

## **Testing that Demonstrates, or Not, High Reliability**

This is the second in a series of three articles on high installed reliability of fiber optic networks. In the [first article](#), I presented the conditions that indicate high installed reliability after installation. In this article, I present the testing that indicates, or not, high installed reliability. In the third article of this series, I present interpretation of test results, with the goal of verification of high reliability.

The four tests indicate, or not, high installed reliability. Those tests are continuity and polarity testing, insertion loss testing, OTDR testing, and microscopic inspection.

### **Continuity and Polarity Testing**

This testing requires a visual fault locator [VFL], based on a high-power visible laser [~650nm]. When connected to one end of a cable under test [CUT], visible light at the opposite end indicates continuity. Without continuity, troubleshooting is necessary. As many fiber links provide duplex communication, two fibers are required. During installation into patch panels, the most common error is incorrect polarity, also known as 'crossed' fibers.

In data centers, a single MPO connector can contain 8 to 72 fibers. During installations, errors can result in improper polarity. Again, the VFL test reveals proper or improper polarity.

### **Insertion Loss Testing**

The insertion loss Test is performed with an optical loss test set [OLTS]. This set consists of a stabilized light source, a calibrated and traceable power meter, appropriate adapters for the source and meter, and at least two test leads with the appropriate connectors on both ends. The source can, and often does, contain multiple wavelength sources. A meter should, and usually does, have internal calibrations at multiple wavelengths.

### **Procedure**

After a test with the test leads to measure the 'input' power level, with test or 'reference' leads between the equipment and the cable under test [CUT], the source and meter are attached to opposite ends of the cable [Figure 1]. This configuration provides a measurement of the 'output power' aka the loss of the CUT.

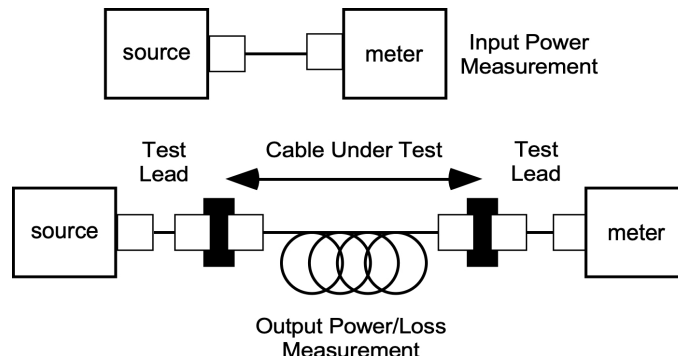


Figure 1: Insertion Loss Set Up

While the fiber standards [ref] allow for a single measurement, this author has found a modified procedure provides indication of the cause of elevated loss and contamination of the connectors. This procedure involves making a measurement, disconnecting and reconnecting the reference leads, and comparing the two measurements. If the difference is small, record the larger of the two measurements.

Even if the long term is for use at one wavelength, this procedure is performed at two wavelengths. Testing personnel make two comparisons of these results: the first is a comparison of the losses at both wavelengths to calculated values. The second is a comparison to each other. This second comparison provides an indication of high reliability, as detailed in the next article of this series.

Except for 'short', indoor, horizontal links, the EIA-TIA-568 standard requires testing in both directions. While almost all the author's clients have request such bidirectional testing, the consistent result has been of small, inconsequential bidirectional loss differences.

There is one additional test that becomes useful when interpreting loss increases in future tests. A future test may indicate an increase in loss. This increase has two interpretations. One is that there is some 'damage' to the cables, connectors, and splices. The second is that the increase is due to the inherent variability of the insertion loss test.

To properly interpret an increase, one needs know this the inherent variability, also known as 'repeatability'. To determine this variability or repeatability, one makes multiple loss tests by disconnecting from and reconnecting the reference leads to DUT. Calculation of the difference between the maximum and minimum losses provides a 'range'. This range is the normal behavior of the connectors.

With the range, an increased loss can be properly interpreted: if the increase is less than or equal to the range, the increase represents normal behavior and not damage to the link. If not, the increase represents damage to the link.

### **OTDR Testing**

OTDR testing provides three measurements. From one end, these measurements are of almost all segment lengths, attenuation rates, and connection losses. 'Almost' refers to hidden details within the dead or blind zone that occur at a connector or splice. A detailed explanation for the word 'almost' is not within the scope of this article.

### **OTDR Procedure**

Normally accepted procedure is testing at two wavelengths and in both directions. Testing at two wavelengths provides indication of stress level on the fiber. Testing in both directions enables calculation of true splice loss. Without this calculation, it is possible to incorrectly and unnecessarily reject apparent high loss splices and connectors or accept actual high loss splices.

**Microscopic Inspection** The purpose of microscopic inspection is verification of lack of defects in or contamination on the fiber optic connector ferrule end face. This verification can be done visually, either manually or automatically. Automatic verification is performed with microscopes having software that digitizes and interprets the image. Manual verification can be subject to error and can be time consuming. To minimize inspection cost, this authors prefers automatic verification.

Automatic verification will eliminate errors and reduce verification time. Such reduction will reduce labor cost, and will, in time, pay for the increase in cost between manual microscopes and those with software.

Microscopes with software can implement the requirements stated in IEC 61300-3-35, 'Examinations and measurements- Visual inspection of fibre optic connectors and fibre-stub transceivers. Alternatively, the software may implement other inspection requirements. Microscopes with automatic verification are available from AFL [FOCIS Lightning<sup>®</sup>2], EXFO [FIP 500], VIAVI [P5000i] and others.

Each of these four tests produces results. Achieving high reliability requires proper interpretation. The next article in this series will provide guidelines for interpretation to achieve high installed reliability.

Eric R Pearson, CFOS/C/S/T/O/H/I  
President, Pearson Technologies Inc.

For 45 years, Pearson Technologies Inc. has provided fiber training and consulting in North America, the Far East, and Europe. Mr. Pearson was a founding Director of the Fiber Optic Association, a Master Instructor for the FOA.

