

**PAAVAI ENGINEERING COLLEGE**

**Paavai Nagar, NH-7, Pachal, Namakkal-637018.**

**DEPARTMENT OF ELECTRONICS**

**AND**

**COMMUNICATION ENGINEERING**

**Optical & Microwave Lab**

**Sub. Code: EC 2405**

**7th Semester ECE**

KLYSTRON POWER SUPPLY

REFLEX KLYSTRON

ISOLATOR

FFREQUENCY METER

DETECTOR MOUNT

V.S.W.R METER

C.R.O

MICROWAVE BENCH SEUP FOR STUDY OF KLYSTRON MODES

**REFLEX KLYSTRON CHARACTERISTICS**

**AIM:**

To study mode characteristics of reflex klystron and hence to determine mode number, transit time, electronic tuning range (ETR) and electronic tuning sensitivity (ETS).

**EXPERIMENTAL REQUIRED:**

Klystron tube, Klystron power supply, Isolator, Frequency meter, Variable attenuator, Detector mount, VSWR meter, C.R.O.

**PROCEDURE:**

Mode studies

1. Connect the components and equipment as per the circuit diagram.

2. Keep the control knob of klystron power supply as below:

Mode switch : CW

Beam voltage knob : Fully anti-clockwise

Repeller voltage knob : Fully clockwise

Meter switch : Cathode voltage position

3. Rotate the frequency meter at one side.

4. Switch on the klystron power supply, VSWR meter and cooling fan for the klystron tube. Wait for 1-2 minutes for the klystron to respond.

5. Cathode voltage knob at minimum position gives a beam voltage of 235V.Observe beam current on the meter by changing meter switch to beam current position. ”The beam current should not be more than 30mA”.

6. Now change the meter switch to repeller voltage position.

7. Select proper range for the power meter so that power output of maximum mode will not exceed the meter range.

8. Decreasing the reflector voltage, record output power.

9. To measure frequency, switch the Mode-switch of klystron to AM mode and observe output on CRO display. By matching the detector with tuning posts adjust for maximum output. Use AM amplitude, frequency controls and controls on Oscilloscope front panel try to get clear display on CRO. By rotating the frequency meter, observe for dip in the output and note the corresponding frequency.

10. Plot power/relative frequency versus repeller voltage to get mode characteristics.

11. Compute various parameters from the graph.

**OBSERVATIONS:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No**. | **Repeller voltage(v)** | **Power output(mW)** | **Wave meter reading frequency(GHz)** |
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**MODEL GRAPH:**

KLYSTRON POWER SUPPLY

KLYSRON MOUNT + KLYSTRON 2K25/723A/B

ISOLATOR

VARIABLE ATTENUATOR

FREQUENCY METER

SLOTTED LINE

TUNABLE PROBE

V.S.W.R METER

DETECTOR MOUNT

SETUP FOR FREQUENCY MEASURI\EMENT

**FREQUENCY MEASUREMENTS**

**AIM:**

To examine the frequency characteristics of klystrons and also to become familiar with typical microwave frequency measurements, in additions, to study 1000cps amplitude modulation of klystrons.

**EQUIPMENTS/INSTRUMENTS:**

Klystron power supply, klystron tube 2k25, klystron mount, isolator, frequency meter, variable attenuator, detector mount, wave guide stands, VSWR meter, BNC cable Etc.

**PROCEDURE:**

Setup the components and equipments as shown in diagram.

Set up variable attenuator at minimum attenuation position

Keep control knobs of vswr meter as given below:-

Range -50db

Input switch-crystal low impedance

Meter switch- normal position

Gain(coarse & fine)-mid position

Keep control knobs of klystron power supply as given below:-

Beam voltage-OFF

Mod-switch-Am

Beam voltage switch-full anti clockwise

Reflector voltage-full clockwise

Am amplitude knob-full clockwise

Am frequency knob- mid position

Switch on the klystron power supply, vswr meter and colling fan switch.

**OBSERVATIONS:**

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| --- | --- | --- | --- |
| **S.NO** | **REPELLER VOLTAGE** | **FREQUENCY METER READING(GHZ)** | **FREQUENCY** |
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Switch on the beam voltage switch and set the beam voltage at 300v withbeamvoltage knob.

Set the reflector voltage knob to get deflection in vswr meter

Maximize the deflection with AM amplitude and frequency control knob of Supply.

Tune the plunger of mount for maximum deflection

Tune the reflector voltage knob for maximum deflection

Tune the probe for maximum deflection in vswr meter.

Tune the frequency meter to get a ‘dip’ on the vswr meter and note the frequency from frequency meter.

Replace the termination & movable short and de tune the frequency meter

Move the probe along with the slotted section. The deflection in vswr meter willvary. Move the probe to a minimum deflection position to get accurate reading if necessary the vswr range db to higher position. Note the probe position move thenext minimum position and note again.

Calculate the waveguide wavelength as twice the distance between two minimumposition.

Measure the waveguide inner broad dimension ‘a’ which will be around 22.85 to22.86 mm for x band.

Calculate with frequency , F=C/λ, where C =velocity of light

Verify with frequency obtained by frequency meter

Where, C=3×108 meter per second

=3×1010 meter per second.

KLYSTRON POWER SUPPLY

KLYSTRON MOUNT

ISOLATOR

VARIABLE ATTENUATOR

SLOTTED LINE

UNKNOWN LOAD

SHORT

V.S.W.R METER

TUNABLE PROBE

**MEASUREMENT OF UNKNOWN LOAD IMPEDANCE**

**AIM:**

To determine impedance of unknown load by measuring VSWR and the position of field minimum.

**EQUIPMENT:**

Klystron power supply, Reflex klystron, klystron mount, Isolator frequency meter, Attenuator Slotted section, Tunable probe, Detector, VSWR meter, Short, Unknown load.

**PROCEDURE:**

1. Set the components and equipments as per the connections.

2. Initially set the variable for maximum attenuation.

3. Terminate the receiving end with unknown load.

4. Keep the control knob of klystron power supply.

Beam voltage - Off

Mode switch - Am

Beam voltage knob - Full anti clockwise

Reflector voltage knob - Full clockwise

Am-amplitude knob - Full clockwise

Am frequency & amplitude knob - Mid position

Switch On the klystron power supply, VSWR meter &cooling fan

Switch On the beam voltage switch and set beam voltage at 300v

Rotate the reflector voltage knob to get deflection in vswr meter

Tune the output by tuning the reflector voltage, amplitude and frequency of am modulation

Tune plunger of klystron mount and probe for maximum deflection in vswr meter

5. Keep the control knob of VSWR meter as below:

i. Switch : normal

ii. Input switch : Low impedance

iii. Range db switch : 40db

iv. Gain control knob : Full clockwise

6. Connect detector output to SWR meter.

**OBSERVATIONS:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Frequency of excited wave** | **Load VSWR** | **Position of minimum** | **Shift in minima <λ/4** | **Direction of shift towards load/generator** |
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7. Adjust the square wave modulation frequency to approximately 1 KHz.

8. Tune the detector by adjusting short plunger for maximum meter deflection.

9. Move the probe along slotted line, adjust it at standing wave minimum. Record the probe position as X1(this is the position of reference minimum)and next successive minimum position as X2.

10. Replace load by short circuit termination and move the probe carriage to new standing wave minimum and record the probe position as Xs(This is known as position of reference plane).

11. Find the shift minima (Xs-X2 or Xs-X1). It will be positive if minimum is shifted towards load(i.e, for inductive load) and negative if minimum is shifted towards generator (for capacitive load). Shift in minimum for different load can be easily known from the standing wave patterns given below.

12. Convert the shift in wavelength units, i.e., (Xs-X1)/l. Wavelengths.

13. Position on minimum can be known more accurately if it is taken as midpoint of positions of equal responses on either side of minimum.

KLYSTRON POWER SUPPLY

KLYSRON MOUNT + KLYSTRON 2K25/723A/B

ISOLATOR

VARIABLE ATTENUATOR

FREQUENCY METER

SLOTTED LINE

PROBE

V.S.W.R METER

MATCHED TERMINATION

SETUP FOR MEASURING LOW, MEDIUM AND HIGH VSWR

**MEASURING VSWR**

**AIM:**

To become familiar with the basic technique for Measuring voltage standing wave ratio.

**EQUIPMENTS/INSTRUMENTS:**

Klystron power supply, klystron mount, klystron tube, Isolator, frequency meter, variable attenuator, slotted section, tunable probe, wave guide stands, movable short load, BNC cable, VSWR meter.

**PROCEDURE:**

Set the equipments as shown

Keep variable attenuator in the minimum attenuation position

Keep the control knob of vswr meter as below

Range db - 40db to 50 db

Input switch - low impedance

Meter switch - normal

Gain - mid position

Keep the control knob of klystron power supply

Beam voltage - off

Mod-switch - Am

Beam voltage knob - full anti clockwise

Reflector voltage knob - full clockwise

Am-amplitude knob - full clockwise

Am frequency & amplitude knob- mid position

Switch on the klystron power supply, vswr meter and cooling fan

Switch on the beam voltage switch and set the beam voltage at 300v

Rotate the reflector voltage knob to get deflection in vswr meter

Tune the output by tuning the reflector voltage, amplitude and frequency of AM modulation.

Tune plunger of klystron mount and probe for maximum deflection in vswr meter

If required change the db switch variable attenuator and gain control knob to get deflection in the scale of vswr meter

As we move probe along the slotted line, the deflection will change.

1. Measurement of low and medium VSWR

Move the probe along the slotted line to get maximum deflection in vswr meter.

Adjust the vswr meter gain control knob or variable attenuator until the meter indicates 1.0 on normal vswr scale.

Keep all the control knobs as it is, move the probe to next minimum position. Read the vswr scale.

Repeat the above step for change of SS tuner probe depth and record the corresponding SWR

If the vswr is between 3.2 and 10, change the range db to next higher position and read the vswr on second vswr scale of 3 to 10.

(2)Measurement of high VSWR

Set the depth of SS tuner slightly more for maximum vswr

Move the probe along with slotted line until a minimum is indicated.

Adjust the vswr gain control knob and variable attenuator to obtain a reading of 3db in the normal db scale (0-10 db) of vswr meter.

Move the probe to the left on slotted line until full scale deflection is obtained on 0-10 db scale. Note and record the probe position on slotted line let it be d1.

Repeat the step3 and then move the probe right along the slotted line until full scale deflection is obtained on 0-10 db normal db let it be d2.

Replace the SS tuner and termination by movable short.

Measure the distance between two successive minima positions of the probe > twice this distance is guide wave length.

Compute VSWR from the following equation.

VSWR= (d1-d2)λg/π (or) (Δx) λg/π

Where λg is the wavelength,d1 and d2 are locatimes of double minimum points.

KLYSTRON POWER SUPPLY

KLYSRON MOUNT + KLYSTRON 2K25/723A/B

ISOLATOR

VARIABLE ATTENUATOR

FREQUENCY METER

SLOTTED LINE

V.S.W.R METER

DETECTOR MOUNT

SET UP FOR ATTENUATOR CHARACTERISTICS

**ATTENUATOR CHARACTERISTICS**

**AIM:**

To study the attenuation characteristics of a variable attenuator

**EQUIPMENTS/INSTRUMENTS:**

Klystron power supply, klystron tube 2k25, klystron mount, Isolator, frequency meter, variable attenuator, Detector mount, wave guide stands, VSWR meter , BNC cable.

**PROCEDURE:**

1. Set the components and equipments as shown in figure.
2. Initially set the variable attenuator for maximum attenuation
3. Terminate the receiving end with unknown load.
4. keep the control knob of klystron power supply

Beam voltage - off

Mod-switch - Am

Beam voltage knob - full anti clockwise

Reflector voltage knob - full clockwise

Am-amplitude knob - full clockwise

Am frequency & amplitude knob- mid position

Switch on the klystron power supply, vswr meter and cooling fan

Switch on the beam voltage switch and set the beam voltage at 300v

Rotate the reflector voltage knob to get deflection in vswr meter

Tune the output by tuning the reflector voltage, amplitude and frequency

of AM modulation.

Tune plunger of klystron mount and probe for maximum deflection in vswr meter

**TABULAR COLUMN**

Micrometer reading : 11.97 mm

Frequency 9.97 Ghz: 9.97 Ghz

**OBSERVATIONS:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **SCREW GAUGE READING(MM)** | **ATTENUATION IN DECIBEL** |
|  |  |  |
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|  |  |  |
|  |  |  |

1. Keep the control knob of VSWR meter as below:
   1. switch : normal
   2. input switch : low impedance
   3. range db switch : 40 db
   4. Gain control knob : fully clockwise
2. Connect the detector output to SWR meter
3. Adjust the square wave modulation frequency to approximately 1 khz
4. Tune the detector by adjusting short plunger for maximum meter deflection
5. Move the probe along slotted line, adjust it at standing wave minimum. Record the probe as X1( this is the position of reference minimum) and next successive minimum position as X2.
6. Replace load by short circuit termination move the probe carriage to new standing wave minimum and record the probe position as Xs.(This is known as reference point)
7. Find the shift minima(Xs-X2 or Xs-X1). It will be positive if minimum is shifted towards load(i.e., for inductive loads) and negative if minimum is shifted towards generator (for capacitive load). Shift in minimum for different loads can be easily known from the standing wave patterns given below.
8. Convert the shift in wavelength units, i.e.,(Xs-X1)/I. wavelengths.
9. Position on minimum can be known more accurately if it taken as midpoint of position of equal responses on either side of minimum.

GUNN POWER SUPPLY

GUNN OSCILLATOR

PIN MODULATOR

ISOLATOR

VARIABLE ATTENUATOR

SLOTTED SECTION

V.S.W.R METER

DETECTOR MOUNT

MICROWAVE BENCH SETUP FOR STUDY OF GUNN OSCILLATOR CHARACTERISTICS

**STUDY OF THE GUNN OSCILLATOR**

**AIM:**

To study the I-V characteristics of Gunn diode and depth of modulation of PIN diode

**EQUIPMENT/INSTRUMENTS:**

Klystron power supply, Gunn oscillator, PIN modulator, Isolator, frequency meter, variable attenuator, Detector mount, VSWR meter.

**PROCEDURE:**

1. Set the components and equipments as shown in figure.

2. Initially set the variable attenuator for maximum attenuation

3. keep the control knob of gunn power supply as below:

Meter switch : ‘OFF’

Gunn bias knob : fully anti clockwise

Pin bias knob/mod amplitude : mid position

Pin mod frequency : mid position

4. keep the control knob of VSWR meter as below:

Switch : normal

Input switch : crystal low impedance/200K

Range db switch : 50 db

Gain control knob : fully clockwise

5. Keep the micrometer of Gunn oscillator between 5-7mm for required frequency of

Operation

6.’ON’ the Gunn power supply, VSWR meter and cooling fan.

**OBSERVATIONS:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **GUNN BIAS VOLTAGE**  **(V)** | **GUNN DIODE CURRENT**  **(I)** |
|  |  |  |
|  |  |  |
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**MODEL GRAPH:**

current

Voltage

7. keep the mode switch of Gunn power supply to square wave/internal modulation

8. Turn the meter knob to voltage position; apply Gunn bias voltage around 5volts.

Now change the meter switch to current position and note that, as Gunn bias

voltage is varied current starts decreasing. This indicates negative resistance

characteristics of Gunn diode. Apply the voltage such that the device is in the

middle of the negative resistance region.

9. Connect detector output to SWR meter

10. Adjust the square wave modulation frequency to approximately 1 khz

11. change the meter range if no reflection is observed

12. keep the slotted line probe at position where maximum deflection in meter is

observed

13. Adjust the attenuator setting; gain control knob on VSWR meter and tune the

detector plunger for the pointer to indicate VSWR1.

14. Move detector probe along the slotted line and note position of probe where

pointer comes to extreme left position, which is first minimum. In order to know

exact position of minimum note the positions of equal response points on either

side of the minimum and then the mid point of those positions will give position

of minimum. The same way note next minimum positions.

15. Repeat the above procedure for different settings of micrometer.

**Depth of modulation of PIN diode:**

Apply Gunn bias voltage slowly so that panel meter of Gunn power supply reads 8v.

Tune the PIN modulator bias voltage and frequency knob for maximum output on the oscilloscope.

Coincide the bottom of square wave oscilloscope to some reference level and not down the micrometer reading of variable attenuator

Now with help of variable attenuator coincide the top of square wave to same reference level and note down the micrometer reading.

Connect VSWR to detector mount and note down the dB reading in VSWR meter for the micrometer reading the variable attenuator

The difference of both dB reading of VSWR meter gives the modulation depth of PIN modulator.

KLYSTRON POWER SUPPLY

REFLEX KLYSTRON

ISOLATOR

FREQUENCY METER

ATTENUATOR

DIRECTIONAL COUPLER

CRYSTAL DETECTOR

V.S.W.R METER

MATCHED LOAD

**PROPERTIES OF DIRECTIONAL COUPLER**

**AIM:**

To measure the coupling factor, directivity and insertion loss of a directional coupler.

**EQUIPMENT/INSTRUMENTS:**

Klystron power supply, reflex klystron, Isolator, frequency meter, variable attenuator(or Gunn power supply, Gunn oscillator, isolator, pin modulator), termination, crystal detector, VSWR meter, directional coupler.

**PROCEDURE:**

1.Set the equipments as shown in diagram without the directional coupler i.e.,

Directly connect crystal detector with VSWR meter inorder to measure input

after attenuator.

2.set variable attenuator in the maximum attenuation position

3.Keep the control knob of vswr meter as below

Range db - 50 db position

Input switch - crystal low impedance/200k

Meter switch - normal position

Gain - mid position

4.Keep the control knob of klystron power supply

Mod-switch - AM

Beam voltage knob - full anti clockwise

Reflector voltage knob - full clockwise

Am-amplitude knob - around fully clockwise

Am frequency & amplitude knob- around mid position

5.Switch on the klystron power supply, vswr meter and cooling fan

**OBSERVATIONS:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **FREQ(GHZ)** | **A1 DB** | **A2 DB** | **A3 DB** | **A4 DB** |
|  |  |  |  |  |

**CALCULATION:**

|  |  |  |
| --- | --- | --- |
| Coupling(dB) | A1-A3 dB |  |
| Directivity(dB) | A3-A4 dB |  |
| Isolation(dB) | A1-A4 dB |  |
| Insertion loss(dB) | A1-A2 dB |  |

6. Turn the meter switch of power supply to beam voltage position and beam

voltage at 300 volt with the help of beam voltage knob.

` 7. Adjust the reflector voltage to set klystron for maximum mode of operation.

Get some deflection in VSWR meter.

8.Maximize the deflection with AM amplitude and frequency control knob of

power supply and set some reference reading in VSWR meter. Note this

attenuator setting as (A1) db.

9. Now insert directional coupler as shown in figure. Feed the power through

port1 and measure the output at port2 by terminating port3 using matched

termination.

10. Reduce the attenuation to get the reference reading obtained in step 8 on

VSWR meter. Note this attenuator setting as (A2) db.

11. Now terminate port 2 with matched load and measure output at port 3. Reduce

The attenuation to get reference reading obtained in step 8. Note this attenuator

Setting as (A2) db.

12. Reverse the directional coupler and feed the power through port2 and measure

The output at port3. let the attenuator setting for this reading be(A4) db

13. calculate directivity, coupling, isolation and insertion loss.

14. Repeat the experiment at other frequencies to obtain coupling characteristics

Over the band of interest.

KLYSTRON POWER SUPPLY

KLYSRON MOUNT

ISOLATOR

VARIABLE ATTENUATOR

TUNABLE CRYSTAL DETECTOR MOUNT

V.S.W.R METER

FOR INPUT POWER MEASUREMENT

**STUDY OF POWER DIVISION IN MAGIC TEE**

**AIM:**

To measure the isolation between E and H arms of the magic tee and demonstrate 3dB power division in the side arm of the magic tee.

**EQUIPMENT/INSTRUMENT:**

Klystron power supply, klystron mount, isolator, attenuator, frequency meter, VSWR meter, magic tee and matched termination.

**PROCEDURE:**

1. Set up the equipment as shown in diagram.
2. Keep the control knob of klystron power supply as below.

Mode switch : AM

Beam voltage knob : Fully Anti clockwise

Repeller voltage knob : fully clockwise

Meter switch : cathode voltage position

1. Measurement or isolation between E and H arms.

3.1 Set the attenuator around 20 dB. Let this setting be (A1) dB

3.2 Achieve a state reference reading on the SWR meter, preferably in 40dB

range of the SWR meter.

3.3 Disconnect and setup as shown in figure

3.4 Reduce the attenuation till the SWR meter reads the value obtained in

step 3.2. Note the attenuation setting (A2) dB. The difference in the

attenuator settings (A1-A2) dB gives the isolation in dB

1. Experiment setup for demonstrating the 3dB power division in the collinear arms.

KLYSTRON POWER SUPPLY

KLYSRON MOUNT

ISOLATOR

VARIABLE ATTENUATOR

TUNABLE CRYSTAL DETECTOR MOUNT

V.S.W.R METER

MAGIC TEE

FOR COUPLED /SOLATED POWER MEASUREMENT

* 1. 4.1 Now the power input be either at E and H arms.
  2. 4.2 Set the attenuator to get reference reading on the SWR meter without the component

under test. Note the attenuator setting(A1) dB

* 1. 4.3 Connect the component under test (magic tee)
  2. 4.4 Reduce the attenuation to get the reference reading obtained in step 4.2
  3. 4.5 Note down the attenuator setting (A2) dB

The difference in the attenuator settings gives the ratio of the power coupled to the collinear to that in the main arm in dB. This value should be around 3dB.

**OBSERVATION:**

**ISOLATION MEASUREMENT**

|  |  |
| --- | --- |
| Attenuator setting when measuring input to E-arm A1 dB | Attenuator setting when measuring input to E-arm A2 dB |
|  |  |

**MEASUREMENT OF POWER DIVISION**

|  |  |
| --- | --- |
| Attenuator setting when measuring input to E/Harm A1 dB | Attenuator setting when measuring power at collinear to arms A2 dB |
|  |  |

**CALCULATIONS:**

Isolation between E and H arm(dB)= (A1-A2) dB

Coupling between collinear arms and E/H arms(dB)= (A1-A2) dB

KLYSTRON POWER SUPPLY

REFLEX KLYSTRON TUBE MOUNT

ISOLATOR

ATTENUATOR

FREQUENCY METER

CRYSTAL DETECTOR

VSWR METER

RECEIVING ANTENNA

TRANSMITTING ANTENNA

**HORN ANTENNA CHARACTERISTICS**

**AIM:**

To obtain the radiation pattern of an Horn antenna

**EQUIPMENTS/INSTRUMENTS:**

Klystron power supply, klystron mount, isolator, variable attenuator, frequency meter, VSWR meter, coupling probes, two pyramidal Horn, radiation pattern Turn table.

**PROCEDURE:**

1. Switch ON the power supply keeping the switch the front panel in beam OFF position.
2. wait for few minutes and then change the switch to beam on position
3. Set the beam voltage to 300v by varying beam voltage control knob.
4. Check the beam current whether it is less than 30mA
5. Set the variable attenuator to max attenuation level.
6. change the modulating voltage control knob from min to max range and find the modulating voltage for which maximum deflection in VSWR meter.
7. Adjust the modulating frequency control knob from 0Hz to 1KHz until to get more deflection in on VSWR meter. If we are getting 2 or 3 maximum deflections choose the least one.
8. Now change the repeller voltage and measure power in db from VSWR meter.
9. For measurement of power in VSWR meter we have to detune the frequency meter every time.
10. Mount the horn antenna one to microwave bench and other towards the VSWR end.
11. Adjusts the two horn antennas to be exactly in line with each other ie. Perfectly aligned condition i.e angular difference is 0.
12. Now note the deflection in the VSWR meter.
13. Now rotate the Horn antenna HZ through 100. The power output increases in the VSWR meter. Note the reading.
14. Similar procedure is carried out to get readings in steps of 10 in anti clockwise and clock wise directions.
15. The same process is carried out by keeping the horn 2 in opposite position ie. For E plane and readings are taken.

**TABULAR COLUMN**

|  |  |  |
| --- | --- | --- |
| **0 IN DEGREES** | **POWER RECEIVED IN DECIBETS CLOCKWISE** | **POWER RECEIVED ANTI CLOCKWISE** |
|  |  |  |
|  |  |  |

**MODEL GRAPH:**

**DC characteristics of LED**

**Aim:**

To study the operation of LED and verify it.

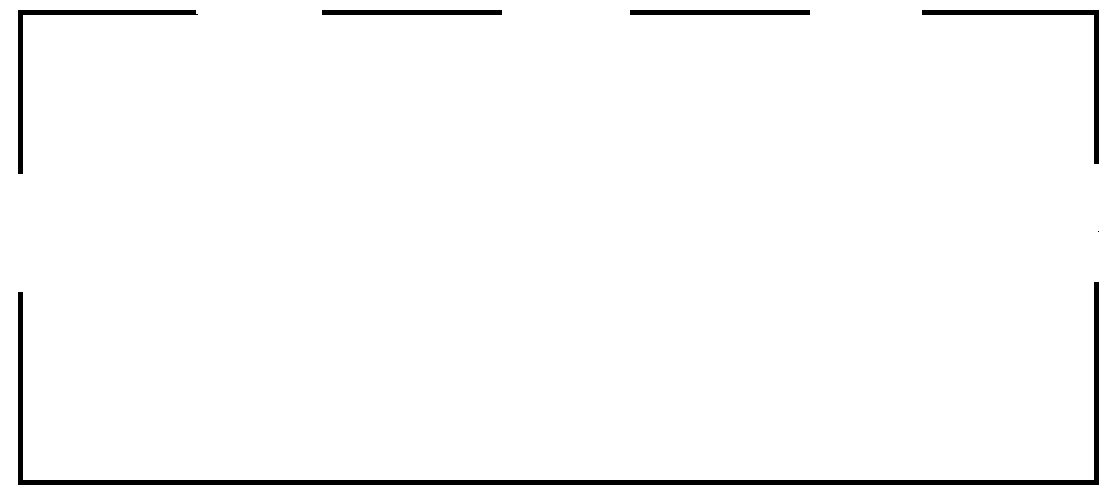
**Apparatus required:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.No** | **Component** | **Quantity** | **Range** |
| 1 | LED | 1 | 660 nm |
| 2 | Resistor | 1 | 1kΩ |
| 3 | Ammeter | 1 | (0 – 20) mA |
| 4 | Voltmeter | 1 | (0 -10) v |
| 5 | Power supply wires | 1 | (0-20)v |

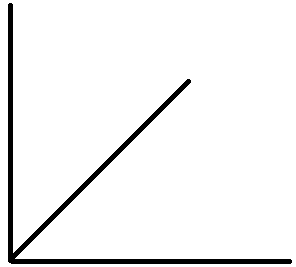
**Procedure:**

1. Connect the power supply to board and execute ensure the all switch faults are in our condition.
2. Due emitter block in digital node make connection as shown in figure.
3. Connect the bias 10 present on comparator Tb3,2 emitter input at Tb5.
4. Connect the Tmm between the supply and Tb6 the cathode of the LED the Dmm will now made the forward voltage.
5. Measure the voltage drop across the connectivity resistor by connecting Dmm between Tb6, Tb8. this is called as threshold current.
6. Measure and vary the bias so as vary the forward voltage note the corresponding forward current.

**Circuit Diagram**



**Modal Graph**

****

**Tabulation:**

|  |  |  |
| --- | --- | --- |
| **S.No** | **CURRENT(I)** | **CURRENT(I)** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Result:**

Thus the characteristic of LED has been executed and the output was verified successfully.

**OPTICAL TRANSMISSION USING ANALOG TRANSMISSION**

**AIM:**

To design intensity modulation of the analog signal, transmit it over a fiber optic cable demodulate the same at receiver.

**APPARATUS REQUIRED:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **COMPONENT** | **QTY** |
| 1 | Link-B kit with power supply | 1 |
| 2 | Patch cable | As required |
| 3 | CRO | 1 |
| 4 | Function generator | 1 |
| 5 | Fiber cable | 1 |

**PROCEDURE:**

* Make connections shown connect the power supply cables with proper polarity to link while connected this ensure that the power supply is off.
* Keep PRBS switch sw7 is shown to generate PRBS signal.
* Keep switch sw8 towards Tx position.
* Keep the switch sw9 towards Tx1 position.
* Keep the switch sw10 at fiber optic Rx output to TTL position.
* Select PRBS generator clock at 32KHZ by keeping jumper jp4 at 32K position.
* Keep jumper jp5 towards T5 position jp6 shorted.
* Switch ON the power supply.
* Keep jumper sides jp8 towards Tx position.
* Connect the POT DATA OUT of PRBS generator to the IN port of digital buffer &also to the DATA IN port of bit error rate even counter.
* Connect the OUT port of digital buffer to Tx IN port to transmitter.
* Slightly unscrew the cap of LED’S FH756 V (660nm). Do not remove the cap from the connector once the cap is unscrewed, insert the one meter fiber into the cap. Now tighten the cap by screwing it back.
* Connect the TTL signal OUT to port IN of noise source.
* Connect port OUT of noise source to port Rx DATA number of bit error rate event counters. Connect port CLK OUT of PRBS generator to port CLK IN of bit error rate event counters.
* Press switch sw11 to start counters. Vary port p3 for noise level to observe effect of noise level on the error OUT.

**BLOCK DIAGRAM:**

AMPLIFIER

**P2 intensity**

**IN**

driver

driver

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

**cabel** **OUT**



**ANALOG BUFFER** **TX**

SW8

**JUMPER SETTING: SWITCH FAULTS:**

OFF

+12V +5V

ON

TX2 TX1 TX2

SW9 SW9

**MODEL GRAPH:**

**TABULATION:**

|  |  |  |
| --- | --- | --- |
| **SIGNAL** | **AMPLITUDE(V)** | **TIME PERIOD(ms)** |
| **ANALOG INPUT** |  |  |
| **ANALOG BUFFER OUTPUT** |  |  |
| **ANALOG OUTPUT** |  |  |

**RESULT:**

Thus the intensity modulation of the analog signal, transmit it and demodulate at the receiver to get back the original signal.

**OPTICAL TRANSMISSION USING DIGITAL MODULATION**

**AIM**:

To obtain the intensity modulation of digital signal transmit in over a fiber optic cable and demodulate the same at receiver and to get back the original signal.

**APPARATUS REQUIRED:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **COMPONENTS** | **QUANTITY** |
| 1. | Fiber optic trainer kit (250Ω) | 1 |
| 2. | Cathode Ray Oscilloscope(CRO) | 1 |
| 3. | Connectors | - |
| 4. | Optical Fiber Cable | 1 |

**PROCEDURE:**

* Connect the power to board.
* Make the full screen
* Connect the function generator output market 1KHZ sine wave to input of emitter1.
* Plug in fiber optic from output of emitter 1 LED to photo resistor of detector.
* Detector1 output blocks with amplifier tp27.
* Turn the 1 KHZ present in function generator block to fully clockwise position.
* Switch on the power supply with the help of dual trace oscilloscope.
* Observe the input signal at emitter tp5 also observe the output from detector1.It should carry a smaller version of signal 1KHZ.sine wave

Illustrate that modulated light beam has recovered back into electrical signal.

* The output from detector1 is further amplified by AC amplifier1 in further amplification increases amplitude of the received signal and also removes the DC component which is present
* While modulating output of amplifier1 tp23 changes the amplitudemodulation sine wave by varying the 1KHZ present in function generator.

**BLOCK DIAGRAM:**

DIGITAL SIGNAL

DETECTOR

EMITTER

FUNCTION GENERATOR

OPTICAL FIBER

CATHODE RAY OSCILLOSCOPE

AMPLIFIER

**MODEL GRAPH**:

AMPLITUDE (volt)

TIME(ms)

**TABULATION:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.NO** | **WAVEFORM** | **AMPLITUDE(v)** | **TIME PERIOD(ms)** |
| 1. | **DIGITAL INPUT** |  |  |
| 2. | **DIGITAL BUFFER OUTPUT** |  |  |
| 3. | **DIGITAL OUTPUT** |  |  |

**RESULT:**

Thus the intensity modulation of digital signal transmit in over a fiber optic cable and demodulate the same at receiver and get back the original signal was done successfully.

**NUMERICAL APERATURE DETERMINATION FOR FIBER**

**AIM:**

To determine the numerical aperture and acceptance angle of an optical fiber.

**APPARATUS REQUIRED:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **APPARATUS** | **QUANTITY** |
| 1. | LED light source | 1 |
| 2. | Optical fiber connector | 1 |
| 3. | Optical fiber cable of various length | 2(1m & 2m) |
| 4. | Numerical Aperture kit | 1 |

**FORMULA USED:**

Numerical Aperature (NA) = W/√(4L^2+W^2)

Acceptance Angle (Өa) = sin^-1(NA)

Where,

NA=Numerical Aperture

W=Width of circular image

L=Distance from fiber end to circular image

Өa=Acceptance Angle

**PROCEDURE:**

* + Using laser, we can find NA of optical fiber cable.
  + A known length of fiber is taken. One end of fiber is connected to NA.
  + The source is switched ON. The opening in NA is completely opened.
  + So that a circular red patch of laser light is observed on the screen.
  + Now the opening in NA is slowly closed with knob providing and at a particular point circular light patch in screen just cuts the radius of opening of NA at which circular path of light just put is measured.
  + Now W2 set illuminated circular path on the screw.
  + The distance from fiber end to circular image of 1 is measured using meter scale.
  + Similarly, the radius of circular image is also measured.

**NUMERICAL APERATURE SETUP**

NASL3

po

LIGHT SOURCE

Source

Optical fiber pin

**TABULATION:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CABLE LENGTH | LENGTH(cm) | WIDTH(mm) | NA | Өa |

LENGTH (1m)

LENGTH(2m)

RESULT:

Thus the determination of the numerical aperture of an optical fiber was calculated successfully.

**MEASUREMENT OF BIT ERROR RATE**

**AIM:**

To measure the bit error rate.

**APPARATUS REQUIRED:**

1.)Link B kit with power supply

2.)Patch card

3.)Meter fiber cable

4.)20MHZ Dual channel oscilloscope

**THEORY:**

**Bit error rate:**

In telecommunication transmission the bit error rate (EBR) is a ratio of bits that have error relative to the total number of bits received in transmission.

**PROCEDURE:**

* Make connections shown connect the power supply cables with proper polarity to link while connected this ensure that the power supply is off.
* Keep PRBS switch sw7 is shown to generate PRBS signal.
* Keep switch sw8 towards Tx position.
* Keep the switch sw9 towards Tx1 position.
* Keep the switch sw10 at fiber optic Rx output to TTL position.
* Select PRBS generator clock at 32KHZ by keeping jumper jp4 at 32K position.
* Keep jumper jp5 towards T5 position jp6 shorted.
* Switch ON the power supply.
* Keep jumper sides jp8 towards Tx position.
* Connect the POT DATA OUT of PRBS generator to the IN port of digital buffer &also to the DATA IN port of bit error rate even counter.
* Connect the OUT port of digital buffer to Tx IN port to transmitter.
* Slightly unscrew the cap of LED’S FH756 V (660nm). Do not remove the cap from the connector once the cap is unscrewed ,insert the one meter fiber into the cap. Now tighten the cap by screwing it back.
* Connect the TTL signal OUT to port IN of noise source.
* Connect port OUT of noise source to port Rx DATA number of bit error rate event counters. Connect port CLK OUT of PRBS generator to port CLK IN of bit error rate event counters.
* Press switch sw11 to start counters. Vary port p3 for noise level to observe effect of noise level on the error OUT.

Observe the error count LED’s for the error count in received signal in time 10sec.

**BLOCK DIAGRAM:**

driver

Data out in

Sw1

Tx TTL

Jp6

swr Sw10

Error count

+12

Tx1 +1v

Tx2

Sw9

off

sf1

Jp8 on

1 2 3 4 5 6 7 8

**MODEL GRAPH:**

**RESULT:**

Thus the bit error rate has been measured and verified.

# ATTENUATION MEASUREMENT

AIM:

To determine the bending loss of the optical fiber.

APPARATUS REQUIRED:

|  |  |  |
| --- | --- | --- |
| S.NO | COMPONENT | QUANTITY |
| 1 | Fiber optic trainer kit | 1 |
| 2 | CRO | 1 |
| 3 | Connectors | 1 |
| 4 | Optical fiber cable | 1 |
|  |  |  |

PROCEDURE:

1.Connet the power to the board.

2.Make the following connection.

3.Connect of the Function generator output marked 1KHz sine wave input of emitter.

4.Plug in fiber optical link from output of emitter LED to photo resistor of detector.

5.Detector one output block switch the anode.select the anode tip to input of amplifier.

6.Then the 1KHZ present in function generator block to fully clockwise position.

7.Switch on power supply with help of dual trace oscillator.

8.The output from the detector from the amplified by at amplifier .which increases the amplitude

Of received signal.

9.While modulating output of amplifier tip2 change the amplitude of modulating sine wave by

Varying 1KHZ in function .

10.Bend the fiber in a loop measure the amplitude of received signal.

11.Plot a graph of received signal amplitude versus loop diameter.

12.Repeat the procedure again for second transmitter.

BLOCK DIAGRAM:

Function generator

CRO

Amplifier circuit

DETECTOR CIRCUIT

Emitter circuit

# MODEL GRAPH:

TABULATION:

|  |
| --- |
| DIAMETER INPUT AMPLITUDE OUTPUT AMPLITUDE TIME PERIOD |

**RESULT:**

Thus the determination of the bending loss (or) attenuator loss of the optical fiber was done successfully.

**EYE PATTERN**

**AIM:**

To study the eye pattern using fiber optic links.

**APPARATUS REQUIRED:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **COMPONENTS** | **QTY** |
| 1 | Link B kit with power supply | 1 |
| 2 | 1 meter power supply | 2 |
| 3 | 100 MHz dual channel | As required |
| 4 | Patch cards | As required |

**PROCEDURE**:

1. Make the connection as shown in fig.
2. Keep switch sw7 to generate RSB signal.
3. Keep switch sw9 towards Tx position.
4. Keep the switch sw10 to eye pattern position.
5. Keep jumper towards +5v position.
6. Connect the post dataout of PRBS.
7. The generator to the IN port of digital buffer to ty-in port.
8. Connect the clk-CT of port of PRBS.
9. This is for to generate the EXT-TRIG oscilloscope.
10. The output from detector1 is further amplified by AC amplifier1 in further amplification increases amplitude of the received signal and also removes the DC component which is present
11. While modulating output of amplifier1 tp23 changes the amplitudemodulation sine wave by varying the 1KHZ present in function generator.
12. Switch on the power supply with the help of dual trace oscilloscope.
13. Observe the input signal at emitter tp5 also observe the output from detector1.It should carry a smaller version of signal 1KHZ.sine wave illustrate that modulated light beam has recovered back into electrical signal.
14. Plot the graph by observed reading.

**BLOCK DIAGRAM:**

driver

Data out in

Sw1

Tx TTL

Jp6

swr Sw10

Error count

+12

Tx1 +1v

Tx2

Sw9

off

sf1

Jp8 on

1 2 3 4 5 6 7 8

**MODEL GRAPH:**

**TABULATION:**

|  |
| --- |
| **Frequency amplitude separation pulsewidth(µs)** |

**RESULT:**

Thus the eye pattern has been measured and verified.

**OPTICAL TRANSMISSION USING ANALOG TRANSMISSION**

**AIM:**

To design intensity modulation of the analog signal, transmit it over a fiber optic cable demodulate the same at receiver.

**APPARATUS REQUIRED**:

|  |  |  |
| --- | --- | --- |
| **S.NO** | **COMPONENT** | **QTY** |
| 1 | Link-B kit with power supply | 1 |
| 2 | Patch cable | As required |
| 3 | CRO | 1 |
| 4 | Function generator | 1 |
| 5 | Fiber cable | 1 |

**PROCEDURE**:

* Make connections shown connect the power supply cables with proper polarity to link while connected this ensure that the power supply is off.
* Keep PRBS switch sw7 is shown to generate PRBS signal.
* Keep switch sw8 towards Tx position.
* Keep the switch sw9 towards Tx1 position.
* Keep the switch sw10 at fiber optic Rx output to TTL position.
* Select PRBS generator clock at 32KHZ by keeping jumper jp4 at 32K position.
* Keep jumper jp5 towards T5 position jp6 shorted.
* Switch ON the power supply.
* Keep jumper sides jp8 towards Tx position.
* Connect the POT DATA OUT of PRBS generator to the IN port of digital buffer &also to the DATA IN port of bit error rate even counter.
* Connect the OUT port of digital buffer to Tx IN port to transmitter.
* Slightly unscrew the cap of LED’S FH756 V (660nm). Do not remove the cap from the connector once the cap is unscrewed ,insert the one meter fiber into the cap. Now tighten the cap by screwing it back.
* Connect the TTL signal OUT to port IN of noise source.
* Connect port OUT of noise source to port Rx DATA number of bit error rate event counters. Connect port CLK OUT of PRBS generator to port CLK IN of bit error rate event counters.
* Press switch sw11 to start counters. Vary port p3 for noise level to observe effect of noise level on the error OUT.

**BLOCK DIAGRAM:** P2 intensity

AMPLIFIER

IN

driver

driver

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

cabel OUT



ANALOG BUFFER TX

SW8

JUMPER SETTING: SWITCH FAULTS:

OFF

+12V +5V

ON

TX2 TX1 TX2

SW9 SW9

**TABULATION:**

|  |  |  |
| --- | --- | --- |
| **SIGNAL** | **AMPLITUDE(V)** | **TIME PERIOD(ms)** |
| **ANALOG INPUT** |  |  |
| **ANALOG BUFFER OUTPUT** |  |  |
| **ANALOG OUTPUT** |  |  |

MODEL GRAPH:

**RESULT:**

Thus the intensity modulation of the analog signal, transmit it and demodulate at the receiver to get back the original signal.

**OPTICAL TRANSMISSION USING DIGITAL MODULATION**

**AIM:**

To design intensity modulation of the digital signal, transmit it over a fiber optic cable demodulate the same at receiver.

**APPARATUS REQUIRED:**

|  |  |  |
| --- | --- | --- |
| **S.NO** | **COMPONENT** | **QTY** |
| **1** | **Link-B kit with power supply** | **1** |
| **2** | **Patch cable** | **As required** |
| **3** | **CRO** | **1** |
| **4** | **Function generator** | **1** |
| **5** | **Fiber cable** | **1** |

**PROCEDURE:**

* Make connections shown connect the power supply cables with proper polarity to link while connected this ensure that the power supply is off.
* Keep PRBS switch sw7 is shown to generate PRBS signal.
* Keep switch sw8 towards Tx position.
* Keep the switch sw9 towards Tx1 position.
* Keep the switch sw10 at fiber optic Rx output to TTL position.
* Select PRBS generator clock at 32KHZ by keeping jumper jp4 at 32K position.
* Keep jumper jp5 towards T5 position jp6 shorted.
* Switch ON the power supply.
* Keep jumper sides jp8 towards Tx position.
* Connect the POT DATA OUT of PRBS generator to the IN port of digital buffer &also to the DATA IN port of bit error rate even counter.
* Connect the OUT port of digital buffer to Tx IN port to transmitter.
* Slightly unscrew the cap of LED’S FH756 V (660nm). Do not remove the cap from the connector once the cap is unscrewed ,insert the one meter fiber into the cap. Now tighten the cap by screwing it back.
* Connect the TTL signal OUT to port IN of noise source.
* Connect port OUT of noise source to port Rx DATA number of bit error rate event counters. Connect port CLK OUT of PRBS generator to port CLK IN of bit error rate event counters.
* Press switch sw11 to start counters. Vary port p3 for noise level to observe effect of noise level on the error OUT.

**BLOCK DIAGRAM:** P2 intensity

AMPLIFIER

IN

driver

driver

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |

cabel OUT



ANALOG BUFFER TX

SW8

JUMPER SETTING: SWITCH FAULTS:

OFF

+12V +5V

ON

TX2 TX1 TX2

SW9 SW9

**TABULATION:**

|  |  |  |
| --- | --- | --- |
| **SIGNAL** | **AMPLITUDE(V)** | **TIME PERIOD(ms)** |
| **ANALOG INPUT** |  |  |
| **ANALOG BUFFER OUTPUT** |  |  |
| **ANALOG OUTPUT** |  |  |

**MODEL GRAPH:**

**RESULT:**

Thus the intensity modulation of the digital signal, transmit it and demodulate at the receiver to get back the original signal.