LAB MANUAL

EC07PPC12

Fiber Optics Communication Lab

Bachelor of Technology

in

Electronics & Communication Engineering

Department of Electronics & Communication Engineering

School of Studies of Engineering & Technology

Guru Ghasidas Vishwavidyalaya

Bilaspur-495009 (C. G.)

Website: www.ggu.ac.in

SCHOOLOFSTUDIESOFENGINEERING&TECHNOLOGY

GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.)

(ACENTRALUNIVERSITY)

CBCS-NEWSYLLABUS

B. TECH. FINAL YEAR (ElectronicsandCommunicationEngineering)

Vision and Mission of the Institute

Vision		To be a leading technological institute that imparts transformative education to create globally competent technologists, entrepreneurs, researchers and leaders for a sustainable society
Mission	1	To create an ambience of teaching learning through transformative education for future leaders with professional skills, ethics, and conduct.
	2	To identify and develop sustainable research solutions for the local and global needs.
	3	To build a bridge between the academia, industry and society to promote entrepreneurial skills and spirit

Vision and Mission of the Department

Vision		The Department endeavors for academic excellence in Electronics & Communication Engineering by imparting in depth knowledge to the students, facilitating research activities and cater to the ever-changing industrial demands, global and societal needs with leadership qualities.
Mission	1	To be the epitome of academic rigour, flexible to accommodate every student and faculty for basic, current and future technologies in Electronics and Communication Engineering with professional ethics.

	2	To develop an advanced research centre for local & global needs.
	3	To mitigate the gap between academia, industry & societal needs through entrepreneurial and leadership promotion.

Program Educational Objectives (PEOs)

The graduate of the Electronics and Communication Engineering Program will

PEO1: Have fundamental and progressive knowledge along with research initiatives in the field of Electronics & Communication Engineering.

PEO2: Be capable to contrive solutions for electronic & communication systems for real world applications which are technically achievable and economically feasible leading to academia, industry, government and social benefits.

PEO3: Have performed effectively in a multi-disciplinary environment and have self-learning & self-perceptive skills for higher studies, professional career or entrepreneurial

endeavors to be confronted with a number of difficulties.

PEO4: Attain team spirit, communication skills, ethical and professional attitude for lifelong learning.

ProgrammeOutcomes: Graduateswillbe ableto:

PO1:Fundamentals: Applyknowledgeofmathematics,scienceandengineering.

PO2:Problemanalysis:Identify,formulateandsolverealtimeengineeringproblemsusingfirstprinciples.

PO3:Design: Designengineeringsystemscomplyingwithpublichealth,safety,cultural,societalandenvironmentalconsiderations

PO4:Investigation: Investigatecomplexproblemsbyanalysisandinterpretingthedatatosynthesize validsolution.

PO5:Tools: Predictandmodelbyusingcreativetechniques,skillsandITtoolsnecessaryformodernengineeringpractice.

PO6:Society: Applytheknowledgetoassesssocietal,health,safety,legalandculturalissuesforpracticingengineeringprofession.

PO7: Environment: Understand the importance of the environment for sustainable development.

PO8: **Ethics:** Applyethicalprinciplesandcommittoprofessionalethics,andresponsibilitiesand normsof theengineering practice.

PO9: **Teamwork:** Functioneffectivelyasanindividualandasamemberorleaderindiverseteamsandmultidisciplinary settings.

PO10: **Communication:** Communicateeffectivelybypresentationsandwritingreports.

PO11: **Management:** Manageprojectsinmultidisciplinaryenvironmentsasmemberorateam leader.

PO12: **Life-longlearning:** Engageinindependentlifelonglearninginthebroadestcontextoftechnological change.

ProgrammeSpecificOutcomes:

PSO1: Identify, formulateand applyconcepts acquired through Electronics&CommunicationEngineeringcoursestothereal-world applications.

PSO2: Designandimplementproductsusingthecutting-edgesoftwareandhardwaretoolstoattainskillsforanalyzinganddevelopingsubsystem/processes.

PSO3: Abilitytoadaptandcomprehendthetechnologyadvancementinresearchandcontemporaryindustry demands with demonstration of leadership qualities and betterment of organization,environment andsociety.

Sub Code	L	T	P	Duration	IA	ESE	Total	Credits
EC07PPC12	-	-	2	2Hours	30	20	50	1

FIBER OPTICS COMMUNICATION LAB

Course Objectives:

- Align light waves into small optical components with high precision
- Calculate and simulate the attenuation and signal degradation due to intermodal and intramodal distortion.
- Calculate power coupling losses due to connectors, splices, source output pattern and fiber numerical aperture.
- Understand, compute and simulate the modes in step index fiber and graded index fiber.
- Understand the reliability issues of the highly delicate optical devices.

Course Outcomes:

At the end of the course, the students will able to:

CO1 :Apply knowledge of optical communication to various application areas

CO2: Optical fiber is compatible for both analog and digital data transmission.

CO3: VI characteristics of LED and photo diode.

CO4: Performance of optical fiber in presence of dispersion.

CO5: Performance of optical fiber in comparison to the copper wire system in presence of EMI.

CourseOutcomesandtheirmappingwithProgramOutcomes& Program Specific Outcomes:

CO	PO												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PS2O3
CO1	3	2	2	2	3				2			3	3	3	2
CO2	3	2	2	2	3				2			3	3	3	2
CO3	3	2	2	2	3				2			3	3	3	2
CO4	3	2	2	2	3				2			3	3	3	2
CO5	3	2	2	2	3				2			3	3	3	2

Experiment No. 1

Aim: ToestablishanaloglinkusingOpticalFiber.

Objectives: i)TogetfamiliarwithOpticalfibertrainerkits.

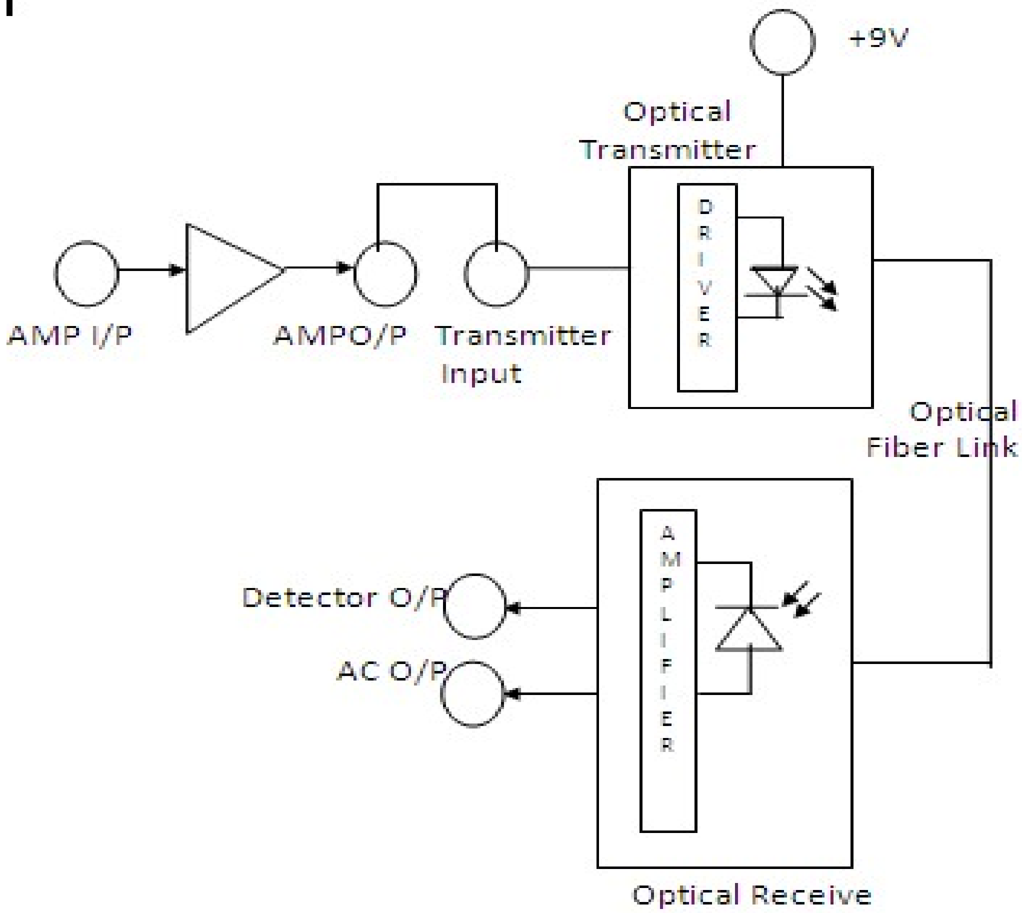
ii) Toobservetransmission&receptionofanalogsignalsthroughOF.

iii) To measure analog bandwidth of OFC link.

Equipment/Components: Kit-1andKit-2,CRO,Functiongenerator,1Meterfibercable,etc.

Circuit/BlockDiagram:

I



BLOCK DIAGRAM FOR SETTING UP AN ANALOG LINK

Theory: Fiber Optic Link can be used for transmission of analog as well as digitalsignals. Basically fiber optic link contains three main elements, a transmitter, anopticalfiberandareceiver.Thetransmittermoduletaketheinputsignalinelectricalformandthentransformitintooptical(light)energycontainingthe
same information. The optical fiber is a medium which carries this energy to thereceiver. At the receiver, light is converted back into electrical form with the samepatternas originally fedto the transmitter.

Transmitter: Fiber optic transmitters are typically composed of a buffer, driver &optical source. The buffer electronics provided both an electrical connection &isolation between the transmitter & the electrical system supplying the data. Thedriver electronics provides electrical power to the optical source in a fashion thatduplicates the pattern of data being fed to the transmitter. Finally to the opticalsource (LED) converts the electrical current to light energy with the same pattern.The LED SFH450V supplied with kit operates outside the visible light spectrum. Itsoptical output is centered at near infrared wavelength of 950nm. The emissionspectrum is broad, so a faint red glow can usually be seen when the LED is on in adark room. The LED SFH450V used in the kit 1 is coupled to the transistor driver ina common emitter mode. The driver is preceded by the amplifier buffer. Theamplifier in this case is a LM741 operational amplifier configured as a voltagefollower. Thus LED emits constant intensity of light. When the signal is applied totheamplifieritoverridestheDClevelatthebaseofthetransistorwhichcausethe Q point of the transistor to oscillate above the midpoint. So the intensity ofthe LED varies about its previous constant value. This variation in the intensity haslinear relation with the input electrical signal. Optical signal is then coupled toopticalfiberbymeans of connector.

Receiver: Thefunctionofthereceiveristoconverttheopticalenergyintoelectrical form which is then conditioned to reproduce the transmitted electricalsignal in its original form. The detector SFH250V used in the kit 2 has a diode typeoutput.Theparametersusuallyconsideredinthecaseofdetectorareitsresponsively at peak wavelength & response time. SFH250V has responsively ofabout 4µA per 10 µW of incident optical energy at 950nm and it has rise & falltime of 0.01µSec.PIN photodiode is normally reverse biased. When optical signalsfalls on the diode, reverse current start flow, thus diode acts as closed switch andin the absence of light intensity, it act as an open switch. Since PIN diode usuallyhas low responsively, a trans impedance amplifier is used to convert this reversecurrentintovoltage.Thisvoltageisthenamplifiedwiththehelpofanotheramplifiercircuit.Thisv oltageistheduplicationofthetransmittedelectricalsignal.

Procedure:

1. Slightly unscrews the cap of IR LED SFH 450v from kit 1. Do not remove the capfrom the connector. Once the cap is loosened, insert the fiber into the cap andassurethatthefiberisproperlyfixed.Nowtightenthecapbyscrewingitback.
2. Connect the power supply cables with proper polarity to kit 1 and kit 2 whileconnectingthis, ensurethatthepowersupplyis off.
3. Connect the signal generator between the AMP input and GND posts in kit 1 tofeedtheanalogsignalto thepreamplifier.
4. Keep the signal generator in sign wave mode and the select the frequency of1KHzwithamplitude of 2VP-P (Max inputlevelis 4VP-P).

5. Switchonthepowersupplyandsignalgenerator.
6. Check the output signal of the pre-amplifier at the post AMP output in kit 1. Itshouldbesameas thatof theappliedinputsignal.
7. Now rotate the OpticalPowerControlpotP1located belowpower supplyconnector in kit 1 in anticlockwise direction. This ensures minimum current flowthroughLED.
8. Short the following posts in kit 1 with links provided.

a)-9Vand-9V.Thisensuressupplytothetransmitter.

b)AMPOutputandTransmitterInput.

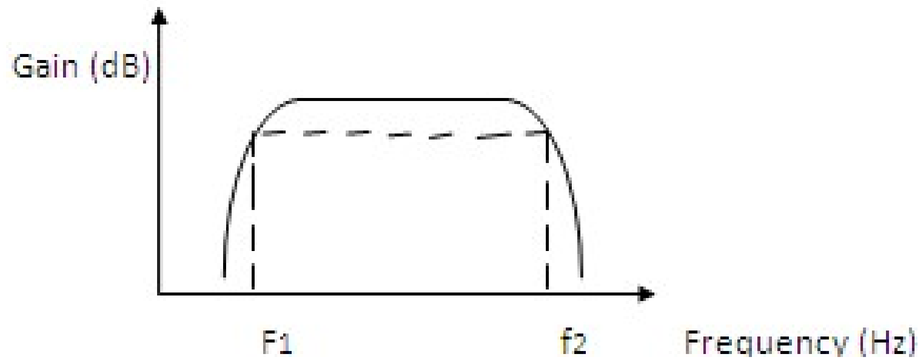
9. Connect the other end of the fiber to detectorSFH250V in kit 2 very carefully aspertheinstructionin step1.
10. Ensure that the jumper located just above IC U1 in kit 2 is shorted to pin 2 andpin3.Shortingofthejumperallowstheconnectionofthe PINdiodetotrans-impedanceamplifierstage.
11. Observe the output signal from the detector at the DETECTOR output post on CRObyadjustingopticalpowercontrolpotP1inkit1andyoushouldgetthereproductionoftheoriginaltransmittedsignal.Note:sameoutputsignalisavailableatpostACoutputinkit2 withoutanyDCcomponent.
12. To measure the analog bandwidth of the link, keep the same connection andvarythefrequencyoftheoutputsignalfrom100Hzonwards.Measuretheamplitudeof thereceivedsignalfor eachfrequencyreading.
13. Plot a graph of gain v/s frequency .Measure the frequency range for which theresponseis flat.

Observation Table:

Input Voltage (V1) = Volts

Sr. No.	**Input Frequency (V1)**	**Output Frequency (V2)**	**Gain = [10 log ((V2 /(V1)**
1			
2			
3			

Nature of graph:



Calculations: Bandwidth = f2 – f1 Hz

Result:

Conclusion:

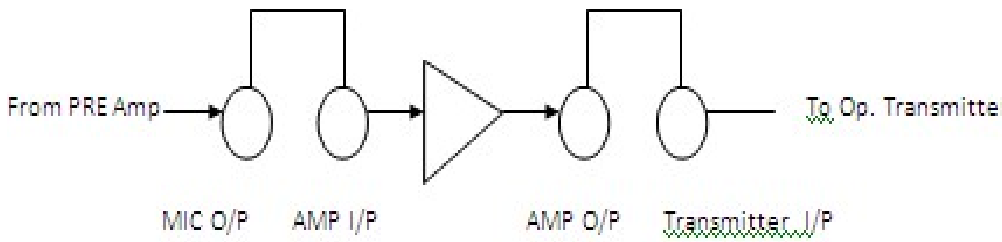
<u>Experiment No. 2</u>

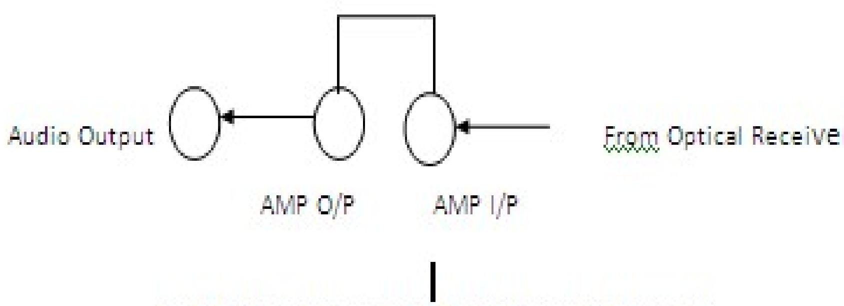
Aim: To establish voice link using optical fiber.

Objectives: To observe transmission and reception of voice signals through OF.

Equipments/Components: kit 1 and kit 2, CRO, Microphone, Loudspeaker (or Function generator), 1 Meter fiber cable,etc.

Circuit/Block Diagram:





BLOCK DIAGRAM FOR OPTICAL VOICE LINK

Theory: Fiber Optic Link can be used for transmission of digital as well as analog signals. Basically fiber optic link contains three main elements, a transmitter, an optical fiber and a receiver. The transmitter module take the input signal in electrical form and then transform it into optical (light) energy containing thesame information. The optical fiber is a medium which carries this energy to the receiver. At the receiver, light is converted back into electrical form with the same pattern as originally fed to the transmitter.

Procedure :

1. Connect the dynamic microphone provided with the kit to the socket marked MIC Input in the audio preamplifier section of kit 1.
2. Connector speakers provided with the kit to the socket marked speaker in the audio amplifier section of kit 2.
3. Now in the above experiment of simple analog link, remove the signal generator output from AMP Input post and supply MIC output from MIC Output post in kit 1.
4. Similarly connect output signal of photo detector from post detector output to the post audio output.
5. Adjust optical fiber control post P1 in kit 1 and voice control post P1 in kit 2 to setup fiber optic audio link

Result:

Conclusion

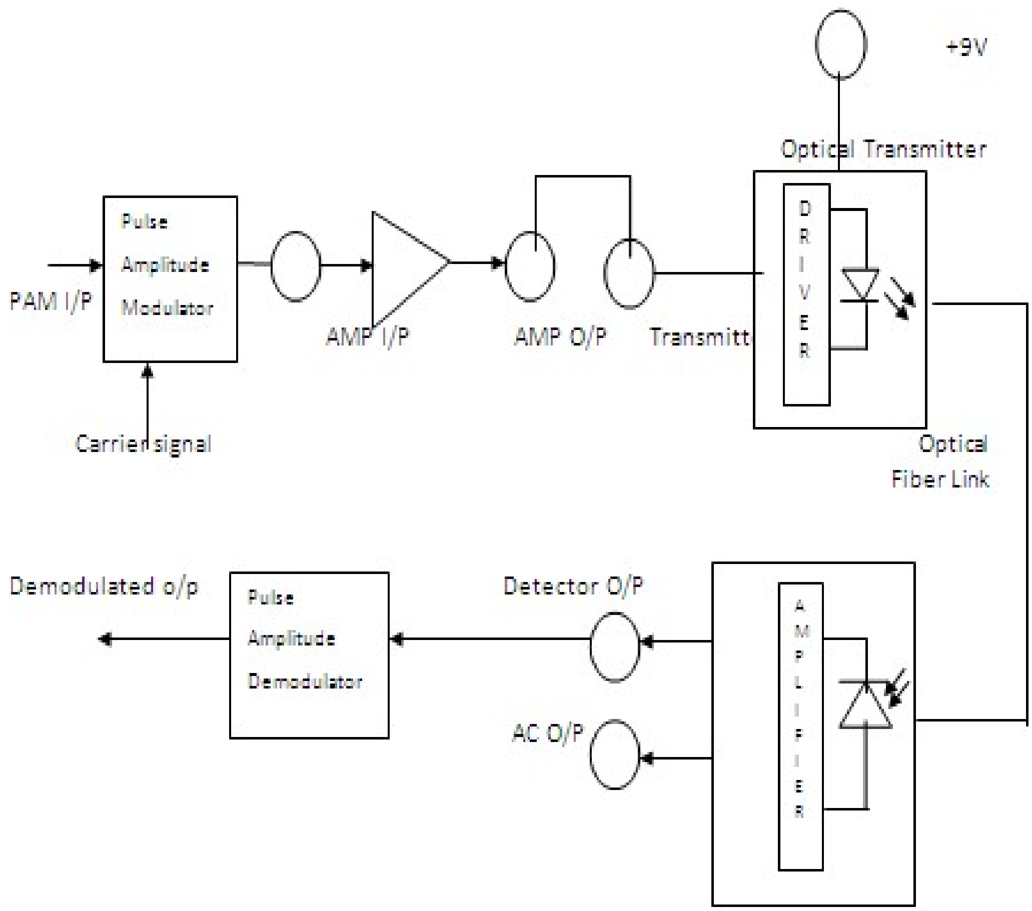
Experiment No. 3

Aim: To Transmit and receive Pulse Amplitude Modulated (PAM) signal using OF.

Objectives: i) To observe transmission and reception of PAM signals through OF. ii)To represent modulating, carrier, PAM and demodulated signals graphically.

Equipments/ Components: kit No.1 & 2, CRO, Function Generator, 1 Meter Fiber Cable, etc.

Circuit/Block Diagram:



BLOCK DIAGRAM FOR PAM SIGNAL TRANSMISION & RECEPTION

Theory: Pulse Amplitude Modulation is a technique of communication in which the high frequency square wave is modulated by the low frequency signal. The modulating signal is sampled by the pulses. The PAM signal is nothing but high frequency square wave in which the amplitude of each pulse is equal to that of the information signal at the respective sampling instant.

Procedure:

1. Concept the power supply cable with proper polarity to kit 1 & kit 2. while connecting this ensure that the power supply is off.
2. Connect the signal generator between the PAM input and GND post for PAM circuit in kit 1.
3. Keep the signal generator in sign wave mode and select the frequency = 1 KHz with amplitude = 1V P-P.
4. Switch on the power supply and signal generator.
5. Check that the clock circuit is properly working by connecting the oscilloscope probe at CLK output post.

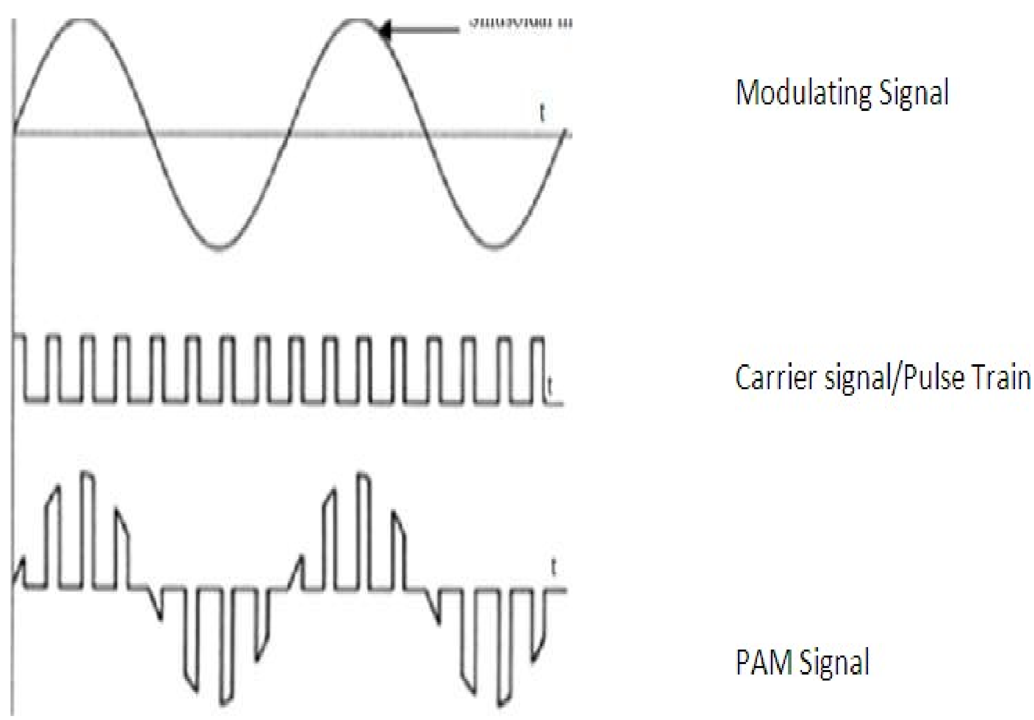
You will find the square wave output with frequency = 32KHz

6. Now observe the output waveform at post PAM output. You will find fantastic pattern of square wave whose amplitude (i.e. pulse height) is varying according to the sine wave input.
7. Now vary the frequency of input sine wave. You will notice that at the output. The frequency is changing, still the output is pulse amplitude modulated. Further, increase the input frequency and notice the change. Try to understand why such angles are occurring in output waveform.
8. Slightly unscrew the cap of IR LED SFH 450V on kit 1. Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap and assure that the fiber is properly fixed. Now tighten the cap by screwing it back. Similarly connect the other end of fiber to detector SFH 250V on kit 2.
9. Connect output of PAM circuit at PAM output post to the AMP input post with the shorting links provided in kit 1.
10. Now establish the link between the posts marked as AMP output and transmitter input. Let the signal be transmitted through optical fiber. While doing this, please ensure that both the +9V posts are shorted by the shorting link.

11. Observe the output of the detector at detector output post in kit 2. Adjust the gain control pot P)below the power supply connector in kit 1 to obtain the same amplitude as the transmitted signal connect this output of receiver to the input of pulse amplitude demodulator circuit by shorting detector output post & PAM Input post in kit 2

12. Observe the output at PAM output in kit 2, You will receive the same sinewaveattheoutput.Inthiswaythesignalispulseamplitudemodulated,transmitted,received andagaindemodulatedsuccessfully.

Observations:



Result:

Conclusion

Experiment No. 4

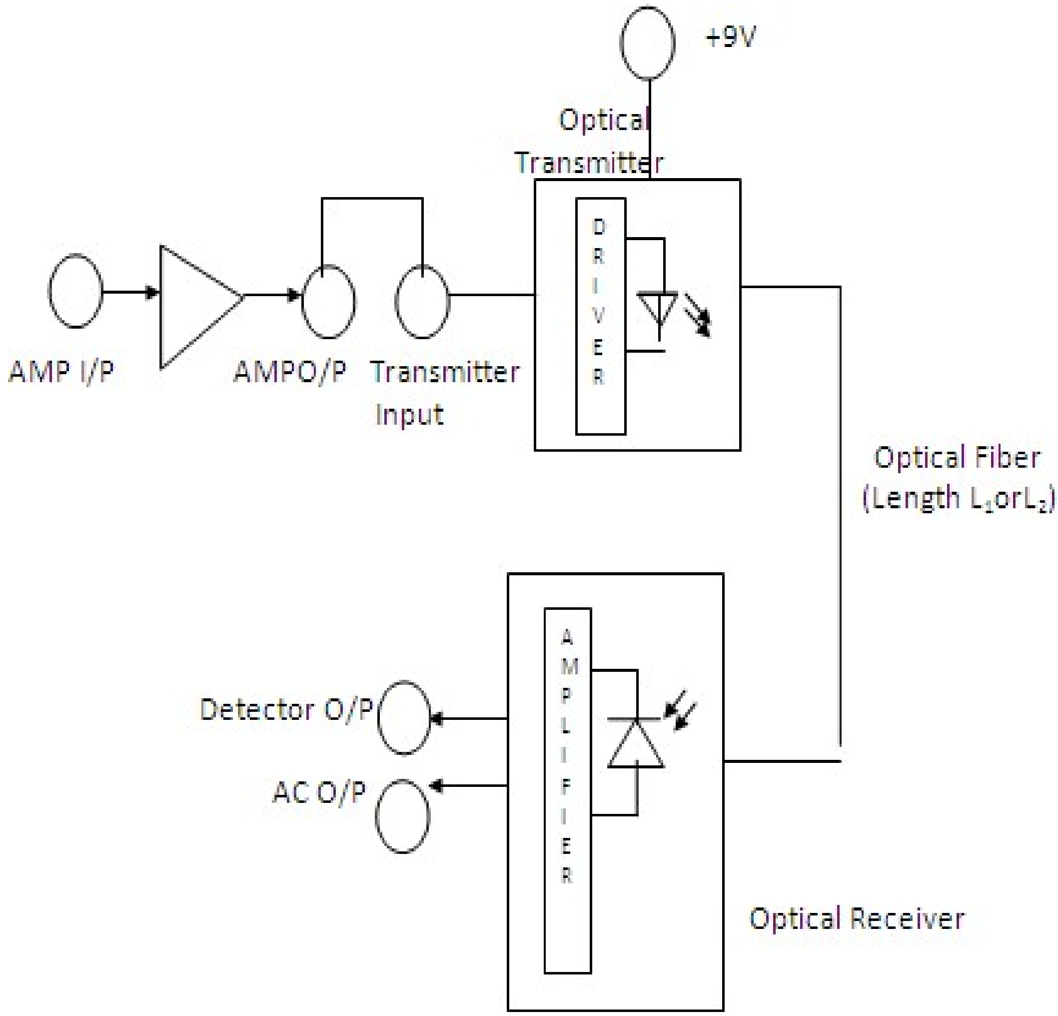
Aim: To measure Propagation loss in optical fiber.

Objectives: i) To observe transmission and reception of signals through OF using two different lengths fiber.

ii) To measure Propagation loss in neper/meter.

Equipments/Components: kit1, kit2, 1MHz Function Generator, 20 MHz Dual Trace Oscilloscope, 1 & 3 Meter Fiber Cable.

Circuit/BlockDiagram



BLOCK DIAGRAM FOR PROPAGATION LOSS MEASURMENT

Theory: Optical fibers are available in different variety of materials. These materialsare usuallyselected by taking into account their absorption characteristics for different wavelengths of light. In case of optical fiber, since thesignal is transmitted in the form of light which is completely different in nature asthat of electrons, one has to consider the interaction of matter with the radiationto study the losses in fiber. Losses are introduced in fiber due to various reasons.As light propagates from one end of fiber to another end, part of it is absorbed inthe material exhibiting absorption loss. Also part of the light is reflected back or insomeotherdirectionsfromtheimpurityparticlespresentinthematerialcontributing to the loss of the signal at the other end of the fiber. In general termsit is known as propagation loss. Plastics fibers have higher loss of the order of 180db/km. whenever the condition for angle of incidence of the incident light isviolated the losses are introduced due torefraction oflight. Thisoccurswhenfiberissubjectedtobending.Lowertheradiusofcurvaturemoreistheloss.Otherlossesaredu etothecouplingoffiberatLED& photodetector ends.

Procedure:

1. Slightly unscrews the cap of IR LED SFH 450v from kit 1. Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap and assure that the fiber is properly fixed. Now tighten the cap by screwing it back.
2. Connect the power supply cables with proper polarity to kit 1 and kit 2 while connecting this, ensure that the power supply is off.
3. Connect the signal generator between the AMP input and GND posts in kit 1 to feed the analog signal to the preamplifier.
4. Keep the signal generator in sign wave mode and the select the frequency of 1KHz with amplitude of 2VP-P (Max input level is 4 VP-P).
5. Switch on the power supply and signal generator.
6. Check the output signal of the pre-amplifier at the post AMP output in kit 1. It should be same as that of the applied input signal.
7. Now rotate the Optical Power Control pot P1 located below power supply connector in kit 1 in anticlockwise direction. This ensures minimum current flow through LED.
8. Short the following posts in kit 1 with links provided.
   a) -9V and -9V . This ensures supply to the transmitter.
   b) AMP Output and Transmitter Input.
9. Connect the other end of the fiber to detectorSFH250V in kit 2 very carefully as per the instruction in step 1.
10. Ensure that the jumper located just above IC U1 in kit 2 is shorted to pin 2 and pin 3. Shorting of the jumper allows the connection of PIN diode to trans- impedance amplifier stage.
11. Observe the output signal from the detector at AC OUTPUT post in kit2 on CRO. Adjust optical power control pot P1 in kit1. You should get the reproduction.of original transmitted signal. Also adjust the amplitude of received signal as that of transmitted one. Mark this amplitude as V1.
12. Now replace 1m fiber by 3m fiber without changing settings of kit1 & kit2. Measure the amplitude of received signal again. You will notice that it is less than previous one. Mark this as

V2.

13. If α is the attenuation/loss in the fiber then, we have,

$V_1/V_2 = \exp\{-\alpha(L_1+L_2)\}$

Where- α=neper/meter,

L_1= Fiber length for $V_{1,}$ L_2= Fiber length for $V_{2,}$

14. Calculate propagation loss α using above equation.

Observations:

i) The measured length of fiber, L_1= meter

ii) O/P voltage V_1 for length of fiber, L_1= Volts

iii) The measured length of fiber, L_2= meter

iv) O/P voltage V_2 for length of fiber, L_2= Volts

Calculations:

$V_1/V_2 = \exp\{-\alpha(L_1+L_2)\}$ $\text{Log}_{10} (V_1/V_2)= -\alpha(L_1+L_2)$

Therefore $-\alpha= \text{Log}_{10} (V_1/V_2) /(L_1+L_2)$ neper/meter= neper/meter

Result:

Conclusion:

Experiment No. 5

Aim: To measure bending loss in optical fiber.

Objectives: i) To observe transmission and reception of signals through bend fiber of different loop diameters.

ii) To Plot a graph of the received signal amplitude through bend fiber v/s loop diameter.

Equipments/Components: kit1, kit2, 1MHz Function Generator, 20 MHz Dual Trace Oscilloscope, Fiber Cable, etc.

Circuit/Block Diagram:

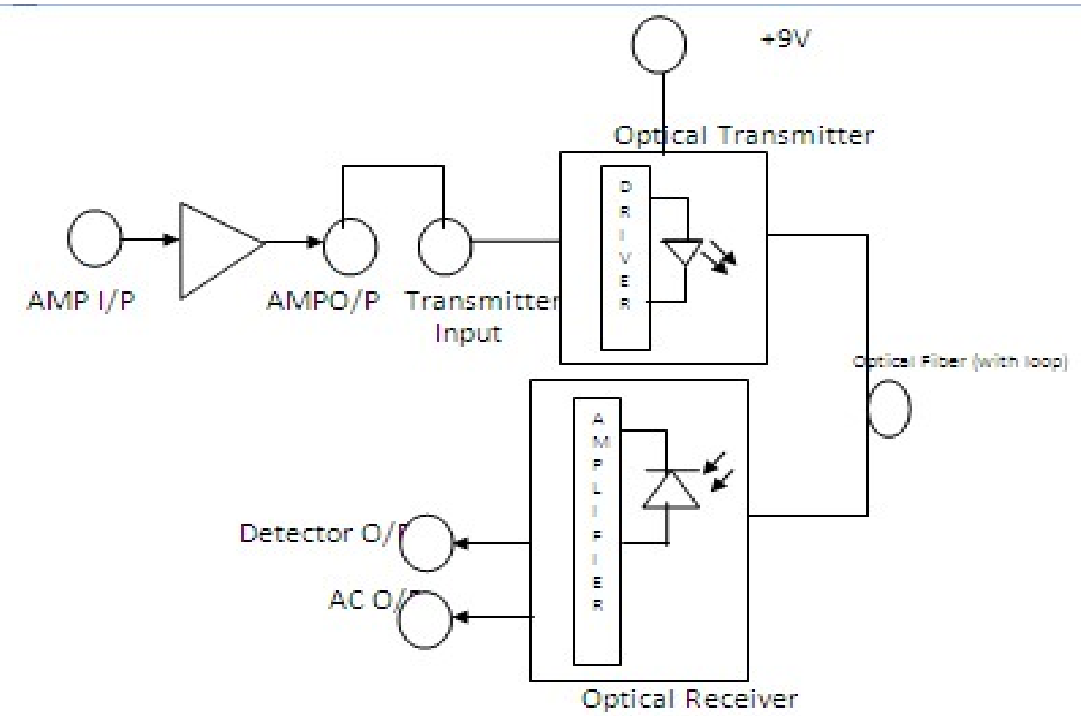


FIG-1 BLOCK DIAGRAM FOR BENDING LOSS MEASURMENT

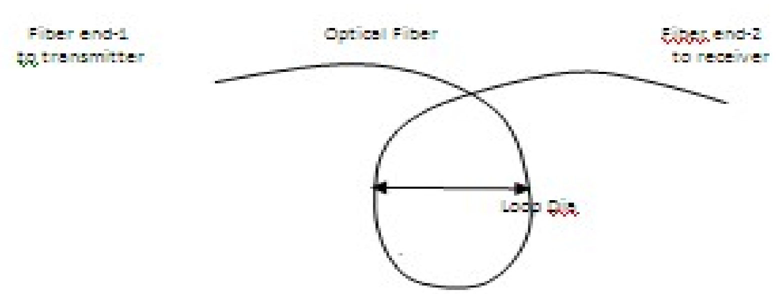


FIG-2 FIBER LOOP FOR BENDING LOSS MEASURMENT

Theory: Optical fibers are available in different variety of materials. These materials are usually selected by taking into account their absorption characteristics for different wavelengths of light. In case of optical fiber, since the signal is transmitted in the form of light which is completely different in nature as that of electrons, one has to consider the interaction of matter with the radiation to study the losses in fiber. Losses are introduced in fiber due to various reasons. As light propagates from one end of fiber to another end, part of it is absorbed in the material exhibiting absorption loss. Also part of the light is reflected back or in some other directions from the impurity particles present in the material contributing to the loss of the signal at the other end of the fiber. In general terms it is known as propagation loss. Plastics fibers have higher loss of the order of 180 db/km. whenever the condition for angle of incidence of the incident light is violated the losses are introduced due to refraction of light. This occurs when fiber is subjected to bending. Lower the radius of curvature more is the loss. Other losses are due to the coupling of fiber at LED & photo detector ends.

Procedure:

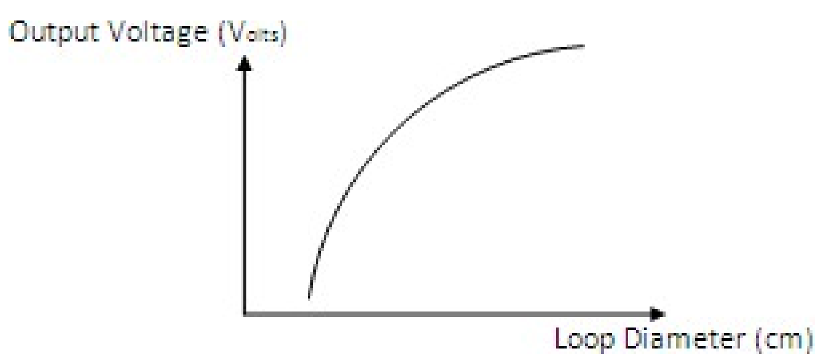
1. Slightly unscrews the cap of IR LED SFH 450v from kit 1. Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap and assure that the fiber is properly fixed. Now tighten the cap by screwing it back.
2. Connect the power supply cables with proper polarity to kit 1 and kit 2 while connecting this, ensure that the power supply is off.
3. Connect the signal generator between the AMP input and GND posts in kit 1 to feed the analog signal to the preamplifier.
4. Keep the signal generator in sign wave mode and the select the frequency of 1KHz with amplitude of 2VP-P (Max input level is 4 VP-P).
5. Switch on the power supply and signal generator.
6. Check the output signal of the pre-amplifier at the post AMP output in kit 1. It should be same as that of the applied input signal.
7. Now rotate the Optical Power Control pot P1 located below power supply connector in kit 1 in anticlockwise direction. This ensures minimum current flow through LED.
8. Short the following posts in kit 1 with links provided.
   a) -9V and -9V . This ensures supply to the transmitter.
   b) AMP Output and Transmitter Input.

9. Connect the other end of the fiber to detectorSFH250V in kit 2 very carefully as per the instruction in step 1.
10. Ensure that the jumper located just above IC U1 in kit 2 is shorted to pin 2 and pin 3. Shorting of the jumper allows the connection of PIN diode to trans- impedance amplifier stage.
11. Observe the output signal on CRO at AC OUTPUT post in kit2.
12. Then bend the fiber in a loop. (as shown in fig-1)
13. Measure the amplitude/voltage of the received signal.
14. Keep reducing the diameter of fiber to about 2cm and take corresponding output voltage readings **(Do not reduce loop diameter less than 2cm)**.
    Plot a graph of the received signal amplitude v/s loop diameter.

Observation Table:

Sr.No.	LoopDiameter(cm)	OutputVoltage(Volts)
1		
2		
3		
4		
5		

Nature of graph:



Result:

Conclusion:

Experiment 6

The objective of this experiment is to measure the numerical aperture of the plastic fiber provided with the kit using 660 nm wavelength LED.

Equipments Required:

- Link-A kit.
- 1 Meter Fiber cable.
- NA JIG.
- Steel Ruler.
- Power supply.

Theory:

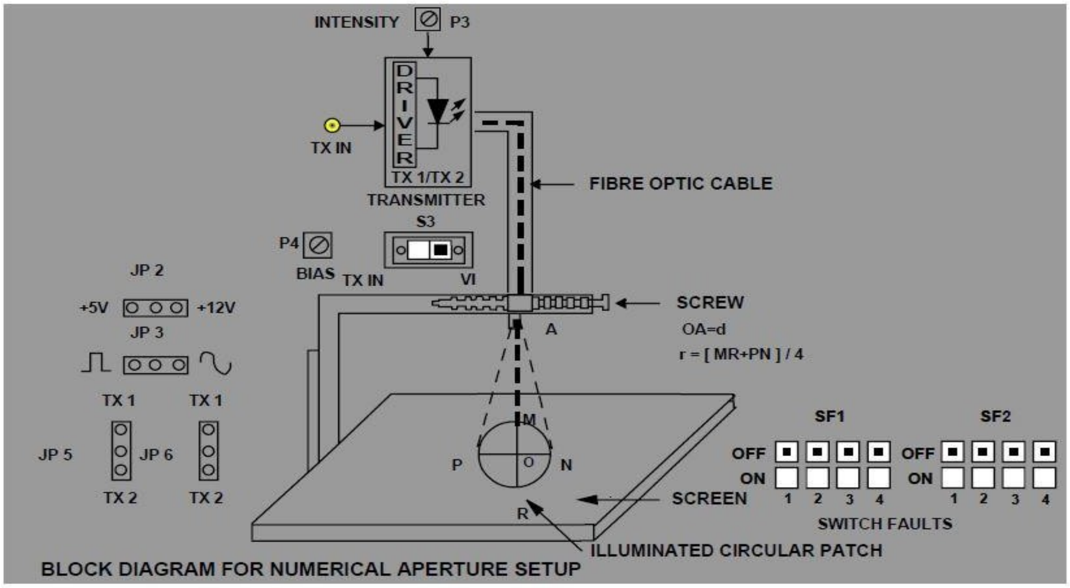
Numerical aperture refers to the maximum angle at which the light incident on the fiber end is totally internally reflected and is transmitted properly along the fiber. The cone formed by the rotation of this angle along the axis of the fiber is the cone acceptance of the fiber. The light ray should strike the fiber end within its cone of acceptance, else it is refracted out of the fiber core.

Considerations in NA measurement:

It is very important that the optical source should be properly aligned with the cable and distance from the launched point and the cable is properly selected to ensure that the maximum amount of optical power is transferred to the cable.

This experiment is best performed in a less illuminated room. Measurement of Numerical Aperture Measurement of the Numerical Aperture (NA) of the fiber

Block diagram for Numerical Aperture Set-up:



PROCEDURE:

- Connect the power supply cables with proper polarity to kit. While connecting this, ensure that the power supply is OFF. Do not apply any TTL signal from Function Generator. Make the connections as shown in block diag.
- Keep all the switch faults in OFF position.
- Keep Pot P3 fully Clockwise Position and P4 fully anticlockwise position.
- Slightly unscrew the cap of LED SFH756V (660 nm). Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap. Now tight the cap by screwing it back. Keep Jumpers JP2 towards +5V position, JP3 towards sine position, JP5 & JP6 towards TX1 position.
- Keep switch S3 towards VI position.
- Insert the other end of the fiber into the numerical aperture measurement jig. Hold the white sheet facing the fiber. Adjust the fiber such that its cut face is perpendicular to the axis of the fiber.
- Keep the distance of about 10 mm between the fiber tip and the screen. Gently tighten the screw and thus fix the fiber in the place.
- Now adjust Pot P4 fully Clockwise Position and observe the illuminated circular patch of light on the screen.
- Measure exactly the distance d and also the vertical and horizontal diameters MR and PN

indicated in the block diagram.

- Mean radius is calculated using the following formula. r = (MR + PN) / 4
- Find the numerical aperture of the fiber using the formula. NA = sin max = r / d + r Where max is the maximum angle at which the light incident is properly transmitted through the fiber.

Observation Table:

S. No.	d (in cm)	r (in cm)	NA

Results

Discussions:

Experiment 7

Equipment required

Link-A kit, 20 MHz Dual Trace Oscilloscope, 1 & 3 Meter Fiber cable, Power supply, Voltmeter, Current meter, Jumper Connecting Wires-4.

Theory In optical fiber communication system, electrical signal is first converted into optical signal with the help of E/O conversion device as LED. After this optical signal is transmitted through optical fiber, it is retrieved in its original electrical form with the help O/E conversion device as photo detector. Different technologies employed in chip fabrication lead to significant variation in parameters for the various emitter diodes. All the emitters distinguish themselves in offering high output power coupled into the plastic fiber. Data sheets for LEDs usually specify electrical and optical characteristics, out of which are important peak wavelength of emission, conversion efficiency (usually specified in terms of power launched in optical fiber for specified forward current), optical rise and fall times which put the limitation on operating frequency, maximum forward current through LED and typical forward voltage across LED. Photo detectors usually come in variety of forms like photoconductive, photovoltaic, transistor type output and diode type output. Here also characteristics to be taken into account are response time of the detector, which puts the imitation on the operating frequency, wavelength sensitivity and responsivity.

Procedure (A) Characteristics of Fiber Optic LED

1. Make the jumper and switch settings as shown in the jumper diagram. Keep pot P4 in fully clockwise position.
2. Connect the ammeter with the jumper connecting wires (provided along with the kit) in jumpers JP3 as shown in the diagram.
3. Connect the voltmeter with the jumper wires to JP5 and JP2 at positions as shown in the diagram.
4. Switch on the power supply. Keep the potentiometer P3 in its minimum position (fully anticlockwise position), P4 is used to control biasing voltage of the LED. To get the VI characteristics of LED, rotate P3 slowly and measure forward current and corresponding forward voltage of the LED, Take number of such readings for forward voltage, forward current & optical power. Keep SW towards VI position.

5. For each reading taken above, find out the power, which is product of I and V. This is the electrical power supplied to the LED. Data sheets for the LED specifies optical power coupled into plastic fiber when forward current was 10 micro A as 200microW. This means that the electrical power at 10mA current is converted into 200 micro W of optical energy. Hence the efficiency of the LED comes out to be approx. 1.15%.

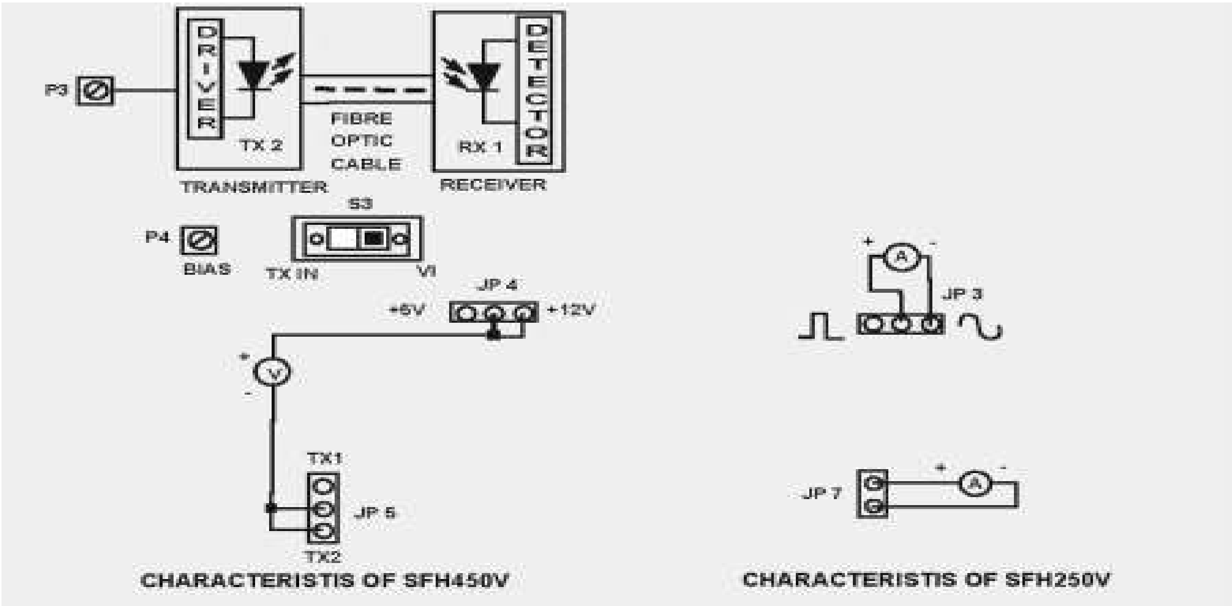
6. With this efficiency assumed, find out optical power coupled into plastic optical fiber for each of the reading in step 4. Plot the graph of forward current v/s output optical power of the LED.

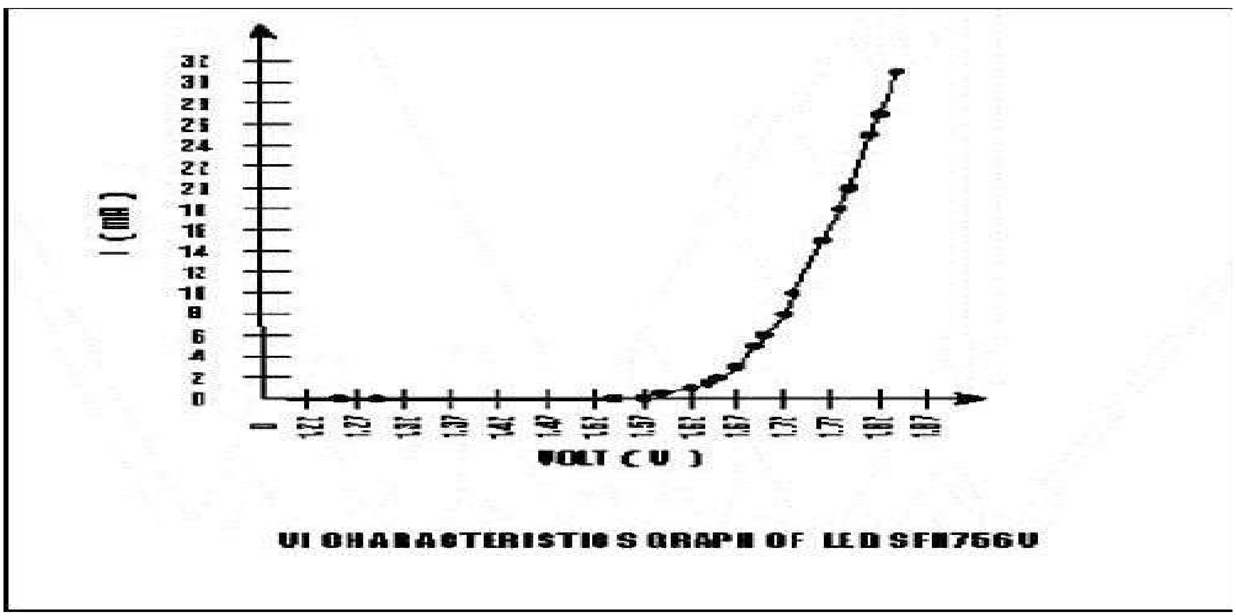
7. Repeat the above procedure by using SFH 450V (950 nm) LED.

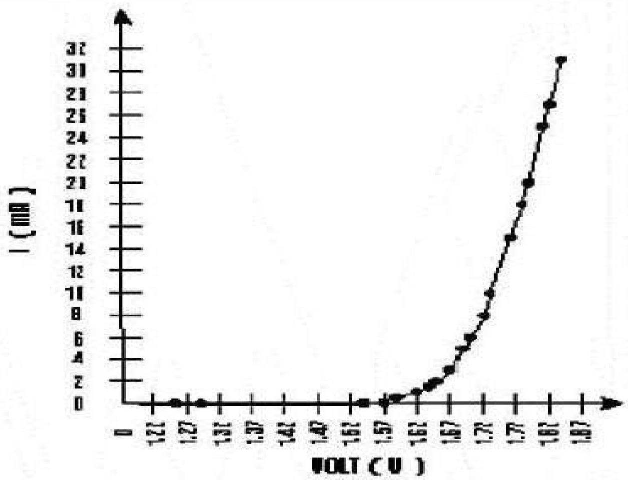
(B) Characteristics of detector 1. Make the jumper and switch settings as shown in the jumper diagram. Keep pot P4 in fully clockwise position. 2. Connect the ammeter with the jumper connecting wires (provided along with the kit) in jumpers JP7 as shown in the diagram. 3. Connect 1Meter Fiber between TX1 & RX1. 4. Measure the current flowing through Detector (RX1) SFH250V at corresponding optical power output (Normally in u A) as per the table. 5. We can observe that as incident optical power on detector increases, current flowing through the detector increases.

Observations

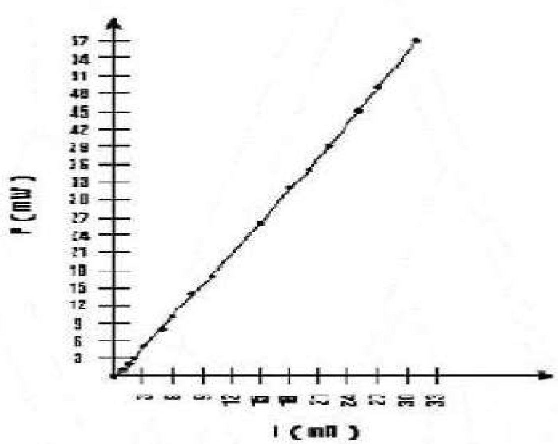
S No	**Forward Voltage of LED (V)**	**Forward Current of LED (mA)**	**Electrical Power Pi = V * I**	**Optical power of LED Po = Pi * 1.15%**	**Output current (µ A)**


P3
DRIVER
TX 2
TRANSMITTER
FIBRE
OPTIC
CABLE
DETECTOR
RX 1
RECEIVER
P4
BIAS
S3
TX IN
VI
JP 4
+6V
+12V
V
TX1
JP 5
TX2
CHARACTERISTIS OF SFH450V
A
JP 3
JP 7
A
CHARACTERISTIS OF SFH250V


I (mA)
VOLT (V)



UI CHARACTERISTICS GRAPH OF LED SFH756V



OPTICAL POWER VERSUS CURRENT GRAPH OF LED SFH756V

Precautions

It is very important that the optical sources be properly aligned with the cable and the distance from the launched point and the cable be properly selected to ensure that the maximum amount of optical power is transferred to the cable.

Result:

The characteristics of LED **&**DETECTOR are found.

Experiment 8

OBJECTIVE:

The objective of this experiment is to study a 650 nm fiber optic digital link. In this experiment, we will study a relationship between the input signal and the received signal.

PROCEDURE:

1 Connect the power supply to the board.

2 Ensure that all switch faults are OFF.

3 Make the following connections.

a. Connect the function generator 1 KHz square wave output to the emitter 1's input.

b. Connect the fiber optic cable between the emitter's output and detector's input.

c. Connect detector 1's output to the comparator 1's input.

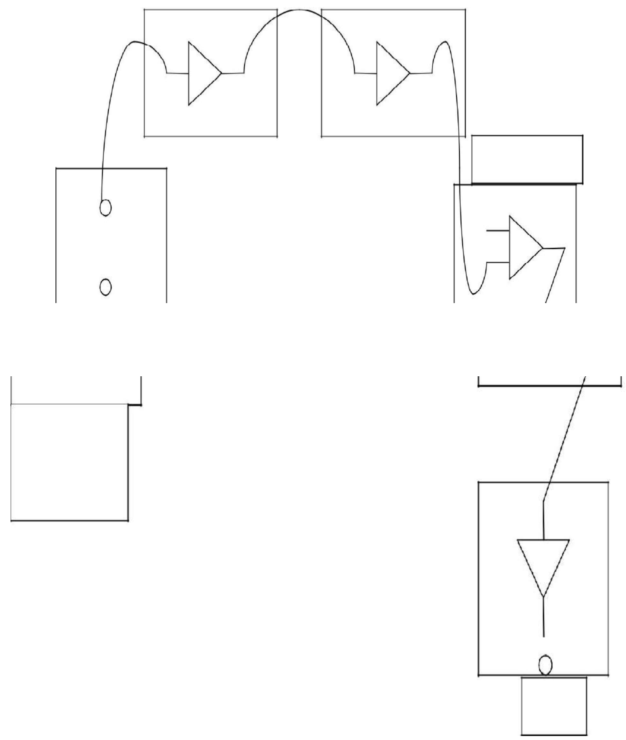
d. Connect comparator 1's output to AC amplifier 1's input.

4 On the board switch emitter 1's driver to digital mode.

5 Switch ON the power.

6 Monitor both the inputs to comparator 1 (tp 13 and tp 14). Slowly adjust the comparator bias. Reset until DC level on the input (tp 13) lies midway between the high and low level of the signal on positive input (tp 14).

7 Observe the input to emitter (tp 5) with output from AC amplifier 1 (tp 28) and note that the two signals are same.



OBSERVATION

Input Voltage (V)	Output Voltage (V)	Time (ms)

Result

Experiment 9

AIM: To Measure bit error rate.

EQUIPMENT:- Link – B Advance Fiber Optic Communication Trainer Kit, Power Supply Fiber Optic Cable (Plastic), 20 MHz Dual channel Oscilloscope, Probes, Patch Chords

THEORY:

BIT ERROR RATE: In telecommunication transmission, the bit error rate (BER) is a Ratio of bits that have errors relative to the total number of bits received in a transmission. The BER is an indication of how often a packet of other data unit has to be retransmitted because of an error. Too high a BER may indicate that a slower data rate would actually improve overall transmission time for a given amount of transmitted data since the BER might be reduced, lowering the number of packets that had to be resent**.**

OBSERVATION:

S.No: Error Counter Eb BER

S No	Error Counter	Eb	BER

BER = Eb/Tb

Where Eb – Errored bits Tb – Total bits Transmitted in a period of time t seconds.

Measuring Bit Error Rate: A BERT (bit error rate tester) is a procedure or device that measures the BER for a given transmission. The BER, or quality of the digital link, is calculated from the number of bits received in error divided by the number of bits transmitted.

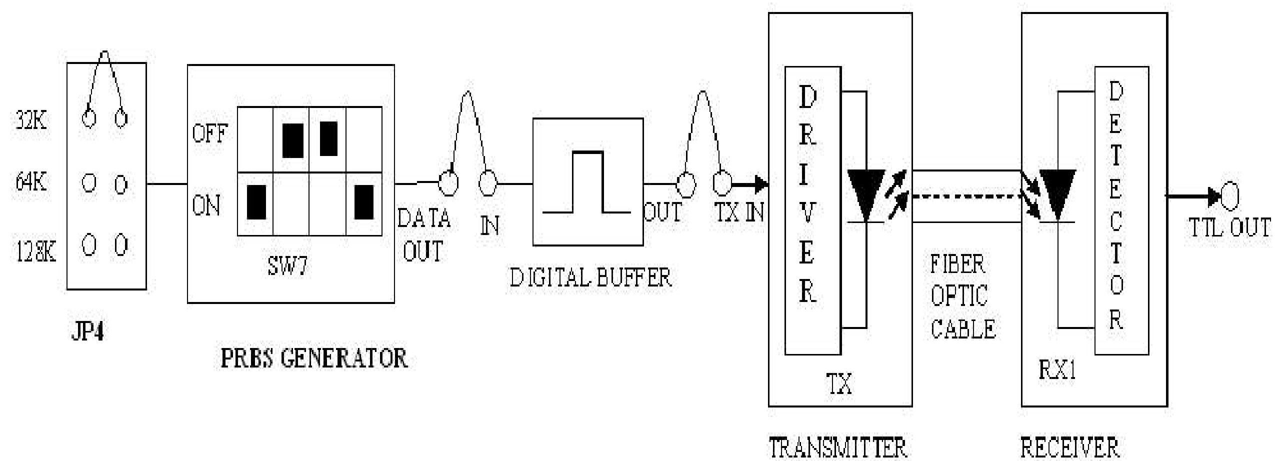
BER = (Bits in error) / (Total bits transmitted)

PROCEDURE:

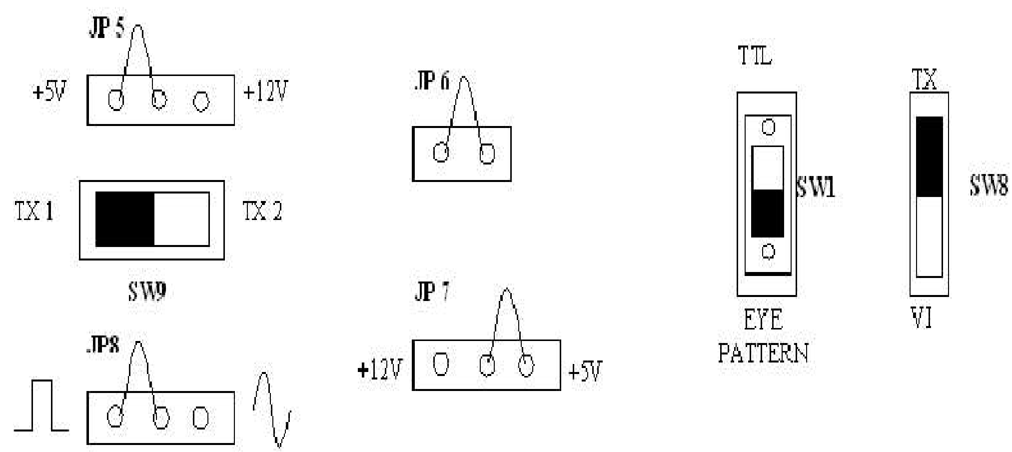
1. Make connections as shown in figure. Connect the power supply cables with proper polarity to Link – B Kit. While connecting this, ensure that the power supply is OFF.
2. Keep PRBS switch SW7 as shown in figure to generate PRBS signal.
3. Keep switch SW8 towards TX position.
4. Keep switch SW9 towards TX1 position.
5. Keep the switch SW10 at fiber optic receiver output to TTL position.
6. Select PRBS generator clock at 32 KHz by keeping jumper JP4 at 32K position.
7. Keep Jumper JP5 towards +5V position.
8. Keep Jumper JP6 shorted.
9. Keep Jumper JP8 towards Pulse position.
10.Switch ON the power supply.
11.Connect the post DATA OUT of PRBS Generator to the IN post of digital buffer. 12.Connect OUT post of digital buffer to TX IN post.
13.Slightly unscrew the cap of SFH 756V (660) nm. Do not remove the cap from the connector. Once the cap is loosened, insert the one Meter Fiber into the cap. Now tighten the cap by screwing it back.
14.Slightly unscrew the cap of RX1 Photo Transistor with TTL logic output SFH 551V. Do not remove the cap from the connector. Once the cap is loosened, insert the other end of fiber into the cap. Now tighten the cap by screwing it back.
15.Connect detected signal TTL OUT to Bit Error Rate event counter DATA IN post & post IN of Noise Source.
16.Connect post OUT of Noise Source to post RXDATA IN of Bit Error Rate event counter.
17.Connect post CLK OUT of PRBS Generator to post CLK IN of Bit Error Rate event counter.
18.Press Switch SW 11 to start counter.
19.Vary pot P3 for Noise Level to observe effect of noise level on the error count.
20.Observe the Error Count LED’s for the error count in received signal in time 10 seconds as shown in figure.

RESULT: Thus Bit error rate for given Sequence was measured.

BLOCK DIAGRAM:



JUMPER SETTING DIAGRAM:



Experiment 10

Aim- To Study of Pulse Position Modulation

Equipment Link A kit, 20 MHz Oscilloscope

1 meter Fiber cable

Power supply

THEORY:

MODULATION:

The position of the TTL pulse is changed on time scale according to the variation of input modulating signal amplitude.

Now pulse width modulated signal is fed as input to this circuit. Please note that input modulating signal must be converted into pulse width modulated form before applying to pulse modulator. As the signal is PWM, naturally, according to the input signal, the pulse duration is changing and this change in pulse duration causes the delay in triggering. The input is given to trailing edge trigger input of monoshot. So finally we get the pulses at the output, which are shifted on the time slot. This is nothing but pulse position modulation.

The Pulse Positions are directly proportional to the instantaneous values of modulating signal.

DEMODULATION:

The pulse position modulated signal is ORed with pulse generated by the rising edge of pulse width modulated signal. The o/p of the OR gate is fed to clk l/p of flip-flop. Thus flip-flop acts as a bistable multivibrator giving out high o/p for the duration between rising edge of PWM signal & PPM signal. Since PPM corresponds to the end of PWM pulse, o/p of flip-flop is exactly same as that of PWM signal. This signal is then demodulated using the same technique of PWM demodulation as described in previous experiment.

PROCEDURE:

1. Slightly unscrew the cap of SFH 756V (660 nm). Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap. Now tight the cap by screwing it back.
2. Make the connections and jumper settings as shown in FIG. 8.1 Connect the power supply cables with proper polarity to kit. While connecting this, ensure that the power supply is OFF.
3. Connect SINE post of the Function Generator section to PPM IN post of PWM/PPM Modulator Section.
4. Keep the Function Generator in sine wave mode & select the frequency 1- 10Hz with amplitude

of 2V p-p (Max) for proper observation of phenomena. Connect PPM OUT post of PWM/PPM Modulator section to IN post of Digital Buffer Section.

5. Switch on the power supply.
6. Observe PPM signal at PPM OUT post by connecting I ST Channel of CRO at PPM OUT post. Refer FIG. 8.2c. Variation in width of square wave is seen clear by connecting II ND Channel of CRO at PWM OUT post. If the frequency is high i.e. frequency is 1 KHz having Level 2Vp-p then due to persistence of vision, only blurt band in the waveform will be observed. If the Function generator is OFF, only square wave of fundamental frequency and fixed ON time will be observed and no width position variations are present.
7. Connect OUT post of the Digital Buffer Section to TX IN post of TRANSMITTER.
8. Connect the other end of the fiber to detector SFH551V (Digital Detector) very carefully as per the instructions in step 1.
9. Observe the received signal over fiber at TTL OUT Post. It should be exactly similar to the signal available at PPM OUT post.
10. Connect this TTL OUT post to PPM DEMOD IN Post in PWM / PPM Demodulator Section.
11. Vary input freq. (not more than 3 KHz) & observe demodulated signal at DEMOD OUT post (FIG. 8.2d).
12. Connect DEMOD OUT post to FILTER IN post & observe output at FILTER OUT post (FIG. 8.2e), which is same as Input signal (FIG. 8.2a).
13. For Different Sampling frequencies change the jumper cap of JP1 from 32 KHz to the desired value of frequency.
14. Repeat the above all procedures for SFH450V.

Result :

Conclusion :

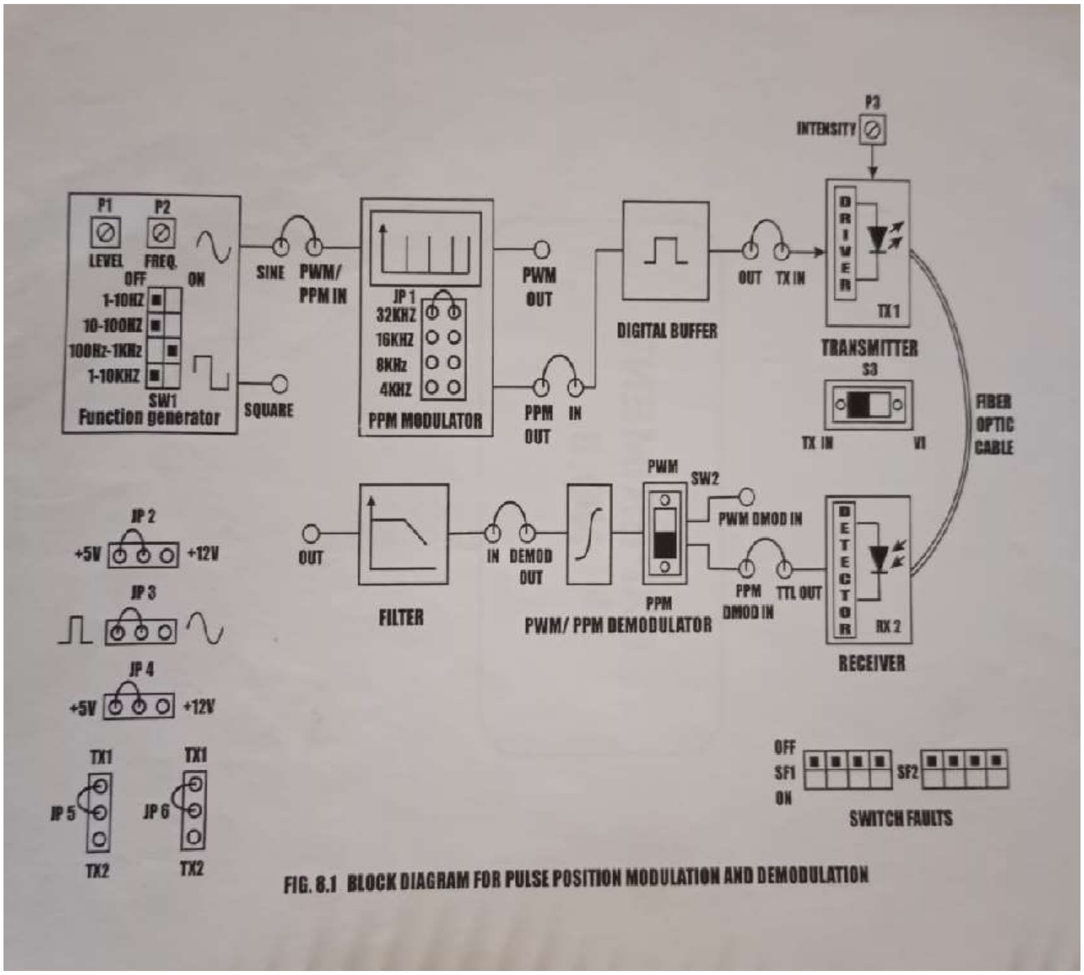


FIG. 8.1 BLOCK DIAGRAM FOR PULSE POSITION MODULATION AND DEMODULATION