Making the Switch from 62.5 µm to 50 µm Multimode Fiber

John Kamino, Product Manager

Multimode fiber systems continue to provide the most cost-effective cabling solutions for Data Centers, Local Area Networks (LANs), and other enterprise applications. Compared to single-mode fiber, multimode systems offer significantly lower costs for transceivers, connectors, and connector installation while meeting and exceeding the bandwidth and reliability requirements of the most demanding networks.

If you're designing a new short reach installation, you will probably choose laser-optimized 50 micron (µm) OM3 or OM4 multimode fiber. These fibers preserve the systems cost benefits over single-mode fiber by using low cost 850 nm laser technology, are capable of 10 Mb/s through 10 Gb/s operation, and will support upcoming 40 and 100 Gb/s speeds.

But if you're upgrading an existing system, many of which have 62.5 µm multimode already installed, should you stick with 62.5 µm? Or can you switch to the higher performance of 50 µm OM3 or OM4 fiber?

Why Two Fiber Sizes?

The numbers under discussion – 50 µm and 62.5 µm – refer to the diameter of the fiber's core, through which light signals are transmitted. The first optical fibers, deployed in the 1970s for both short and long reach applications, were 50 µm multimode fibers.

In the early 1980s, single-mode fiber replaced 50 µm fiber in longer distance installations. However, 50 µm multimode continued to be more cost-effective for short-reach interconnects, such as building and campus backbones, up to 2000 meters.

But as data rates increased, 50 µm fiber could not support 10 Mb/s rates over the two kilometer (km) distances required by some campus installations. Not enough power could be coupled from the LED light sources in use at that time into the 50 µm core to support these link distances.

62.5 µm multimode fiber was introduced in 1985 to solve this problem. It could capture more light from an LED in its larger core, and 2 km campus links operating at 10 Mb/s could be easily supported. Also, the larger core fiber was easier to cable and connectorize. It became the most commonly used fiber for short reach enterprise applications in North America.

Today, as data rates surpass 10 Gb/s and lasers have replaced LEDs, 62.5 µm fiber has reached its performance limit. 50 µm fiber offers as much as ten times the bandwidth of 62.5 µm fiber. What's more, improvements in technology have made 50 µm fiber easier to use.

Multimode Fiber Choices

If you're considering a switch from 62.5 µm to 50 µm multimode, it's important to first understand the terminology used to designate the various performance grades of multimode fiber. Table 1 explains these designations.

The newest multimode fiber designation is OM4, which represents laser-optimized 50 µm fiber having an Effective Modal Bandwidth (EMB) of 4700 MHz-km at 850 nm. It is designed for 10 Gb/s transmission over longer distances. It's important to remember that for next-generation 40 and 100 Gb/s Ethernet, only OM3 and OM4 fibers are included in the IEEE 802.3ba standard as sup-

Fiber Designation	EMB (in MHz-km) @ 850 nm	OFL (in MHz-km) @ 850 nm	OFL (in MHz-km) @ 1300 nm
OM1 (62.5)	N/A	200	500
OM2 (50)	N/A	500	500
OM3 (laser-optimized 50)	2,000	1,500	500
OM4 (laser-optimized 50)	4,700	3,500	500
EMB – Effective Modal Bandwidth/OFL – Overfilled Bandwidth			

Table 1 – ISO/IEC 11801 OM Designation

ported (multimode optical fiber) media. OM1 and OM2 fibers are not supported media types for these applications.

Upgrading a 62.5 µm Network

The primary considerations for an upgrade or extension of an existing 62.5 µm network are:

- the required transmission speed (now and in the future)
- link distance
- the ease and cost of cable replacement

If you are running Gigabit Ethernet (1 Gb/s), then legacy 62.5 µm fiber will transmit a distance of 220 to 275 meters, depending on its bandwidth rating. But at 10 Gb/s, it will only support 26 – 33 meters. If your network will not need to support 10 GbE at distances greater than 25 meters, then you may be able to stick with 62.5 µm fiber.

It's important to note, however, that most 62.5 µm fiber has not been measured for laser bandwidth, and some legacy fiber may have difficulty supporting even this short distance.

And if you want to transmit longer distances over 62.5 fiber, you'll be forced to use much more expensive 1300 nm transceivers that will operate over multimode or singlemode fiber. These cost significantly more than 850 nm multimode transceivers, because the 1300 nm opto-electronics package is much more complex.

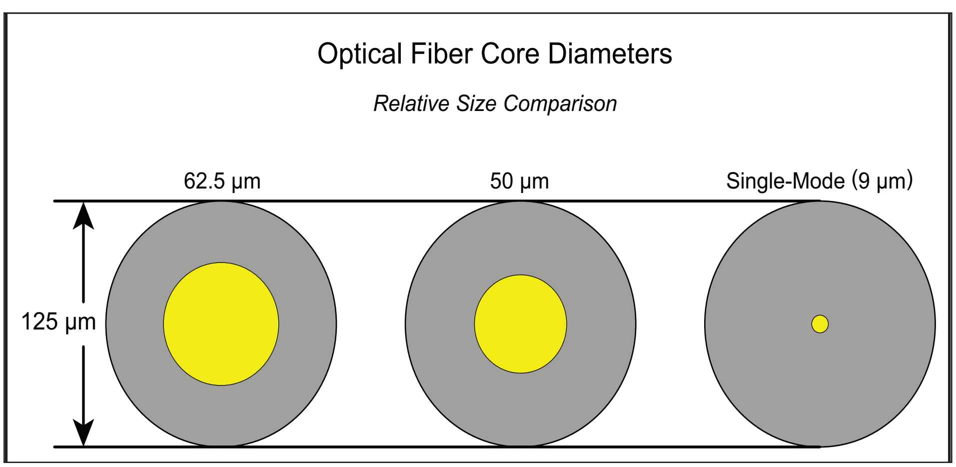
If you are considering extending your network by installing additional 62.5 µm fiber, you need to carefully review your future network plans. If you plan to upgrade your network speed to 10 Gb/s in the near future, re-cabling with laser-optimized OM3 or OM4 fiber would be a wiser choice.

Measuring Laser Bandwidth

As previously stated, 62.5 µm fiber provides limited support for 10 Gb/s, so it generally is not measured for laser bandwidth (also known as EMB). To verify bandwidth of 62.5 µm fiber, the traditional overfilled launch (OFL) measurement method is used.

50 µm fibers are measured for EMB using a method called Differential Mode Delay (DMD). This test is required by the standards to verify 10 Gb/s performance, and involves scanning the fiber's core in small increments to see how the signal travels in various regions of the core.

Once the DMD test is conducted and a DMD "profile" is obtained, the standards allow two methods to disposition the fiber. One is the DMD Mask method, and the other is the Effective Modal Bandwidth Calculated (EMBc) method.



The DMD Mask method offers direct verification of the fiber's performance using a set of clearly defined DMD masks and templates that are overlaid on the DMD profile.

This technique provides flexibility in applying more stringent DMD performance criteria in certain regions of the fiber, like the critical 0 – 5 µm center region.

The EMBc method involves complex calculations involving 10 weighting functions intended to represent the wide variety of 10 GbE VCSELs available on the market. This technique is theoretical in nature and does not provide the scrutiny on fiber quality and performance that the DMD Mask technique does.

Furthermore, the EMBc method virtually ignores the center 0 – 5 µm (radial) region of a fiber's core because the weighting functions put little emphasis on this region.

Mixing 50 & 62.5 µm Fibers

If you decide to add 50 µm fiber to an existing 62.5 µm infrastructure, connecting 50 µm fiber directly to a 62.5 µm fiber is generally not recommended. The difference in core sizes could cause high loss when transmitting from the 62.5 µm into the 50 µm fiber.

Also, the bandwidth of 62.5 µm fibers is typically much lower, degrading system performance further. Even if a low speed application operates over a link made up from mixed fiber types, upgradability will be compromised.

The problem with elevated loss occurs when transmitting from the largercore (62.5 µm) fiber to a smaller (50 µm) core. It's comparable to a 4" water pipe connecting to a 3" pipe – there is no problem going from the smaller pipe to the larger pipe, but going in the opposite direction can lead to a lot of lost water (or in this case, light).

The amount of connection loss you could experience is about 4 dB for an LED-based system (which fills the entire core of a 62.5 µm fiber), and anywhere from 0 to 4 dB for a VCSEL (laser) based system (which only fills a portion of the core).

Since most optical loss test sets use LEDs, you should plan for the worst and assume you'll see a 4 dB loss in one direction. If your link budget can tolerate this additional 4 dB loss, then you can get away with connecting 50 µm directly to 62.5 µm.

The better scenario is to separate 50 µm from 62.5 µm with active electronics, such as a switch, router, or media converter.

Choosing a 50 µm Fiber

To enable low cost, short reach applications, OFS recommends the following fiber choices:

- **LaserWave® 550/300 Fiber** offers Gigabit Ethernet support of 1000 meters at 850 nm and 300 meter support for serial 10 Gigabit Ethernet transmission at 850 nm

- **LaserWave G+ Fiber** offers extended Gigabit Ethernet distances of 750 meters at 850 nm and 600 meters at 1300 nm.

OFS Optical Fiber Center of Excellence

OFS designs and manufactures graded-index multimode fiber capable of high bandwidth performance over long distances. Among U.S. manufacturers, OFS offers the widest range of graded-index multimode fibers as standard selections.

The OFS Optical Fiber Center of Excellence operates a state-of-the-art facility that has been supplying leading cable manufacturers with high-performance optical fiber since 1981. The facility benefits from the full technical support of OFS Laboratories, the direct descendant of Bell Labs, with its unmatched reputation for communications technology.

For additional information, visit our website at www.ofsoptics.com/ofs-fiber or call 1-888-fiber-help. For regional assistance, contact:

North America
Telephone: 508-347-8590
Toll Free: 800-799-7732
Fax: 508-347-1211
E-mail: fibersalesnar@ofsoptics.com

Caribbean, Latin America
Telephone: 508-347-8590
Fax: 508-347-1211
E-mail: fibersalescala@ofsoptics.com

Europe, Middle East, Africa
Telephone: +45-43 48 3736
Fax: +45 4348 3444
E-mail: fibersalesemea@ofsoptics.com

Asia Pacific
Telephone: +852 2836 7102
Fax: +852 2836 7101
E-mail: fibersalesap@ofsoptics.com

Japan
Telephone: +81-3-3286-3424
Fax: +81-3-3286-3708 or 3190
E-mail: fibersalesjapan@ofsoptics.com

China
Telephone: +86 10 6505 3660
Fax: +86 10 65059515
E-mail: fibersaleschina@ofsoptics.com

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A Furukawa Company