ER Measurement

Q. Which General Photonics instruments can measure polarization extinction ratio (PER)?

A. Several General Photonics instruments can measure the polarization extinction ratio of a light source or PM fiber component or system. The ERM-202 polarization extinction ratio meter is a dedicated PER measurement instrument that uses the rotating polarizer method. The POD-201 and PSY-201 polarimeters and the PSGA-101A polarization measurement system can measure PER using the polarimeter method. The PXA-1000 distributed polarization crosstalk analyzer can also measure PER by measuring all crosstalk events that contribute to the PER.

Q. What is the operating principle of the polarization extinction ratio (PER) meter?

A. The ERM-202 polarization extinction ratio meter is composed of a rotating polarizer with ultra high PER and a photodetector circuit with low polarization dependent responsivity and very high dynamic range. For every polarizer rotation cycle, the PER meter measures the maximum power P_{max} and minimum power P_{min}, and calculates and displays the polarization extinction ratio $PER=10\log(P_{max}/P_{min})$ and input light power $P=P_{max}+P_{min}$. The displayed angle is the orientation angle of the internal polarizer, with respect to the connector key, at which maximum power is detected during each polarizer rotation cycle. Looking into the connector, an angle rotated counterclockwise from the key slot is positive. The 2-input version can measure the ER of two light paths at once and can also compare the power ratio of the two outputs, making it a good choice for characterizing PM components such as PM couplers.

Q. What is the operating principle of the polarimeter method?

A. Polarimeters such as those used in the POD-201, PSY-201, and PSGA- 101A measure the PER by measuring the polarization state change while the input wavelength is swept, or while the fiber is stretched or heated/cooled. The PER can be calculated from the size of the circle traced out. In the PSGA-101, which has a free-space input, the position of the rotation axis of the circle also gives information about the slow axis of the PM fiber and whether the connector is stressed.

Q. What are the differences between PER measurements using the different instruments?

A. The ERM-202 directly measures the PER by monitoring the power change during polarizer rotation, and its test results include both the polarization and depolarization information of the device under test. Therefore, the PER meter can provide a more conservative and reliable result for some signals than the polarimeter method. However, because it bases its measurement on the power ratio between orthogonal linear polarization components of light, it cannot distinguish between unpolarized light and circularly polarized light.

PER measurement instruments such as the PER meter and PSGA, for which the input is free space, can accurately measure the PM connector orientation angle.

A fiber-coupled polarimeter like the POD-201 and PSY-201 cannot give PM connector key alignment information because there is single mode fiber between the input connector and the polarimeter optical head. On the other hand, these instruments can measure the PER of a DUT even with SM fiber connected between the DUT and the polarimeter.

Polarimeter based measurements characterize the effects of DUT input connector stress and misalignment, as well as fiber effects, but do not measure the effects of the DUT output connector. The ERM-202 measures the effects of the output connector as well as those of the input connector and the fiber.

For a PM fiber coil or a DUT consisting of multiple PM fibers connected by connectors or splices, the PXA-1000 provides the most detailed information. In addition to a cumulative PER measurement, it can provide information on polarization crosstalk at each location in the system, and allows the user to exclude sections of fiber from the PER calculation.

	ERM-202	POD-201 / PSY-201	PSGA-101A	PXA-1000
Cumulative PER measurement of DUT	X	X	X	X
Can measure very high PER	X			X
Can measure very low PER	X	X	X	
Can distinguish between unpolarized and circularly polarized light		X	X	
Requires stretching/heating fiber or wavelength scanning		X	X	
Measure output connector key alignment	X		X	
Detect stress on output connector			X	
Can measure PER of PM fiber DUT with SM fiber in the measurement path		X	X	
Can exclude sections of fiber from PER calculation				X

Q. Should a narrow band or broadband light source be used for PER measurement?

A. It depends on the measurement instrument.

For the ERM-202, a broadband light source should be used in order to measure the worst-case (minimum) PER of a DUT. The light source coherence length should be shorter than $\lambda_{center} * l_{PM}$ /beat length, where λ_{center} is the center wavelength of the light source and l_{PM} is the length of PM fiber under test. When a narrow band laser source with a coherence length much longer than $\lambda_{center} * l_{PM}$ /beat length is used, the polarization components of the light aligned to the slow and fast axes will be coherent. If they are either in phase or antiphase, the output light will be linearly polarized even if the input light is misaligned. Generally, the instantaneous PER values are not stable because of the variable phase difference between the slow and fast axes caused by stress changes in the PM fiber or temperature fluctuations, so the instantaneous PER cannot be used for device performance specification. In this case, the PER meter should be operated in minimum search mode and the performance specification should be the minimum ER measured by the PER meter as the fiber is stretched or heated/cooled.

A polarimeter based system such as the POD-201, PSY-201, or PSGA-101A uses a narrow band laser source. For the POD-201 or PSY-201, the measurement requires stretching or heating the fiber. For the PSGA-101A, the measurement can be done either by stretching/heating the fiber or wavelength scanning the laser.

The PSGA-101A and PXA-1000 generally come with integrated light sources, while the ERM-202, POD-201, and PSY-201 require external light sources.

Q. What is the minimum input power needed to measure high PER values up to 50dB?

A. Only the ERM-202 and the PXA-1000 can measure PER values around 50 dB. For the ERM-202, the power range is limited by the extinction ratio of the internal polarizer and by the dynamic range of the detection circuit. For power levels above −25 dBm, the PER meter can measure PER values up to about 30 dB. For power levels above −5 dBm, the PER meter can measure PER values up to 50 dB.

For the PXA-1000, the attenuation should be adjusted such that the DUT power out is >1mW and the detector does not saturate during measurement.