

Experiment - 1: Study of Optical Components

Date: - 17/01/25

1. **Aim:** To study the different optical components including fibers, cables, connectors and their applications.

2. **Requirements:** Optical Pigtails and Patch Cords

3. **Pre Experiment Exercise:**
Brief Theory

Fiber optic pigtails are basically used to splice with the fiber so that they can be connected to the patch panel or equipment. They also present a feasible and reliable solution for easier fiber termination, effectively saving operating time and labour cost.

Fiber optic pigtail offers an optimal way to joint optical fiber, which is used in 99% of single- mode applications.

Fiber optic patch cable, often called fiber optic patch cord or fiber jumper cable, is a fiber optic cable terminated with fiber optic connectors on both ends. It has two major application areas: computer work station to outlet and fiber optic patch panels or optical cross connect distribution center. Fiber optic patch cables are for indoor applications only.



Fiber Patch Cable



Fiber Optic Pigtail

Fiber optic pigtail is a fiber optic cable terminated with a factory-installed connector on one end, leaving the other end terminated. Hence the connector side can be linked to equipment and the other side spliced with optical fiber cables.

Fiber optic pigtail are utilized to terminate fiber optic cables via fusion or mechanical splicing. High-quality pigtail cables, coupled with correct fusion splicing practices offer the best performance possible for fiber optic cable terminations. Fiber optic pigtails are usually found in fiber optic management equipment like ODF, fiber terminal box and distribution box.

Fiber Optic Pigtail Types:

- By Fiber Type - single-mode (colored yellow) and multimode (colored orange) fiber.
- By Connector type- LC fiber pigtail, SC fiber pigtail, ST fiber pigtail, FC fiber pigtail, MT- RJ fiber pigtail, E2000 fiber pigtail and so on.

Fiber Optic Pigtail Splicing: Easy and Fast Fiber Termination

The quality of fiber pigtail is typically high because the connectorized end is attached in the factory, making it more accurate than a field-terminated cable. It can be attached to optical fibers by fusion or mechanical splicing. Given the access to a fusion splicer, you can splice the pigtail right onto the cable in a minute or less, which greatly speeds the splicing and saves significant time and cost spent on field termination. While for mechanical fiber optic pigtail splicing, it precisely holds a fiber optic pigtail and fiber patch cord together, the joint could be temporary or permanent, enabling light to pass from one fiber to the other. Always order fiber pigtail assembly a few feet more than you'll need. The extra slack allows for splicing errors to be corrected. Besides, selecting fiber pigtail assembly with reliable quality would make the splicing process way easier.

COMMON TYPES OF FIBER OPTIC PATCH CABLES

Fiber optic patch cables can be divided into different types based on fiber cable mode, cable structure, connector types, connector polishing types and cable sizes.

Fiber Cable Mode:

1. Single mode fiber patch cables: Single mode fiber optic patch cables use 9/125 micron bulk single mode fiber cable and single mode fiber optic connectors at both ends. Single mode fiber optic cable jacket color is usually yellow. Here is the explanation of what is single mode and single mode fiber.

2. Multimode fiber patch cables: Multimode fiber optic patch cables use 62.5/125 micron or 50/125 micron bulk multimode fiber cable and terminated with multimode fiber optic connectors at both ends. Multimode fiber optic cable jacket color is usually orange. Here is the explanation of what is multimode and multimode fiber.

3. 10 gig multimode fiber optic patch cables: 10 Gig multimode fibers are specially designed 50/125 micron fiber optimized for 850nm VCSEL laser based 10Gig Ethernet. They are backward compatible with existing network equipment and provide close to three times the bandwidth of traditional 62.5/125 multimode fibers. 10 Gigabit is rated for distances up to 300 meters using 850nm Vertical Cavity Surface Emitting Lasers (VCSEL). 10Gig fiber optic cable jacket is usually aqua.





Fiber Cable Structure:

1. Simplex fiber optic patch cables: Simplex fiber patch cable has one fiber and one connector on each end.
2. Duplex fiber optic patch cables: Duplex fiber patch cable has two fibers and two connectors on each end. Each fiber is marked “A” or “B” or different colored connector boots are used to mark polarity.
3. Ribbon fan-out cable assembly: For ribbon fan-out cable assembly, one end is ribbon fiber with multi fibers and one ribbon fiber connector such as MTP connector (12 fibers), the other end is multi simplex fiber cables with connectors such as ST, SC, LC, etc.



Connector Types:

1. Same connector type fiber patch cable: This fiber optic patch cable has the same type of connector on both ends, such as ST, SC, LC, FC, etc.
2. Hybrid fiber optic patch cables: This fiber optic patch cable has different connectors on each end. One end can be SC and the other end can be LC, ST, FC, etc.

Some of the common connector types are:

1. Standard Connector (SC)

Simple, rugged and low cost, SC connectors use a ceramic ferrule to deliver accurate alignment of the SMF. The SC connector comes with a locking tab that enables push on / pull off operation.



At the time of writing the most popular choice for such equipment like Fiber Multiplexers, GPON and EPON ONU's, Fiber Media Converters and more.

2. Ferrule Core Connector (FC)

Although the FC connector was widely used in fiber optic networks until of late, its use is dwindling fast. This connector uses a threaded container and a position locatable notch to achieve exact locating of the SMF in relation to the receiver and the optical source. Once the connector is installed, its position is maintained with total precision. FC connector is pretty common choice for example in Video over Fiber Transmission Equipment.



3. ST Connector

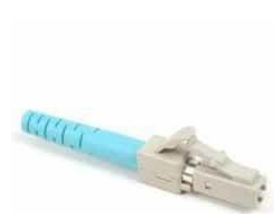
The ST connector's keyed bayonet design is similar to that of a BNC (Bayonet Nut Connector or Bayonet Neill-Concelman) connector. The connector is used widely for MMF and SMF FOC and is extremely easy to use. The ST connector is manufactured in two versions – the ST and the ST-II. Both types are keyed and spring loaded, and use a “push-in and twist” mechanism.



4. Lucent Connector (LC)

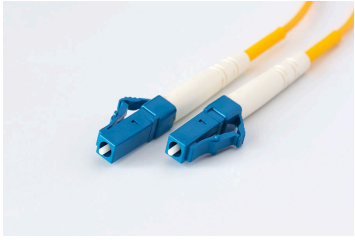




The Lucent Connector, sometimes referred to as the Little Connector, is a small form factor FOC that uses a 1.25 mm ferrule. There are 3 different types of LC connectors:

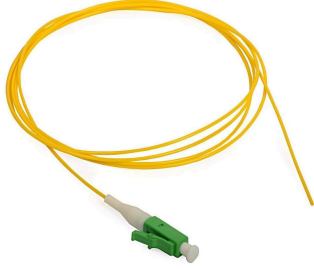
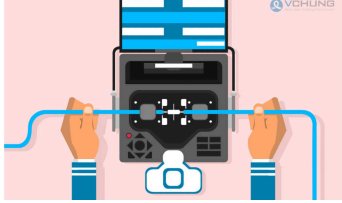
- Single Mode LC APC
- Single Mode LC UPC
- Multi-Mode LC UPC



4. Laboratory Exercise:

1. Observe the different connectors, patch cord, pigtails, cable and splice available in the laboratory and tabulate the observations with specifications and applications of the optical components. Tabulate your observations.

Name	Image	Specifications	Applications
LC (Lucent Connector)		<ul style="list-style-type: none"> • 1.25 mm ferrule • Insertion loss: ≤ 0.3 dB • Return loss: ≥ 50 dB 	High-density applications like data centers and telecom networks.
FC (Ferrule Connector)		<ul style="list-style-type: none"> • 2.5 mm ferrule • Insertion loss: ≤ 0.3 dB • Return loss: ≥ 55 dB • Threaded screw-on coupling 	Telecom and measurement equipment where vibration resistance is important.
SC (Subscriber Connector)		<ul style="list-style-type: none"> • Insertion loss: ≤ 0.3 dB • Return loss: ≥ 50 dB • Push-pull coupling mechanism 	Used in data centers, CATV, and FTTx networks.
ST (Straight Tip)		<ul style="list-style-type: none"> • Insertion loss: ≤ 0.25 dB • Return loss: ≥ 45 dB • Bayonet-style coupling mechanism 	Used in LANs, campuses, and multimode fiber networks.
Patch Cord		<ul style="list-style-type: none"> • Core diameter: 9 μm (SM), 50/62.5 μm (MM) • Length: 1m, 2m, etc. 	Interconnects devices in fiber-optic networks for signal transmission.

Pigtails		<ul style="list-style-type: none"> • Fiber type: SM or MM • Connector: Pre-terminated • Length: ~1m 	Used for splicing with optical cables and connecting to equipment or patch panels.
Splice		<ul style="list-style-type: none"> • Insertion loss: ≤ 0.1 dB (Fusion) • Strength: 1.5-2 N 	Used to join optical fibers permanently (fusion) or temporarily (mechanical).

2. Draw the basic block diagram of the optical communication System and explain it.
3. What is the need for colour codes in optical cables and explain the different colour codes.

5. Conclusion/Comments:
