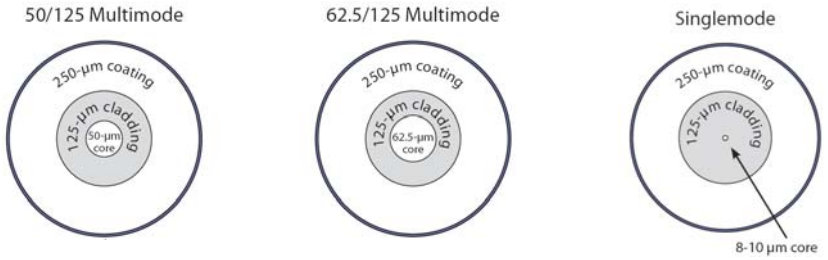
Multimode vs. Singlemode – Fiber Fundamentals

In this first of a series of articles on fiber optic facts and applications, we will start with some of the basics of fiber optics – the fiber itself – and discuss some of the fundamental differences between multimode (MM) & singlemode (SM) fiber. Of all the differences between MM & SM fiber, the most fundamental differences are the size of the fiber's core and the associated attenuation or loss and bandwidth of the fiber. The fiber itself consists of 3 basic portions – the core, cladding and buffer or coating. The core is the most central portion of the fiber where the light travels. There are 3 basic fiber core diameter sizes. Singlemode fiber has a core diameter of nominally 9µm while multimode fiber has either a 50µm or 62.5µm core diameter. For the fibers we use, the cladding is always 125µm while the protective coating has a diameter of 250µm. Other buffers and jacketing materials help build the fiber up to more practical and rugged cable structures.



(Courtesy: The Light Brigade, 2008)

The basic rule of thumb is that the smaller the core diameter, the higher the fiber's bandwidth and the lower the attenuation (loss in dB per kilometer). The fiber's attenuation and bandwidth are also dependent on wavelength. The table below illustrates the approximate attenuation of both multimode & singlemode fibers.

Fiber Type		Multimode	Multimode	Singlemode
Core diameter		50µm	62.5µm	8 – 10µm
Attenuation (dB/km)	850nm	2.5	3.5	N/A
	1300/1310nm	0.8	1.4	0.3
	1550nm	N/A	N/A	0.2

As we later explore the characteristics of these fibers, we will show that systems will be either loss or bandwidth limited. The fiber will either attenuate the optical signal to such a point where the receiver cannot reliably recover the information or the bandwidth of the fiber will distort the signal to where it cannot be recovered even though there is plenty of optical signal at the receiver.

Due to its industry familiarity and relatively large core size, multimode fiber is the currently accepted fiber for many installations particularly in environmentally hostile locations such as outdoor, dirty/dusty floors, etc. The large core of MM fiber is more tolerant to dust and dirt at the optical connectors. Small specs of dust can easily block the entire core of a SM fiber resulting in significantly higher connector attenuation. In addition, it is somewhat easier to terminate MM fiber on connectors in the field. However, the bandwidth limitations of MM fiber can severely limit the transmission distance of high bandwidth video signals. Fiber

attenuation is one of the basic characteristics of fiber that needs to be understood and taken into consideration when designing any fiber transmission system.

As we continue to explore the characteristics of MM & SM fiber, we will show that the maximum distance of MM fiber will typically be limited by the bandwidth of the transmitted signal while the maximum distance of SM fiber will be limited by the attenuation of the fiber or the loss budget of the fiber transmission equipment.

Our next topic will discuss the bandwidth issues of fiber and highlight the characteristics of each and how it affects video performance as a function of fiber type & distance. If you have any questions or if you have any particular fiber topic you would like to know more about, please send an email to emiskovic@meridian-tech.com.

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