OZ OPTICS LTD.

APPLICATION NOTE

AUTOMATED POLARIZATION ALIGNMENT

USING OZ OPTICS' FAMILY OF POLARIZATION MAINTAINING COMPONENTS, SOURCES, AND MEASUREMENT SYSTEMS

INTRODUCTION

Thank you for considering OZ Optics for your polarization maintaining applications. Here at OZ, we pride ourselves for being your expert on all aspects of polarization maintaining fiber optics, including fibers, connectors, patchcords, components, sources, and measurement systems.

This application note is intended to provide the user with information on how to use OZ Optics' extinction ratio meter to automatically align components for maximum coupling efficiency and polarization extinction ratio. This includes both sequential alignment, where the system alternatively optimizes the coupling efficiency, then the polarization, and simultaneous alignment, where both alignments can be done independently of one another.

APPLICATIONS

- Pigtailing Laser Diodes
- Modulator Assembly
- Active Component Packaging
- Passive Component Packaging
- MEMS Packaging
- Polarization Maintaining Fusion Splicing

Polarization Extinction Ratio Meter

Polarized Source

THEORY OF OPERATION

Alignment Optimization Requirements With Polarization Maintaining Fibers

In photonics manufacturing there always exists a need to efficiently couple optical fibers to optical devices (such as a laser diode, waveguide, or another optical fiber). To achieve good coupling efficiency, the fiber to waveguide alignment requires submicron tolerances, due to the small dimensions of the optical components and fibers involved. To align such devices, sophisticated automatic alignment processes have been developed within the industry. These processes are based on high precision electronically controlled linear translation stages, together with some sort of power monitoring and feedback algorithm.

Figure 1 shows a typical automated alignment system. A fiber is mounted onto a XYZ translation stage to receive light from an optical device. The output end of the fiber is connected to a photodiode to monitor the coupled signal intensity. A computer with appropriate control software then adjusts the position of the fiber until optimum coupling efficiency is achieved. The update rate is very fast (on the order of hundreds of times per second), allowing rapid and accurate alignment of singlemode fibers. However the existing systems do not provide an automated polarization axis alignment technique.

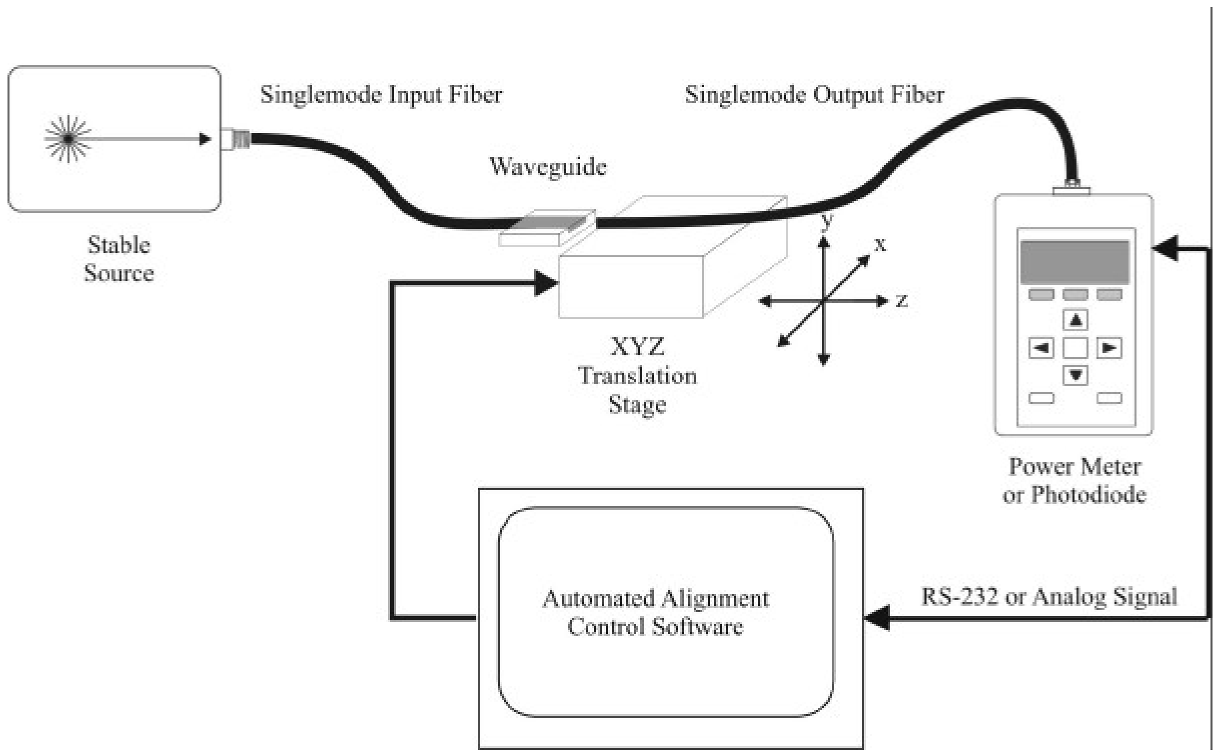

Figure 1: Typical Alignment Optimization System.

Fortunately, OZ Optics' Polarization Extinction Ratio Meter (ER Meter) now allows one to align polarization sensitive devices to PM fiber to achieve high level extinction ratios, without a dramatic algorithm change. The polarization extinction ratio meter, together with OZ Optics' highly polarized stable sources, provide you the equipment you need to transform your existing system into a polarization alignment system for either active or passive components.

The key feature that enables the OZ ER meter to provide this functionality is that it has two measurement modes. In the first mode, called the power mode, the polarizer inside the meter is initially rotated to the point where maximum throughput occurs, and is then stopped. The meter then reads and transmits the raw signal from the photodiode through a serial communication link. The output signal is updated at a rate of over 600 samples per second, depending on the signal strength. This is sufficient to drive an XYZ alignment system.

The second mode is the extinction ratio mode (ER mode). In this mode the polarizer continuously rotates and the power is monitored. The maximum and minimum signal strengths are obtained, and the meter uses them to calculate the polarization extinction ratio. The meter then transmits the ER level, the maximum power, and the angle at which the maximum signal is noted. The data is updated four times per second, which is sufficient for the somewhat easier task of rotation alignment.

Since the extinction ratio meter can be completely controlled by remote access, it is easy to devise software to switch the system from power measurement to extinction ratio measurements. Thus it is relatively straight forward to create an automated system where the computer uses the ER meter for both power and polarization optimization.

Standard Alignment Process, Using The OZ ER Meter

Figure 2 shows a system that has been modified to perform polarization optimization as well as alignment optimization. The source has been upgraded to a polarized stable source, while the standard power meter has been replaced by the extinction ratio meter. Communication between the ER meter and the control software is handled via an RS232 channel, set at 57600 Baud. In addition, the a rotation stage has been added to the linear translation stages, to rotate the polarization axis of the fiber with respect to the waveguide.

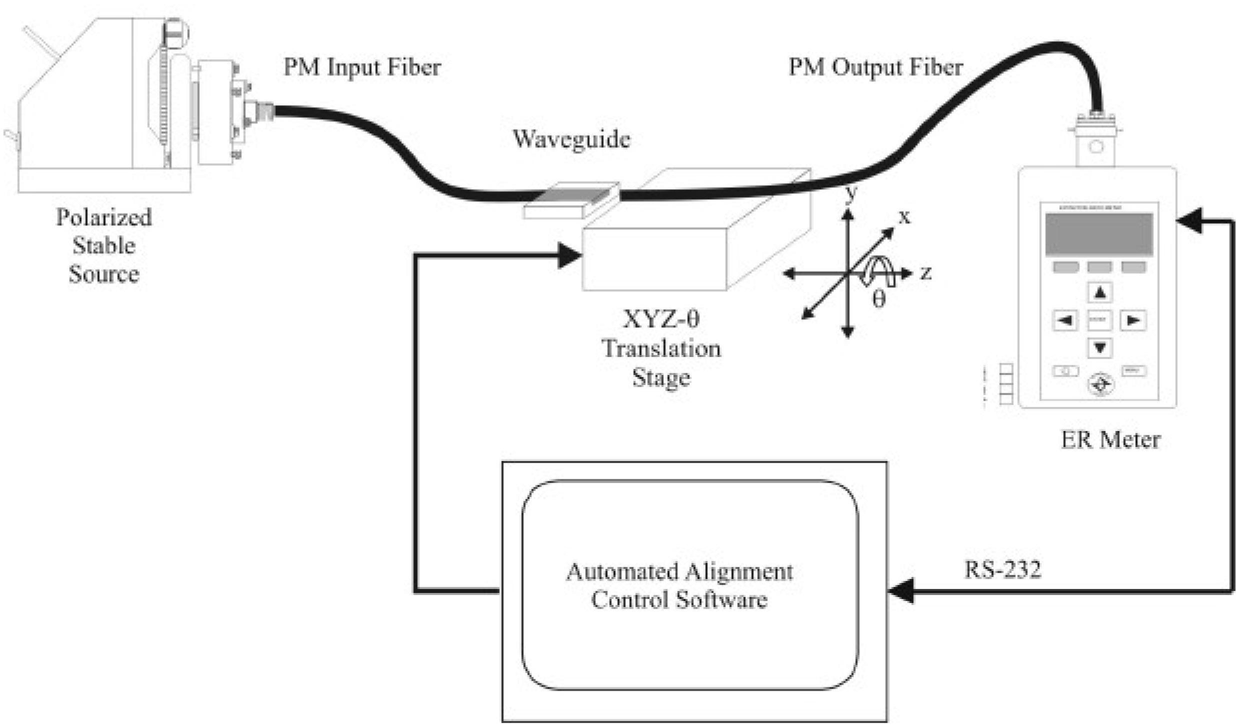

Figure 2: Polarization Maintaining Alignment Optimization System

For this example we will assume that the input PM fiber has already been correctly aligned, and that the light from the waveguide is well polarized.

To start the alignment process, the equipment is initialized, and the software commands the ER meter to operate in Power Level Mode. The system then waits for the ER meter to respond that it is ready to start measurements (about 2 seconds). The control software then instructs the meter to capture the power readings and send the data to the control software.

The ER meter transmits power levels in terms of a logarithmic (dB) scale, with 0.0dB equating to the maximum signal the detector can accept without saturating. Note that this is not a calibrated power reading. It is only useful for measuring relative powers, and is affected by wavelength and how well the input signal is polarized. However, by calibrating the control software against a known, well-polarized reference signal, one can get a relatively accurate indication of the output signal strength.

The system can now use the ER meter data to perform XYZ translation to optimize the coupling efficiency. Because the polarization axis has not been optimized, there may be some variation in the signal. Therefore it will usually be necessary to further improve the alignment after optimizing the polarization alignment.

Once the coupled output power has reached an acceptable level, the control software then instructs the meter to enter normal (polarization extinction ratio) mode. Once in this mode the system instructs the meter to again capture and transmit data. The meter will now report the output polarization in dB, the angle orientation in degrees, and the relative maximum power levels. These readings are updated about four times per second.

The system now uses the extinction ratio meter data to perform rotational alignment to optimize the extinction ratio. Because this alignment is not quite as critical as the xyz alignment, the update rate is sufficient to achieve proper alignment in under a minute.

If the rotation axis of the stage is not precisely aligned with the fiber, there will be loss of coupled power as the fiber is rotated. It will therefore be necessary to repeat the xyz alignment process, should the coupled power drop too low. Since the coupled power is reported simultaneously with the polarization extinction ratio, this can be easily monitored.

To ensure optimum power coupling and polarization axis alignment, it is recommended that the xyz alignment and polarization measurement be repeated at least once, to ensure that both parameters are optimized.

Before and after bonding the components together, the meter can be used to confirm the stability of the output polarization. To do so, the system software can instruct the ER meter to enter its data logging mode. One can then stress the output fiber (for instance by using a heating plate), and the meter will report the worst-case polarization during the stressing period. This aids in quality control of the finished product.

Alternative Alignment Process using the ER meter

In some cases rotation of the fiber cannot be performed without dramatically affecting the XYZ alignment. In these cases the alignment cannot be performed in the simple iterative technique described above. For these cases an alternative technique must be used, one that allows both extinction ratio and power coupling to be optimized simultaneously. Figure 3 shows one method to do this.

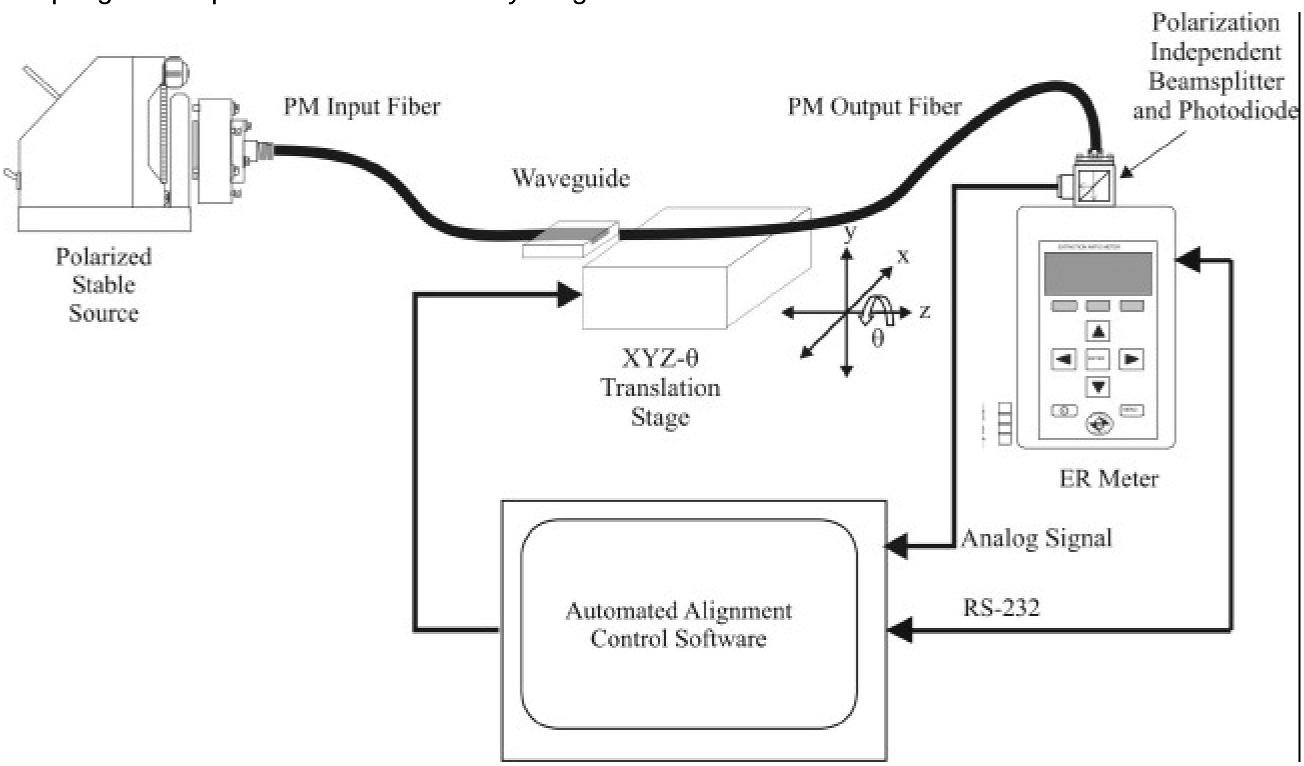

Figure 3: Alternative Polarization Maintaining Alignment Method

In figure 3, a polarization independent beam splitter has been added to the optical path, to divert part of the light to a monitor photodiode. The light from the photodiode is used to control the XYZ alignment for optimum coupling efficiency. The ER meter is only used to monitor the output polarization.

The most significant drawback to this technique is that the beam splitter itself can degrade the polarization of the light before it reaches the ER meter. Systems using this technique have so far not achieved much more than 20dB polarization levels. Therefore this technique should only be used if the first technique is completely impractical.

ADDITIONAL INFORMATION

For more information on basic properties of polarization maintaining components, please refer to the following application notes, both of which can be found on our web site, *www.ozoptics.com*.

Application Notes – Polarization Measurements

Article – Accurate Alignment Preserves Polarization, reprinted from the December 1997 edition of *Laser Focus World*

In addition, please refer to our web site for detailed specifications on OZ Optics polarized stable sources and extinction ratio meters.

Should you require further assistance, please contact our sales staff at OZ Optics, and they will be able to refer you to one of our product managers for test equipment.