Computing Insertion Loss when Transitioning Through Dissimilar Fiber

Luna Technologies' Optical Backscatter Reflectometer (OBR) is ideally suited for measuring Insertion Loss (IL) and Return Loss (RL) in optical networks with extremely high spatial resolution.[1,2] When trying to make an insertion loss measurement in dissimilar fiber (e.g. SMF-to-Low Bend Loss to-SMF), the calculation is complicated by the fact that the Raleigh scatter level is generally different, and the shift in scatter level must be accounted for to produce an accurate result. To properly measure insertion loss we need to know the relative difference in scatter levels. The simplest way to measure the difference is to fabricate and measure the IL of a jumper cable composed of CorningSMF-28E spliced to a segment of the fiber of interest, and spliced back to SMF-28E, as depicted in Figure 1. We show an OBR scan of a jumper between SMF-Test fiber-SMF in Figure 2.

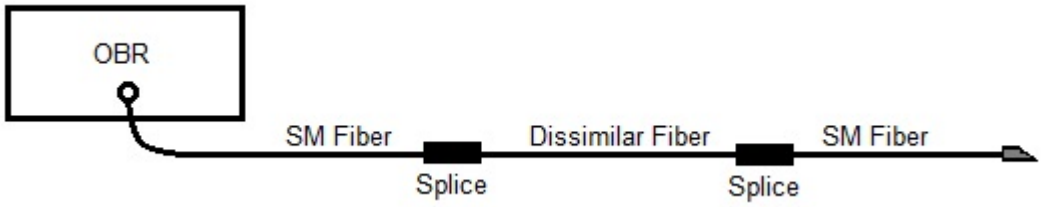

Figure 1. Jumper required for measuring relative scatter level of dissimilar fiber jumper.

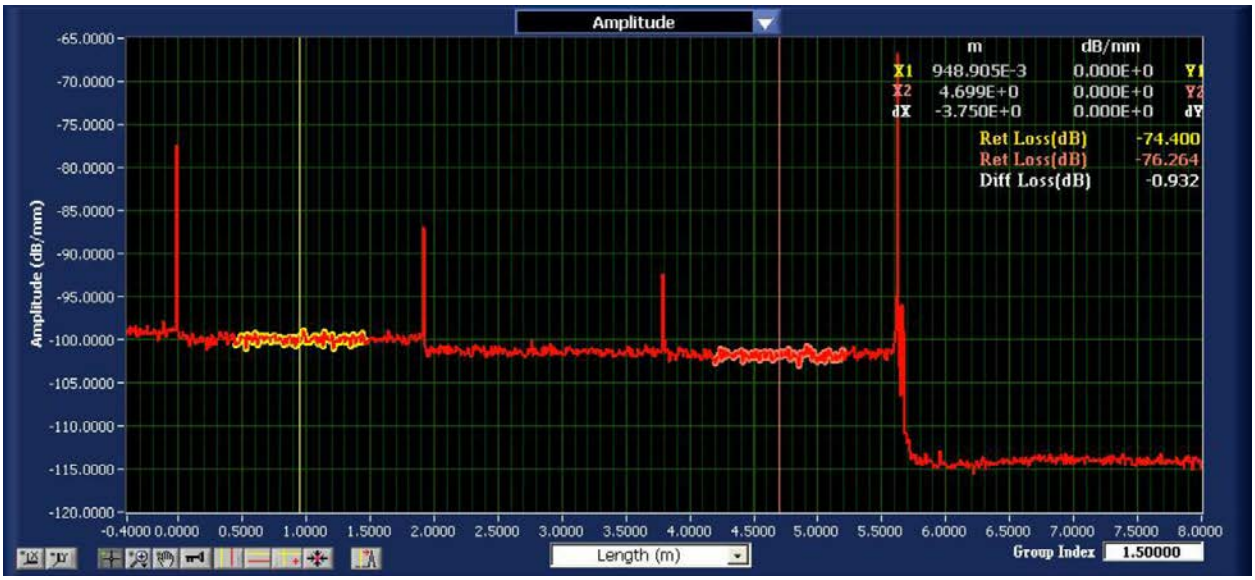

Figure 2. The OBR upper graph trace for the network depicted in Figure 1.

If we label the RL of each of the three sequential fiber segments as RL_a, RL_B, and RL_C, then the average IL of the splices is:

$$IL_{splice} = -\frac{1}{2}\left(\frac{RL_a - RL_B}{2} + \frac{RL_b - RL_c}{2}\right) = (RL_c - RL_a)/4 \quad (1)$$

The shift in scatter level between the dissimilar fiber and SMF-28E (Δ_{SL}) is given by the difference between the measured gap between RL_a and RL_b or between RL_b and RL_c and twice IL_{splice}:

$$\Delta_{SL} = -\left((RL_a - RL_b) + 2IL_{splice}\right) = \left(2IL_{splice} + (RL_b - RL_c)\right) = RL_b - \frac{(RL_a + RL_c)}{2} \quad (2)$$

For the case shown in Figure 2, IL_{splice} is -0.47 dB and Δ_{SL} is -0.53 dB at 1550nm. The scatter level shift should be subtracted from scatter level separation when calculating IL when transitioning from SMF-28E to dissimilar fiber. In this instance, the splice loss at each splice location was assumed to be equal.

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1 B. Soller, D. Gifford, M. Wolfe and M. Froggatt, “High resolution optical frequency domain reflectometry for characterization of components and assemblies”, Optics Express, Vol. 13, No. 2, 2005, 674.

2 B. Soller, M. Wolfe, M. E. Froggatt, “Polarization resolved measurement of Rayleigh backscatter in fiber-optic components,” OFC Technical Digest, Los Angeles, March, 2005, paper NWD3.

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