Technologies

Advance Optical Fiber Communication

ELX-2405

+91 79 4892 1020

http://elvux.net

info@elvux.net

Advance Optical Fiber Communication
ELX-2405

Elvux - ELX-2405 kit is providing knowledge of the fundamental techniques used in Advance Optical Fiber Communication in Optical fiber Communication System. Practical experience on this board carries great educative value for Students.

Features

Full Duplex Analog & Digital Trans-receiver.
Single module covering large number of experiments including experiments with Optical Power Meter.
660 nm & 950 nm Fiber Optic LED channel with Transmitter & Receiver.
PAM-FM-PWM modulation / demodulation.
PC-PC comm. with RS232 ports & software.
On board Function Generator.
Crystal controlled Clock.
Functional blocks indicated on-board.
Input-output & test points provided.
On board voice link.
Built in DC Power Supply.
Numerical Aperture measurement jig and mandrel for bending loss measurement.
Switched faults on Transmitter & Receiver.

Objective

Setting up Fiber Optic Analog & Digital link.
PAM system using Digital input signals.
Frequency Modulation system and Pulse Width Modulation system.
Study of Propagation Loss, Bending Loss & measurement of Numerical Aperture.
Characteristics of Fiber Optic communication link.
Setting of Fiber Optic voice link using Amplitude, Frequency & PWM Modulation.
Study of Switched Faults in PAM, FM & PWM system.
Full Duplex Computer Communication using RS232 ports and software.
V-I characteristics of LED.
Characteristics of Photo Receiver.

Specifications

Transmitter	:	2 nos., Fiber Optic LED having peak wavelength of emission 660 nm & 950 nm
Receiver	:	2 nos., Fiber Optic Photo receiver
Modulation Techniques	:	PAM, FM, PWM, AM
Drivers	:	1 no. with Analog & Digital modes
AC Amplifier	:	2 nos.
Clock	:	Crystal controlled Clock 4.096 MHz
PLL receiver	:	1 no.
Comparator	:	2 nos.
Filters	:	2 nos. 4th order Butter worth, 3.4 KHz cut-off frequency
Function Generator	:	1 KHz Sine wave (Amplitude adjustable) 1 KHz Square wave (TTL)
Voice Link	:	PCM voice coding using microphone & speaker
PC-PC Communication	:	Using RS232
Port	:	RS232 (9 Pin)
Baud Rate	:	9600
Switched Faults	:	4 in Transmitter & 4 in Receiver
Fiber Optic Cable	:	Connector type standard SMA
Cable Type	:	Step indexed multimode PMMA plastic
Attenuation	:	Typically 0.3dB per meter (at660nm)
Numerical Aperture	:	Better than 0.5 Acceptance
Angle	:	Better than 60 deg.
Fiber Cable Length	:	0.5m & 1m
Test Points	:	More than 20 nos.
Inter connections	:	2 mm sockets
Power Supply	:	230 V, ± 10%, 50 / 60 Hz

Included Accessories with Kit:

Numerical Aperture measurement jig, Fiber Cables.

Microphone, Headphone, Set of Patch Cords.

Practical Manual.

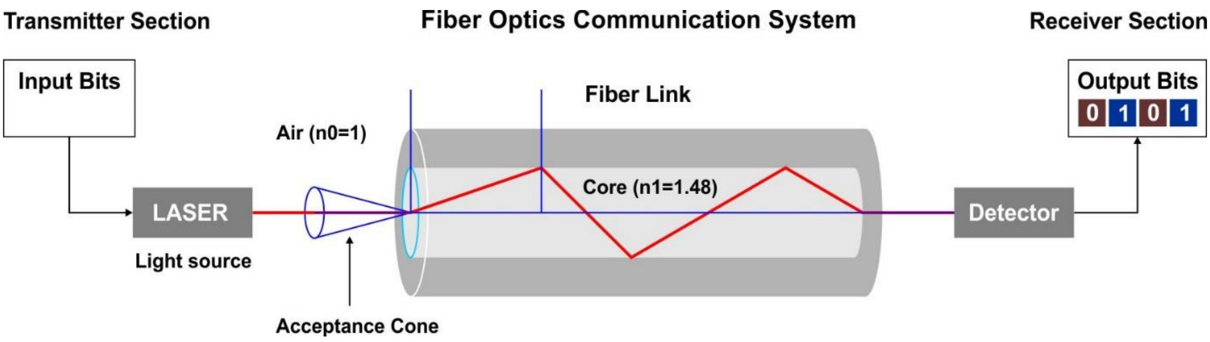
Soft Copy of Manual on CD.

Introduction to Optical Fiber:

Communication can be broadly defined as the transfer of information from one point to another. Before Fiber optics came along, the primary means of real time data communication was electrical in nature. It was accomplished by using copper wire or by modulating information on to an electromagnetic wave which acts as a carrier for the information signal. All these methods have one problem in common the communication had to be over a straight line path. Fiber optics provides an alternative means of sending information over significant distances using light energy. Light is utilized for communication has major advantages because it can be modulated at significant higher frequencies than electrical signals. That is till 1870, when an Irish physicist John Tyndall carried out a simple experiment. He filled a container with water and shone light into it. In the darkened room he pulled the bung from the opposite end of the container. The light shone out, of course but in which direction?
The light followed the curved path of water. The light was guided and a new science was born. This was due to a property of light called refraction.

Understanding how Fiber optics are made and function for uses in everyday life is an intriguing work of art combined with science. Fiber optics has been fabricated from materials that transmit light and are made from a bundle of very thin glass or plastic Fibers enclosed in a tube. One end is at a source of light and the other end is a camera lens, used to channel light and images around the bends and corners. Fiber optics has a highly transparent core of glass, or plastic encircled by a covering called "cladding". Light is stimulated through a source on one end of the Fiber optic and as the light travels through the tube, the cladding is there to keep it all inside. A bundle of Fiber optics may be bent or twisted without distorting the image, as the cladding is designed to reflect these lighting images from inside the surface. This Fiber optic light source can carry light over mass distances, ranging from a few inches to over 100 miles. There are two kinds of Fiber optics. The single-mode Fiber optic is used for high speed and long distance transmissions because they have extremely tiny cores and they accept light only along the axis of the Fibers. Tiny lasers send light directly into the Fiber optic where there are low-loss connectors used to join the Fibers within the system without substantially degrading the light signal. Then there are multi-mode which have much larger cores and accept light from a variety of angles and can use more types of light sources. Multi-mode Fiber optics also uses less expensive connectors, but they cannot be used over long distances as with the single-mode Fiber optics.

Fiber optics has a large variety of uses. Most common and widely used in communication systems, Fiber optic communication systems have a variety of features that make it superior to the systems that use the traditional copper cables. The uses of fiber optics with these systems use a larger information- carrying capacity where they are not hassled with electrical interference and require fewer amplifiers then the copper cable systems. Fiber optic communication systems are installed in large networks of Fiber optic bundles all around the world and even under the oceans. Many Fiber optic testers are available to provide you with the best Fiber optic equipment. In Fiber optic communication systems, lasers are used to transmit messages in numeric code by flashing on and off at high speeds. This code can constitute a voice or an electronic file containing, text, numbers, or illustrations, all by using Fiber optics. The light from many lasers are added together onto a single Fiber optic enabling thousands of currents of data to pass through a single Fiber optic cable at one time. This data will travel through the Fiber optics and into interpreting devices to convert the messages back into the form of its original signals. Industries also use Fiber optics to measure temperatures, pressure, acceleration and voltage, among an assortment of other uses.



Here, the information source provides an amplified electrical signal to a transmitter comprising an electrical stage, which drives an optical source to give conversion, may be either a semiconductor, LASER (Light Amplification by Stimulated Emission of Radiation) or LED. The transmission medium consists of optical source, which provides an electrical to optical conversion, an optical Fiber cable used for transmission of signal and the receiver, consists of an optical detector, which drives a further electrical stage and hence provides demodulation of optical carrier. This electrical signal is amplified and applied to the destination example speaker.

Photo diodes (P-I-N or Avalanche) and in some instances photo transistors and photo conductors are utilized for detection of optical signal and optical to electrical conversion. The optical carrier may be modulated using an analog or digital information signal. Analog modulation involves the variation of light emitted from the optical source in continuous manner. In digital modulation however, discrete changes in the light intensity are obtained (i.e. 'On-Off' pulses) although often simpler to implement, analog modulation with an optical Fiber communication system is less efficient, requiring a far higher signal to noise ratio (SNR) at the receiver than digital modulation. Also, linearity needed for analog modulation is not provided by semiconductor optical sources especially at high modulation frequencies.

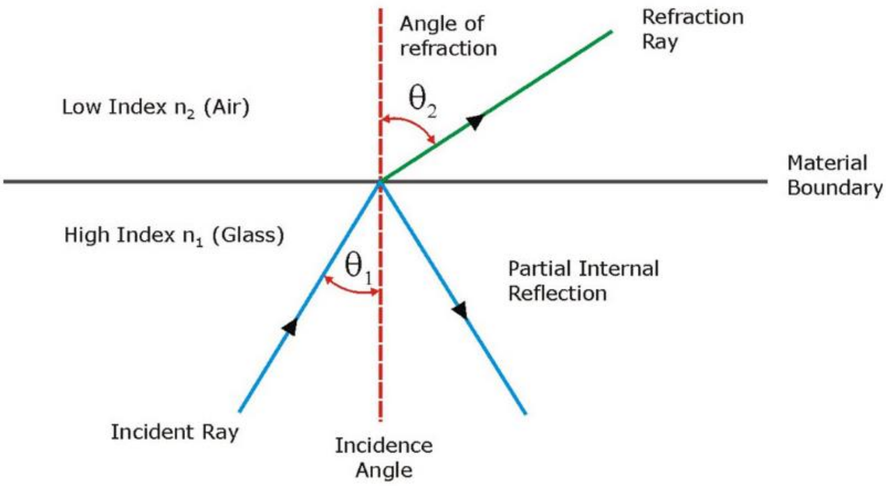
Principle of operation of Optical Fiber:

The principle of operation of optical Fiber lies in the behavior of light. It is a widely held view that light always travels in straight line and at constant speed. Of course, the light propagates in straight lines, but when it is reflected inside the optical Fiber million and trillion times by the clad, each movement comprising of a straight line and consequently because of such reflections, it acquires the shape of the optical Fiber. So effectively, it is said to have been traveling along the Fiber. It changes its direction only if there is a change in the dielectric medium as also illustrated by the Tyndall's experiment. To understand the propagation of light within an optical Fiber it is necessary to take into account refractive index of the dielectric medium. Refractive index of a medium is defined as the ratio of velocity of light in vacuum to velocity of light in medium.

$$Refractive\ index = \frac{Velocity\ of\ light\ in\ vaccum}{Velicity\ of\ light\ in\ medium}$$

Since, the velocity of light in any solid, transparent material is less than in vacuum the refractive index of such material is always greater than 1.0. A ray of light travels slowly in an optically dense medium than one that is less dense. Now, the direction that the light approaches the boundary between the two materials is very important. When a ray is incident on the interface between two dielectrics of differing refractive indices, refraction occurs.

The light is refracted and also partly reflected internally in the same medium; which is referred as *Partial Internal Reflection.* It may be observed that the ray approaching the interface is propagating in a dielectric of refractive index n_x and is at an angle Õ$_1$ to the normal at the surface of the interface. If the dielectric on the other side of interface has a refractive index n_2 which is less than n_x, then the refraction is such that the ray path in this lower index medium is at angle Õ$_2$ to the normal where Õ$_2$ is greater than Õ$_1$.



The angle of incidence Õ$_1$ and refraction Õ$_2$ are related to each other and to refractive indices of dielectrics by ***Snell's law of refraction*** which states that:

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_1}{n_2}$$

It is this change in refractive indices which causes the change in the path of the incident ray as evident from the Snell's law. Larger the change in the refractive indices larger change in the direction of the incident ray. The sine of the angles will be in the ratio of their refractive indices. As the angle of incident ray increases, the angle of refraction also increases even faster and when the angle of refraction becomes 90° thereafter, if the angle of incidence is increased a condition is arrived where the incident ray is totally reflected in the same medium from where it has emerged; this is referred as the total internal reflection.

Total Internal Reflection:

Since, the angle of refraction is always greater than the angle of incidence, when the incident medium is denser than the refraction medium. Thus, the angle of refraction is 90° and the refracted ray emerges parallel to the interface between the dielectrics. This is the limiting case of refraction and this angle of incidence is known as critical angle Õ C.

The value of critical angle is given by:

$$\theta_2 = 90°$$

$$\theta_1 = \theta_c$$

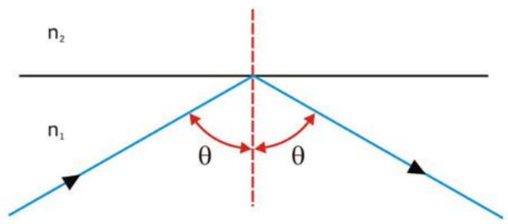
Substituting this in the equation for Snell's law gives

$$n_1 \sin\theta_c = n_2 \sin 90°$$

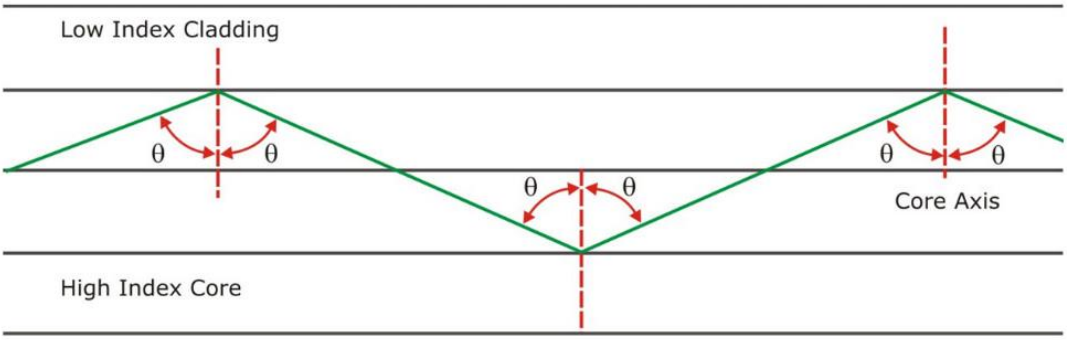
$$\therefore \sin\theta_c = \frac{n_2}{n_1}$$

At angles of incidence greater than the critical angle the light is reflected back into the originating dielectric medium. This behavior of light is termed as Total Internal Reflection.

Here, Angle of Incidence = Angle of Reflection



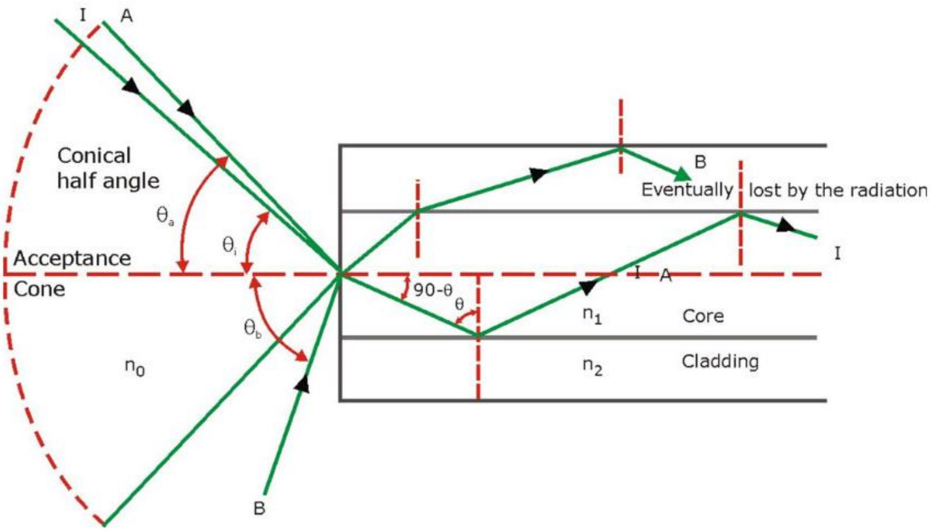
This is the mechanism by which light may be considered to propagate down an optical fiber with low loss. shown in next figure below illustrates the transmission of a light ray in an optical fiber via a series of total internal reflection at the interface of the silica core and slightly lower refractive index silica cladding.



The light ray shown in next figure is known as meridian ray as it passes through the axis of the fiber core. It is generally used when illustrating the fundamental transmission properties of optical fiber.

Acceptance Angle:

Since, only rays with an angle greater than critical angle at the core cladding interface are transmitted by total internal reflection, it is clear that not all rays entering the fiber core will continue to propagate down the length.



Shown in next figure illustrates two incident rays I and B. It may be observed that ray 'I' enters the fiber core at an angle θ_i less than θ_a (conical half angle for the fiber explained herein under) to the fiber axis and is refracted at the air- core interface before transmission to the core- cladding interface at an angle ố more than the critical angle Õc. This ray is totally internally reflected and propagated along the fiber. While incident ray 'B' is incident into the fiber core at an angle θ_b greater than θ_a and will be transmitted to the core- cladding interface at an angle less than Õc and will not be totally internally reflected instead will be refracted into cladding and eventually lost by the radiation. Thus, for rays to be transmitted by total internal reflection within the fiber core they must be incident on the fiber core within an acceptance cone defined by conical half angle θ_a. Hence, θ_a is the maximum angle to the axis at which light may enter the fiber in order to be propagated and is referred to as the acceptance angle for the fiber?

Here $\theta_i < \theta_a < \theta_b$

Numerical Aperture:

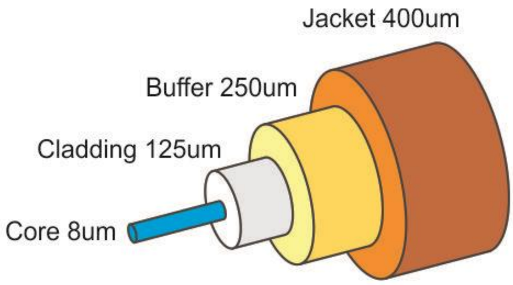
It gives the relationship between the acceptance angle and the refractive indices of the three media involved viz. the core, the cladding and air.

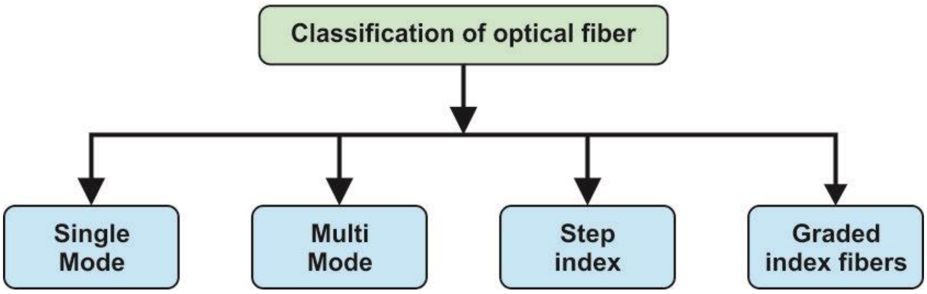
In the shown in next figure above θ_i corresponds to θ_i; when Õi approaches Õc; $\theta_i$approaches θ_a.

The Optic Fiber:

The simplest Fiber optic cable consists of two concentric layers of transparent materials. The inner portion the core transports the light, the outer covering (the cladding) must have a lower refractive index than the core so the two of them are made up of different materials.

To provide mechanical protection for the cladding an additional plastic layer; called Primary Buffer is added. Some constructions of optic Fiber have additional layers of buffers that are then referred to as Secondary Buffers. It is very important to note that the whole Fiber-Core, Cladding & Primary Buffer is solid and the light is confined to the core by the Total Internal Reflection due to the difference in the refractive index of the core as compared to that of cladding.



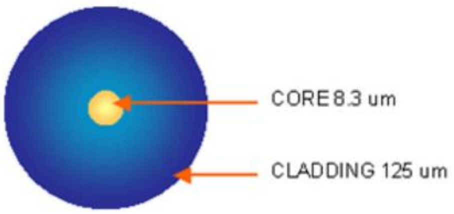


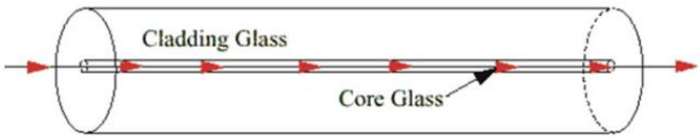
Single Mode versus Multi Mode:

As we have already seen that there are particular angles of propagation defined by cone of acceptance, which can be transmitted down the optic fiber. At these angles, the electromagnetic wave that the light can set up a number of completes patterns across the fiber. The number of complete patterns called Modes depends on the dimensions of the optic fiber core. There are essentially two different types of fiber optic transmission schemes in use viz.

- Single Mode
- Multi-Mode

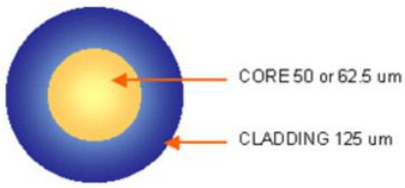
Single Mode:
As the name suggests the single mode cable is able to propagate only one mode (Electromagnetic wave). This is used in long distance and/or, high-speed communication. It is beneficial over long distances since it completely eliminates a problem known as Intermodal Dispersion associated with Multimode cables. All our long distance telephone conversations are now carried by single mode optic fiber system over at least some part of the route.

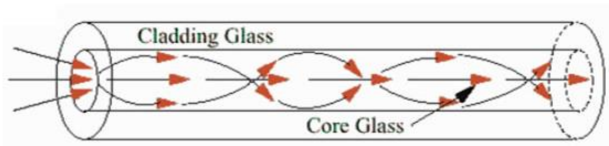




Multi-Mode:
The term multimode means that the diameter of the fiber optic core is large enough to propagate more than one mode (Electro Magnetic Wave).

Because of the multiple modes the pulse that is transmitted down the fiber tends to become stretched over distance this is referred to as dispersion & has the effect of reducing the available bandwidth. These are typically used in applications such as LAN (Local Area Networks) & FDDI (Fiber Distributed Area Interface).





Experiment – 1

Setting up Fiber Optic Analog link.

Objective:

Setting up Fiber Optic Analog Link

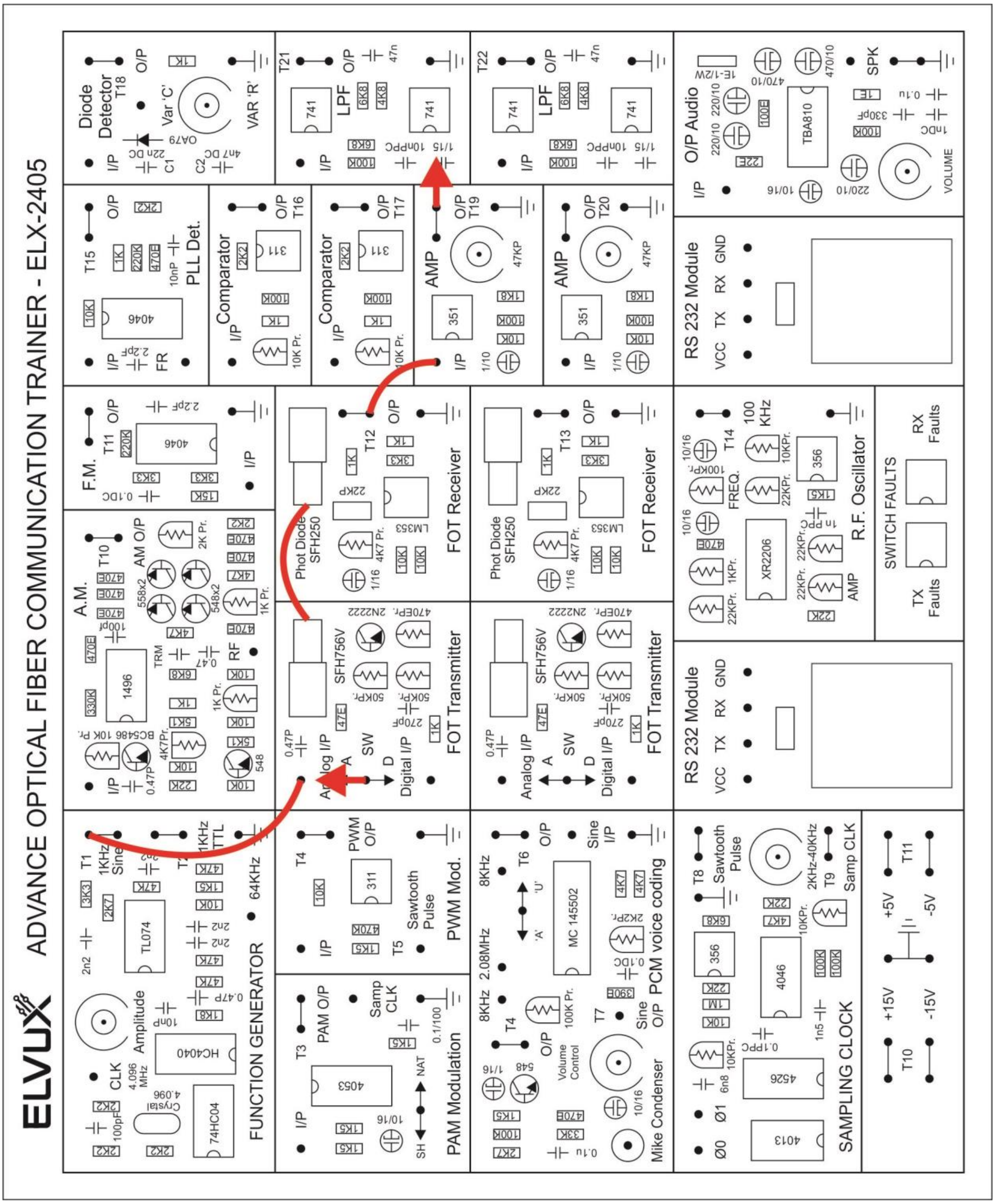
Study of a 650nm fiber optic analog link in this experiment you will study the relationship between the input signal and received signal

Equipements Required:

- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Procedure:

1. Connect the Power Supply cord to the main power plug & to ELX-2405.
2. Ensure that all switched faults are ‘Off'.
3. Make the following connections as shown in next figure.
4. Connect the 1 KHz sine wave output TP1 to FOT Transmitter 1's input.
5. Connect the Fiber Optics cable between Transmitter output and Receiver input
6. Receiver 1's output to AC amplifier 1’s input TP19.
7. On the board, switch Transmitter 1's driver to analog mode.
8. Switch ON the Power Supply of ELX-2405 and Oscilloscope.
9. Observe the input to Transmitter-1 with the output from AC amplifier-1 and note that the two signals are same.



Fiber Optic Analog Link

Experiment – 2

Setting up Fiber Optic Digital link.

Objective:

Setting up Fiber Optic Digital Link

Study of a 650 nm fiber optic digital link

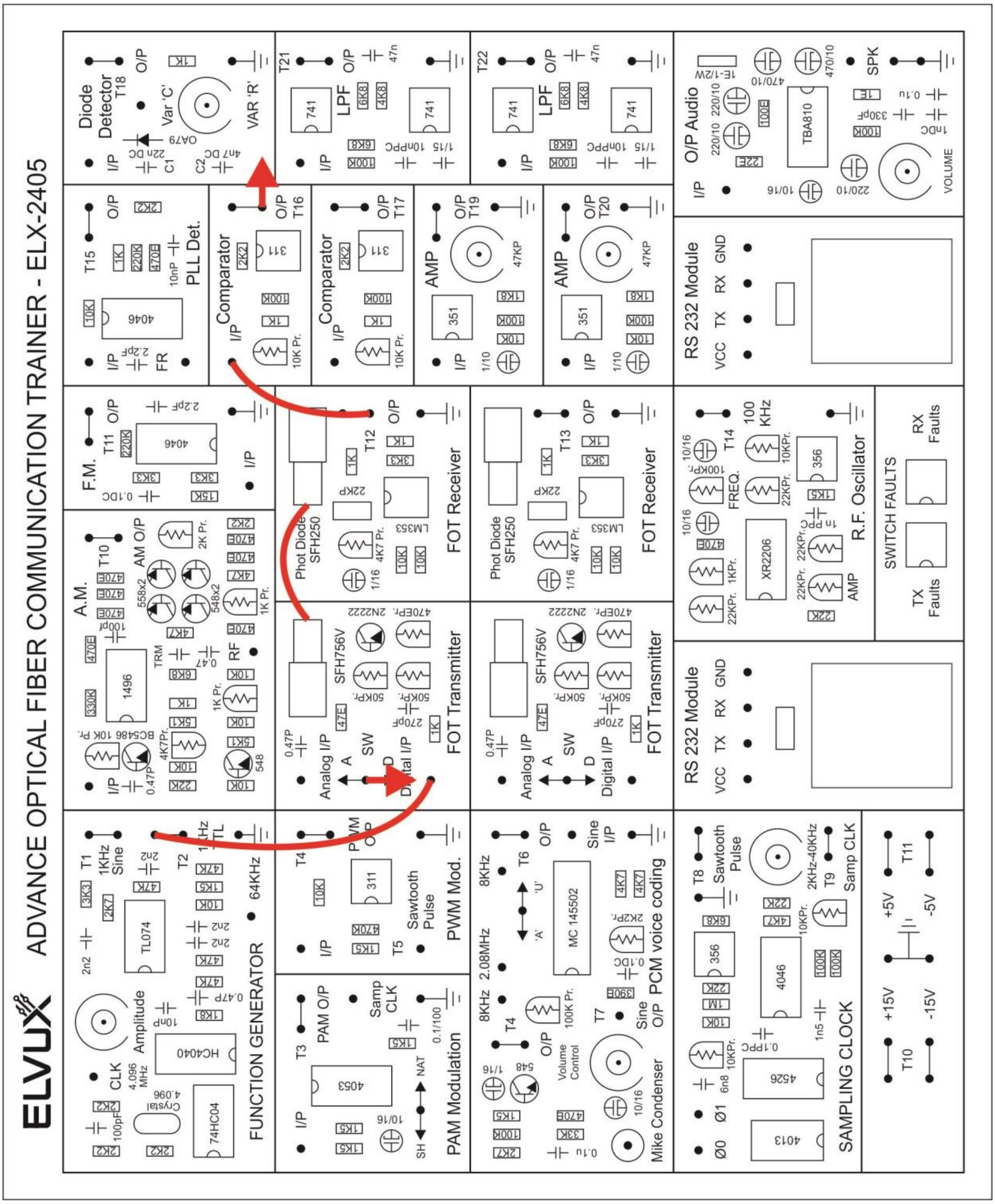
In this experiment you will study the relationship between the input signal and received signal

Equipements Required:

- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Procedure:

1. Connect the Power Supply cord to the main the Power Supply to the board.
2. Ensure that all switched faults are ‘Off’.
3. Make the following connections as shown in next figure.
4. Connect the 1 KHz square wave output TP2 to Transmitter 1's input.
5. Connect the fiber optic cable between Transmitter output and receivers input.
6. Receivers 1's output to comparator 1’s input TP16.
7. On the board, switch Transmitter 1's driver to digital mode.
8. Switch ON the Power Supply of ELX-2405 and Oscilloscope.
9. Observe the input to transmitter-1 with the output from comparator-1 and note that the two signals are same.



Fiber Optic Digital Link

Experiment – 3

PAM system using Digital input signals.

Objective:

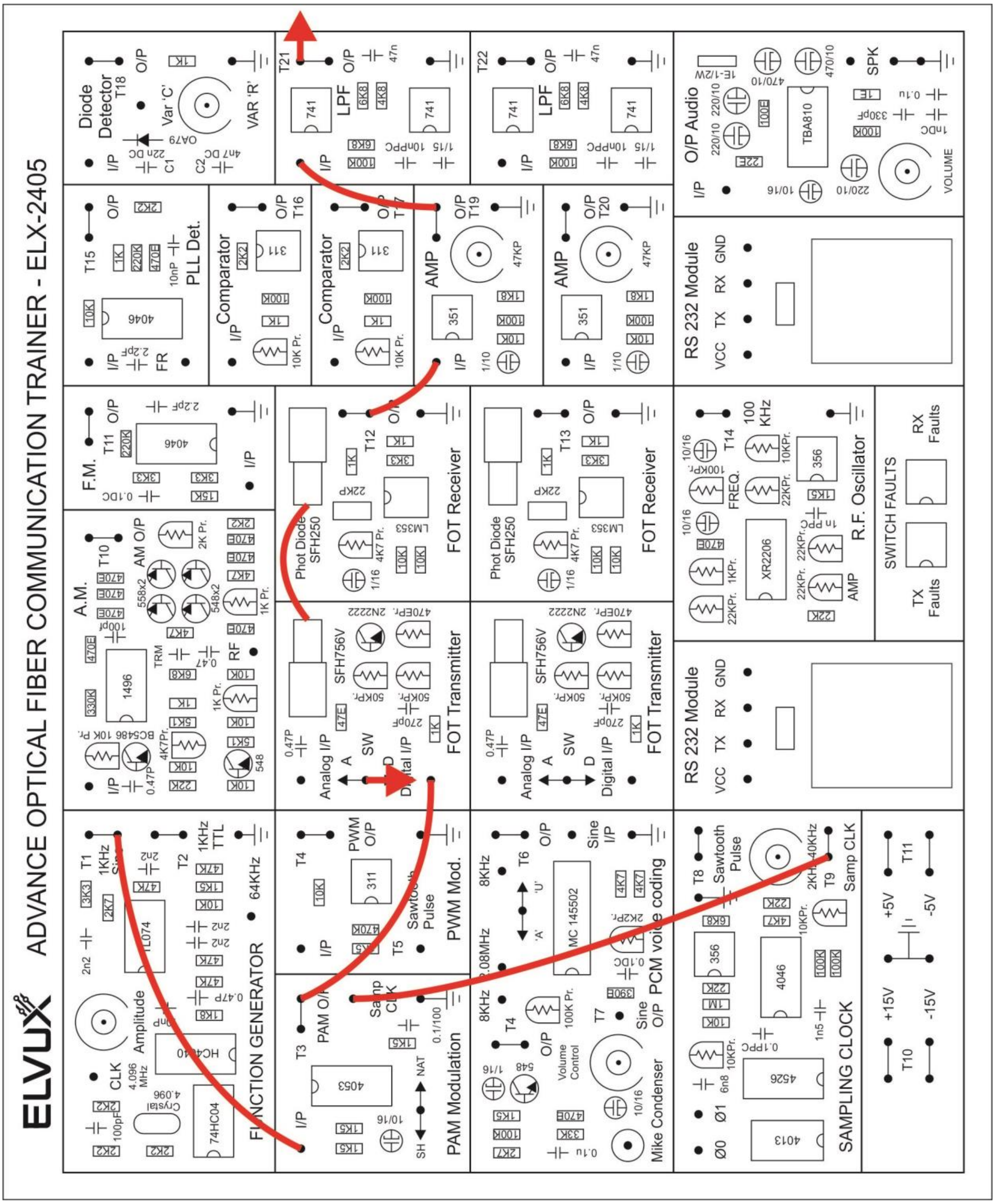
PAM system using Digital input signals

Equipements Required:

- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Procedure:

1. Connect the Power Supply cord to the main power plug & to ELX-2405.
2. Ensure that all switched faults are 'Off'.
3. Make the following connections as shown in next figure.
4. Connect Function Generator 1 KHz sine wave signal TP2 to Pulse amplitude modulator input.
5. Connect Sampling Clock output TP9 to PAM Modulator Sampling clock input.
6. Connect pulse amplitude modulator output TP3 to the transmitter-1 input.
7. Connect the optic fiber between the transmitter-1 circuit and the receiver-1 circuit.
8. Receiver-1 output TP12 to Amplifier-1 Input.
9. Amplifier-1 output TP19 to Low pass filter input.
10. Switch Transmitter 1's driver to digital mode.
11. Turn the 1 KHz preset in the Function Generator block to fully anticlockwise (Zero amplitude) position.
12. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
13. Monitor the output of PAM block.
14. Examine the output of FOT receiver-1 and check that the transmitted digital pulses are successfully detected at the receiver.
15. In order to fully understand how this pulse amplitude modulation transmitter/ receiver system works, examine the inputs and outputs of all functional blocks within the system, using an Oscilloscope.



PAM system using Digital input signals

Experiment – 4

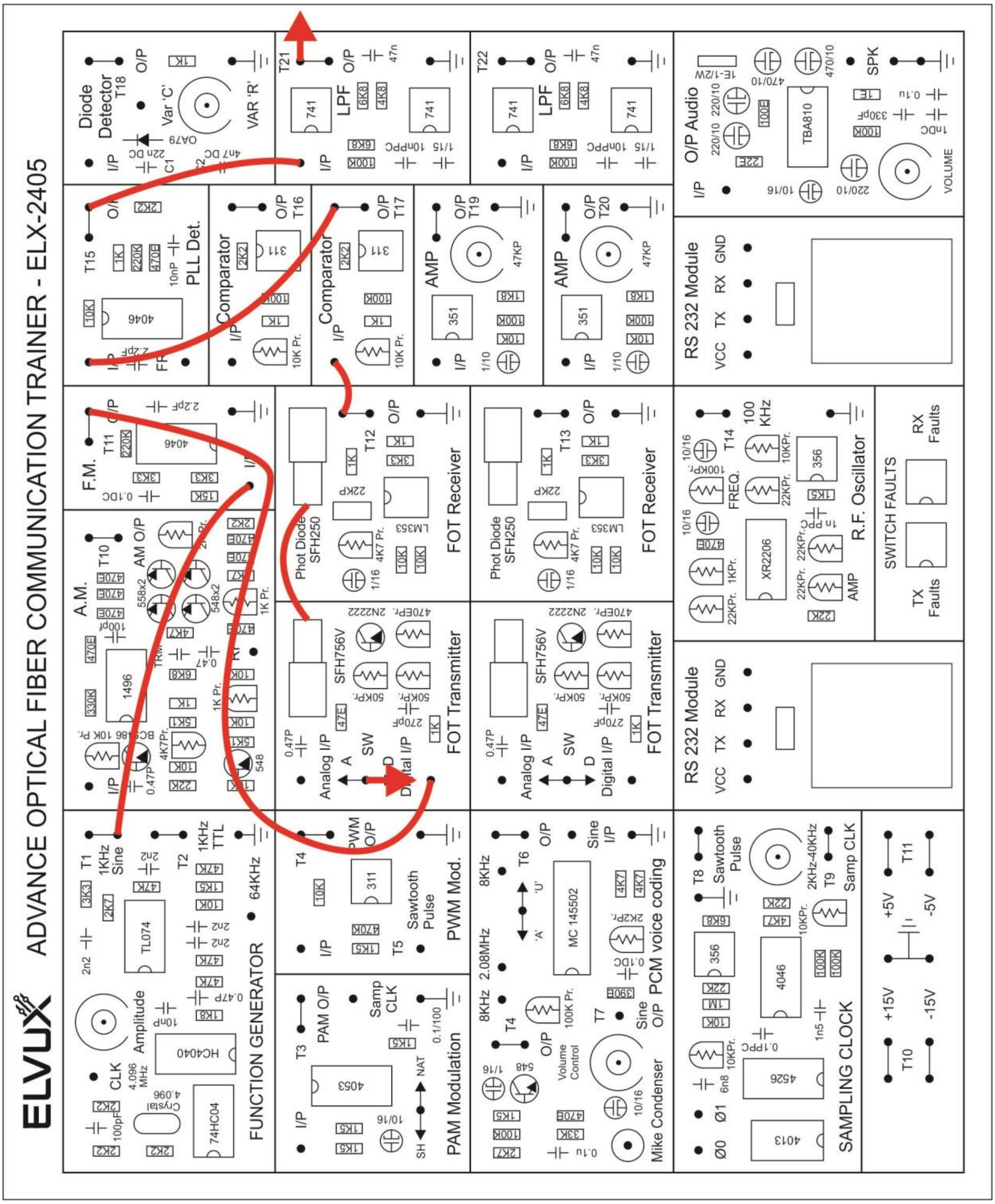
Frequency Modulation system

Objective:
Frequency Modulation system

Equipements Required:
- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Procedure:
1. Connect the Power Supply cord to the main power plug & to ELX-2405.
2. Ensure that all switched faults are 'Off'.
3. Make the following connections as shown in next figure.
4. Connect Function Generator 1 KHz sine wave signal to frequency modulator input.
5. Frequency modulator output TP11 to the transmitter-1 input.
6. Connect the optic fiber between the transmitter-1 circuit and the receiver-1 circuit.
7. Connect receiver-1 output TP12 to comparator-1 input.
8. Comparator-1 output TP17 to the PLL receiver input.
9. PLL receiver output TP15 to the low pass filter-1 input.
10. Switch transmitter 1's driver to digital mode. This ensures that fast changing digital signal applied to the drivers input causes the transmitter LED to switch quickly between 'On' & 'Off' states.
11. Turn the 1 KHz preset in the Function Generator block to fully anticlockwise (Zero amplitude) position.
12. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
13. Monitor the output of the frequency modulator block. Note that the frequency of this digital signal is at present constant, since the modulating 1 KHz sine wave has zero amplitude.
14. Examine the output of receiver-1 and check that the transmitted digital pulses are successfully detected at the receiver.
15. With the help of dual trace Oscilloscope monitor both inputs to comparator.
16. Now adjust the bias 1 preset until the bias input at is halfway between the top and bottom of the square wave. You will remember that the function of the comparator is to clean up the square wave after its transmission through the fiber optic link.

17. While monitoring the input to the frequency modulator block and the output from low pass filter-1 turn the 1KHz preset to its fully clockwise maximum amplitude) position. Note that the modulating 1 KHz signal now appears at the low pass filter output. If necessary, adjust the amplifiers gain, adjust 1 preset until the two monitored signal are equal in amplitude.
18. In order to fully understand how this frequency modulation transmitter/ receiver system works, examine the inputs and outputs of all functional blocks within the system, using an Oscilloscope.



Frequency Modulation system

Experiment – 5

Pulse Width Modulation system.

Objective:

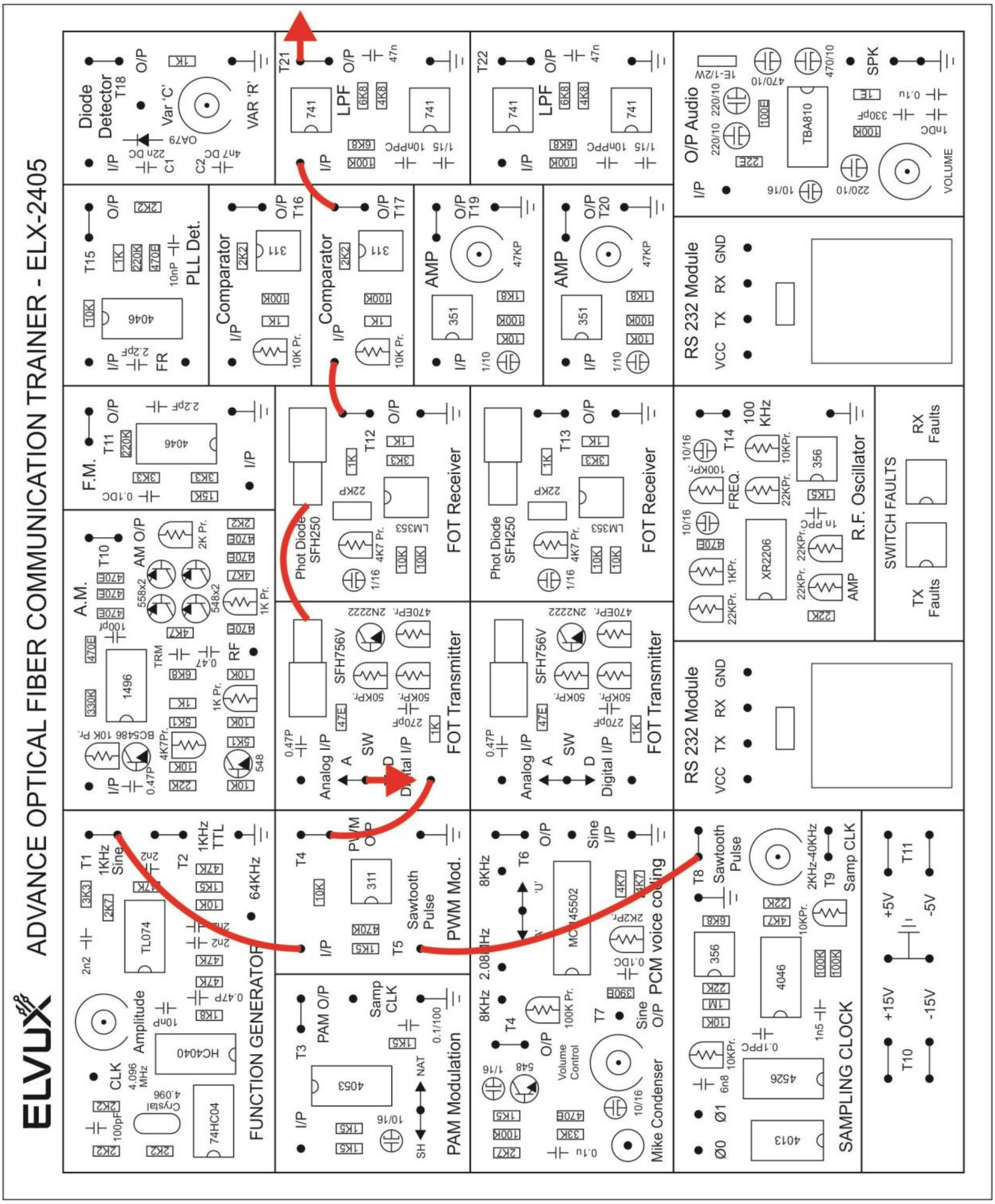
Pulse Width Modulation system.

Equipements Required:

- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Procedure:

1. Connect the Power Supply cord to the main power plug & to ELX-2405.
2. Ensure that all switched faults are set to 'Off'.
3. Make the following connections as shown in next figure.
4. FG's 1 KHz sine wave signal to the Pulse width modulator input.
5. Pulse width modulator output TP4 to transmitter-1 input.
6. Connect the optic fiber between the transmitter-1 circuit and receiver-1 circuit.
7. Receiver-1 output to comparator input.
8. Comparator-1 output TP17 to LPF-1 input.
9. Switch transmitter 1's driver to digital mode. This ensures that fast changing digital signals applied to the drivers input because the transmitter LED to switch quickly between 'On' & 'Off' states.
10. Turn the 1 KHz preset of Function Generator block to fully anticlockwise (zero amplitude) position.
11. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
12. Monitor the output of the pulse width modulator block TP4. Note that the pulse width of this digital signal is at present constant, since the modulating 1 KHz sine wave has zero amplitude.
13. Examine the output Receiver TP12 and check that the transmitted digital pulse is successfully detected at the receiver.
14. The average level of comparator 1's output is extracted by LPF 1. Since, the average level of the comparator output is proportional to the pulse width, the original analog signal appears at the low pass filter output TP21.
15. In order to fully understand how this pulse width modulation transmitter/ receiver system works, examine the inputs and outputs of all functional blocks within the system using an Oscilloscope.



Pulse Width Modulation system.

Experiment – 6

Study of Propagation Loss, Bending Loss & measurement of Numerical Aperture.

Equipements Required:

- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Objective

Study of Propagation Loss in Optical Fiber

Procedure:

1. Connect Power Supply cord to the main power plug & to ELX-2405.
2. Make the following connections as shown in next figure.
3. Function Generator's 1 KHz sine wave output TP1 to Input socket of transmitter-1 circuit via 2 mm lead.
4. Connect 0.5 m optic fiber between transmitter-1 output and receiver-1 input.
5. Connect receiver-1 output to amplifier-1 input socket.
6. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
7. Observe the output signal from receiver TP12 on CRO.
8. Adjust the amplitude of the received signal same as that of transmitted one with the help of gain adjust potentiometer in AC amplifier block. Note this amplitude and name it V1.

$$V_1/V_2 = e^{-a(L1+L2)}$$

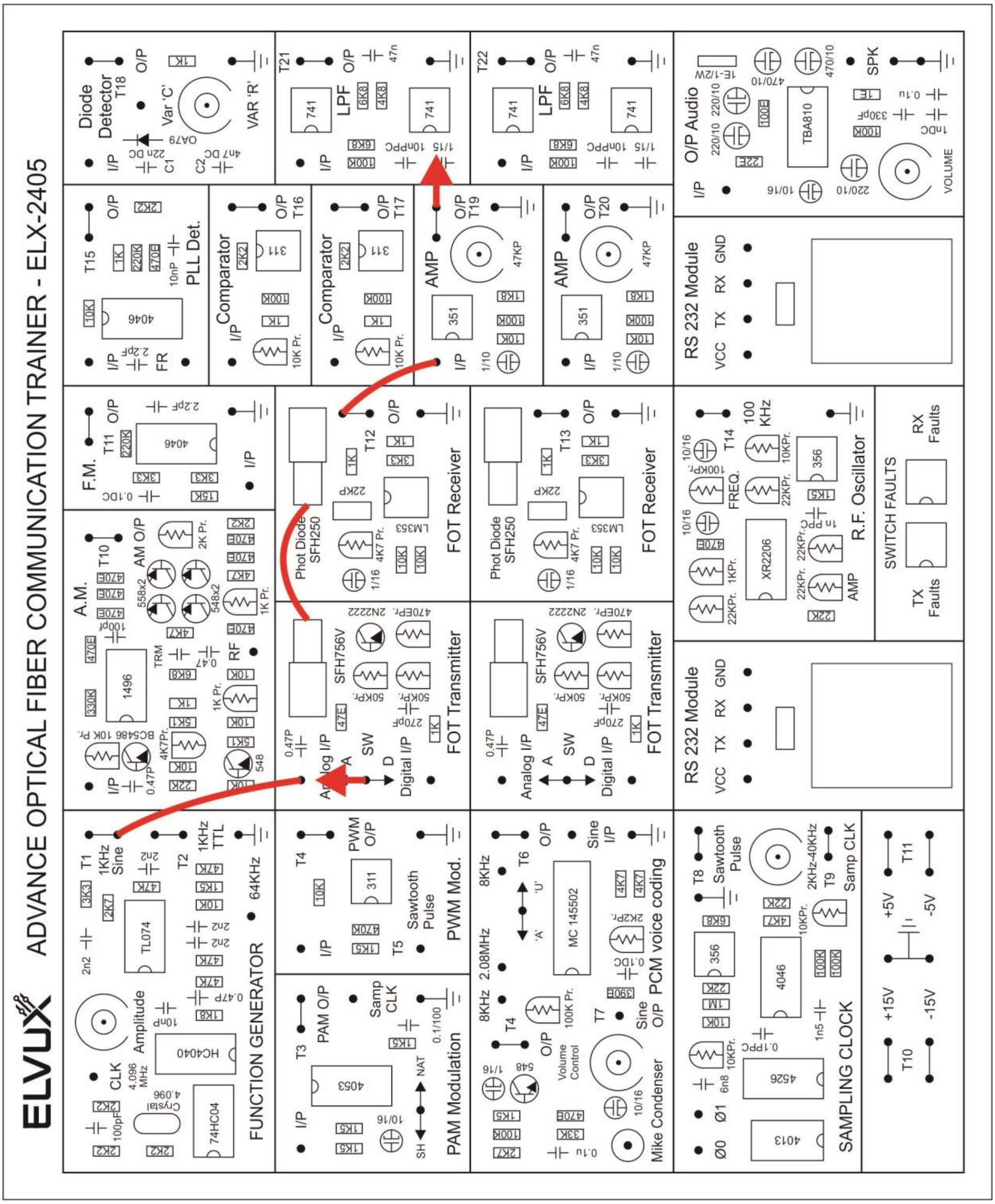
9. Now replace the previous FG cable with 1 m cable without disturbing any previous setting.
10. Measure the amplitude at the receiver side again at output of amplifier-1 socket TP19. Note this value end name it V2.
    Calculate the propagation (attenuation) loss with the help of following formula.

Where a, is loss in nepers / meter

1 neper = 8. 686 dB

L_1= length of shorter cable (0.5 m)

L_2 = Length of longer cable (1 m)



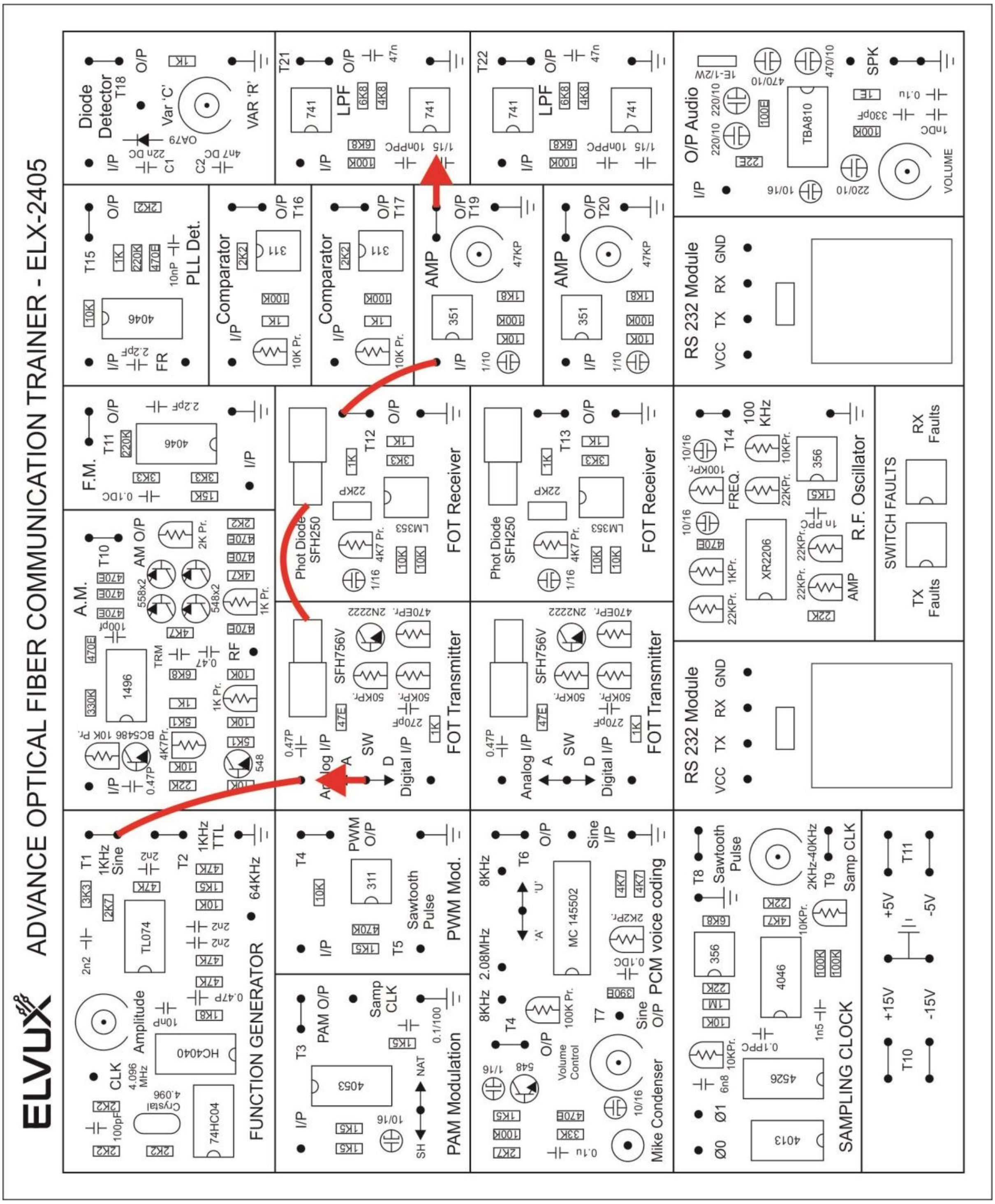
Propagation Loss

Objective

Study of Bending Loss in Optical Fiber

Procedure:

1. Connect the Power Supply cord to mains supply and to the ELX-2405.
2. Make the following connections as shown in next figure.
3. Ensure that all switched faults are 'Off'.
4. Function Generator's 1 KHz sine wave output TP1 to Input socket of transmitter-1 circuit via 2 mm lead. Set amplitude 2Vp-p.
5. Connect 0.5 m optic fiber between transmitter-1 output and receiver-1 input.
6. Connect receiver-1 output to amplifier-1 input socket.
7. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
8. Observe the output signal from Amplifier-1 on Oscilloscope.
9. Bend the fiber cable using given leads of different diameters and note the readings as per diameters.



Bending Loss

Objective

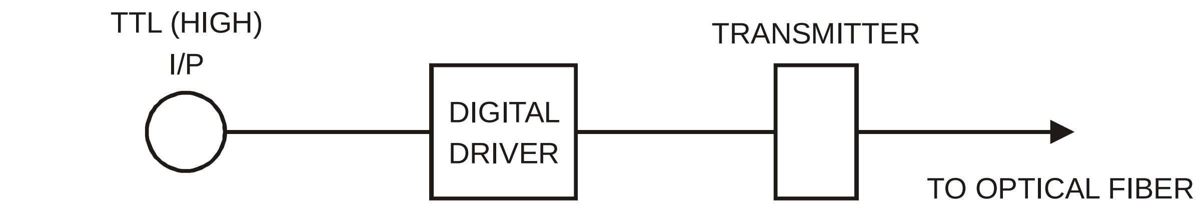
Study of Numerical Aperture in Optical Fiber

Procedure

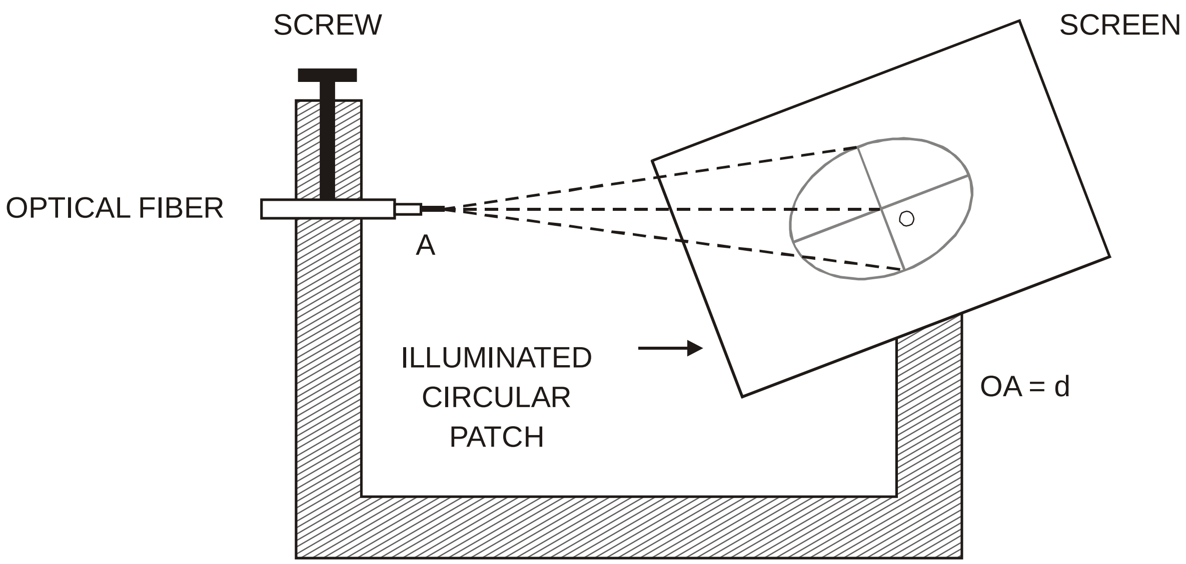
1. Connect the Power Supply cord to mains supply and to the ELX-2405.
2. Connect the frequency generator's 1 KHz sine wave output TP1 to input of transmitter-1 circuit. Adjust its amplitude at 5Vpp.
3. Connect one end of fiber cable to the output socket of transmitter-1 circuit and the other end to the numerical aperture measurement jig. Hold the white screen facing the fiber such that its cut face is perpendicular to the axis of the fiber.
4. Now observe the illuminated circular patch of light on the screen.
5. Measure exactly the distance “d” and also the vertical and horizontal diameters MR and PN as indicated In the fig.
6. Mean radius is calculated using the following formula
   $r = (MR + PN) / 4$
7. Find the numerical aperture of the fiber using the formula

   $$NA = \sin \phi_{max} = r / \sqrt{d^2 + r^2}$$

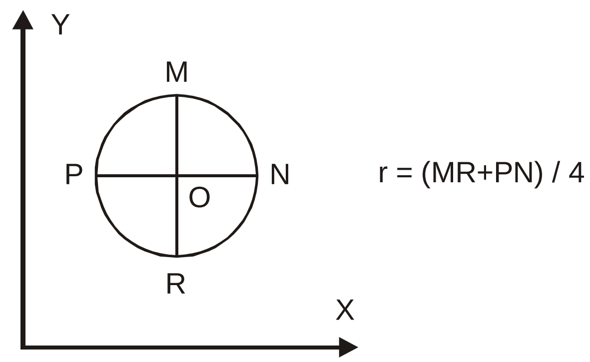
Where ϕ_{max} is the maximum angle at which the light incident is properly transmitted through the fiber.



BLOCK DIAGRAM FOR NUMERICAL APERTURE MEASUREMENT



NUMERICAL APERTURE MEASUREMENT SETUP



OBSERVATION TABLE

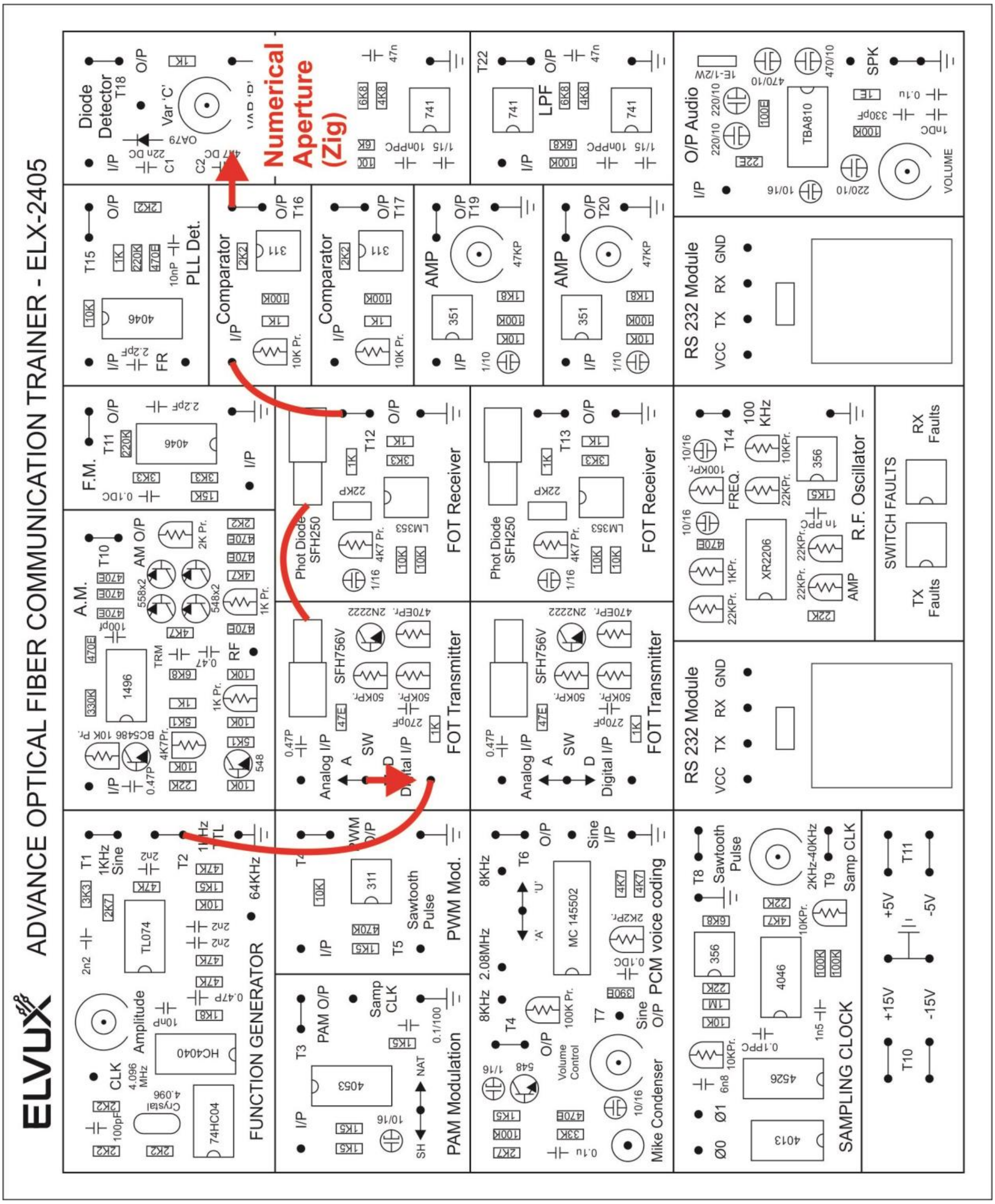
SR. No.	Distance (cm)	MR	PN	r	N.A.	Ø
1						
2						
3						

N.A. (avg.) = 0.55

Calculation:

N.A. = Sin Ø = $r / \sqrt{d2 + r2}$

Conclusion:
By Performing this practical, we measure light O/P from Fiber optic Cable with the help of instrument. We successfully measure the N.A. of the Cable which N.A. (avg.) = 0.55



Numerical Aperture in Optical Fiber

Experiment – 7

Characteristics of Fiber Optic communication link.

Objective:

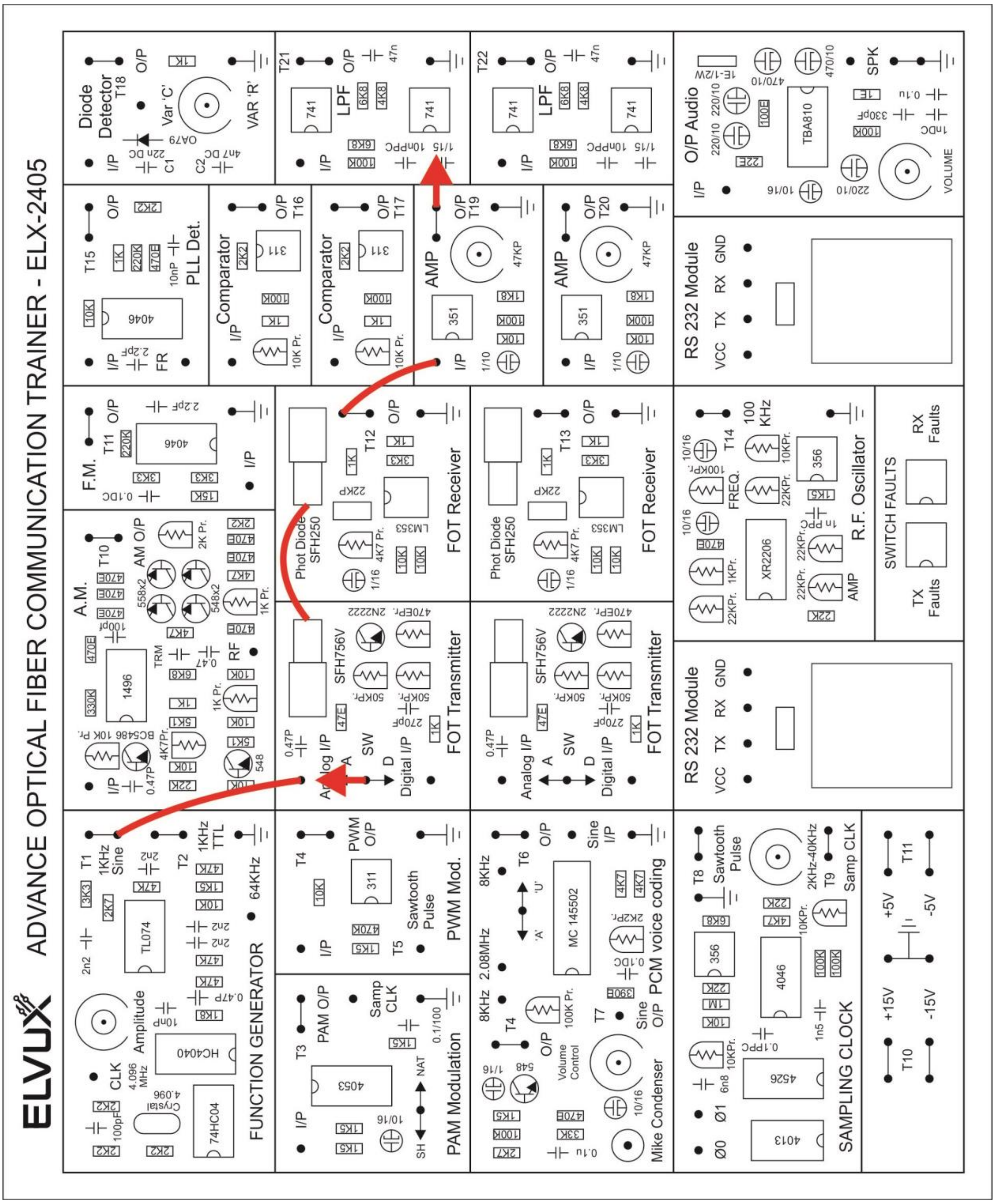
Characteristics of Fiber Optic communication link.

Equipements Required:

- ELX-2405 Training Kit
- Optical Fiber cable
- Cathode ray Oscilloscope with necessary Connecting probe

Procedure:

1. Connect the Power Supply cord to mains supply and to the ELX-2405.
2. Make the following connections as shown in next figure.
3. Function Generator 1 KHz sine wave output TP1 to input socket of transmitter-1 circuit via 2mm lead.
4. Connect optic fiber between transmitter 1's output and receiver 1's input.
5. Connect Receiver-1 output TP12 to amplifier-1 input socket.
6. Switch on the Power Supply.
7. Set the amplitude of the Function Generator.
8. Observe the transmitted and received signal on CRO. V_O (output voltage) should be in the same order as V_{IN} (input voltage).
9. Next set V_{IN} to suitable values and note the values of V_O.
10. Tabulate and plot a graph V_O versus V_{IN} & compute V_O/V_{IN}.



Characteristics of Fiber Optic communication link

Experiment – 7

Setting of Fiber Optic voice link using Amplitude Modulation, Frequency Modulation & PWM.

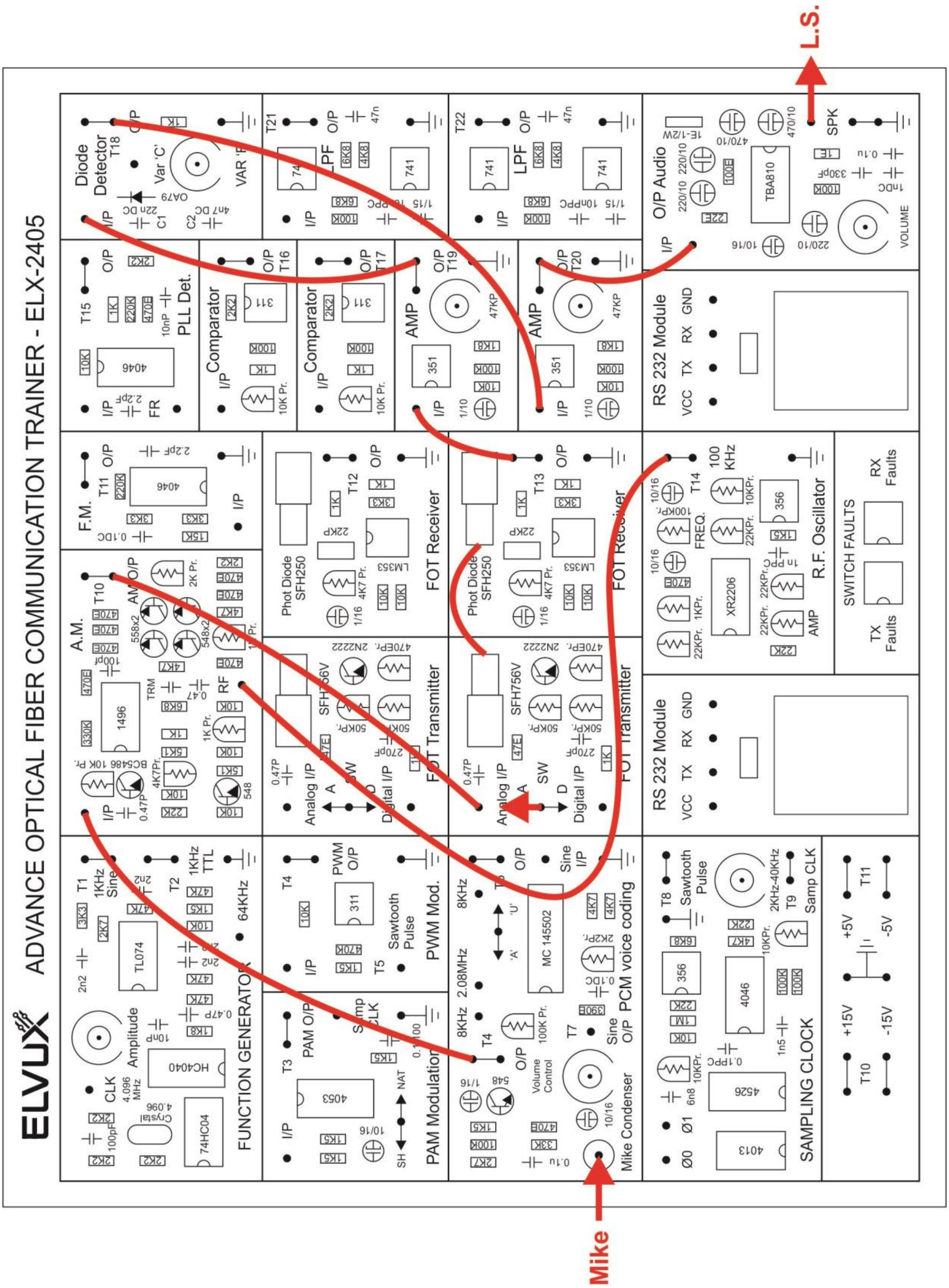
Objective:

Fiber Optic voice link using Amplitude Modulation

Procedure:

Connect the Power Supply cord to the main power plug & to ELX-2405.
Make the following connections as shown in next figure.

1. Audio input block's input to microphone.
2. Voice Coding output TP4 to input socket of Amplitude Modulator circuit via 2mm lead.
3. Connect RF Oscillator Output TP14 to RF input of Amplitude Modulator.
4. Amplitude modulator output TP10 to the transmitter-2 input.
5. Plug in a fiber optic link from output of transmitter-2 LED to the photo transistor of the receiver-2.
6. Receiver-2 output TP13 to input of Amplifier-1.
7. In the transmitter-2 block switch the mode select to analog.
8. Connect Amplifier-1 output TP19 to Diode detectors Input.
9. Connect diode detector output TP18 to input socket of Amplifier-2.
10. Now Amplifier-2 Output TP20 to input of Output audio amplifier circuit via 2mm lead.
11. Connect Speaker to O/P amplifier.
12. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
13. Observe that same audio output is available on the speaker as fed to the microphone.



Voice link using Amplitude Modulation

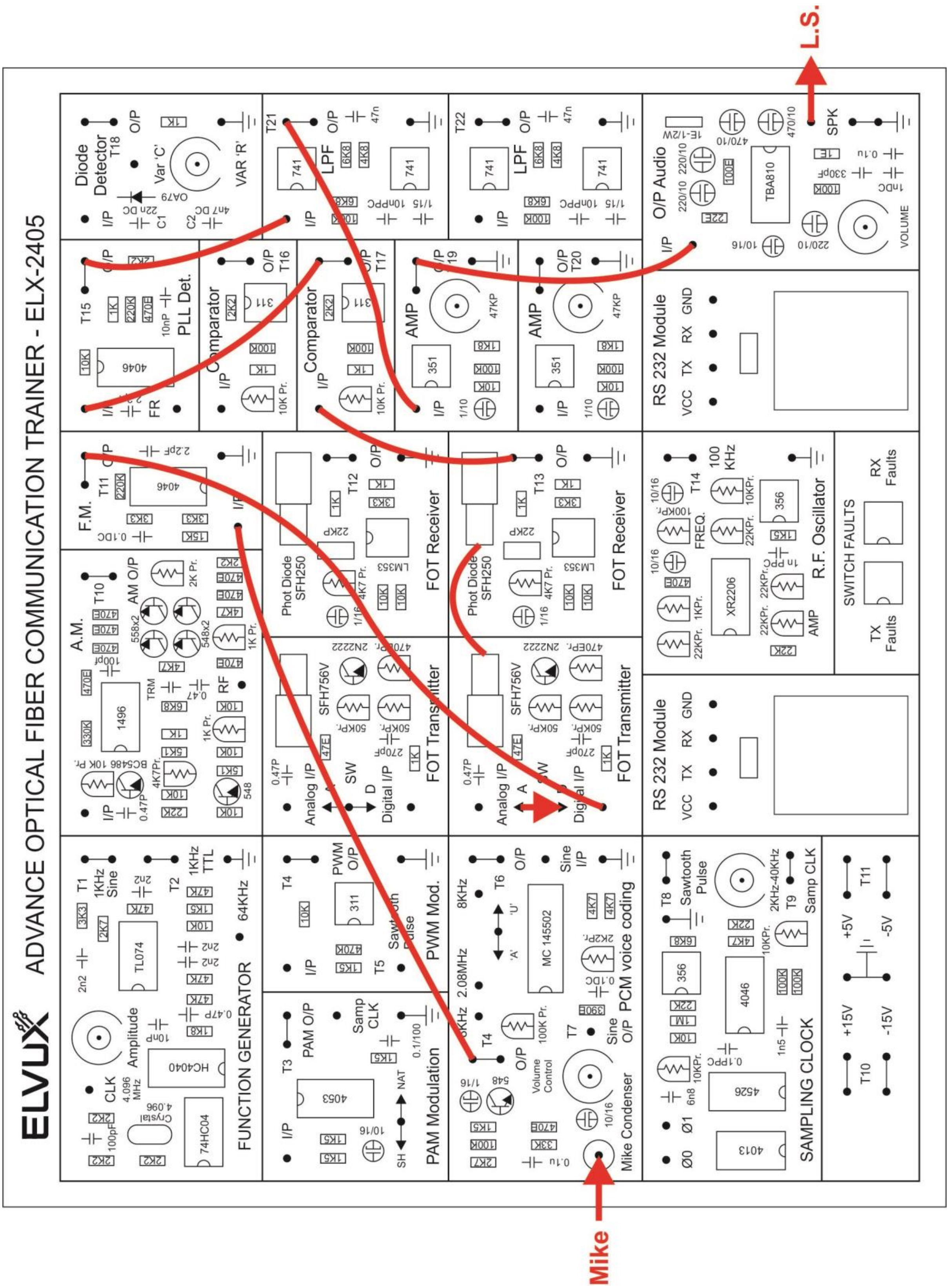
Objective:

Fiber Optic voice link using Frequency Modulation

Procedure:

Connect the Power Supply cord to the main power plug & to ELX-2405.
Make the following connections as shown in next figure.

1. Audio input block's input to microphone.
2. Voice Coding output TP4 to input socket of FM input.
3. FM output TP11 to the transmitter-2 input.
4. Plug in a fiber optic link from output of transmitter-2 LED to the photo transistor of the receiver-2.
5. In the transmitter-2 block switch the mode select to ‘Digital’.
6. Receiver-2 output TP13 to input of Comparator-2.
7. Connect Comparator-2 output TP17 to PLL detector Input.
8. PLL detector output TP15 to input socket of low pass filter-1
9. Low pass filter output TP21 to input of Amplifier-1.
10. Now Amplifier-1 Output TP19 to input of Output audio amplifier circuit via 2mm lead.
11. Connect Speaker to O/P amplifier.
12. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
13. Speak in the Microphone and listen the same in the speaker/ Headphone.



Voice link using Frequency Modulation

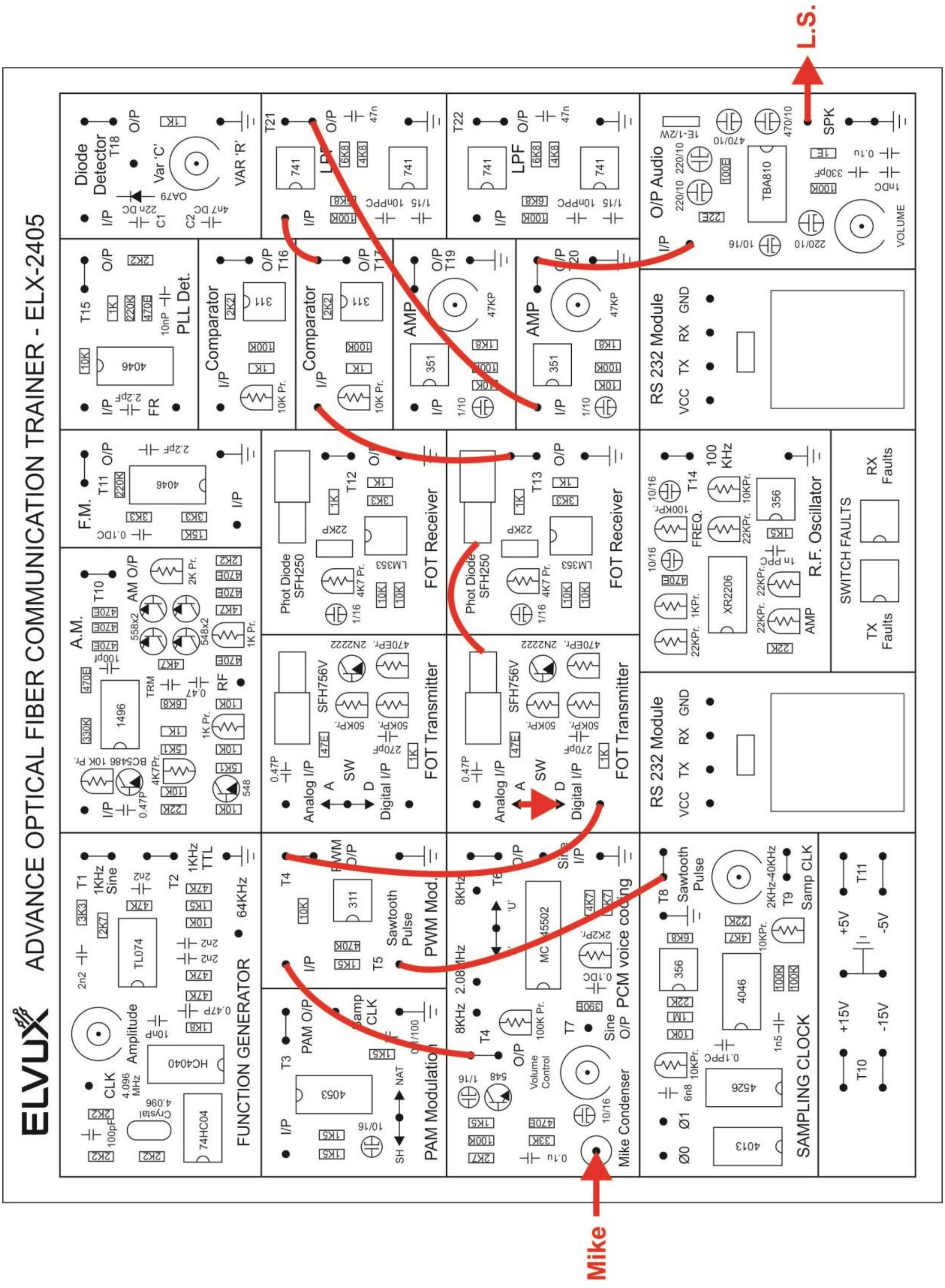
Objective:

Fiber Optic voice link using PWM

Procedure:

Connect the Power Supply cord to the main power plug & to ELX-2405.
Make the following connections as shown in next figure.

1. Audio input block's input to microphone.
2. Voice Coding output TP4 to input socket of PWM input.
3. Connect Saw tooth pulse to PWM block
4. PWM output TP4 to the transmitter-2 input.
5. Plug in a fiber optic link from output of transmitter-2 LED to the photo transistor of the receiver-2.
6. In the transmitter-2 block switch the mode select to ‘Digital’.
7. Receiver-2 output TP13 to input of Comparator-2.
8. Connect Comparator-2 output TP17 to low pass filter Input.
9. Low pass filter output TP21 to input of Amplifier-2.
10. Now Amplifier-2 Output TP20 to input of Output audio amplifier circuit via 2mm lead.
11. Connect Speaker to O/P amplifier.
12. Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
13. Speak in the Microphone and listen the same in the speaker/ Headphone.



Voice link using PWM

Experiment – 8

Study of Switched Faults in PAM, FM & PWM system.

Amplitude Modulation Fault

Connect the Power Supply cord to the main power plug & to ELX-2405.
Ensure that all switched faults are 'Off'.

- Connect Function Generator 1 KHz sine wave signal TP2 to Amplitude modulator input.
- Connect RF Oscillator output TP14 to AM Modulator RF input.
- Connect amplitude modulator output TP10 to the transmitter-1 input.
- Connect the optic fiber between the transmitter-1 circuit and the receiver-1 circuit.
- Receiver-1 output TP12 to Diode detector Input.
- Diode detector output TP18 to Low pass filter input.
- Switch Transmitter 1's driver to digital mode.
- Turn the 1 KHz preset in the Function Generator block to fully anticlockwise (Zero amplitude) position.
- Switch ON the Power Supply of the ELX-2405 and Oscilloscope.
- Monitor the output of AM block.
- In order to fully understand how this amplitude modulation transmitter/ receiver system works, examine the inputs and outputs of all functional blocks within the system, using an Oscilloscope.

See that AM System is operating correctly.
Switch 'On' fault 1. All other faults are set to 'Off'. This will stop AM signal to be passed further so AM system will not operate correctly.
Turn 'Off' the fault 1 and check that A.M. system is operating correctly.

Now switch 'On' fault 5. All other faults are set to 'Off'.
This open output of the diode detector.
Switch 'Off' fault 5.
Switch Power Supply 'Off'.

Fault in F.M. System

Connect the Power Supply cord to the main power plug & to ELX-2405.
Ensure that all switched faults are ‘Off’.

- Now repeat the procedure of experiment no. 4

See that FM System is operating correctly.

Switch 'On' fault 3. All other faults are set to 'Off'. This will stop FM signal to be passed further so FM system will not operate correctly.
Turn 'Off' the fault 3 and check that F.M. system is operating correctly.

Now switch 'On' fault 7. All other faults are set to 'Off'.
This open output of the PLL detector.
Switch 'Off' fault 7.
Switch Power Supply 'Off'.

Fault in PWM System

Connect the Power Supply cord to the main power plug & to ELX-2405.
Ensure that all switched faults are ‘Off’.

- Now repeat the procedure of experiment no. 5

See that PWM System is operating correctly.

Switch 'On' fault 2. All other faults are set to 'Off'. This will stop PWM signal to be passed further so PWM system will not operate correctly.
Turn 'Off' the fault 2 and check that PWM system is operating correctly.

Now Switch 'On' fault 6. All other faults are set to 'Off'.
This open output of the Comparator-1.
Switch 'Off' fault 6.
Switch Power Supply 'Off'.

Fault in PAM System

Connect the Power Supply cord to the main power plug & to ELX-2405.
Ensure that all switched faults are ‘Off’.

- Now repeat the procedure of experiment no. 3

See that PAM System is operating correctly.

Switch 'On' fault 4. All other faults are set to 'Off'. This will stop PAM signal to be passed further so PAM system will not operate correctly.
Turn 'Off' the fault 4 and check that PAM system is operating correctly.

Now Switch 'On' fault 8. All other faults are set to 'Off'.
This open output of the Amplifier-1.
Switch 'Off' fault 8.
Switch Power Supply 'Off'.

Experiment – 9

Full Duplex Computer Communication using RS232 ports and software.

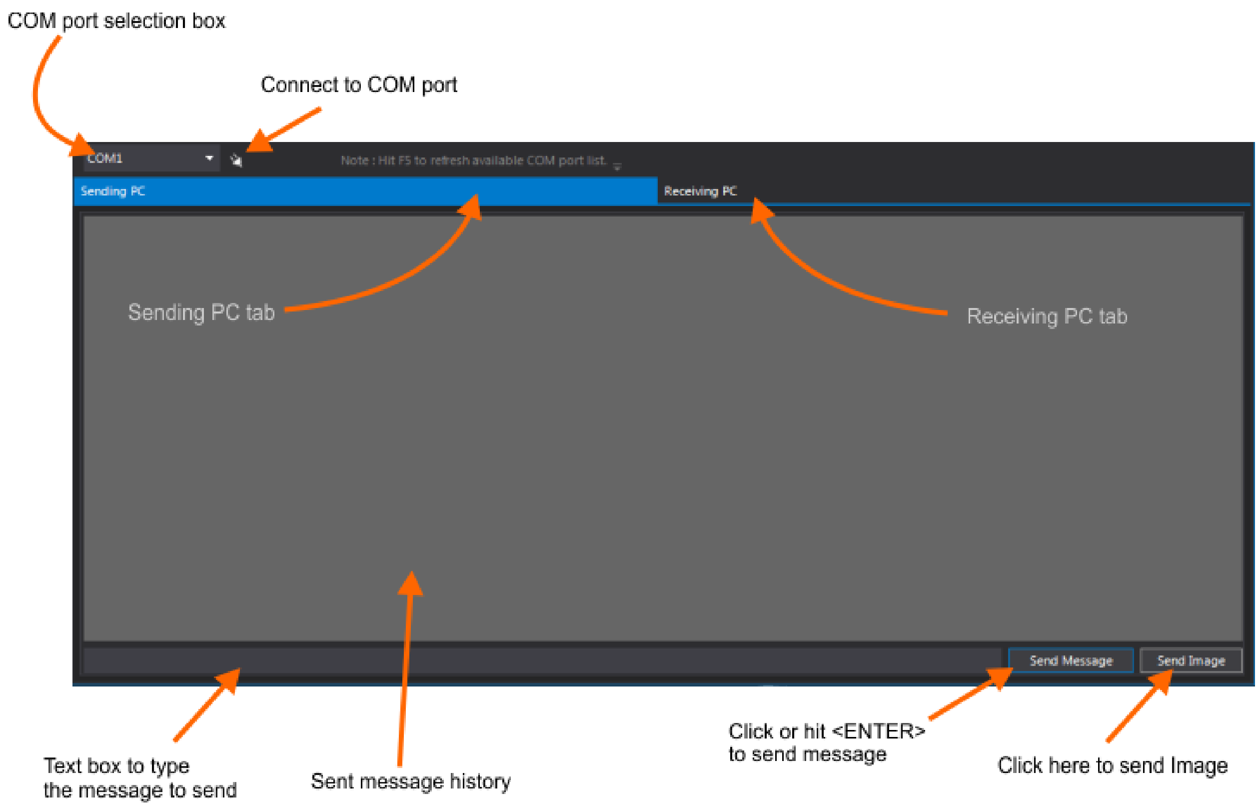
Keep one PC towards left and another towards right of Optical Fiber Communication.
Load the software in PC1 & PC2, with the help of the CD supplied/Download from link provided.
Keep one of the COM port free on each PC to connect the RS232 cables.

Make the following connections on the Optical Fiber Communication.

- Connect Fiber Link on CH1 (transmitter to receiver).
- Connect output of Receiver-1 to comparator-1 input.
- Keep mode switch of transmitter channel to digital and all Switched Faults in 'Off' position.

Switch on the Kit, Observe input to transmitter-1 and output of comparator 1. Adjust bias of comparator 1 for square wave output.

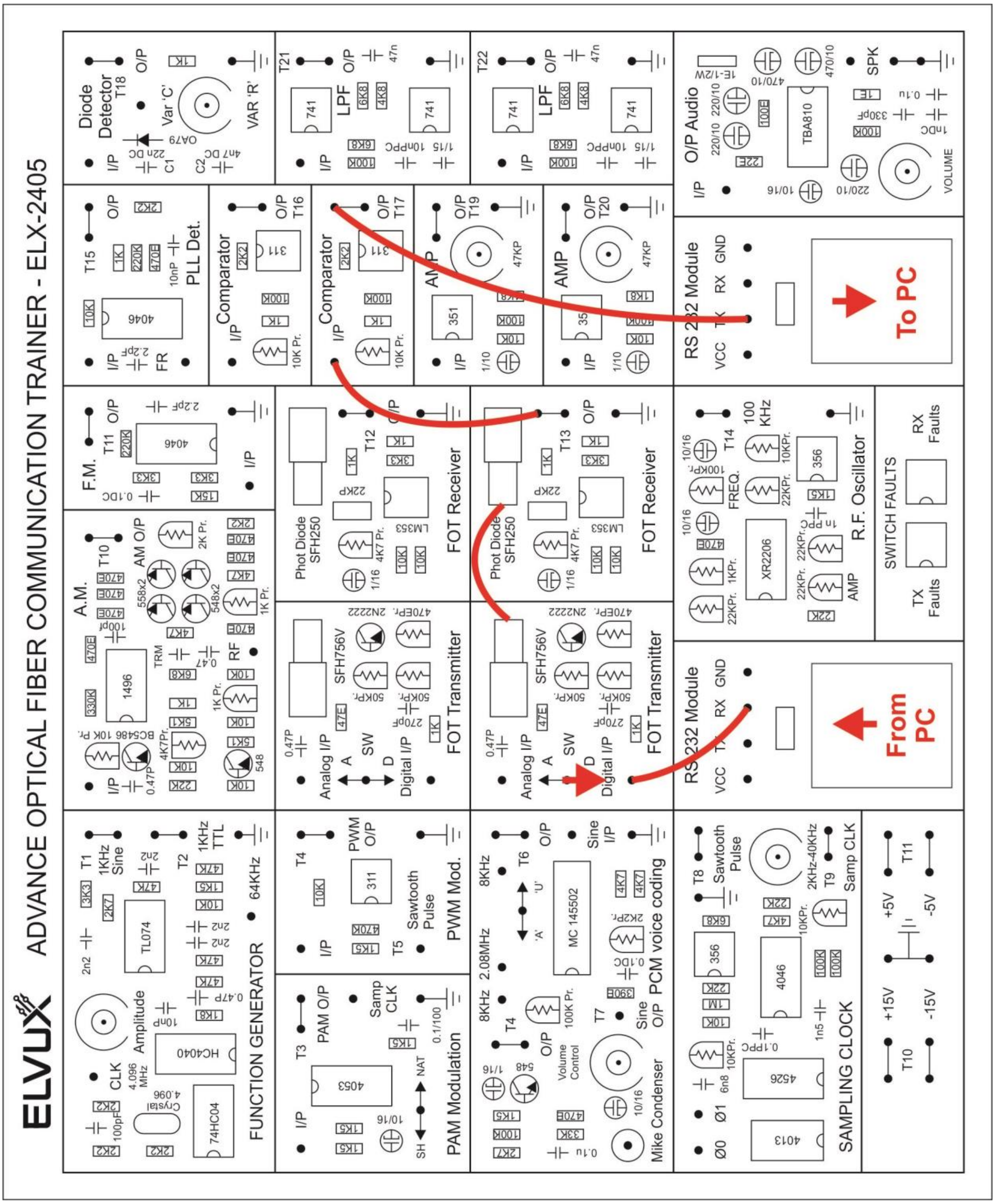
Make connections as shown in diagram.
Optical Fiber Communication is ready for connection to PC's.



(Elvux Satellite communication software)

Connect PC1 & PC2 to ELX-2405 using cables provided.
Switch on the PC's and the ELX-2405 Kit & start working.
Select COM from “COM port selection box” and connect to COM port.
Select “Sending PC” tab in software for PC who is sending message and for receiving PC select tab “Receiving PC”.
Whatever message you will type in textbox of “Sending PC” tab and press “Send message” button and the message will be added to “sent message history” and will also be received by PC2.
All messages received by PC2 will be seen under “Receiving PC” tab.
You can also send an Image by pressing “send image” button and selecting an image form PC. When you send image from one PC to another, image received by receiving PC will be displayed in “Receiving PC” tab.

Remove any of the fiber links. To transmit & receive of that link is disconnected.



PC to PC Communication

Experiment – 10
V-I characteristics of Photo-LED.

Theory:

LED's and LASER diodes are the commonly used sources in optical communication systems, whether the system transmits digital or analog signal. It is therefore, often necessary to use linear electrical to optical converter to allow its use in intensity modulation & high quality analog transmission systems. LED's have a linear optical output with relation to the forward current over a certain region of operation.

Procedure:

- Connect Power Supply to the board.
- Ensure that all switched faults are in OFF condition.
- Put transmitter-1 block in Digital Mode.
- Make connections as given below.

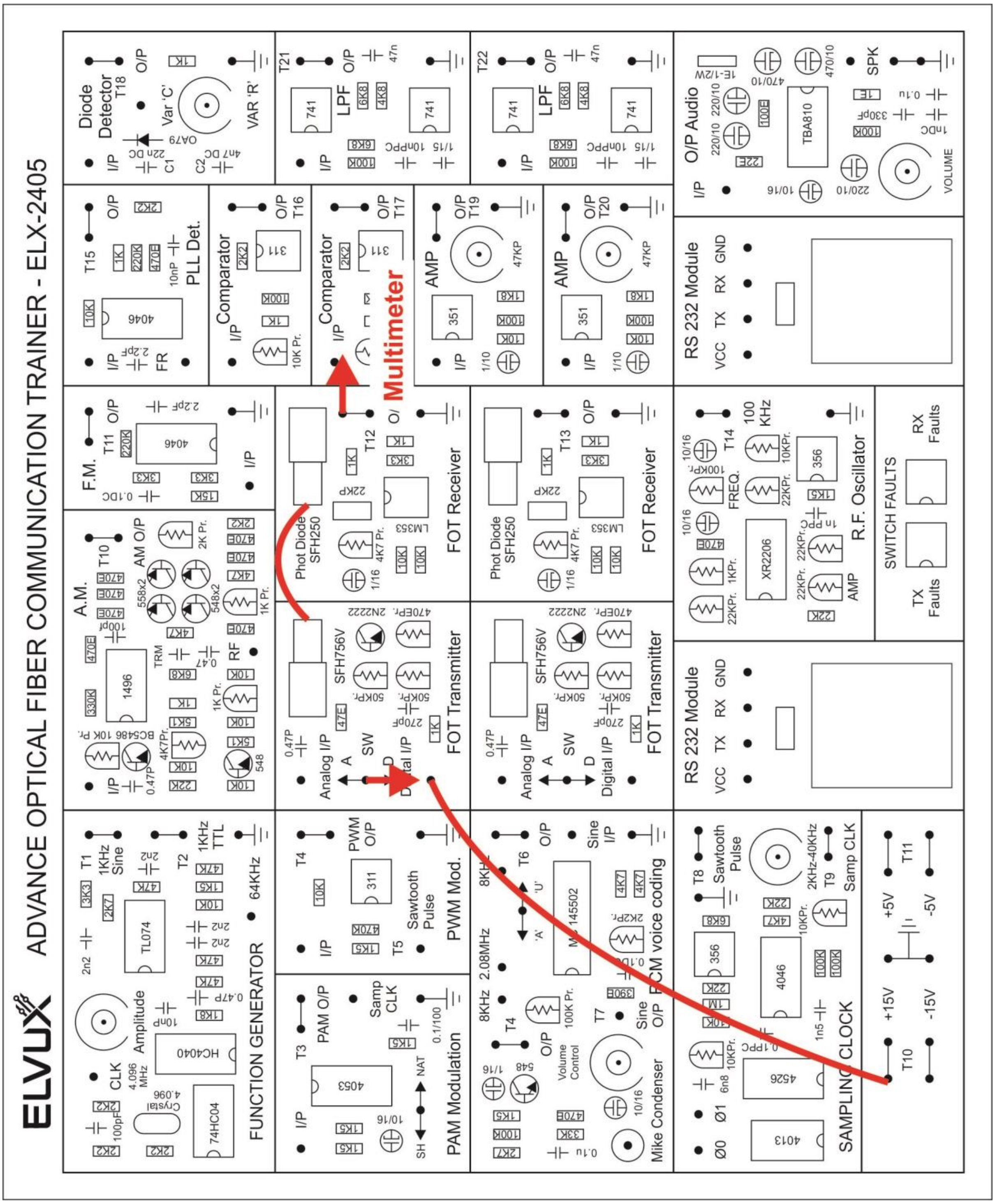
Connect the External Power Supply At Input of Transmitter-1. The DMM will now read the forward voltage (Vf).

Measure the voltage drop across the current limiting resistors by connecting DMM between Input of Transmitter LED. The forward current is given by dividing the readings by 47E This If is known as threshold current.

$$If = \frac{DVM\ Reading}{47000}\ mA$$

Vary Power Supply the forward voltage (as 1.0, 1.5...4.0), note the corresponding If (forward current).

Record these values of Vf and If & plot the characteristic between these two.



V-I characteristics of Photo-LED

Experiment – 10

Characteristics of Photo Receiver.

Theory:

Photo Transistors and Photo Diodes are the commonly used receivers in optical communication systems, whether the system receives digital or analog signal. It is therefore, often necessary to use linear optical to electrical converter to allow its use in intensity demodulation & high quality analog receiving systems. Photo Diodes have a linear electrical output with relation to the light intensity over a certain region of operation.

Procedure:

- Connect Power Supply to the board.
- Ensure that all switched faults are in OFF condition.
- Put transmitter-1 block in Analog Mode.
- Make connections as given below.

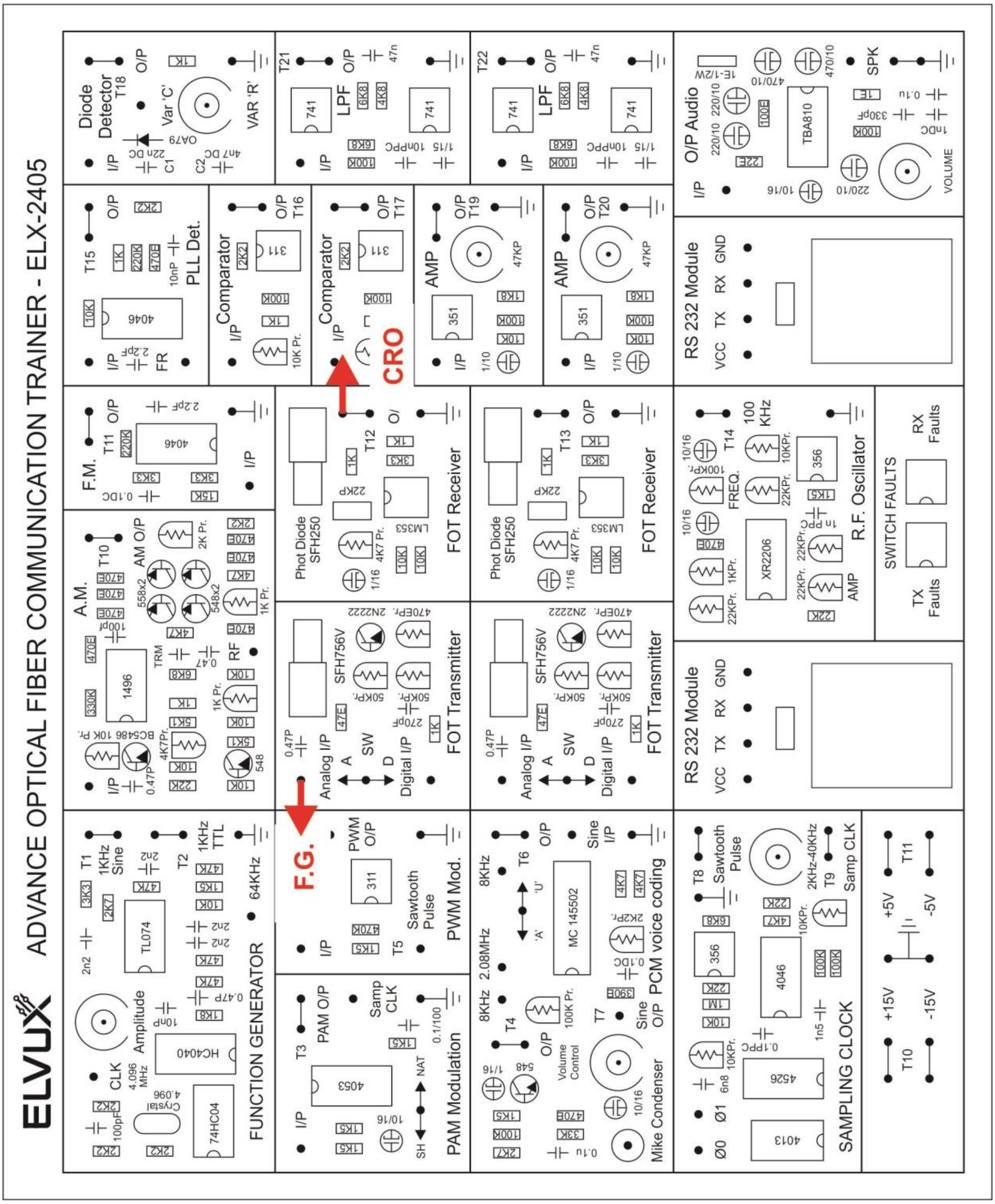
Connect Function generator output 1 Hz Sine wave 2Vpp amplitude at Transmitter-1 input and very the frequency of sine wave 1 Hz to 200 KHz.

Connect Analog oscilloscope at receiver -1 output.

Vary the frequency Span of 10 KHz and note down the readings.

Plot the graph input Frequency versus output voltage.

If frequency increase output voltage decrease.



Characteristics of Photo-Diode