Building Fiber Optic Cables

Note: This is just one of many different styles and types of termination.

Introduction

Fiber optic cable has the potential to transfer data faster than any other type of cable.

Many people do not realize that fiber optic cable is the transport media for today and tomorrow. Computer applications that require intensive data transfer rates use fiber optic links to the desktop.

Building fiber optic connections requires more practice than twisted pair or coax connectors, but the process recommended is an easy and very reliable method.

In this section you will learn the basics of making fiber optic terminations.

Objectives

At the end of this section you should be able to:

- Identify three applications that utilize fiber optic cable
- Identify the tools required to terminate fiber optic cable
- Describe the process used to construct fiber optic terminations
- Identify characteristics of a flawed fiber connection
- Identify three problems associated with terminating fiber optic cable

Applications Using Fiber Optic Cable

Because of its increased data transfer capabilities over traditional twisted pair or coax cable, fiber optic cable is currently the best choice for technologies such as:

- High-speed computer networking
- Voice and data transmission
- Security cameras
As methods for installing fiber optic cable are improved, more technologies will embrace this fast, reliable method of data transfer. Some of these future technologies include:

- Satellite TV
- Cable TV
- Internet and web access
- Local and long distance dial-tone
- Security Monitoring

In addition to established technologies currently utilizing fiber optic cable and those being modified to take advantage of the speed and security it provides, increased demands for intensive data transfer rates make fiber optic cable the cabling medium of the future.

**Fiber Optic Cable Specifications**

Fiber is the cable of choice when extreme climate, temperatures, or EMI is unavoidable. Unlike coax or twisted pair, fiber does not conduct an electrical signal so it cannot be interfered with by strong electrical signals.

Fiber optic cable is also the most secure cabling mechanism. It is possible for a covert operation to read data from a copper wire without actually tapping it. This is not true with fiber. In addition, the distance a signal can be transmitted over fiber is measured in thousands of feet instead of hundreds of feet, as is the case with copper.

The cable recommended is a 62.5, multi-mode fiber optic cable. Another type of fiber optic cable, single-mode fiber, is especially designed for high-speed data transfer. Figure 6-1 illustrates the components of the fiber optic cable.

![Figure 6-1: Fiber Optic Cable](image)

The strengthening yarn is a strong fiber called Aramid Yarn™, which is similar in nature to Kevlar™ and is very strong.
Tools and Materials Required for Fiber Optic Cable

The tools required for fiber optic cable are more extensive than other types of cable, however they are not complicated to use or maintain.

- 3 in 1 sanding film
- 5' straight hemostats
- Crimp tool
- Electrician's scissors
- Two-part epoxy
- Inspection light
- Microscope with ST adapter
- No-Nik™ Stripper
- Safety glasses
- ST polishing disc
- T Strippers for fiber optic cable

Required Connectors

- 2 ST connectors for each cable segment

Other Helpful Materials

- Alcohol wipes
- Sanding surface (plastic sanding board)
- Electrician’s tape

Note: The tools and materials may vary depending on the fiber connections used.
Overview of Fiber Optic Construction

Constructing a fiber optic cable utilizes the same basic steps as building other cables, however there are a few more steps involved.

**Note:** The glass fiber can penetrate skin if you are not careful. Be cautious: pick up any glass pieces by using the electrical tape as demonstrated in class.

Safety glasses are always a good idea; but when working with glass fibers, they are a necessity. Please use a great deal of caution during this section.

Building fiber optic cables is a learning experience. You should not be discouraged if it takes you several attempts to complete a successful cable. This experience will give you a good insight into the mechanics of fiber optic termination. However, be aware that there are several different methods of terminating fiber optic cabling. See your local distributor for more information on the various types of connectors and tools available.

Assembling the Fiber Cable

The following procedure steps you through the process of cutting, assembling, and curing a fiber optic cable.

Read through the following steps prior to assembling your cable. Carefully complete the following steps:

1. Gather the required tools

2. Assemble the connectors

3. Prepare the materials

   Make sure you have all your materials together. At this time, take about two feet of electrical tape, turn it inside out and make a sticky bail of tape. Put on your safety glasses.

4. Place the hemostats on the end of your fiber cable.

   On short pieces like we are working with in this class, this prevents the glass fiber from moving inside the outer jacket. This may not be necessary in an actual installation setting.

5. Place the reinforcement boot and crimp sleeve on the cable as indicated in Figure 6-2.
6. Using the T strippers, remove approximately 1 1/2" of the outside jacket.

Use the template, Figure 6-3, to prepare the cable end.

Use electrician's scissors to cut away the yarn to the distance indicated in Figure 6-3. Dispose of the yarn. Pick up any fibers by using your sticky ball.

Caution: If you have not already put on your safety glasses, do so now. Safety glasses must be worn from this point on.

7. Use No-Nik strippers to remove the PVC buffer, as indicated in Figure 6-3.

No-Nik strippers are designed especially to remove the PVC jacket and the outer coating of fiber optic cable. The size of the stripper is important. For our purposes, we are using a 203 micron stripper, which has been calibrated to the correct depth of cut.

To remove the PVC, place the fiber optic cable in the NO-Nik strippers. Be sure the measurement of 203 microns and arrow are facing up, if not, you are holding the stripper upside down. Squeeze the handle of the strippers until you feel and or hear a gentle click. Do not apply any further pressure to the handles of the strippers after you hear or feel this click. While holding the head of the stripper, pull the stripping tool in the direction indicated by the arrow on the top of the No-Nik strippers.
8. Once the final PVC jacket has been removed, you should see a small glass fiber. If any residue is left on the fiber, the ST connector will not fit. To ensure that there is no residue on the fiber, clean the glass fiber with the alcohol wipe.

**Note:** The fiber is very brittle. Be careful how you handle the cable at this stage. If you break the fiber, use the sticky tape to clean up any stray fibers.

9. Trial fit the ST connector by gently slipping it into the ST connector, as shown in Figure 6-4.

![Figure 6-4: Cable Inserted into ST Connector](image)

Note: If the glass fiber will not come through the end of the connector, there is still residue on the glass fiber.

10. Insert the retaining compound into the ST connector using a syringe or injector. Insert the syringe or injector needle as far as possible into the ST connector and inject the retaining compound. Inject the compound into the connector until a small green bead of compound shows on the tip of the connector as illustrated in Figure 6-5.

![Figure 6-5: Injecting the ST Connector](image)
11. Coat tip of exposed glass fiber with primer by dipping into primer as illustrated in Figure 6-6

Figure 6-6: Coating the Tip of the Fiber with Primer

12. Gently reinsert the cable into the ST connector. You have about 15-20 seconds to insert the fiber cable into the ST connector. It takes about 45 seconds to a minute for the epoxy to cure.

13. Slide the crimp sleeve up to rear of the connector and crimp the sleeve using the .151" hole of the crimp tool, as illustrated in Figure 6-7.

Figure 6-7: Crimping the ST Connector

14. Slide the reinforcement boot up over the metal crimp sleeve and against the ST connector
Polishing the Fiber Optic Cable

To this point you have assembled and cured the fiber optic connection. The following instructions guide you through the process of removing the excess fiber and polishing the connection.

Polishing Overview

In order for the light to be transmitted through the cable effectively, the fiber must have a clean polished surface. This process is outlined below:

- Remove excess glass fiber
- Air sand the tip
- Sand the tip of the connector using three types of sanding film

The materials you need are:

- Sanding puck
- Three part sanding film

Step-by-Step Process

Each of the steps should be performed carefully.

1. Remove excess glass fiber. Take a six-inch piece of black tape and join it sticky side out. Double the tape and place it on either side of the fiber, as illustrated in Figure 6-8. Squeeze the tape together and gently bend the fiber backward to snap it off.
Figure 6-8: Remove Excess Glass Fiber

Caution: You should be wearing safety glasses. When you snap the fiber off, it should stick to the folded tape. If it should fall off, use your sticky ball of tape to locate it.

2. Air-sand the tip of the connector lightly. Lightly sand the tip of the fiber with the coarse end of the sanding film, as illustrated in Figure 6-9.

Figure 6-9: Air Sanding the Tip of the Connector

3. Polish the end. Insert the ST connector into the sanding puck, as illustrated in Figure 6-10.
4. With gentle pressure, sand the end of the connector on the medium grit on the sanding film. Sand the tip using a figure-8 motion on the medium grit of the sanding film. Do five repetitions, or until the tip leaves no marks on the sanding film. Figure 6-11 illustrates the layout of the sanding film.

5. Sand the tip on the fine grit. Sand the tip with five figure-8’s on the finest grit of the sanding film. Inspect the end as describe in the following text.

**Inspecting the Termination**

In order to ensure the connector is polished correctly you need to inspect your work carefully. In the following procedure you will learn to inspect the end of each termination.
**Inspection Overview**

Light cannot be transported properly if the termination is not done properly. Chips, fractures and pits all limit the ability of the fiber to transmit light.

You will learn to inspect the connection for any flaws.

The materials you need are:

- Microscope
- Light source

For this class, the inspection is simple. We will use a 100 power microscope and a light source to verify that our fiber segment is transmitting light.

**Inspecting the Termination**

Complete the following process:

1. Inspect the connection with the microscope. Insert the connector into the end of the microscope, as illustrated in Figure 6-12

![Figure 6-12: Microscope with Fiber Connector Inserted](image)

To activate the light, separate the two arms of the inspection scope. To focus, spin the focus wheel located on the fixed arm of the inspection scope. You may need to adjust the microscope until the end comes into focus.
2. Inspect for cracks or chips. You should see an end that has sharp, clear edges.

An ideal surface is smooth with no scratches or pits.

A scratched surface should be sanded again by following the sanding process. Start from the medium sanding point.

A pattern like this indicates a fracture in the glass fiber. Depending on the signal loss generated by the fracture, you may need to cut off the connector and re-terminate the cable.

A rough surface like this may indicate a dirty or chipped surface. Start the sanding process again by starting at the medium grit.

Figure 6-14: Examples of Connections

Repeat the termination and inspection process for each connector.
Testing Fiber Optic Cable

We have used the microscope to inspect the termination and verify that it has a clean, residue free surface. The next step is to verify that the cable is not broken or spliced and will pass light from one end to the other.

Attaching to a Light Source

A simple way to test the continuity of the cable is to connect a light source to one end of the cable segment. If light passes through the segment, you know that the cable is not broken.

However, it is possible to see light through the cable and still have a bad connection. The connection may be pitted or a fracture may deflect enough light that the quality of the signal is affected and the attached devices may not work correctly.

Advanced Testing

There are tests for fiber that verify the quality of signal. By using an OTDR (Optical Time Domain Reflect meter) we can determine the length of the cable and the quality of signal that is returned.

Other testing equipment determines the dB loss of each connection.

If you choose to do more with fiber optic cable, you should be prepared to learn how to employ advanced testing techniques.

Troubleshooting Fiber Optic Terminations

Fiber optic cable is one of the best cabling options because it is impervious to electromagnetic interference (EMI) and temperature differences that can cause problems for copper cabling. Essentially, if the cable transmits light, it works.

The basic problems you may encounter are:

- Fiber is broken and no light is transmitted
- Connection is flawed and light is not transmitted
• Connection is flawed and light flow is disrupted

In any of the above, proper fiber optic testing process can isolate the problem and allow you to correct it.

Summary

In this section, you have learned the following

• The method recommended by FutureSmart for terminating a fiber optic connection.

• There are various methods for terminating fiber optic connections. The method you choose is up to you, but the issues of quality and warranty should always be taken into consideration.

• There are several types of tests used to verify a termination.

FutureSmart recommends that your staff be thoroughly trained in the testing of fiber, twisted pair, and coaxial cable.