Fiber Optic FAQ

Questions – give us a call
1-888-797-3697

1. What is fiber optics?

Fiber Optics is a product field that enables high speed Voice Data Video (VDV) communications by guiding modulated light through an optical fiber. People generally say "fiber" when they refer to the optical fiber itself. Some folks use it to mean a cable of optical fiber.

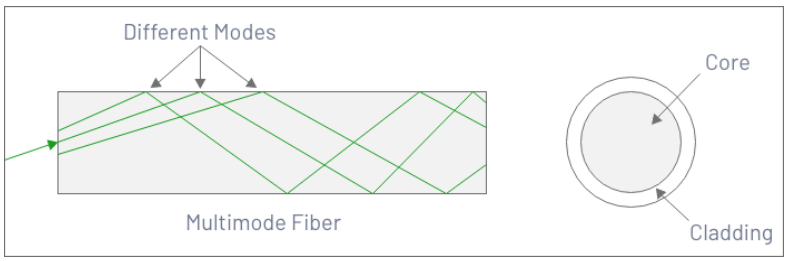
It began over 40 years ago in the R&D labs (Corning, Bell Labs, ITT UK, etc.) and was first installed in Chicago, IL, USA in 1976. By the early 1980s, fiber networks connected the major cities on each coast.

For more details, refer to our fiber optic glossary on the web.

2. What is multi-mode fiber?

It's a type of optical fiber, which allows light to travel down multiple paths (modes). Modes are the equivalent of standing waves in a fiber. Think of permitted modes as lanes of travel (see image).

Multi-mode cable features a core diameter of 50 to 62.5 microns. Multi-mode fiber is most often used to transmit voice-data-video signals in short-to-intermediate-distance applications, such as within a building, or building to building applications.



3. Why do I need to install optical fiber cable?

Network managers choose to install optical fiber cable for several reasons depending on the application. A few of the major reasons include:

Longer link lengths: Because of its high bandwidth and low attenuation, fiber cable can support much longer link lengths, compared to the industry standard of 100 meters for unshielded twisted-pair (UTP) copper cabling. For example, with 10 Gigabit Ethernet (GbE), copper is limited to lengths of 100 meters or less. However, multi-mode fiber can support lengths of at least 400 meters. These longer lengths give designers much more flexibility in their infrastructure layouts and enable them to maximize the use of their real estate.

Network infrastructure longevity: Today's multi-mode fibers will support network design requirements well into the future. With laser-optimized, multi-mode fiber cables (OM3, OM4, OM5), companies can easily migrate to 40-GbE and 100-GbE backbones. These fibers offer enough headroom to support anticipated applications for years to come.

EMI/RFI immunity: In some installations—particularly industrial applications and some schools and hospitals—electromagnetic interference (EMI) or radio frequency interference (RFI) from fluorescent lighting or industrial equipment can cause network problems. Because fiber is dielectric, it's immune to these problems. Unlike facilities with copper wiring, dielectric fiber cabling systems do not conduct lightning strikes or electrical currents that can damage sensitive electronic equipment.

4. How do you classify fiber optic cable?

This is a broad question, but the Fiber Optics Association classifies FOC by:

Fiber types, which include multi-mode, single-mode, and hybrid.

Cable types, which include tight buffer, distribution, breakout, and loose tube.

Cable materials, whether the cable consists of fiber, wire, or both (composite cable).

Flame rating (NEC/UL standards).

5. What wavelengths are used with multi-mode fiber?

Multi-mode fiber is used to transmit wavelengths of 850 nm or 1300 nm. Fibers that transmit at 850 nm and 1300 nm are used most often because low-cost, semiconductor light sources and photodetectors that transmit and receive these wavelengths are inexpensive.

6. When should I use multi-mode fiber instead of single-mode?

Use multi-mode fiber to transmit signals for hundreds of meters or thousands of feet. It's ideal for transmitting signals between floors of a building or from an equipment room to a wide variety of rooms and spaces. It is not appropriate for long haul links – that's where single-mode fiber excels.

7. What type of multi-mode fiber should I use for new installations?

Use OM3 or OM4 multi-mode fiber for new installations. Doing so provides a future-proof installation to handle future/higher data rates.

8. Can single-mode and multi-mode fiber be used in the same system?

You use both single-mode and multi-mode fiber if you're using a switching system that supports both fiber types. However, you must connect a single-mode fiber to a single-mode port and connect multi-mode fiber to a multi-mode port.

Connecting single-mode fiber directly to multi-mode fiber is not feasible – the difference in core sizes introduces significant signal loss.

9. Do any applications require fiber?

Most applications are media agnostic. That is, they are supported by a variety of cable types, including copper and either multi-mode or single-mode fiber optic cable. Although copper cables can be used for many high-speed protocols, the link distances supported by copper standards are often very short.

Multi-mode fiber can support 40/100GbE links up to 150 meters long, and single-mode fiber can support links of 10-km or longer. The increasing need for security is also driving users to deploy fiber cables. In fact, it's required for many government applications.

10. Is fiber more difficult to install than copper cables?

It depends on the comfort level and skills of your technicians. Fiber optic cable has been the standard choice for communications backbones for many years. Installers are generally comfortable with the technology. However, there's a learning curve for those just starting out. The invention of the pre-polished field installable FASTConnect fiber connectors from AFL Telecommunications have vastly improved the ease of installation. These connectors can typically be installed in under 1 minute.

Of course, the new generations of copper cabling have their own learning curves. High-speed copper cable requires more precise and time-consuming installation techniques than were required in the past. Compared to newer grades of copper cable, fewer regulations exist on the methods that guide how optical cable is pulled and terminated. There's no need to worry about the location of EMI/RFI sources during installation. Also, with fiber cables, when you migrate to 10GbE and higher data rates, there are no requirements for mitigating techniques as there are with UTP copper media.

11. What are the distance limitations of single-mode and multi-mode fiber? Also, what are the fiber sizes for each distance limitation?

Multi-mode distance limits vary with the grade of fiber and Ethernet variant (see table).

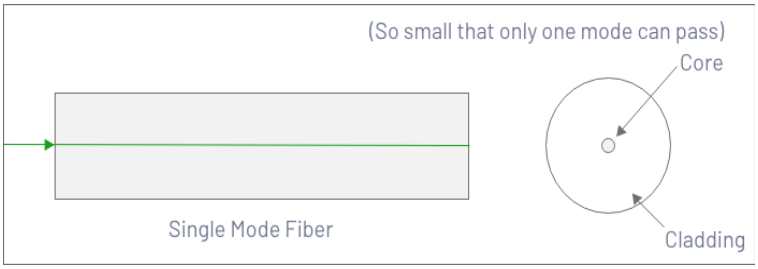
Single-mode fiber can transmit signals for 20 km (12 miles) or more and is therefore used primarily for long haul applications.

Category	Minimum Modal Bandwidth 850/953 1300nm	Fast Ethernet 100BASE-FX	1 GB (1000mb) Ethernet 1000BASE-SX	1 GB (1000mb) Ethernet 1000BASE-LX	10 GB Ethernet 10GBASE-SR	40 GB Ethernet 40GBASE-SWDM4	40 GB Ethernet 40GBASE-SDR	100 GB Ethernet 100GBASE-SR10
FDDI (62.5/125)	160/-/500 Mhz-km	2000m	220m	550m	26m	Not Supported	Not Supported	Not Supported
OM1 (62.5/125)	200/-/500 Mhz-km		275m		33m	Not Supported	Not Supported	Not Supported
OM2 (50/125)	500/-/500 Mhz-km		550m		82m	Not Supported	Not Supported	Not Supported
OM3 (50/125) *Laser Optimized*	1500/-/500 Mhz-km			550m	300m	240m Duplex LC	100m (330m QSFP+eSR4)	100m
OM4 (50/125) *Laser Optimized*	3500/-/500 Mhz-km				400m	350m Duplex LC	150m (550m QSFP+eSR4)	150m

12. What is single-mode fiber?

Single-mode fiber is optical fiber that enables light to travel down a single path, known as the fundamental mode. The fiber features a core diameter of 8 to 9 microns. Use single-mode fiber to transmit signals over extreme distances up to many miles or kilometers.

Single-mode bandwidth / distance limit depends on the grade of transceiver. An inexpensive 1000-BaseLX device supports gigabit transmissions up to 5km. Other variants support much further distances.



13. What wavelengths are used with single-mode fiber?

In single-mode fiber applications, the most common wavelengths are 1310 nm and 1550 nm. At 1310 nm, chromatic dispersion (pulse width spreading) in the fiber is near zero; at 1550 nm signal attenuation is near its minimum.

14. What is the cutoff wavelength of single-mode fiber?

It's the minimum wavelength that supports one mode of propagation. Above the cutoff wavelength, single-mode fiber propagates only one mode. Below the cutoff wavelength, single-mode fiber propagates more than one mode, like multi-mode fiber.

15. When should I use single-mode fiber?

Single-mode fiber is optimal for long-haul transmissions of up to 30 km (18.75 miles). It's ideal for transmitting signals between buildings on a university or corporate campus. You can also use it for long-haul transmission between separate facilities.

16. Why does single-mode fiber cost less than multi-mode fiber?

Single-mode fiber has a step index core, while multi-mode fiber has a graded index core with very tight performance requirements. The extra precision needed to manufacture the fiber boosts multi-mode fiber production costs. However, light sources and receivers suitable for single mode fiber are more expensive than those used for multi-mode fiber.

17. Why not use single-mode fiber for all applications?

Costs. Laser light sources and photodetectors used in single-mode applications are more expensive than those that use multi-mode cable. This difference translates into higher equipment costs for single-mode systems.

18. Do signals really travel faster in fiber optics?

Fibers "speed" doesn't refer to the speed of the signal in the fiber. Instead, it refers to the bandwidth potential of the fiber.

In fiber optics applications, sending communications "at the speed of light" really means the speed of light in glass which is approximately 125,000 miles per second. That's blazing fast! You may be surprised to know that signals in unshielded twisted pair (UTP) category cables travel at about the same 125,000 miles per second.

19. When I want to join fiber cables using a connector, what should I watch out for?

Whenever you connect or disconnect optical cables you want to avoid damaging the fiber or the connector on the device. When you disconnect a fiber cable, use dust caps to protect the end from damage. Make sure to clean the fiber and connector before mating them. Also, make sure that there is no optical signal in the cable or coming out of the connector when you connect, disconnect, or clean optical cables.

20. What do I use to clean fiber optic connectors?

You'll need special solvents, cleaners, lint-free wipes, and swabs to do the job. Solvents are used for cleaning the water blocking gel used in underground cabling. We recommend using AFL One-Click Fiber Cleaners to quickly and effectively clean inside connectors. Also, always follow the manufacturer's cleaning instructions.

21. What is a better way of communicating, copper cables, or fiber optic cables?

Telecommunications and CATV companies use fiber optic cables to save $$. Fiber cable has much greater bandwidth and lower attenuation. This enables signals to travel 100 times farther and more than 1,000 times faster than on copper wire. And, fiber can deliver more voice or video channels per fiber pair.

22. I'm trying to test fiber optic cable. Please tell me the difference between dB and dBm.

dB: Table of Ratios

dB	P(in)/P(out)	V(in)/V(out)
-30	0.001	0.032
-10	0.10	0.32
-6	0.25	0.50
-3	0.50	0.71
-1	0.79	0.89
-0.6	0.87	0.93
-0.3	0.93	0.97
-0.1	0.98	0.99
0	1.00	1.00
0.1	1.02	1.01
0.3	1.07	1.04
0.6	1.15	1.07
1	1.26	1.12
3	2.0	1.4
6	4.0	2.0
10	10	3
30	1,000	32

Fiber optic and most other power measurements are expressed using a logarithmic (powers of 10) scale in units of decibel (dB). The dB unit is a ratio (see equation). Ten times more power (101) reflects an increase of 10 dB. One hundred times more power (102) equals an increase of 20 dB.

Signal losses are reflected by negative values. For example, -3 dB represents a signal reduced to ½ of the original value while -6 dB indicates a signal power level ¼ its original power.

The equation is actually: dB=10 log (power 1/power 2)

For absolute measurements, you must have a reference point. If 1 milliwatt of power is the reference, the equation becomes: dBm= 10 log (power/1 mW)

So, 1 mW is 0 dB, 10 mW is 10 dB, 0.1 mW is -10 dB, etc.

23. What skills do I need to install optical fiber?

You'll need skills similar to the ones required to install UTP copper cabling. Fiber optic cable construction uses strength members that enable you to pull long cable runs without destroying the cable. Field termination kits that make optic fiber termination as easy as working with coaxial cable are available. Also, as with electrical installations, you need to get trained before you work with fiber cables.

24. How far can I bend optical fibers during installation?

Manufacturers specify the minimum bend radius for optical fiber. It's very important not to bend the fiber beyond the manufacturer's recommendations. If you don't know the specifications, here's a rule of thumb: for standard fiber optic cable, the minimum bend radius is 20 times the cable diameter. Many newer cables use bend-insensitive fiber, which has an extremely tight bend radius.

25. What happens if I bend a fiber too far?

Bending fiber beyond the minimum bend radius causes loss in the fiber optic signal and could damage the fiber.

26. When must I clean fiber optic connectors?

Clean connectors are critical for link performance. Clean both the fiber and connector ends immediately before mating. Make sure that no optical signal is in the fiber during cleaning. Many fiber optic testers also require cleaning after each use.

27. Why must I clean fiber optic connectors?

The size of a dust particle is about the same size (or slightly larger) as the core of a single-mode optical fiber. Even in clean environments, one dust particle could completely block an optical signal.

28. What are the types of fiber optic connectors?

Common types of fiber optic connectors include LC, ST, SC, SC/APC, and LC/APC are the most common connectors used for VDV cabling. LC connectors are very popular because they are small, easy to use, and deliver high levels of performance.

Multi-fiber connectors are gaining popularity. MTP/MPO connectors are preferred for 40-Gbps and 100-Gbps

29. How do I repair a broken fiber?

To repair broken fibers, choose from fusion splicing, mechanical splicing, or connector splicing methods.

The best method for each situation depends on the optical loss budget, type of application, available equipment, and the skills of the repair technician. In most cases, you'll choose a fusion or mechanical splice for repairs. You'll use a connector splice when you must install another component or device in line with the fiber.

30. What is a mechanical splice?

A mechanical splice is a device that holds two fiber ends in a precisely aligned position that enables light to pass from one fiber to another.

31. What is a fusion splice?

A fusion splice uses a splicing machine to align the fibers and fuse or weld them together by using an electric arc. This approach produces a very low-loss connection that is superior to a mechanical splice. However, the equipment required for fusion splicing is more expensive. {Include link to 'Fiber Cleavers and Splicers' category}

32. What types of fiber optic cables are available for structured cabling applications?

Many fiber cable types are available, depending on the application. Fiber optic indoor cables are available as riser or plenum rated. Outdoor cables are available as aerial or direct burial cables. Indoor/Outdoor rated cables are available for building to building applications requiring both ratings. Armored cables are also available to provide extra protection from rodent damage or tampering.

33. What is dark fiber?

Dark fiber is unused fiber optic cable that has been installed for future use. Structured cabling is often installed with extra fiber optic cables to enable system expansion in the future.

If dark fiber is available, you can use it to install new equipment without the added cost of installing new fiber. The availability of dark fiber simplifies installation and reduces costs when signals are transmitted between floors of a building or between buildings on a campus.

34. How do you identify undocumented fiber cables?

The color of the fiber jacket might help you identify the type of fiber. Multi-mode 62.5/125 (OM1) jacketing is orange. Multi-mode 50.125 (OM3/OM4) jacketing is aqua. Single-mode jacketing is yellow. If the jacket is rated for outdoor use, it will most likely be Black in color, and you cannot tell simply by the color. You can use the print on the jacket to identify what type of fiber it is.

Cable markings might also help to identify the cable's type and manufacturer. Manufacturer data sheets can provide performance specifications.

35. What cable markings are used for plenum-rated fiber optic cable?

Plenum-rated fiber optic cable is marked as OFNP, which stands for Optical Fiber Nonconductive Plenum. If the fiber optic cable includes metallic armor, it is marked as OFCP for Optical Fiber Conductive Plenum.

36. What cable markings are used for riser-rated fiber optic cable?

Riser-rated fiber optic cable is marked as OFNR, which stands for Optical Fiber Nonconductive Riser. If the fiber optic cable includes metallic armor, it is marked as OFCR for Optical Fiber Conductive Riser.

37. Will fiber cable survive harsh conditions?

Optical fiber is not your typical glass. Made of ultra-pure silica, it is an extremely strong material that can handle exposure to extreme temperatures and pressures.

In fact, tensile strength (resistance to pulling) of optical fiber exceeds 600,000 pounds per square inch. It's stronger than copper or steel strands of the same diameter and easily surpasses the strength requirements of modern communications applications.

38. What is a light-emitting diode?

A light-emitting diode (LED) is a semiconductor device that emits light when an electrical current passes through it. In structured cabling applications, LEDs serve as a low-cost light source for low-data rate fiber optic links such as 100BASE-SX Ethernet cables. A laser diode or VCSEL is used for high-data rate applications.

39. What is a laser diode?

A laser diode is a semiconductor device. It emits a narrow beam of coherent light, such as the beam of a laser pointer. Laser diode light sources are used in transceivers for high-data rate applications.

40. What is a VCSEL?

A vertical cavity surface-emitting laser (VCSEL) is a special type of laser diode, less costly to manufacture than other types of laser diodes. VCSELs can be mass-produced with high yield rates. Their smaller footprint makes them ideal for use as fiber optic transmitters for high-data rate applications.

41. What is a photodetector?

A photodetector is a semiconductor device that converts an optical signal into an electrical signal. Fiber optic transceivers use photodetectors to convert optical pulses to electrical signals. They are the receiver portion of a transceiver.

42. Can fiber optic light cause harm?

The wavelengths of light used to transmit signals in fiber optic cable are in the infrared range. Although not visible to the human eye, laser light is a concentrated beam that can cause injury or blindness. Avoid looking directly into a fiber strand.

43. How does an optical power meter differ from an OTDR?

Fiber optic power meters measure the amount of power transmitted in a fiber.

OTDRs (optical time domain reflectometers) work like optical radar to find faults in cables, measure cable length, or test the signal loss in cable splices. Use OTDRs to troubleshoot or document outside plant cables that include splices. (Usually premises cabling runs don't include splices.) You can find a more detailed explanation of cable testing options here. Look here for more information about OTDRs.

44. What is optical return loss?

It's simply a measure of unwanted reflectance; the signal reflected at a connector or splice, caused by imperfect mating of the fibers.

The reflected light might cause laser transmitter problems with linearity. Or, the light might create background noise that affects transmission. Reflectance does not affect LED systems.
Good, single-mode ORL values include:

- 30-40 dB for PC connectors
- 40-50 dB for super PCs
- 50+ dB for APC connectors

ORL has become a problem in multi-mode, Gigabit systems that use VCSELS.

45. What is an optical loss budget?

It's the maximum allowable amount of optical power lost or reduced at a fiber optic link. Engineers calculate this loss as the difference between the output power of the light transmitter and the sensitivity of the receiver.

46. How is optical loss budget data used in structured cabling system design?

Calculate the total loss of power at a fiber optic link by adding the signal attenuation caused by glass fiber, connectors, splices, and other optical components.

To determine the loss margin, subtract the total loss from the loss budget.

To account for future cabling repairs and aging of optical components maintain a loss margin of at least 3 dB.

47. What type of fiber is required to communicate at gigabit speeds?

It depends on how far you want to send a signal. Practically every fiber manufacturer has 50/125 laser-optimized premium multi-mode fiber (/OM3/OM4/OM5) that will satisfy typical structured cabling distance needs.

48. In which situations can I string fiber cable overhead?

There are two solutions: self-supporting aerial cable or regular cable lashed to a messenger. Cables that are not self-supporting should not be strung overhead without a messenger, even for short distances.

49. Can I patch into my multi-mode fiber data distribution system by using an adapter of some kind?

The connection from single-mode to multi-mode fiber is OK. The big multi-mode fiber catches all the light. But connecting from multi-mode to single-mode fiber is a problem because it gives a 16-dB to 20-dB loss. You must match connectors. You can get adapters, called media converters, which will convert from single-mode to multi-mode and vice versa.

50. Are there problems if I splice together fiber from different manufacturers, if the cable is manufactured to the same specifications?

There are no problems if the cables are the same type and size. For example, multi-mode 62.5/125 or 50/125 and single-mode fiber should be normal (no dispersion shifting).

51. What is the difference in connecting tight-buffered and loose-tube cables?

You can terminate mechanical fiber connectors to tight buffered cable directly. The 900-micron coating on the fiber is rugged enough to enable you to join the connector directly. If there is a 3-milimeter jacket, crimp it to the connector for strength.

A loose tube cable has a 250-micron buffer on the fiber and is too fragile to attach a connector directly. Be sure to use a breakout kit that wraps the fiber in a protective tube before termination.

52. Can I splice 62.5/125 fiber to 50/125 fiber?

No, the transition loss will be high. Core size, which determines numerical aperture (NA) needs to be identical. NA is the maximum acceptance angle at which light is accepted and propagated down the fiber. Fifty-micron fiber has a lower NA than 62.5 creating a -1.6 dB loss.

53. Will a single-mode connector work on multi-mode cable?

Because field installable connectors, like the AFL FastConnect fiber connectors, have a pre-polished fiber stub, the connector must match the core size of the fiber being terminated.

54. I am looking for a fast, inexpensive, and reliable way to do fiber reel acceptance testing. What type of equipment should I use with an OTDR or power meter?

The normal way to test fiber on the reel is to complete an inspection of the reel and its contents. Any sign of physical damage means you should test it very carefully to ensure that the cable or fiber has not been damaged.

55. What do I need to connect optic fiber cable to a Cat 5 cable?

You need a media converter, a device you can get for under $100 for many applications (e.g. non-industrial).

56. If I have a 50-micron fiber backbone, can I use 62.5 fiber jumpers on each end?

NO! On the receiver end it's OK to do this. On the transmitter end, however, joining the larger 62.5 core with smaller 50-micron fiber will produce losses of 2 to 4 dB.

57. If I have a have 62.5 fiber backbone, can I use 50-micron patch cords?

NO, for the same reason as the previous answer. The only difference is that in this case, the excess loss occurs at the receiver end. In both cases, the losses depend on the modal distribution in the fiber. Losses are the result of the source output and the number of connections in your system.

58. Will intelligent buildings use fiber optics or copper wiring to carry voice, data, and video throughout a structure?

They will carry both:

- Projects will use fiber when distances are longer than 90 meters or when in environments where electrical noise or power spikes are likely.
- Most backbones will be fiber.

59. I'm running a secure fiber optic cable through a conduit. Are there special tools that help me pull fiber optic cable? If so, where can I find these tools?

You use the same gear to pull fiber and other types of cable. However, there's one big caveat: Pull **all** fiber optic cables by their strength members, which are usually Kevlar fibers. **Do not** simply put a Kellum's grip on the jacket and pull. That will ruin most cables.

60. In data center and storage area network (SAN) environments, which cabling media are used most often?

You can deploy a variety of cabling media in the data center. Multi-mode and single-mode fiber, direct attach connection (DAC) cables, CX4 copper cables, and Category 6A twisted-pair cables all have their place. The cabling type that you use depends on port type, project cost, and link length. Data center designs can use a centralized/direct connect, distribution/top-of-rack switching, zoned distribution, or combination architecture. The architecture dictates the distance.

Often, you'll use fiber:

- To connect top-of-rack switches to an aggregation switch at the end of the row or in another location
- In centralized architectures for home runs
- In zoned-distribution architectures

In many data centers, multi-mode fiber supports all link lengths in uses such as connecting top-of-rack switches within rows back to an aggregation or core layer or connecting servers to end-of-row switches.

61. Is it possible to send a forward and reverse signal along the same fiber?

Yes, the direction is unimportant. FTTH PONs use this technique to send signals both ways over one fiber. You can send a signal upstream on one wavelength and downstream on another. Folks have been doing this for years. Use 1300 nm and 1550 nm on single-mode fiber. Or, use 850 nm and 1300 nm on multi-mode. For example, you could use a 1550 nm transmitter with a fiber amp to broadcast to numerous locations. Then, use a 1300 nm signal coming back upstream with 1300/1550 nm WDMs.