Laser-Optimized Fiber:

Built for Price, Bandwidth, and Distance to Make the Most of Your Investment

Over the past 25 years, Ethernet standards have evolved from 10 Mbps and 100 Mbps to Gigabit and now 10 Gigabit. The rapid growth of Internet use and bandwidth-intensive applications combined with routine transmission of large files is driving the need for 10 Gigabit Ethernet (10GbE) in many network backbone and data center connections. Implementation is happening all around us. Sales of 10GbE switch ports are increasing dramatically, and will continue to grow over the next decade.

With increased network speeds comes a rise in the significance of fiber optic cabling and connectivity. Most data centers today have equal amounts of fiber and copper terminations, and fiber links are vital to carrying backbone traffic to and from a large number of sources. With many grades to choose from, selecting the right fiber type for your network can be an overwhelming task. Careful consideration of price, bandwidth, and distance is critical to choosing fiber today that will support requirements in the future. Laser-optimized 50µm multimode fiber offers many benefits for both today's and tomorrow's network and data center applications, and it may be the key to maximizing your investment.

An Inevitable Shift

Although 50µm multimode fiber was developed 10 years prior to 62.5µm, North America adopted fiber distributed data interface (FDDI)-grade 62.5µm fiber for Ethernet in the late 1980s. At that time, connectorization and alignment were not as controlled as they are today, and the larger-core 62.5µm was ideal for use with larger light-emitting diode (LED) transmitters.

As backbone speeds increased to Gigabit Ethernet, LED signaling technology was no longer a viable solution. With a maximum modulation rate of 622 Mbps, LEDs could not be turned on and off quickly enough to support the higher bandwidth. This caused the industry to shift to low-cost vertical-cavity surface emitting laser (VCSEL) transmitters operating at 850nm (short wavelength). VCSELs have much faster rise and fall times than LEDs with more power and a smaller spot size.

Unfortunately, the use of VCSELs can cause differential mode delay (DMD), an effect that happens when the laser beam launched into a small area of the fiber's core splits into several modes of light traveling at different speeds. DMD ultimately causes the transmission pulse to spread out, which reduces the ability of the receiver to properly identify the signal and therefore reduces transmission capacity (see Figure 1).

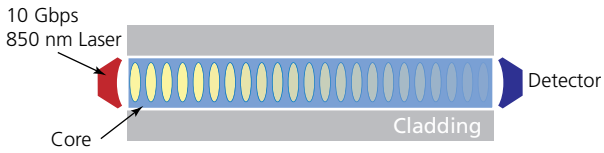

Figure 1. The Effect of DMD on Transmission

Because a larger fiber core has more modes of light excited and more modal dispersion, VCSELs do not perform as well with 62.5µm multimode fiber as they do with 50µm. So when low-cost 850nm VCSEL transmission technology was introduced for higher speeds, the industry moved away from 62.5µm fiber. However, as the 10 Gigabit Ethernet standard developed, it became apparent that even 50µm multimode fiber could not take full advantage of the VCSEL point-like precision technology to run 10GbE over a 300-meter distance. As a result, fiber manufacturers began manufacturing laser-optimized 50µm multimode fiber, which is now the most recommended fiber type for new installations and upgrades.

Truly Advanced Technology

What exactly is laser-optimized fiber and what does it mean? It's important to acknowledge that the term "laser optimized" is not a marketing ploy or misnomer. Also referred to as OM3 fiber, laser-optimized fiber is specifically designed, developed, and tested for effective use with 850nm VCSELs.

With standard fiber, defects and variations in the fiber core can affect the angle and speed that a light pulse can travel. This effect is the refractive index profile of the material, which is calculated as the ratio of the speed of light in a vacuum to the speed of light through the material. For example, the refractive index of a vacuum is 1.0, while air is slightly higher than 1.0, and glass ranges from 1.45-1.48. The higher the refractive index, the slower the speed of light through that media.

In laser-optimized multimode fiber, manufacturers have removed impurities and carefully graded the index of refraction of the fiber core to enhance VCSEL transmission. By carefully controlling the refractive index profile, DMD is reduced and the several modes of light are able to travel at similar speeds thus increasing the modal bandwidth. This prevents the transmission pulse from spreading out, and as a result, the receiver can accurately detect the signal over longer distances, therefore maximizing bandwidth (see Figure 2).

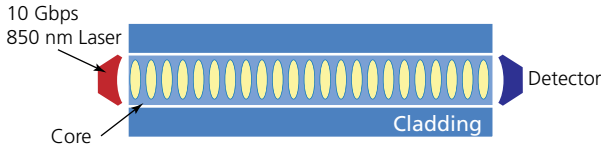

Figure 2. Laser Optimized Fiber Reduces DMD for Reliable Transmission

Laser-optimized 50µm fiber provides a much higher modal bandwidth than standard 50µm or 62.5µm fiber. A 10GbE signal at a wavelength of 850nm is only guaranteed for 26 meters on standard 62.5µm fiber and for 86 meters on standard 50µm fiber. Standard laser-optimized 50µm fiber can support 10GbE to 300m, which is the distance specified under TIA standards as the minimum distance for backbone cabling. Higher-grade laser-optimized 50µm multimode fiber can even support 10GbE beyond the standard to distances up to 550 meters.

Laser-optimized (OM3) 50µm fiber is now well accepted in the industry, and many cable and connectivity manufacturers offer a variety of 50µm fiber optic products. Laser-optimized 50µm fiber has also been accepted and specified by all major standard bodies, most notably under IEEE 802.3 and ANSI/TIA 568-C. Following is a table of IEEE GbE and 10GbE standards with related fiber types and bandwidths/distances (see Table 1).

As shown in Table 1, standard 62.5µm and 50µm only support 10GbE to 300m using wavelength division multiplexing (WDM) electronics, which uses four laser sources at 2.5 Gigabit each and is cost prohibitive. With 62.5µm fiber making up much of the installed base, the IEEE is exploring ways to run 10 Gigabit Ethernet over 300 meters of 62.5µm fiber with the use of a singlemode laser source. The proposed standard, however, is slow to develop and does not currently appear as cost effective as upgrading to laser-optimized 50µm multimode fiber, the benefits of which are many.

Fiber Type	Gigabit Link @ 850nm Laser IEEE 802.3z 1000BASE-SX	Gigabit Link @ 1310nm Laser IEEE 802.3z 1000BASE-LX	10 Gigabit Link @ 850nm Laser IEEE 802.3ae 10GBASE-SR	10 Gigabit Link @ 1310 CWDM Laser IEEE 802.3ae 10GBASE-LX4*
62.5/125 µm multimode fiber				
062/OM1	300m	550m	86m	300m
50/125 µm multimode fiber				
050/OM1	550m	550m	86m	300m
50E/OM2	750m	600m	150m	300m
50U/OM3	970m	600m	300m	300m
5U5/OM3	1040m	600m	550m	300m

*LX4 standard uses Wide Wave Division Multiplexing scheme

Table 1. Fiber Type and Distance per IEEE Standards

Maximizing Your Investment

With the same percentage of terminations as copper, fiber optic cabling and connectivity is a significant part of the data center. Fiber backbone links are also the most critical links because they carry data to and from a large number of sources, including telecommunication rooms and the outside world. As emerging technologies continue to be layered onto the network, laser-optimized 50µm fiber will be key to maximizing your investment in all LAN applications.

Laser-optimized 50µm multimode fiber is ideal for use in any LAN infrastructure or data center application, including campus backbone, riser, storage, or horizontal connections. Laser-optimized 50µm fiber is available in several grades and construction types to meet a variety of applications and cost benefits. For example, ADC's TrueNet® Structured Cabling solutions includes three grades of laser-optimized multimode fiber – Enhanced, Ultra 300, and Ultra 550, which support 10GbE to 150m, 300m, and 550m respectively. Each of these laser-optimized grades is also available in a variety of constructions including outside plant, indoor/outdoor, plenum, riser, and armored.

Because fiber optic cabling is backwards compatible, but not forwards, it's critical to choose fiber today that will support current and future bandwidth requirements. Laser-optimized 50µm fiber is compatible with legacy LED signaling technology while enabling migration to higher speeds. In other words, you can install laser-optimized fiber today for use with slower data rates, and when the need for more bandwidth arises, you only need to upgrade electronics to VCSEL-based transceivers for GbE or 10GbE. As discussion begins surrounding next-generation Ethernet like 40Gbps or 100Gbps, it's expected that laser-optimized 50µm multimode fiber will also support those speeds through higher-grade fibers or WDM schemes.

When you consider the total investment to upgrade or deploy a network or data center, the cost difference between fiber types is minimal. Singlemode fiber electronics, however, can cost two to three times more than multimode electronics. In addition, it is anticipated that the cost per port of 10GbE over fiber will continue to decrease. So choosing laser-optimized 50µm multimode fiber just makes sense – it's the one fiber type that allows for affordable electronics while reaching all areas of your LAN, providing the most flexibility and future growth for your data center and backbone infrastructure.

Conclusion

As you set out to choose a fiber type for your LAN infrastructure and data center connections, it's important to recognize that within the rank of multimode fiber are higher performance grades known as laser-optimized multimode fiber. Gigabit and 10 Gigabit Ethernet speeds in the backbone are a reality today, and so is this remarkable advanced fiber technology. Laser-optimized 50µm multimode fiber offers the following benefits over other types of fiber:

- Offers the most bandwidth with cost-effective 850nm VCSELs
- Ensures reliable transmission through advanced technologies
- Thoroughly recognized and specified by standards bodies
- Enables easy migration to Gigabit and 10 Gigabit network speeds
- Ideal for use in any LAN or data center fiber connection
- Available in several products, grades, and cable constructions

It is important to carefully examine your network and evaluate the distances and bandwidths required now and in the future. To maximize your investment, you must choose the correct type and grade of fiber to support future needs.

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