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Part 1: How to Avoid Confusion When Testing Insertion Loss According to TIA/EIA-568 B.1 and B.3

I have been reviewing a Draft 1.0 of TSB 140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems. In order to understand this draft, I have needed to review six testing procedures (FOTPs) for both multimode and singlemode cable systems. In part 1 of this issue, I will present the methods which are required.

TSB140 references the Building Wiring Standard, ANSI/TIA/EIA-568-B.1. This standard calls out different test procedures for multimode and for singlemode cable systems. These two fiber optic test procedures (FOTPs) reference other test procedures, for the enjoyment, or frustration, of those who enjoy complicated puzzles.

Multimode Testing Clause 7.1 of the -568 B.3 requires that multimode insertion loss testing be performed in accordance with Method B of OFSTP-14A, otherwise known as TIA/EIA-526-14A. This same clause requires that the light launch conditions meet the requirements of TIA/EIA-455-50 B (FOTP-50 B). Many, but not all light sources are LEDs which overfill the fiber core and therefore, do not meet the requirements of FOTP-50 B.

KEY POINT: You need to know whether your light source is a Category 1 source, as designated in Annex A of TIA/EIA-526-14A.

Wait. Do not go out to buy a new light source. Your light source may create the required condition internally. If not, you can achieve the required launch condition with a mode filter to strip out higher order modes. These modes can result in field measured attenuation rates which are higher than those stated by the fiber and cable manufacturers.

A mode filter, also called an equilibrium mode simulator (EMS) in TIA/EIA-171, is a round tube of a specific diameter. The diameter is determined by the fiber being tested (Table 1). To use the mode filter to create the proper launch condition, you will wrap the light source reference lead (Figure 1) five times around the mandrel of the proper diameter. This requirement appears in Clause 11.3.3 of TIA/EIA-568 B.1.

Table 1: Mandrel Diameter Vs. Cable Diameter and Fiber Type

- Fiber Type	Cable Type 900 µm	- 2 mm cable	- 2.4 mm cable	- 3.0 mm cable
50 µm	24.1 mm	23 mm	22.6 mm	22 mm
62.5 µm	19.1 mm	18 mm	17.6 mm	17 mm

Figure 1: Reference Cable Wrapped Around a Mode Filtering Mandrel (Courtesy; Noyes Fiber Optics)

KEY POINT: You will need to wrap the reference lead around a mandrel prior to setting the launch power.

The use of a mode filter, or mandrel, is a requirement new to field testing of fiber networks in buildings. It did not appear in TIA/EIA-568 A. TIA/EIA-568 A references Method B of TIA/EIA-526-14 A without the requirement for meeting the launch conditions of FOTP-50 B.

This change in launch conditions was deemed necessary because of the use of new type of light sources, the vertical cavity, surface emitting laser or VCSEL, which have launch conditions significantly different from those of LEDs. The power loss through links will be less with VCSEL sources than with LED sources (Table 2).

Table 2: Comparison of LED to VCSEL Insertion Loss Test Results

Length, m	LED Loss, dB	VCSEL loss, dB	LED- VCSEL, dB
25	-0.4	-0.5	0.1
25	-0.4	-0.2	-0.2
125	-1.1	-1.2	0.1
210	-3.6	-2.0	-1.6
22	-3.1	-1.8	-1.3
210	-3.4	-2.0	-1.4
545	-5.9	-4.6	-1.3
		average=	-0.8

There is good new and bad news about this change. The good news is that this change in launch conditions results in standardized testing conditions regardless of the type of light source in the testing equipment.

Now for the bad news: the test results with a mandrel may not simulate the power loss which the transmitter experiences. If the transmitter is a LED which overfills the fiber core, use of the mandrel can result in a power loss which is less than that experienced by the transmitter. If the transmitter is a VCSEL, the use of mandrel wrap can result in a power loss which is greater than that experienced by the transmitter.

KEY POINT: troubleshooting of power problems becomes more complicated. The power loss can measure acceptably low and the receiver may receive insufficient power. Conversely, power loss can measure unacceptably high and the receiver may receive sufficient power. This complication arises because the generic test method may not simulate operation.

The solution to troubleshooting such power problems is the use of a light source which simulates the operation of the source in the transmitter. That is, if the transmitter has an overfilling LED, the test source should have an overfilling LED. If the transmitter has a VCSEL, in which launched most of the light is launched into the fiber in a donut shaped area with a diameter of approximately 35 µm, the test source should have a VCSEL with the same characteristics.

In order to simulate operation, a testing source must have the same characteristics as the transmitter. These characteristics include: wavelength, spectral width, angle of divergence and spot size and shape. While

Singlemode Testing Clause 7.2 of the TIA/EIA-568 B.3 requires that singlemode insertion loss testing be performed in accordance with Method A.1 of OFSTP-7, otherwise known as TIA/EIA-526-7. This method requires that the reference operates as singlemode. To accomplish this requirement, the source reference cable needs a 2 inch diameter loop to filter out the higher order modes which may be present in a short launch cable. Often field installers overlook this loop.

Part 2: Evaluation of the Panduit Prepolished SC Connector

I have been unimpressed with connectors which do not require polishing. Prior to this project, all of the cleave and leave connectors I have tested and with which I have trained exhibited three problems: excessive power loss, low installation yield and high variability. Our experience did not leave us hopeful.

Recently, we tested the Panduit Prepolished SC connectors. Our evaluation method was unorthodox and did not follow all the directions recommended by Panduit. In spite of our method, we found the Panduit SC prepolished connectors to have: the lowest average power loss; the highest installation yield and the lowest variability we have observed from different products using this method of installation.

We present the Method A insertion loss test results in Table 3. These results represent the lowest loss, highest yield (19 good out of 20 connector plugs) and most consistent losses we have seen with any of the cleave and leave products.

Table 3: 850 nm, Method A Insertion Loss Test Data of Jumpers with the Panduit SC Prepolished Connectors on Both Ends

-0.62	-0.66	-0.77	-0.38	-0.81	-0.36
-0.83	-0.54	-0.42	-0.45	-0.64	-0.47
-0.26	-0.62	-0.81	-0.75	-0.78	
				Average=	-0.60

Those of you familiar with test results may view as high these values. However, a pair of cleave and leave connectors has two mechanical splices in addition to the connector pair. The Building Wiring Standard, TIA/EIA-568 B allows a maximum splice loss of 0.3 dB. If we assume worst case mechanical splices in the connectors, the maximum loss could be as high as 1.35 dB/ pair (=0. 75 dB/air for the connectors plus 2* 0.3 dB for the splices). The results in Table 3 reveal an average of less than half that maximum value.

If we assume that each splice in the backshell has an average loss of 0.15 dB, then the average connector loss should be 0.6 dB/pair (=0.3 dB/ connector pair plus 2* 0.15 dB per splice).

Against both of these well accepted metrics, the Panduit product compares well.

The full installation and test details are in PanduitSCTestResults.pdf. To obtain your copy, request it via email.

Part 3: The Proof Is In: Test Data Prove the Value of a Precision Cleaver

Since about 1992, Pearson Technologies Inc. has based splicing training on Alcoa Fujikura (AFL) cleavers. We have experienced reduced splice losses and increased yields (good splices/total splices). Recently, we purchased Fujikura fusion splicers with the capability to measure cleave angle .

With this equipment, we are able to cleave fibers with different cleavers to determine the differences in performance. We have done so with seven different cleavers, four relatively expensive cleavers from Alcoa Fujikura (AFL) and 3 less expensive cleavers.

We present the results in Table 4. The cleave angles are in absolute degrees. These results demonstrate the superior performance of the AFL CT-07 cleavers. This superior performance is indicated by the reduced average cleave angles and reduced standard deviations. We did not directly measure yields, but all of the cleaves made with the AFL cleavers were good. Not all of the cleaves made with the inexpensive cleavers were good.

Table 4: Comparison of Absolute Cleave Angles of AFL and Inexpensive Cleavers

- Cleaver	- S/N	- Ave., ∞	Standard Deviation, ∞	No. Cleaves	- Notes
AFL CT 07	3069	0.36	0.65	22	
AFL CT 07	3068	0.22	0.26	20	
AFL CT 07	48127	0.21	0.23	12	Bought used
AFL CT 07	34670	0.52	0.45	10	Bought used
Inexpensive 1		1.31	1.14	22	Good condition
Inexpensive 2		1.82	1.39	20	Adequate condition
Inexpensive 3		0.79	0.66	18	With new blade

If we were to calculate the total cost of time spent making unacceptable splices or installing high loss cleave and leave connectors, we would find that the more expensive cleaver will pay for itself in reduced labor cost and increased yields.

The full test details are in CleaverStudy1.pdf. To obtain your copy, request it via email.

Part 4: A Pearson Personal Perspective: Will Fiber Miss the Data Networks Boat?

The premises situation does not look good. It has been obvious that many organizations are ignoring the benefits of fiber to the desk (FTTD). The slow but steady progress of UTP categories from 3 to 6 and beyond is witness to that fact.

While there has been increasing implementation of FTTD, the rate has been slow. The basic benefits of fiber-increased bandwidth, security, increased transmission distance, low BERs- have not offset the perception of a cost penalty.

Even the cost model created by the FOLAN subcommittee of the TIA and Pearson Technologies Inc. (http://www.fols.org/pubs/costmodel.htmlg) does not appear to have changed many minds.

Out of this situation comes a concern: what is the future of the premises fiber optic market? This concern leads to examination of competing technologies, specifically, wireless networks. Will end users opt for wireless instead of fiber? If so, then wireless networks becomes an upsetting technology.

The wireless arguments of increased ease of installation and increased convenience of use seem to be accepted. In the summer 2002 issue of its alumni magazine, CWRU Magazine, Case Western Reserve University (CWRU) touts its wireless network as being a technology that can more fully exploit the potential of the existing fiber optic infrastructure. In other words, the applications that were thought to justify the need for FTTD have not evolved, even 12 years after the installation. For CWRU, fiber to the desk is no longer necessary or desirable for most computers.

Ironically, the CWRU wireless network is only possible because of its advanced fiber network, which was installed in the late 1980s. In the words of the author: ..the Internet industry settled on a communication standard that does not exploit the full potential of the fiber optic cable, with the result that, even now, ten years later (after installation of the network) the University investment in the fastest cable available has yet to fully pay off. That is about to change.

In the case of CWRU, the FTTD network installed many years ago is about to become a backbone network, with wireless networks feeding it.

If the CWRU example represents an example of a trend, the business models of many fiber companies will have to change. Significantly.

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