

Multimode Fiber Certification: Light Source Launch Conditions and Encircled Flux Standard

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A multimode light source with controlled launch conditions ensures accuracy, reproducibility and consistent loss readings. The type of light source used for multimode fiber-link certification and the way it is coupled to the fiber greatly affects the launch conditions.

Generally, surface-emitting LED sources overfill the fiber, while edge-emitting light sources (EELS), including LED and laser sources, have a smaller spot size, numerical aperture and emission, which means they significantly underfill the fiber. Vertical-cavity surface-emitting lasers (VCSELs) are similar to laser light sources and also underfill the fiber.

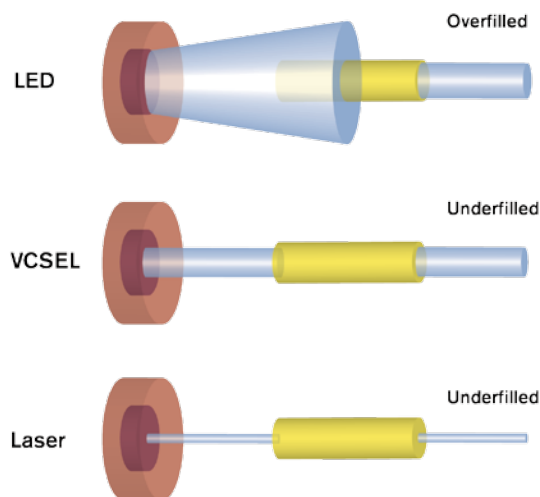


Figure 1. Typical launch conditions for commonly used light sources

Usually, certifying fiber links using a light source that underfills the fiber when testing multimode-fiber link attenuation could produce misleading and overly optimistic test results. Also, some types of connector problems could remain undetected; for example, a connector ferrule could be slightly misaligned.

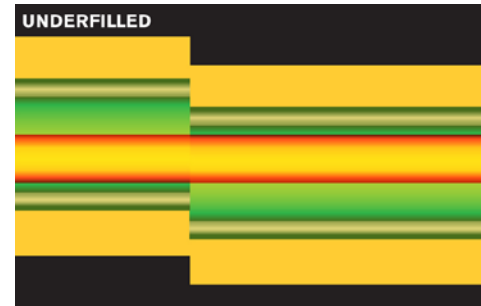


Figure 2. Underfilled launch conditions may not allow for the detection of ferrule-alignment problems in connector interfaces

On the other hand, using a light source that overfills fiber when testing attenuation of multimode links may produce unrepeatable and unreliable loss readings. Chances are that the loss reading obtained will be over-estimated, leading to loss values that will not correspond to reality due to the significant transient loss effect.

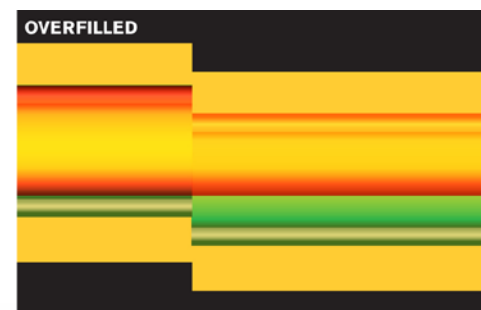


Figure 3. Overfilled launch conditions may give unrealistic and overestimated loss readings

Another issue that arises when using a LED light source is the use of a mandrel tool. If the LED produces overfilled launch (OFL) conditions, a mandrel tool of the correct diameter is recommended. By using a mandrel tool, any existing higher-order-mode power levels are filtered out, but the light does not travel very far along the fiber.

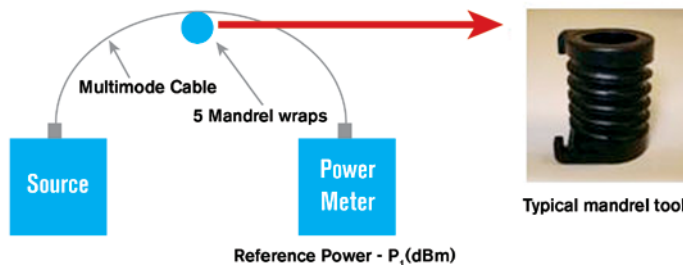


Figure 4. Using a mandrel tool to filter out higher-order-mode power levels

IMPACT OF THE NEW ENCIRCLED FLUX STANDARD

Over the years, many standards have tried to address multimode launch conditions, including:

- › 1-km multimode fiber after overfilled launch
- › 70/70 launch (steady-state launch)
- › Mandrel after OFL (e.g., coupled-power ratio (CPR) C1 plus mandrel)
- › CPR (class 1 to 5)
- › Specific diameter requirements at 5% relative power on near field and far field (70/70 to 95/95)
- › Three diameter requirements at 5%, 25% and 75% relative power on near field and far field
- › Mode-power distribution (MPD) template + tight CPR (1 dB tolerance)
- › Encircle flux template: target with upper and lower limits

Note: No. 1 is in TIA/EIA-455-50A; no. 2 is in TIA/EIA-455-50B; no. 3 is in TIA/EIA-526-14A; no. 4, 5 and 6 are mainly used by the military; no. 7 is in ISO/IEC 14763-3 and no. 8 is the IEC 61280-4-1/TIA-526-14-B standard.

The latest multimode launch condition proposal is known as Encircled Flux, and it improves upon the other known standards. This standard proposes a filled condition with upper and lower limits, which is optimal to get consistent, realistic and repeatable loss readings.

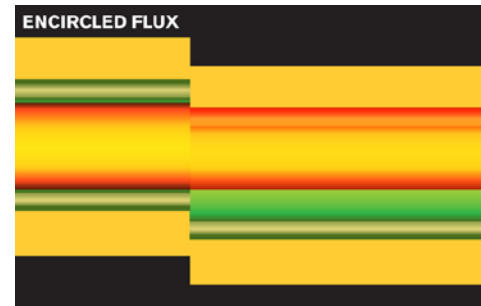
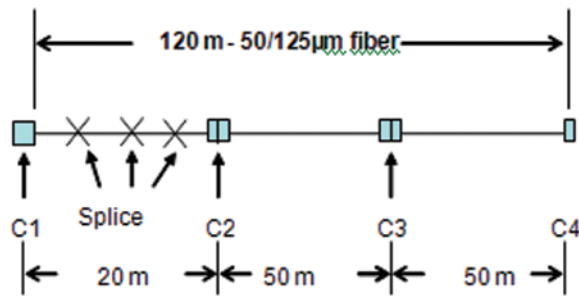


Figure 5. Light sources following the Encircled Flux standard are optimized to deliver accurate loss readings

WHAT'S IN IT FOR YOU?

If you have ever measured the loss of a multimode fiber with a light source from different manufacturers and gotten different loss readings, this is for you. If you have ever measured the loss of multimode fiber links with a light source and power meter and then measured loss with an OTDR and gotten different loss readings, then this is for you. The Encircled Flux proposal tries to establish a universal launch condition, which all manufacturers will hopefully adhere to. This will impose a uniform multimode launch-condition standard, so regardless of which manufacturer you purchased your light source from, as long as the light source is Encircled Flux-compliant and Encircled Flux-compliant reference grade jumpers (reference jumper connected to source can affect the launch conditions) are used, the loss measurements will be about the same ($\pm 10\%$ for a loss > 1 dB). The same applies to OTDRs. If the OTDR and reference jumper are Encircled Flux-compliant and the light source, and reference jumpers used with the power meter are Encircled Flux-compliant, the loss reads between the instruments will also be the same ($\pm 10\%$ for a loss > 1 dB).

EXFO has performed experiments comparing light source and power meter readings versus OTDR loss readings on short fibers under different launch conditions at 850 nm. When the light source, reference jumpers and OTDR are Encircled Flux-compliant, again, the readings are in agreement.



Attenuation/Loss vs Mode Launch Conditions for
"short Link" at 850nm

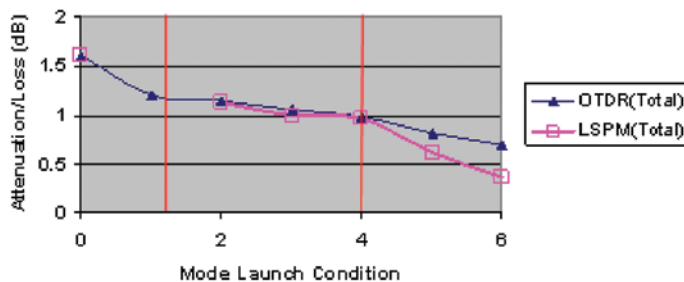


Figure 6. Results of EXFO experiments - Attenuation/loss vs. mode launch conditions

The figure above illustrates results of tests performed with six different mode launch conditions (MLC). MLC0 is the most overfilled, while MLC5 and MLC6 are the most underfilled. MLC1 to MLC4 are distributed relatively evenly between the upper and lower limits of the Encircled Flux template. However, MLC5 and MLC6 clearly show a difference between the measured values (OTDR vs. light source and power meter (LSPM)).

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