

Fiber Optic Cabling for Indoor/Outdoor Installations

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Local Area Network (LAN) campus or building backbone cabling infrastructure typically encompasses two basic operating environments: Outside Plant and Inside Building. As such, traditional cabling methods typically call for the use of two different cable constructions best suited for each of these conditions: Loose tube, Outside Plant (OSP) cables for the outdoor environment, and tight buffer fire-rated cables for use inside the building.

When using this method, Article 770 of the National Electric Code (NEC) requires a transition from the OSP cable to the appropriate fire-rated indoor cable within 50 feet of entering the building. However, considerable cost savings and notable system reliability improvements are achievable by installing a cable that is suitable for both outdoor and indoor environments. This article is intended to provide an overview of the factors that systems engineers should consider when selecting the correct cable for their campus or building infrastructure.

Cable Design Factors

When designing any fiber optic cable, including those that are intended for use in both the outside plant environment as well as inside buildings the engineers must carefully balance a wide range of critical factors which affect the long term reliability and performance of the systems that these cables support. All of these factors are equally important and can be divided into the following main categories: Mechanical/Physical, Environmental, Optical, and Cost.

To give a brief overview of how complex these design criteria really can be, the following is a breakdown of what each category encompasses. Each single element, if neglected, can lead to failure of your mission-critical network infrastructure. For this reason, it is imperative, that cable specifications developed by network designers, consultants, end-users, etc. mandate compliance to industry standards that will ensure that the cable

installed will meet or exceed a minimum set of performance requirements. (A list of these standards is provided at the end of this article for reference.)

Mechanical/Physical Characteristics

Mechanical/Physical characteristics of cables include: cable size and weight, minimum bend radius, tensile strength, flexibility, twist, impact, and crush resistance, water blocking, color-code identification, print permanency, as well as resistance to corrosive fuel, chemicals, and even fungus. While the cable size and weight may not be listed in cable standards, the system designer must determine allowable space and compute weight restrictions to ensure both the initial, and future cables will fit and can be supported by the designated pathways and spaces.

Environmental Performance

Environmental performance involves temperature cycling and thermal aging, as well as sunlight and ozone resistance, cable freezing, low and hot temperature bend and impact. Here it is important to differentiate between operational performance limits versus installation performance. Many thermoplastic materials used in cable buffering and jacketing have difficulty performing below – 20 deg C, a temperature well below their respective low temperature brittleness points. Material selection is particularly challenging for plenum rated cables.

Optical Performance

Optical performance is not as straightforward as it may seem. While many cable manufacturers rightfully specify “maximum cabled” attenuation values for their products, others use descriptions such as average or even typical, both of these options should be meaningless to a system design engineer. It is important to note that maximum attenuation for tight buffer fiber cables is usually higher than for loose tube constructions. Furthermore, while it is understood that bandwidth of multimode fibers (overfilled launch, or OFL bandwidth, measured in MHz.km) is not typically affected by the cabling process, the same cannot be said for Differential Mode Delay (DMD).

Along with cabled fiber attenuation, DMD is the limiting performance-mitigating factor in 10 Gbps transmission systems using low cost VCSEL technology at 850 nm. Only a few cable manufacturers, Berk-Tek included, have verified that their respective cable designs and processes do not negatively affect the DMD performance of the laser optimized 50 micron multimode fibers required for these 10-gig systems (Ethernet or Fibre Channel).

Cable Attenuation

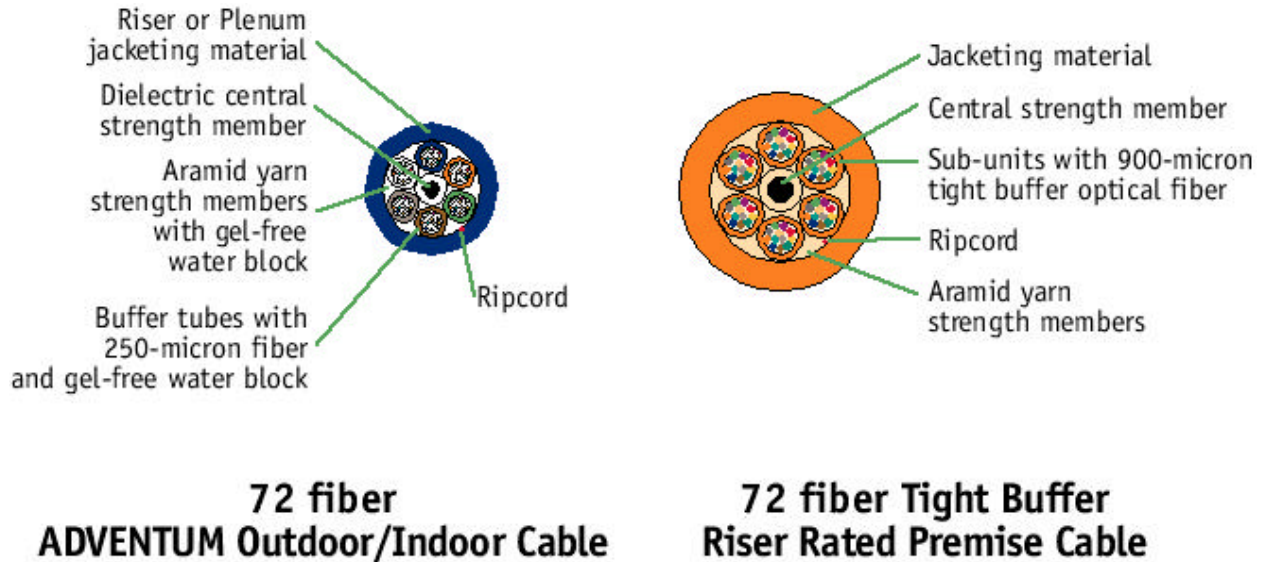
Cable attenuation changes with temperature cycling. This change is typically much more pronounced with tight buffer cables than it is with loose tube constructions. The reason is that 900micron tight buffer thermoplastic materials have a thermal expansion coefficient approximately 100 times greater than that of the silica based optical fiber to which the plastic is physically bonded. This bond strength varies from cabler to cabler but a sufficient bond is necessary nonetheless to ensure no “pistoning” of the fiber to buffer occurs. Basically, the plastic buffer materials expand and contract at considerably greater rates than the optical fiber thereby exerting stresses on the fiber, which is manifested in, increased attenuation or in extreme cases fiber breaks. *This is the prime reason for which tight buffer fiber cables are not ideal for outdoor installation.*

This overview would be incomplete without a brief discussion on cable and systems cost.

When computing total installed cable cost the designer must take into consideration all aspects of purchasing, installing, terminating, and maintaining a fiber optic cable. While the tight buffer cable offers ease of direct termination, it is most often a heavier cable of larger outer diameter requiring the use of larger plenum inner ducts or interlocking armor. To properly water-block this cable and offer appropriate UV and fungus resistance, the cable cost increases over traditional premises versions of tight buffer designs. Also, the added cost of installing and terminating a larger cable negates the perceived value of being able to “just put a connector on the end of the tight buffer fiber” and not having to install a breakout kit.

Newer all-dry, plenum or riser rated loose tube cable designs, such as Berk-Tek’s Adventum™ cables, can offer many advantages over a tight buffer cable. These include significantly smaller diameters (see Figure 1), as well as considerably lower cable cost. In addition, these cables offer much better

Figure 1 Cable cross-sections show relative diameter difference for same fiber count.



mechanical, environmental, and physical robustness (See Table 1), including full water blocking, in a cable which exceeds all applicable North American and International standards for use in an indoor and an outdoor environment (See Table 2). Tight buffered cables do not generally meet these outdoor cable requirements and are not the best choice for installation in an outdoor environment. And because cables like Adventum eliminate the need for installing a transition point between a traditional gel filled OSP cable and an indoor tight buffer cable, they can provide significant savings in material and labor costs, even with the added cost and time to install a breakout kit.

Table 1

Design Parameter	ADVENTUM Loose Tube Cables	Tight Buffer Cables (Typical)
Operating Temperature	-40°C to + 75°C	-20°C to + 75°C
Tensile Strength	1335 – 2670 N (300-600 lbs)	660 – 1320 N (150-300 lbs)
Crush Resistance	2200 N (495 lbs)	1000 N (225 lbs)

Table 2

Standard	Indoor or Outdoor	ADVENTUM Compliance	Tight Buffered Compliance
TIA/EIA-568-B.3 (4.3.1)	Indoor	Yes	Yes
Telcordia GR-409	Indoor	Yes	Yes

ANSI/ICEA S-83-596	Indoor	Yes	Yes
ANSI/ICEA S-104-696	Indoor/Outdoor	Yes	Yes (only for special designs)
TIA/EIA-568-B.3 (4.3.2)	Outdoor	Yes	No
Telcordia GR-20	Outdoor	Yes	No
ANSI/ICEA S-87-640	Outdoor	Yes	No

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