

PSM-003

Micro Polarization Controller/Scrambler



User Guide

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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.

After powering off the PSM-003, wait at least 5 seconds before powering it back on. If this procedure is not followed, the PSM-003 may not function properly.

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 PSM-003 is an OEM micro polarization controller that integrates miniature sized electronic driving/control circuitry with General Photonics' all-fiber dynamic polarization controller. The state of polarization (SOP) of the output light is controlled via three 0-5V analog control voltages. The device requires a ± 12 VDC power supply, and the power consumption is low enough for it to be powered by batteries or a wall-plug transformer.



Figure 1 PSM-003 micro polarization controller/scrambler

1.1 Principle of Operation

The PSM-003 is based on a PolaRite™ III polarization controller, which consists of 3 fiber squeezers oriented 45° from each other. Each fiber squeezer is driven by an applied voltage signal. Squeezing the optical fiber produces a linear birefringence in the fiber and thus alters the state of polarization of a light signal passing through it.

An arbitrary polarization state of monochromatic light can be represented by a single point on the Poincaré Sphere, as shown in Figure 2. Increasing the voltage on one fiber squeezer (X1 or X3) increases the pressure from that squeezer, causing the polarization state to rotate clockwise about the OQ axis. Decreasing the voltage causes the point to rotate counterclockwise. Similarly, increasing or decreasing the voltage on a second fiber squeezer (X2) oriented 45° from the first one causes the polarization state to rotate clockwise or counterclockwise about an axis (OH axis) orthogonal to the first one.

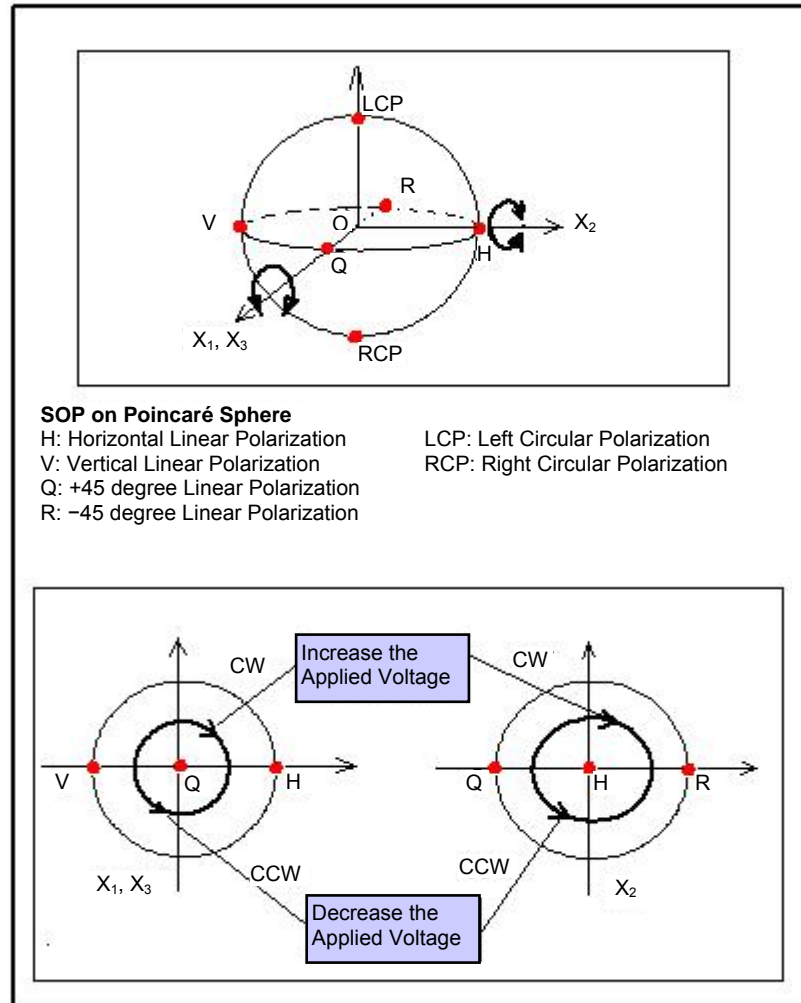


Figure 2 Poincaré Sphere SOP representation and illustration of effects of fiber squeezers

The half-wave voltage $V_n(\lambda)$ at wavelength λ can be calculated from

$$V_n(\lambda) = V_n(1550 \text{ nm}) \times \lambda / 1550$$

where $V_n(1550 \text{ nm})$ is the half-wave voltage at 1550 nm. For example, the half-wave voltage at 1310 nm is 85% of the half-wave voltage at 1550 nm.

By appropriately tailoring the control signals, the polarization controller can be made to perform various polarization control or scrambling functions.

1.2 Device Configurations and their Functions

The PSM-003 is available in 3 different configurations, selected at the time of order:

1. Polarization Controller
2. Fixed rate, continuous-trace polarization scrambler
3. Fixed rate random scrambler

For the polarization scrambler configurations, the scrambling rate is also specified at the time of order.

The functions of the three types of PSM-003 are described below:

Polarization controller: The SOP of the output light can be set or modulated by applying a 0-5V analog control voltage to each of the 3 fiber squeezers. The control signal can be a DC voltage or a sine wave of frequency up to 10 Hz.

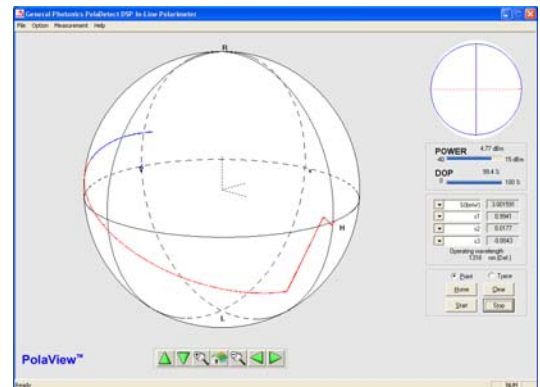


Figure 3 SOP change by sequentially changing control voltages of different channels

Continuous polarization scrambler: The PSM-003 generates a continuous polarization trace that evenly covers the Poincaré sphere at a preset rate.

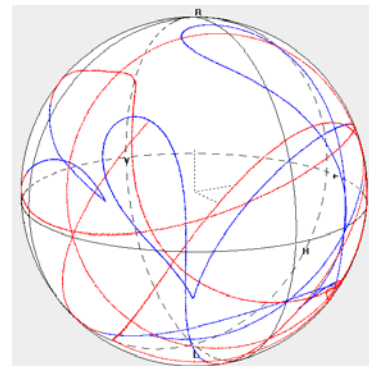


Figure 4 Continuous scrambling trace

Random polarization scrambler: The PSM-003 generates discrete random points evenly distributed on the Poincaré sphere.

There are two modes of operation:

Internal trigger: Points are automatically generated at a preset rate.

External trigger: PSM-003 generates one random point per trigger pulse received.

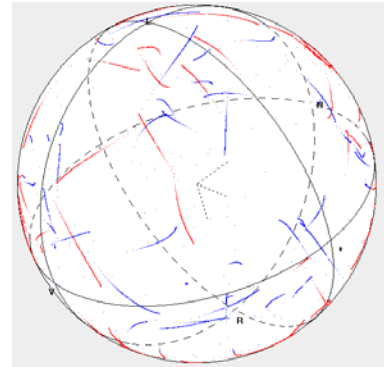


Figure 5 Random scrambling trace

Section 2.0 Features

2.1 Optical Features

The PSM-003 has two fiber pigtailed to accommodate the input and output optical signals.

2.2 Electrical Features

The electrical interface to the PSM-003 is a 10-pin IDC connector. The connector diagram is shown below. The tables list the pin definitions for the connector for the different PSM configurations.

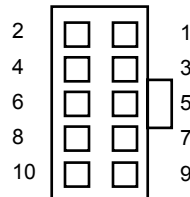


Figure 6 PSM-003 electrical connector pinout

Table 1 Electrical connector pin definitions for PSM-003-C (controller)

Pin #	Label	I/O	Description	Range and Function
1	AIN1	I	Analog input axis 1	DC 0 to 5V
2	AIN2	I	Analog input axis 2	DC 0 to 5V
3	AIN3	I	Analog input axis 3	DC 0 to 5V
4	N/C		Not connected	
5	N/C		Not connected	
6	N/C		Not connected	
7	EN	I	Enable/Disable	TTL, Low=Enable, High=Disable
8	+12V	I	+12V Power input	DC+12V±5%, current >25mA
9	-12V	I	-12V Power input	DC-12V±5%, current >25mA
10	GND	-	Ground	System ground

Table 2 Electrical connector pin definitions for PSM-003-S (Continuous scrambler)

Pin #	Label	I/O	Description	Range and Function
1	N/C		Not connected	
2	N/C		Not connected	
3	N/C		Not connected	
4	N/C		Not connected	
5	N/C		Not connected	
6	N/C		Not connected	
7	EN	I	Enable/Disable	TTL, Low=Enable, High=Disable
8	+12V	I	+12V Power input	DC+12V±5%, current >25mA
9	-12V	I	-12V Power input	DC-12V±5%, current >25mA
10	GND	-	Ground	System ground

Table 3 Electrical connector pin definitions for PSM-003-S (Random scrambler)

Pin #	Label	I/O	Description	Range and Function
1	N/C		Not connected	
2	N/C		Not connected	
3	N/C		Not connected	
4	N/C		Not connected	
5	EXT	I	Trigger Select	TTL, Low = external, High = internal
6	TR	I	External Trigger	TTL, triggers on rising edge
7	EN	I	Enable/Disable	TTL, Low=Enable, High=Disable
8	+12V	I	+12V Power input	DC+12V±5%, current >25mA
9	-12V	I	-12V Power input	DC-12V±5%, current >25mA
10	GND	-	Ground	System ground

Voltage/Current Guidelines:

Analog Control Voltages (PSM-003-C: AIN1-3):

Voltage Range: 0 to 5V

Drive current: <1.5 mA

Digital TTL (EN, EXT, TR):

Logic Level	Voltage	Current (TTL circuit capacity)
High	3 to 5V	>400µA
Low	0 to 0.4V	>1mA

2.3 Dimensions and Mounting Holes

The PSM-003 has 4 mounting holes on the bottom of the enclosure. Package dimensions and the locations and sizes of mounting holes are given below.

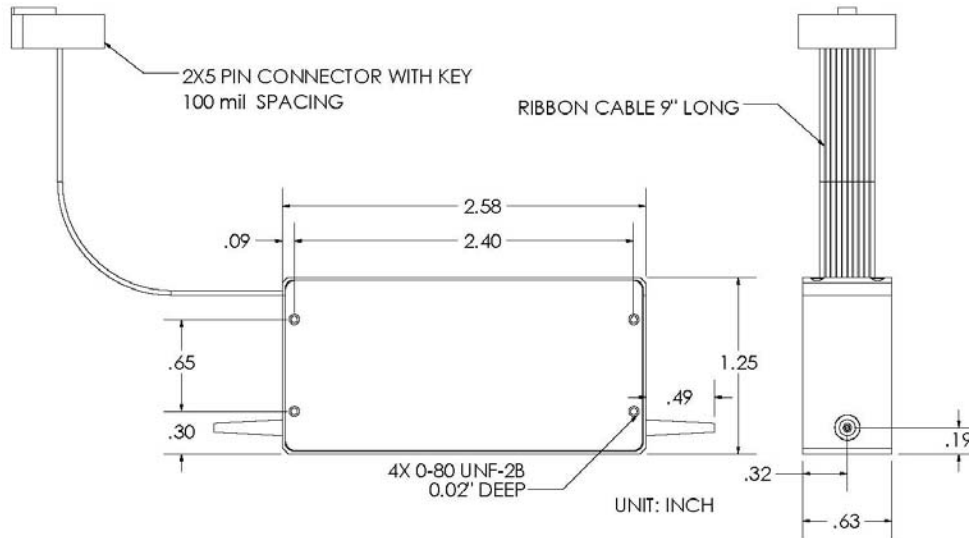


Figure 7 Dimensions and mounting hole information
All dimensions given in inches.

Section 3.0 Operation Instructions

3.1 Unpacking

Inspect PSM-003 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.

Packing List

Item #	Description
1	PSM-003
2	Electrical connection cable
3	User Guide
4	Control board (optional)
5	Power adapter (optional; only for devices with control board)

3.2 Operation

Polarization Controller

1. Connect optical input and output to PSM-003.
2. Make the necessary electrical connections to the 10-pin IDC connector (see Table 1 for pin definitions). For a polarization controller, these include:
 - a. Power supply: $\pm 12\text{VDC}/25\text{ mA}$
 - b. Enable/Disable signal: TTL level. Low = Enabled, High = Disabled. The default condition is enabled, so if this pin is left unconnected, the controller will be enabled. For a controller, the Enable/Disable function acts as a position lock; while disabled, the controller remains in its current setting. It does not respond to further changes in control voltage until enabled.
 - c. Analog control voltage for each of the 3 channels of the polarization controller: The user can manually adjust the output SOP by changing the value of DC control voltages to the different channels, or can generate periodic SOP traces or patterns on the Poincaré sphere by using periodic waveform control voltages. Guidelines for control voltages:
 - i. Voltage range: 0 to 5V
 - ii. Frequency limit for periodic waveform inputs: 10 Hz.

Polarization Scrambler (Continuous)

1. Connect optical input and output to PSM-003.
2. Make the necessary electrical connections to the 10-pin IDC connector (see Table 2 for pin definitions). For a continuous polarization scrambler, these include:
 - a. Power supply: $\pm 12\text{VDC}/25\text{ mA}$
 - b. Enable/Disable signal: TTL level. Low = Enabled, High = Disabled. The default condition is enabled, so if this pin is left unconnected, the scrambler will be enabled. For a scrambler, the Enable/Disable function acts as a pause/resume function; while paused, the SOP remains at the setting at which the scrambling was paused. When resumed, the SOP variation begins from that state.

Polarization Scrambler (Random)

1. Connect optical input and output to PSM-003.
2. Make the necessary electrical connections to the 10-pin IDC connector (see Table 3 for pin definitions). For a random polarization scrambler, these include:
 - a. Power supply: $\pm 12\text{VDC}/25\text{ mA}$
 - b. Enable/Disable signal: TTL level. Low = Enabled, High = Disabled. The default condition is enabled, so if this pin is left unconnected, the scrambler will be enabled. For a scrambler, the Enable/Disable function acts as a pause/resume function; while paused, the SOP remains at the setting at which the scrambling was paused. When resumed, the SOP variation begins from that state.
 - c. Trigger select: This selects between external and internal triggering. In internal trigger mode, the PSM-003 generates random SOPs at a preset rate determined at the time of purchase. In external trigger mode, the PSM-003 generates one random point per trigger pulse received. TTL Low = external trigger; TTL High = internal trigger. The default state is internal trigger.
 - d. External trigger signal:
 - i. Trigger edge: Rising edge
 - ii. Voltage levels: TTL levels
 - iii. Minimum pulse width: 1 ms
 - iv. Maximum pulse frequency: 10 Hz

3.3 Driver Board (Optional)

General Photonics offers an optional manual control driver board for the PSM-003. The purpose of the board is to facilitate testing and integration of the PSM-003. The user controls the PSM-003 via sliders, switches, and buttons on the control board. The board comes with a power adapter that plugs into a wall power supply.

Driver board dimensions: 3.5 × 3.5 × 0.7 inches.

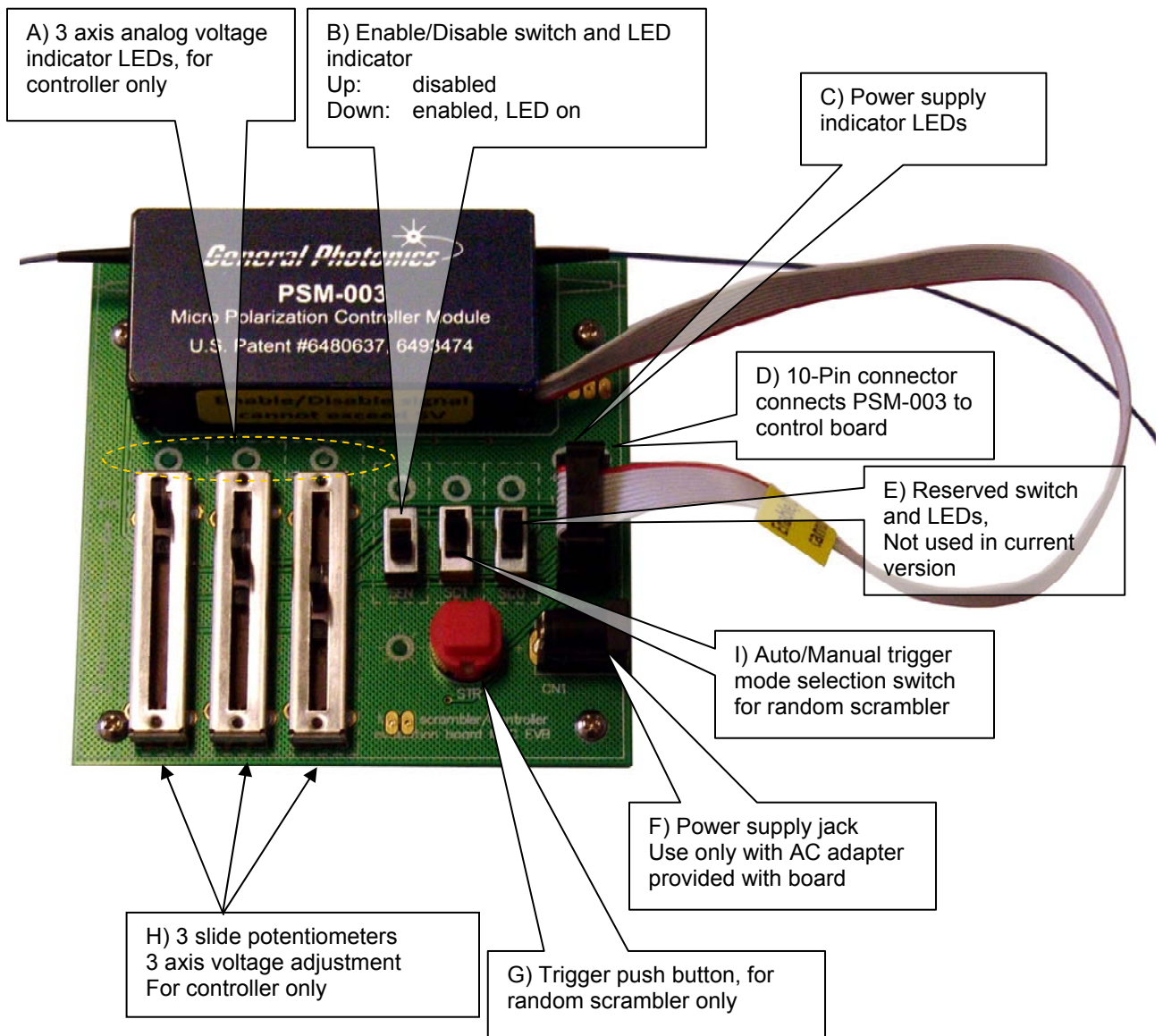


Figure 8 PSM-003 controller board

Setup

1. Connect optical input and output to PSM-003.
2. Make sure the PSM-003's 10-pin electrical connector is connected to the corresponding connector on the driver board (middle right in Figure 8). The board and cable connectors are keyed and can only be connected in one orientation.
3. Connect the external power adapter to the board's power jack and plug it into the wall electricity supply. Both power indicator LEDs on the board should turn on.
Power supply adapter output: 12VAC/500 mA
4. Move the Enable/Disable switch to the Enabled position.

Polarization Controller

Use the three sliders to control the voltage input to the three channels of the polarization controller.

The Enable/Disable switch can be used to lock in the current setting. If the switch is in the Disable position, the polarization controller will not respond to slider movement.

Polarization Scrambler (Continuous)

The PSM-003 performs continuous scrambling at a preset rate as long as it is enabled. Use the Enable/Disable switch to pause and resume scrambling.

Polarization Scrambler (Random)

The trigger selection switch selects between automatic and manual triggering of random SOP generation.

Switch position: UP	Automatic triggering
DOWN	Manual triggering

In automatic mode, the PSM-003 generates random SOPs at a preset rate. In manual mode, the PSM-003 generates one random SOP each time the push button (immediately to the left of the power jack in the diagram) is pressed.

Use the Enable/Disable switch to pause and resume scrambling.

Section 4.0

Specifications

Optical

Operating Wavelength	1260-1650 nm standard
# of control axes	3
Insertion Loss	Measurement grade: 0.05 dB, excluding connectors Control grade: 0.1 dB, excluding connectors
Return Loss	> 65 dB, excluding connectors
Activation Loss	Measurement grade: 0.01 dB Control grade: 0.1 dB
PDL	Measurement grade: <0.01 dB Control grade: <0.1 dB
PMD	< 0.05 ps
Optical Power Handling	300 mW
Preset scrambling rates	(select when ordering)
Continuous scrambling	0.0192π , 0.096π , 0.48π , 2.4π , 12π , 60π rad/s
Random scrambling	0.1, 0.2, 1, 5 points/s

Electrical

Control voltage range	0 to 5V
Rise and Fall Time	<5 ms/V (or 12.5 ms/V _n)
V _n	2.5V (typical), 3V (maximum) at 1550nm
Input sine wave frequency	10 Hz max.
Electrical interface	8-wire flat cable
Electrical connector	IDC 10-pin (2x5), 0.1 inch grid
Power Supply	±12VDC/25 mA
Power consumption*	<0.6W typical

* Controller: 5V input on all 3 axes at 25°C
Scrambler: Continuous scrambling at 12n rad/s and 25°C.

Physical and Environmental

Fiber Type	9/125 μm single mode fiber standard
Operating temperature	-10 °C to 70 °C
Storage temperature	-40 °C to 85 °C
Dimensions	2.58"(L) × 1.25"(W) × 0.63"(H) (6.54 (L) × 3.18 (W) × 1.60 (H) cm)
Weight	2 Oz. (50g)