

## EXPLAINING FIBER PROPAGATION MODES

When we send a light signal through a fiber optic cable, the ray of light can travel in one or more methods of transmission. Methods in this context refer to modes. These modes are always an integer as there is only a certain whole number of ways of transmitting light. When there is one mode in the fiber, it is called a **singlemode fiber**. When there is more than one mode in the fiber, it is called a **multimode fiber**.

The physical structure of singlemode and multimode fibers are different in terms of the diameter of the fiber core. For singlemode fibers, the typical core diameter is between 8 to 10 $\mu\text{m}$ . For multimode fibers, the typical core diameter is either 50 or 62.5 $\mu\text{m}$ . In general, the larger the diameter of the fiber core, the more modes the fiber can carry.

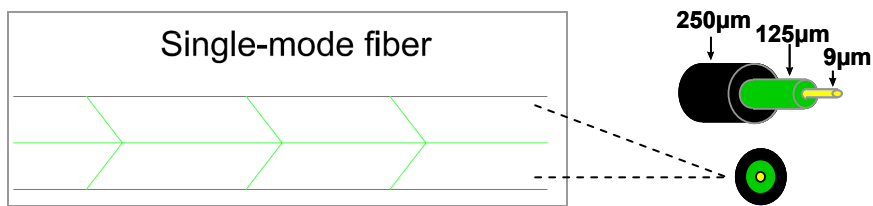


Diagram-1: Singlemode fiber with a typical fiber core diameter of 8 to 10 $\mu\text{m}$

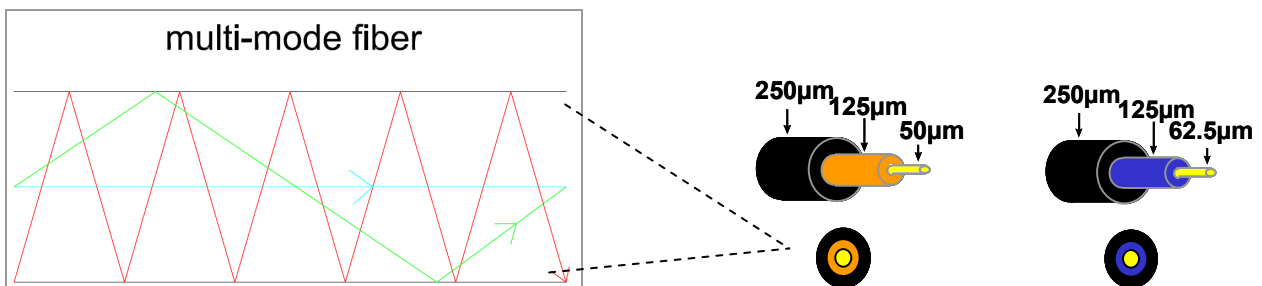
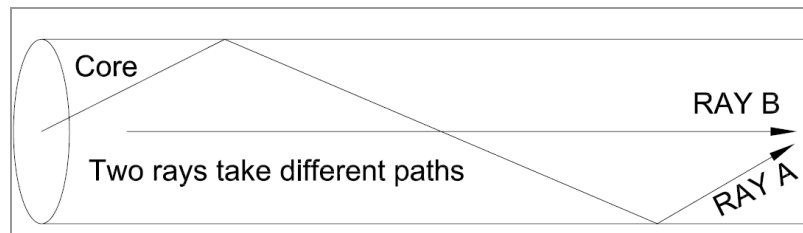


Diagram-2: Multimode fiber with a typical fiber core diameter of 50 or 62.5 $\mu\text{m}$

## INTERMODAL DISPERSION

When different modes of light travel at different speeds or at different light paths along the same fiber, they will not be received at the same time. This would cause the signal to become distorted, a phenomenon known as **intermodal dispersion**.



*Diagram-3: Rays in multimode fibers can travel in different light paths within the same fiber*

Intermodal dispersion is minimized in the design of fibers. The design of fiber eliminates up to 99% of intermodal dispersion. They do this by varying the speed of each mode so that they are received at the same time. For example in *Diagram-3*, Ray A travels a longer distance than Ray B. Intermodal dispersion is minimized when Ray A travels faster than Ray B so that both rays arrive at the same time.

Since intermodal dispersion is applicable only to multimode fibers, singlemode fibers have better performances with lower signal loss.

## STANDARDS

Various standard bodies have aimed to categorize and standardized various types of single mode and multi mode fibers. The following list is some of the most internationally recognized standard bodies governing optical fibers:

- **IEC** (International Electrotechnical Commission)
- **ISO** (International Organization for Standardization)
- **ITU** (International Telecommunication Union)
- **TIA** (Telecommunications Industry Association)

## UNDERSTANDING OS/OM FIBER DESIGNATIONS

The OS/OM standards were introduced in the ISO/IEC 11801 standard where fiber types specified were OS1 for single mode, OM1, OM2 and OM3 for multi mode. OS2 single mode fiber was introduced in 2006 in ISO/IEC 24702. OM4 multi mode fiber is the recent addition in 2009, as specified in ISO/IEC 60793-ID and TIA-492AAAD.

These standards identify the cable transmission performance of each fiber type. Each fiber type is given a specification of maximum attenuation (i.e. signal loss) of a cabled fiber. They are given according to the wavelength in decibels per kilometer. For multi mode fibers, there is an additional metric of the minimum bandwidth for each fiber type. The difference between overfilled launch and laser launch is from the type of signal launch used in transmission. For overfilled launch, it is generically referring to LED as the launching device. OM3 and OM4 have an additional laser launch modal bandwidth as OM3 and OM4 are designed to be laser optimized.

*Table-1* and *Table-2* show the maximum attenuation and the minimum modal bandwidth for single mode fiber and multi mode fiber, respectively.

Fiber Type	Max. attenuation (db/km)		
	1310nm	1383nm	1550nm
OS1	1,0	Not specified	1,0
OS2	0,4	0,4	0,4

*Table-1: Single Mode Fiber Characteristics for OS1 and OS2*

Fiber Type	Max. attenuation (db/km)		Min. modal bandwidth (MHz x km)		
			Overfilled launch		Laser launch
	850nm	1300nm	850nm	1300nm	850nm
OM1	3,5	1,5	200	500	Not specified
OM2	3,5	1,5	500	500	Not specified
OM3	3,5	1,5	1500	500	2000
OM4	3,5	1,5	3500	500	4700

*Table-2: Multi Mode Fiber Characteristics for OM1, OM2, OM3 and OM4*

With the various standard bodies' categorizations, *Table-3* shows the cross-referencing of each fiber types within ISO/IEC and TIA/EIA:

ISO/IEC 11801	IEC 60793-2-10	TIA/EIA
OM2	A1a.1 fiber	492AAAB
OM3	A1a.2 fiber	492AAAC-A
OM4	A1a.3 fiber	492AAAD

*Table-3: Fiber cross-referencing standards*

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