

PSM-002

Miniature Polarization 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.

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-002 is a miniature polarization scrambler that integrates General Photonics' PolaRite III polarization controller, driver circuit, and a microprocessor-based electronic control circuit into a single module, as shown in Figure 1. It generates random, discontinuous output states of polarization (SOPs) at a user-controllable rate between 0.01 and 20,000 points/s. Its continuous fiber construction results in extremely low optical insertion loss, polarization dependent loss, and polarization mode dispersion. It uses a 5V DC power supply. It is available in both a standard temperature version for lab applications and an extended temperature version for extreme-environment applications such as wind or oil and gas sensors.

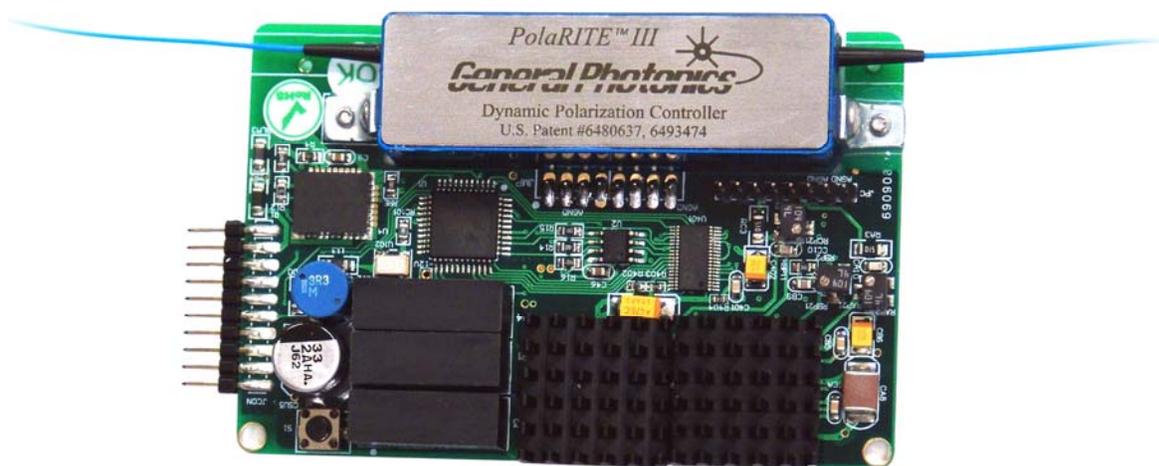


Figure 1 PSM-002 polarization scrambler

1.1 Principle of Operation

The PSM-002 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.

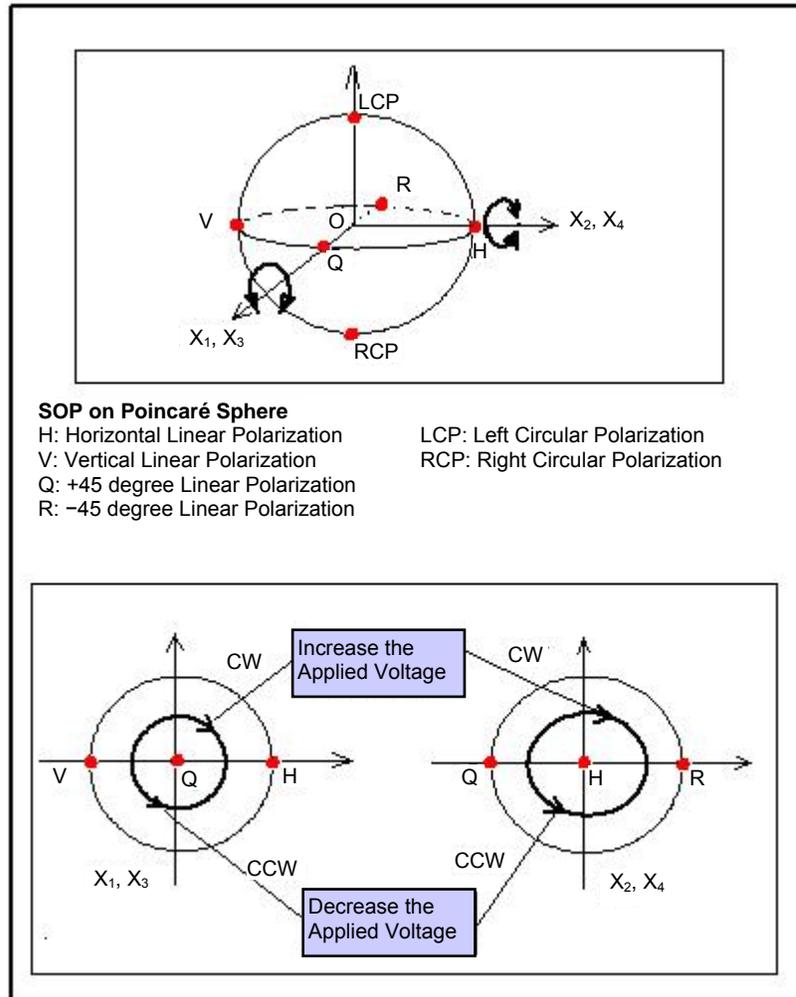


Figure 2 Poincaré Sphere SOP representation and illustration of effects of fiber squeezers

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. The PSM-002's microprocessor and driver circuits generate discrete sets of control voltages at the specified scrambling rate, resulting in a near uniform polarization state distribution on the Poincaré sphere.

Microprocessor control greatly expands the capability of the PSM-002 module. It can operate over a large temperature range and a wide wavelength band. Depending on the version, it covers either the 1260-1650 nm or 980-1310 nm wavelength ranges.

Section 2.0 Features

2.1 Optical Features

The PSM-002 has two fiber pigtails, one for the input and the other for the output. The input and output pigtails are interchangeable unless a user specifies a particular connector combination for the input/output pigtails.

Standard connector types include FC/PC, FC/APC, SC/PC, and SC/APC.

2.2 Board Overview and Electrical Features

Figure 3 shows the PSM-002 with and without an enclosure. The board consists of a PolaRite III polarization controller, driving electronics, and power and communication connector blocks. The external power supply, RS-232 communication, external TTL trigger, and electrical enable/disable signals are connected to the PSM-002 via a 10-pin connector, located on the left side of the PSM-002 without enclosure and on the right side of the PSM-002 with enclosure in Figure 3.

The button on the board is reserved for factory use.

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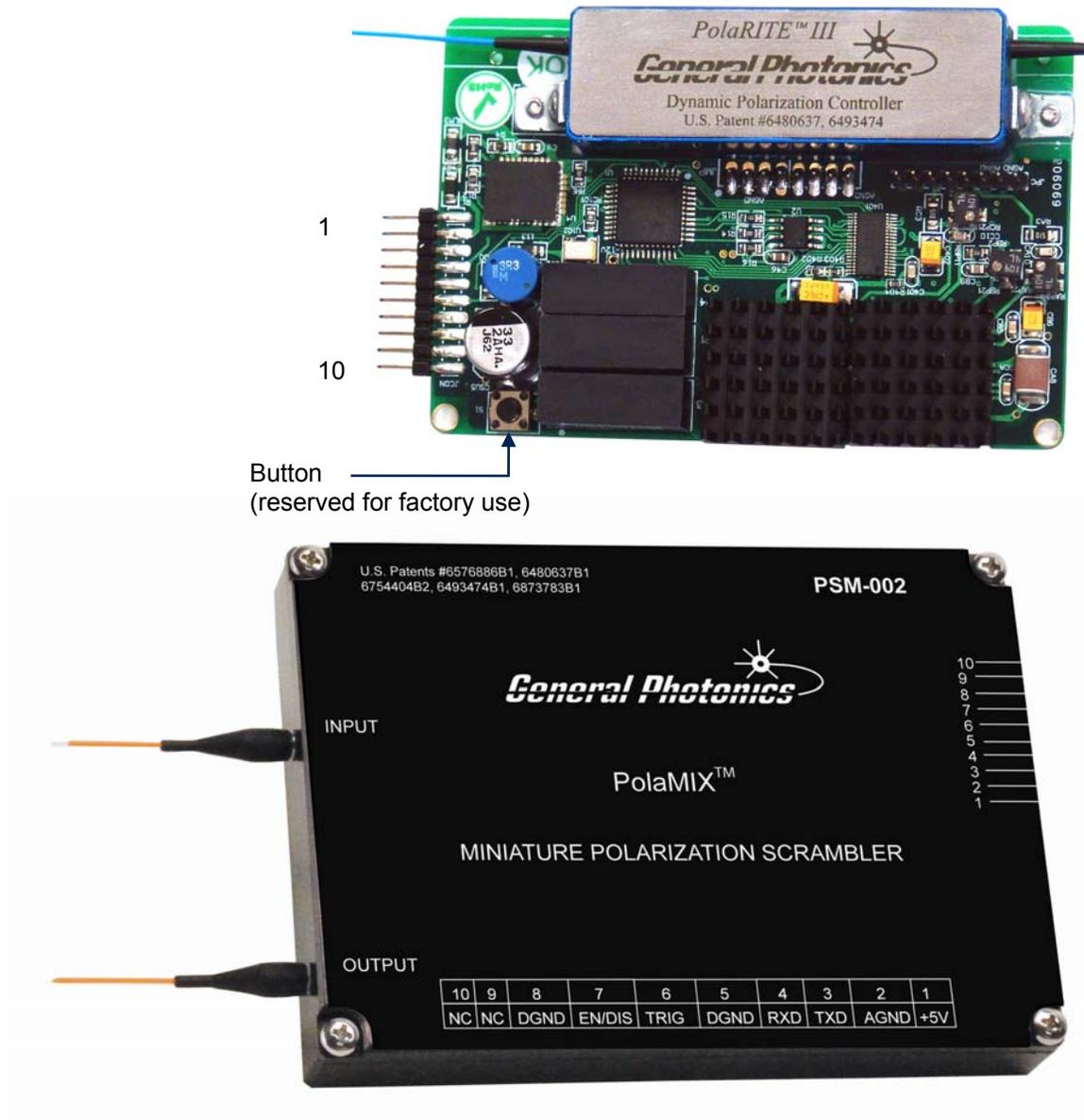


Figure 3 PSM-002 electrical interfaces

Electrical connector pin definition:

Pin #	Label	Definition
1	VIN	+5V DC Input.
2	AGND	Analog Ground
3	TXD	RS-232 TXD (Data sent from PSM to PC), pin 2 on DB9 connector
4	RXD	RS-232 RXD (Data sent from PC to PSM), pin 3 on DB9 connector
5	DGND	Digital Ground (MCU, DAC, and RS-232).
6	EX_TRIG	External Trigger: In external trigger mode, the PSM generates one random SOP for each TTL pulse received. Scrambler triggers on 5V → 0V falling edge.
7	EN/DIS	Enable/Disable: 5μs width TTL pulse. Scrambler toggles on falling edge (5V → 0V) of pulse.
8	DGND	Digital Ground (MCU, DAC, and RS-232).
9	NC	Not Connected
10	NC	Not Connected

The PSM-002 requires a +5V DC power supply and has a power consumption of up to 9W, depending on scrambling rate.

The PSM-002 generates discrete, random polarization states. In automatic scrambling mode (the default operation mode), it generates the SOPs at a user-defined rate between 0.01 and 20,000 points/s. The factory default scrambling rate setting is 1000 points/s.

The scrambling rate can be changed via remote control commands sent through the RS-232 port (see Appendix 1 for command descriptions).

The PSM-002 also has an external trigger operation mode. In this mode, it generates a random state of polarization (SOP) on receipt of each external trigger pulse. The operation mode (triggered or automatic random state generation) can also be set via remote control.

2.3 Dimensions and Mounting Holes

Figure 4 shows the mechanical drawings for the PSM-002 without (top) and with (bottom) enclosure. In addition to the module dimensions, the drawings also include the size and location of mounting holes, and the size and pitch of electrical connector pins. While the pinout is the same for the PSM-002 with and without enclosure, the pins are different. The version with enclosure uses round pins, while the one without enclosure uses square pins.

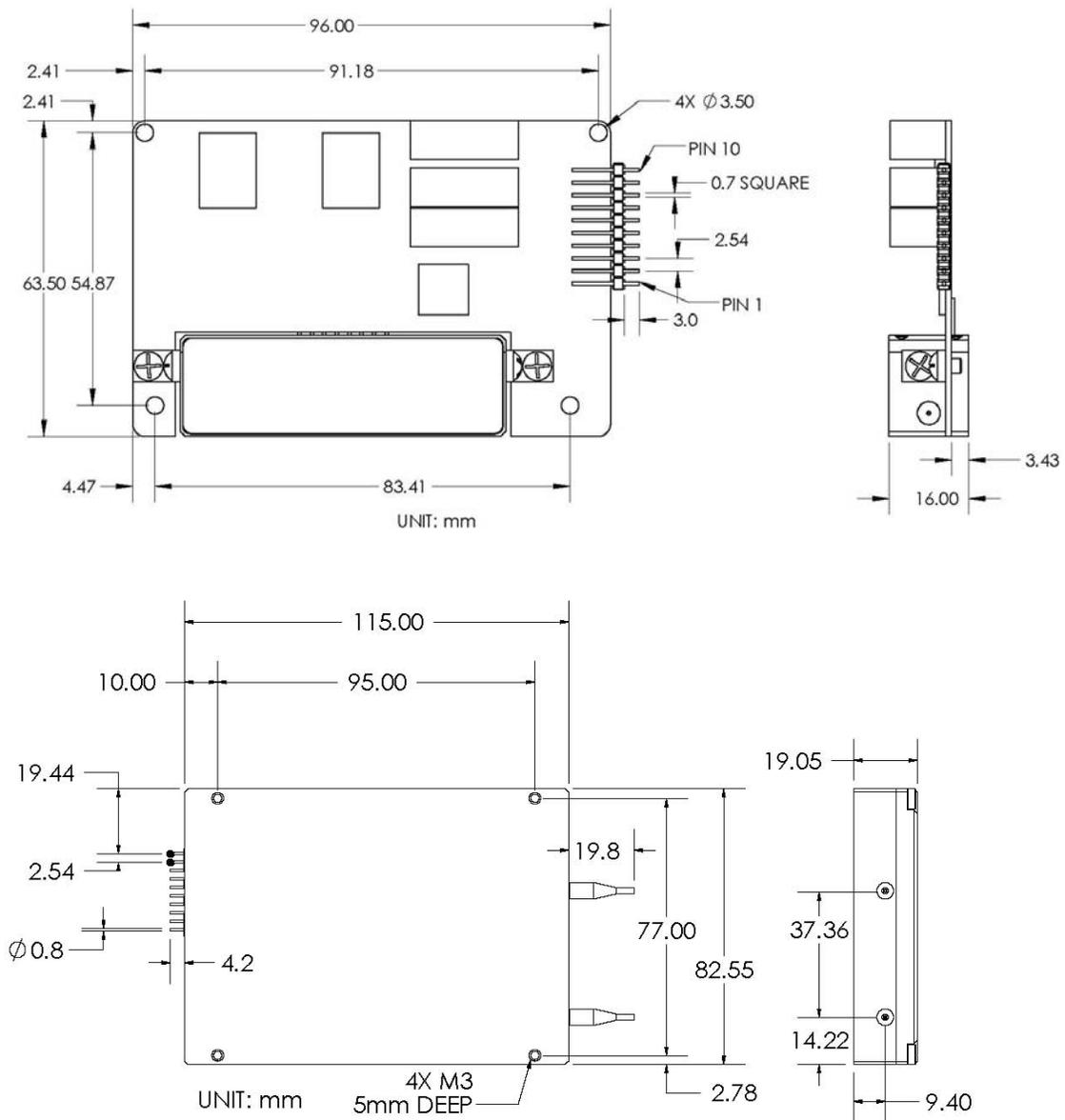


Figure 4 PSM-002 mechanical drawings
Top: Without enclosure
Bottom: With enclosure

2.4 Environmental Requirements

The PSM-002 board is designed to be installed in a sealed enclosure, which allows it to be used in a wide range of ambient temperature and humidity conditions. The enclosure also acts as a heat sink for the circuit. It is recommended that natural or forced-air cooling be used at fast scrambling rates or in extreme environmental conditions.

The specified operating temperature range is 0 to 65°C for the standard temperature version and –35 to 70°C for the extended temperature version.

Section 3.0 Operation Instructions

3.1 Unpacking

Inspect PSM-002 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.

The PSM-002 board is sensitive to static discharge. Follow standard ESD procedures when handling the board.

Be careful when removing the product from the packing material and when handling the fiber pigtailed. 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 pigtailed.

Packing List

Item #	Description
1	PSM-002
2	Electrical connection cable
3	Modified RS-232 cable
4	User guide

3.2 Operation

The PSM-002 is set to Mode 0 (automatic random scrambling) and is enabled by default when it is powered on. The following steps should be followed before operation:

1. If mounting the PSM-002 to another board or enclosure, refer to Figure 4 for locations and sizes of mounting holes.
2. Set the power supply to the correct voltage before connecting the power cable. Connect power source to power pins (PIN1: +5VDC; PIN2: GND) as shown in Figure 3. If the PSM is being installed as part of a larger system, make sure that its ground is common with the ground for the rest of the system.
3. Clean the fiber connectors using industry standard procedures and connect the optical input and output. If using a high power laser source, turn off optical power source while cleaning connectors and making connections.
4. If using remote control, connect RS-232 communication pins to PC COM port. (See Appendix 2.).

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5. If using external enable/disable triggering, connect the enable/disable trigger signal to the PSM (PIN 7: Pull-down signal, PIN 8: GND).
The PSM can also be enabled/disabled via RS-232 commands.
6. If using external trigger mode for random SOP generation, connect the external trigger signal to the PSM (PIN 6: TTL pull-down signal, PIN 8: GND).
7. Turn on the power supply. The PSM will begin scrambling at the last saved speed setting. If no setting was saved, this will be the factory default setting of 1000 points/s.
8. Scrambling settings can be changed via RS-232 command. See Appendix 1 for the command list.

Section 4.0 Specifications

Optical

Operating wavelength range ¹	1260-1650 nm or 980-1310nm
Insertion loss ²	<0.05 dB without connectors <0.6 dB with connectors
Output DOP ³	<5%, 2.5% typical
Scrambling Rate	User selectable from 0.01 to 20,000 points/s Default setting: 1000 points/s
Return Loss	>65 dB without connectors
Average PMD	<0.05 ps
Intrinsic PDL	<0.05 dB, 0.01 dB typical
Activation Loss	<0.01 dB
Residual Phase Modulation	0.1n
Optical Power Handling	>300 mW

Electrical/Communication

Power Supply	5.0 to 5.5 VDC/9W max.
Power Consumption	0.5 to 9W, depending on scrambling rate
Communication Interface	RS-232 (requires special cable)
Trigger In (for triggered random state generation)	TTL pulse Scrambler triggers on falling edge
Electrical Enable/Disable	TTL pulse Pulse width >5 μ s Scrambler toggles on falling edge

Physical and Environmental

Dimensions	96 (L) x 63.5 (W) x 18 (H) mm (board version) 115 (L) x 82.6 (W) x 19 (H) mm (enclosure)
Fiber Type	Single mode fiber
Fiber Input/Output Connectors	FC/PC, FC/APC, SC/PC, SC/APC
Operation Temperature	Standard: 0 to 65°C Extended: -35 to 70°C
Storage Temperature	-40 to 85°C

Notes:

1. Standard calibrated wavelengths are 1550nm (1260-1650nm version) and 1310nm (980-1310nm version). Others available.
2. For SMF-28 compatible fiber. Other fibers may have higher loss, especially with connectors.
3. DOP specification is < 5% (to within 2 σ) when averaged over 4000 or more points.

Appendices

The PSM-002 is enabled by default and will begin scrambling at the latest saved scrambling rate (or at the default setting of 1000 points/s if no other setting was saved) when powered on.

Operation parameters such as operation mode, wavelength setting, and scrambling rate can be changed by remote control command.

Appendix 1.0 Remote Control Commands

The commands and responses listed in Table 1 and Table 2 are for communication via RS-232. General Photonics provides an electrical connection cable and a custom RS-232 cable that connects the PSM-002 electrical cable to the RS-232 port of a computer.

Table 1 Command List

Command	Description	Default	Range	Response
*IDN?	Query product number.	N/A	N/A	*PSM-002#
*VER?	Query Firmware Version.	N/A	N/A	*PSM-002-V12-15-20151521# or *PSM-002-V12-13-20151521# Version dependent
*SER?	Query serial number	N/A	N/A	*xxxxxxxx#
*ENA#	Enable scrambling ¹	N/A	N/A	*E00#
*DIS#	Disable scrambling ¹	N/A	N/A	*E00#
*MOD x#	Select operation mode. ² Mode 1: Random scrambling at selected scrambling rate. Mode 2: Triggered-random state generation	Mod 1	1 ~ 2	*E00#
*MOD?	Query current operation mode	Mod 1	1 ~ 2	x, where x = 1 or 2
*SPD:RAN xxxx.xx#	Set Random scrambling rate. Unit: Points/s	1000	0.01 ~ 20000	*E00#
*SPD:RAN?	Query random scrambling rate	1000	0.01 ~ 20000	xxxx.xx
*WAV xxxx.xx#	Set operating wavelength Range and default are version dependent. Unit: nm.	1550nm or 1310nm	1260-1650 or 980-1360	*E00#
*WAV?	Query operating wavelength	1550nm or 1310nm	1260-1650 or 980-1360	xxxx.xx
*SAV#	Save current settings: ³ 1. Random scrambling rate 2. Operating wavelength.	N/A	N/A	*E00#
*DEF#	Reset all operational parameters to default values. Default scrambling rate: 1000 points/s Default wavelength: 1550nm or 1310nm.	N/A	N/A	*E00#

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Notes:

1. There are two ways to enable/disable scrambling.
 - a) Use the RS-232 commands described in the table.
 - b) Use an electrical trigger signal. Sending a pull-down (5V to 0V), 5 μ s falling pulse to pin 7 of the PSM's 10 pin electrical connector will enable/disable the PSM.
2. Operation mode descriptions:
 - a) Mode 1: Automatic random scrambling at the selected scrambling rate. This is the main operation mode for the PSM.
 - b) Mode 2: Externally triggered random state generation. In this mode, the PSM will generate a random SOP upon receipt of a pull-down (falling edge) TTL pulse at pin 6 of its 10 pin electrical connector. This mode can be used to synchronize SOP generation with the operation of other instruments in a system.
3. The *SAV# command saves operational parameters to nonvolatile memory. Operational parameters such as scrambling rate and wavelength can be changed at any time using the corresponding commands, and the new settings will be immediately applied. However, they will not be retained after the PSM is powered off unless the *SAV# command is used.

Table 2 Command Response Codes

E00	No error (Correct command received)
E01	Undefined Command
E02	Missing start character
E03	Missing end character
E06	Invalid mode command

Appendix 2.0 RS-232 connection and setup

The RS-232 serial interface port allows the user to remote control the PSM-002. Any program that supports RS-232 communications protocols can be used to send ASCII commands to the PSM-002.

The PSM-002's RS-232 communication pins are located next to its power pins (see Figure 3).

Communication pins on PSM-002:

PIN5: GND

PIN4: COM3 (RXD)

PIN3: COM2 (TXD)

Connect the communication pins to the RS-232 port of a computer or other control signal source (see Figure 5 for correspondence between the PSM-002 communication pins and the DB9 connector on the connection cable).

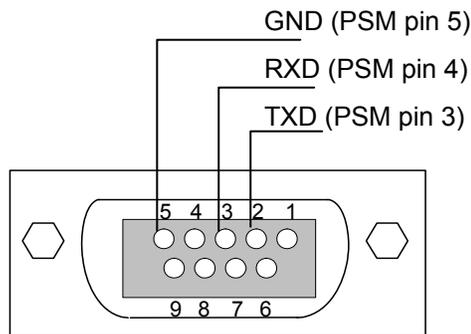


Figure 5 RS-232 connector pin correspondence to PSM.

RS-232 settings:

RS-232 port uses asynchronous framing, 8 data bits, no parity bit, and 1 stop bit.

RS-232 baud rate: 9600 bps.

Only one command is allowed in each command string.