TECH NOTE

Determining the Polarization Response of the FPM-8220 Fiber Optic Power Meter

OVERVIEW

One of the fundamental specifications of any fiber optic component is how its transmission depends on input polarization. Even components viewed to be “polarization independent” have some level of Polarization Dependent Loss (PDL). The following table provides a reference of typical maximum values for PDL for various optic components and instrumentations.

Component	PDL (max)
Attenuator	<0.2dB
Circulator	≤0.1dB (0.2dB)
Polarization Independent Isolator	≤0.1dB (0.25dB)
Splitter/Combiner – 2x2	<0.2dB
Wavelength Division Multiplexer	<0.1dB (0.3dB)

Polarization sensitivity can be directly measured by recording the transmission through the component using a polarization independent power meter while intentionally changing the state of polarization of the input. The Polarization Dependent Response (PDR) of the power meter being used should be much less than the component being tested, such as those listed in the table above. This is true of the ILX Lightwave FPM-8220 Fiber Optic Power Meter and compatible FMH-8715 and FMH-87107 Fiber Optic Measurement Heads. It is valuable to know the typical PDR of these measurement heads that may contribute to the uncertainty of your PDL measurement.

TEST SET UP

A common, 1mW, 1580nm, DFB butterfly laser diode was used as a laser source for the PDR measurement. The laser was mounted in an ILX Lightwave LDM-4984 Butterfly Laser Diode Mount and was temperature and current controlled using an LDC-3724C Laser Diode Controller.

The output from the butterfly laser diode was coupled to a 1x2 fiber splitter to direct 50% of the laser signal to a germanium reference detector so that any power drift in the laser could be divided out of the final signal. The other output of the splitter was connected to a 6m length of SMF-28 single mode optical fiber. The beginning of this fiber was wrapped 10 turns around an Φ = 25mm mandrel to remove any high order spatial modes. The opposite end of the fiber was wrapped around Φ = 65mm polarization paddle wheels with 1, 3, 1 wraps consecutively to both establish and control the polarization state of the input beam to the measurement head. It is important to broaden the linewidth of the DFB laser using a strong current modulation (80% p-p at 15 kHz) in order to stabilized the output power from the fiber caused by interference effects at the 1 x 2 splitter and various fiber connectors.

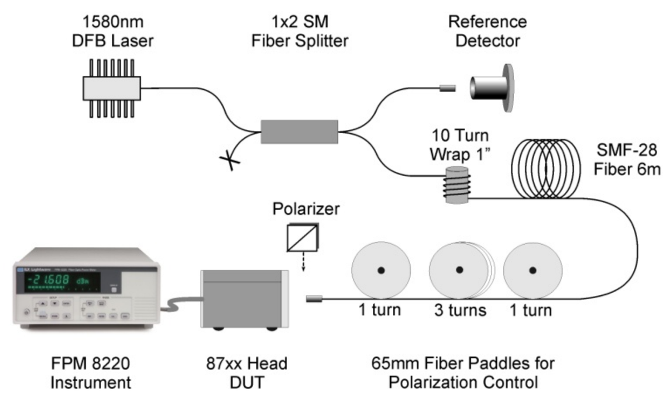

FIGURE 1. Experimental set up to measure PDR of the fiber optic measurement heads

TEST PROCEDURE

The following procedure is used to test the PDR of the FMH-8715 and FMH-87107 Fiber Optic Measurement Heads. This same set up and procedure can also be used to test the PDL of any fiber optic component by inserting the component at the output of the fiber paddles and measurement head.

The fiber paddles are optimized for linear polarization of the output by inserting a high quality, AR coated, linear polarizer (such as a Glan Thompson polarizer with ≥ 1000:1 polarization ratio) between the output of the fiber and measurement head. It is not important at this step to capture the entire beam because only the relative transmission through the polarizer is important. The first and last paddles act as λ/4 waveplates and the middle paddle acts as a λ/2 waveplate. Through optimizing the angular position of the fiber paddles and rotation of the polarizer, ~100:1 linear polarization ratio can be achieved and is measured by rotating the middle paddle and noting $Power_{max}/Power_{min}$. This signal is shown in blue in Figure 2.

In order to avoid long term system drift, 120 samples at 5 samples/second were recorded over the complete rotation of the middle fiber paddle (~25 seconds). In addition, the FPM-8220 power meter is set to auto range so it can accurately measure large intensity differences.

The polarizer is then removed and the measurement is retaken by rotating the middle fiber paddle through the same angle as before. This signal is shown in red in Figure 2. This measurement represents the worst case scenario of head sensitivity to polarization: linear polarized input (~100:1) rotated > 90^{o}. Other types of polarization such as elliptical, circular, or polarization with <100:1 will result in lower polarization dependent response.

RESULTS

The plot shown in FIGURE 2 is a typical measurement of the maximum PDR for the FMH-8715 and FMH-87107 Fiber Optic Measurement Heads. Note that the maximum PDR is measured from the maximum to the minimum of the normalized power signal recorded by the measurement head during rotation of the middle fiber paddle. The maximum PDR is calculated by:

$$PDR_{\max} = \frac{Power(\max)}{Power(\min)}$$

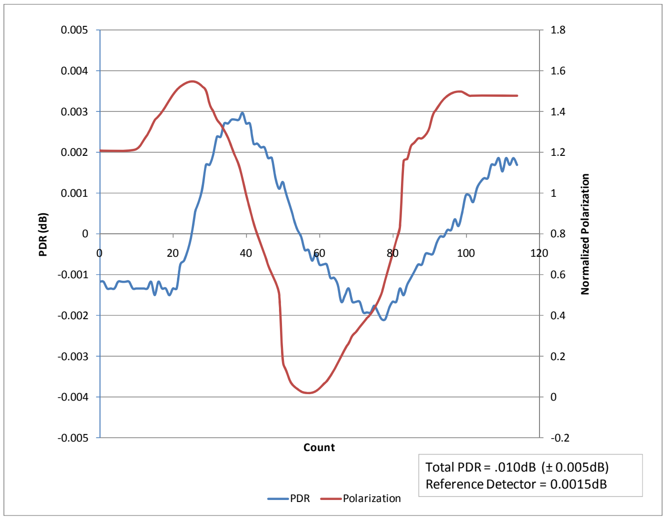

FIGURE 2: Polarization ratio of the input beam (blue) and the measured PDR of the fiber measurement head (red) as a result of rotating the input, linearly polarized light into the head.

The reported PDR is then ±1/2 PDR_{max} since the measurement uncertainty follows a symmetric distribution. Note that the measured maximum PDR of 0.005dB meets the specification of ± 0.003dB. Since this value is much less than the PDL of typical fiber optic components, these measurement heads are ideal for making PDL measurements.