Course 400

Fiber Optic Installation and Testing

Student Manual

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Performance Objective

Given an interactive discussion, hardware, tools and equipment, and associated materials, the trainee will perform the following tasks to 100% mastery.

- Understand the fundamentals of fiber optic technology, including history, advantages, disadvantages and applications.
- Perform the process of removing the jacket off fiber optic cable and placing the cable in the cabinet connected to other hardware.
- Demonstrate how to make a variety of connectors.
- Fuse two fibers together using either a mechanical splice or a fusion splice.
- Examine the function of the coupler, including how the coupler distributes optical signals.
- Examine the hardware used in specific areas to house the cable and terminating points of the fiber cable.
- Understand building construction from interior walls to outside brick work, and learn pertinent building codes such as National Electrical Code including designations OFNP, OFCP, etc.
- Describe the thought process of a designer when considering both fiber and copper issues.
- Understand the basics of local area network concepts as they relate to fiber optic cabling.
- Demonstrate how to find and correct system problems using accepted testing practices.

Instructional Flow

This course is presented in 24 hours. The course will provide participants with opportunities to demonstrate their skills immediately upon returning to work. Students receive feedback and improvement and suggestions during the classroom. The sections are taught in consecutive order, each section building upon that which was learned in the previous section.

Instructional Method

Interactive Discussion
Hands-on Demonstration

Instructional Media

Instructional Manual
Overhead Projection
Cabling Materials, Tools and Equipment

Duration

3 Days

Business Need

Fiber optics is the fastest growing field in communications. All communications network including telecommunications, CATV, LANs, and security are using more fiber every day. Fiber optics has become the transmission medium of choice for most communications. Its high speed and long distance capability make it the most cost-effective communications medium. While higher performance and lower cost components are in continual development, it has become critical to train competent personnel to design, install and maintain state-of-the-art fiber optics networks. Fiber isn't hard to learn, but the unique aspects of fiber optics can make on-the-job training expensive, since little mistakes cost big money.

Course Goal

The goal of this course is to provide the participants with an understanding of the attributes and operating characteristics of fiber optics network infrastructures and be able to place, terminate and test within recommended standard parameters. In addition, participants will have a working knowledge of all related standards, how they apply in a commercial environment, and which references or articles are applicable. The outcome measure of the course is to train and certify participants for 100% mastery of the knowledge and skills needed for a job position as a telecommunications fiber optics technician.

Course Overview

This course is the fourth course in the Cabling Business Institute's curriculum for telecommunications cabling professionals. This course is taught within the instructional guidelines of EIA/TIA, IEEE, ANSI, ETA, and NFPA (NEC). Participants in the course will receive a certificate of completion and can apply for accreditation through the Association of Cabling Professionals and Cabling Business Institute. This course is approved for twenty-one (21) BICSI RCDD continuing education units. In addition, the program will support further certifications through the Texas A & M University System's Telecommunications Training Program.

Course 400

Informative References:

Section 1.0
Overview of Fiber Optics

Objective

Understand the fundamentals of fiber optic technology, including history, advantages, disadvantages and applications.

Outline

- *History of Fiber Optics*
- *Evolution of Fiber Optics*
- *Is Fiber Right for Everyone?*
- *Fiber Applications*
- *Parts of a Fiber Optic System*

Learning Activity

Assessment: Test Module 1
Lab Exercise: None

History of Fiber Optics

The recorded history of light as a communications medium dates back to ancient times, approximately 1184 B.C., when the Greeks used signal fires on a chain of islands to announce their victory over the Trojans to Queen Clytemestra some 900 km (559.23 miles) distant.

John Tyndall, an Irish physicist and scientist living in England is best known for experiments with light and light scattering. The Tyndall Effect states that particles of strong light that are normally invisible are easily discernable when viewed from the side. These particles become visible because they reflect some of their incident light. In 1880, Tyndall demonstrated the principal of guiding light through internal reflection using water. (See Figure 1.1.)

In 1880, Alexander Graham Bell invented a device called the photophone. This device used reflected light and vibrating mirrors to transmit a voice signal to a receiver in line of sight some distance away. (See Figure 1.2.)

Today, fiber optic networks and their applications are integrated into all aspects of today's communications and telecommunications, both commercial and public. Fiber networks are used in long-distance services, cable television and is the backbone of the information highway.

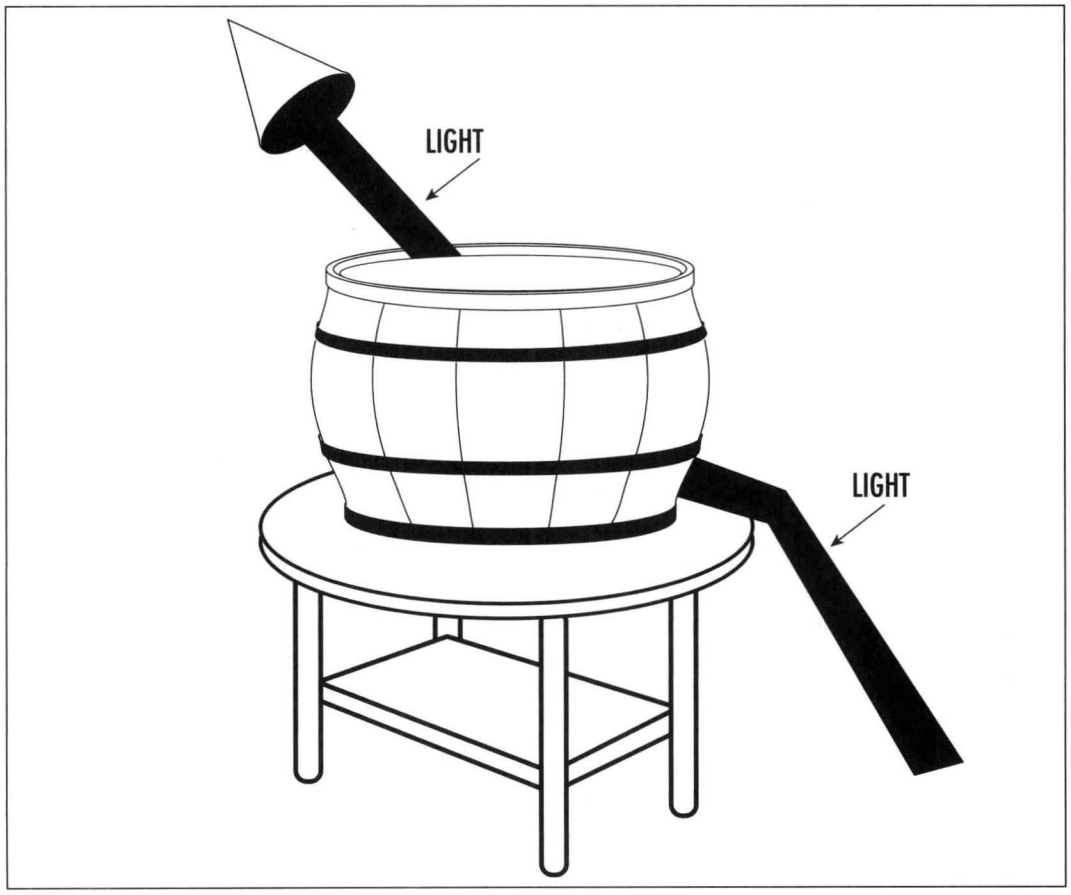
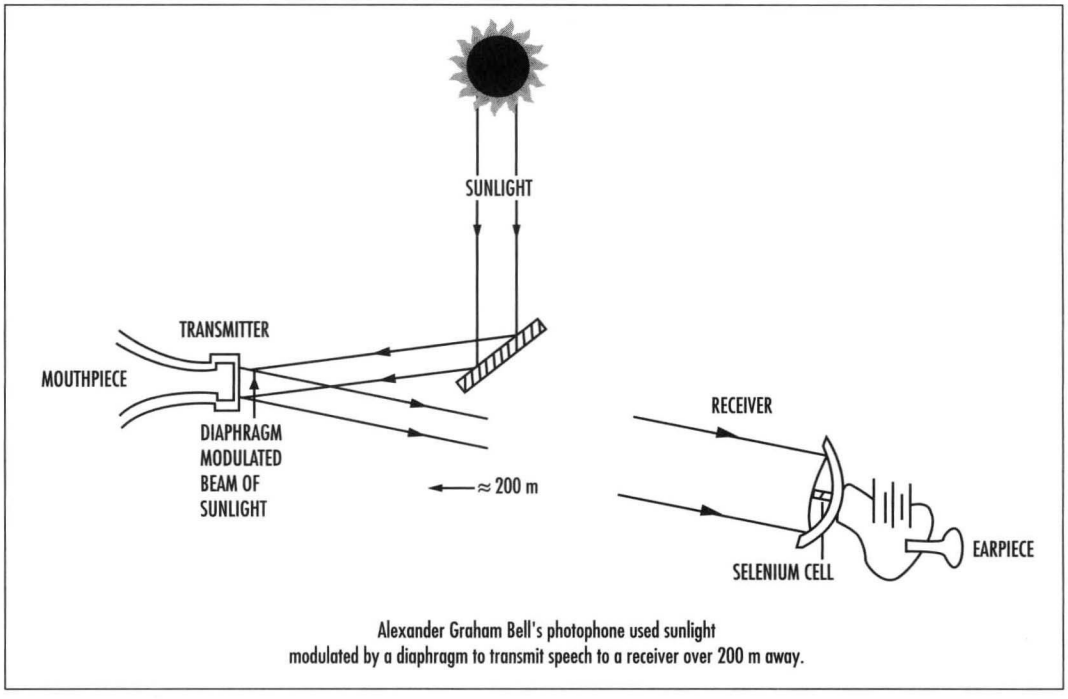


Figure 1.1

Figure 1.2



Alexander Graham Bell's photophone used sunlight modulated by a diaphragm to transmit speech to a receiver over 200 m away.

Evolution of Fiber Optics

The term fiber optics was first used in the 1950s with the development of the flexible fiberscope, which is still widely used in the field of medicine. These types of fibers are also used in industrial applications to inspect inaccessible areas, such as the inside of jet aircraft engines to search for signs of stress or metal fatigue. Light loss in these early fibers was extreme, but the length of the fibers was so short, this was not of particular concern.

In the 1960s, the laser became the topic of much research and the possibility of optical communications became a topic of great interest. Extremely wide bandwidth was not ignored by the telecommunications industry. However, interference by rain, fog, dust and other obstructions showed that line of sight transmission by laser through the atmosphere was simply not practical.

Finally, in 1970, Corning Glass Works announced the development of optical fiber with less than 20 dB/km loss. At last, telecommunications by fiber optics was to become a reality. By the mid- to late 70s lasers, LEDs, photodetectors, connectors, splices and other components were developed for use with these low loss fibers, and working systems were tested and made available to the market. Shortly thereafter, long haul lines were being installed up and down both coasts, and east and west across the United States.

Is Fiber Right for Everyone?

Is fiber perfect for every situation? No, probably not. There is not a set of standards that dictate when and where you must use fiber, but a quality assessment of a company's needs will yield that result. Many companies burden themselves financially by installing a complete fiber optic network only to find out they do not even use a fraction of the fiber's capabilities.

Fiber is best used in large-capacity and/or in long-haul systems. Companies that only have a handful of users would not really benefit from the use of fiber unless there was a problem with line noise, such as is found in many industrial applications. However, new

high-end graphics, CAD/CAM and engineering programs create a need for fault-free, high-speed communications that thrives on fiber.

It is still, for the most part, less expensive to hook up a system with copper than with fiber. Although the cost of the fiber optic cable is comparable to the cost of high-grade copper cable, the electronics that must be used to couple into the fiber optic systems are still cost prohibitive. Thus, until the prices come down (and they are headed that way), a lot of people who might benefit from fiber probably will not take advantage of it.

The telephone industry has obviously accepted fiber for its long-haul and intermediate trunking. The military market, one of the fiber pioneers, is expanding its fiber usage. Most large data communications systems utilize fiber in the backbone and in some cases, even to the desktop.

Advantages and Disadvantages

There are definite disadvantages in using copper cabling: the amount of cabling required in large applications, the crosstalk, susceptibility to electromagnetic inference (EMI) and radio frequency interference (RFI) weight of the copper cable, ease of handling, etc. To provide 22,000 voice channels, it would require 900 pairs of copper versus 12 pairs of fiber. (See Figure 1.3.)

Fiber Advantages	Fiber Disadvantages
Wide bandwidth	Cost of tooling
Electromagnetic immunity	Cost of test equipment
Lightweight	Complex terminations
Small size	Cost of electronic equipment
Safety	Terminations somewhat costly
Security	
RFI immunity	

Fiber overcomes EMI and RFI because it is made of a dielectric material and not susceptible to any type of electromagnetic, radiation or other interference. Thus, users will not suffer a hum on their telephone lines or glitches appearing on their data systems. Fiber optic cable is smaller, easier to install and carries more information. Most users do not realize any communications system that can run on copper can run on fiber. Since most of the fiber optic cables used in today's LANs have no ground wires or metallic sheaths, optical networks are basically free of the ground current problems that can plague copper- based systems.

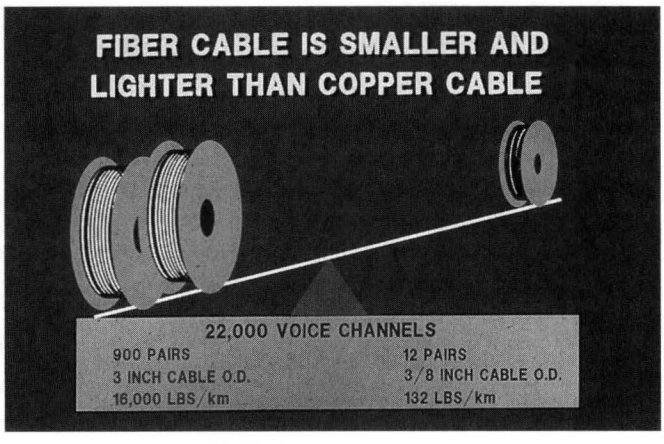


Figure 1.3

In some applications, the physical size and considerable weight of copper cable can be problematic. For example, a coaxial cable weighs about 80 lbs. per 1,000 feet, while an identical length of fiber optic cable weighs only about 9 lbs. and may carry more data. (See Figure 1.4.) Fiber optic cable is intrinsically safe. Breaking the fiber neither produces sparks that could ignite flammable material, nor poses an electrical shock hazard.

Installation is made somewhat easier because fiber optic cable is smaller and lighter than comparative copper cable lengths. However, make no mistake, fiber optic cables and all high-grade copper cables require more installation skills than older types of cabling ever did.

Fiber Applications

Dark or Dormant:

Many large users such as IBM, Prudential, military, local, state and federal government agencies have installed a large amount of fiber paralleling their copper-based system. Some of these will sit dormant or dark (installed and connectorized but not used) until technological changes force the price of interfacing equipment to come down to a respectable level. In this way, they are prepared for the future today.

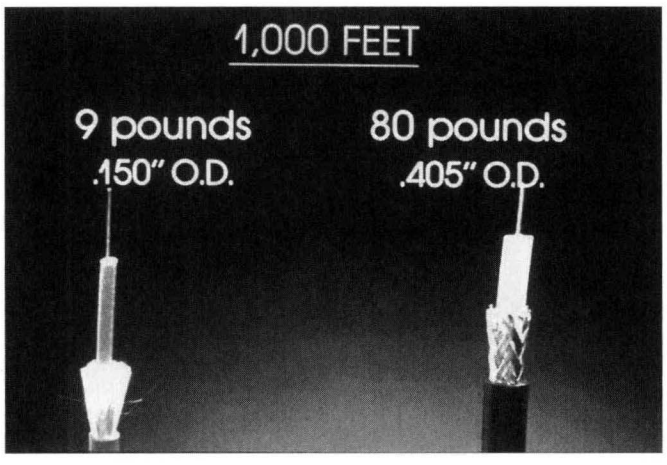
Point-to-Point Applications:

Many of today's fiber optic communication systems are point-to-point applications. These consist of two nodes (or communications devices) communicating directly and exclusively with each other. Point-to-point applications usually require a fiber pair (transmit and receive) to operate, except in cases such as simultaneous simplex fiber two-way transmission, simplex video and instrumentation applications. Point-to-point applications exploit fiber optic bandwidth and low attenuation, allowing a signal to be sent longer distances at faster speeds than available on coaxial or twisted pair cables. The illustration in Figure 1.5 consists of a simple point-to-point link from one building to another building in a campus environment.

A fiber optic communication system is designed in form division: hardware, cable, terminations and the optic electronics.

Starting at (A) in the illustration (See Figure 1.5.), the fiber starts from the terminal (A) to the optoelectonics and cross-connect panel (B) via the riser cable (C) and is spliced as it enters the building (D). Then cabling to another building, the cable is spliced (E) and the same function occurs in the other building.

Figure 1.4



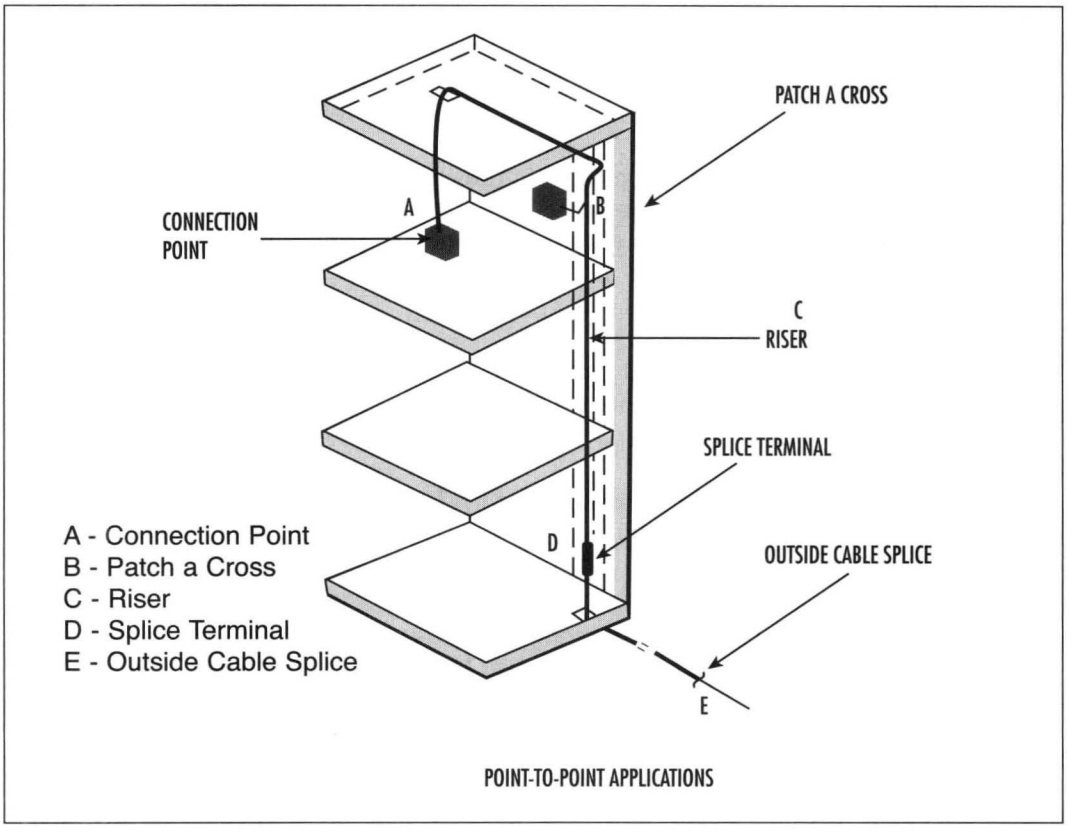


Figure 1.5

Other Point-to-Point Applications

Channel Extender

A fiber optic channel extender allows a mainframe computer to communicate directly with a controller or other peripherals at much greater distances than possible with copper. It allows for such things as a remotely located high-speed channel attached printer, something not possible before fiber optics.

Voice/Data Multiplexer

A fiber optic multiplexer combines several communications channels into a single bit stream for transmission over the fiber. Channels are then separated at the receiving end. Common applications include T-1 communications, large PBX internodal links, and RS-232 and 3270 transmission.

Modem

A fiber optic modem converts electronic signals to light pulse signals. Fiber modems have a multitude of purposes, from extending distances between computers to the linking of peripheral devices. (PC printer sharing is a common use.)

Video

Fiber optic links are often used for video systems. Broadcast quality video transmission over fiber is not susceptible to the inherent problems encountered with coaxial cables but may require special connectorization.

Security Video

Fiber optic point-to-point links are often used in outdoor environments to minimize lightning damage, interference and to extend distances.

LAN Applications

The installation and use of fiber optic LANs is growing rapidly. In a fiber optic LAN, two or more nodes communicate with one another via the fiber optic cable. The nodes can be logically arranged in a ring, star, bus or tree configuration as they would be with any other communications medium.

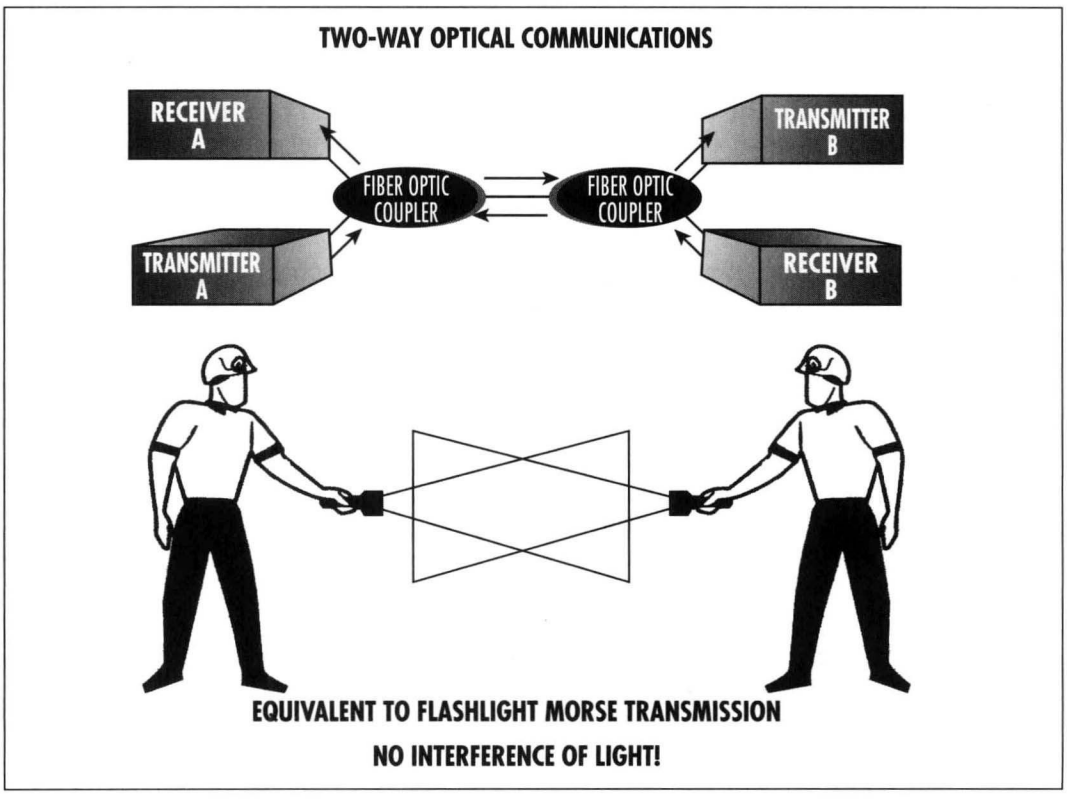
Fiber-to-the Desktop

In certain high-end, high-speed and high-capacity applications, fiber is required to the desktop. These applications may include CAD/CAM or specialized graphics and engineering programs.

Parts of a Fiber Optic System

Optical fiber is the medium in which communication signals are transmitted from one location to another in the form of light guided through thin fibers of glass or plastic. These signals are digital pulses or continuously modulated analog streams of light representing information. These can be voice, data, computer, video or any other type of information. Fiber optic communication could be compared to Morse transmission as shown in Figure 1.6.

Figure 1.6



Four Parts of a Fiber Optic System

There are four groups that make up a fiber optic system as defined below:

- The fiber, which acts as a conduit, allowing the light to travel.
- The cable protects the fiber.
- The connecting group provides alignment of both connectors and sleeves.
- Electro-optical devices are required to convert the electrical signals to optical signals and the optical back to electrical signals. (See Figure 1.7.)

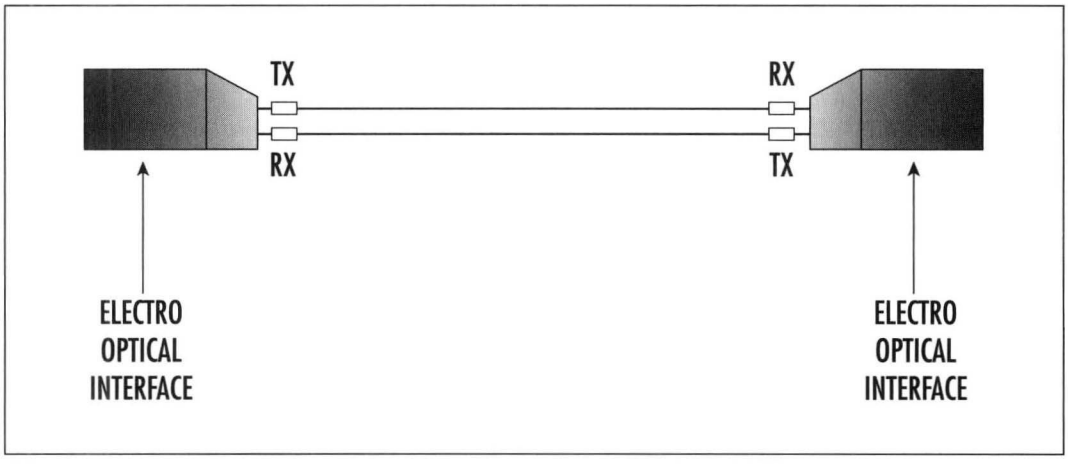


Figure 1.7

TEST MODULE 1

1. Fiber optics was first used in the 1950s with the development of the flexible fiberscope, which is still widely used in the field of medicine.

   True False

2. Fiber is best used in small-capacity and/or in long-haul systems.

   True False

3. Point-to-point applications exploit fiber optic bandwidth and low attenuation, allowing a signal to be sent longer distances at faster speeds than available on coaxial or twisted pair cables.

   True False

4. Optical fiber is the medium in which communication signals are transmitted from one location to another in the form of light guided through thin fibers of steel or plastic.

   True False

5. The four groups that make up a fiber optic system are fiber, cable, connecting group and electro-optical devices.

   True False