

APPLICATION NOTE

Fiber Optic Polarization

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25xxP Series Polarization Instrument Overview and Applications

25xxP Series Polarization Instrument Overview and Applications

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Introduction

Polarization in optical fiber is a much more complicated subject than the free space counterpart. Likewise, measurement and control of polarization in optical fiber requires much more complex and sensitive tools than when dealing with free space polarization. Newport Corporation's 25xxP Series Polarization Instruments are designed and manufactured specifically for the former. In this application note, for each product, after a brief introduction to each instrument is given, followed by a sample application.

Newport's New Polarization Control Instrument Family

Newport's new, state of the art polarization control and measurement instrumentation portfolio provides you with the tools to control, stabilize, measure, and analyze polarization in fiber-optic based applications. The complete line-up includes seven products with industry-leading performances: low insertion loss, low cost, high speed, and wide operating wavelength ranges.

Instrument Models

2530P = Polarization Extinction Ratio Meter

2540P = Polarization Scrambler

2550P = Degree of Polarization Meter

2560P = Polarization Stabilizer

2570P = Polarization Multimeter

2580P = Multifunctional Polarization Controller

2590P = Polarization Synthesizer/Analyzer

Table 1. Newport polarization instruments product family.

Application Matrix for Polarization Instruments

Below is an extensive list of applications that can be used with Newport polarization instruments. Many of them are related to device manufacturing and telecommunication. There are a huge number of scientific research applications where fiber polarization control and measurement are of importance, too. Some specific examples will be discussed in other application notes to be posted on Newport's web site.

2530P PER Meter

The 2530P Series Polarization Extinction Ratio Meter (PER) is a high-performance instrument that measures the polarization extinction ratio (PER) with a dynamic range larger than 50 dB, the axis angle with a resolution of as small as 0.06°, and the optical power at the same time. The 2530P is ideal for characterizing polarization maintaining (PM) fiber: pigtailed of laser diodes, fiber patch cord manufacturing and connectorization, fusion splicing, fiber coil production and quality assurance for fiber gyros. Key features include high polarization extinction ratio, high angular resolution, and an option for a detached optical head for measuring laser diodes and fiber optic components in close proximity to the device.

Figure 1 shows an application where the 2530P PER Meter can be used to determine the best PM fiber angular orientation with respect to the light source. When the PM fiber polarization axis is well aligned to that of the light source, the PER is maximized and is stable to externally applied stress on the fiber.

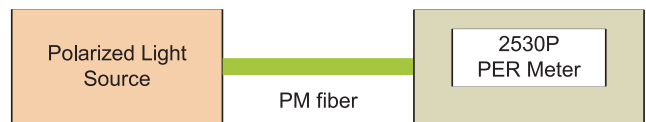


Figure 1. An example of 2530P PER Meter for PM fiber pigtailed to a polarized light source.

2540P Polarization Scrambler

The 2540P Series Polarization Scrambler randomizes the output polarization state from any arbitrary input state, with the output degree of polarization maintained < 5 % at 500 Hz detection bandwidth. This is an essential instrument required to reduce the polarization dependent characteristics of any fiber components or systems. This instrument finds uses in polarization dependent gain (PDG) suppression and polarization mode dispersion (PMD) monitoring. The instrument operates at 980, 1060, 1310, 1480, 1550 and 1600nm center wavelengths, selectable from the front panel or via computer interface.



Figure 2. A 2540P Polarization Scrambler application for PDG mitigation. Without polarization scrambling, the finite amount of the DOP from the signal source results in different receiver signal intensity due to PDG.

POLARIZATION INSTRUMENT APPLICATIONS CHART							
APPLICATIONS	INSTRUMENT						
	2530P	2540P	2550P	2560P	2570P	2580P	2590P
Amplifier Noise Figure Measurement			✓				
ASE & SLED Source Characterization			✓				
Coherent Communications				✓			
Deterministic SOP Generation							✓
DOP Measurement					✓		
Elimination of Polarization Fading				✓			
Fiber Gyro QA	✓						
Insertion Loss Measurement					✓		
Optical Amplifier Noise Reduction				✓			
Optical Sensor Source Characterization			✓				
Optical SNR							✓
PDL Measurement					✓		
PDL/DOP Measurement					✓	✓	
PDL/DOP Monitoring			✓		✓		
PM fiber coil QA	✓						
PM fiber connectorization	✓						
PM fiber fusion splicing QA	✓						
PM Fiber patch cord production	✓						
PM fiber pigtailling of laser diodes	✓						
PMD Emulation						✓	
PMD monitoring & compensation		✓	✓				✓
Polarization Analysis							✓
Polarization DeMultiplexing				✓			
Polarization Scrambling		✓				✓	
Polarization Stabilization							✓
Raman Amplifier Block Manufacturing			✓				✓
Recirculating Loop Studies						✓	
Sensor Systems							✓
SOP/DOP monitoring			✓				✓
System Polarization Studies						✓	
PDG Mitigation		✓					
Elimination of Polarization Sensitivity		✓					
Facilitating PMD Emulation		✓				✓	
Facilitating PMD Compensation		✓				✓	
Facilitating PDL Measurement		✓					

Table 2. Newport 25xxP Series Polarization Instrument applications.

2550P DOP Meter

The **2550P Series Degree of Polarization Meter (DOP)** can measure and display the Degree of Polarization (DOP) of a light source in real time with high accuracy and wide dynamic range. It provides simple and accurate DOP measurements for both low and high DOP sources. It is a low cost solution that delivers real-time, high accuracy measurements for both low and high DOP sources, while also simultaneously measuring optical power. The instrument has a wide dynamic range and covers the entire S, C and L Bands.

Many unpolarized light sources such as an amplified spontaneous emission (ASE) source, a super-luminescent diode (SLED), and a fiber amplifier output can be connected to the DOP meter to make a quick DOP measurement. One of high-speed network system applications is shown in Figure 3. Optical signal to noise ratio (OSNR) can be obtained from the DOP measurement, assuming the PMD influence is absent and that the signal is totally polarized while the noise is totally unpolarized. [i]

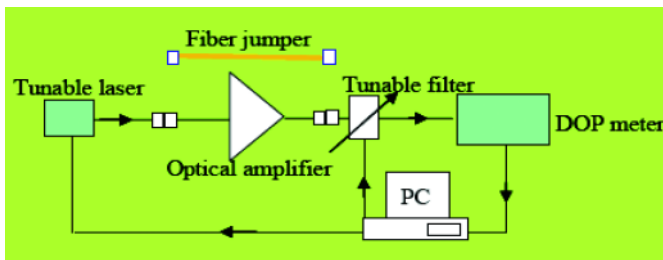


Figure 3. An example of 2550P DOP Meter for OSNR monitoring in networks. [Courtesy of Ref. [1]].

2560P Polarization Stabilizer

The **2560P Series Polarization Stabilizer** actively maintains a stable output state of polarization (SOP) against an input SOP fluctuating as fast as 2msec (See Figure 4). It can be used to suppress noise in optical amplifiers, reduce polarization dependent loss (PDL), demultiplex polarization division multiplexed channels, and eliminate polarization fading in coherent communication and fiber sensor systems. It provides a SOP rotation tracking speed of less than 16 p/s, with accuracy and repeatability of less than 0.1 dB. The Stabilizer can be useful in the sensitive fiber sensor applications, as shown in Figure 5.

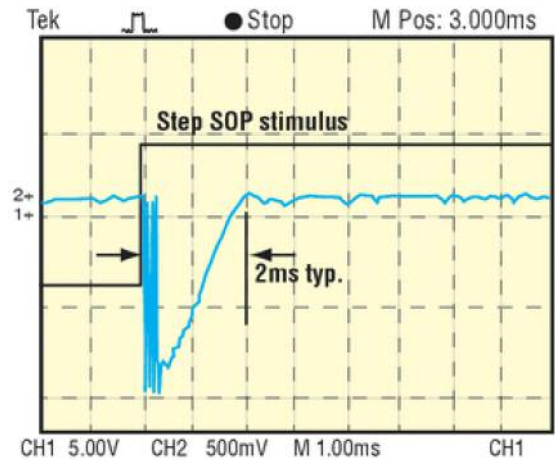


Figure 4. The state of polarization gets stabilized within 2 msec of the 2560P Polarization Stabilizer activation.

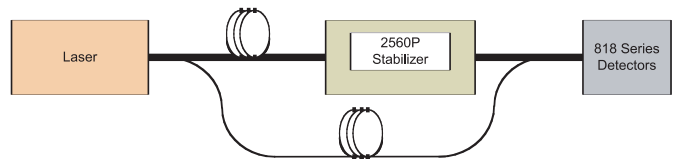


Figure 5. Fiber sensor system stabilization using 2560P Polarization Stabilizer.

2570P Polarization Multimeter

The **2570P Series Polarization Multimeter** measures Polarization dependent loss (PDL), insertion loss (IL), optical Power and DOP of a device under test (DUT), all in less than 0.2 seconds – and is accurate for both low and high PDL and SOP values. This instrument is ideal for fast and accurate characterization of the performance of passive devices, especially DWDM components. It is an essential instrument needed for fiber component manufacturing companies.

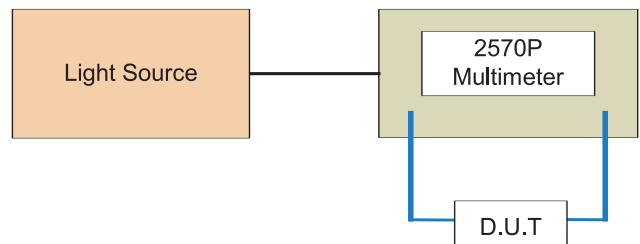


Figure 6. Fiber characterization using 2570P Polarization Multimeter.

2580P Multifunction Polarization Controller

The **2580P Series Multifunction Polarization Controller** features an ultra low insertion loss of 0.005 dB over the 1260-1620 nm wavelength range. Four operational modes are available: variable speed polarization scrambling at 10 kHz rates, manual polarization adjustment, polarization function generation delivering sine, saw square and random functions, and externally triggered scrambling up to 10 kHz rates. This instrument can be an indispensable tool when polarization must be actively controlled. For example, the 2560P in Figure 5 can be replaced with a 2580P with a feedback circuitry for the photodetector signal. Using the same feedback circuitry, 2580P can also be used in coherent communication, which can be used not only in future telecommunication but also in many scientific research areas including remote sensing.

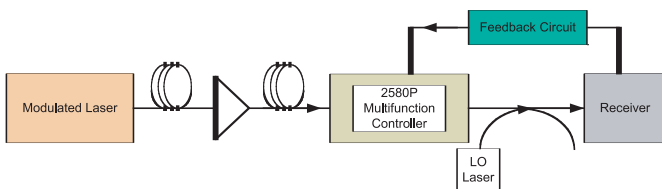


Figure 7 Coherent communication configuration with a 2580P Multifunction Polarization Controller.

2590P Polarization Synthesizer and Analyzer

The **2590P Polarization Synthesizer and Analyzer** a turnkey instrument for generating, maintaining and analyzing any desired SOP, regardless of the input SOP. The generated SOP and corresponding Poincaré sphere are displayed on a monitor via PC interface. The instrument has multiple operation modes: deterministic SOP trace generation, polarization analysis and polarization scrambling, and is available for 1260-1360nm and 1500-1600nm wavelength ranges. It represents the flagship product of the new portfolio. It is an integration of Newport's polarization controller, in-line polarimeter, and proprietary algorithm in one box. The generated SOP and the corresponding Poincaré Sphere can be readily displayed on a computer screen via the USB interface. When the synthesizer function is disabled, the instrument becomes a polarimeter and the traced SOP can also be displayed on the sphere.

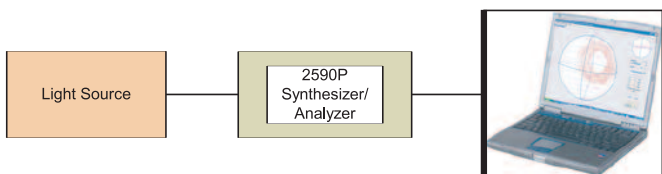


Figure 8. 2590P used as a polarization analyzer, or polarimeter.

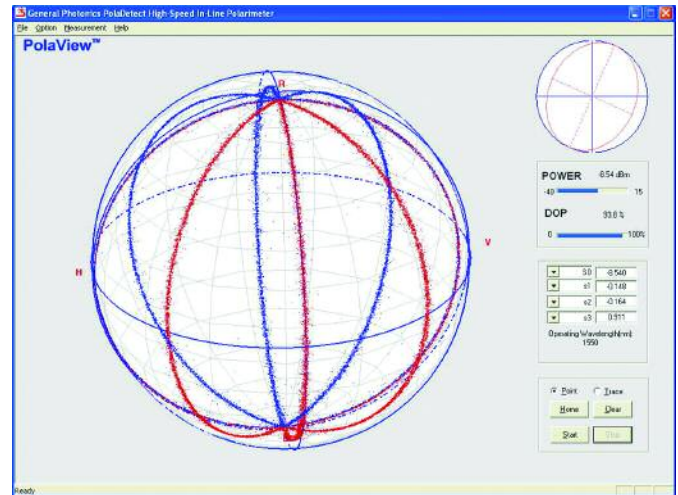


Figure 9. 2590P Polarization Synthesizer/Analyzer can also perform predefined polarization scans so that Stokes parameters can be easily obtained.

Conclusion

In conclusion, we provided a brief introduction of each of the Newport 25xxP Series Polarization Instrument family along with an example application diagram. Equipped with these new powerful products, a whole new level of precise control and accurate measurements of fiber polarization is realized.

References:

- [1] S. Yao, "Accurate DOP Characterization with Less Effort", General Photonics 2005/06 Catalog.

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