Polarimeters

Q. What is the main difference between an in-line polarimeter and a terminated polarimeter? What are the advantages of an in-line polarimeter?

A. The main difference between the two types of polarimeters is that an in-line polarimeter allows data traffic to continue along the optical fiber to the next stage, while terminated polarimeters terminate data transmission at the polarimeter. The in-line polarimeter offers direct, accurate measurement of polarization-related properties for the network environment, eliminating errors introduced by fiber splitting or tapping. GP's in-line polarimeter also offers a wider bandwidth than other types of polarimeters, an advantage for fast network response and quick feedback/feedforward control.

Because terminated polarimeters can use all of the light signal for analysis, they can have higher detection sensitivity.

Q. What are the major applications of an in-line polarimenter?

A. GP's in-line polarimeter is designed for polarization-related measurements in fiber optic systems. It is particularly useful for fiber optic networks that carry live data traffic and require accurate state of polarization (SOP) and/or degree of polarization (DOP) measurements. It can be used in a broad range of applications including PMD monitoring, PMD compensation, DOP monitoring, polarization stabilization, coherent optical communications, fiber optic sensors, network performance monitoring, polarization multiplexing/demultiplexing, etc.

Q. What are the insertion loss and PDL of General Photonics' polarimeter?

A. In-line PolaDetect™ devices generally have an insertion loss of less than 1.2 dB and a PDL of less than 0.25 dB, excluding connector contributions.

Q. What is the operation principle of GP's polarimeters?

A. GP's polarimeters are based on the 4-detector polarization measurement approach. Each photodetector measures the optical signal intensity of a particular polarization state. Stokes vector components are a linear combination of these measured intensities. The Stokes vector directly provides the state of polarization (SOP). The degree of polarization (DOP) can be calculated from the Stokes vector components.

Q. What is the measurement speed of GP's polarimeter?

A. It depends on the product. GP's polarimeter optical head (model POD-001) has an analog bandwidth of 1.5 MHz (from DC to 1.5 MHz). The module with a preamplifier board (POD-002) has a bandwidth of 50 kHz. When a data acquisition (DAQ) card is used, the sampling rate of the card may impose additional limits on the measurement speed. The PSY-201 and POD-201 have a measurement bandwidth of 1MHz, and a sampling rate of up to 4Msamples/s.

Q. What is the output data format of GP's polarimeter?

A. It depends on the product. The output of the PolaDetect™ modules (POD-001/002) consists of four analog voltage signals. Each voltage signal is linearly proportional to the optical intensity of a particular polarization state. The maximum output voltage is 10 Volts, which corresponds to an input optical power of 5 mW. Analog to digital conversion is required when a digital computer is used to process the polarimeter measurement data. Analog to digital conversion can be performed with a plug-in DAQ card designed for computers.

The polarimeter instrument (PSY-201 or POD-201) performs the necessary conversions and can display measured SOP in the form of Stokes parameters, azimuth and ellipticity angles, and degree of linearity or circularity, as well as displaying DOP.

Q. Do you have any suggestions on DAQ card selection? What are the card settings?

A. General Photonics' suggested DAQ cards for use with the polarimeter modules POD-001/002 are the NI PCI-6024E for desktop and NI DAQCard-6062E for laptop computers, with an I/O Connector Block and cable. Both cards are manufactured by National Instruments (www.ni.com). Once the hardware and software are installed, users can use NI Measurement & Automation Explorer, which accompanies the delivered card, to set up DAQ card parameters. The Analog Input (AI) should be set to Differential Mode. Please make a note of its device number, which will be used in software parameter setting.

Q. Do you offer an integrated polarization measurement system based on this polarimeter?

A. General Photonics currently offers an integrated system (the PSY-201 or POD-201) which combines the polarimeter, high speed electronics, a USB interface, and the corresponding software for rapid measurement and readout of SOP and DOP, with a trigger mode for synchronization to external equipment and a data logging function for long-term SOP monitoring. SOP properties can be displayed either in real

time on the Poincaré Sphere, or on an oscilloscope readout, as shown below. The PSY-201 or POD-201 can also be used for PM fiber extinction ratio measurements.

For those who need in-depth PMD and PDL analysis, General Photonics also makes a polarization measurement system, the PSGA, based on a different technology.

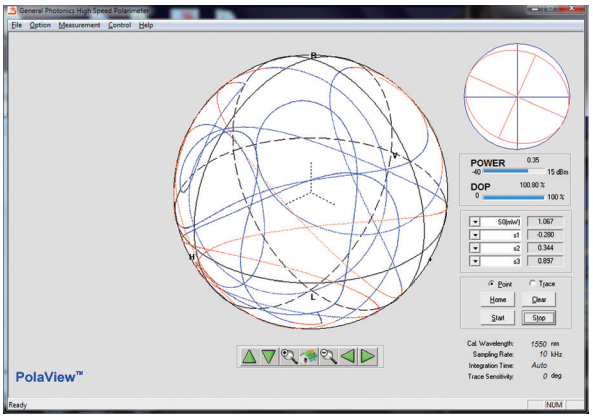

Fig. 1 Poincaré Sphere display of a polarization-scrambled input signal.

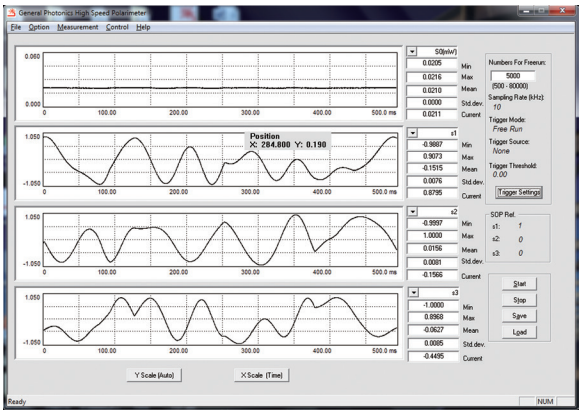

Fig. 2 Oscilloscope display of 4 Stokes parameters, with polarization modulation

Q. The SOP of the light may be different at different locations between the input and output fiber connectors. Where does the measured state of polarization apply?

A. The measured data indicates the SOP at the polarimeter optical module location. It is well known that even a short section of optical fiber can transform the input SOP to a different SOP. Therefore, when the in-line polarimeter is connected to an optical fiber path, the measured SOP, in general, will be different from the SOP at the input connector. The fiber pigtail to the polarimeter may alter the input SOP, depending on the fiber mounting.

Q. Is the output polarization state the same as the input polarization state?

A. No. Due to the construction of the polarimeter and the output fiber pigtail, the output SOP is generally different from the input SOP and the measured SOP.

Q. Why do I need a calibration matrix to calculate polarization state?

A. The calibration matrix ensures an accurate mapping between the measured voltages and SOP. Although SOP can be directly calculated from the measured voltage outputs, the fabrication tolerance sometimes affects the accuracy of the direct calculation. The calibration matrix corrects errors induced by fabrication tolerance.

For the PSY-201 and POD-201, the calibration matrices are stored in the instrument's memory. These instruments also include a self-calibration function that can be used to increase the measurement accuracy at the user's wavelength of interest.

Q: What is the optical power range?

A. GP's in-line polarimeter is designed mainly for fiber optic network applications. Therefore, the optical power level is similar to that of data traffic, typically from –23 dBm to +7 dBm at 1550 nm. The POD-201 can accept inputs as low as -35 dBm.