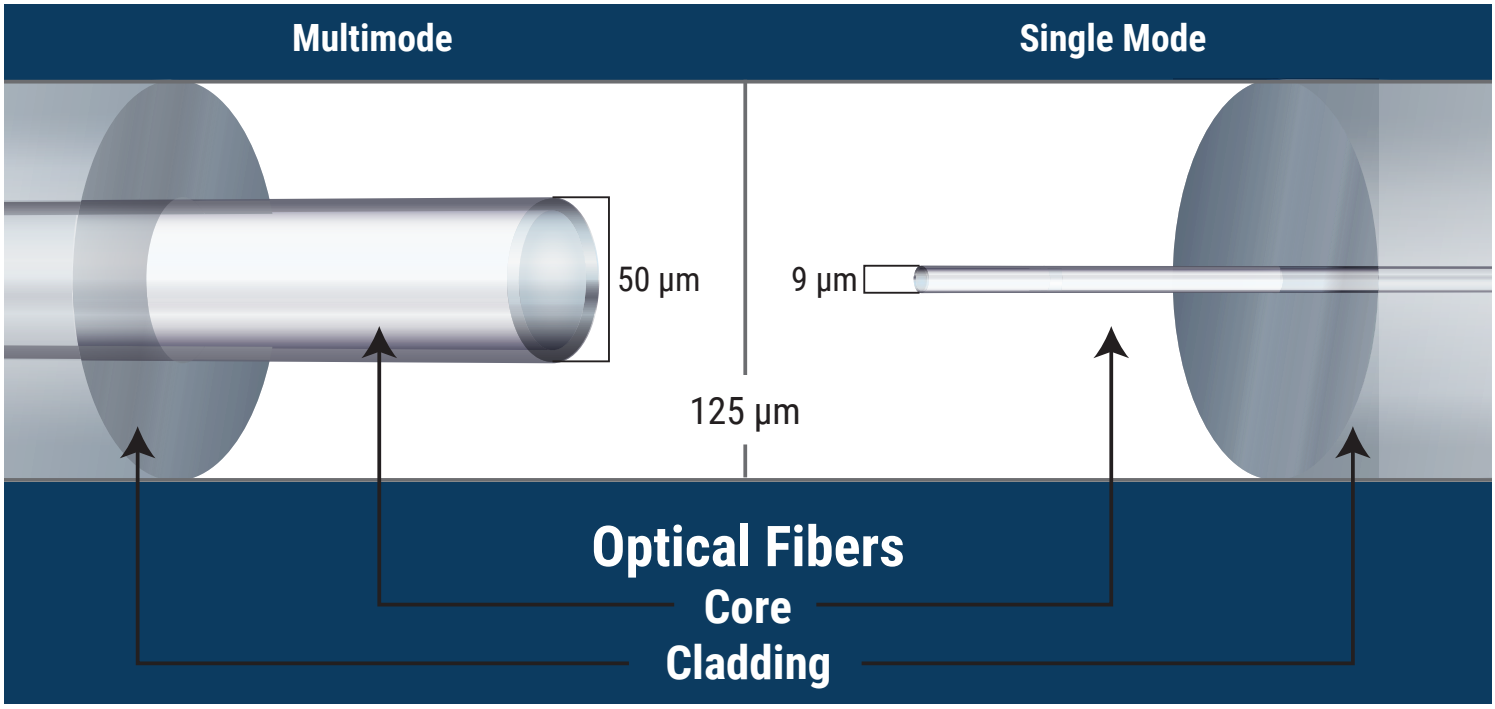

Single Mode vs. Multimode Fiber Optic Cabling:

An Overview

Many decisions come into play when installing fiber optic cabling. By far, one of the most important questions is whether to install single mode or multimode. This decision has huge implications for your network's distance, bandwidth, and budget, so it's vital to understand the differences between these two types of fiber optic glass.

Before we discuss each type of fiber, here are some definitions:

Optical fiber: The glass portion of a fiber optic cable – no jacketing or strength members included. An optical fiber is made up of a light carrying core surrounded by cladding. The cladding prevents light from escaping the core, effectively keeping the signal moving down the glass.

Single mode fiber: a fiber featuring a small light-carrying core of about 9 micrometers (µm) in diameter. For reference, a human hair is closer to 100 µm. The core is surrounded by a cladding that brings the overall diameter of the optical fiber to 125 µm.

Multimode fiber: a fiber with a core of 50 µm or above. A larger core means multiple modes (or rays of light) can travel down the core simultaneously. Just like single mode, the core is surrounded by a cladding that brings the overall diameter of the optical fiber to 125 µm.

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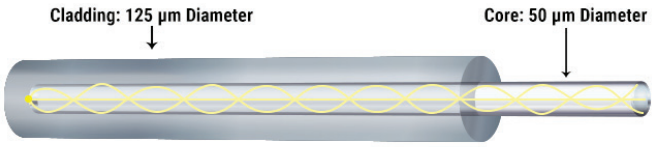
Common Misconceptions

It's important to remember that (without the visual acuity of Superman) there is no way to distinguish between single mode and multimode optical fibers with the naked eye. As noted above, standard optical fibers have cladding around the core that brings the diameter of the optical fiber itself to 125 µm. When you put a connector on an optical fiber, you are primarily seeing the cladding and any integral protective coating, like SSF™ polymer.

The terms "single mode" and "multimode" also have no relation to the number of optical fibers in the fiber optic cable you are running. It's possible to have a cable containing 144 single mode optical fibers, and it's also possible to have a cable containing 144 multimode optical fibers.

Is Multimode Better?

To installers new to fiber, multimode fiber may seem appealing because the name implies that more can be sent over the cable. However, "multimode" refers to multiple rays of light simultaneously taking different tracks down the core of the fiber. This characteristic, enabled by multimode's larger core, actually creates some limitations.



50/125 Multimode

In multimode fiber, light travels down the core, bouncing off the cladding as it goes. As each beam of light has an individual path, each will reach the end of the optical fiber at different times. This spread is modal dispersion, and it creates limits on data and distance. For OM3 multimode, 10 Gbs can be sent a maximum of about 300 meters or 1000 feet before the signal becomes indistinguishable.

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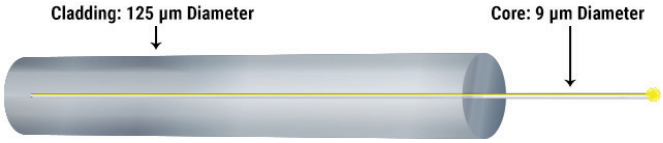
Conversely, single mode's minuscule core limits dispersion, so higher bandwidth signals can be sent over a longer distance. Sending data over the ocean floor? Single mode would be the cable for you. In general, single mode is the cable of choice for installations above about 300 m (1000 ft).



9/125 Single Mode

Single Mode Distance Limitations

BANDWIDTH	APPLICATION	MAX. DISTANCE	WAVELENGTH
Gigabit	1000BASE-LX	5 km	1310 nm
10 Gigabit	10GBASE-LX4	10 km	1310 nm
	10GBASE-E	40 km	1550 nm
40 Gigabit	40GBASE-LR4	10 km	1310 nm
	40GBASE-FR	2 km	1310 nm
100 Gigabit	100GBASE-LR4	10 km	1310 nm

ANSI/TIA-568.0-D-1

Why Run Multimode at All?

The answer to this comes down primarily to budget and applications. Single mode cable requires single mode transceivers, and those tend to be more expensive than multimode equivalents. The difference in electronics can bring single mode system costs far above those of multimode, even if the per foot cost of single mode cable is low. This is one of the primary reasons we'll generally recommend multimode before single mode fiber in lower-distance applications. However, there are still times when single mode may be recommended for short cable runs. It depends on the installation!

Choosing Multimode? Pick the Right Grade.

Multimode fiber is currently constructed in five different grades: OM1, OM2, OM3, and OM4, and OM5.

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Each grade of multimode fiber has a different bandwidth and distance limitation, with OM4 and OM5 providing the greatest bandwidth over longest distance and OM1 providing the lowest.

At the moment, our general grade recommendation for installations suitable for multimode is OM3. As can be seen in the Multimode Distance Limitations table, OM3 provides good options for bandwidth over distance, and it is generally more cost-effective than OM4.

Multimode Distance Limitations

FIBER TYPE	10 GB ETHERNET DISTANCE (10GBASE-SR)	40 GB / 100 GB ETHERNET DISTANCE (40GBASE-SR4 /100GBASE-SR10)
OM1	33 m / 100 ft	N/A
OM2	82 m / 260 ft	N/A
OM3	300 m / 1000 ft	100 m / 330 ft
OM4	400 m / 1300 ft	150 m / 500 ft
OM5	400 m / 1300 ft	150 m / 500 ft

It is extremely important to note that while OM2, OM3, OM4, and OM5 all have a core of 50 µm, OM1 has a core of 62.5 µm. While these optical fibers are all surrounded by a cladding to 125 µm, OM1 can't be used as a patch cable in a system involving OM2/OM3/OM4/OM5, and it will not work with connectors rated for OM2/OM3/OM4/OM5.

Don't Mix and Match

Just as it's important to note that you can't mix OM1 and OM4, also note that single mode and multimode are not interchangeable. Single mode electronics and connectors only work with single mode fiber, and multimode, likewise, only works with multimode. This is due to the difference in core diameters between fiber types, as well as light wavelengths used for transmission.

Both single mode and multimode fibers provide excellent solutions for durable, high bandwidth installations. Being aware of the differences between the two types of fiber will allow you to select the fiber most appropriate for your installation and data requirements.

The Short Version

- Single mode fiber has a smaller core than multimode and is suitable for long haul installations. Single mode systems are generally more expensive.
- Multimode fiber has a larger core and is recommended for fiber runs less than 400 meters (1300 feet). The grade of multimode fiber affects its distance and bandwidth capabilities. Multimode systems are generally less expensive.
- Single mode only works with single mode, and multimode only works with multimode. This is true for cable, connectors, and electronics.
- Our recommendation for cable runs under 300 m (1000 ft) is generally multimode OM3. This provides high bandwidth and is more budget-friendly than OM4.

About Us

Cleerline Technology Group provides end-to-end solutions for every fiber optic installation. Whether your installation is in a commercial environment or a residential dwelling, Cleerline has the fiber optic components you need. From our unique fiber optic cable to connectors, termination tools, enclosures, and more, Cleerline is Fiber Optics Redefined.

Cleerline SSF™ Stronger, Safer, Faster-to-terminate optical fiber uses an innovative Glass, Glass, Polymer design. The integral SSF™ polymer coating dramatically improves the bend insensitivity and strength of the glass, allowing fiber termination in as little as one minute.

Learn more at www.cleerlinefiber.com.

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