LEVITON®

INTRO TO Single-Mode

ADDRESSING PRECONCEPTIONS

In recent years, more enterprise and data center networks have adopted single-mode fiber optics. Traditionally, single-mode had been limited to applications such as long haul, service provider networks, metropolitan area networks, and backbone distribution for large campuses. However, single-mode is now finding its way into shorter reach applications.

If you are new to single-mode networks and installations, this article will address some prevailing preconceived notions about single-mode fiber — whether true or false — and provide guidance for single-mode testing, cleaning, and inspection.

Single-mode **ONLY WORKS WITH DUPLEX CONNECTIONS**, not MPO/MTP®.

FALSE

This statement is no longer true. Transceiver vendors are now making single-mode versions that run on parallel optics, in order to reduce costs for shorter data center links. These parallel options also allow for cabling breakouts, which has already become a very popular approach in multimode networks. With breakouts, you can split a 100 Gb/s transceiver out to four 25 gigabit channels. This helps create more efficiency and greater port density in network designs.

Single-mode transceivers are **MORE EXPENSIVE.**

FALSE TRUE

Some single-mode options are now in line with multimode. The primary decision to use multimode instead of single-mode over the years has come down to transceiver cost. In fact, there was a point in time when a single-mode transceiver was 7.5 times the price of a multimode transceiver.

However, times have changed, and single-mode transceivers have come down in cost. This is largely the result of large hyperscale data centers installing more lower cost single-mode transceivers, and as a result reshaping the enterprise and data center markets. Adoption by these companies has reduced the cost of single-mode optics to the point where the cost for 100 Gb/s single-mode transceivers dropped tenfold over the past two years, bringing it in line with multimode fiber.

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A GREATER INSERTION LOSS IS ALLOWED
for single-mode compared to multimode.

FALSE

This is no longer a true statement. With cheaper transceivers comes a reduced allowance for insertion loss. Designers especially need to be aware of reduced loss budgets for newer transceivers targeted at data centers. And if your design has multiple connections, you can run into trouble. Be sure to ask specific questions, particularly if you are using MPO/MTP connections.

FIGURE 1

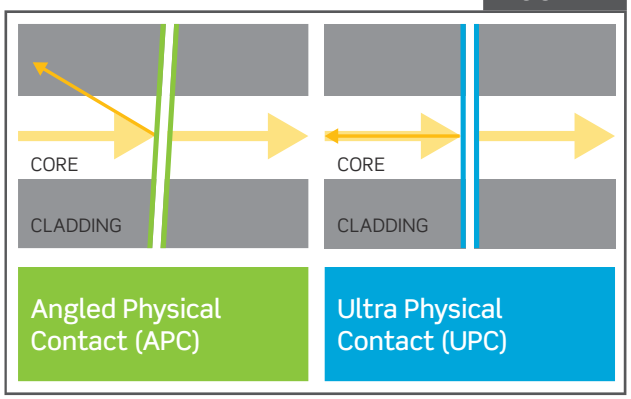
100 Gb/s Ethernet	Channel Loss
100GBASE-ER4	15.0 dB
100GBASE-LR4	6.3 dB
100GBASE-CWDM4	5.0 dB
100GBASE-PSM4	3.3 dB
100GBASE-DR	3.0 dB

As an example of stricter insertion loss allowances for 100 Gb/s, consider the channel loss limits list to the right in **Figure 1**. When you move to new options like 100GBASE-PSM4 and 100GBASE-DR, you are no longer designing for 6 or 7 dB loss but 3.3 dB and 3.0 dB respectively.

Single-mode brings **ADDITIONAL RETURN LOSS** (reflectance) concerns.

TRUE

FIGURE 2



Return loss is a real concern with single-mode. Multimode is a lot more tolerant of light being reflected back into the transceiver, but single-mode is not. At higher data rates, errors are generated if too much light is received back. This reflectance is a result of small air gaps that can occur at the physical contact where two connections are joined together, as shown by the yellow arrow in **Figure 2**. Return loss is measured as a ratio (in decibels) of the power of the outgoing signal to the power of the signal reflected back.

All single-mode MPO/MTP connections use Angled Physical Contact (APC), as it is nearly impossible to achieve a good return loss with a Ultra Physical Contact (UPC) MPO over single-mode. With APC, an eight degree angle results in any reflections being absorbed into the cladding rather than the transceiver, resulting in better return loss.

Single-mode transceivers use high power lasers, and as a result there are **ADDITIONAL SAFETY CONCERNS**.

FALSE TRUE

Typically this notion is true for long haul single-mode versions, but these additional safety issues are not an issue with the lasers used in the enterprise and data centers. These lasers — known as Class 1M lasers — are considered safe for viewing, except when passed through magnifying devices such as microscopes and telescopes.

That said, if you are viewing an end face, make sure your fiber scope has a built-in filter. Eyeglasses or reading glasses are not considered a filter.

If a single-mode link is too short, the transmitted light could saturate the receiver and **REQUIRE AN ATTENUATOR** to reduce the power of the signal.

~~FALSE~~ TRUE

This is an issue, but it only arises with high powered lasers used in outside plant installations. Data centers typically use low power Fabry-Perot (FP) lasers, with a nominal output of -3 dBm. CWDM4 transceivers use a slightly higher powered laser known as a Distributed Feedback Laser, with a nominal output of 2.5 dBm, but this is still a relatively low power. For Class 1M lasers, saturation of the receiver is not an issue, as long as your link is 2 meters (6.6 feet) or longer.

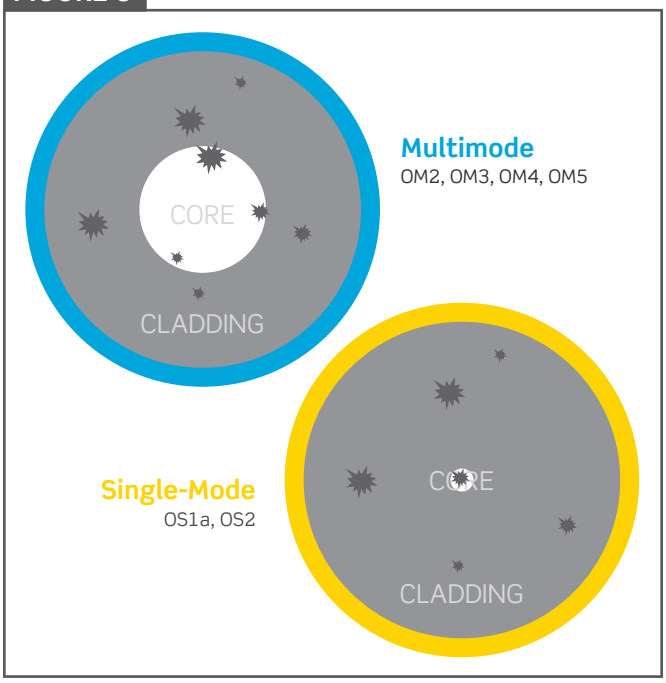
Single-mode fiber is **MORE CHALLENGING TO CLEAN** than multimode.

TRUE

This is a real concern. While dirt can collect on the multimode core, light can still pass through multimode's larger 62.5 µm or 50 µm core sizes. With single-mode, one speck of dust can block all light. The size of a speck of dust in an office is typically 2.5 to 10 µm, whereas a single-mode core is 8.2-8.6 µm, as shown in **Figure 3**. To put these into perspective, a single human hair is 100 µm. That means that, in single mode fiber, data is transmitted through an area that is one-tenth the thickness of a human hair.

Be sure to inspect all connectors before installing and clean them if necessary. Then be sure to inspect them one more time after cleaning.

FIGURE 3



Want to learn more about single-mode fiber?
Check out the free on-demand webinar from Leviton and Fluke Networks, "**The Road to Single-Mode**."

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