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Application Note

Encircled Flux – The New Standard in Multimode Testing Accuracy

Different testers yield different results

Have you ever tested a multimode fiber optic link with light sources from two different equipment vendors? By simply using a different light source you may notice that the loss measurement is different by as much as 50%! Ever wonder why this happens?

Without proper controls, multimode light sources will inject light into multimode fiber over variable paths, or "modes". "Modal power distribution" is a way of explaining how many modes are supported by a multimode fiber; typically, multimode fiber supports hundreds of modes while a singlemode fiber supports one mode. This modal power distribution is commonly referred to as a "launch condition". When light sources operate under different launch conditions, link-loss measurements will vary proportionately, resulting in different and confusing test results.

Launch condition variability

Different types of light sources produce different types of launch conditions. For example, a light emitting diode (LED) overfills a multimode fiber with too many mode groups while a laser underfills a multimode fiber with not enough mode groups. Overfilling a fiber tends to produce link-loss measurements that are too high while underfilling a fiber tends to produce link-loss measurements that are too low. In other words, certification tests involving underfilled launches can obscure actual high-loss events such as misaligned connectors, which can lead to false "pass" results, that may ultimately hamper cabling infrastructure performance.

As networking technology has evolved and loss budgets have decreased, link-loss measurements have become more demanding. New networking applications require more accurate and reproducible multimode attenuation measurements from different field test instruments. Consequently, industry experts concluded that narrowing launch condition variability was needed, especially when testing for 1 Gigabit or higher supportability over multimode fiber. "Encircled Flux" (EF) is the name of the new standard that is a major improvement over previous methods.

Tighter launch conditions = more accurate and repeatable measurements

Encircled Flux is a method of characterizing the launch conditions of a multimode light source such as a light emitting diode (LED) or laser. EF is the percentage of power within a given fiber core radius when light is launched by a transmitter into a multimode fiber and is determined from the near-field measurement of the light coming from the end of a reference-grade test cord attached to the test instrument. Encircled Flux compliance reduces loss measurement variation to a goal of +/- 10%[1]. Reducing variability by up to 75% compared to the preceding standard, it is the most recent standard that increases multimode testing accuracy and repeatability.

While the lab is the ideal environment to meet EF launch conditions, there are now external solutions available for field testing purposes. Such accessories, called "launch controllers" (labeled 1 and 2 in Figure 1 below), are specially constructed test-grade reference cords fitted with modal conditioners. These launch controllers work by restricting the number of mode groups launched from the test cord to within EF specifications, ensuring that the resulting measurements are precise and repeatable according to the standards. See Figure 2 for an Encircled Flux compliance template specified in the IEC standard.

[1] For link attenuation measurements greater than 1dB.

EF in international standards

EF compliance is confirmed by test instrument suppliers using lab equipment designed to make a direct measurement of the power distribution among the various modes contained within a multimode fiber. The measurement consists of analyzing the near-field distribution at the end of the test cord using video and processing methods. The image is then converted to data and a graphical representation. The graph can be plotted within selected EF limits to check for compliance. TIA and IEC standards bodies both have documents that describe the requirements for EF, specifically IEC 61280-4-1 Ed. 2.0 – of which the latter will likely be adopted as TIA-526-14-B, "Multimode Cable Plant Attenuation Measurements."

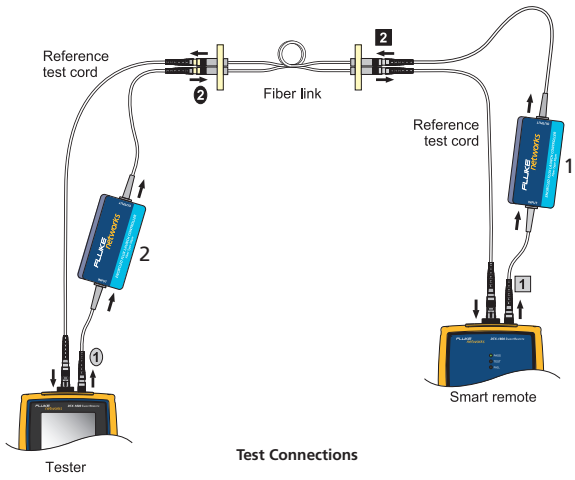

Figure 1: Use model for an Encircled Flux launch controller

Conclusion

Encircled flux is a major improvement in tightening multimode link-loss measurements to within a 10% variability target. As a result, it improves upon older methods such as modal power distribution (MPD) and coupled power ratio (CPR). Because test instruments meeting the EF standard will provide the most consistent and reliable results when performing certification testing, it is recommended that network engineers and designers update their test specifications to reference the utilization of EF-compliant sources.

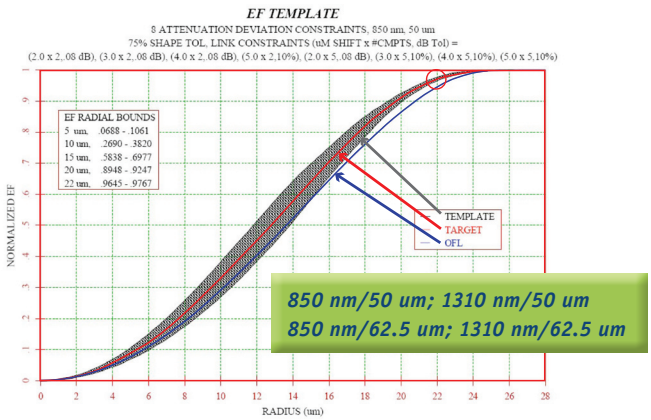

Figure 2: Example of one of the four compliance templates specified by IEC 61280-4-1 for 850 nm and 50 µm cabling. The gray area represents the acceptance region at various fiber core radial control points.

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