PUNE INSTITUTE OF COMPUTER TECHNOLOGY, PUNE - 411043

Department of Electronics & Telecommunication

Subject –BCS Class-BE E&TC

INDEX

Subject: BROADBAND COMMUNICATION SYSTEMS

ROLL NO.: 42428 DIV. BE 8 YEAR: 2020-21 SEMESTER: II

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2	Measure attenuation of MMSI fiber and comment on the result based on attenuation due to increase in length as well as loss due to bend.	**16-02-2021**	**23-02-2021**	**5**	
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This is to certify that Shri / kum **Kapadne Chandan Jitendra** has carried out the above mentioned __**09**__ experiments in **BROADBAND COMMUNICATION SYSTEMS** laboratory of the institute.

For PUNE INSTITUTE OF COMPUTER TECHNOLOGY, Pune: 43

Date: **25-05-2021** **Staff In charge** **PRINCIPAL**

Subject –BCS Class-BE E&TC

ROLL NO. 42428
EXPERIMENT NO. : 1
TITLE: Numerical Aperture of fiber: To estimate the numerical aperture of given fiber.
DATE OF PERFORMANCE : 26-01-2021
DATE OF CHECKING : 02-02-2021

PROBLEM STATEMENT: For a given optical fiber find out N.A by scanning and visual method.

OBJECTIVE: 1) To study concept of N.A.
2) To study concept of acceptance angle.
3) To calculate N.A. for given optical fiber.

APPARATUS: N.A. measurement kit, optical fiber.

PROCEDURE:

I) VISUAL METHOD

1. Insert one end of the fiber into NA measurement unit. Adjust the fiber such that its tip is 10mm from the screen.
2. Gently tighten the screw to hold the fiber firmly in place.
3. Connect the other end of fiber to LED through the simplex connector. The fiber will project a circular patch of red light onto the screen. Let "h" the distance between the fiber tip and the screen. Now measure the diameter of circular patch of red light is D.
4. Repeat steps 3 for different value of "h". Compute the average value of NA.

II) SCANNING METHOD

1. Switch on the power supply.
2. Adjust fiber such that it just touch the light source using lead screws provided for vertical & horizontal movement.

3. Take reading on vertical scale as a reference reading.
4. Adjust distance “h” between fiber & light source to 10mm using lead screw for vertical movement.
5. Adjust fiber in horizontal position such that we get maximum voltmeter reading & take vernier scale reading.
6. So adjust fiber at different horizontal points using lead screw for horizontal movement.
7. Take vernier scale reading when voltmeter reading is half the maximum reading. This reading is D1.
8. Similarly take reading in opposite direction say ‘D2’.

$$\text{N. A.} = \sin\theta_a = \sin(\tan^{-1}(R/h))$$

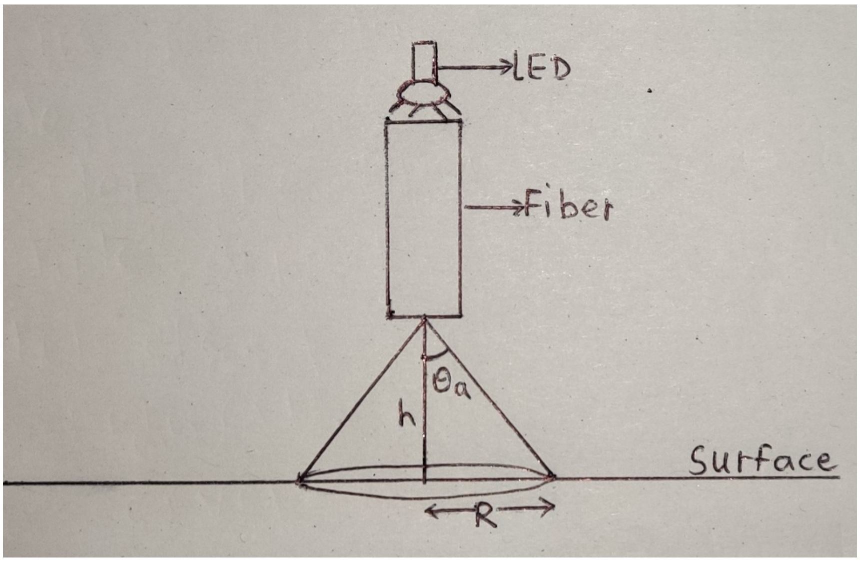
$$NA = \frac{R}{\sqrt{R^2 + h^2}}$$

Where R = radius =D/2
D= (D2-D1) or (D1-D2) &
h= distance between fiber& Light source.

9. Repeat the procedure at h= 15mm.
10. Calculate avg. value of N.A.

DIAGRAM:

VISUAL METHOD:



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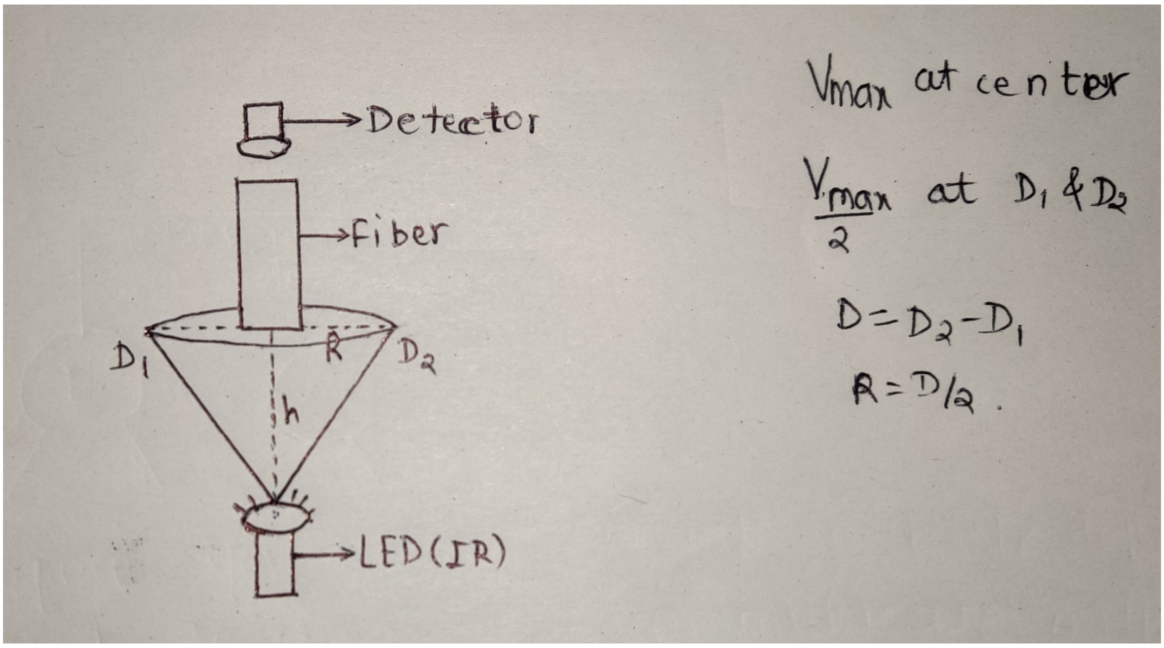
SCANNING METHOD:



OBSERVATION TABLE:

I] VISUAL METHOD:

Sr. No.	h (mm)	R (mm)	$\theta = \tan^{-1}(R/h)$	NA= $\sin\theta$	$NA = \frac{R}{\sqrt{R^2+h^2}}$	Mean NA
1	5	2	21.80	0.37	0.37	0.41
2	10	5	26.56	0.45	0.44	
3	15	7	25.01	0.42	0.42	

II] SCANNING METHOD:

Sr. No.	h (mm)	R (mm)	$\theta = \tan^{-1}(R/h)$	NA= $\sin\theta$	$NA = \frac{R}{\sqrt{R^2+h^2}}$	Mean NA
1	4	0.65	9.22	0.16	0.16	0.12
2	8	0.85	6.06	0.105	0.105	
3	12	1.15	5.47	0.0954	0.0954	

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CONCLUSION:

In this experiment, we understood the concepts of Numerical aperture and acceptance angle. We understood the relationship between numerical aperture and acceptance angle. We calculated the Numerical aperture of different heights using two different setups and verified the relationship between numerical aperture and acceptance angle.

REFERENCES:

“Optical Fiber Communication”-G. Keiser
“Optical Fiber Communication”-John Senior

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ROLL NO. 42428
EXPERIMENT NO. : 2
TITLE: Fiber Attenuation: Measure attenuation of MMSI fiber and comment on the result based on attenuation due to increase in length as well as loss due to bend.
DATE OF PERFORMANCE:16/02/2021
DATE OF CHECKING:23/02/2021

PROBLEM STATEMENT: To measure the attenuation of given fiber. Also Study the effect of length and effect of bending on attenuation.

OBJECTIVE: 1.Calculation of power loss per meter.
2. To observe effect of fiber bending

APPARATUS:Loss measurement kit, fiber cables of different Length, connecting wires, CRO.

PROCEDURE:

1. Switch on the power supply.
2. Adjust o/p of signal generator to 1Vp-p &freq 1KHz. using freq adjust & amplitude adjust pot. & connect it to i/p of optical transmitter.
3. Connect ‘A’ point to anode of optical transmitter & ‘B’ to cathode of opt. Transmitter.
4. Connect ‘C’ point to cathode of optical receiver & ‘D’ point to anode.
5. Connect L1 mtr fiber cable between optical transmitter & optical receiver.
6. Measure o/p of receiver (Measure peak to peak amplitude) V1.
7. Now remove L1 mtr fiber & Connect L2 mtr fiber cable between optical transmitter & optical receiver.
8. Measure o/p of receiver (Measure peak to peak amplitude) V2.
9. Now remove L2 mtr fiber & Connect L3 mtr fiber cable between optical transmitter & optical receiver.
10. Measure o/p of receiver (Measure peak to peak amplitude) V3.

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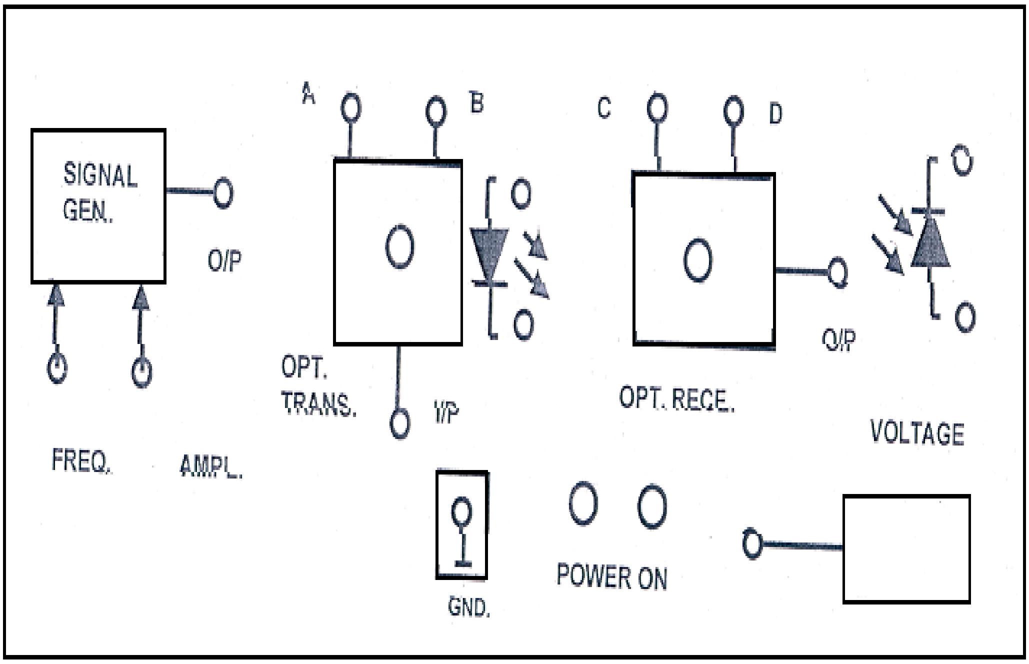
PANEL DIAGRAM:



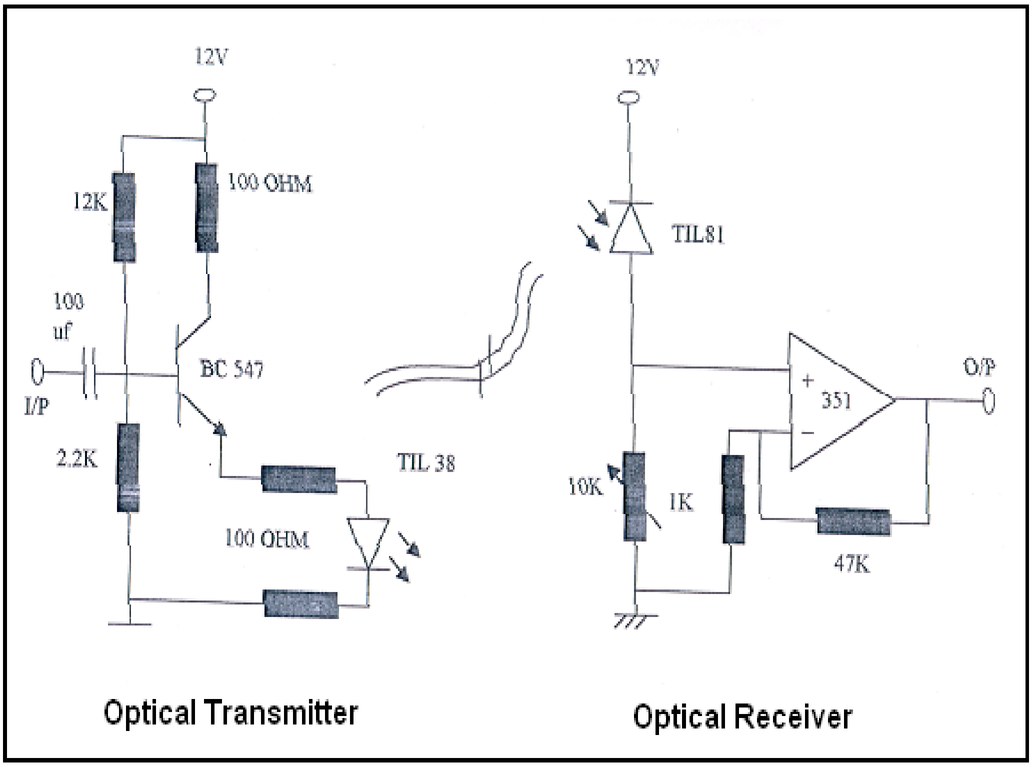


Figure: Fiber Loss Measurement

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OBSERVATION TABLE:

L1= 0.42 METER	V1=820 mV
L2= 0.62 METER	V2=552 mV
L3= 1.02 METER	V3=424 mV

CALCULATIONS:

1) Loss1 = 20 log (V1/V2) db = 20 log (820/552) db
= 3.437495 db

This is a loss when fiber length is extended from **0.42** mtr to **0.62** mtr.

2) Loss2 = 20 log (V2/V3) db = 20 log (552/424) db
= 2.29146 db

This is a loss when fiber length is extended from **0.62** mtr to **1.02** mtr.

3) Loss3 = 20 log (V1/V3) db = 20 log (820/424) db
= 5.72896 db

This is a loss when fiber length is extended from **0.42** mtr to **1.02** mtr.

Therefore Avg. loss per 1 meter of fiber cable is

$$Avg.Loss = \frac{1}{3}\left[\frac{\mathrm{Loss1}}{(\mathrm{L2}-\mathrm{L1})} + \frac{\mathrm{Loss2}}{(\mathrm{L3}-\mathrm{L2})} + \frac{\mathrm{Loss3}}{(\mathrm{L3}-\mathrm{L1})}\right]\mathrm{db/meter}$$

Calculate Avg. Loss = $\frac{1}{3}\left[\frac{3.4375}{(0.62-0.42)} + \frac{2.2915}{(1.02-0.62)} + \frac{5.7289}{(1.02-0.42)}\right]$

Avg. Loss = (17.1875 + 5.72875 + 9.5482)/3

Avg. Loss = **10.82158 db/meter**

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Bending Effect:

Length of fiber: **1.02 mtr**

Output without Bend	Output with Bend		
	R1= 4.5 cm	R2= 3 cm	R3= 2 cm
488 mV	472 mV	456 mV	400 mV

CONCLUSION:
In this experiment, we discussed about different types of losses in the optical fiber of which we performed practical analysis for loss due to increase in length and macro bending loss. From the observations it is observed that as we increase the length of optical fiber the amplitude of voltage observed at the receiving end decreases which indicates the loss. Also, as the bending increases there is a decrease in the amplitude of voltage observed at the receiving end decreases which indicates the loss.

REFERENCES:
"Optical Fiber Communication"-John Senior
"Optical Fiber Communication"-G. Keiser

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ROLL NO. 42428
EXPERIMENT NO. : 3
TITLE: Plot the characteristics of various sources and detectors **A: LED Characteristics**
DATE OF PERFORMANCE:23/02/2021
DATE OF CHECKING:02/03/2021

PROBLEM STATEMENT: To plot the electrical and optical characteristics of different light sources.

OBJECTIVE: 1)To plot V-I characteristics of optical transmitter.
2)To verify result for given specification of transmitter.

APPARATUS: FOC cable, experimental kit, patch chords, DMM.

PROCEDURE:

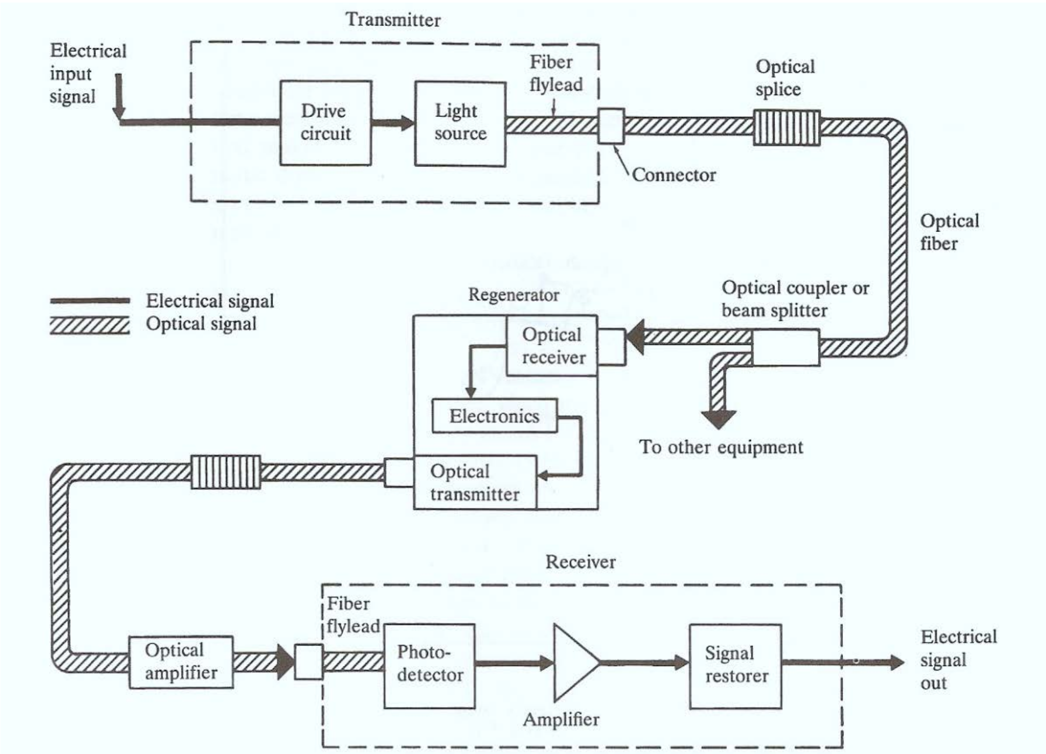

Fig. block diagram of optical fiber communication

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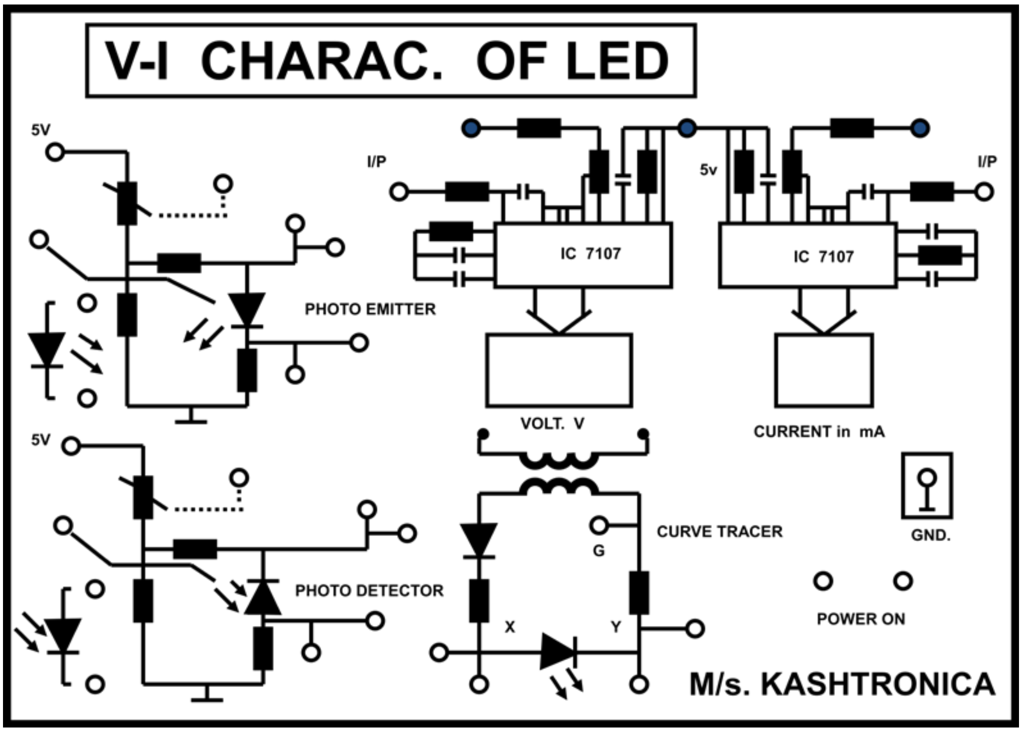
For LED kit

Test LED

1. For curve Tracing connect optical transmitter in curve tracer section, situated at the bottom of panel.
2. Connect Gnd of CRO to G point & CH –I to Y point & CH-II to X point. Press XY mode & observe VI curve on CRO.

LED Characteristics

1. Connect optical transmitter in test circuit.
2. Connect anode of transmitter to voltmeter & cathode to current meter.
3. Vary voltage & current using pot.
4. Plot the graph of voltage & current.
5. Also observe reverse bias characteristics by reversing the connections of photo transmitter.



For V – I characteristics of receiver follow the following procedure:-

1. For V – I characteristics of Receiver adjust transmitter current to 10 mA.
2. Connect optical Receiver in Reverse bias condition.
3. Connect anode to current meter and cathode to voltmeter.

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4. Connect fiber cable between transmitter and Receiver.
5. Vary voltage and current using pot and plot graph.
6. Repeat the procedure for different transmitter current.

For Receiver Actual Current = METER Reading/200

Observation Table: - For Optical Transmitter

Sr. No.	Voltage across Trans.	Current in mA	Power mW
1	0.2	0	0
2	0.4	0	0
3	0.6	0	0
4	0.8	7	5.6
5	1.0	15	15
6	1.1	21	23.1
7	1.2	29	34.8
8	1.3	40	52
9	1.4	50	70
10	1.5	60	90
11	1.6	62	99.2
12	1.7	64	108.8
13	1.8	65	117
14	1.9	66	125.4
15	2.0	67	134
16	2.2	68	149.6
17	2.4	69	165.6
18	2.6	70	182
19	2.8	71	198.8
20	3.0	71.5	214.5
21	3.2	72	230.4
22	3.4	72.5	246.5
23	3.6	73	262.8
24	3.8	73.5	279.3
25	4.0	74	296
26	4.2	74.5	312.9
27	4.4	75	330
28	4.6	75.5	347.3
29	4.8	76	364.8
30	5.0		

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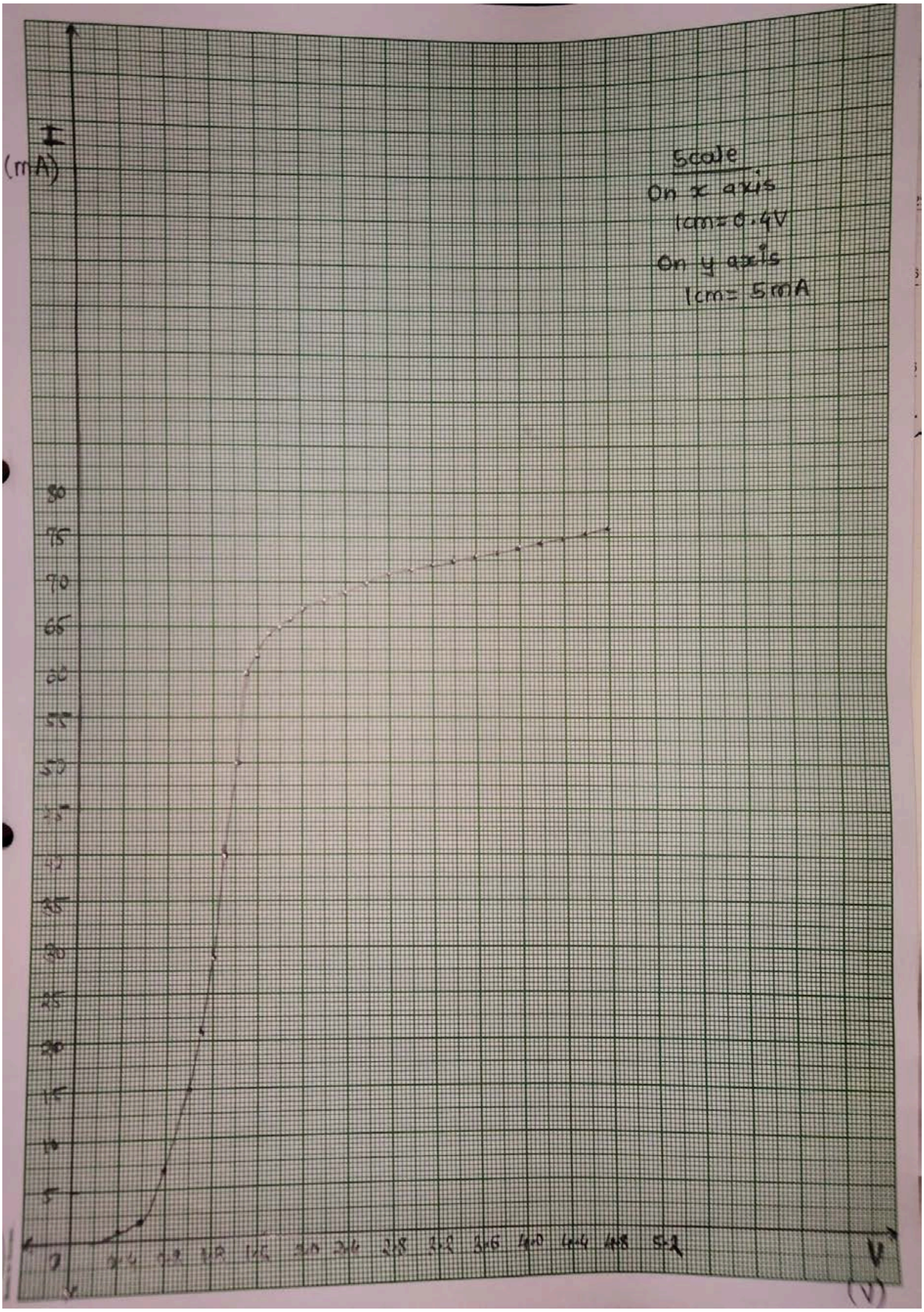
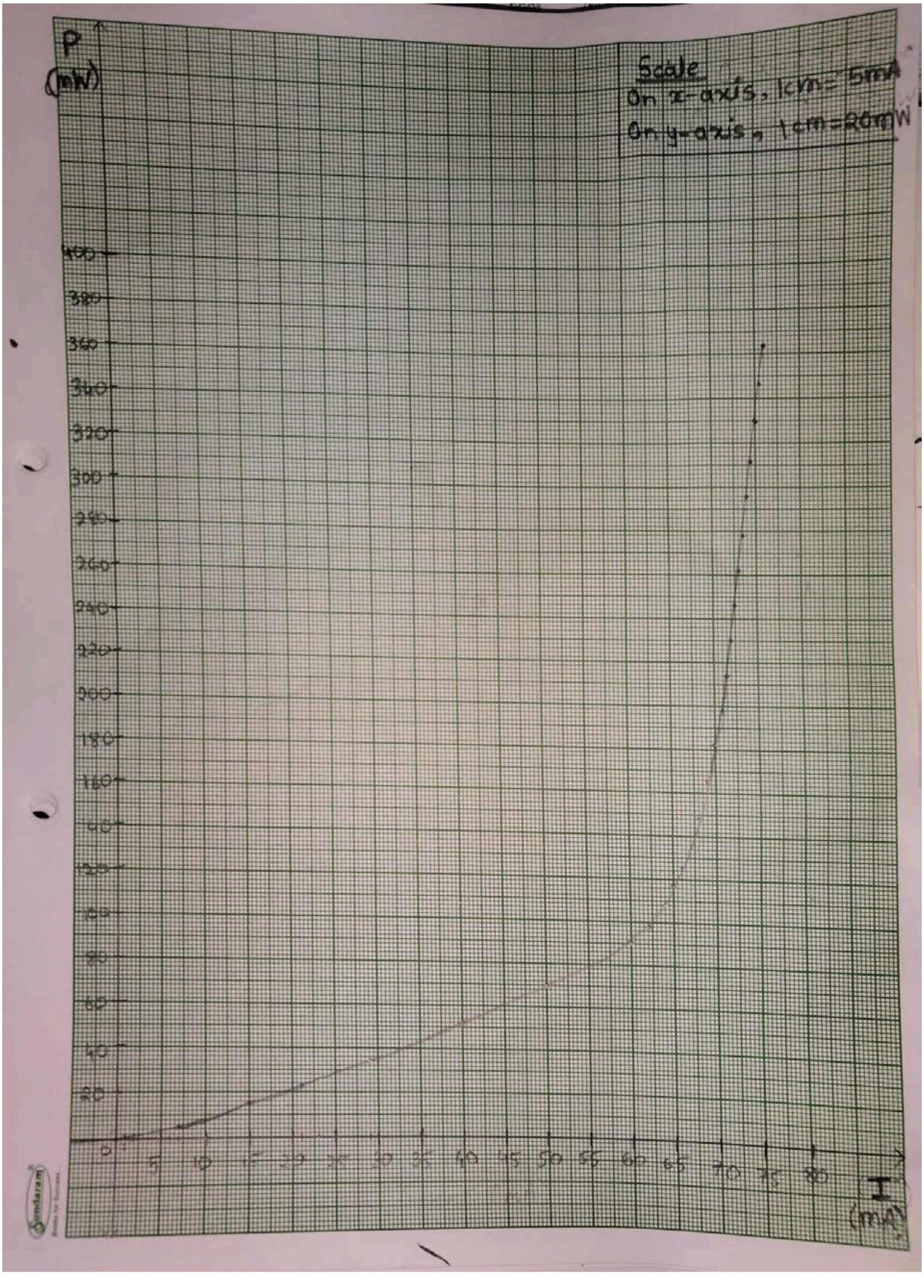


Subject –BCS

Class-BE E&TC



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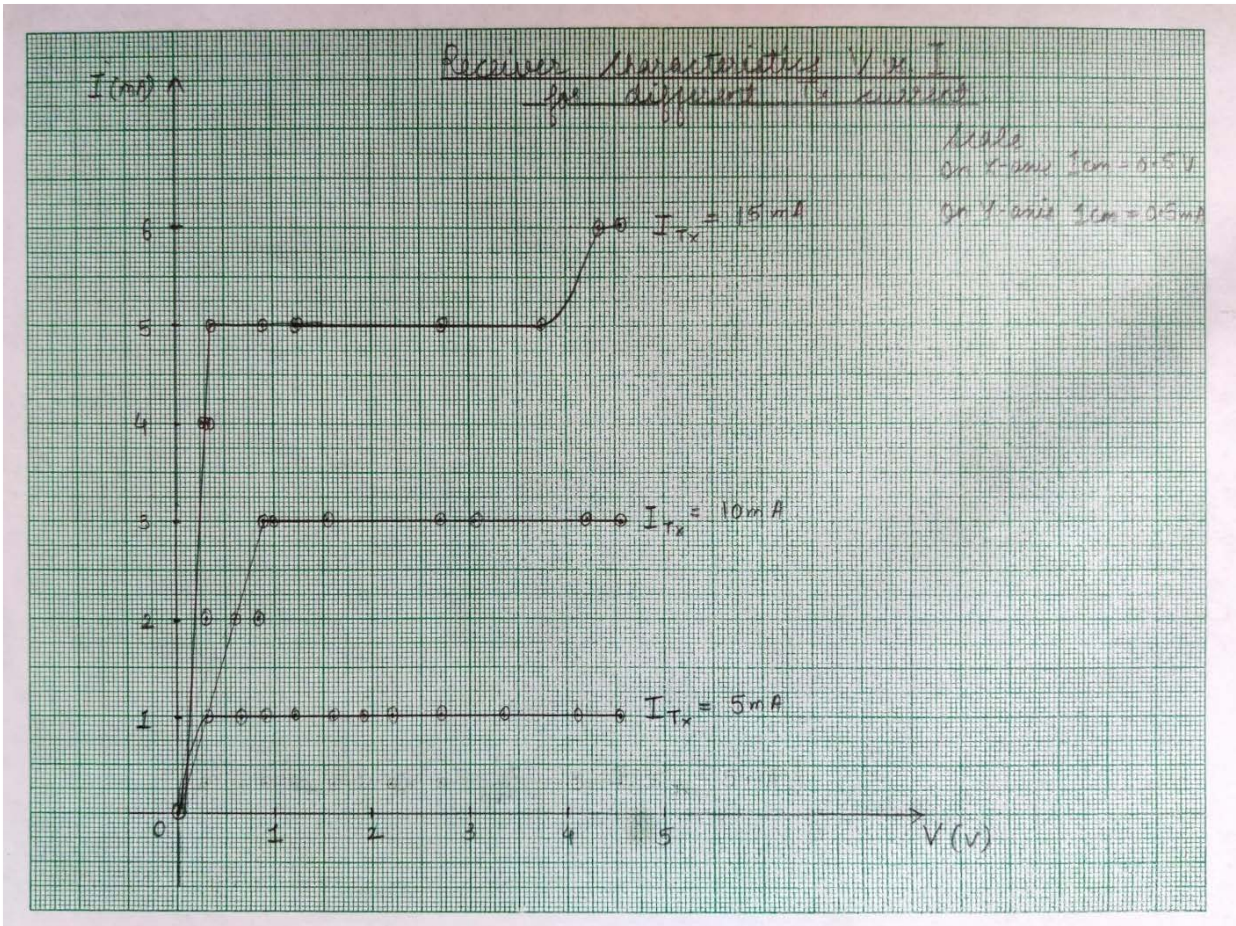
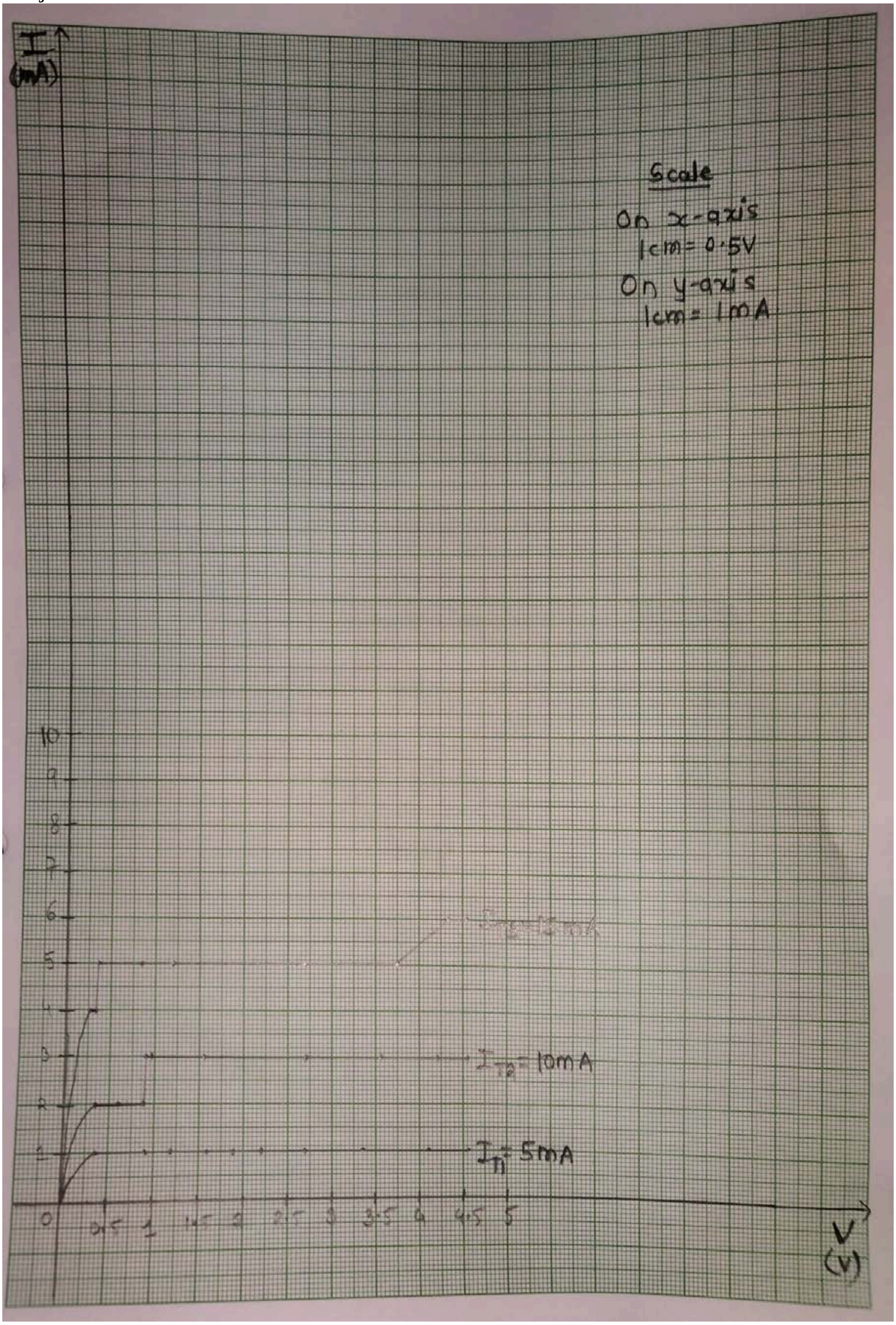
For Optical Receiver:-

Sr. No.	Trans. Current 5mA		Trans. Current 10mA		Trans. Current 15mA	
	Voltage	Current	Voltage	Current	Voltage	Current
1	0.3	1	0.3	2	0.29	4
2	0.9	1	0.6	2	0.3	4
3	1.2	1	0.83	2	0.35	4
4	1.6	1	0.87	3	0.36	5
5	1.9	1	0.97	3	0.87	5
6	2.2	1	1.52	3	1.21	5
7	2.7	1	2.7	3	2.7	5
8	3.36	1	3.54	3	3.76	5
9	4.1	1	4.21	3	4.34	6
10	4.54	1	4.54	3	4.54	6



Subject –BCS Class-BE E&TC



Graphs :

1. V-I Characteristics of LED: V Vs I
2. Output power characteristics of LED: optical power Vs Current.
3. Receiver characteristics V Vs I for different transmitter current.

CONCLUSION:

In this experiment we understood the working of LED source as optical transmitter and PIN diode detector for optic fiber. We also understood the characteristics of the LED and PIN diode. We observed the current, voltage and power for LED and PIN diode using the practical setup, plotted the characteristics and compared the results with the ideal curves. From observation we can observe that the PI characteristics is almost a straight line and VI characteristics is increasing curve.

REFERENCES:

"Optical Fiber Communication"-John Senior
"Optical Fiber Communication"-G. Keiser

TEXAS INSTRUMENTS

Optical transmitter TIL 32 or 38

P – N Gallium Arsenide Infrared- Emitting diode

Features:-

1) Designed to emit near – infrared radiation when forward biased.
2) Output Spectrally Compatible with Silicon Sensors.
3) High Power Efficiency – Typically 5 percent at 25 c.
4) High Power output – Typically 1-2mW at 25 c.
5) High Radiant intensity – Typically 4mW per Steradian.
6) Plastic package with two leads for ease of Handling.

Absolute Maximum Ratings :-

1) Reverse Voltage at 25 c → 2 V
2) Continuous forward current → 40mA.
3) Operating temperature range → 40 c to 100 c

4) Storage temperature range ⟶ 40 c to 125 c

5) Lead temperature 1.6 mm from case ⟶ 240 c for 5 seconds.

Operating Characteristics at I_f = 20 mA

1) Po = radiant Power output = 1.2 mW
2) P = Wavelength of peak Emission = 940 mm.
3) d = Spectral Bandwidth = 50 mm.
4) Half intensity Beam angle = 35
5) vf = Static forward voltage = 1.2 v
6) tr = radiant pulse Rise time = 600 nS.
7) tf = radiant pulse fall time = 350 nS.

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OPTICAL RECEIVER TIL 78 or 81

N – P – N Silicon Phototransistors.

Features :-

1. Designed for automatic or Hand insertion in Sockets or PC Boards.
2. Recommended for industrial Applications requiring Low – Cost Discrete Phototransistors.
3. Spectrally & Mechanically Matched with TIL 38 IR Emitter.

Absolute Maximum ratings at 25 c

1. Collector Emitter Voltage = 50 v
2. Emitter – collector Voltage = 7 v
3. Continuous device dissipation = 50 mW
4. Operating temperature range = -40 c to 100 c.
5. Storage temperature range = -40 c to 125 c.
6. Lead temperature 1.6 mm from case= 240 c for 5 seconds.

Electrical Characteristics at 25 c

1) VBR (CEO) at Ic = 100 mA - 50 v
2) VBR (ECO) at IE = 100 mA – 7 v
3) ID – Dark Current at VcE = 30 V - - - 25 nA& at TA = 80 c ImA
4) IL = Light Current at VCE = 5 v → 7 mA
   E = 20 nW/cm3 & at E = 2nW/cm3 → 0.5mA
5) VCE (sat) = Collector – Emitter Saturation Voltage at Ic = 2 mA
   0.4v & E = 20 nW/cm3
6) Tr = rise time → 8us Tf = fall time →6us Test conditions

Vcc = 30 V IL = 800 uA RL = 1K

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ROLL NO. 42428
EXPERIMENT NO. : 3
TITLE: Plot the characteristics of various sources and detectors **B : Frequency Response**
DATE OF PERFORMANCE:02/03/2021
DATE OF CHECKING:09/03/2021

PROBLEM STATEMENT:To plot the frequency response of detector with different values of load resistor.

OBJECTIVE: 1. To observe the effect of different load
2. To plot the frequency response of optical receiver.

APPARATUS: Optical detector characteristics measurement kit, fibercable, connecting wires, CRO.

PROCEDURE:

1) Switch on the power supply.
2) Connect o/p of IC 8038 to i/p of optical transmitter. By varying it's frequency. Observe that it remains constant throughout the frequency range.
3) Connect fiber cable between optical transmitter and optical receiver.
4) Connect RL1 as load resistance to anode of optical receiver.
5) Now vary the frequency of function generator and observe and measure the voltage across load resistance of optical receiver.
6) Draw the graph of frequency Vs 20 Log Vo(p-p).
7) Repeat step 4 to 6 for RL2 and RL3.
8) From graph find out optical bandwidth and electrical bandwidth.

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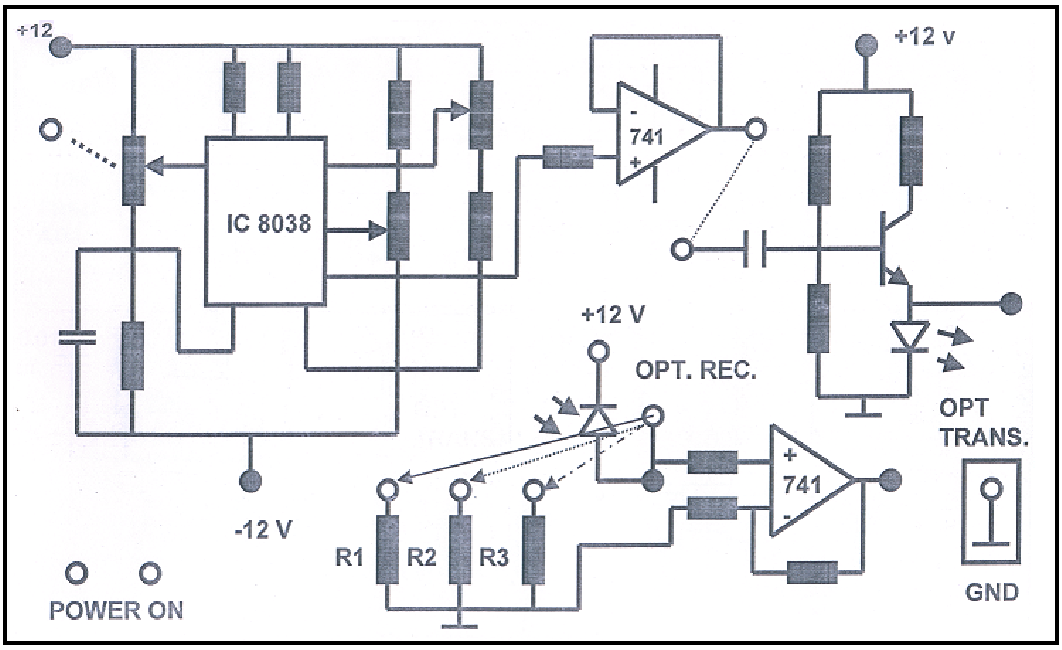
PANEL DIAGRAM:



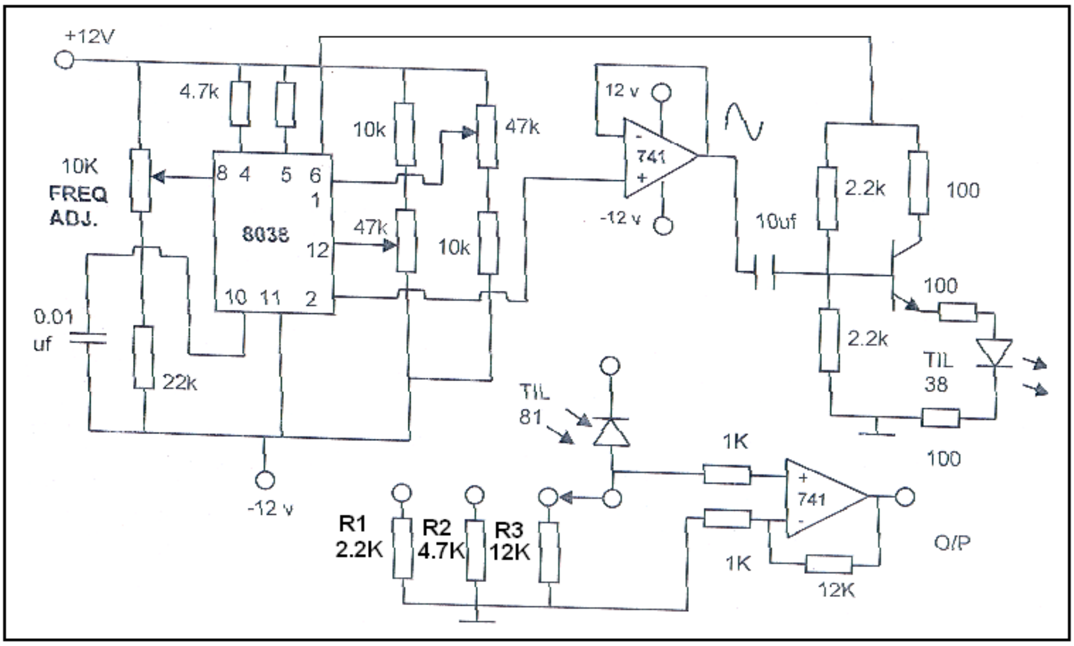


Figure: **Frequency response of optical receiver**

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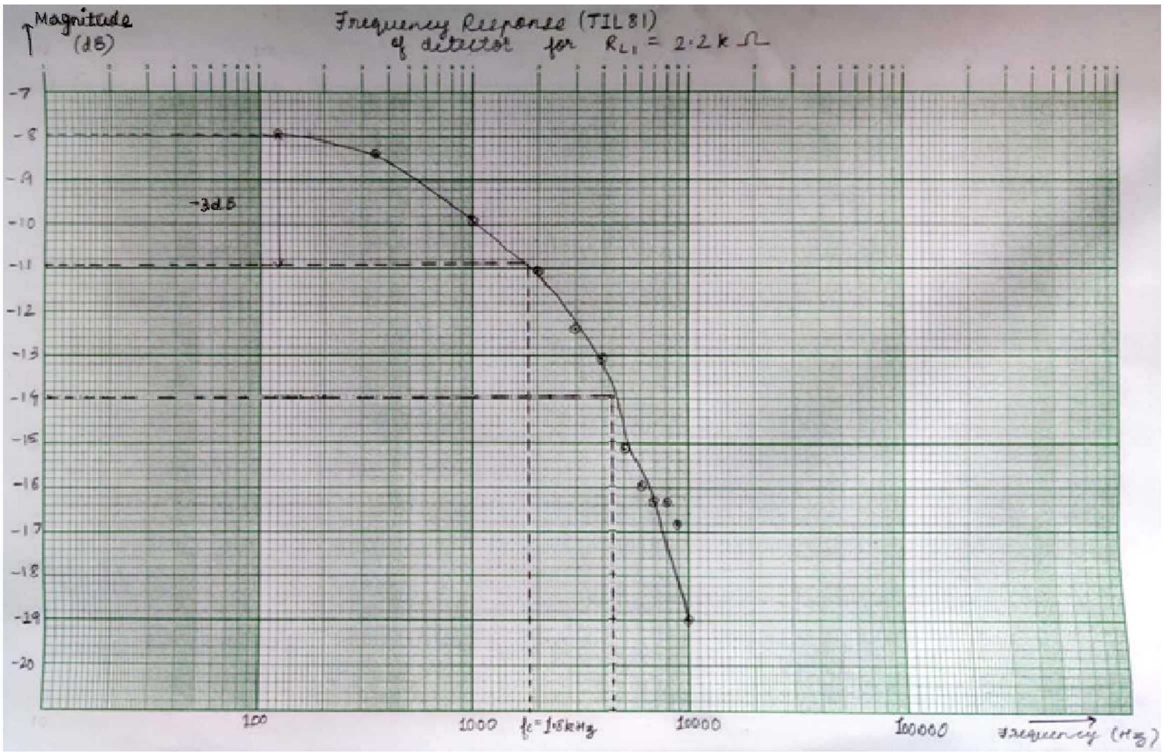
OBSERVATION TABLE:

RL1= 2.2KΩ, RL2= 4.7KΩ, RL3=12KΩ

Sr. No	Frequency (kHz)	VR1 (V)	VR1 (dB)	VR2 (V)	VR2 (dB)	VR3 (V)	VR3 (dB)
1	117Hz	400mV	-7.96	3.2	10.10	8	18.06
2	350Hz	380mV	-8.40	2.8	8.94	7	16.90
3	1KHz	320mV	-9.90	2.2	6.85	4	12.04
4	2KHz	280mV	-11.06	2	6.02	3	9.54
5	3KHz	240mV	-12.40	1.8	5.11	2.4	7.60
6	4KHz	220mV	-13.15	1.5	3.5	2.4	7.60
7	5KHz	176mV	-15.10	1.2	1.58	1.8	5.11
8	6KHz	160mV	-15.92	1.1	0.83	1.6	4.08
9	7KHz	152mV	-16.36	1.04	0.34	1.4	2.92
10	8KHz	152mV	-16.36	960	-0.35	1.2	1.58
11	9KHz	144mV	-16.83	880mV	-1.11	1	0
12	10KHz	112mV	-19.02	640mV	-3.88	900mV	-0.92



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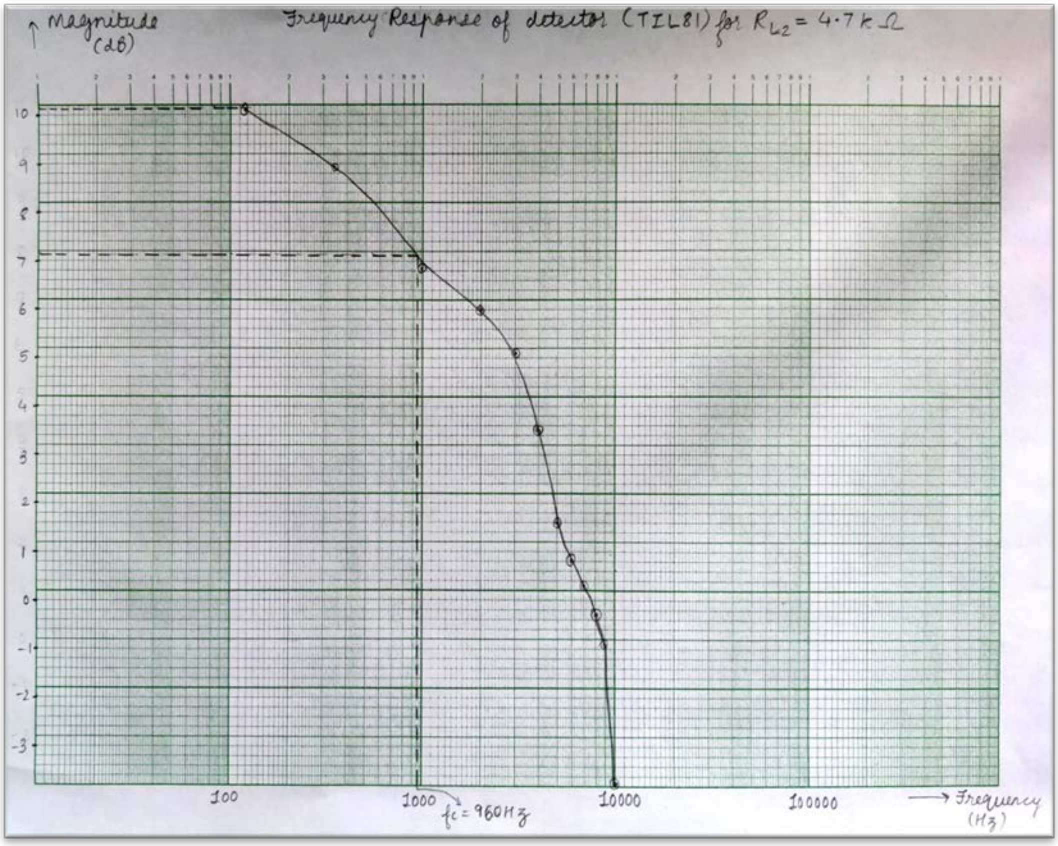

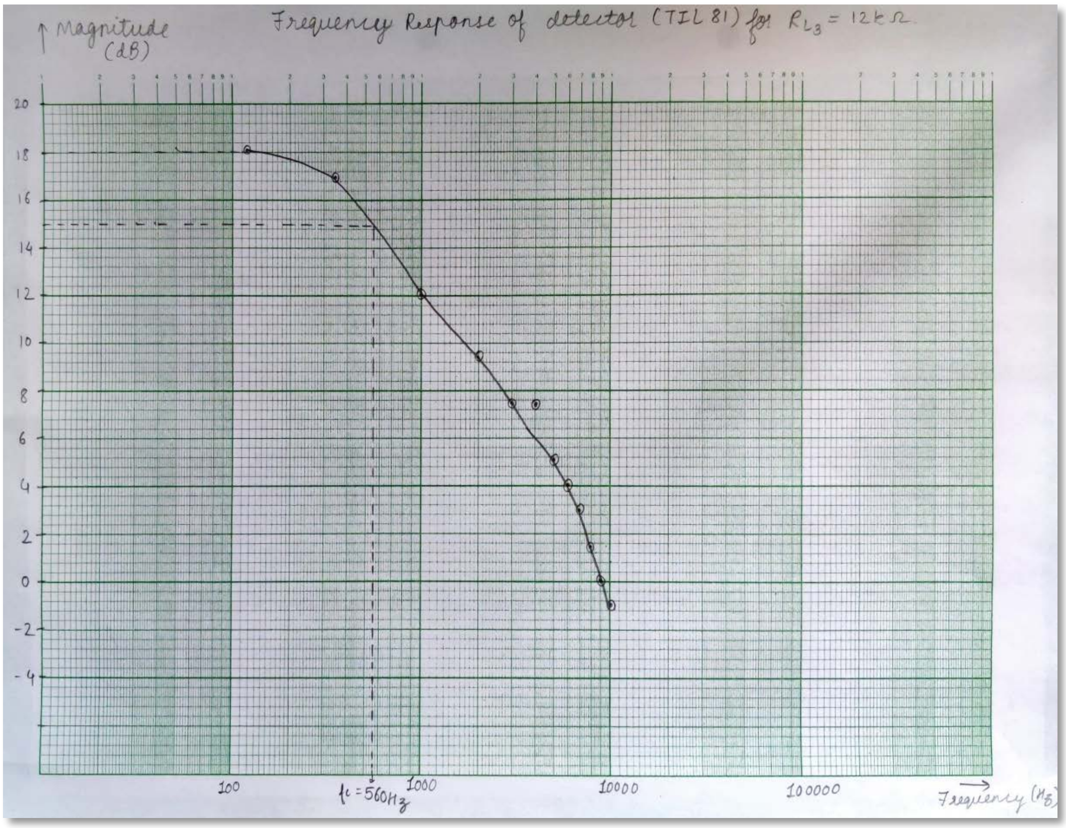

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CONCLUSION:

In this part of the experiment, we observed the frequency response of the optical receiver for different loads (RL1=2.2kohm, RL2=4.7kohm, RL3=12kohm). Through the graphs we can observe that the practical graphs align with the ideal expected graphs. The respective cutoff frequencies were found to be RL1=2.2 kohm and fc1=1.8kHz, RL2=4.7 kohm and fc2=960Hz, RL3=12 kohm and fc3=560 Hz

REFERENCES:

"Optical Fiber Communication"-John Senior
"Optical Fiber Communication"-G. Keiser

Subject –BCS Class-BE E&TC

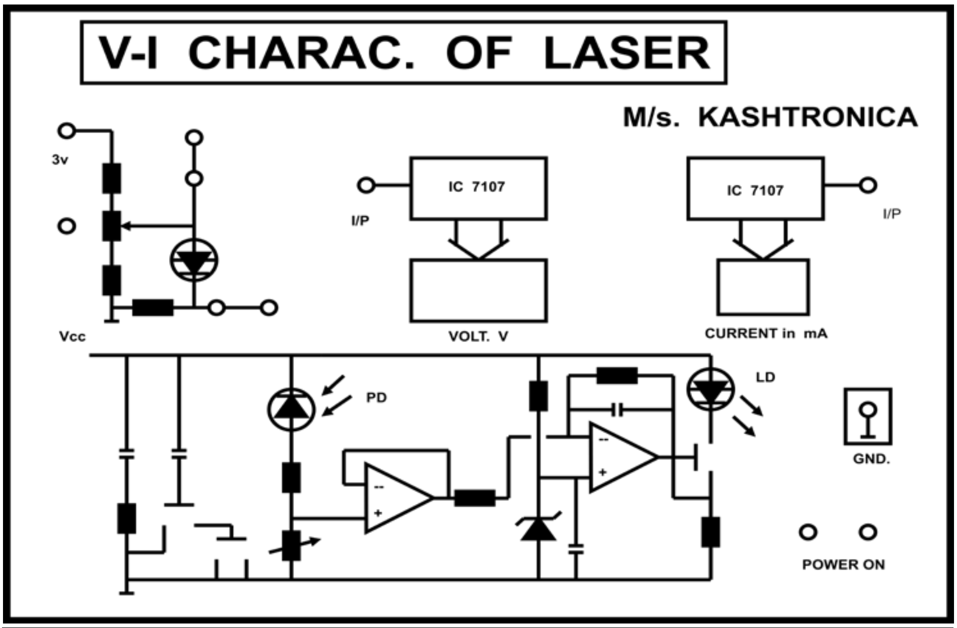
ROLL NO. 42428
EXPERIMENT NO. : 3
TITLE: Plot the characteristics of various sources and detectors **C: LASER characteristics**
DATE OF PERFORMANCE:09/03/2021
DATE OF CHECKING:16/03/2021

PROBLEM STATEMENT: To plot the electrical and optical characteristics of different light sources.

OBJECTIVE: To plot V-I characteristics of optical transmitter.

APPARATUS: FOC cable, experimental kit, patch chords, DMM.

PROCEDURE: For LASER kit



1) First ensure that power supply is off.
2) Connect Anode of Laser diode to voltmeter i/p
3) Connect Cathode of Laser diode to i/p of current meter.
4) Now switch on the power supply.

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5) Using pot adjust voltage across laser diode to minimum value.
6) Now gradually increase the voltage & take voltmeter & ammeter readings at regular intervals. Plot the graph of voltage Vs current.
7) Also connect o/p of Laser diode to optical power meter & plot graph of current Vs optical power.

Observation Table: - For Optical Transmitter

Sr. No.	Voltage across Trans.	Current in mA	Power mW
1	0.2	0	0
2	0.4	0	0
3	0.6	0	0
4	0.8	0	0
5	1.0	0	0
6	1.2	0	0
7	1.4	0	0
8	1.6	0	0
9	1.8	1	1.8
10	2.0	3	6
11	2.05	5	10.25
12	2.1	6	12.6
13	2.15	7	15.05
14	2.2	8	17.6
15	2.25	10	22.5
16	2.3	12	27.6
17	2.35	13	30.55
18	2.4	16	38.4
19	2.45	19	46.55
20	2.5	20	50
21	2.55	21	53.55
22	2.6	24	62.4

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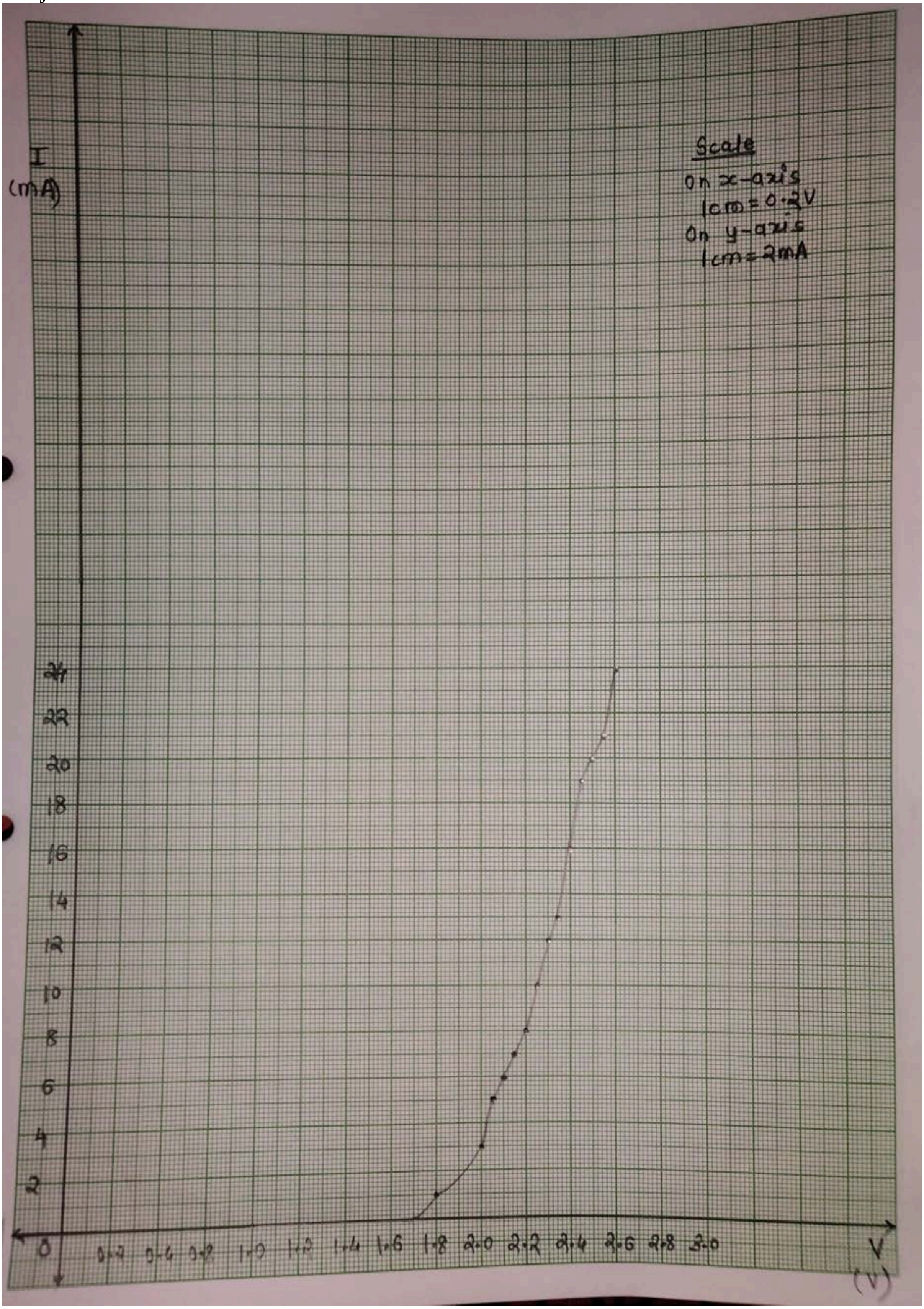

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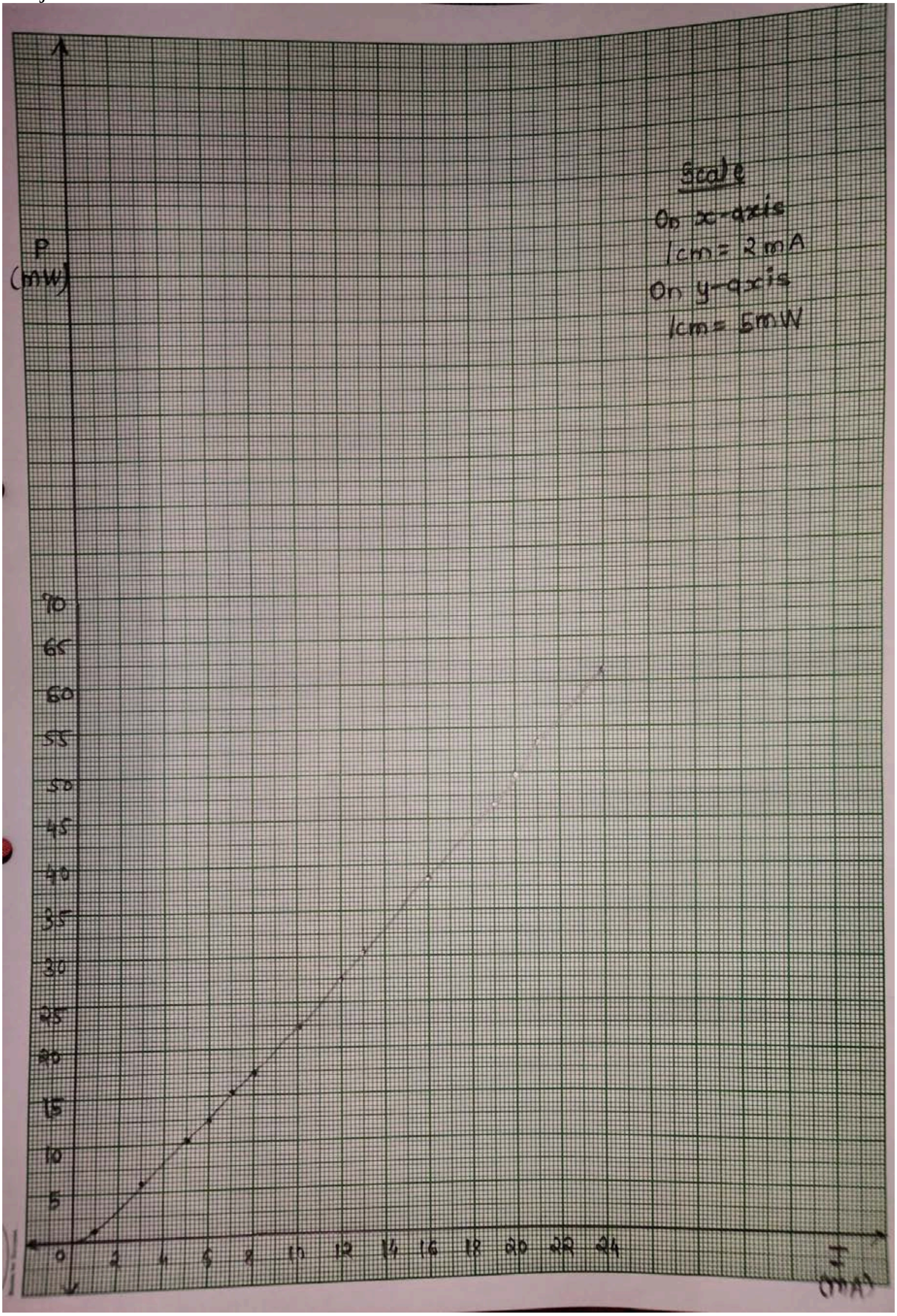

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Graphs :

1. V-I Characteristics of LASER: V Vs I
2. Output power characteristics of LASER: optical power Vs Current

CONCLUSION:

In this part of the experiment, we observed the VI and PI characteristics for the LASER source for optical fiber and plotted the graphs for the same. On observing the graphs and comparing with the graphs of LED source we can say that the LASER source performs better than LED source and is mostly used in long distance communication.

REFERENCES:

"Optical Fiber Communication"-John Senior
"Optical Fiber Communication"-G. Keiser

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ROLL NO. 42428
EXPERIMENT NO. : 04
TITLE: Set up digital link for fiber optic communication and analyze.
DATE OF PERFORMANCE: 18/05/2021
DATE OF CHECKING:25/05/2021

PROBLEM STATEMENT: To set up optical digital link for fiber optic communication.

OBJECTIVE: To study how the optical link can be used for the transmission of digital signal.

APPARATUS: Kashtronica Fiber optic digital communication kit, Digital storage oscilloscope, microphone, fiber.

PROCEDURE 1:

1. Switch on the power supply.
2. Keep frequency of CLK Gen. Minimum.
3. Connect pattern O/p to I/p of transmitter.
4. Observe point ‘A’ with I/p pattern on dual scope CRO O/p is inverted.
5. Connect fiber cable between optical transmitter & receiver.
6. Connect anode of optical receiver to 1KΩ as R_L.
7. Observe O/p across R_L.
8. Observe O/p of OPAMP amplifier.
9. Observe final O/p of receiver. It is same as I/p pattern.
10. Note all Waveforms on graph papers with to respect to clock signal.
11. Repeat steps 1 to 10 for R_L = 4.7KΩ

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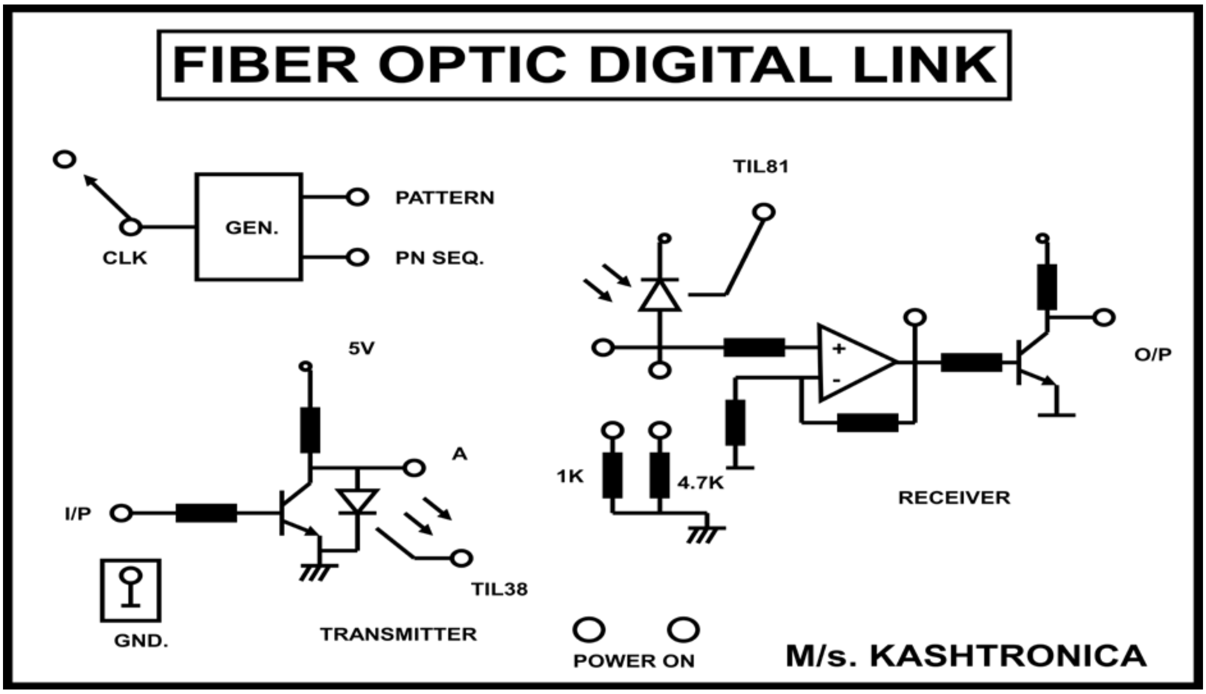
PANEL DIAGRAM:

Digital Optical Link:



PROCEDURE 2: Procedure to observe eye pattern

1. Observe O/p of OPAMP amplifier on CRO. Connect Clk to 1 channel of CRO & O/P of OPAMP to other Channel. Trigger CRO w.r.t.to Clk. Adjust Time Base such that you can observe only 2 or 3 clk Cycles only.
2. Increase frequency from minimum to maximum, you will observe' EYE PATTERN' on CRO. Observe the point at which eye is closed. Measure CLK freq. at that point.
3. Now at same clock freq. connect pattern to I/p of transmitter & observe final O/p of receiver. The O/p is distorted one.
4. Now instead of 1K use 4.7K as RL & repeat above steps & calculate frequency limits. What is your conclusion? As RL $\uparrow$ bandwidth $\downarrow$.

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OBSERVATION TABLE:

Propagation Delay for 1KΩ =

Propagation Delay for 4.7KΩ =

For load	Frequency Limit of eye pattern	Data rate
1KΩ	4.5 K	4.7 Kbps
4.7KΩ	2.5 K	3.5 Kbps

Data Rate: = $0.7/t_{sys}$

For 1KΩ, Data rate = 0.7/0.1489m = 4.7 Kbps

For 4.7KΩ, Data rate = 0.7/0.2m = 3.5 Kbps

CONCLUSION:

We are using NRZ Pattern. Fiber used is multimode step index fiber in first window of operation. We set up the digital link system and gave digital patterns as input to the system. Observed the receiver side and verified the received signal with original signal. Calculated delays between transmitted and received signals using cursors in CRO. Connected clock to channel 1 and op amp output at channel 2 to get eye pattern. For Determination of limiting frequency, we used x-y mode for ease of determination. In x-y mode at the frequency where the two dots start joining, that frequency is eye limiting frequency

REFERENCES:

"Optical Fiber Communication"-John Senior
"Optical Fiber Communication"-G. Keiser

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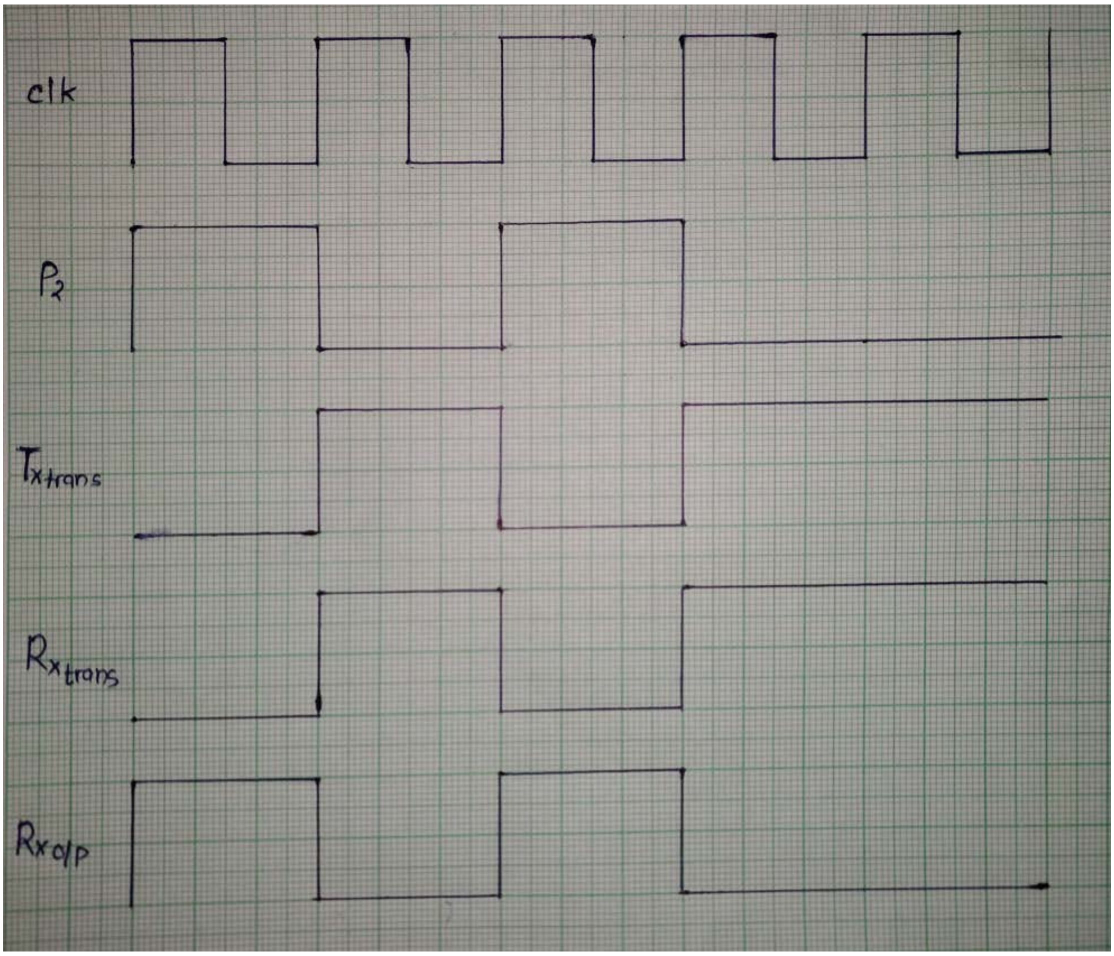
GRAPH 1



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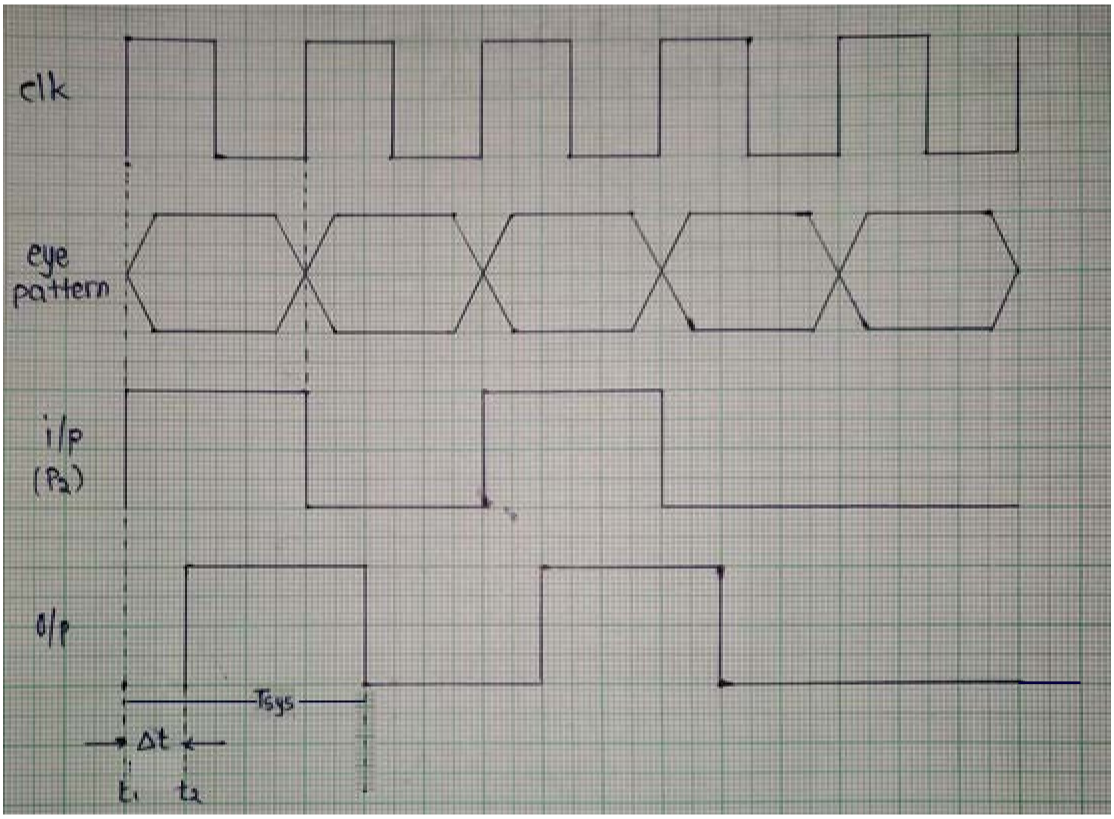
GRAPH 2



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ROLL NO. 42428
EXPERIMENT NO. : 5
TITLE: Tutorial on power budget and time budget analysis of optical fiber system.
DATE OF PERFORMANCE: 16/03/2021
DATE OF CHECKING: 23/03/2021

PROBLEM STATEMENT: To solve numerical for power budget and time budget analysis of optical fiber system.

OBJECTIVE: Perform power and rise time budget analysis of given fiber optic system

APPARATUS: Given problems questions

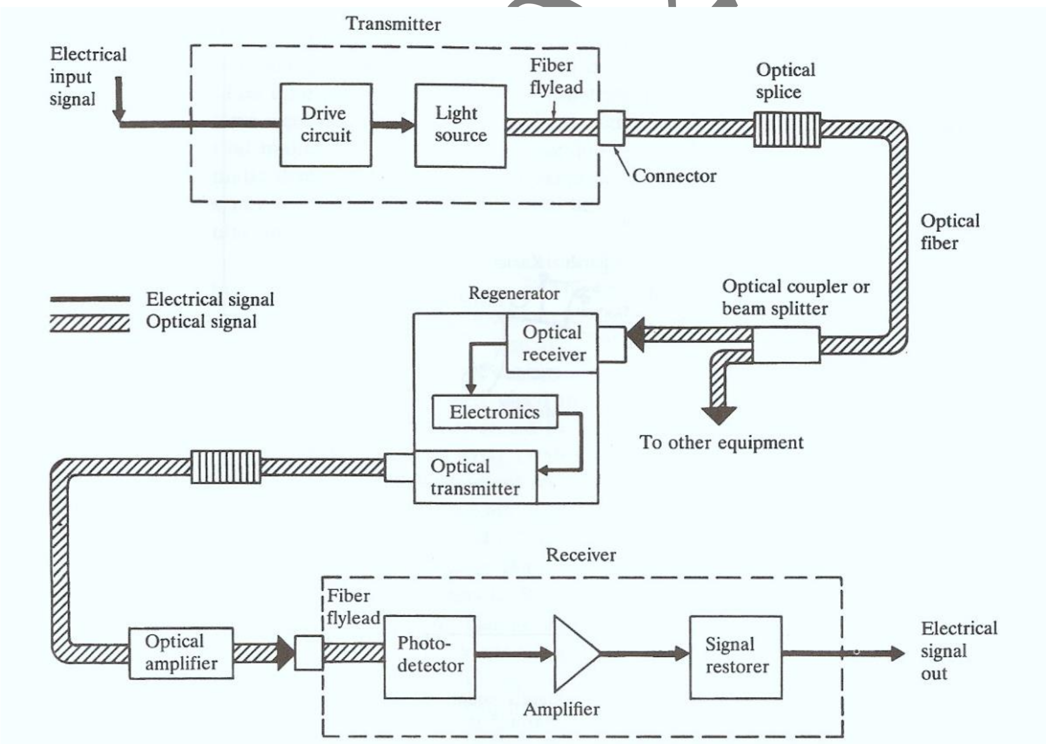

Fig. block diagram of optical fiber communication

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1	What is the need of optical power budget? Explain Link power with the help of optical power loss model for a point to point communication.
2	What are the key requirements of point to point link in FOC? Explain link design with respect to choose of components & its characteristics.
3	Explain Rise time budget in OFC Systems.
	Power budget problems
1	Components are chosen for a digital optical fiber link of overall length 7KM, 20Mbps data rate and RZ code. An LED emitting at 0.85 µm is capable of launching an average of 100 µw of optical power.(Including connector loss). A graded index fiber of 50 µm core diameter is choosen.The fiber has attenuation of 2.6dB/km and requires splicing every kilometer with loss of 0.5dB/splice. There is also a connector loss at receiver of 1.5dB.Receiver requires mean incident optical power of -41dBm for necessary BER of 10^{-10}, safety margin of 6dB will be required. Write down the optical power budget for the system and hence determine its viability.
2	The following parameter are established for a long –haul single-mode optical fiber system operating at a wavelength of 1.3 µm: Mean power launched from the laser transmitter:-3dBm Cable fiber loss: 0.4dB km^{-1} Spilce loss: 0.1 dB km^{-1} Connector losses at the transmitter and receiver: 1 dbB each Mean power required at the APD receiver: When operating at 35 Mbit s^{-1} (BER 10^{-9}):-55 dBm Required safety margin: 7dB Estimate the maximum possible link length without repeaters when operating at 35 Mbit s^{-1} (BER 10^{-9}).It may be assumed that there is no dispersion-equalization penalty at this bit rate.
3	A 1550 mm single mode digital fiber optic link needs to operate at 622 Mb/s over 80 km without amplifiers. A single mode laser launches an average optical power of 13dB m into the fiber. The fiber has a loss of 0.35 dB/km and there is a splice with a loss of

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	0.1dB every kilometer. The coupling loss at the receiver is 0.5dB and the receiver uses an lnGaAs APD with a sensitivity of -39 dBm. Excess noise penalties are predicted to be 1.5 dB. Set up an optical power budget for this link and find the system margin. What is the system margin at 2.5 GB/s with an APD sensitivity of -31dBm?
4	A student wishes to establish a 10 km optical fiber link that utilizes a fiber with a loss of 1.5 dB /km. The fiber is available in short pieces of 1 km each. The connectors available in the laboratory have a loss of 0.6 dB each. Determine the minimum optical power which must be launched into the fiber so as to maintain mean optical power level of 300 mW at the detector.
5	Components chosen for a digital optical fiber link of overall length 10km and operating at a 20M bit/s using a RZ code are given below: i) LED capable of launching an average power of 0.1mW at 0.85um[including connector loss into a 50um core diameter graded index fiber] ii)Fiber attenuation 2.5dB/km and iii) Requires splicing every 2km with a loss of 0.3dB per splice. There is also a connector loss at the receiver of 1.5dB. iv) The receiver requires mean incident optical power of -46 dBm in order to give the necessary BER of 10^{-10} v) Predicted safety margin of 6 dB. Write down the optical power budget for the system and hence determine its viability.
6	Components are chosen for a digital optical link of overall length of 6km, which has an attenuation of $3dbkm^{-1}$. I require splicing every kilometer with a loss of 0.5dB per splice. The connector loss at the receiver is 1.5dB. The receiver requires mean optical power of -41 dBm in order to give necessary BER of 10^{-10} . It is also predicted that a safety margin of 6dB will be required. Write down the optical power budget for the system and hence determine its viability.
7	A 1550 nm single mode digital fiber optical link needs to operate at 622Mb/s over 90 km without amplifiers. A single mode InGaAs P laser launches an average optical power of 13dBm into the fiber. The fiber has a loss of 0.35dB/km and there is a splice a with a loss

	of 0.1dB every kilometer. The coupling loss at the receiver is 0.5dB and the receiver uses an InGaAs APD with sensitivity of -39dBm. Excess noise penalties are predicted to be 1.5dB. Set up an optical power budget for this link and find the system margin.
8	Calculate the maximum attenuation-limit transmission distance of the following two systems operating 100Mb/s: ***System I operating at 850nm*** i) GaAlAs laser diaode:0dBm fiber-coupled power. ii) Silicon APD with -50 dBm sensitivity. iii) Graded-index fiber :3.5dB/km attenuation at 850nm. iv) Connector loss: 1dB/connector ***System II operating at 1300nm*** i) InGaAsP LED diode:13dBm fiber-coupled power. ii) InGaAs pin photodiode with -38dBm sensitivity. iii) Graded-index fiber: 1.5 dB/km attenuation at 1300nm. iv) Connector loss : 1 dB/connector. Allow a 6 dB system operating margin in each case. Comment on result.
	Rise time budget
1	An optical fiber system is to be designed to operate over an 8-km length without repeater. The rise times of the chosen components are: Source (LED)=>8ns Fiber: Intermodal =>5 ns km^{-1} (Pulse broadening) intra-modal => 1 ns km^{-1} Detector (p-i-n photodiode) => 6 ns From the system rise time consideration, estimate the maximum bit rate that may be achieved on the link when using an NRZ format.

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2	Analog optical fiber link has following rise time components: Source (LED)=> 10ns Fiber cable: Intermodal => 9 ns km; Intra-modal => 2 ns/ km; Detector (APD) => 3 ns The desired link length without repeaters is 5km and the required optical Bandwidth is 6MHz. Determine whether the above combination of components give an adequate response.
3	For a digital link using optical fiber, LED with its driver circuit has rise time of 15 ns, Taking a typical LED spectral width of 40nm, a material dispersion related rise –time degradation of 21 ns over the 6 km link. Model dispersion induced fiber rise –time is 3.9nsec. Assuming that receiver has 25MHz bandwidth, the contribution to the rise-time degradation from receiver is 14 nsec. Calculate link rise-time. Hence find which data format is supported NRZ or RZ?

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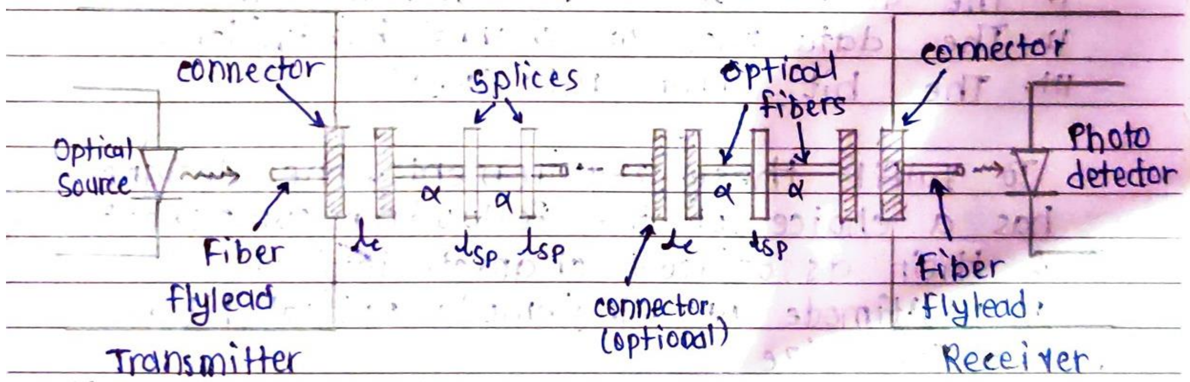
1) What is the need of optical power budget? Explain Link power with help of optical power loss model for a point to point commⁿ?

⇒ The design of optical link involves many interrelated variables among the fiber, source & photodetector operating characteristics, so that the actual link design & analysis may require several iterations before they are completed satisfactorily. Since performance & cost constraints are very important factors in fiber optic commⁿ links, the designer must carefully choose the components to ensure the desired performance level can be maintained over the expected system lifetime.

Link power budget-



The optical power received at photo detector depends on amount of light coupled into fiber & losses occurring in the fiber & connectors & splices. The link power loss budget is derived from the sequential loss contributions of each element in the link, each of these losses are expressed in dB as

$$\text{loss} = 10 \log \frac{P_{out}}{P_{in}}$$

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In addition to link loss contributions, a link power margin is normally provided in the analysis to allow for component aging, temp. fluctuations & losses arising from components that might be added in future, which is usually 3 to 6 dB.

The link loss budget simply considers the total optical power loss P_T that is allowed betn light source (P_S) & photodetector (P_R)

$$P_T = P_S - P_R$$

$$= 2l_c + \alpha L + \text{system margin}.$$

2) What are the key requirements of point to point link in FOC? Explain link design w.r.t. choose of components & its characteristics.

=

Key requirements of point to point link in FOC-

I. The desired (or possible) transmission distance.

II. The data rate or channel bandwidth.

III. The bit error rate (BER)

To fulfil these requirements, the designer has a choice of the following components & their associated characteristics -

1. Multimode or singlemode optical fiber-

a) Core size

b) Core ~~reflectance~~ refractive-index profile

c) Bandwidth or dispersion

d) Attenuation

e) Numerical aperture or ~~multi~~mode field diameter.

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II. LED or laser optical source-
a) Emission wavelength.
b) Spectral line width.
c) O/P power.
d) Effective radiating area.
e) Emission pattern.
f) No. of emitting modes.

III. Pin or avalanche photodiode-
a) Responsivity.
b) Operating wavelength.
c) speed.
d) sensitivity.

3) Explain Rise time Budget in OFC systems.
=

Rise time budget analysis determines the dispersion limitation of an optical fiber link.
Rise time determine the overall response time & the resulting Bandwidth.
It also determines the total rise time of the system.

$$\text{Total rise time} = t_{sys} = \left(\sum_{i=1}^{N} t_{ri}^2 \right)^{1/2}$$

$$t_{sys} = \sqrt{t_{r1}^2 + t_{r2}^2 + t_{r3}^2 + \ldots}$$

Four basic elements that contributes to the rise time.
i) Transmitter rise-time (t_{tx})
ii) Group velocity dispersion rise-time (t_{GVD})
iii) Modal dispersion rise time of fiber (t_{mod})
iv) Receiver rise time. (t_{rx})

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Modal dispersion rise time (t_{mod})

$$t_{mod} = \frac{440}{B_M} = \frac{440 \times L \times q}{B_0}$$

where, B_M = Bandwidth
L = length of fiber
q = parameter ranging 0.5 & 1
B_0 = BW of 1km length fiber.

Group velocity dispersion rise time of fiber (t_{GVD})

$$t_{GVD} = D \times \sigma_\lambda \times L$$

where, D = dispersion
L = length of fiber
σ_λ = half power spectral width of source.

Receiver Rise time

$$t_{rx} = \frac{350}{B_{rx}}$$

where, B_{rx} = 3-dB electrical BW of receiver.

The system Bandwidth is given by,

$$BW = \frac{0.35}{t_{sys}}$$

BW = bit rate ..... for RZ format.

Maximum bit rate-

For RZ Format → $B_T = \frac{0.35}{t_{sys}}$

For NRZ Format → $B_T = \frac{0.7}{t_{sys}}$

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Power Budget Problems.

1) Components are chosen for a digital optical fiber link of overall length 7km, 20 Mbps data rate & RZ code. An LED emitting at 0.85 μm is capable of launching an average of 100 μW of optical power. (Including connector losses.)
A graded index fiber of 50 μm core diameter is chosen. The fiber has attenuation of 2.6 dB/km. & requires splicing every km with loss of 0.5 dB/splice. There is also a connector loss of 1.5 dB. Receiver requires mean incident optical power of −41 dBm for necessary BER of 10^{-10}, safety margin of 6 dB will be required. Write down the optical power budget for the system & hence determine its viability.

=

Given data,

I. Fiber length = 7 km.

II. Fiber attenuation = 2.6 dB/km.

$\therefore$ Total attenuation = $7 \times 2.6 = 18.2$ dB

III. 6 splices as length is 7 km & splice at every km.

$\therefore$ 6×0.5 (loss per splice) = 3 dB.

IV. Connector loss at receiver = 1.5 dB.

V. Receiver mean optical power = −41dB.

VI. Safety margin = 6dB.

VII. Source power = 0.1 mW.

Source power in dB (P_S) = $10 \log [0.1m] = -10$ dBm

Total allowed power loss in system

$$P_T = P_S - P_R$$

$$= -10 - (-41)$$

$$\boxed{P_T = 31 \text{ dB}} \quad \dots\dots (1)$$

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Total atual power loss in the system.

P_T = Attenuation loss + Splices loss + Connector loss + Margin.

$P_T = 18.2 + 3 + 1.5 + 6.$

$\boxed{P_T = 28.7 \text{ dB}}$ ------- (2)

∴ From (1) & (2)

The allowable loss is 31 dB & actual loss is 28.7 dB. Hence this budget is viable with 7 km link.

Power budget in tabular form.

Components parameters	Output /Sensitivity/ loss	Power margined (dB)
LED o/p	−10 dB	
Receiver Sensitivity	−41 dBm	
Allowed loss = −10−(−41)		31 dB
Fiber attenuation	2.6 × 7 = 18.2 dB	31 − 18.2 = 12.8 dB
Splices loss	0.5 × 6 = 3 dB	12.8 − 3 = 9.8 dB
Connector loss at receiver	1.5 dB	9.8 − 1.5 = 8.3 dB
Safety margin	6 dB	8.3 − 6 = 2.3 dB
		Extra margin = 2.3 dB

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2) The following parameters are established for a long-haul single mode optical fiber system operating at a wavelength of 1.3 μm.
Mean power launched from the laser transmitter is −3 dBm.
Cable Fiber loss = 0.4 dB/km.
Splice loss = 0.1 dB/km.
Connector losses at the transmitter & receiver = 1 dB each.
Mean power required at the APD receiver when operating at 35 Mbit/s ($BER = 10^{-9}$) = −55 dBm.
Required safety margin = 7 dB.
Estimate max. possible link length without repeaters when operating at 35 Mbit/s ($BER = 10^{-9}$). It may be assumed that there is no dispersion-equalization penalty at ~~receiver~~ this bit rate.

= Given data,

Optical power source = −3 dBm
Cable Fiber loss = 0.4 dB/km
Splice loss = 0.1 dB/km.
Connector loss = 2 dB (at source & receiver)
Mean receiver power = −55 dBm
Required safety margin = 7 dB.

∴ Total allowed loss in the system (P_T) $= P_S - P_R$

$$= -3 - (-55)$$

$$= 52 \text{ dB}.$$

Total actual loss in the system

$$= (0.4)L + (0.1)L + 2 + 7$$

$$= (0.5)L + 9$$

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∴ Allowed loss > Actual loss for viable system.

$\therefore 0.5L + 9' < 52$

$L < 86$ km.

∴ Maximum possible length for system viability is 86 km.

3) A 1550 nm single mode digital fiber optic link needs to operate at 622 Mb/s over 80 km without amplifiers. A single mode laser launches an average optical power of 13 dBm into the fiber. The fiber has a loss of 0.35 dB/km & there is a splice with a loss of 0.1dB every km. The coupling loss at the receiver is 0.5 dB & the receiver uses an InGaAs APD with sensitivity of −39 dBm. Excess noise penalties are predicted to be 1.5 dB. Set up an optical power budget for this link & find the safety margin. What is the system margin at 2.5 GB/s with an APD sensitivity of −31 dBm?

= Given,

Optical power source = 13 dBm.

Fiber length = 80 km

Fiber loss = 0.35 dB/km

splice loss = 0.1 dB/km.

coupling loss = 0.5 dB.

Receiver sensitity = −39 dBm.

excess noise loss = 1.5 dB.

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$\therefore$ Total allowable power loss $(P_T) = P_S - P_R$

$= 13 - (-39)$

$= 52\,dB$

Total actual loss $= (0.35) \times 80 + (0.1) \times 80 + 0.5 + 1.5 +$ Safety margin

$=$ 38 + Safety margin.

$\therefore$ Total allowed loss = Total actual loss

$\therefore$ 38 + Safety margin = 52

$\boxed{\therefore \text{Safety margin} = 14\ dB}$

ii) in case 2, Receiver sensitivity $= -31\,dBm$

$\therefore$ Total allowed loss $= P_S - P_R$

$= 13 - (-31)$

$= 44\,dB$

$\therefore$ 38 + Safety margin = 44

$\boxed{\therefore \text{Safety margin} = 6\ dB.}$

4) A student wishes to establish a 10 km optical fiber link that utilizes a fiber with a loss of 1.5 dB/km. The fiber is available in short pieces of 1 km each. The connectors available in the laboratory have loss of 0.6dB

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each. Determine the minimum optical power which must be launched into the fiber so as to maintain mean optical power of 300 mW at the detector.

= Fiber length = 10 km.

Fiber loss = 1.5 dB/km = 15 dB.

11 connectors with 0.6 dB loss.

$\therefore$ connector loss = $0.6 \times 11 = 6.6$ dB.

Receiver power = 300 mW

i.e. $10 \log (300 m) = -5.22878$ dBm.

$\therefore$ Allowed loss = $P_S - P_R$

$= P_S - (-5.22878)$

$= P_S + 5.22878$

Actual loss = $(1.5 \times 10) + 6.6$

$= 15 + 6.6$

$= 21.6$ dB.

$\therefore$ Actual loss = Allowed loss.

$21.6 = P_S + 5.22878$

$$\boxed{P_S = 16.37122 \text{ dBm}}$$

$\therefore$ Minimum optical power required is 16.37122 dBm

5) Components chosen for a digital optical fiber link of overall length 10 km & operating at 20 Mbps using a RZ code are given below:

i) LED capable of launching an average power of 0.1 mW at 0.85 μm (including conductor loss into a 50 μm core diameter graded index fiber).

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ii) Fiber attenuation : 2.5 dB/km &

iii) Requires splitting every 2 km with a loss of 0.3 dB per splice. There is also a connector loss at the receiver of 1.5 dB.

iv) The receiver ~~power~~ requires mean incident optical power of −46 dBm in order to give the necessary BER of 10^{-10}.

v) Predicted safety margin of 6 dB.

Write down the optical fiber budget for the system & hence determine its viability.

= Given data,

1. Fiber length = 10 km.

II. Fiber attenuation = 2.5 dB/km.

$\therefore$ Total attenuation = $2.5 \times 10 = 25$ dB.

III. 4 splices as length is 10 km & splice at every 2 km.

$\therefore$ $4 \times 0.3 = 1.2$ dB = loss due to splices

IV. Connector loss at receiver = 1.5 dB.

V. Receiver mean optical power = −46 dBm.

VI. Safety margin = 6 dBm.

VII. Source power = 0.1 mW.

$P_S = 10 \log (0.1m) = -10$ dBm.

Total allowed loss in the system

$P_T = P_S - P_R$

$P_T = -10 - (-46)$

$P_T = 36$ dB

Total actual loss in system:

$P_T = 25 + 1.2 + 1.5 + 6$

$P_T = 33.7$ dB.

The allowable loss in the system is 36 dB & actual loss is 33.7 dB, hence this budget is viable with 10 km link.

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Power budget in tabulated form.

Component parameter	O/P / Sensitivity loss	Power margined (dB)
LED O/P	-10 dBm	
Receiver sensitivity	-46 dBm	
Allowed loss = -10-(-46)		36 dB
Fiber attenuation	2.5 x 10 = 25 dB	36-25 = 11 dB
Splice loss	0.3 x 4 = 1.2 dB	11-1.2 dB = 9.8 dB
Connector loss	1.5 dB	9.8-1.5 = 8.3 dB
Safety margin	6 dB	8.3-6 = 2.3 dB
		Extra margin = 2.3 dB

6) Given data,

I. Fiber length = 6 km.

II. Fiber attenuation = 3 dB/km

∴ Total attenuation = 6 x 3 = 18 dB.

III. 5 splices as length is 6 km & splice at every km.

∴ 5x 0.5 = 2.5 dB

IV. Connector loss at receiver = 1.5 dB.

V. Receiver mean optical power = -4[illegible] dBm

VI. Safety margin = 6 dB.

VII. P_S = -10 dBm

∴ Total allowed Power loss in the system = $P_S - P_R$

$P_T = -10-(-45) = 3[illegible]$ dB

Total actual Power loss in the system

$P_T = 18 + 2.5 + 1.5 + 6 = 28\ dB$

Allowable loss in the system is 31 dB & actual power loss is 28 dB. Hence the system is viable.

Power budget in tabular form.

component parameter	o/p / sensitivity loss	Power Margined (dB)
LED o/p	−10 dBm	
Receiver sensitivity	−45 dBm	
Allowed loss = −10 −(−45)		~~35 dB~~ 31dB
Fiber attenuation	3×6 = 18dB	31−18 = 13dB
Splice loss	0.5×5 = 2.5 dB	13−2.5 = 10.5 dB
connector loss	1.5 dB	10.5−1.5 = 9 dB
safety margin	6 dB	9−6 = 3 dB
		Extra margin = 3dB.

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7) Given,

Optical power source = 13dBm

Fiber length = 90 km

Fiber loss = 0.35 dB/km

Splice loss = 0.1 dB/km

Coupling loss = 0.5 dB

Receiver sensitivity = −39 dBm

excess noise loss = 1.5 dB

∴ Total allowable power loss = $P_S - P_R$

$= 13 - (-39)$

$= 52$ dB.

Total actual loss = $(0.35 \times 90) + (0.1 \times 90) + 0.5 + 1.5$ + safety margin.

= 42.5 + safety margin

∴ safety margin = 52 − 42.5

safety margin = 9.5 dB.

8)

i) Given,

Source power (P_s) = 0 dBm

Receiver sensitivity = −50 dBm

Fiber attenuation = 3.5 dB/km

Connector loss = 1 dB / connector

Safety margin = 6 dB

∴ allowed power loss = $P_S - P_R$

$= 0 - (-50)$

$= 50$ dB

Actual power loss = $(3.5 \times L) + (1 \times 2) + 6$

$= 3.5L + 8$

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$\therefore \quad 3.5L + 8 = 50$

$3.5L = 42$

$$\boxed{L = 12 \text{ km}}$$

ii) Source power (P_s) = 13 dBm

Receiver sensitivity (P_R) = −38 dBm.

Fiber loss = 1.5 dB/km

connector loss = 1 dB/connector

Safety margin = 6 dB

$\therefore$ Total allowable loss $= P_S - P_R$

$= 13 - (-38)$

$= 51$ dB

Total actual loss $= (1.5 \times L) + (1 \times 2) + 6$

$= 1.5L + 8$

$\therefore \quad 1.5L + 8 = 51$

$\therefore \quad L = \dfrac{43}{1.5}$

$\therefore \quad \boxed{L = 28.667 \text{ km.}}$

$\therefore$ Maximum attenuation-limit transmission distance of the 1st system is 12 km & 2nd system is 28.667 km operating at 100 Mb/s.

Subject –BCS Class-BE E&TC

Rise Time Budget.

1) Given,

$t_{tx} = 8\,ns$

$t_{intermodal} = 8 \times 5 = 40\,nsec.$

$t_{intramodal} = 8 \times 1 = 8\,nsec.$

$t_{rx} = 6\,ns.$

System rise time

$$t_{sys} = [t_{tx}^2 + t_{intermodal}^2 + t_{intramodal}^2 + t_{rx}^2]^{1/2}$$

$$t_{sys} = [8^2 + 40^2 + 8^2 + 6^2]^{1/2}$$

$$\boxed{t_{sys} = 42\,nsec}$$

Max. Bit rate for NRZ format.

$$B_T = \frac{0.7}{t_{sys}} = \frac{0.7}{42 \times 10^{-9}} = 16.6\,Mbps.$$

$$\boxed{B_T = 16.6\,Mbps}$$

2) Given,

$t_{tx} = 10\,ns$

$t_{intermodal} = 9 \times 5 = 45\,ns$

$t_{intramodal} = 2 \times 5 = 10\,ns$

$t_{rx} = 3\,ns$

System Bandwidth (BW) = $\frac{0.35}{t_{sys}}$

$\therefore$ System rise time = $t_{sys} = [t_{tx}^2 + t_{intermodal}^2 + t_{intramodal}^2 + t_{rx}^2]^{1/2}$

$$t_{sys} = [10^2 + 45^2 + 10^2 + 3^2]^{1/2}$$

$$\boxed{t_{sys} = 47.26521 \text{ ns}}$$

$$\therefore BW = \frac{0.35}{t_{sys}} = \frac{0.35}{47.26521 \times 10^{-9}}$$

$$\boxed{BW = 7.405 \text{ MHz}}$$

As required BW is 6 MHz which is less than the system BW, the above combn will give an adequate response.

3) Given,

$t_{tx} = 15$ ns.

$t_{mat} = 21$ ns

$t_{mod} = 3.9$ ns

$t_{rx} = 14$ ns

$\therefore$ system rise time

$$t_{sys} = [t_{tx}^2 + t_{mat}^2 + t_{mod}^2 + t_{rx}^2]^{1/2}$$

$$t_{sys} = [15^2 + 21^2 + 3.9^2 + 14^2]^{1/2}$$

$$\boxed{t_{sys} = 29.61 \text{ ns.}}$$

Subject –BCS Class-BE E&TC

ROLLNO. 42428
EXPERIMENTNO.: 06
TITLE:Establishing a direct communication link between Uplink Transmitter and Downlink Receiver using tone signal. *To transmit and receive function generator waveforms through satellite link.
DATE OF PERFORMANCE:- 11/05/2021
DATE OF CHECKING:- 18/05/2021

OBJECTIVE:1.To establishes a direct communication link between Uplink Transmitter and Down-link Receiver using tone signal.

2. To transmit and receive function generator waveforms through satellitelink.

APPARATUS:Sigma make Satellite communication trainer kit,DSO,function generator,speaker etc.

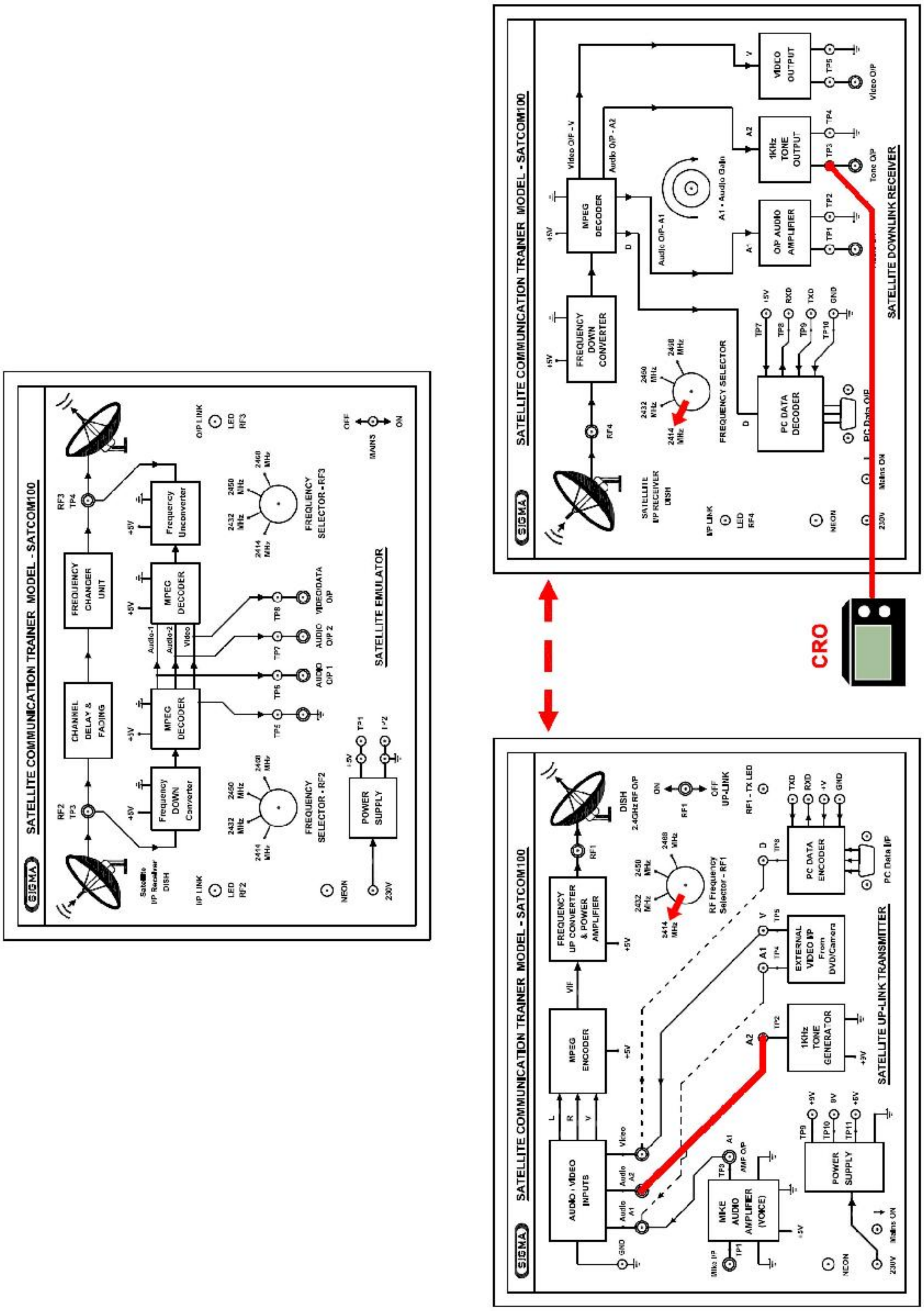
PROCEDURE:**a.Establish direct communication link**

1. Connect links in Satellite Uplink transmitter and down link Receiver as shown in Connection diagram below.
2. Connect both to AC Mains and make it ON.
3. KeepTransmitter and Receiver at 2 to 4meter distance.
4. The transmitting frequency can be selected by rotary switch. The frequency can be set to any one of 2414,2432,2450,2468 MHz.
5. Keep switch position as shown in diagram below.
6. Connect CRO at 1KHz output at downlink receiver.
7. Observe1KHz sinewave.
8. Also connect speaker at 1KHz Tone out signal and hear 1KHz sound.
9. This is a test link for direct communication between transmitter and receiver.
10. Connect any other audio signal to the Audio I of Uplink transmitter and you will hear the music in the speaker of Downlink Receiver.
11. Using function generator transmits all signals and observe.

Subject –BCS

Class-BEE&TC

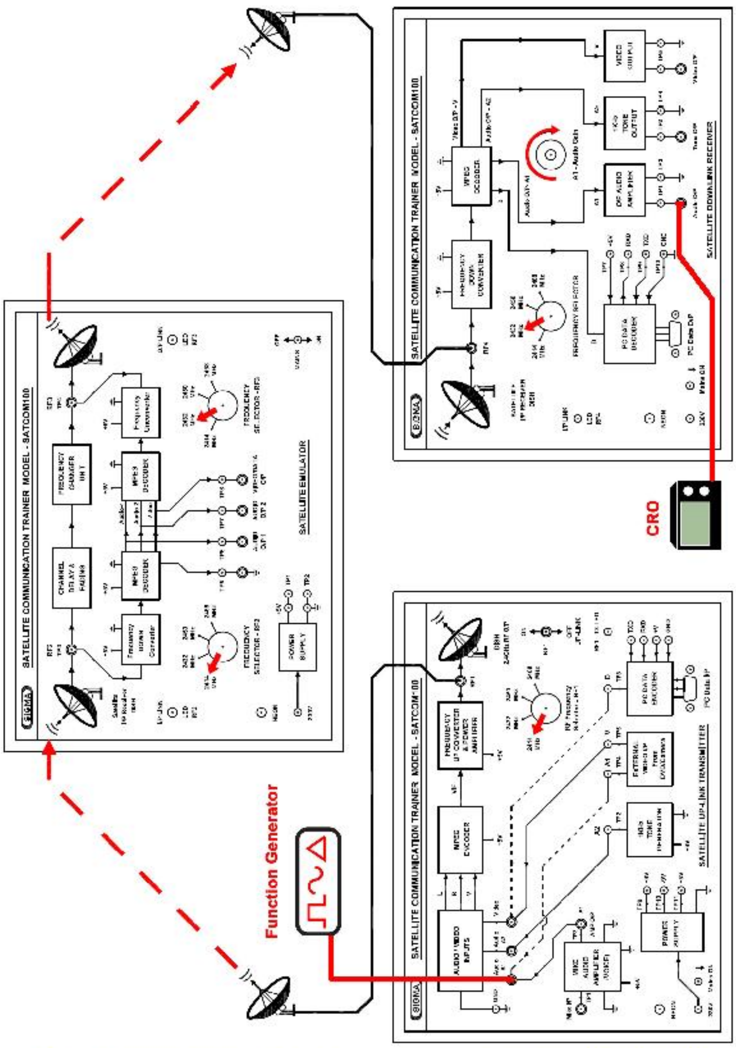
PANEL DIAGRAM:



EXP-6: To establish a direct communication link between Uplink Transmitter and Down-link Receiver using tone signal.

b.Transmit and receive function generator waveforms

1. Connect links in Satellite Uplink transmitter, Emulator and downlink Receiver as shown in Connection diagram below.
2. Connect Function generator and CRO as shown in diagram below.
3. Apply 1KHz 1Vpp Sinewave signal form Function generator and observe received waveform at receiver.
4. Now try for Square and triangle waveform also.
5. See effect of audio gain by varying gain of receiver by rotating Pot A1 at receiver.
6. Vary frequency at receiver and check that if transmitting and receiving frequencies are not matching then there is no reception.



EXP-6: To transmit and receive function generator waveforms through satellite link.

Subject –BCS Class-BEE&TC

OBERSVATIONS:

A direct communication link between Uplink Transmitter and Downlink Receiver was setup via a satellite and a tone signal was transmitted over it. Different tone signals from the function generator output were transmitted via uplink to the satellite and received via downlink from the satellite. Functioning and requirement of different blocks present was observed.

Note: Waveforms on graph papers.

CONCLUSION:

A clear music indicates that the microwave link has been successfully setup between uplink transmitter and Down-link receiver directly. We have setup a direct communication link between Uplink Transmitter and Downlink Receiver via a satellite and a tone signal was transmitted over it.

REFERENCES:

Satellite communication by Pratt
Sigma trainer kit manual.

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Subject –BCS Class-BEE&TC

ROLLNO. 42428
EXPERIMENTNO.: 07
TITLE:To set up an Active Satellite link and demonstrate Link Fail Operation.
DATE OF PERFORMANCE:- 11/05/2021
DATE OF CHECKING:- 18/05/2021

OBJECTIVE:

To establish a Satellite link between Uplink Transmitter and Down-link Receiver using Satellite Emulator and then showsatelliteLinkFail operation.

APPARATUS:

Sigma makes Satellite communication trainer kit,Speaker etc.

THEORY:

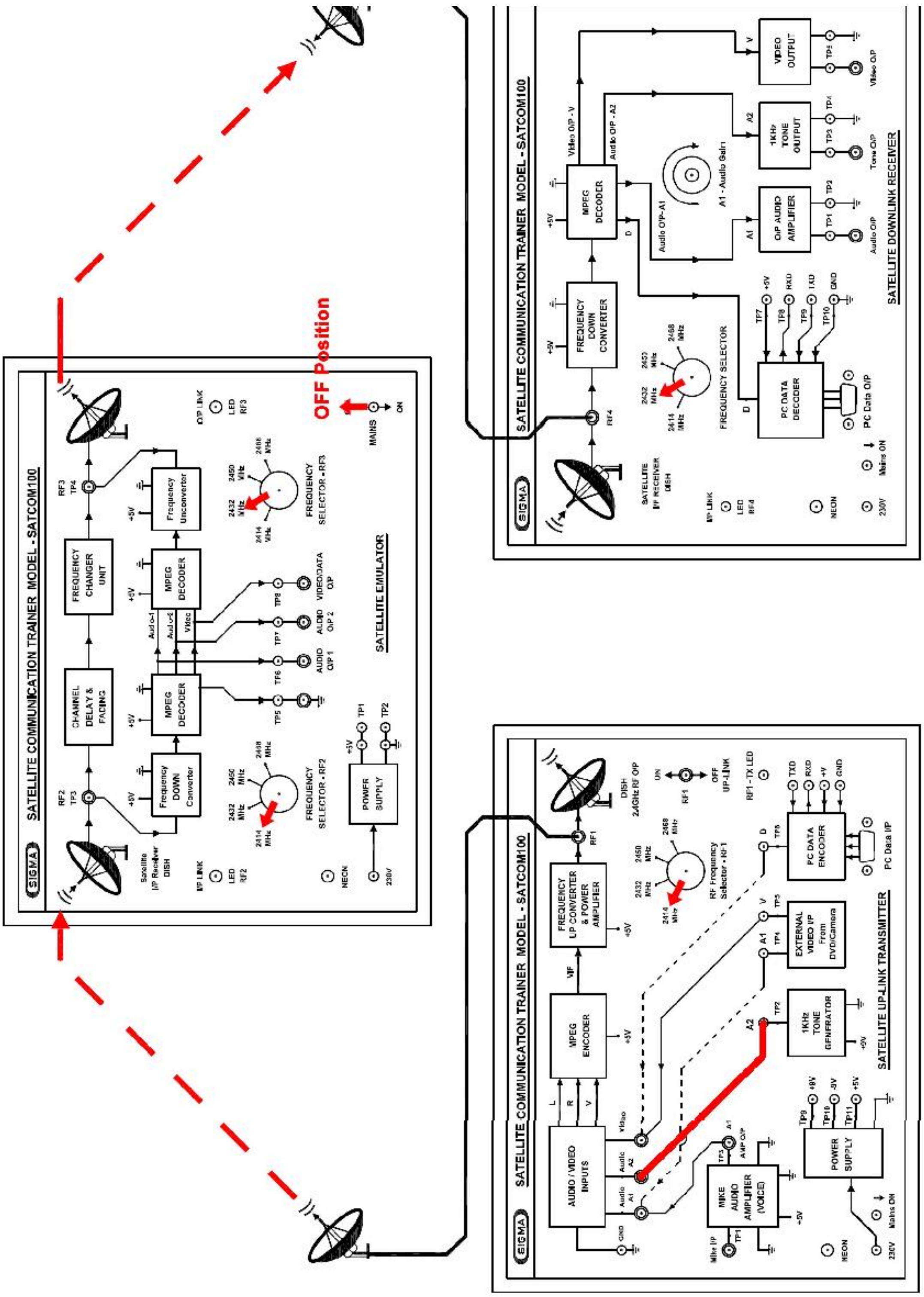
The Uplink Transmitter sends signals at an Uplink frequency,which is higher than down link frequency to avoid the interference.The quality of signal is much improved with active satellite specially when distances between transmitter and receiver is considerable.

PROCEDURE:

1. Connect links in Satellite Uplink transmitter, Emulatorand downlink Receiver as shown in Connection diagram below.
2. Connect all to AC Mains and make it ON.
3. KeepTransmitter and Receiver at 2 to 4 meter distance.
4. The transmitting frequency can be selected by rotary switch. The frequency can be set to any one of 2414,2432,2450,2468 MHz
5. Keep switch position as shown in diagram below.
6. Connect CRO at 1KHz outputat downlink receiver.
7. Observer 1KHz sinewave.
8. This is a testlink for Active Satellite communication.
9. Now set toggle switch at Emulator to OFF position.Then 1 KHz output at receiver will stop. This shows satellite link fail operation.

Subject –BCS Class-BEE&TC

PANEL DIAGRAM:



EXP-7: To setup an Active satellite link and demonstrate Link Fail operations.

OBERSVATIONS:

We saw that once the link failed that is, we turned the transmitter section on satellite to off we were not able to receive anything on the earth station receiver.

CONCLUSION:

The above setup shows that a successful satellite communication link has been setup between Transmitter and Receiver. We observed and studied the link failure operation of a satellite link.

REFERENCES:

Satellite communication by
Pratt.Sigma trainer kit manual.

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Subject –BCS Class-BEE&TC

ROLLNO. 42428
EXPERIMENTNO.: 08
TITLE:To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver.
DATE OF PERFORMANCE:- 25/05/21
DATE OF CHECKING:- 25/05/21

OBJECTIVE:

To establish an AUDIO-VIDEO satellitelink between Transmitter and Receiver

APPARATUS:

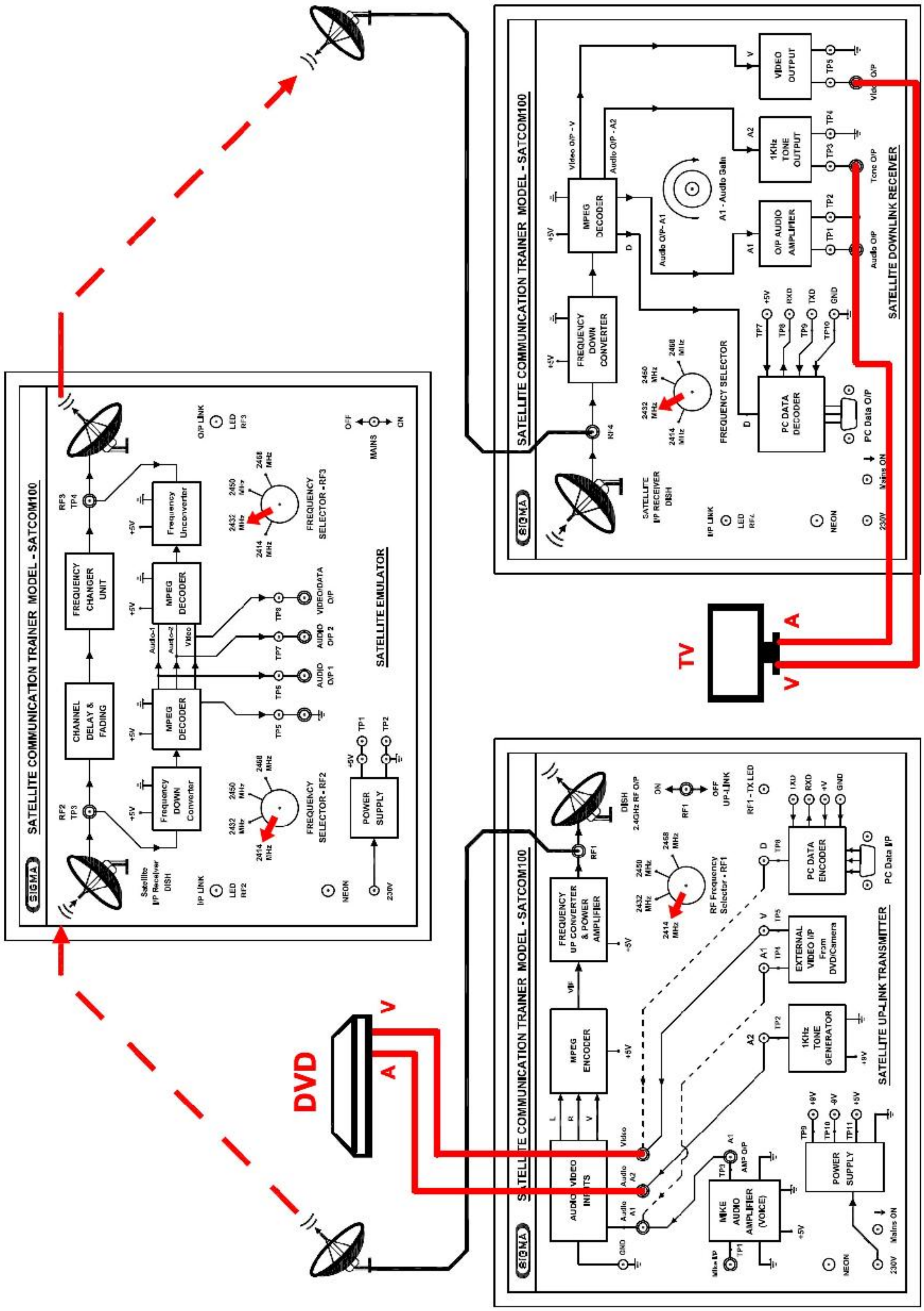
Sigma makes Satellite communication trainer kit,Speaker,DVDplayer,TVetc.

PROCEDURE:

1. Connect links in Satellite Uplink transmitter, Emulator and downlink Receiver as shown in Connection diagram below.
2. Connect all to AC Mains and make it ON.
3. Keep Transmitter and Receiver at 2 to 4 meter distance.
4. The transmitting frequency can be selected by rotary switch. The frequency can be set to any one of 2414,2432,2450,2468 MHz
5. Keep switch position as shown in diagram below.
6. Connect links in Satellite Uplink transmitter, Emulator and downlink Receiver as shown in Connection diagram below.
7. Connect DVD Player and TV as shown in diagram.
8. Play any DVD and observer movie on TV.
9. Vary frequency at receiver and check that if transmitting and receiving frequencies are not matching then there is no reception.

Subject –BCS Class-BEE&TC

PANEL DIAGRAM:



EXP-8: To establish an AUDIO-VIDEO satellite link between Transmitter and Receiver

OBERSVATIONS:

We observed the video signal on the receiver side being displayed on a TV screen and audio being played on the speakers. Thus, a successful satellite communication link was established.

CONCLUSION:

The above setup shows that a successful satellite communication link has been setup between Transmitter and Receiver. We studied that we can simultaneously transmit audio and video signals over the satellite link.

REFERENCES:

Satellite communication by
Pratt.Sigma trainer kit manual.

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Subject –BCS Class-BEE&TC

ROLLNO. 42428
EXPERIMENTNO.: 9
TITLE: To transmit and receive three separate signals(Audio, Video, and Tone)simultaneously through satellite link.
DATE OF PERFORMANCE:- 25/05/2021
DATE OF CHECKING:- 25/05/2021

OBJECTIVE:

To transmit and receive three separate signals(Audio,Video,and Tone) simultaneously through satellite link.

APPARATUS:

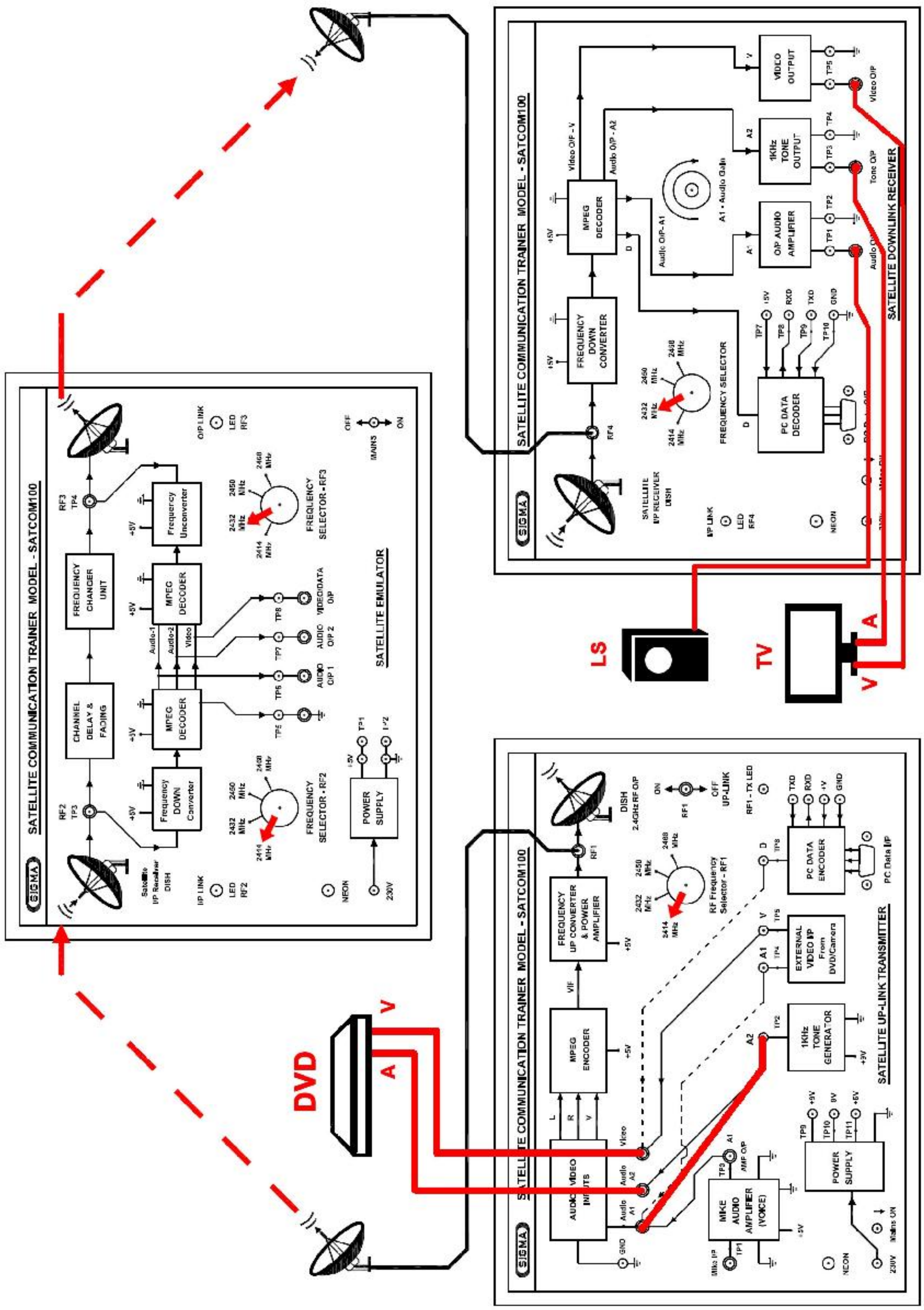
Sigma makes Satellite communication trainer kit,Loud Speaker,DVD Player and TV etc.

PROCEDURE:

1. Connect links in Satellite Uplink transmitter, Emulatorand downlink Receiver as shown in Connection diagram below.
2. Connect all to AC Mains and make it ON.
3. Keep Transmitter and Receiver at 2 to 4 meter distance.
4. The transmitting frequency can be selected by rotary switch. The frequency can be set to any one of 2414,2432,2450,2468 MHz
5. Keep switch position as shown in diagram below.
6. Connect links in Satellite Uplink transmitter, Emulator and downlink Receiver as shown in Connection diagram below.
7. Connect Mike,Loud Speaker,DVD Player and TV as shown in diagram below.
8. Play any DVD and observer movie on TV.
9. Speak to mike and here received voice in loud speaker at receiver. See effect of audio gain by varying gain of receiver by rotating Pot A1 at receiver.
10. Vary frequency at receiver and check that if transmitting and receiving frequencies are not matching then there is no reception.

Subject –BCS Class-BEE&TC

PANEL DIAGRAM:



EXP-10 To transmit and receive three separate signals (Audio, Video, Tone) simultaneously through satellite link.

OBERSVATIONS:

We observed the tone signal on DSO, video signal displayed onto a TV screen and audio signal being played on a loudspeaker. Thus, we could observe simultaneous transmission of three signals over our satellite communication link.

CONCLUSION:

Three separate signals (Audio, Video, Tone) are successfully received at downlink receiver through satellite communication link.

REFERENCES:

Satellite communication by
Pratt.Sigma trainer kit manual.

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