Volume 2, Issue 4
October 27, 2003

Friends of Fiber Optics

In this issue we present two subjects and three announcements. I hope you find this issue useful. Please consider how we can assist you in meeting your fiber optic goals. You may see something that you'd like to see in a more focussed structure.

We've been helping clients meet fiber optic challenges, solve and avoid fiber optic problems for 24 years. It's likely that we can help you and your company. Call so we can discuss your needs.

We appreciate your interest in our newsletter, Eye on Fiber Optics. As this is free, feel free to distribute it. Associates can obtain their own copies by requesting it at our web site, www.ptnowire.com.

At the end of this newsletter, you'll find lists of future subjects. Feel free to send or call us with your comments or experiences. If you'd like to see a specific subject, let us know.

For Pearson Technologies Inc.,

Eric

Eric R. Pearson, CPC, CFOS
President, Pearson Technologies Inc.
800-589-2549, fax: 509-693-5670,
www.ptnowire.com, fiberguru@ptnowire.com

Part 1: Cleave and Leave Connectors: Finally, Acceptable Loss and Yield!

Executive Summary

Pearson Technologies evaluated the performance of 40 SC cleave and leave connectors with the 62.5 µm fiber. The average TIA/EIA-568 B bi-directional insertion losses were –0.39 and –0.43 dB/pair. These loss values, slightly higher than those of connectors installed with an adhesive, are acceptable for data communications networks. The yield for these connectors, 94.7%, was acceptable. The yield was approximately the same as that for connectors installed with adhesive.

Introduction

In this report, we present the results of an evaluation of cleave and leave, SC connectors from Corning Cable Systems. The primary purpose of this evaluation was to determine the typical loss, in dB/pair, that an installer would expect to achieve. The second purpose was to determine the process yield, in percent, that an installer would expect to experience. The ultimate purpose of this evaluation was verification of the values stated in product data sheets.

Test Procedure

Pearson Technologies installed all connectors according with the following procedure:

removal of the cable jacket,
trimming of the strength members flush with the jacket,[1]
removal of the tight buffer tube and primary fiber coating,
cleaning of the fiber,[2]
cleaving of the fiber to a cleave length of 8.5 ±0.5 mm,
insertion of the fiber into the connector and
crimping of the connector to the fiber and the tight buffer tube.

Pearson Technologies substituted an Alcoa Fujikura [AFL] cleaver, part

---

[1]Trimming of the strength members flush with the jacket simulated installation of the connectors onto premises cable, the most common field installation scenario.

[2]We cleaned the fiber with 99 % isopropyl alcohol and lens grade tissues.

number CT07 [Figure 1], for the cleaver included as part of the manufacturers kit. With this substitution, Pearson Technologies evaluated the cleave-and-leave connectors, not the cleave-and-leave installation process.

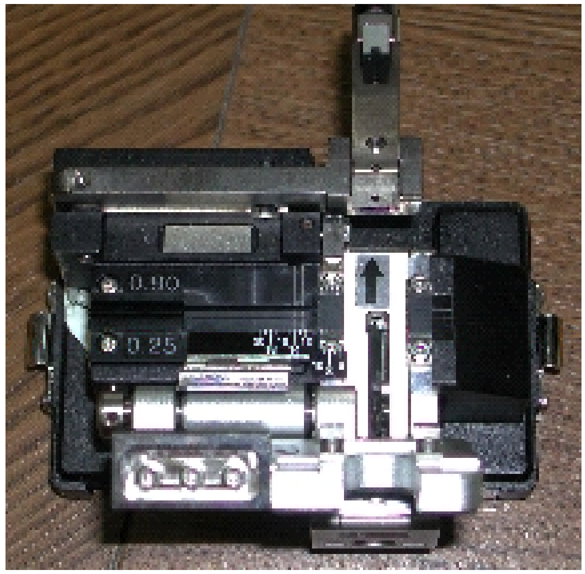

Figure 1: AFL CT07 Cleaver

The reason for this substitution was the improved cleave angle produced by the CT07 cleaver [Eye on Fiber, Volume 1, Issue 2]. The CT07, which has a list price of about $1500, produces a cleave angle lower than that of lower cost cleavers. Also, our experience indicates reduced connector loss and increased process yield with the AFL cleaver as compared with those obtained with low cost cleavers.

We installed one connector on the end of a long length of cable on a reel. With an 850 nm OTDR,[3] we measured the loss of that connector. If the loss of that connector were low, we cut eight feet of cable from the reel and installed a connector on the opposite end. This procedure enabled our determination of the end with high loss, if high loss occurred.

We measured the loss of the eight-foot patch cord in accordance with TIA/EIA-568 B, which requires measurement according to Method B of TIA/EIA-526-14 A. The reference leads were qualified with losses of better

[3]The OTDR was a Tektronix TekRanger 3031 with a launch cable.

than -0.5 dB according to TIA/EIA-526-14 A.[4][5]

Method B requires a loss measurement of two connector pairs. With the TIA/EIA-568 B requirement that connector loss be less than 0.75 dB/pair, we would expect all measurements to be less than 1.5 dB.

Analysis

We installed 40 Corning Cable System SC connectors on 62.5 µm tight tube cable. We present the results in Table 1. Because of operator error, we ignored the results from two connectors [connectors 1 and 21]. With two exceptions [numbers 7 and 31], the connectors had acceptable insertion losses of better than -1.5 dB.

Table 1 indicates low loss, an average of -0.39 and -0.43 dB/pair in opposite directions. This loss is higher than that of typical connectors requiring adhesives and polishing. Such connectors with ceramic ferrules have typical values of -0.30 dB/pair.[6]

These measured losses would be expected to be higher than the losses of adhesive and polish connectors due to the mechanical splice in the back shell of the cleave-and-leave connector. If we assume that the ferrules of the Corning connectors provide a typical loss of -0.30 dB/pair, the measured insertion losses imply an average mechanical splice loss of -0.05 to -0.065 dB/ connector. Such a low loss is impressive. The, low loss values support the data sheet typical value of 0.4 dB/pair.

Table 1 indicates an acceptable, high yield of 94.7 %. Professional installers expect field yields of 95- 98 %.

---

[4]We used a Category 2 light source. This source produced the same losses as a Category 1 source for cable lengths between 1 and 200 meters [See Eye On Fiber, Volume 2, Issue 3]. We used a mandrel on the source reference lead. This mandrel is required by TIA/EIA-568 B.

[5]The cable was Krone Optical System 3 mm cable.

[6]We note a difference in the insertion loss test procedure used to support the –0.3 dB/pair value. Our adhesive connector data are based on Method A tests, a Category 2 source and no mandrel. Such a test procedure results in losses that are higher than those made with a Category 1 source with a mandrel [Eye On Fiber, Volume 2, Issue 3].

Table 1: Data On Cleave-and-Leave Connectors

U-#	OTDR loss	TIA/EIA-568 B Insertion Loss odd # @ Source	even # @ Source		Status
1					broken fiber; operator error; do not count
2	-0.42		-0.58	G	
3		-0.58		G	
4	-0.46		-0.43	G	
5		-0.54		G	
6	-0.32		-1.09	G	
7				**NG**	was -1.54/-1.60
8			-1.16	G	replaced #7
9	-0.40	-1.05		G	
10			-1.00	G	
11	-0.47	-0.78		G	
12			-0.85	G	
13	-0.41	-0.77		G	
14			-1.02	G	
15	-0.35	-1.20		G	
16			-1.13	G	
17	-0.35	-1.17		G	
18			-1.36	G	
19	-0.32	-0.94		G	
20			-0.72	G	
21				G	operator error; do not count
22	-0.36		-0.66	G	
23		-0.50		G	
24	-0.06		-0.68	G	
25		-0.63		G	
26	-0.40		-0.61	G	
27		-0.55		G	
28	-0.23		-1.07	G	
29		-0.69		G	
30	-0.27		-0.81	G	
31				**NG**	was -5.28/-5.36
32			-0.67	G	replaced # 31
33	-0.34	-0.86		G	
34			-1.01	G	
35	-0.44	-0.48		G	
36			-0.74	G	
37	-0.42	-0.98		G	
38			-0.92	G	
39	-0.38	-0.73		G	
40			-0.54	G	
average=	-0.36	-0.78	-0.85	dB	
yield=	94.7%	36	38		
average=		-0.39	-0.43	dB/pair	
standard deviation		0.25	0.26	dB/ two pairs	
		0.16	0.13	dB/pair	

Comments and Observations

The results presented herein apply to multimode connectors installed with the CT07 cleaver. We expect both loss and yield of cleave-and-leave, multimode connectors installed with a low cost cleaver to be inferior to those values presented herein.[7]

Conclusions

With the assumption that the loss and yield performance of the connectors used in this evaluation are the same as those obtained from connectors purchased through any distribution source, we conclude that cleave-and-leave connectors offer power loss and yield that are acceptable. Although the loss of these connectors is higher than that of adhesive connectors, the small increase, approximately 0.1 dB per pair, is inconsequential to operation of data networks based on data standards. The equivalence of cleave-and-leave yield with adhesive connector yield implies the possibility of a favorable cost comparison with adhesive connectors. Assuming an appropriate connector cost, the high installation rate of cleave-and-leave connectors may result in a total installed cost that is less than that for adhesive connectors

---

[7] We have used lower cost cleavers in training programs. With such cleavers, loss was higher, loss had a wider variation, and the yield was lower than those values presented herein.

Part 2: True of False: Reduced Connector Losses With Mandrel Wrapping are Better?

Executive Summary

Mandrel wrapped insertion loss tests are required by TIA/EIA-568 B. Such a test procedure may conceal high loss connectors that cause links to fail. Troubleshooting such a concealed problem requires insertion loss testing without a mandrel wrapped source reference lead.

Overview

In a recent article, we noticed the phrase ‘improve your loss measurements with a mandrel’. In this Part, we examine this phrase.

Analysis

As part of our evaluation of Category 1 light sources [Eye On Fiber, Vol. 2, Issue 3, Part 1, Table 1], we tested links with a Category 1 light source twice, with and without a mandrel. The losses without the mandrel were consistently higher than those with a mandrel [Table 1]. Does this difference mean that the results with a mandrel are better than those without?

In a nutshell, no. The mandrel removes optical power from part of the fiber core. The reduced connector losses result from removal of optical power from the area near the core-cladding boundary and from the high order modes. High order modes are those rays that travel at high angles to the fiber axis. Such light, which is removed by the mandrel, will be lost when the connectors have fibers than are laterally offset from one another (Figure 2). By removing the light at the core-cladding boundary, the mandrel blinds the insertion loss test to some of the core offset. This core offset results from offset of the fiber hole in the ferrule or by an oversized fiber hole. Oversized fiber hole can allow the fiber to be offset from the center of the ferrule.

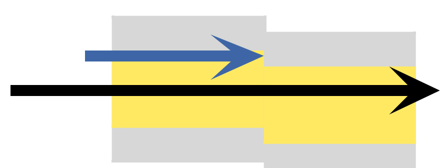

Figure 2: Light in Core Without Mandrel

If this light is not present, as is the case when a mandrel is used, it will not be lost (Figure 3). As you can see, mandrel wrapping has the potential of providing low power loss measurements from high loss connectors.

Figure 3: Light in Core With Mandrel

If the insertion loss test results in low loss, what is the problem? The problem occurs when a link has a low insertion loss yet the link does not work with the transmitter receiver pair. Troubleshooting becomes difficult.

This problem results from the lack of simulation of operating conditions. The mandrel removes light from the area most susceptible to loss in a connector. The light source in an LED based transmitter[8] does not remove such light. In fact, such light is present and a significant portion of the total optical power in the fiber. Because the LED launches light into the core-cladding boundary area, it can be lost at a connector pair.

Some of you may think that this makes no sense. In fact, there is a reason for mandrels. Different light sources launch light into a multimode core in different ways. At this time, there are at least four sets of launch conditions: LEDs, laser diodes, 1 gigabit vertical cavity surface emitting lasers [VCSELs], and 10 gigabit VCSELs. Testing of a multimode link for all possible applications would require five tests: four tests that simulate the operation of these four light sources and a 1300 nm LED test. Such testing would be expensive. The mandrel wrap test, which is required by TIA/EIA-568 B, normalizes the test procedure so that tests made with different reference leads and different light sources will produce the same insertion loss values. As we demonstrated in Eye On Fiber [Vol. 2, Issue 3, Part 1], this normalization achieves its objective, even when the light source is not a Category 1 source.

Suggestion

If insertion loss test results are sufficiently low and the transmitter receiver pair does not work, make the insertion loss test without the mandrel. If the loss without the mandrel is significantly higher than the loss

---

[8] LED sources are used for bit rates up to approximately 200 Mbps.

with the mandrel, offset fiber cores is a likely problem. Table 1 indicates that the difference between insertion loss values with and without a mandrel is about 0.20 dB for a link with two pairs.

Such offset cores can be due to offset fiber holes in the ferrule or to oversized fiber holes.

Conclusion

Insertion loss tests with a mandrel can conceal defective connectors. An insertion loss test without a mandrel may enable identification of the defective connectors.

Part 3: Fiber Optic Association Elects Vice President

Summary

At its September Board of Director meeting, the Fiber Optic Association [FOA, www.thefoa.org] unanimously elected Mr. Eric R. Pearson to the position of Vice President. Since 1995, Mr. Pearson has been one of the founding Directors of the FOA. He coordinated the development of the Advanced Certification Program for the FOA. The advanced certification program leads to the certifications: Certified Fiber Optic Specialist/ Connectors [CFOS/C], Certified Fiber Optic Specialist/Testing [CFOS/T], and Certified Fiber Optic Specialist/Splicing [CFOS/S].

Mr. Pearson stated: 'The advanced certification examinations were developed by our Board of Directors and Board of Advisors. These two boards have a cumulative of 233 years of experience in fiber optic communications. No other organization brings this depth and breadth of experience to the process of certifying installers. This experience has made these three certification examinations an excellent tool for assessing the true understanding and ability to perform reliable fiber optic installations. The Specialist certifications normalize the knowledge of field personnel. With these certifications, general contractors can reach into his 'bucket' of certified installers and know that he will obtain reliable installations. I am honored by the Board's continued confidence in my ability to make a contribution to the FOA.'

Part 4: FOLS Updates Cost Model and Schedules WebCast

Summary

Pearson Technologies and the Fiber Optics LAN Section of the TIA/EIA- [FOLS, www.fols.org] have completed and released an update of their Fiber-UTP Cost Comparison Model. Available without cost from the FOLS web site, this model allows network designers to compare the true costs of traditional networks to fiber to the desk [FTTD] networks, with surprising results. From 2:00-3:30 PM [ECT] on 11/20, Mr. Pearson will present this model during a webcast. During the week of 11/3, the TIA Will issue details for attending the webcast.

Editorial Summary

Fiber Optics Too Expensive? Not Today!

A Reality Check Of Fiber To The Desk Networks

For many years, there has been a perception that fiber optic communication is 'too expensive' to justify. In this editorial, we will examine this perception.

In data communications, fiber has been used in three types of networks: campus, or building-to-building, backbones; vertical riser backbones; and fiber to the desk [FTTD] networks. For much of the last 20 years, fiber has dominated campus backbones. For much of the last 10 years, fiber has dominated vertical riser backbones. Such domination indicates fiber's cost advantage.

However, for much of the last 10-15 years, FTTD has represented less than 5 % of new installations. The major disadvantage cited was high fiber electronics cost. In reality, this reason missed the point: total network cost was the realistic criterion that determined whether or not FTTD was cost effective. Rejecting fiber on the basis of fiber electronic cost was like rejecting your next new car because the tires were not what you wanted!

Starting in 1995, Pearson Technologies developed a comparative network cost model to identify those factors that would favor FTTD. This cost model compared the cost of traditional networks [horizontal UTP and vertical fiber] to the cost of FTTD networks. In 1998, Pearson Technologies joined with the Fiber Optic LAN Section of the TIA [FOLS, www.fols.org] to complete the model. This joint venture resulted in a generic cost model that allowed identification of scenarios that would, or would not, favor FTTD on the basis of initial installed cost.

This cost model, released to the public in 2001[see www.fols.org], revealed that the cost of the telecommunication room [TR, formerly telecommunication or wiring closet] was the single factor that determined whether FTTD would be favored: if this cost were high, the initial installed cost of FTTD networks would be less than that of traditional networks. The TR cost factor is not a new concept: I began following TR cost concerns in 1992.

This model showed that FTTD would be favored when the cost of the telecommunication room was in the range of $20,000-$40,000. However, during the last two years, most of the cost factors in this model changed.

To respond to these significant changes, Pearson Technologies and the FOLS reviewed the model, incorporated new cost factors and developed 12 scenarios. The result of these new cost factors was astounding**: all 12 scenarios indicated that the initial installed cost of an FTTD network was less than the cost of a traditional network design.** This result is impressive because of the built-in bias, which is slightly against fiber.

The most surprising result was the fiber to the zone scenario [FTTZ]. In FTTZ, fiber connects a low level switch to a central equipment location. In this configuration, the cost of the fiber electronics is distributed over 8, or perhaps 16, nodes. With this configuration, the apparent disadvantage of fiber cost is reduced by a factor of 8, or perhaps 16. With this reduction, the cost of a FTTZ network is an impressive 65.4 % of the cost of a traditional network. An FTTD network saves $443.09/node.

It is my hope that network designers apply this free model [download from www.fols.org] to their network designs to determine their realistic FTTD cost. We believe that most designers who do so will find that UTP is too expensive!

There is a rule that myths, mis-perceptions and old wives' tales die slowly. Hopefully, the myth that fiber is too expensive will violate that rule: it would be nice to hear a deafening crash as the perception of 'fiber being too expensive' was resoundingly shattered.

Part 5: New Fiber Installation Book Available In January

Friends

I'm writing a sequel to my 1995 book on fiber optic installation. This new book, tentatively titled "Successful Fiber Optic Installation: The Essentials" will bring my 1995 book [The Complete Guide to Fiber Optic Cable System Installation] up to date and expand upon the materials presented.

I have written this book for three groups of people: for fiber optic field installers, for those instructing in field installation, and for those who wish to become certified as professional fiber optic installers.

This book has three parts: information on products and networks; principles of installation and testing; and field procedures. All three parts incorporate the information I believe to be essential to the success of the installer. Success means achieving low power loss, high reliability and low installation cost.

In Part 1, I present the language and numbers of fiber optic products. The common understanding of the language and the numbers of fiber optics created by this part will enable installers to communicate accurately with each other and their supervisors. The numbers in this part will enable installers to recognize properly and improperly installed products.

In Part 2, I present the principles of fiber optic installation and testing. The installer who understands and follows these principles will be successful, as defined above.

In Part 3, I present procedures for installation of cables, connectors, splices; and for testing and certification of installed links. The installer can use these procedures as field procedures. The trainer can use these procedures as hands on training activities.

Some of this information results from my field experience; some, from conversations with my generous fiber optic colleagues; and some, from 14 years of training more than 6200 personnel in installation procedures. My training experience has been most influential in determining the information in Parts 2 and 3. That training has identified those procedures that work consistently and those instructions that lead to consistent success by novice installers.

Finally, I have written this book to enable trainees to pass the four professional certification examinations of the Fiber Optic Association: the Certified Fiber Optic Technician [CFOT] examination and the three Certified Fiber Optic Specialist [CFOS] examinations. The CFOS certifications are in connector installation, splicing and testing.

This twenty chapter field guide will be delivered in printed form or on CD-ROM with cross links.

I expect that those who use this book will find it extremely useful.

If you are interested in additional information, send me an email with the subject: “Send information on book.”

Eric R. Pearson, CPC, CFOS

Coming in Future Issues

Product Update: Evaluation of Cleave and Leave Connector Products
The Problem With OTDR Ghosts
How to Minimize the Complications from Ghosts
The Hidden Cost of Cheap Training
Do You Need to Know About Repeatability?
Case Study: Field Fusion Splicing
Case Study: Planning, Installing and Certifying The FTTD Network
Do You Need to Know About Multimode Reflectance?
Planning to Upgrade to GbE or 10 GbE? Don't Fusion Splice Multimode Fiber!
LED vs. VCSEL Insertion Loss Testing
Fusion Splicing Fiber from Different Manufacturers
Comparison of OTDRs
Tips on Using OTDRs for Training
The Three Benefits of Fiber Sales Training

Previous Articles, White Papers & Other Publications

Honey, I Shrunk the Wiring Closet!
Spreadsheet for Comparing Costs of All Fiber to Fiber and Copper Networks
Improving Fiber Network Reliability Through Choice of Certification Strategy
Maximizing Fiber Optic Network Reliability Through Choice of Installer
The Novice's 10 Minute Introduction to Fiber Optics
Myths and Reality: Fiber Vs. Copper

Eye on Fiber, Vol. 1, Issue 1

The Six Subtilties of Accurate Singlemode Testing
Unstable Test Measurements? Don't Blame the Test Equipment!
A Personal Perspective: Concern for the Future

Eye on Fiber, Vol. 1, Issue 2

How to Test Installed Links According to TIA/EIA-568

B.1 and B.3
Evaluation of the Panduit Prepolished SC Connector
The Proof Is In: Test Data Prove the Value of a Precision Cleaver
A Pearson Personal Perspective: Will Fiber Miss the Data Networks Boat?

Eye on Fiber, Vol. 2, Issue 1

Full Evaluation of the Panduit Prepolished SC Connector
Pay Less and Spend More: The Lesson of Total Hardware Cost

Eye on Fiber, Vol. 2, Issue 2

Part 1: Which Connector Installation Method to Use? The Qualitative Answer: It Depends
Part 2: Connector Installation Cost Model: A Strategy for Profitability
Part 3: How to Avoid Cursing at Cursers: An Introduction To Interpretation of OTDR Traces
Part 4: Fiber Optic Connector Update: Yesterday Today, and Tomorrow

Eye on Fiber, Vol. 2, Issue 3

Part 1: Category 1 Testing- Much Ado Nothing?
Part 2: True of False: Modified Method B Testing Works.
Part 3: True of False: FTTD Costs Less Than UTP/Fiber Networks [The Answer Will Surprise You]
Part 4: Difficult Connectors? Try an Alcohol Flush!

Training Programs, Presentations and Schedules

FiberPro™ 1: The Essentials for Success, monthly in the Atlanta, GA area; available for on site presentations.

FiberPro™ 2: Do It Right the First Time, Every Time- Advanced Connector Installation and Advanced FOA Certification. See schedule on web site. Available for on site presentations.

FiberPro™ 3: Certifying and Troubleshooting Fiber Optic Cable Systems for

Maximum Reliability and Advanced FOA Certification. See schedule on web site. Available for on site presentations.

FiberPro™ 4: Advanced Training and Advanced FOA Certification for Splicers, available for on site presentations.

FiberPro™ 5: Fiber Optic Network Design, Certification and Costing, 11/17-19/03, Tampa, FL. Available for on site presentations.

Presentation: Certifying Fiber Optic Networks For Maximum Reliability, available from web site in late November 2003.

Presentation: Fiber Optic Connectors: Today, Tomorrow and Yesterday: An Update, available from web site in late November 2003.

Presentation: How Not to Curse at Cursers, available from web site in late November 2003.