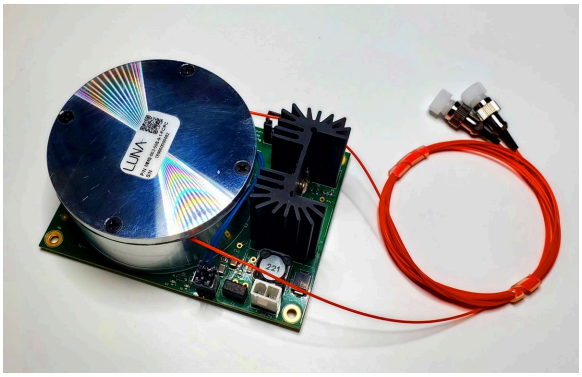


DESCRIPTION

Speckle patterns from a multimode fiber can cause problems in many applications that require uniform, stable light distributions at the fiber output. The MMS-003 is a miniature multimode scrambler that is specially designed to randomize multimode speckle patterns over time at a high frequency of over 725 kHz. The light distribution at the output appears uniform and stationary when viewed by cameras or detectors with averaging times > 80 ms. In addition, the all-fiber optical path minimizes the scrambler's insertion loss.

The MMS-003 can improve performance in various applications including DNA sequencing, multimode fiber sensing, optical imaging, as well as testing and measurement of multimode fiber devices.

FEATURES

- Compact
- Reliable
- Hight Speed
- Efficient

FIBER DESCRIPTION

Input Fiber	50/125µm Step Index Multimode Fiber
Output Fiber	50/125µm Step Index Multimode Fiber
Pigtails	900um loos tube on fiber
Pigtails Length	100cm +/ 5cm
Fiber Connector	FC/PC, FC/APC

SPECIFICATIONS

Physical Operating Conditions				
Parameter	Min.	Typical	Max.	Unit
Operating Temperature[1]	10		60	°C
Storage Temperature	−20		70	°C
Weight		360		g

1. 1-Optical head surface temperature should be kept < 60 °C by having an airflow (heatsink on the top is a plus) around the MMS. For reference, the optical head surface temp is expected to be around 25 °C when 25 CFM fan is used 12 cm away from the MMS with a one-way controlled airflow environment.

Optical Characteristics				
Parameter	Min.	Typical	Max.	Unit
Operation Wavelength	600		800	nm
Insertion Loss [1]			1.0	dB
Return Loss [1]			-50	dB
Scrambling Frequency		725 ± 5%		kHz
Scrambling Efficiency [2, 3]		>80		%
Flatness [4, 6]		< 20		%
Ripple [5, 6]		< 10		%
Optical Power Handling			400	mW

Note:

2. With FC/PC connector
3. 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).
4. Measured over 80 ms integration time at 635 nm.
5. 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.
6. 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.
7. 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.

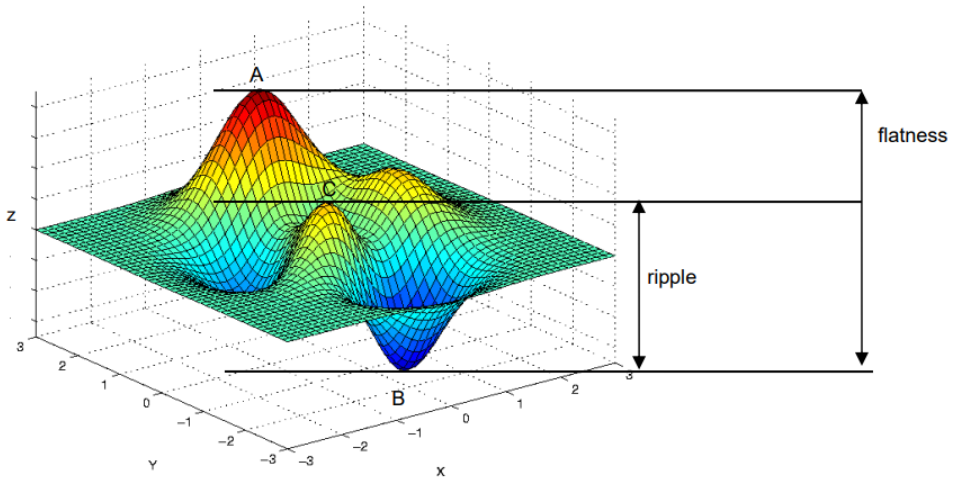


Figure 1 Flatness and Ripple definition

Electrical Parameters		
Parameter		Unit
Power Supply Voltage	DC 24 ± 2%	V
Working Current	0.4 ± 0.1	A
On Board Connector Definition		
EN1	Enabled/Disabled control: TTL control signal, L/H=enabled/Disabled, required drive current >1mA@100kΩ	
PW IN1	+ 24V POWER IN	
OH [1]	In-board use	

Note:

1. OH Connector and peripheral circuits will have a high-frequency AC high voltage of up to 68Vpp when the module is working, so pay attention to safety to prevent electric shock.

Connectors Definition *(Refer to Figure 2)*	
Power Connector (PW IN1)	
P/N #	Würth Elektronik 64900211122
Mating connector P/N #	Würth Elektronik 649002013322
Pin	
1	+ 24 VDC
2	GND
Enable/Disable (EN1)	
TE Connectivity AMP Connector P/N	5-103669-1
Mating connector P/N #	5-103956-1
Pin	
1	TTL Low/Open = Enabled TTL High = Disabled
2	GND

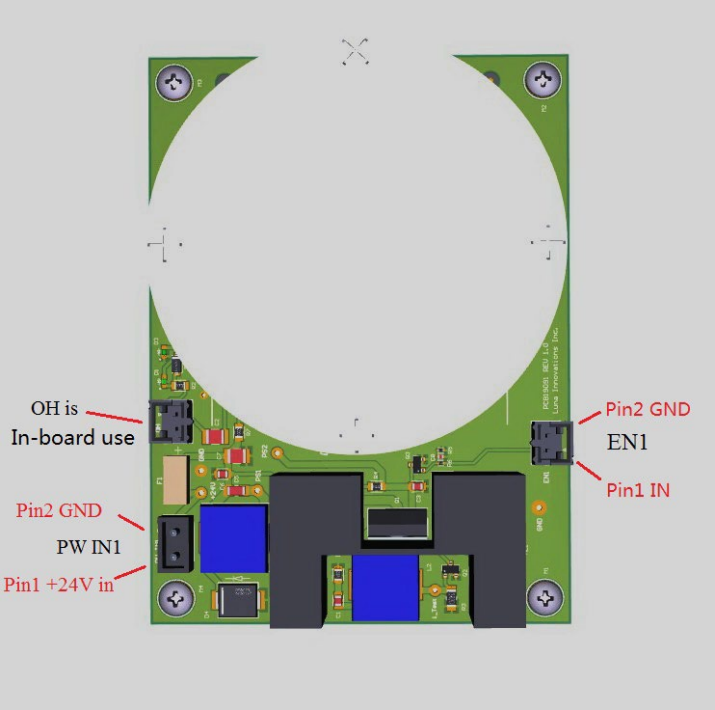
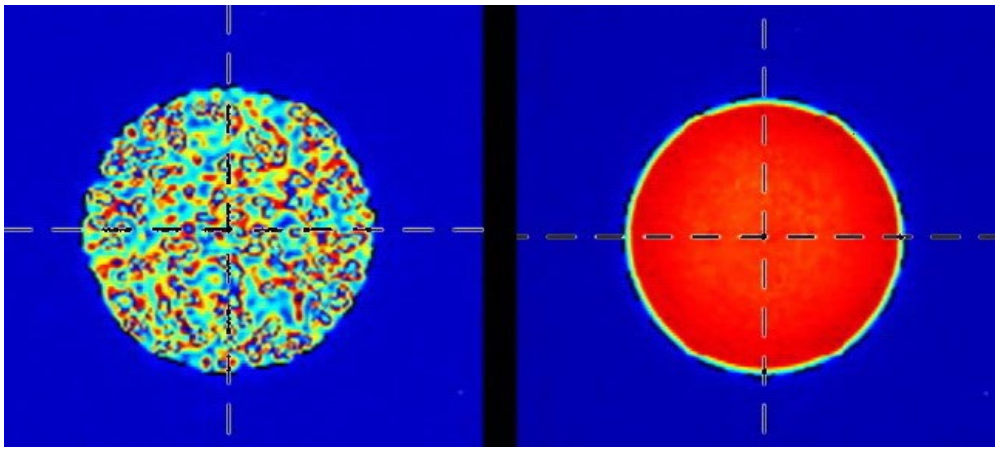


Figure 2 Driver Board Socket Distribution and Function

OPERATION

1. Make sure the 2-pin power connector is in good shape. If not, do not proceed. Contact Luna Innovations Corporation immediately.
2. Connect the power cable to the 2-pin connector. Make sure the ground pin of the power cord is also connected.
3. Connect input and output fibers to MMS-003. 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 EN1 connector on the board is 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 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.



Scrambler disabled **Scrambler enabled**

Figure 3 Illumination patterns with scrambler disabled and enabled

As shown in Figure 3, the illumination pattern projected from a multimode fiber is typically very uneven. Once the scrambler is enabled, the spot becomes much more uniform.

8. If the module is used in the chassis, the chassis must have forced air cooling, and the air flow requirement is ≥ 10CFM.
9. When the module is working, the OH connector and peripheral circuits will generate high-frequency AC high voltage up to 68Vpp, please pay attention to safety and prevent electric shock.

DIMENSIONS

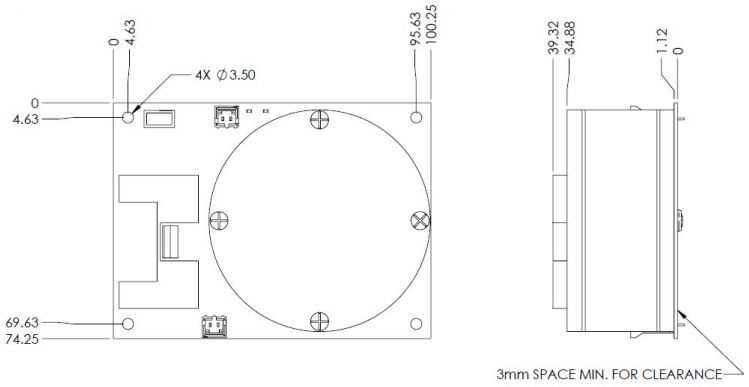


Figure 4 Mechanical drawing and dimensions (in mm)

ORDERING INFORMATION

MMS – 003 – 50S – 9 – 1 – FC/PC

Miniature Multimode scrambler OEM module, 50µm core step index MM fiber, scrambling efficiency 80% at 635nm over 80 ms integration time, Reduced size board, no enclosure. Pigtails: 1m long with 900µm jacket FC/PC connectors

MMS – 003 – 50S – 9 – 1 – FC/APC

Miniature Multimode scrambler OEM module, 50µm core step index MM fiber, scrambling efficiency 80% at 635nm over 80 ms integration time, Reduced size board, no enclosure. Pigtails: 1m long with 900µm jacket FC/APC connectors

REVISION HISTORY

REVISION	DATE	NOTE
1.0	7/26/2023	Original document
1.1	08/09/2023	Airflow requirements added

CONTACT INFORMATION

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