# 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 examples of typical maximum values for PDL for various fiber optic components.

| 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 at the input. For accurate results, the Polarization Dependent Response (PDR) of the power meter being used should be much less than the PDL of the component being tested. The ILX Lightwave FPM-8220 Fiber Optic Power Meter and compatible FMH-8715 and FMH-87107 Fiber Optic Measurement Heads offer a very low PDR specified at less than ± 0.003dB. This Tech Note describes the test procedure and results for measuring the PDR of these products.

## TEST SET UP

PDR was measured using the polarization scanning method[1]. A conventional, 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 a 25mm diameter mandrel to remove any high order spatial modes. The opposite end of the fiber was wrapped around 65mm diameter 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 eliminate instability caused by interference effects at the 1 x 2 splitter and fiber connectors.

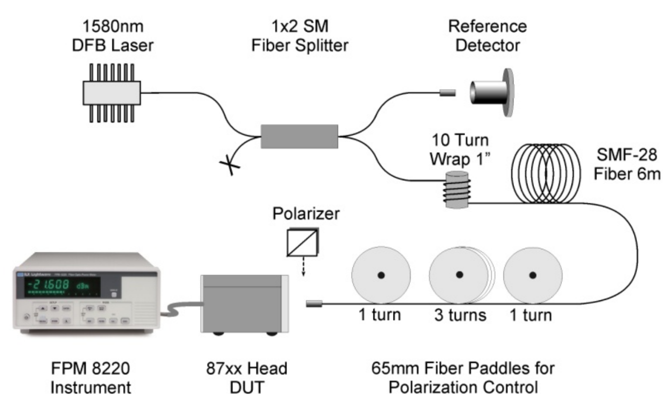


*FIGURE 1. Experimental set up to measure PDR of the fiber optic measurement heads*

## TEST PROCEDURE

The following procedure was 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 between the fiber paddles and measurement head.

First, the fiber paddles are optimized to produce a linearly polarized 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. 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 linear polarizer, ~100:1 linear polarization ratio can be achieved and verified by rotating the middle paddle and noting $Power_{max}/Power_{min}$.

The polarizer was then removed and the measurement was retaken by rotating the middle fiber paddle through the same angle as before. In order to mitigate the effect of system drift, 120 samples at 5 samples/second were recorded over the complete rotation of the middle fiber paddle in approximately 25 seconds.

The variation in the measured signal is shown 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

Figure 2 shows the typical polarization dependency of response of the FMH-8715 and FMH-87107 Fiber Optic Measurement Heads.

The PDR is calculated simply as the difference between maximum and minimum recorded optical power levels measured in dBm.

$$PDR = P_{dBm, max} - P_{dBm, min}$$

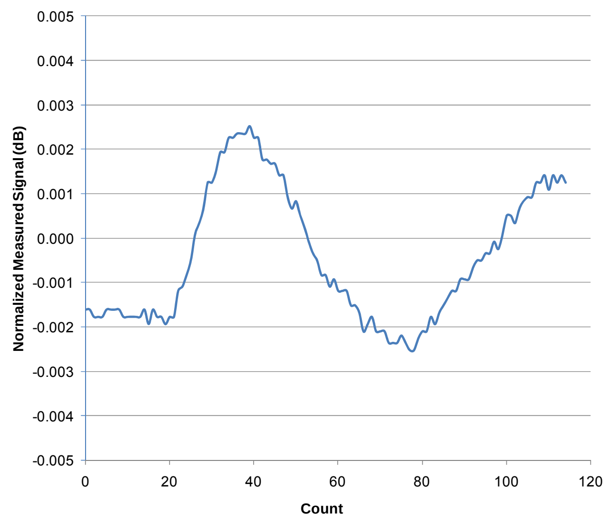


*FIGURE 2: Measured polarization dependent response of an FMH-8715 measurement head to a linearly polarized input signal rotated through 180 degrees.*

The PDR of the FMH-8715 and FMH-87107 measurement heads is typically 0.005dB. Since these heads are calibrated with an unpolarized incoherent light source, the contribution to uncertainty due to polarization dependent response for absolute power measurement is less than ± 0.003dB.

## REFERENCE

1. Fiber Optic Test and Measurement, Dennis Derickson, editor, Prentice Hall, 1998.