The Fiber Optic Association, Inc.

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FOA-Sponsored Mode Conditioning Tests
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The FOA purchased two Arden Photonics "ModCon" modal controllers (http://www.ardenphotonics.com/products/mod_con.htm) for experimentation in loss and bandwidth testing on multimode fibers.

For our first tests, we decided to try to repeat the correlation studies done in the UK that were referenced in the justification of elevating OTDR loss measurements to being equal to LSPM (OLTS) testing in new international standards.

Fiber: We obtained current generation OM2 and OM3 50/125 fiber from a major manufacturer for testing. Each fiber was spooled into 250m, 500m and 1000m segments and terminated with adhesive/polish ST connectors. Tested with the Tek OTDR, the attenuation rate of the OM3 fiber was 850 nm 2.13 dB / km, 1300 nm 0.43 dB/km.

Test equipment:

Tektronix Tekranger OTDR spec with filled launch (http://www.tek.com/site/ps/0,,22-10554-INTRO_EN,00.html)
EXFO OTDR with non-specified launch (Model?)
Fotec S710 source + FM310 meter
Fotec source CPR is Category 2 at 850 nm,Category 1 at 1300 nm
OLTS launch and receive reference cables 2m, terminated by EP.
Mandrel: AFL Noyes plastic part for 50/125 fiber per TIA-568.

All OTDR tests were done with a 500m launch and 250m receive (tail) cable and analyzed manually.

We will present all data and comment, then conclude with comments, questions and recommendations.

Test Results

Test 1 - OTDR vs OLTS-short 250 m at 850 nm only. Test includes 250 m of fiber and two connections.

Fiber C250mC (C means connector)– Spool B fiber-OM3 - launch OM2 500M wOTDR @ 850 nm only

Mode Cond	OTDR Tek Loss	OLTS Loss
None	1.30	1.45
Mandrel	1.25	0.88
Arden MC	1.29	1.26

For this low loss test, the OTDR and OLTS results are similar to the MC, but vastly different from the source with mandrel wrap. Neither the mandrel nor the mode conditioner has significant effect on the OTDR measurements.The OTDR does not seem to be launching with a fill as great as the Fotec 850 nm LED source. The vast difference in the source alone, mandrel and Arden MC are indicative of the difference between the mode fills of the modal conditioning methods.

Test 2 - OTDR vs OLTS – long, concatenated, 1 km, at 850 and 1300 nm

Fiber C250mC+C500mC+C250mC - B fiber-OM3 -1008m- launch OM2 500M

Wavelength	OTDR Mode Cond	Loss (TEK)	Loss (EXFO)	OLTS Loss
850	None	4.16	4.10	5.06
	Mandrel	4.07	4.07	4.35
	Arden MC	4.14	3.98	5.02
1300.00	None	2.43		3.44
	Mandrel	2.54		2.52
	Arden MC	2.47		3.08

For this test, we added testing at both 850 and 1300 nm and tried a second OTDR. For these longer lengths of fiber with two intermediate connections, the differences between OTDR and OLTS are greater, as are the differences in OLTS tests with different mode conditioning.

Test 3 - OTDR vs OLTS - long - no midspan connections, 1.3 km - launch OM2 500M

Wavelength	Mode Cond	OTDR Loss (TEK)	OTDR Loss (EXFO)	OLTS Loss
850	None	3.41	2.13	3.12

	Mandrel	3.30	2.49	2.90
	Arden MC	3.38	2.11	3.29
1300	None	1.09	0.55	0.99
	Mandrel	1.01	0.41	0.72
	Arden MC	0.95	0.47	1.21

On the final test, we used a single length of fiber (1.295 km) to see what happens without connections. Note that the two OTDRs now differ greatly, with the Tek measuring loss significantly higher than the Exfo. Again, the mandrel wrap method with the OLTS has significantly lower loss.

Conclusions

Well, the first conclusion is that this comparison merits a lot more time than the weekend that we devoted to it because of the questions it raises. The data itself appears trustworthy, as the equipment and methodology were well controlled and measurements were reproducible within expected limits. However, we lacked time and more selection of equipment and components to gather more data and we lacked the equipment to measure actual mode fill to compare the different test conditions at the launch cables.

The second conclusion is that neither the bare source, mandrel wrap nor Arden MC should be accepted as a standard method of testing until more definitive research is done.

Thirdly, allowing an OTDR to be used instead of an OLTS for any cable plant based on the current data available is a premature conclusion. Two OTDRs can't always agree among themselves, a necessity before allowing them to be compared to OLTSs.

Questions

Why does the mandrel have a much higher effect than the Arden MC? Does the AFL Noyes mandrel used with the launch cable we used have too great an effect at filtering modes? Is it sensitive to cable types? (The launch cable was a grey-jacketed cable which was stiff.)

What happens when sources from different manufacturers using LEDs with different mode fills are compared with the same launch cables and mode conditioners? What happens with the OLTS types with internal couplers that offer two wavelength and/or bidirectional testing?

Why do the OTDRs not respond to the mode conditioning? Is it due to their low mode fill?

Why do the EXFO and Tek OTDRs agree on the concatenated fiber but not on the single length of fiber?

What differences would one see comparing more OTDRs?

What happens if the cable plant tested included more connections and short patchcords?

Followup

We'd like to see the following done:

Duplication of our tests by labs capable of measuring mode fill of all the launches.

A industry round robin of testing by manufacturers and users with several samples of fibers duplicating our short, long and concatenated tests, plus a short/concatenated/with short patchcords test. Tests should be done with various OLTS and OTDRs.

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