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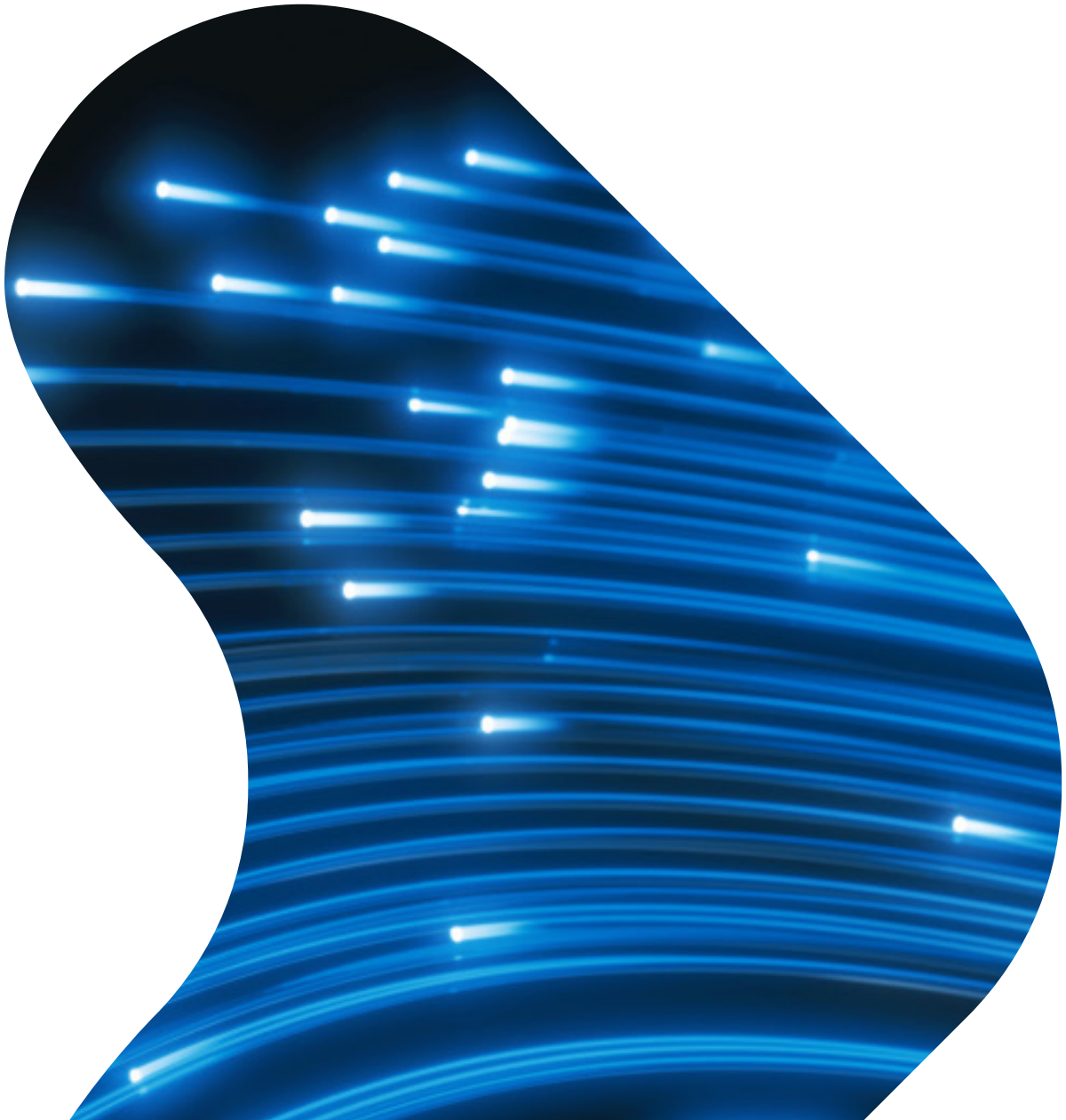
Selecting the correct cable type for Outside Plant Application



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Abstract
This application note discusses differences between various types of Multimode and Single mode optical fiber cable nomenclatures mentioned in ISO/IEC and ANSI/TIA standards.

Keywords
Fiber optic cable, Optical fiber, Multi-mode fiber, Single Mode fiber, Bandwidth, Attenuation

What are OM and OS type fiber optic cables?

Fiber optic cables used in telecommunication are broadly categorized in two types – Multimode fiber and Single mode fiber cables. Multimode fiber cable is prefixed with 'OM' and Single mode fiber cable is prefixed with 'OS'. In ISO/IEC 11801 and EIA/TIA standards four types of Multimode – OM1, OM2, OM3 & OM4 and two types of Single mode – OS1 & OS2 fibers are mentioned. In all the standards the OM/OS system applies to cabled optical fiber, and the cabling standards deal with cable and connecting hardware. ISO/IEC 11801 and 24702 make it clear that the nomenclatures OM1, OM2, OM3, OS1 and OS2 relate to cable transmission performance whereas the BS EN 50173 series makes it even clearer by describing the OM/OS nomenclature as “optical fiber cable categories”.

What are the differences between OM and OS type cables?

The main difference between OM and OS type cables is in core diameter with OM multimode fibers has a much larger core size. Two types of OM cables with core diameters of 50 micron and 62.5 micron are specified. The large core gives OM cables a higher "light-gathering" capacity compare to OS cables. In practical terms, the larger core size simplifies connections and allows the use of lower-cost light sources such as light-emitting diodes (LEDs) and vertical-cavity surface-emitting lasers (VCSELs) operating at 850 nm and 1300 nm. OS cables used in telecommunications operate mainly at 1310 or 1550 nm wavelengths and require more expensive laser sources. Compared to OS cables, the –band width distance product (represented as MHz.km) of OM fibers is low because the larger core-size supports more than one propagation mode; hence it is limited by modal dispersion.

The LED light sources also contain a wide range of wavelengths that propagate at different speeds and produce chromatic dispersion, which is another limit to the useful length for OM type fiber optic cable. In contrast, the lasers used to drive single-mode fibers produce coherent light of a single or narrower wavelength range.

Comparison between different types of OM fiber optic cables

Conventional 62.5/125 µm (OM1) and 50/125 µm (OM2) multi-mode cables were widely deployed in premises applications for many years. These cables were ideal for use with LED transmitters and support applications ranging from Ethernet (10 Mbit/s) to Gigabit Ethernet (1 Gbit/s). Later as users required higher speed networks laser-optimized 50/125 µm OM3 & OM4 cables were deployed that provide bandwidth to support transmission above 10 Gigabit Ethernet. Laser optimized multi-mode (LOMMF) cable OM3 & OM4 are designed for use with 850 nm VCSELs that are capable of modulation over 10 Gbit/s whereas LEDs have a maximum modulation rate of 622 Mbit/s.

OM cables are often characterized in terms of their modal bandwidth. OM1 & OM2 light sources typically exceed the numerical aperture of the fiber and so the modal bandwidth values are commonly known as 'overfilled launch'. OM3 & OM4 require restricted launch conditions provided by lasers/VCSELs to achieve high modal bandwidths in addition to 'overfilled launch'. Table 1 shows bandwidth and attenuation values of different types of OM cables.

A guide to typical transmission distances for each category of OM cables are shown in the table 2. It should be remembered that the actual reach for a given bandwidth depends upon the network design and chosen engineering hardware solution. The choice of cable is therefore part of a solution package and needs to b es pecified by the network designer.

Table 1-
Bandwidth and attenuation comparison between different OM fiber optic cables

Multimode Fiber			Bandwidth (MHz. km)			Attenuation (dB/km)	
Nomenclature	TIA Fiber Standard	Core Diameter (micron)	Overfilled Launch (OFL) at 850 nm	Overfilled Launch (OFL) at 1300 nm	Laser Launch at 850 nm	At 850 nm	At 1300 nm
OM1	492-AAAA	62.5	200	500	Not specified	3.5	1.5
OM2	492-AAAB	50	500	500	Not specified	3.5	1.5
OM3	492-AAAC	50	1500	500	2000	3.5	1.5
OM4	492-AAAD	50	3500	500	4700	2.5	0.8

Table 2-
Maximum channel length comparison between different OM fiber optic cables

Ethernet Data Rate	Wavelength (nm)	Maximum channel length (meters)			
		OM1	OM2	OM3	OM4
100 Mbps	850	Up to 2000	Up to 2000	Up to 2000	Up to 2000
1 Gbps	850	275	550	550	1000
10 Gbps	850	33	82	300	550
40 & 100 Gbps	850	—	—	100	150
1 Gbps	1300	550	550	550	550
10 Gbps	1300	Up to 300	Up to 300	Up to 300	Up to 300

Comparison between different types of OS fiber optic cables

The difference between OS1 and OS2 fiber optic cables is mainly in cable construction rather than optical fiber specifications. OS1 type cable is predominantly of a tight buffered construction whereas OS2 is a loose tube or blown cable construction where the cable designs applies less stress on the optical fibers. OS1 fiber optic cable is designed for premises where the maximum distance is 2,000 metres with transmission speeds of 1 to 10 gigabit Ethernet.

OS2 fiber optic cable is designed for larger transmission distances in the range of 5,000 to 10,000 metres with similar transmission speed of 1 to 10 gigabit Ethernet. In Table 3 attenuation specifications of OS1 and OS2 fiber optic cables as mentioned in ISO/IEC and EN standards are summarized.

Table 3-
Attenuation comparison between different OS fiber optic cables

Fiber Optic Cable Category	Maximum Attenuation (dB/km)		
	1310 nm	1383 nm	1550 nm
OS1(EN50173-1:Ed.2: 2010)	1.0	1.0	1.0
OS2(EN50173-1:Ed.2: 2010)	0.4	0.4	0.4
OS1(ISO/IEC11801Ed.2.2:2010)	1.0	Not Specified	1.0
OS2(ISO/IEC11801Ed.2.2: 2010)	0.4	0.4	0.4
OS2(ISO/IEC24702: 2006)	0.4	0.4	0.4

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