



BEYONDTECH™

 THE MOST USED
FIBER OPTIC CONNECTORS

OVERVIEW

This white paper explains optical fiber connectors' use, as well as their characteristics and types. It also points out which ones are the most used and why.

-  1 In **Optical fiber connectors' types** you will find information about connectors' classification: whether they are PC, APC or UPC, multimode or single-mode, followed by a description of the connectors that gained popularity over the years.
-  2 In **The most used connectors** it is said which are the most popular connectors, according to the data we collected.
-  3 In **Beyondtech's Connectors** we describe the quality of the products we offer, as well as their main technical characteristics.



INTRODUCTION

Optical fiber connectors are mechanical devices that are placed at the end of a fiber cable, allowing it to be connected to telecommunication equipment such as another cable, a receiver or a light source. They align the core of microscopic fibers together so light pulses can travel through them and allow communication. These devices make temporary links, which means they can be easily joined and detached.

A place in which two connectors meet, marks a spot in an optical fiber data link where signal power can be lost. Therefore, in order to provide suitable attenuation levels optical fiber connectors need to have low back reflection and be able to perfectly align fiber together over hundreds or thousands mating cycles.

Over the course of optical fiber technology development and improvement, several communication companies have created and introduced more than 100 connectors to the market,¹ but just a few of them made it to the present days. And even fewer are considered the most used.

Optical fiber connector identifier – The Fiber Optic Association.

OPTICAL FIBER CONNECTORS TYPES

Optical fiber connectors

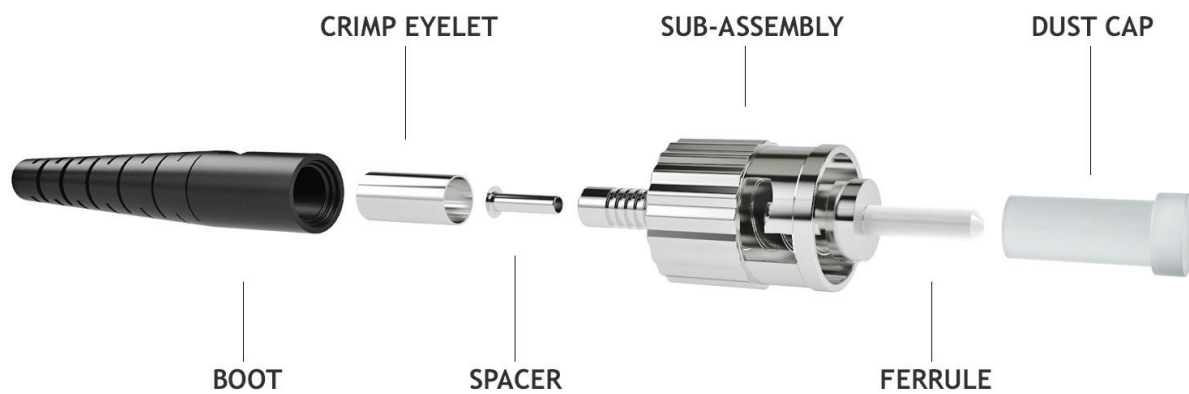
Optical fiber connectors are used in premises installations, inside and outside plant applications, in CATV and telephony systems to join cables and equipment where a connect/disconnect capability is needed.

Connectors are considered the weakest link in a fiber optic system, because they mark a spot in which signal power can be lost. So for optical fiber systems to have an outstanding performance, well designed connectors, good terminations and an installer with skills are needed.



There are several types of optical fiber connectors and they are all integrated by three main mechanisms:

- **The ferrule:** This is the most important component of fiber optic connectors because it holds, protects and aligns the glass fiber. Ferrules are usually made of ceramic, high-quality plastic or metal. Of all those materials, zirconia ferrules are the ones that offer the highest performance and durability after several mating cycles.
- **Coupling mechanism:** It keeps the connector in place when it is joined to another device. It could be push-pull or bayonet style.
- **Connector body:** Is the structure that holds the ferrule, the coupling mechanism and the boot. It is made of plastic or metal.



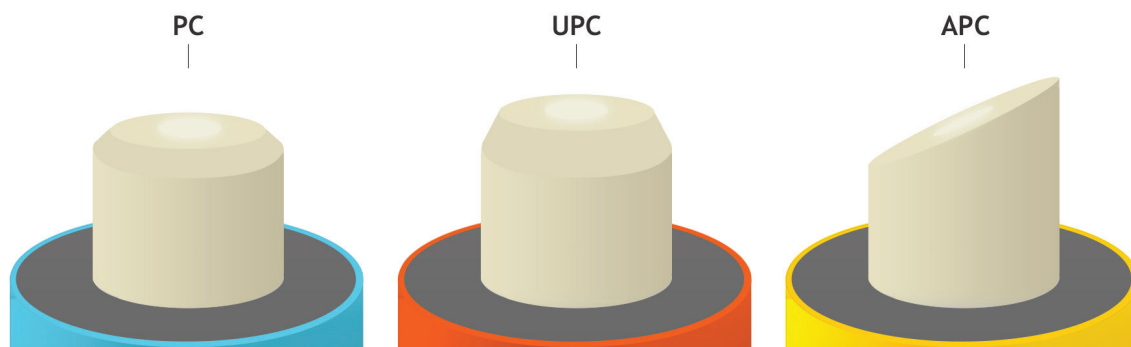
Connectors' end-face

The connectors' end-face determines what the return loss, also known as back reflection, of a fiber optic cable will be.

Return loss is the loss of power that happens when light returns from the fiber to the light source device due to discontinuities or air gaps caused in the ferrule's end-face. It is measured in decibels.

Ferrules are polished in different ways, which classifies connectors as:

- **PC (Physical Contact):** PC connectors are polished with a slight curvature, which reduces the air gaps between fibers. These connectors' back reflection is between 30dB and 40dB.
- **UPC (Ultra Physical Contact):** UPC connectors also have a convex end-face, but have a finer surface finish. Their return loss goes from -40dB from -55dB, which makes them reliable for transmitting TV and data signals.
- **APC (Angled Physical Contact):** APC connectors have an 8° angle cut in their ferrules, which makes connections between optical fibers even tighter. Industry standards indicate that APC connectors back reflection is -60dB.



Fiber optic termination

Since the beginning of fiber optic technology, terminating a cable meant you had to attach a connector with an adhesive, polish the ferrule and then wait the adhesive to cure overnight, a process that is considered to be very difficult if you have to do an emergency termination field.

Luckily, a lot of other methods were developed overtime in order to simplify this process, from fast curing adhesives and connectors that need to be heat up to melt the adhesive or prepolished/splice connectors that don't require any adhesive.

- **Epoxy/polish connectors:** Although terminating a fiber with this kind of connectors is very difficult, they are still preferred because they are more reliable and have lower loss and costs. Typical loss of epoxy/polish connectors is around 0.1dB to 0.3dB.

- **Pre-polished/splice connectors:** With this connectors it isn't necessary to use any adhesive. They have a short stub fiber glued inside and they are already factory polished. They attach to the fiber with a crimp and a mechanical splice with index matching gel that reduces loss, which makes them really easy to install. Typical loss of this kind of connectors is around 0.5dB to 0.7dB.

Single-mode and multimode connectors

Optical fiber connectors can also be categorized as single-mode and multimode, and there are several differences between each other.

For starters, single-mode connector's bodies and boots are blue, while multimode's are beige and APC connectors' green. Then there's size: single-mode fiber connectors have 126 microns openings, while multi-mode connectors are 127/128 microns.

And the key differences: single-mode connectors have a higher price, but also higher data transmission rates. They offer lower distortion as well as reduced attenuation when compared with multimode connectors.

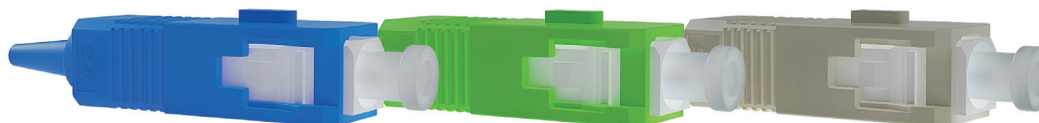


Optical fiber connector's types

Hundreds of types of optical connectors have been created over the course of the years by telecommunication companies, but not all of them acquired great popularity in the marketplace.

Connectors that prevailed comply with TIA Fiber Optic Connector Intermateability Standards (FOCIS), the specifications manufacturers need to follow to assure their connectors will be intermateable with other manufacturer's connector.

SC (Standard Connector)



The SC was created in the mid-eighties by the Japanese telecommunication company Nippon Telegraph and Telephone, but it wasn't widely used at the beginning because it was considered highly expensive. ST connector has a typical connection loss of 0.25 dB and is rated for 1000 connect-disconnect cycles.

SC connector aligns fibers with precision due to its 2.5mm spring-loaded ceramic ferrule, which uses a push-pull joining system that has given it the name of "Set and Click" and "Stab and Click" connector. It was initially used in Gigabit Internet applications, but was replaced by smaller connectors. It is currently used with single mode and multimode cables in CATV applications and telephony environments.

FOCIS-3: TIA-604-3

LC (Lucent Connector)



The LC, also known as Little Connector, was created by Lucent Technologies and is widely used in single mode applications because it has an excellent performance and it can be simply terminated with any adhesive. It has a 1.25mm ceramic ferrule that uses push-pull mechanism and has a typical insertion loss of 0.10 dB. LC connector's small size reduces space needed for patch panels in 50% compared with SC or ST connectors, thus it is used in high density telecommunication applications such as racks and panels, FTTH, premises distribution, Local Area Networks, Data processing networks and CATV. It can be used with both single mode and multimode cables, but is favored for single mode fiber applications.

FOCIS-10: TIA-604-10.

ST (Straight Tip)



The ST was created and licensed by AT&T and is still one of the most popular connectors used in networking applications. It has an insertion loss of about 0.25 dB and holds the fiber with a ceramic, spring-loaded 2.5mm ferrule that stays in place with a half-twist bayonet mount, which has made common for technicians to also call them “Set and Twist”, “Stab and Twist” or “Single Twist” connector.

ST connector is used in both long and short distance applications such as campuses or corporate network environments and military applications. It can be easily attached and detached due to its flexibility and is rated for roughly 500 mating cycles.

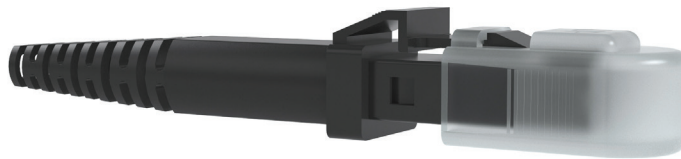
FOCIS-2: TIA-604-2

FC (Ferrule Connector)



Designed by Nippon Telephone and Telegraph (NTT), the FC is a 2.5mm zirconia ceramic ferrule, which stays in place with a screw-on nut mechanism. It is available for both single and multimode fiber, but it's widely used in single mode applications and in high-speed optical fiber communication networks. It is also used in high-vibration environments due to its threaded body. Its insertion loss is of 0.3 dB.

MTRJ (Mechanical Transfer-Registered Jack)



MTRJ is duplex connector, meaning it holds two fibers at the same time. Its body and ferrule are made of plastic and it has male and female versions that stay in place with pins. MTRJ only works with multimode optical fiber.

MPO (Multi-fiber Push-on)



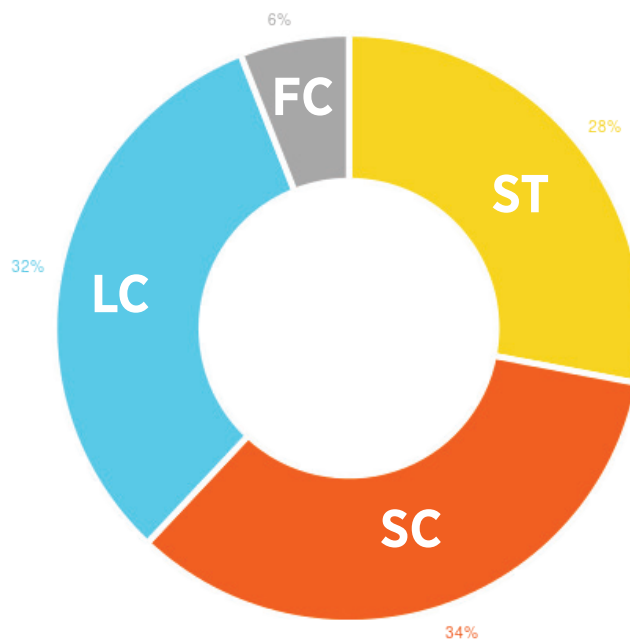
Is a multi-fiber connector that brings together from 12 to 24 fibers in a single rectangular ferrule and is used for building 40Gb to 100Gb optical parallel connections. It comes in UPC and APC versions. A male MPO connector has two pins on its ferrule tip, while females has two holes. Its typical insertion lost is 0.25dB.

THE MOST USED CONNECTORS

Best sellers

No stores or technicians seem to agree when asked “What are the most popular optical fiber connectors?”

There isn't any verified information for such a frequently asked question. Therefore, we decided to investigate it searching over every optical fiber equipment store that would let us check which ones were their most popular products. Using Beyondtech's information and the data we collected, we found that SC connector is the most popular connector in 34% of the visited online stores, LC connector in 32%, ST connector in 28% and FC connector in 6%.



The characteristics that made these connectors the most popular ones are:

- SC connectors are low cost, simple and durable. They offer accurate fiber alignment thanks to their ceramic ferrule.
- LC connectors' small size makes them perfect for high density environments.
- ST connectors are still the most used in campuses and building multimode fiber applications.
- FC connectors provide more reliable real-time data transmission in high vibration scenarios.



BEYONDTECH'S CONNECTORS

What we offer

Beyondtech is an American fiber, rack network and infrastructure equipment designer, manufacturer and provider. We have an extensive line of fiber products, from patch cords to connectors and couplers. Our wide connectors' variety is manufactured with high-quality components, providing reliable connections.

Our connectors' specifications

<i>Item</i>	<i>Single mode</i>	<i>Multimode</i>
Insertion Loss	≤0.2 dB	≤0.3 dB
Insert-pull test	1000 times	1000 times
Operating Temperature	-104 °F ~+185 °F	-104 °F ~+185 °F
Ceramic ferrule spec	125.5um Concentricity deviations: ≤ 1um	127um Concentricity deviations: ≤ 3um
Suitable fiber	9/125 um	50/125 um, 62.5/125 um

Table 1: Beyondtech Connectors Specifications.

<i>Fiber type</i>	<i>Connector</i>	<i>End-face</i>
OM1 62.5 um	Beige/Black/Aqua	Beige
OM2 50 um	Beige/Black/Aqua	Black
OM3 50 um	Beige/Black/Aqua	Aqua
Single mode	Blue	Blue
Single mode APC	Green	Green

Table 2: Connector color coding.



<i>Connector Boot</i>	<i>End-face</i>	<i>Fiber type</i>
Blue	UPC	Single mode
Green	APC	Single mode
Black	UPC	OM2 50 um
Grey/Beige	UPC	OM1 62.5 um
White	UPC	OM3 50

Table 3: Connector color coding according to the endface polish style.

CONCLUSION

When choosing a connector you have to consider the optical fiber cable you are going to use and the purpose. Therefore, though LC, ST and SC are the best-selling and most commonly used connectors, you have to be sure what your connection needs are and be aware there are another connector types that might suit the requirement.

Beyondtech manufactures and extensive optical fiber connectors product line, using very high-quality components in order to achieve accurate, precise and reliable connections. Current and future telecommunication technologies demand an efficient performance in data communication companies.

Beyondtech optical fiber products receive and transmits data without outside interferences, providing right solutions and excellent performances.

Digital sources:

Newport.com, (2016). *Fiber Optic Basics*. [online] Available at:
<http://www.newport.com/Fiber-Optic-Basics/978863/1033/content.aspx>

Thefoa.org, (2016). *Fiber Optic Connector Identifier*. [online] Available at:
<http://www.thefoa.org/tech/connID.htm>

Thefoa.org, (2016). *Fiber Optic Connector Identifier*. [online] Available at:
<http://www.thefoa.org/tech/connID.htm>





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