Fiber Technology Leadership Beyond The Glass™

40 / 100 GbE Fiber Optic Solutions: Just The Facts

To support the changing and fast-growing bandwidth demands of business critical data centers and service providers, the IEEE 802.3ba Task Force is actively developing a standard (IEEE 802.3ba) that will support 40 and 100 Gigabit Ethernet (GbE) data rates in fiber and copper. The standards body is looking at ratification by August 2010.

PANDUIT actively participates within standards groups to enable the next generation of fiber and copper networks. This document is designed as a quick-reference guide to increase your familiarity with issues and terms critical for migration to fiber-based 40 and 100 GbE systems.

Where and How?

IEEE's approach to higher speed data rates over fiber is based on advanced transceiver technologies engineered to use the full bandwidth of laser optimized fibers, thus allowing facilities to leverage existing investments in higher-grade fiber media. Both single mode (SMF) and multimode (MMF) solutions are being developed.

New Transmission Application / New Issues

Both single mode 40 and 100 GbE and possibly multimode 40GbE applications are expected to be deployed using the same cabling systems employed today – namely optical fiber cables with duplex LC connectivity. Multimode 100 GbE systems (and some versions of 40 GbE) are expected to employ parallel optics transceivers requiring up to 10 pairs of optical fiber per channel.

PANDUIT is ready to implement the architectural guidelines successfully, whatever the outcome of the standard.

40/100 GbE Fiber Optic Trends

(Likely IEEE Specifications)

Data Rate	40 Gb/s	100Gb/s
Application	• Access layer apps (i.e., blade servers, virtualization) • High-performance computing (HPC) clusters • Storage area network (SAN) Inter Chassis Links	• Core switching and routing • Data center aggregation • Internet exchanges / service provider peering points • High-bandwidth apps (i.e., video-on-demand)
Minimum Reach 100m 10km 40km	MMF SMF Not supported	MMF SMF SMF
Transmission Method **MMF**	**Serial or Parallel** Duplex or 12-fiber ribbon cables and MPO connectors	**Parallel Optics** 12- / 24-fiber ribbon cables and MPO connectors (20 fibers per channel)
SMF	**Wave Division Multiplexing (WDM)** 4x10G / 4x25G duplex cables and LC connectors	

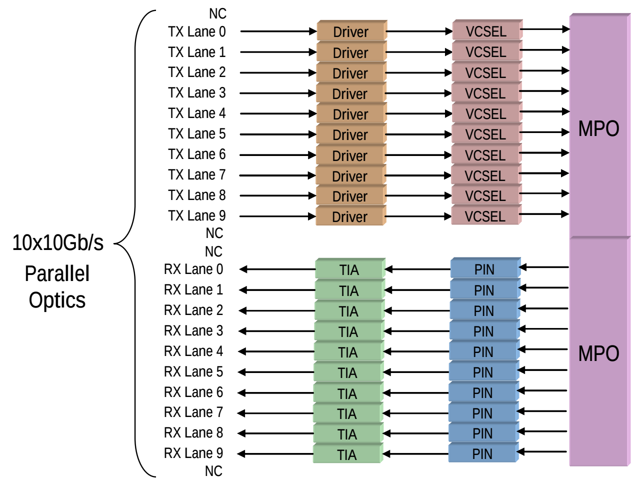
A Word on Bandwidth

Per standard, bandwidth performance of the fiber is ensured by meeting Effective Modal Bandwidth (EMB) measures. Other terms (EMBc and DMD) are also used by fiber manufacturers to describe the bandwidth performance of the glass. *PANDUIT* research focuses on channel certification testing as a true measure of network performance as other factors such as induced cable stress will influence channel performance. These parameters are independent of manufactured fiber bandwidth.

In other words, EMB is necessary as a raw fiber metric, but **the fact is that specifying the highest-grade fiber (OM3/OM4) is simply not sufficient to ensure fiber channel performance.** Most deployed channels consist of multiple connectivity segments in the permanent infrastructure, cabled fiber product, and fiber patch cords. Each can affect system performance.

The Jump to Parallel Optics

It is also a fact that for MTP systems that service serial channels today, migration to future parallel systems will require upsizing the cable plant. For example, a one-to-one transceiver swap from six serial 10 Gb/s links to six parallel 40 Gb/s links would involve the addition of five new 12-fiber ribbon cables along the permanent link and twelve ribbonized equipment cords. Customers may choose to build incrementally.



Schematic 100 Gb/s parallel optics system utilizing MMF for short reach communication

Fiber Technology Leadership BEYOND THE GLASS™
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What are the core performance issues at 40 and 100 Gb/s speeds?

A true determination of the *BEYOND THE GLASS*™ methodology includes consideration of all factors of the channel that contribute to signal integrity. Several new parameters are being defined by the IEEE:

Skew

Skew is defined as the difference in signal arrival times across parallel cable lanes. Because 40 and 100 Gb/s traffic may be carried over parallel lanes of 4 or 10 discrete fibers, respectively, differences in bit transport time over individual fibers must be kept to a minimum to ensure that data can be resynchronized at the receiver.

More skew requires more electronic processing to correct for the skew, resulting in:

- *Higher power dissipation*
- *Greater Latency*
- *Reduced Power budget*

The total skew over a channel is affected by optical characteristics, such as:

- *Physical fiber length*
- *Effective refractive index*
- *Modal dispersion*
- *Chromatic dispersion*

Localized stress in the cabling elements can introduce physical and/or optical path length changes, adding to skew.

The fact is, the quality of the glass manufacturing process and the assembly methods used to ribbonize and jacket the cables are the significant elements in the control of skew.

Process variations in fiber production, cabling, and installation can create variations in optical characteristics, resulting in unacceptable skew levels. Ultimately, tight control over fiber and cable manufacturing, combined with *PANDUIT*'s capability to accurately measure fiber skew performance, result in higher channel reliability.

Channel Insertion Loss (CIL)

CIL is the sum of all signal loss incurred along a fiber cable channel by both media and connectivity. CIL budgets for data rates of 10 Gb/s and above are very strict compared to historical, lower-speed Ethernet variants, and get even tighter for 40/100 Gb/s channels.

The fact is that connectivity has the biggest impact on the CIL budget. Any connectors placed in the fiber path can consume over 50% of the total insertion loss budget. Strategies to minimize total CIL include:

- *Deploying the lowest-loss connectors available*
- *Using high-quality, factory-terminated patch cords and cable assemblies*

PANDUIT was first to market with low-loss array connector systems, and demonstrates Best-In-Class polishing techniques for connector processing to achieve full fiber contact and consistently high return loss performance. *PANDUIT* also performs full physical layer media (i.e. Bit Error Rate [BER]) and EMB testing on 10 GbE systems and will do the same with 40 / 100 GbE systems.

Polarity

The matching of the transmit port (Tx) to receive port (Rx) at both ends of the fiber optic link is referred to as polarity. The objective of polarity is simple: provide transmit-to-receive connections across the entire fiber optic system in a consistent, standards-based manner.

Methods for ensuring polarity of array-based systems are defined in TIA/EIA-568-B.1, Addendum 7 (and forthcoming TIA/EIA-568-C.0 standard). This standard instructs users of array connector systems in the conversion of standard polarity Methods ‘A’ and ‘B’ to parallel optic systems. Method ‘C’ does not support migration to parallel optics.

The fact is, it is yet to be determined what polarity scheme for 100 GbE transceivers will be required. The end-user is best served by network designs that follow a single standards-based method that maintains polarity now over 1-10 Gb/s serial fiber channels and can migrate to parallel optics in support of 40 and 100 Gb/s data rates. Although Methods ‘A’ and ‘B’ both provide migration paths to parallel optics, *PANDUIT* endorses Method ‘A’ because it provides the simplest, most flexible deployment for singlemode and multimode fiber channels and supports network extensions.

This method is also easily extendable to emerging parallel optics systems. During migration, all backbone ribbon cabling is retained, and cassettes and patch cords at either end of the channel are exchanged for multi-fiber MTP patch cords that plug directly into the transceivers.

Proprietary methods not based on TIA/EIA guidelines will neither assure future interoperability, nor guarantee availability of future product inventory at a time of greatest need. The most widely available polarity method from component vendors is Method ‘A’.

40 / 100 Gb/s: PANDUIT Will Get You There…

Multi-lane 40 / 100 GbE optical signal integrity is directly related to connectivity IL performance (low mated-pair loss), proper cable design (to mitigate frozen-in and applied stress), consistent control of optical fiber properties, and bandwidth performance of the individual fibers (EMB).

From a media perspective, *PANDUIT* helps customers specify the appropriate fiber grade and cable design by knowing all key performance parameters. This attention to detail puts us in a better position to maintain signal integrity and ensure the robustness of the network.