Preliminary
Application Notes

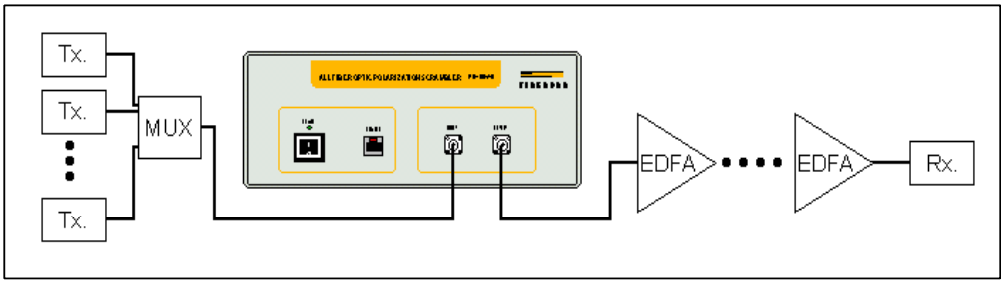
Applications of FIBERPRO's Polarization Scrambler PS3000 Series

Most semiconductor lasers used in many optical systems have definite polarization nature. These polarization natures cause severe problems in systems, and most of them can be overcome by using unpolarized light source instead of highly polarized source. FIBERPRO's polarization scrambler (PS) can scramble the polarization state at high speed, and then make the highly polarized light unpolarized. (Degree of Polarization-DOP- becomes zero on time average.)

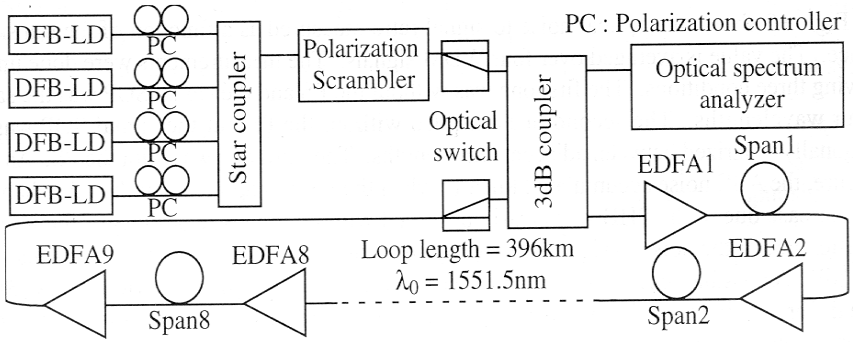
In measurement systems polarization scrambler can be utilized in order to remove the polarization dependence, and then we can measure the characteristics of optical fiber components independently of their PDL.
Polarization scrambler enhances the SNR of long haul transmission systems employing a number of EDFAs drastically by depressing the effect of PDG due to PHB.
Polarization scrambler can remove the phase noise induced by the input polarization change in the interferometric fiber optic sensor systems.

1. Solving PDG/PHB in long-haul systems

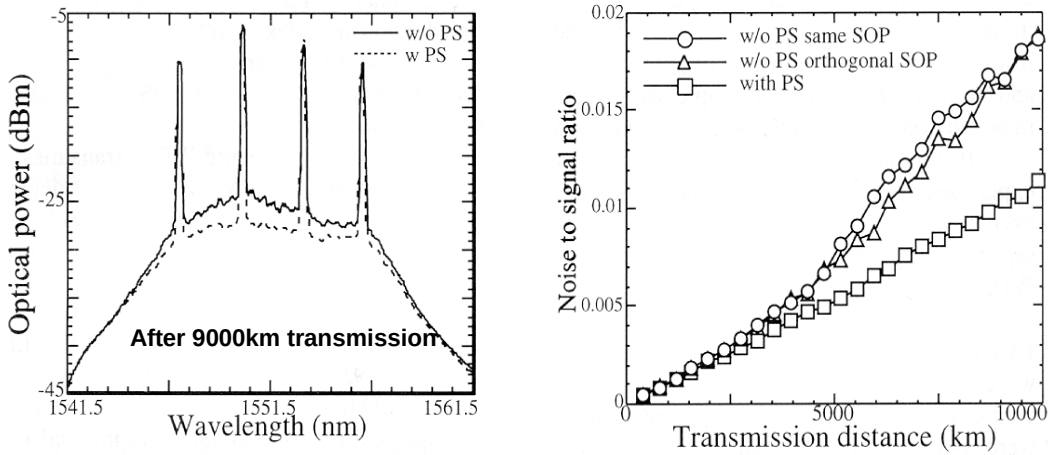
An EDFA has PDG induced by Polarization Hole Burning (PHB) of which the time constant is approximately 1 msec. The PS can remove Polarization Dependent Gain (PDG) of a long EDFA chain. If the light signal is polarization scrambled faster than the response of the EDFA, PDG gets suppressed and so does the degradation of SNR. (See Figure 2)



<Figure 1>



Reduce accumulated ASE noise **SNR improvement**

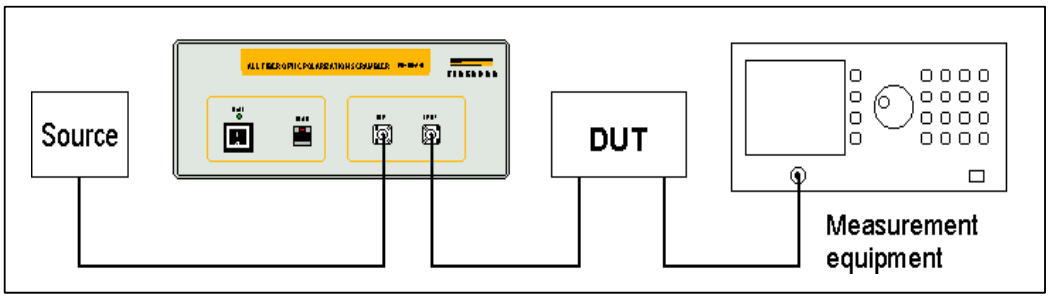


<Figure 2. H. Taga, et.al., WE6-1, OFC'99 Technical Digest (1999)>

2. Measurement

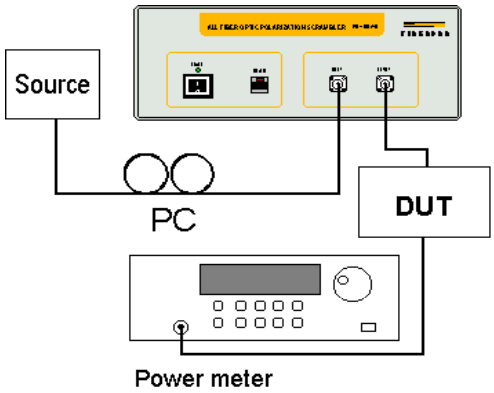
(1) Component characterization without polarization dependence

An optical component has Polarization Dependent Loss (PDL) in itself. Due to the PDL, the optical component can be measured an erroneous value with the extent of the PDL. The PS is used to depolarize optical source for polarization independent measurement. The measurement system can interrogate accurate value of the DUT characteristics such as insertion loss(IL), filter profile etc.

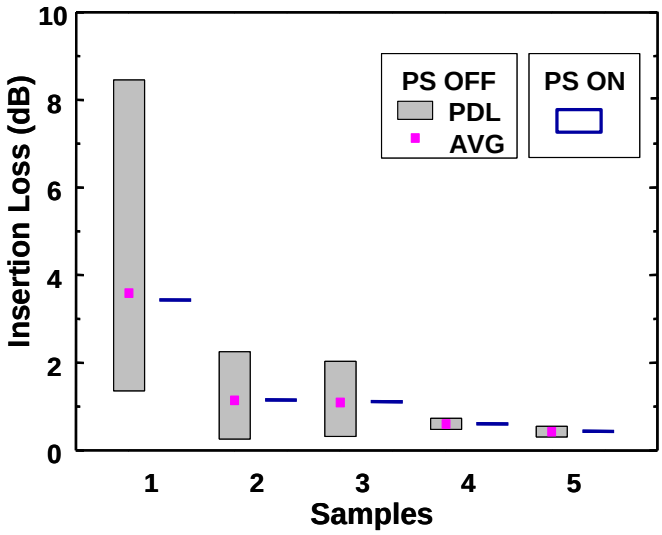


<Figure 3>

Consider an example of PDL independent IL measurement conducted with the PS. (Figure 4. experimental setup) The graph 1 shows five samples with both IL and PDL. If we don not use PS we get different values of IL depending on the input polarization state. The gray in the graph show the error ranges corresponding to each sample. On the contrary the result with the PS turned on exhibits very small variation of measured values. Using PS gives an easy, fast and accurate measurement of Insertion Loss, Filter profile etc.



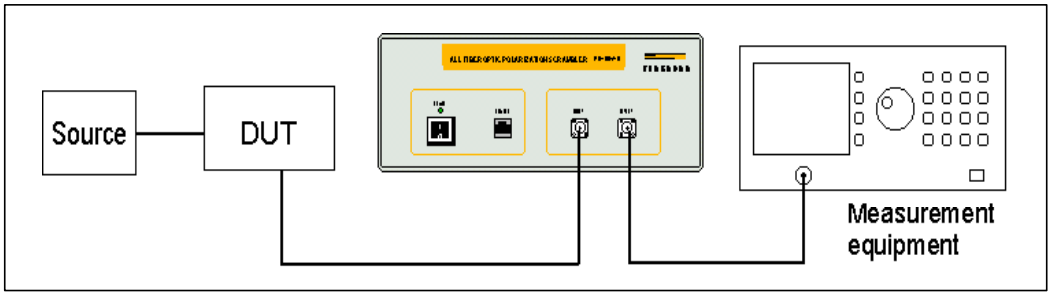
<Figure 4>



<Graph 1>

(2) Removing PDL induced instrumental error

Some measuring instruments have polarization dependence. This creates serious errors increase in measurements. PS removes polarization dependence of the measuring instrument such as spectrum analyzer.



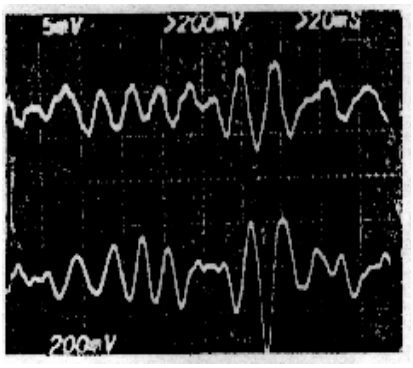
<Figure 5>

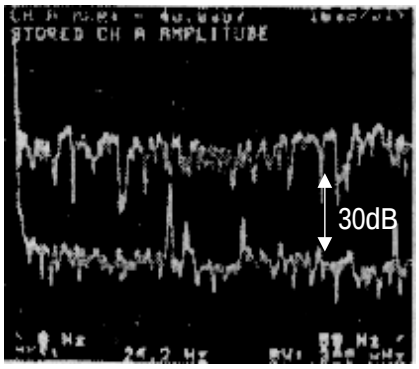
3. Sensors - Removing Polarization induced Phase Noise or Errors in Fiber Interferometers

The external polarization perturbation can induce phase noise and errors in fiber interferometers and sensor system. The PS can depolarize monochromatic optical source such as tunable LD or DFB LD. Because polarization is modulated very fast, sensor signal is clear and the physical quantity of the sensor system to be measured is very exact.

In fiber optic interferometers, it has been reported that so-called polarization induced phase noise exists. (Reference : A. D. Kersey, et. Al., Journal of Lightwave Technology, Vol. 8, No. 6, 838 ,1990)

The upper trace represents the change of polarization state at the interferometer input arm and the lower trace is the interferometer output. (Figure)You can readily see the correlation between the two signals. The undesirably high noise floor due to the input polarization induced phase noise can be suppressed remarkably by using the PS in the input arm. (Figure 6)





<Figure 6>

4. Others - Polarization perturbation for experiment

The PS generates pseudo-random polarization states at high speed. This can be utilized in testing the system which is required to experiment under polarization variation.

Conclusions

As we have seen so far, our all fiber PS is the best solution to solve PDG and PDL problems in long haul transmission systems. It enables you to conduct optical component characterization regardless of the polarization dependency of the components or the measurement systems. So it can be a very useful tool in manufacturing filters or WDM components.