

Specifying Fiber Optic Connectors

By Andy Devine, Coastal Connections

Overview

This Specifying Guide is provided, as an aid to help select and purchase fiber optic connectors for each of your project needs. It covers the different types of commonly used connectors and what to specify when ordering connectors.

Common Connector Types

DIN: A metal screw on connector, with a 2.5mm ferrule, developed by Siemens. Deutsch Telecom mainly uses it. This is a good connector to use where the ruggedness of a metal screw on connector is required but where there is not enough space for a FC Connector.

E2000: A plastic push-pull connector, with a 2.5mm ferrule, developed by Diamond. The built in dust cap always stays on the connector protecting the ferrule and blocking harmful laser light when the connector is disconnected.

FC: A metal screw on connector, with a 2.5mm ferrule, developed by NTT. The ruggedness of this connector leads to its extensive use at the interfaces of test equipment. It is also the most common connector used for PM, polarization maintaining, connections. Please note that there are currently four different specifications for the key width on FC connectors and for the slot width on FC adapters. Therefore not all FC connectors will fit into all FC adapters.

LC: A small form factor plastic push/pull connector, with a 1.25mm ferrule, developed by Lucent. The LC has been referred to as a miniature SC Connector. It is mainly used in the United States.

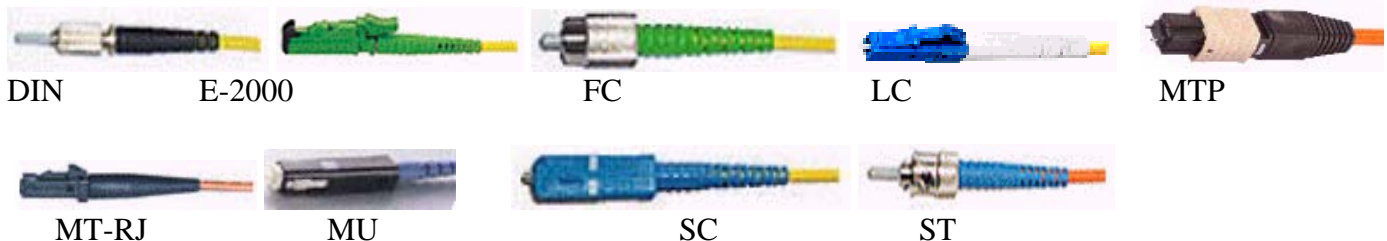
MTP: A push/pull ribbon connector, which holds up to 12 fibers. The 12-fiber capacity allows for very dense packing of fibers and a reduction in the number of connectors required.

MT-RJ: A push/pull ribbon connector, which holds 2 fibers. The idea of a two fiber connector is to support transmit and receive fibers in one connector.

MU: A small form factor plastic push/pull connector, with a 1.25mm ferrule, developed by NTT. The MU has been referred to as a miniature SC Connector. The MU is very similar to the LC except that it is mainly used in Asia.

SC: A plastic push-pull connector, with a 2.5mm ferrule, developed by NTT. Push-pull connectors require less space in patch panels than screw on connectors. The SC is the second most commonly used connector for PM, polarization maintaining, connections.

ST: A metal bayonet coupled connector, with a 2.5mm ferrule, developed by AT&T. The ferrule moves as load is applied to the cable in this aging design. There is a version of the ST, which the Navy uses extensively, where the ferrule does not move as a load is applied to the cable.



History of Different connector Types

The ST connector is the oldest design of the connectors still in common use. It was the first connector to use a 2.5mm ferrule. The FC and DIN connectors improved on the ST connector by: isolating cable tension from the ferrule, keying the location of the ferrule for angle polishing, and threading onto the adapter for a more positive connection. The SC connector was then developed to eliminate having to screw and unscrew

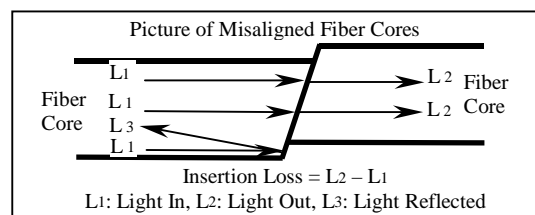
the connector every time and to reduce the cost by molding instead of machining the connector. A big advantage of this push/pull connector over a FC connector is that less room is required between connectors on patch panels. The E-2000 was developed as an improvement on the SC connector design by having: a latch that retains the connector, a dust cap always in place, and a smaller size. As patch panel densities increased the LC and MU connectors were developed to reduce the space required for connectors on patch panels. Both of these connectors use a 1.25mm ferrule. The MT-RJ connector was then developed to put transmit and receive fibers into one connector. This was the first connector to use the MT ferrule design as opposed to a 2.5mm or 1.25mm diameter ferrule. The MTP connector was then developed to increase fiber density even more. The MTP currently has 12 fibers in its MT ferrule however a 24-fiber version is under development. Obviously there are many more influences that lead to the development of these different commonly used connector types but I hope this helps you understand why all of the different connector types exist. Beyond these commonly used connector types there are a multitude of specialty connectors.

Insertion Loss

Typical specification: Maximum insertion loss $\leq 0.5\text{dB}$. Insertion loss is a measurement of the light lost as it passes through a connector. The light loss comes from the cores of the mating fiber not aligning. This misalignment comes from either one core being offset from the other or one fiber being at an angle to the other.

Connectors that you buy will have a higher average and maximum insertion loss than what is specified from the manufacturers. The reason for this is that manufacturers test the cables they produced against a reference cable, which is very close to being perfect. Everyone does this to make comparing specifications between manufacturers easier. However it also means that the insertion loss that the manufacturer measures will be lower than what you measure unless you also use a reference cable. For example two connectors with 0.5dB insertion loss relative to a reference cable might have 1.5dB insertion loss when mated to each other. How can this happen, you might ask? The best way to understand this is to think of the fiber in the manufacturers reference cable as being perfectly centered and the two cables you are buying as having connectors “A” and “B”. Now think of connector “A” as being 0.5um offset toward the connector key causing 0.5dB insertion loss relative to the manufacturers reference cable. Connector “B” is also offset by 0.5um but away from the key also causing 0.5dB insertion loss relative to the reference cable. Now you mate connector “A” and “B” together and the fibers are offset by 1um causing 1.5dB insertion loss. The insertion losses do not directly add up since we are dealing with the area in round fiber cores mismatching.

The other area to be aware of is that some manufacturers specify typical insertion loss and not maximum insertion loss. Since typical implies the average of all of their terminations the maximum insertion loss can be two to four times higher than the typical insertion loss.

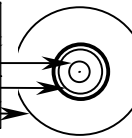


Visual Inspection Criteria

Typical singlemode specification: No visual scratches when viewed at 200X. This is a very poor specification as it is subjective and very dependent on the quality of the microscope used.

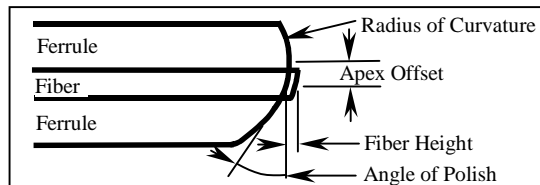
A better way to specify visual inspection criteria is to specify what size imperfections are allowed on the fiber.

Note: Most commonly used 200X microscopes will not pick up a scratch less than 2um and these scratches will not cause degradation in the performance of the connector.

Singlemode Visual Inspection Criteria				Ferrule Endface
Diameter	Scratch	Chips/Voids	Fixed Contaminant	
0 - 50um	≤2um	≤ 2umØ	≤ 2umØ	
50 - 100um	≤2um	≤ 2umØ	≤10umØ	
100 - 400um	≤3um	≤10umØ	≤20umØ	

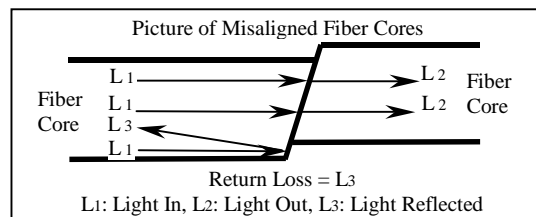
Endface Geometry

Typical specification: Meet Telcordia GR-326-CORE or IEC 60874-14-n specification. Endface geometry defines the shape of the connector where the fibers meet to insure mating of the fibers. There are four parameters that are typically specified: radius of curvature, apex offset, fiber height, and angle of the polish. These parameters are defined in the Telcordia or IEC specifications.



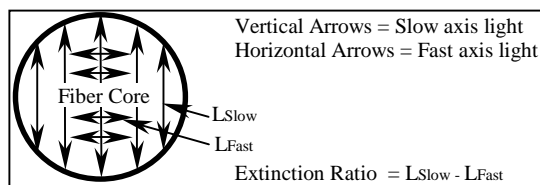
Return Loss

Typical specification: Singlemode return loss >50dB for PC and >60dB for APC connectors. Multimode return loss is typically >40dB. Return loss is a measurement of the light reflected back from a connector interface.



Extinction Ratio

Typical specification: Extinction Ratio >20dB. Extinction ratio is the difference in power between the desired light and the undesired light traveling down a fiber. Extinction ratio is only specified when PM, polarization maintaining, fibers are used.



About the Author

Andrew Devine is the President of Coastal Connections, www.coastalcon.com 805-644-5051, a specialty fiber optic termination company. Formerly he was the Director of Operations and a Business Unit Leader at Tempo/RIFOCS. He has worked with fiber optic connectors in military and telecommunication applications for sixteen years. His experience includes using fiber optic connectors under the ocean, on land, in the air and in space. He has a BS in Engineering from Cal Poly State University, San Luis Obispo and an MBA from Pepperdine University.