VIAVI Solutions

Application Note

Improving Connector Loss and Splice Loss OTDR Measurement Accuracy of a High Backscatter Coefficient (High K) Fiber Pigtail

Application

More and more often we find "Bend Insensitive" (BI) fibers used in headend and central office (CO) jumpers as well as in pre-terminated terminal equipment. Some designs of these fibers have relatively high backscattering coefficients ("K"), primarily due to a larger mode field diameter (MFD).

The difference in backscatter at the pigtail splice does not prevent but somewhat complicates measurement of the connector loss at the front panel or the splice loss at the front panel. If the pigtail is sufficiently long, 10 meters or so, VIAVI Solutions™ Optical Time Domain Reflectometers (OTDRs) with pulses as short as 1 foot can perform these measurements. Depending upon their particular specifications and the actual distances involved, some instruments may or may not use these techniques. At sufficiently small distances, such as 3 or 4 meters, field OTDRs can likely measure only the combined loss of the connector and splice.

(NOTE: for the purposes of this Application Note, BI fiber used had a relatively higher K than the standard G.652 fiber to which it was spliced; however, this is the result of the particular design of this BI fiber. Nothing in this document is intended to imply that all BI fiber brands or makes share this characteristic [although they may be unique in other ways]. The recommendations in this Application Note apply to "high K" [or "low K"] fiber.)

Theory

Two different measurement principles are used here.

One principle refers to bidirectional measurement or averaging the losses for each direction to negate any changes in K from one side of the event to the other. The effect of the backscatter level mismatch reverses the sign of the loss value reversing the measurement direction, allowing it to be negated mathematically. This technique is used to measure the pigtail splice between the OSP Standard K fiber and the Pre-Term High K fiber. Locate a generic discussion of bidirectional measurement in the excerpted portion of our Fiber Guide Volume 1. (The entire Fiber Guide Library, Volumes 1, 2, and Glossary are available for order or download at **www.viavisolutions.com**.)

The second technique uses a "High K" Receive cable. (Receive cables function similarly to Launch cables and provide a backscatter baseline used in measuring the far-end connector of a system. The excerpt section in this application note of the Reference Guide to Fiber Optic Testing Volume 1 also explains this technique.) However, in this case, without a dedicated High K launch/receive box an adjacent pigtail was used as a Receive cable that was then looped back to measure the span from the far end. As expected, a small backscatter (coefficient, K) mismatch remains; however, it can be overlooked because it remains well below the magnitude of connector loss. OTDR one-way measurement backscatter mismatches are deemed acceptable, because it is assumed that "like" fibers are spliced or connected.

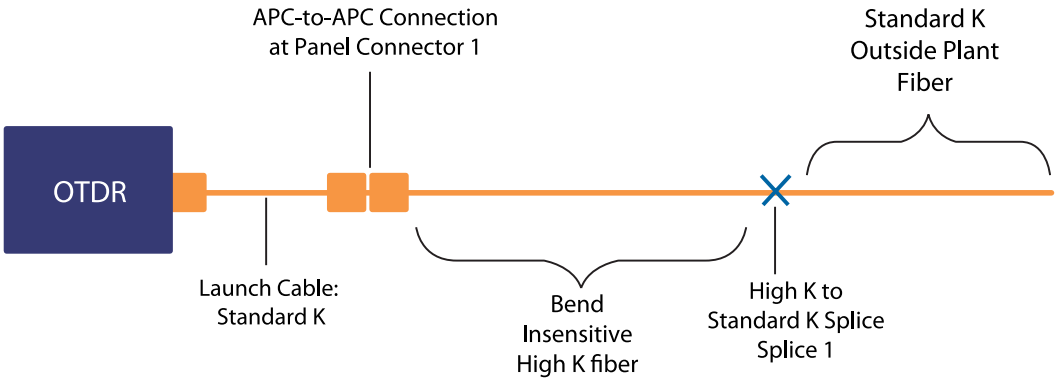

Figure 1. Test setup for forward measurement of Splice 1 using a standard K fiber

OTDR Display with Elevated K Coefficient

The OTDR display shown in Figure 2 (actually the PC emulation software) clearly shows the section of fiber with the elevated K coefficient. Note the relevant value in this trace for the unidirectional loss of Splice 1 taken from the High K fiber to the Standard K fiber of 0.541 dB. Also notice the Connector 1 value of –0.352 dB shown is a relatively large "gainer" due to the K mismatch, but we can overlook this result for now.

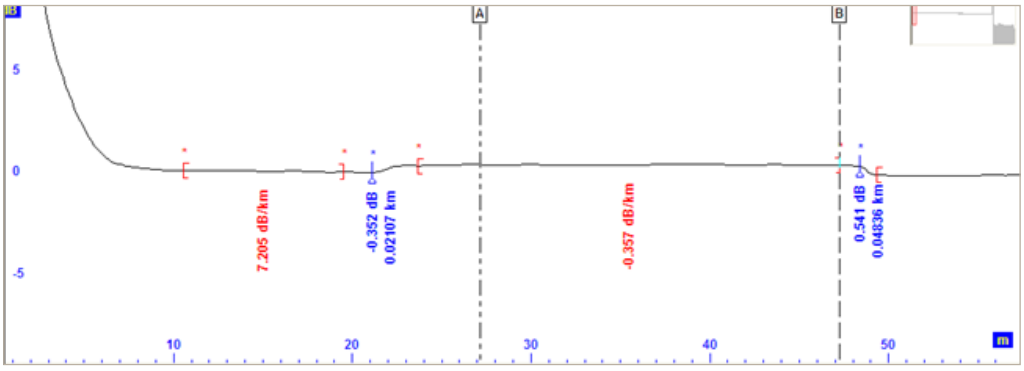

Figure 2. OTDR display of a section of fiber with an elevated K coefficient

Reverse Measurement of Splice 1 and Connector 1 (Using a "High K" Receive Cable)

Figure 3 shows the test setup using the fiber from the previous measurement that is now connected to an adjacent pre-term pigtail and then "shot" from the far end. Thus, now measuring Splice 1 in the opposite direction and applying standard bidirectional calculations. This now measures Connector 1 through an adjacent Bend Insensitive pigtail acting as a "K matching" "receive cable", which enables direct measurement of the connector loss value with minimal risk of error.

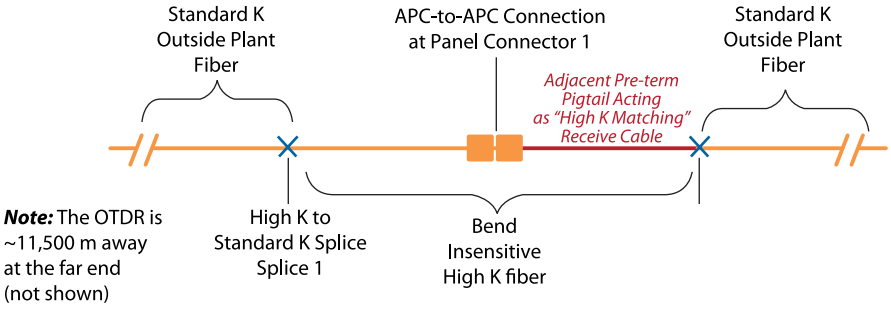

Figure 3. Test setup for reverse measurement of Splice 1 and Connector 1 using a High K Receive Cable

OTDR Display for Reverse Measurement of Splice 1 and Connector 1 using a High K Receive Cable

The display in Figure 4 shows cursors placed to identify section slopes and events that assist in measuring the relative events, which can be accomplished using the PC software or on the OTDR display.

Taking the simplest measurement first, notice Connector 1 with a loss value of 0.053 dB that can be further refined by measuring in the reverse direction and averaging. Doing so would result in a very small K difference (this is High K fiber-to-High K fiber), which is considered unnecessary as we can be confident in this value. Therefore, we accept the one-way loss measurement for the connection.

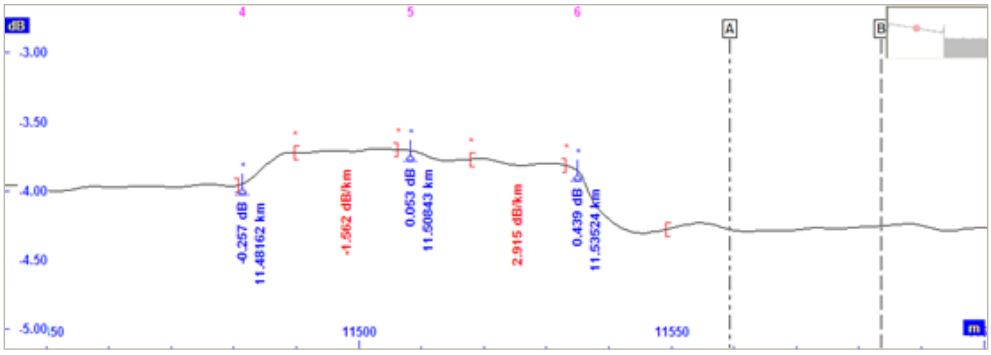

Figure 4. Cursors are placed to identify section slopes and events to assist with measuring the relative events

Conclusion

Increased use of specialty fibers, such as BI fibers, can cause concern for OTDR measurements using the standard and time-tested techniques and tools, such as unidirectional measurement and standard fiber launch boxes.

These techniques were used with certain "assumptions" (all Ks being equal), which is not necessarily true. Small measurement errors allowable under previous assumptions were often deemed acceptable variations in Backscatter coefficients in most fiber used lately.

If previous assumptions are incorrect, and a significant difference does exist in fiber types (and K coefficients) spliced or connected, the errors may not be that easy to overlook. Nonetheless, as this paper demonstrates, an OTDR of sufficiently high resolution and dynamic range, and depending somewhat on the pigtail lengths, can accurately measure the connector loss and splice loss of High K pigtails.

The technique of using a "K matching" launch or receive cable provides a simple method for measuring connector losses for these fibers. We successfully measured Connector 1 with this technique; and we did not have a dedicated cable, so we used an adjacent cable.

(Note: A very long system may have required increasing the OTDR pulse width and might have "blurred" the two events [Connector 1 and Splice 1] allowing us only to report a combined loss for the two.)

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