DON'T JUDGE A CABLE BY ITS COVER

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When you see an orange or yellow fiber optic cable jacket, you recognize it as either multimode or single mode, respectively, for indoor backbone or horizontal applications. When high-speed VCSEL technology for 10 Gigabit Ethernet was developed along with an emerging generation of laser-optimized 50-micron multimode cable, the industry saw the need to delineate between the old and the new.

At that time, Lucent Technologies adopted a new aqua jacket color as a differentiator between legacy 50- and 62.5-micron multimode fiber, and the new laser-optimized 50-micron optical fiber cable for 10 Gb/s, making it easier for installers and end-users to distinguish between them. This color was adopted quickly by other cable manufacturers and eventually by the governing TIA standards. This transition has not been completed by all manufacturers, and in some cases, the aqua color is used for varying grades of 50-micron fiber that have performance characteristics and distance capabilities that differ from the standard. Today, regretfully, you cannot always determine the exact performance of the fiber by looking at the aqua jacket color. So, how can you tell what you have?

UNDERSTANDING TIA-598-C

The TIA-598-C standard, published in October 2005, set out to distinguish among indoor fibers and corresponding jacket colors. Cables with colored jackets are typically used only in intra-building applications and colors within the standard identify the levels of fire resistance. It is important to note that TIA-568-B.3 references TIA-598-C for optical fiber color coding.

Outdoor cables were not a part of this standard, as most cables deployed outside incorporate additives in the jacket material to withstand the damaging effects of solar radiation and other harsh environments. Such products typically contain black carbon material to provide the requisite level of protection. Although color-compatible materials designed

FIBER TYPE	TIA-598C PREFERRED COLOR CODING SCHEME FOR PREMISE JACKET		
	Non-military Applications	Military Applications	Suggested Print Nomenclature
Multimode (50/125) (TIA-492AAAB)	Orange	Orange	50/125
Multimode (50/125) (850 nm Laser-optimized) (TIA-492AAAC)	Aqua	---	850 LO 50 /125
Multimode (62.5/125) (TIA-492AAAA)	Orange	Slate	62.5/125

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Table 1. ISO 11801 Channel Distances

GRADE	BANDWIDTH @850NNM	1 GBE DISTANCE	10 GBE DISTANCE
OM1	200 MHz*km (OFB)	300 meters	N/A
OM2	500MHz*km (OFB)	550 meters	N/A
OM3	2000 MHz*km (EMB)	1 kilometer	300 meters

to resist solar radiation are available for outdoor use, and other means for color-coding black jackets are possible (i.e., colored striping), the use of such materials and methods were beyond the scope of this standard.

The TIA-598-C standard identifies the jacket color to be used for cables containing only one fiber type. The table on the previous page, lists these colors according to the standard. If a premises cable contains more than one fiber type, a printed legend on the outside jacket is required to identify the quantities and types of fibers within the cable.

Within the standard there are exceptions including: natural jackets with tracers that can be used instead of solid colors; printed nomenclature that can be agreed upon between manufacturer and end user; other colors may be used providing that the print on the outer jacket identifies classifications; and distinctive jacket colors for other fiber types may be considered as an addition to this table.

Per TIA-598-C, the aqua jacket designation should only be utilized for cables containing laser optimized

Berk-Tek's Adventum's cable is constructed with GIGAlite-10XB fiber which can deliver 10 Gb/s at 4900 MHz out to 600 meters.

Table 2. 50-Micron Non-laser optimized fiber Overfilled Launch Bandwidth (OFL @ 850 nm)

GRADE	BANDWIDTH	1 GBE GUARANTEED DISTANCE	10 GBE GUARANTEED DISTANCE
FDDI	500 MHz*km	550meters	N/A
FDDI Premium	500 MHz*km	600 meters	N/A

fibers with a minimum effective modal bandwidth of 2000 MHz*km and corresponding distance guarantee of 300 meters. These fibers are also defined in the international standards - ISO/IEC 11801 as OM3 grade fibers. OM3 grade multimode fiber allows the use of lower cost light sources, so-called VCSELs (Vertical Cavity Surface Emitting Lasers) to achieve speeds and distances previously only possible through a more expensive single mode fiber laser such as Fabry-Perot or Distributed Feedback lasers. When utilizing VCSEL technology, OM3 grade fiber can support Gigabit Ethernet to 1,000 meters and 10 Gb/s Ethernet up to 300 meters. Higher grades of LOMF (laser optimized multimode fiber) can further deliver 10 Gb/s up to 600 m more cost effectively than switching to single mode fiber technology which utilizes the much more costly lasers, mentioned above.

There is no confusion regarding single mode fiber as the cable is universally recognized as yellow, or on few special occasions (such as polarization-maintaining fibers and newer "bend-Insensitive" fibers) as blue. The real dilemma arises when differentiating between multimode fiber types. The term "laser-optimized" refers to the Differential Mode Delay (DMD) performance of the fiber, which is tested and certified by the glass manufacturer and ensures that the fiber is capable of delivering 10 Gb/s performance to a specific distance.

On the market today are six grades of 50-micron fibers, four tiers of which are laser-optimized. They are differentiated from one another by varying 10 Gb/s distance guarantees into: 150 m, 300 m, 550 m, and 600 m. Table 3 segments the different 50-micron fibers used for 1 Gigabit Ethernet and 10 Gigabit Ethernet applications.

OM3 AND THE AQUA JACKET

As referenced in the TIA-598-C document, TIA-492AAAC-A outlines the specifications for OM3 as an 850-nm, laser optimized, 50-micron cabled fiber for 10 GbE distances out to 300 m, with an EMB of 2000/500 MHz*km. The TIA-598-C standard adopted the aqua jacket color to correspond to the performance requirements of TIA-492AAAC-A. However, it is important to note that there are manufacturers that use the aqua color for sub OM3 grade fibers, specifically, for the 950 MHz*km EMB cabled fiber which can only deliver 10 Gb/s up to 150 m This practice is not supported by the governing TIA standards and obviously, this can create some confusion in the end-user community as to what exactly the aqua jacketed product they have purchased is capable of.

Both the TIA standard, along with the ISO/IEC 11802 (2nd edition) which includes the specifications for laser bandwidth and OM3 fiber (See Table 1), enable enterprises to confidently install high-bandwidth 10 Gb/s networks today, or at the least, assure an easy migration for tomorrow.

All fibers are not the same, and not all fall within the OM3 guidelines. Buyer beware. Make sure you know what you are installing without assuming that the aqua jacket tells all. The good news is that on the other side of the spectrum, some manufacturers offer "beyond the specs" with 50-micron high-quality fibers (referred to as OM3+) that can deliver 10 Gb/s at 4200 MHz out to 550 meters as well as a premium fiber (for example Berk-Tek's GIGAlite-10 XB) that is defined at 4900 MHz for 10 Gb/s out to 600 meters.

Since all fibers are not the same, be sure that you clarify with your supplying vendor which fiber you need for your applications. Other methods to guarantee the fiber performance is to make sure that each fiber passes stringent DMD specifications a outlined by TIA/EIA-455-220 or IEC 60793-2-10 which ensures the specified EMB at 850 nm. Don't just judge performance by its color. ■

Table 3. 50-Micron Laser optimized Effective Modal Bandwidth (EMB @ 850 nm)

GRADE	BANDWIDTH	1 GBE GUARANTEED DISTANCE	10 GBE GUARANTEED DISTANCE
Enhanced OM2	950 MHz*km	750 meters	150 meters
OM3	2000 MHz*km	1 kilometer	300 meters
Enhanced Laser Optimized	4700 MHz*km	1 kilometer	550 meters
Premium Laser Optimized	4900 MHz*km	1.2 kilometer	600 meters

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