OPTICAL FIBER TRAINING SET

Introduction

An optical communication system is simply composed of an optical transmitter, an optical medium and an optical receiver. Optical fiber cable, air (atmosphere) or guided media can be preferred as optical media. The basic diagram of the optical communication systems is given in Figure-1.

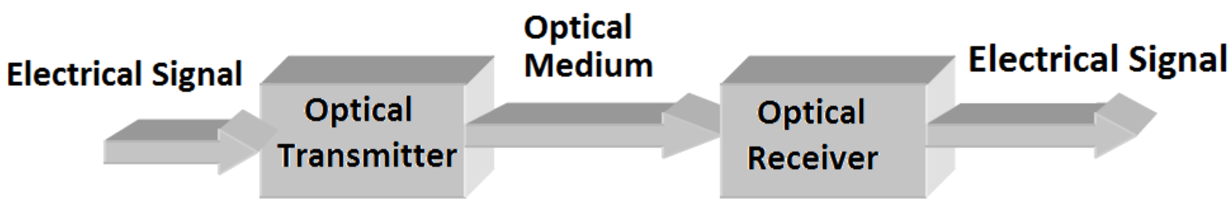
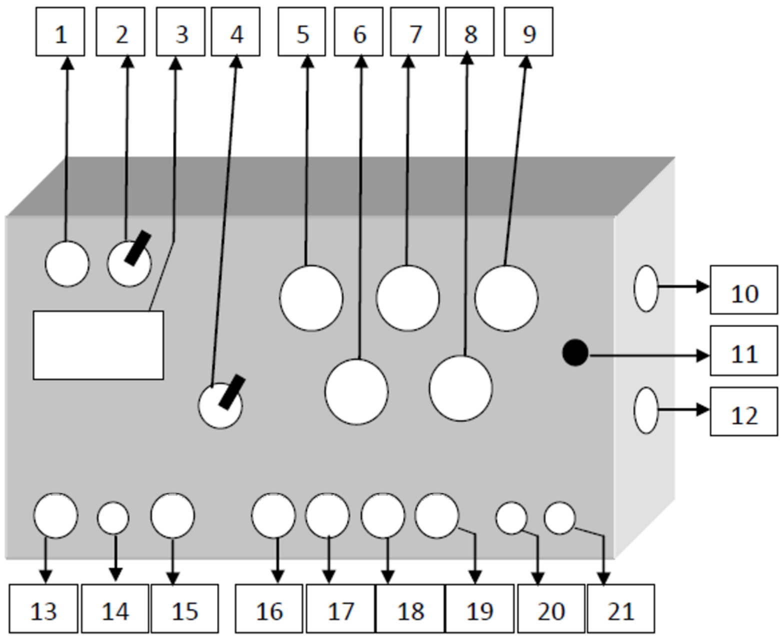


Figure-1: Block Diagram of an Optical Communication System

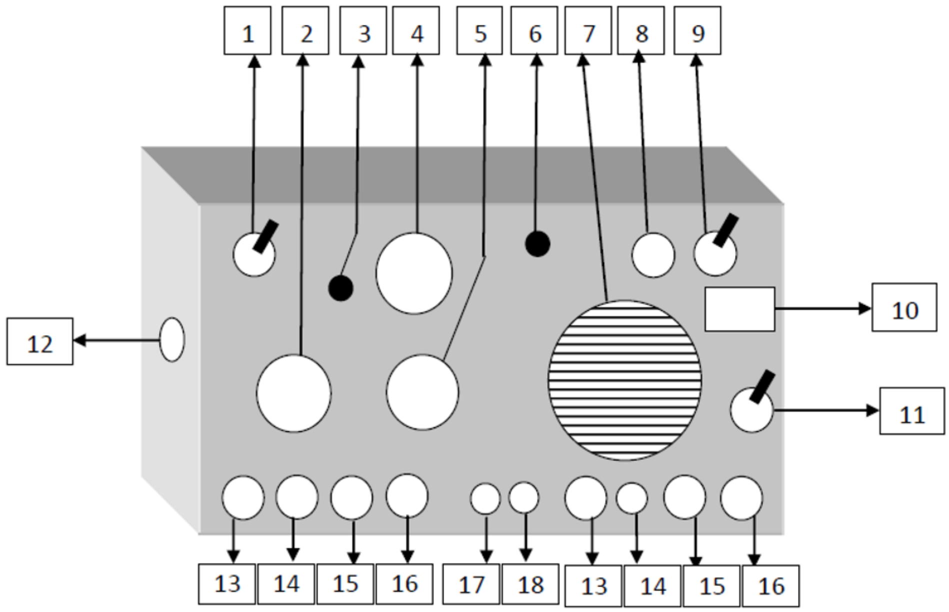
Optical Fiber is a plastic or glass cable with special optical features that transporting the light containing information over the long distance to the receiver. The electrical signal applied to the input of the transmitter is converted to light information and transferred to the optical environment by LED or Laser Diode. The optical receiver detects the light coming from the optical receiver input with PIN diode or APD (Avalanche type photodiode) and converts it to electrical signal.

Transmitter Unit



1. Shows state of power supply.
2. ON/OFF switch for battery. Does not control optional external supply.
3. Battery holder for PP3-type battery.
4. Morse key for manually inputting digital data. Overrides all other digital inputs.
5. Controls the frequency of the pseudo-random and square wave signal generator (20Hz to 4.5kHz).
6. Selection switch for type of digital input.
7. Switches the transmitter between digital and analogue modes.
8. Controls gain of analogue amplifier (28dB range)
9. Controls output intensity of high –radiance infra-red Led and output indicator (Approx 20dB range).
10. High-radiance red Led socket.
11. Gives a visible indication of the output of the transmitting diodes.
12. Infra-red Led window.
13. Terminal for optional external supply of +9V to +15V d.c., to be used with supply ground terminal.
14. 2.5mm socket for optional external power supply of +9V to +15V d.c., which can be used as an alternative to supply terminals.
15. Supply ground.
6. TTL logic level input.
17. CMOS logic level input.
18. RS232 voltage level input. Also acts as output monitor for signal generator.
19. Common ground for all digital inputs.
20. Analogue input, high impedance (20kΩ)
21. Analogue input, low impedance (8Ω)

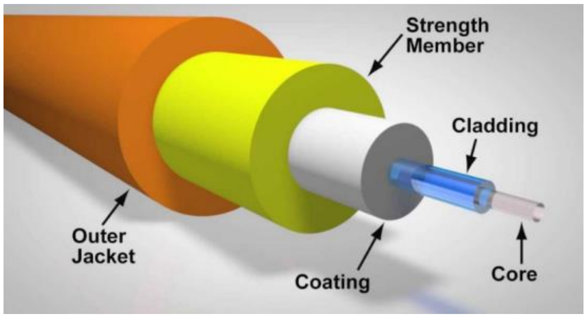
Receiver Unit



1. Switches the buzzer to the circuit. The buzzer gives an audible indication of the state of the digital signal.
2. Adjusts the sensitivity of the Digital comparator.
3. Indication of the status of the digital signal.
4. Switches the receiver to digital or analogue mode.
5. Adjusts the gain of the analogue amplifier (30dB).
6. Visible display proportional to the amplitude of the analogue signal.
7. Loudspeaker of analogue circuit.
8. Shows the status of the power supply.
9. ON / OFF switch of the battery. It does not control the optional external switch.
10. Slot for 9V PP3 type battery.
11. ON/OFF s witch for low impedance analogue output and loudspeaker.
12. Receiver diode socket.
13. TTL logic level output.
14. CMOS logic level output.
15. RS232 voltage level output.
16. Common ground for all digital outputs.
17. Analogue output, high impedance (1kΩ).
18. Analogue output, low impedance (less than 1Ω) disconnects the loudspeaker.
19. Terminal for DC external power supply to be used with optional + 9V to + 15V ground terminal.
20. 2.5mm socket for dc external power supply.
21. Ground.
22. Negative power supply input to be used with the ground terminal between -9V -15V for RS 232 voltage level output.

Optical Fibers and Optical Connectors

An optical fiber is a flexible and transparent glass (silica) fiber or plastic fiber whose diameter is as small as a human hair. Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than electrical cables.



Experiment-6:

OPTICAL FIBERS AND OPTICAL CONNECTORS

EQUIPMENTS

Voltmeter, Ampermeter

Optical Fiber Cable (5m and 0.5m)

Optical connectors

Optical transmitter

Optical Receiver

Bulb

Procedure:

1. Point one end of the fiber-optic cable to a light source, such as room lighting or window light. Notice that the light passes through the cable and can be seen at the other end. The effect is heightened by passing a finger repeatedly across the end of the fiber where the light is entering, and viewing the interrupted beam coming from the fiber.
2. Turn on the torch provided, and place the bulb close to one end of the longer length of cable. The light coming from the fiber is yellow. This is because the fiber absorbs some colours more than others, and the yellow light is absorbed least out of all the colours present in the white torch light.

3. The way the cable is coiled or wound has very little effect on the transmission of light through its length.
4. Using the through-connector provided, join together the two optical cables by pushing the two ends into this connector.
5. Again shine the torch light into one fiber end, and notice that this light, although slightly reduced in intensity by the connector, still passes through the connected fibers. If the fiber ends become dirty, they should be cleaned to minimize optical losses. This is easily done by wiping them lightly with a damp cloth.

2. ANALOGUE TRANSMISSION

When the Educator is used in the analogue mode, the output light intensity at the transmitter is directly proportional to the input voltage signal (plus a d.c. bias).

2.1. Radio Signal Over 'Free-Space'

Procedure:

1. Switch on both the transmitter and receiver, and switch both over to analogue. (The transmitter's output indicator and high radiance red diode, and also the receiver's analogue indicator should now be on).
2. Turn on the FM radio, and tune in to a clear signal (the FM band normally gives the best reception within a building). Using one of the electrical leads provided, connect the earphone output socket of the radio to the 'low Z' socket of the transmitter.
3. Set the transmitter analogue gain control to minimum (by turning it fully anti-clockwise).
4. Put the transmitter output power onto maximum by turning the output power control fully clockwise.
5. Adjust the radio volume control until the transmitter's output indicator begins to flicker in intensity, and then reduce this volume control to the point where this intensity just becomes constant. (This procedure ensures that the transmitter is giving out a signal with very little distortion).
6. Turn on the loudspeaker/low Z switch. Place the receiver so that the receive diode socket is facing the emitting diode socket of the transmitter, and adjust the analogue gain of the receiver until an adequate output is heard from the loudspeaker. If the sound is distorted, then turn down the radio's volume control until the distortion disappears. The receiver and transmitter units may be separated by a distance of a few meters while still maintaining transmission.

In this demonstration, the signal being transmitted comes mainly from the infra-red light emitting diode. This can be shown by placing a finger over the high radiance red diode and noting that the level of the received signal is hardly affected. (The output power of the infra-red diode is higher than that of the high radiance red diode).

7. To show that infra-red radiation behaves in a very similar way to visible light, place the transmitter and receiver at right-angles, and position a mirror or any reflecting material to reflect the radiation into the receiving diode when sound will again be produced at the loudspeaker.

It is possible to transmit the optical signal over many hundreds of metres using a lens system. This is done by positioning a converging lens one focal length away from the transmitting diode (and thereby producing a parallel light beam), and accurately positioning another converging lens some distance along the light beam, and focussing the signal down onto the receiving diode (which is similarly one focal length away from the lens). Figure.1 illustrates this arrangement.

Transmisson over a long distance using lenses

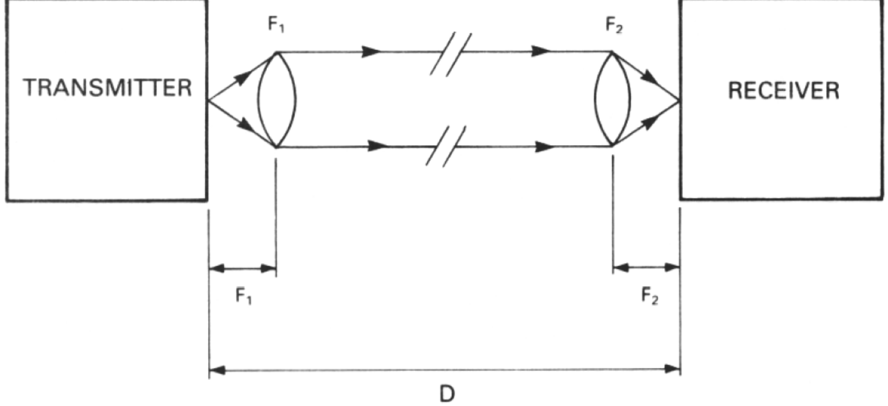


Fig 1. Free space optical communication using lenses

2.2 RADIO SIGNAL OVER OPTICAL FIBER

Procedure:

1. Connect the radio to the transmitter, and set up the signal levels as in the first two paragraphs of Section .2.1.
2. Turn the loudspeaker on.
3. Take a length of optical cable, and push into the sockets at both the transmitter and receiver.
4. Reduce the output power of the transmitter (by turning the output power knob anti undistorted. (This operation is carried out to ensure tha fibre is not high enough to overload the receiver).

5. Then adjust the analogue gain of the receiver for the most suitable loudspeaker sound level.
6. A good demonstration of the fact that the audio signal is really using the set-up described in the above paragraph, turn both the transmitter output power and the receiver analogue gain to maximum (fully clockwise), connect the shorter opti-transmitter, and the longer one to the receiver, and position the free cable ends close to each other — the intensity of the loudspeaker output varies with the positioning of these two ends

2.3 USING THE OUTPUT INDICATOR AS THE TRANSMITTING DEVICE

The output indicator diode at the transmitter emits the same signal as the main emitting diodes, although at lower intensity. This can be demonstrated by setting up the transmitter and receiver for analogue transmission of the radio signal.

1. Turn the transmitter output power to maximum and the receiver analogue gain to maximum.
2. Connect the smaller length of fiber to the receiver input socket, and position the other end of this fiber close to the transmitter output indicator.

The radio signal will be heard at the loudspeaker.

2.4. VOICE SIGNAL OVER SYSTEM

Demonstrations 2.1 and 2.2 can be carried out using the microphone connected into the 'high Z' socket of the transmitter, with the radio disconnected. In order to prevent the high whistle caused by feedback from loudspeaker to microphone, separate the loudspeaker and microphone by as much as the optical and electrical cables permit, and reduce the analogue gain in the receiver and/or the transmitter's output power until the whistling stops. The transmitter analogue gain should be at maximum in these demonstrations.

2.5. GENERAL ANALOGUE SIGNALS OVER SYSTEM

Any analogue signal in the bandwidth of 25Hz to 25kHz may be passed through the system. There are choices of high and low impedance sockets at both the transmitter and receiver. Care must always be taken when transmitting analogue signals to ensure that:

1. The analogue gain in the transmitter must be adjusted to ensure that the signal at the emitting diodes is not high enough to distort the optical output through 'clipping'. If this signal is too high,

the transmitter indicator diode will fluctuate in intensity. The highest suitable gain of the analogue signal is at a position just less than when this intensity fluctuation begins to occur. Distortion of the optical signal due to the Led response not being exactly linear may be decreased by further reducing the analogue gain.

2. The received optical power must not be high enough to overload the receiver circuitry. To set an acceptable level, carry out the following procedure:

a. Connect up the optical route, set the transmitter to analogue and turn the output power to maximum (control fully clockwise).

b. Switch the receiver to digital, and turn the threshold sensitivity control fully anti clockwise (lowest sensitivity). If the digital indicator light is OFF, follow instruction C1, and if it is ON, follow C2.

If the receiver's digital indicator light is OFF:

C1. Leave the transmitted power at its maximum position, and switch the receiver to analogue. The system is now set up for the transmission of analogue signals, and the receiver analogue gain may be adjusted to required level.

If the receiver's digital indicator light is ON:

C2. Turn the transmitter output power control anti-clockwise until the indicator goes OFF, and switch the receiver back to analogue operation. The system is now set up for the transmission of analogue signals, and receiver analogue gain may be adjusted to the required level.

Throughout the above setting-up procedure, the buzzer may be switched on and used as the indicator instead of the digital indicator light.

2.6. USING A REFLECTING DIAPHRAGM AS A TRANSMITTER

1. Connect the earphone with the top removed (this is provided with the Educator) into the ear phone socket of the radio.
2. Turn the radio volume control up to a high level. Turn the loudspeaker on, switch the receiver to analogue and turn its analogue gain up to maximum.

3. Connect the shorter optical cable to the receiver, and position the torch, earpiece and cable end as in Figure 2.

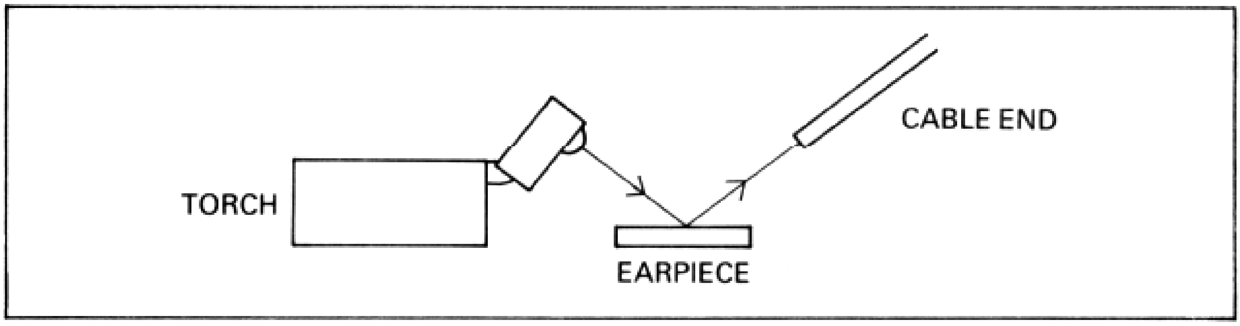


Figure 2. *Reflecting Diaphragm Transmitter*