AMP NETCONNECT
XG FIBER SYSTEM

The Complete High-Performance, Cost-Effective
Optical Fiber Premises Cabling Solution for Supporting the Emerging Ten Gigabit Networks

von

mit freundlicher Genehmigung
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1. Introduction

If history is any indication, network applications will continue to demand higher data transfer rates. New applications such as high-resolution graphics and complex scientific modeling continue to pressure bandwidth requirements at the desktop and backbone. Increases in the number of high bandwidth applications, the number of users and the volume of network traffic dictate that old 10Mb/s Ethernet and 100 Mb/s Fast Ethernet LANs will be replaced with even higher speed LAN connections. Fibre Channel networks, too, are migrating to faster data rates, and LAN applications are evolving to cover the WAN and even access applications like fiber to the home. Network managers have to look for even higher data rates in backbone connections.

Many customers have turned to **Gigabit Ethernet (1000 Mb/s)** to maintain acceptable LAN performance levels. While the need for a gigabit "pipe" to the desktop may be overkill today, the rapidly decreasing price differentials between Fast Ethernet and Gigabit Ethernet make an effective argument for Gigabit Ethernet as an inexpensive insurance policy against future re-cabling headaches. Just as the growing number of Fast Ethernet connections created the need for Gigabit Ethernet connections in backbone applications, so too has Gigabit Ethernet created the need for **Ten Gigabit Ethernet (10000 Mb/s)**.

Ten Gigabit Ethernet (10GBASE-X) provides the solution for high-speed backbone connections. As a natural upgrade for extending the existing network investment to ten gigabit per second speeds at a reasonable cost without the need to re-educate support staff. The IEEE 802.3ae task group spent over two years developing the Ten Gigabit Ethernet Standard, which will be published in 2002. The new Standard will provide the opportunity to significantly increase the system bandwidth while maintaining compatibility of the installed base of Ethernet.

The convenience of a one-fiber-fits-all solution is inestimable, and was not available before now. Tyco Electronics introduces the AMP NETCONNECT XG Fiber System to provide a migration path from 10 Mb/s all the way to 10 Gb/s on the same fiber, using the same wavelength (850nm) for the complete horizontal and riser network. The XG Fiber System offers the high bandwidth 850nm laser-optimized 50/125µm fiber cables and the connector components capable of running 10 Gigabit applications, such as Ethernet and Fibre Channel, for distances of 2 to 300 meters at a wavelength of 850nm. The same fiber supports legacy applications just like the standard 50/125µm fibers. Install this one fiber today and use it for all future equipment upgrades.

2. History

Technological advances used to enable applications such as Gigabit Ethernet and now 10 Gigabit Ethernet demand faster optical sources to support the rapid modulation rates necessary for intelligible bit streams yet still need the low-cost advantages that propelled Ethernet to the most popular LAN application. The traditional and inexpensive light-emitting diode (LED) can be utilized only for applications running up to 622 Mb/s - the output is unreadable at faster data rates. Single-mode lasers capable of higher speeds have been available for many years, but are much more expensive than the common LEDs. Fortunately, the industry has developed and refined a cost-effective laser technology called the VCSEL (Vertical Cavity Surface Emitting Laser) for short wavelength (850nm) high-speed data applications. Of course, any source is only as good as its coupled fiber.

The standard 62.5/125µm and 50/125µm fibers were generally sufficient to support VCSELs used for Gigabit Ethernet and similar data rates for LAN networks. However, to take advantage of 10Gb/s VCSEL technology, a higher bandwidth fiber had to be developed. Physical limits prevent a 62.5/125µ multimode fiber from providing bandwidth this high except in rare cases.

A standard 50/125µm fiber offers higher bandwidth, but is designed with an index of refraction profile that provides optimum bandwidth at 980nm, providing good bandwidth at both the 850nm and at 1300nm wavelengths – the two operating wavelengths for premises optical networks. This explains why standard 50/125µm fiber offers equal bandwidth for both wavelengths, typically 500 MHz•km. The models show that 500 MHz•km is not sufficient for 300 meters of 10 Gb/s. In fact, neither is 1000 MHz•km, nor even 1500 MHz•km. To support 10 Gigabit Ethernet and 10 Gigabit Fibre Channel, 2000 MHz•km bandwidth is needed at 850 nm. Normal production of 50/125µm fiber is unlikely to produce a fiber of this bandwidth, so a change was necessary.

850nm, laser-optimized 50/125µm OM3 fiber is produced by making small changes in the index of refraction profile (the fiber core's index of refraction vs. core position) of **50/125µm** fiber to provide the maximum bandwidth at **850nm**, rather than 980nm. With this change, it became possible to produce fibers with the minimum bandwidth needed to support 10Gb/s applications to the full 300m distance of structured cabling building backbones. This fiber, specifically designed to work with VCSELs was optimized for laser sources – **laser optimized**.

Even that was not enough. The traditional overfilled launch (OFL) bandwidth measurement could not assure that a 2000MHz·km fiber would support a 10Gb/s application. Because VCSEL sources only partially fill the multimode fiber core with light, it is much more susceptible to perturbations in the optical fiber's index of refraction profile. These perturbations, a consequence of the manufacturing process, are most pronounced in the centerline of the fiber - at the point where the VCSEL launches. Instead of OFL, a measurement method that approximates a laser launch and compensates for the light power distribution in the core was developed. Now, it is easier to determine the ability of a fiber to support 10Gb/s data rates for the 300m distance.

This fiber, called **850nm Laser-Optimized 50/125µm OM3 Multimode Fiber**, is now available for the networks of today and tomorrow.

3. Why 50/125 µm Laser optimized OM3 Fiber?

In a word, the answer is "compatibility". This fiber, with a laser bandwidth of 2000 MHz·km @ 850nm complies with the optical fiber performance requirements of the newer laser-based Standards, while still supporting all legacy systems using LEDs. Thus, this one fiber type will support the network needs of today (Ethernet, Token Ring, Fibre Channel, FDDI, Fast Ethernet, etc.), of tomorrow (Gigabit Ethernet, 2 Gigabit Fibre Channel, etc.) and beyond (10 Gigabit Ethernet and 10 Gigabit Fibre Channel). Further, this fiber type supports the use of 850nm optical sources – the lowest cost sources – and the electronics that use them (see tables 1 and 2). Now, there is no need to make a jump to higher cost electronics or to re-cable a facility in order to migrate to faster data rates.

The fibers in the XG Fiber System are screened to ensure clean laser light transmission, while still providing clean LED light transmission. In fact, the XG fiber offers very high OFL bandwidth – a minimum of 1500/500 MHz·km at 850nm/1300nm – plenty of bandwidth for legacy applications that require 500/500 MHz·km bandwidth (or less). Additionally, the high laser bandwidth at 850nm means extended distances for Gigabit Ethernet – up to 900 meters!

From table 1, the Gigabit Ethernet distances of 62.5/125 at 850nm are too short for a 300m riser distance or for a centralized network. The distance limitations are even more severe at 10 Gigabit speeds, and insufficient for even the horizontal distance of 100m as shown in table 2. Standard 50/125 optical fiber can support Gigabit Ethernet on a majority of the horizontal, centralized and riser network links installed today, but distance limitations for 10 Gigabit speeds mean either deploying single-mode fibers (and the associated high-cost electronics) to cover a 300m distance or deploying the 850nm laser optimized

50/125µm. The AMP NETCONNECT XG fiber system will support 10 Gigabit applications for horizontal cabling (100 meters maximum), centralized cabling centralized cabling and building backbone cabling to distances of 300 meters.

Table 1: Distance Capability of Gigabit Ethernet

	Minimum OFL Bandwidth (MHz•km) @850/1300nm	1000BASE-SX (850nm) (m)	1000BASE-LX (1300nm) (m)
TIA 62.5/125 µm	160/500	220	550
ISO OM1 62.5/125 µm	200/500	275	550
ISO OM2 50/125 µm	500/500	550	550
XG 50/125 µm	**1500/500**	**900**	**550**

Table 2: Distances for 850nm Serial 10 Gigabit Ethernet (10GBASE-SR)

	OFL Minimum Bandwidth (MHz•km) @850/1300nm (unless marked)	10GBASE-SR (850nm) (m)
TIA 62.5/125 µm	160/500	26
ISO OM1 62.5/125 µm	200/500	33
50/125 µm	400/400	66
ISO OM2 50/125 µm	500/500	82
XG 50/125 µm	**2000*/500** (* Laser Bandwidth)	**300**

4. Why not just buy higher bandwidth fiber?

The bandwidth provided on specification sheets for standard fibers are LED, or overfilled, bandwidth values. For applications where only LED sources will be used, a higher bandwidth may, depending on the application, support higher performance levels. However, LED bandwidth is not a good predictor of performance with laser sources. Because the overfilled measurement minimizes the impact of a centerline index of refraction profile defect, this measurement may not indicate a problem that underfilled laser sources will experience. Accordingly, high LED bandwidth does not mean better laser performance. In fact, some fibers installed today have lower laser bandwidth than LED bandwidth. Another factor to consider is cost. Fiber with higher LED bandwidth is selected from the distribution and carries a cost premium. This may result in a higher priced fiber that will not provide any better laser performance than standard optical fiber. It is also worth pointing out that the Standards do not guarantee any better performance than that shown in Tables 1 and 2 for a higher LED bandwidth.

The best way to ensure fiber will support the legacy LED applications of yesterday and today, while supporting the higher data rate laser-based applications of today and tomorrow, is to purchase and install 850nm laser optimized 50/125µm OM3 fiber. The fiber bandwidth is certified using a laser measurement test procedure, ensuring its compatibility with VCSEL transceivers, and was designed in cooperation with VCSEL manufacturers to ensure an operational 10Gb/s network.

5. Conclusion

Advances in optical source technology and in optical fiber have resulted in higher data rate applications than ever imagined. For short wavelength (850nm) laser-based technology, the fastest enterprise fiber technology today, 10 gigabit, impose severe limitations on the application of 62.5/125 µm to the point where they do not fully support the requirements of centralized and intra-building backbones. Standard 50/125 µm can be used for gigabit data rates in horizontal, centralized, and intra-building backbone networks, but distance limitations occur at 10 Gigabit speeds. The AMP NETCONNECT XG Fiber System provides the best choice for future proofing the intra-building cabling structure. The new fiber systems not only works well with today's readily available LED-based components, but provides a migration path into laser-based technology, making it the best choice for applications from 10 Megabits to 10 Gigabits.

6. AMP NETCONNECT XG Fiber System Components

- A complete line of AMP NETCONNECT XG System Cables
  - Interconnect, Distribution, Indoor/outdoor, Outdoor – dielectric & armored
  - Low-Smoke, Zero-Halogen (LSZH)
  - Hybrid cables

- A complete line of AMP NETCONNECT XG Connectors
  - No-epoxy, no-polish MT-RJ
  - No-epoxy, no-polish LightCrimp Plus SC
  - No-epoxy, Polish LightCrimp
  - Compatible to all AMP NETCONNECT enclosures and faceplates

- A Complete Line of AMP NETCONNECT XG Cable Assemblies
  - MT-RJ and SC Duplex Assemblies in standard and custom lengths
  - Hybrid Assemblies
  - Pigtails

7. For More Information

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