Making Light Work Lighter

General Photonics

C o r p o r a t i o n

POD-001
PolaDetect™

In-line high speed polarimeter

Operation Manual

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Section 1. Specifications:

Physical Features:

Dimensions	1.45" (L) × 0.80" (W) × 0.58" (H) for optical module
	125 mm (L) × 50 mm (W) for preamplifier board
Input Fiber	Single mode SMF-28 or compatible
Output Fiber	PM fiber or single mode fiber
Fiber Connector	FC/PC, FC/APC, SC/PC, or SC/APC
Number of Electrical Connection Pins	10-pin without preamplifier
	20-pin with preamplifier

Optical Characteristics:

Insertion Loss	0.8 dB typical, 1.2 dB max.(@1550 nm)
Return Loss	55 dB
PDL	0.25 dB max.
PMD	0.1 ps max.
Input Optical Power Sensitivity	5 µW
Max. Input Optical Power	5 mW
Analog Dynamic Range	30 dB
Analog Bandwidth	1.5 MHz
Operation Wavelengths[1]	1550 +/- 50 nm, 1310 +/- 50 nm
Wavelength Dependent Loss (WDL)	0.15 dB (across C-band)
SOP Accuracy at Calibration Wavelengths[2]	1% max.
DOP Accuracy at Calibration Wavelengths[2]	+/-2% max.
Operation Temperature	0° to 40 °C
Storage Temperature	-40 °C to 85 °C
Damage Power	300 mW min.

Electrical Characteristics:

Power Supply	+/- 12 volts/0.2 A
Maximum Voltage	+/- 15 volts
Output Connector	10-pin without preamplifier
	20-pin with preamplifier

Note:
1. Calibration matrices are provided for C-band operation around 1550 nm. Contact General Photonics if the intended operation wavelength is outside C-band.
2. Measurement is against Agilent 8509C polarization analyzer.

Section 2. Overview:

General Photonics' in-line polarimeter (PolaDetect) is specially designed for high-speed, low cost polarization monitoring without interrupting data traffic. It outputs four voltage signals for calculating both the degree of polarization (DOP) and the state of polarization (SOP) of the light passing through the device. The measurement applies to the state of the light at the input end of the polarimeter. A calibration matrix is provided with every device at a specific wavelength for the calculation.

PolaDetect is ideal for integrating into polarization monitoring and polarization stabilization modules to increase their operation speeds. It can also be used in polarization characterization instruments. An integrated preamplifier circuit board provides analog signals for SOP/DOP calculation, feedback control, and computer interface.

Section 3. Device description

General Photonics' Polarimeter includes four photodetectors, which output four photovoltages (or photocurrents) for polarization analysis. The SOP and DOP of an input light signal can be readily calculated using the four photovoltages and a 4x4 calibration matrix. In general, the calibration matrix is wavelength dependent, so calibration matrices are provided at 10 nm intervals. For example, for the 1550 nm band, five calibration matrices are provided: for 1520 nm, 1530 nm, 1540 nm, 1550 nm, and 1560 nm operation, respectively. Each matrix is for a wavelength band of +/- 5 nm.
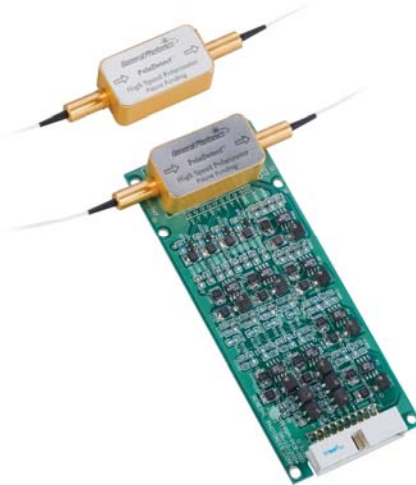

Fig. 1 Photograph of a PolaDetect

NOTE: the resulting SOP is that at the input entrance of the polarimeter.

As illustrated in Fig. 1, PolaDetect consists of two main parts: the optical module and the electronic preamplifier board.

3.1 Optical interface

1. The optical module has two fiber pigtails: one for the input and the other for the output.

2. An arrow ("$\rightarrow$") sign is marked on the side of the package to indicate the direction of the input light beam.

3. Fiber connectors can either be FC/PC or FC/APC per customer specification.

4. Coordinate orientation is marked on the **output face** of the device. The measured Stokes parameters are based on this coordinate system, as shown in Table I. In addition, for the PM fiber output option, the slow axis is aligned with the 0° vertical line.

Table I

Stokes parameter (s_1, s_2, s_3)	State of Polarization (SOP)
(1,0,0)	Linear SOP oriented at 45°
(-1,0,0)	Linear SOP oriented at –45°
(0,1,0)	Linear SOP oriented at 0°
(0,0,1)	Right hand circular SOP

3.2 Electrical interface:

Two models are available. POD-xx-xx-01 has no preamplifier circuit while POD-xx-xx-02 does. POD-xx-xx-01 is for OEM customers who have mastered the art of polarization analysis and will perform their own calibrations for their power detection circuits. General Photonics will only provide the calibration for the POD-xx-xx-02 with an integrated preamplification circuit designed and fabricated by General Photonics.

1. For POD-xx-xx-01, there are 10 pins on the bottom side of the package. $+i$ and $–i$ are the output from detector # i, where i = 1, 2, 3, 4 respectively. The last two pins are ground.
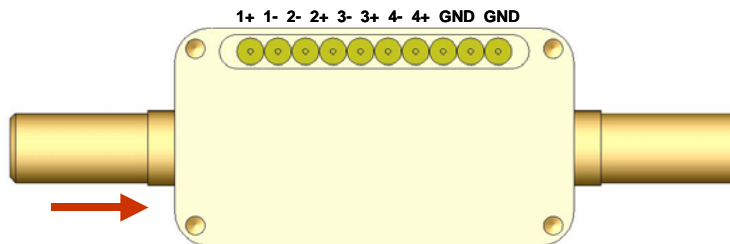

1+ 1- 2- 2+ 3- 3+ 4- 4+ GND GND

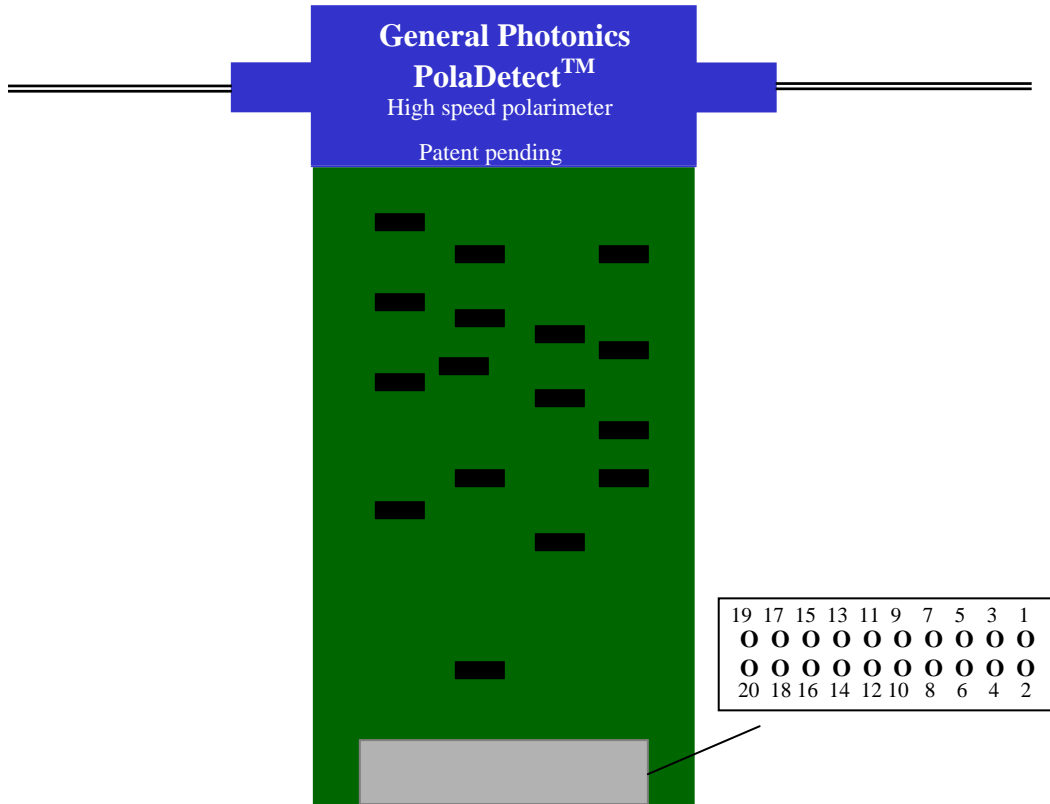Fig. 2a Pin locations on the electronic output connector for the POD-001 (back side view)

Fig. 2b: Pin locations for the electrical output connector for the POD-002.

2. For POD-xx-xx-02, there is a 20 pin connector for signal output and power supply input. The pin assignment is listed in Table II.

Table II

Pin 1	NC
Pin 2	GND
Pin 3	NC
Pin 4	GND
Pin 5	V4
Pin 6	GND
Pin 7	V3
Pin 8	GND
Pin 9	V2
Pin 10	GND
Pin 11	V1
Pin 12	GND
Pin 13	+12V
Pin 14	GND
Pin 15	GND
Pin 16	GND
Pin 17	-12V
Pin 18	GND
Pin 19	NC
Pin 20	GND

Section 4. Operation Instructions
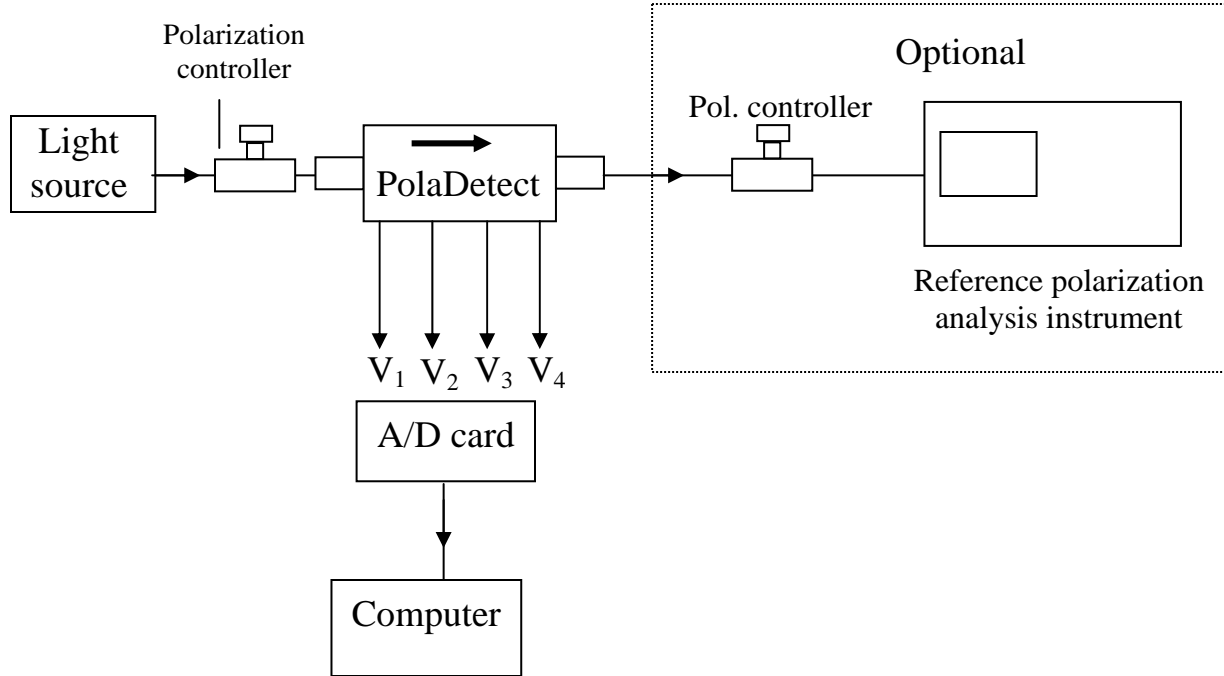
4.1 Getting started

Fig. 3. An example setup for using the PolaDetect polarimeter.

Fig. 3 illustrates an example setup using General Photonics' PolaDetect. In the setup, an optional reference polarization analysis instrument can be used to verify the accuracy of the PolaDetect. An analog-to-digital converter card (A/D card) is used to convert the analog output signals from the PolaDetect into digital signals so that a computer or microprocessor can be used to calculate the SOP and DOP of the input light using the following formula:

$$
\begin{bmatrix} S_o \\ S_1 \\ S_2 \\ S_3 \end{bmatrix} = M \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \\ m_{41} & m_{42} & m_{43} & m_{44} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix}
\tag{1}
$$

$$
DOP = \sqrt{S_1^2 + S_2^2 + S_3^2} / S_0
\tag{2}
$$

where V_1, V_2, V_3, and V_4 are the photovoltages derived from the four photodetectors, and M is a 4×4 calibration matrix. With this matrix, the calculated SOP is the SOP of the light at the input entrance of the device. Note that S_o indicates the optical power at the

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output end of the device (actual output power) in mW. The input optical power P_{in} of the device in dB is:

$$P_{in}(dB) = S_o(dB) + IL \qquad (3)$$

where IL is the insertion loss of the device, which is provided in the data sheet of every PolaDetect unit.

In general, the calibration matrix is wavelength dependent. Each matrix is sufficiently accurate for wavelengths within +/- 5 nm of the specified wavelength. General Photonics provides 5 matrices, at 1520 nm, 1530 nm, 1540 nm, 1550 nm, and 1560 nm, respectively, for C-band operation. The file name for each matrix is Matrix_xxxxnm_xxx-x-xxx.xls, where xxxxnm is the wavelength band of the device and xxx-x-xxx.xls is the series number.

4.2 Comparing the results with a polarization measurement instrument

To verify the performance of General Photonics' PolaDetect against a reference polarization instrument, the setup shown in Fig. 3 may be used. However, coordinate alignment procedures must be performed before the measurement, because the output fiber of the PolaDetect has some residual birefringence which causes the SOP to change. Contact General Photonics for details.