

SEMBODAI RUKMANI VARATHARAJAN ENGINEERING COLLEGE

SEMBODAI, VEDARANIAM [T.K],

NAGAPATTINAM [Dist] -614820.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING



LAB MANUAL

EC2405 – OPTICAL AND MICROWAVE LAB

NAME			
REG.No			
BRANCH			
YEAR		SEMESTER	



SEMBODAI RUKMANI VARATHARAJAN ENGINEERING COLLEGE
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
ACADEMIC YEAR 2015-2016 ODD SEM

EC2405 – OPTICAL AND MICROWAVE LAB

IV YEAR / VII SEMESTER

Prepared By
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AP/ECE

SETTING UP FIBER OPTIC ANALOG LINK

Ex. No: 01

Date :

1.1 OBJECTIVE:

The objective of this experiment is to study an 660 nm/ 950 nm Fiber Optic Analog Link. In this experiment you will study the relationship between the input signal & received signal.

1.2 APPARATUS REQUIRED:

S.No	Name of the Components	Specification	Quantity
1	Fiber optic trainer kit.	Link A	1
2	CRO	-	1
3	Power supply	(0±12)v	1
4	Fiber optic cable	950 nm	1
5	Connecting Chords.	-	As required

1.3 THEORY:

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

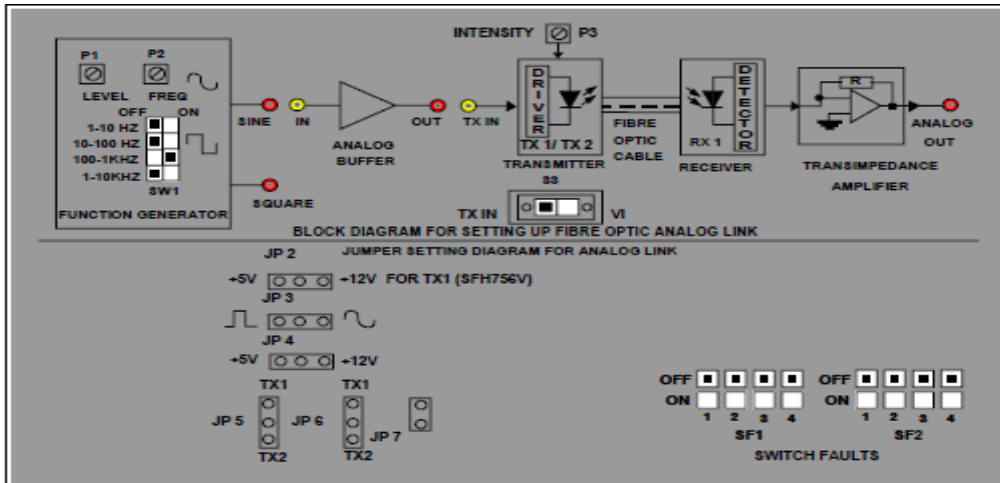
TRANSMITTER:

Fiber optic transmitters are typically composed of a buffer, driver and optical source. The buffer electronics provides both an electrical connection and isolation between the transmitter and the electrical system supplying the data. The driver electronics provides electrical power to the optical source in a fashion that duplicates the pattern of data being fed to the transmitter. Finally the optical source (LED) converts the electrical current to light energy with the same pattern.

RECEIVER:

The function of the receiver is to convert the optical energy into electrical form which is then conditioned to reproduce the transmitted electrical signal in its original form. The detector SFH250V used in the kit has a diode type output. The parameters usually considered in the case of detector are it's responsivity at peak wavelength and response time. SFH250V has responsivity of about 4 mA per 10 mW of incident optical energy at 950 nm and it has rise and fall time of 0.01 m sec. PIN photodiode is normally reverse biased.

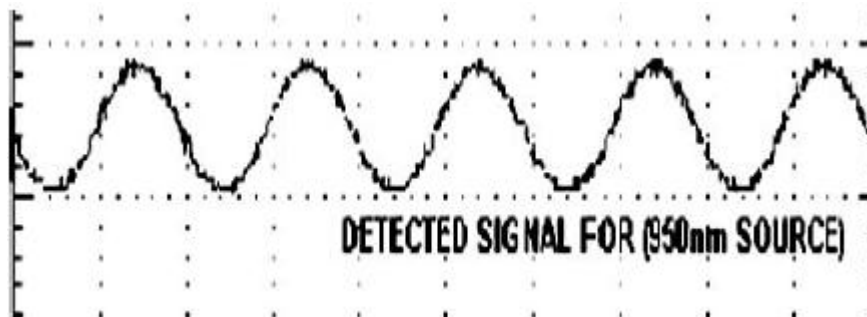
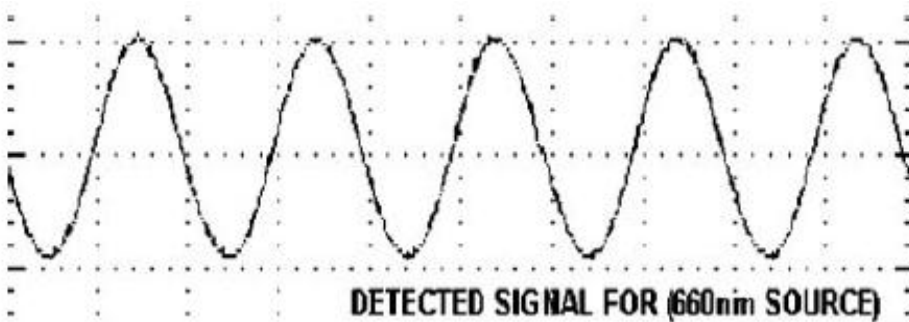
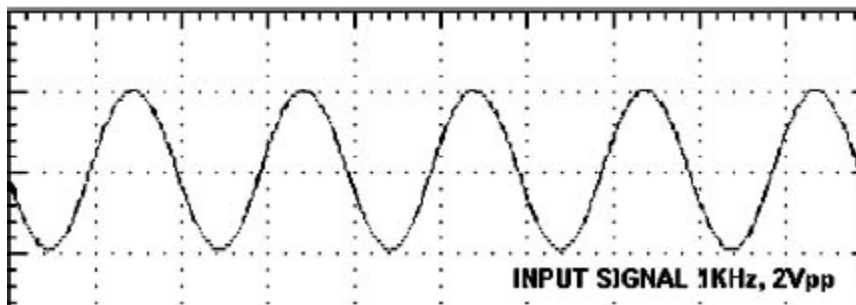
BLOCK DIAGRAM:



PROCEDURE:

- Make the connections and Jumper settings as shown in block diagram. Connect the power supply cables with proper polarity to kit. While connecting this, ensure that the power supply is OFF.
- Keep all the switch faults in OFF position.
- Switch on the power supply.
- Select the frequency range of Function Generator with the help of Range Selection Switch SW1, frequency can be varied with Pot P2. Adjust the voltage LEVEL of the Sine Wave with Pot P1 as per following setting. FREQUENCY: 1KHz, LEVEL: 2Vp-p.
- Connect SINE post of the Function Generator section to IN post of Analog Buffer Section. Keep Jumpers JP2 & JP4 towards +12V position, JP3 towards sine position, JP5 towards TX1 position, JP6 towards TX1 position & JP7 shorted.
- Keep switch S3 towards TX IN position.
- Connect OUT post of the Analog Buffer Section to TX IN post of TRANSMITTER.
- Slightly unscrew the cap of LED SFH 756V TX1 (660 nm) from kit. Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap and assure that the fiber is properly fixed. Now tight the cap by screwing it back. Keep INTENSITY pot P3 at minimum position i.e. fully anticlockwise.
- Connect the other end of the fiber to detector SFH 250V (RX 1) in kit very carefully.
- Check the output signal of the Analog Buffer at its OUT post in Kit. It should be same as that of the applied input signal.
- Observe the output signal from the detector at ANALOG OUT post on CRO by adjusting INTENSITY (Optical Power Control) Pot P3 in kit and you should get the reproduction of the original transmitted signal.
- To measure the analog bandwidth of the link, connect the external Signal Generator with 2Vp-p sine wave to IN post of Analog Buffer Section and vary the frequency of the input signal from 100 Hz onwards. Measure the amplitude of the received signal for each frequency reading.
- Plot a graph of gain / Frequency. Measure the frequency range for which the response is flat.

- Keep Jumpers JP5 & JP6 towards TX2 position.
- Remove Fiber from TX1. Slightly unscrew the cap of LED SFH 450V TX2 (950 nm) from kit. Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap and assure that the fiber is properly fixed. Now tight the cap by screwing it backs. Keep INTENSITY pot P3 at minimum position i.e. fully anti clockwise.
- Check the output signal of the Analog Buffer at its OUT post in Kit. It should be same as that of the applied input signal.
- Observe the output signal from the detector at ANALOG OUT post on CRO by adjusting INTENSITY (Optical Power Control) Pot P3 in kit and you should get the reproduction of the original transmitted signal.
- To measure the analog bandwidth of the link, connect the external Signal Generator with 2Vp-p sine wave to IN post of Analog Buffer Section and vary the frequency of the input signal from 100Hz onwards. Measure the amplitude of the received signal for each frequency reading.
- Plot a graph of gain / Frequency. Measure the frequency range for which the response is flat.



1.5 TABULATION:

Signal	Amplitude(V)	Time(ms)	Frequency(Hz)

1.6 RESULT:

Thus the relationship between input and output waves was obtained.

SETTING UP A FIBER OPTIC DIGITAL LINK.

Ex. No: 02

Date :

OBJECTIVE

The objective of this experiment is to study an 660nm Fiber Optic Digital Link. In this experiment you will study the relationship between the input signal and received signal.

APPARATUS REQUIRED:

S.No	Name of the Components	Specification	Quantity
1	Fiber optic trainer kit.	Link A	1
2	CRO	-	1
3	Power supply	(0±12)v	1
4	Fiber optic cable	950 nm	1
5	Connecting Chords.	-	As required

THEORY :

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

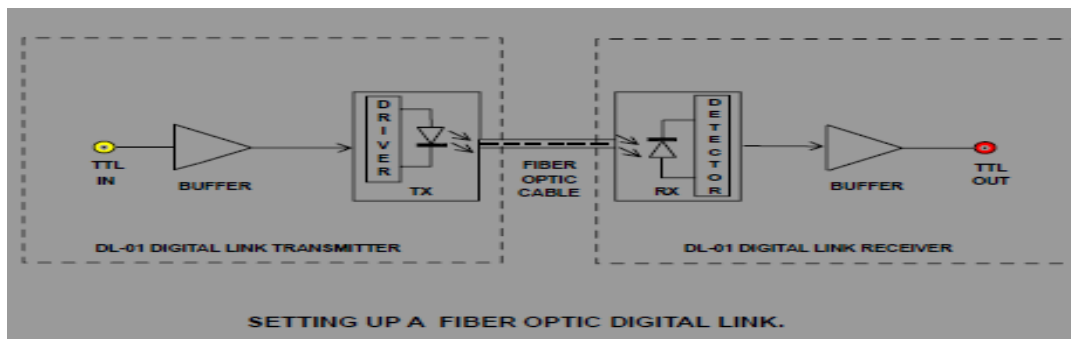
TRANSMITTER:

Fiber optic transmitters are typically composed of a buffer, driver and optical source. The buffer electronics provides both an electrical connection and isolation between the transmitter and the electrical system supplying the data. The driver electronics provides electrical power to the optical source in a fashion that duplicates the pattern of data being fed to the transmitter. Finally the optical source (LED) converts the electrical current to light energy with the same pattern. The LEDSFH756V supplied with the link operates within the visible light spectrum. It's optical output is centered at wavelength of 660 nm. The LED SFH756V used in the link is coupled to the transistor driver in common emitter mode. The driver is preceded by the buffer. The buffer in this case is a 74HCT14 inverting gate configured as voltage follower. In the absence of input signal no voltage appears at the base of the transistor. This biases the transistor to the cutoff region for linear applications. Thus LED emits no intensity of light at this time. When the signal is applied to the input post it biases the transistor to the active region for linear applications. Thus LED emits full intensity of light at this time. This variation in the intensity has linear relation with the input electrical signal. Optical signal is then carried over by the optical fiber.

RECEIVER:

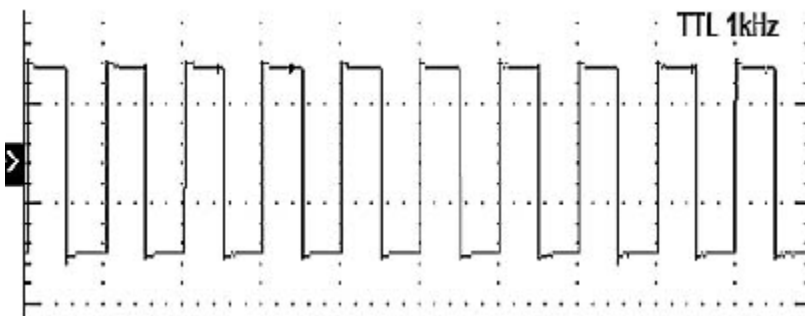
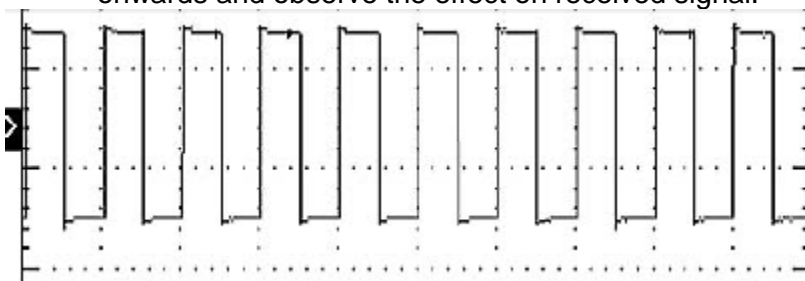
There are various methods to configure detectors to extract digital data. Usually detectors are of linear nature. We have used a photodetector SFH551V having TTL type output. Usually it consists of PIN photodiode, transimpedance amplifier and level shifter.

BLOCK DIAGRAM:



PROCEDURE:

- Connect the power supply cables with proper polarity to kit. While connecting this, ensure that the power supply is OFF. Now switch on the power supply.
- Feed the TTL signal of about 1 KHz Square wave, to IN post of buffer Section.
- Slightly unscrew the cap of LED SFH 756V (660nm). Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap. Now tight the cap by screwing it back.
- Set the clock frequency of the PRBS generator to minimum i.e. 16 KHz using jumper JP1.
- Connect the other end of Fiber to detector SFH 551V very carefully.
- Observe the received signal on CRO at O/P post.
- To measure the digital bandwidth of the link, vary the frequency of the input signal from 100Hz onwards and observe the effect on received signal.



1.5 TABULATION:

Signal	Amplitude(V)	Time(ms)	Frequency(Hz)

RESULT:

Thus the relationship between input and output waves was obtained.

STUDY OF NUMERICAL APERTURE OF OPTICAL FIBER.

Ex. No: 03

Date :

OBJECTIVE

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

EQUIPMENTS:

S.No	Name of the Components	Specification	Quantity
1	Fiber optic trainer kit.	Link A	1
2	CRO	-	1
3	Power supply	(0±12)v	1
4	Fiber optic cable	950 nm	1
5	NA JIG.		
6	Connecting Chords.	-	As required

THEORY:

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

CONSIDERATIONS IN NA MEASUREMENT:

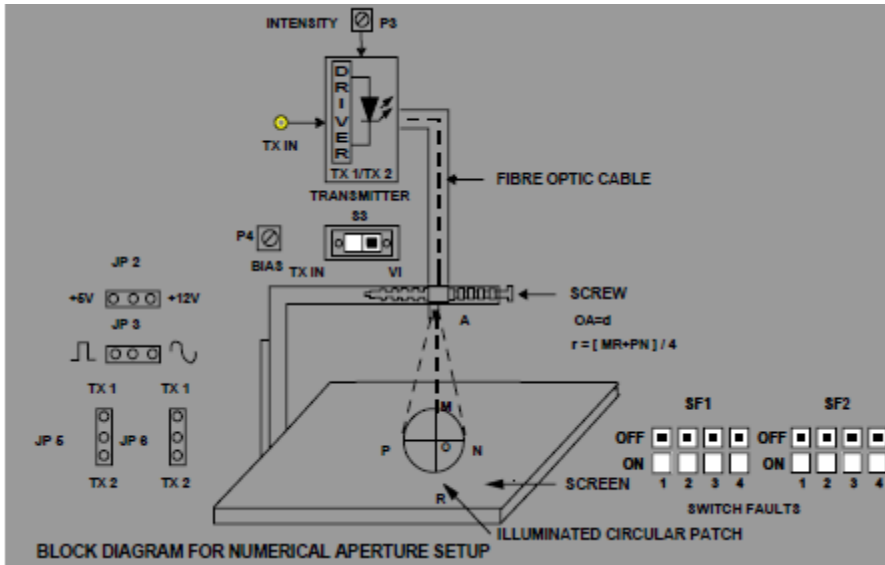
It is very important that the optical source should be properly aligned with the cable and distance from the launched point and the cable is properly selected to ensure that the maximum amount of optical power is transferred to the cable.

PROCEDURE:

- Connect the power supply cables with proper polarity to kit. While connecting this, ensure that the power supply is OFF. Do not apply any TTL signal from Function Generator. Make the connections as shown in block diag.
- Keep all the switch faults in OFF position.
- Keep Pot P3 fully Clockwise Position and P4 fully anticlockwise position.
- Slightly unscrew the cap of LED SFH756V (660 nm). Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap. Now tight the cap by screwing it back. Keep Jumpers JP2 towards +5V position, JP3 towards sine position, JP5 & JP6 towards TX1 position.
- Keep switch S3 towards VI position.
- Insert the other end of the fiber into the numerical aperture measurement jig. Hold the white sheet facing the fiber. Adjust the fiber such that its cut face is perpendicular to the axis of the fiber.
- Keep the distance of about 10 mm between the fiber tip and the screen. Gently tighten the screw and thus fix the fiber in the place.
- Now adjust Pot P4 fully Clockwise Position and observe the illuminated circular patch of light on the screen.
- Measure exactly the distance d and also the vertical and horizontal diameters MR and PN indicated in the block diagram.
- Mean radius is calculated using the following formula. $r = (MR + PN) / 4$

- Find the numerical aperture of the fiber using the formula. $NA = \sin \theta = r / d + r$ Where θ is the maximum angle at which the light incident is properly transmitted through the fiber.

BLOCK DIAGRAM:



TABULATION:

WIDTH IN cm	Distance in cm	NA	θ

RESULT:

Thus the numerical aperture of the fiber is calculated.

STUDY OF PROPAGATION LOSSES IN OPTICAL FIBER

Ex. No: 04

Date :

OBJECTIVE

The objective of this experiment is to measure propagation loss in plastic fiber provided with the Lab for three different wavelengths of radiation as 950 nm, 660 nm.

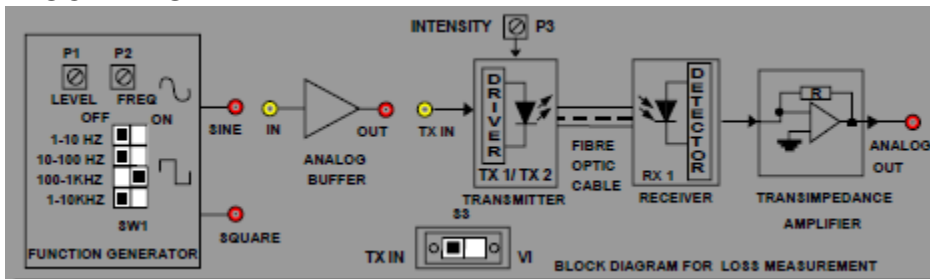
EQUIPMENTS:

S.No	Name of the Components	Specification	Quantity
1	Fiber optic trainer kit.	Link A	1
2	CRO	20 Mhz dual trace	1
3	Power supply	(0±12)v	1
4	Fiber optic cable	950 nm	1
5	Connecting Chords.	-	As required

THEORY:

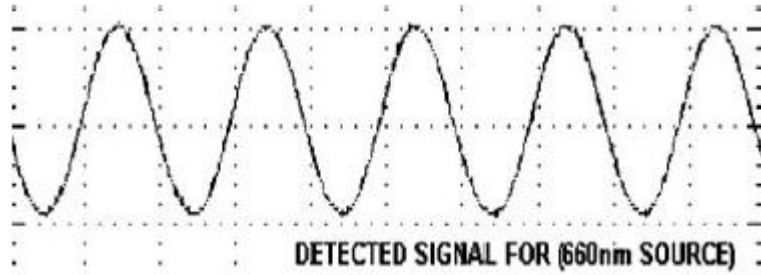
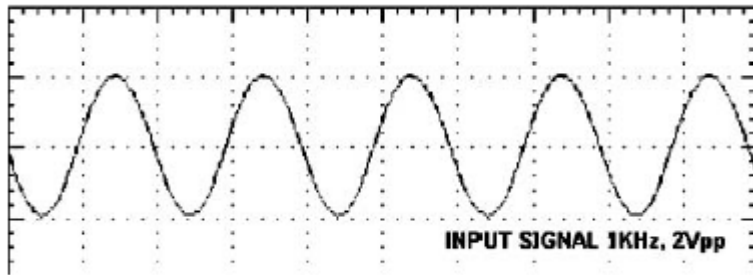
Optical fibers are available in different variety of materials. These materials are usually selected by taking into account their absorption characteristics for different wavelengths of light. In case of optical fiber, since the signal is transmitted in the form of light which is completely different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

BLOCK DIAGRAM:



PROCEDURE:

- Make the connections and Jumper settings as shown in block diagram Connect the power supply cables with proper polarity to kit. While connecting this, ensure that the power supply is OFF.
- Keep all the switch faults in OFF position.
- Switch on the power supply.
- Select the frequency range of Function Generator with the help of Range Selection Switch SW1, frequency can be varied with Pot P2. Adjust the voltage LEVEL of the Sine Wave with Pot P1 as per following setting. FREQUENCY: 1KHz, LEVEL: 2Vp-p.
- Connect SINE post of the Function Generator section to IN post of Analog Buffer Section. Keep Jumpers JP2 & JP4 towards +12V position, JP3 towards sine position, JP5 towards TX1 position, JP6 towards TX1 position & JP7 shorted.
- Keep switch S3 towards TX IN position.
- Connect OUT post of the Analog Buffer Section to TX IN post of TRANSMITTER.
- Slightly unscrew the cap of LED SFH 756V TX1 (660 nm) from kit. Do not remove the cap from the connector. Once the cap is loosened, insert the fiber into the cap and assure that the fiber is properly fixed. Now tight the cap by screwing it back. Keep INTENSITY pot P3 at minimum position i.e. fully anticlockwise.
- Connect the other end of the fiber to detector SFH 250V (RX 1) in kit very carefully.
- Check the output signal of the Analog Buffer at its OUT post in Kit. It should be same as that of the applied input signal.
- Now replace 1 meter fiber by 3 meter fiber without disturbing any of the previous settings. Measure the amplitude level at the receiver side again. You will notice that it is less than the previous one. Mark this as V2.
- If alpha is the attenuation of the fiber then we have, $P1/P2=V1/V2=e^{-\alpha(L1+L2)}$ where alpha = nepers / meter L1 = fiber length for V1 L2 = fiber length for V2 This alpha is for the wavelength of 950 nm. To get the alpha for 660 nm wavelength proceed as follows.
- Remove fiber from TX2 & connect it to TX1.
- Keep Jumpers JP5 & JP6 towards TX1 position.
- Observe the output signal from the detector at ANALOG OUT post on CRO by adjusting INTENSITY (Optical Power Control) Pot P3 in kit and you should get the reproduction of the original transmitted signal. Mark this amplitude level as V1.
- Now replace 1 meter fiber by 3 meter fiber without disturbing any of the previous settings. Measure the amplitude level at the receiver side again. You will notice that it is less than the previous one. Mark this as V2. If alpha is the attenuation of the fiber then we have, $P1/P2=V1/V2=e^{-\alpha(L1+L2)}$ where alpha = nepers / meter
- L1 = fiber length for V1 L2 = fiber length for V2
- Compare the values of alpha and find out the wavelength which has less attenuation in the fiber.



TABULATION:

Input signal (v)	Fiber output voltage		Propagation loss
	Cable 1	Cable 2	

RESULT:

Thus the propagation loss in optical fiber is measured.

STUDY OF BENDING LOSSES IN OPTICAL FIBER

Ex. No: 05

Date :

OBJECTIVE :

The objective of this experiment is to measure bending loss in plastic fiber provided with the Lab for three different wavelengths of radiation as 950 nm, 660 nm

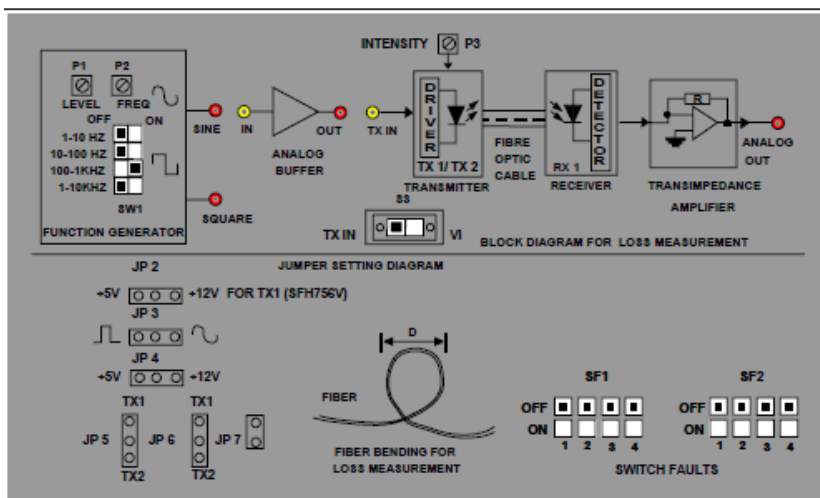
EQUIPMENTS:

S.No	Name of the Components	Specification	Quantity
1	Fiber optic trainer kit.	Link A	1
2	CRO	20 Mhz dual trace	1
3	Power supply	(0±12)v	1
4	Fiber optic cable	950 nm	1
5	Connecting Chords.	-	As required

THEORY:

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

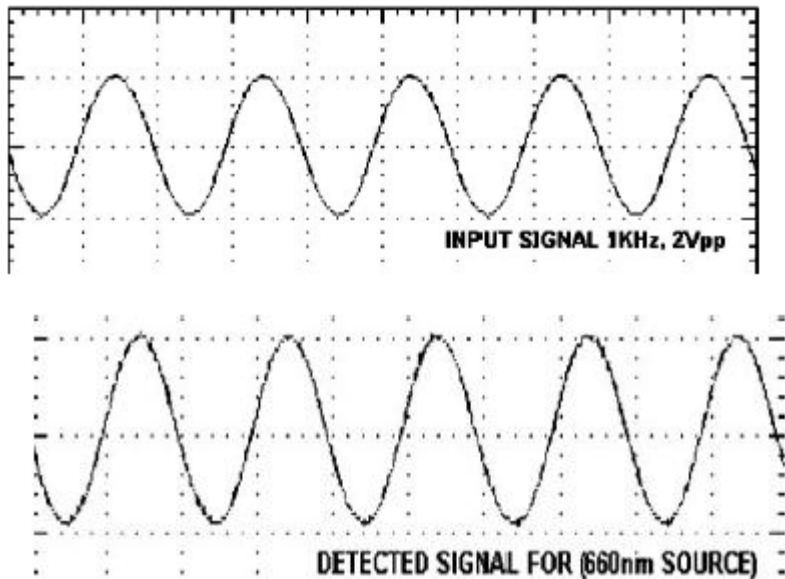
BLOCK DIAGRAM:



PROCEDURE:

MEASUREMENT OF BENDING LOSSES:

- Bend the fiber in a loop as shown in block diagram Measure the amplitude of the received signal.
- Keep reducing the diameter to about 2 cm & take corresponding output voltage readings. (Do not reduce loop diameter less than 2 cm.)
- Plot a graph of the received signal amplitude versus the loop diameter



TABULATION:

Input signal (v)	Output voltage for no.of windings		
	1	2	3

RESULT:

Thus the propagation loss in optical fiber is measured.

STUDY OF CHARACTERISTICS OF FIBER OPTIC LED AND DETECTOR

Ex. No: 06

Date :

OBJECTIVE :

To study the VI characteristics of fiber optic LED'S.

EQUIPMENTS:

S.No	Name of the Components	Specification	Quantity
1	Fiber optic trainer kit.	Link A	1
2	CRO	20 Mhz dual trace	1
3	Power supply	(0±12)v	1
4	Fiber optic cable 1,3 meter	950 nm	1
5	Connecting Chords.	-	As required

THEORY:

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

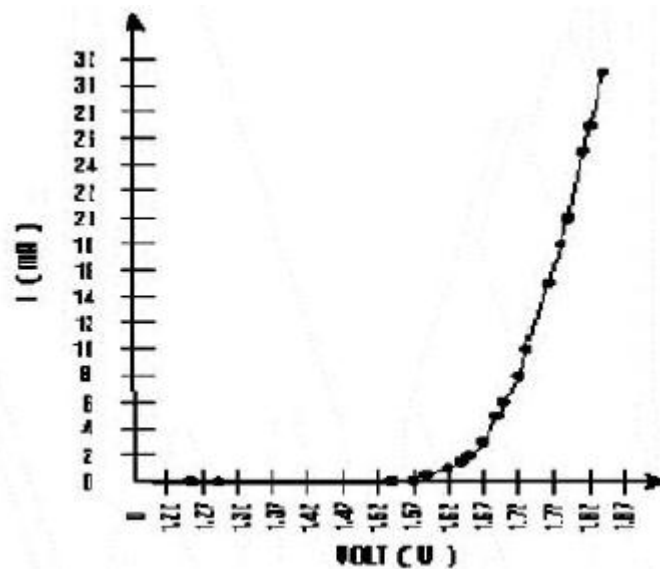
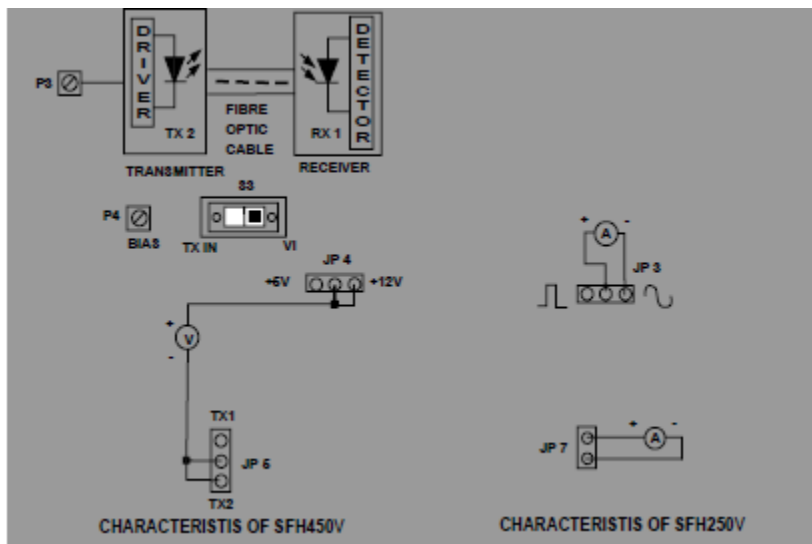
PROCEDURE:

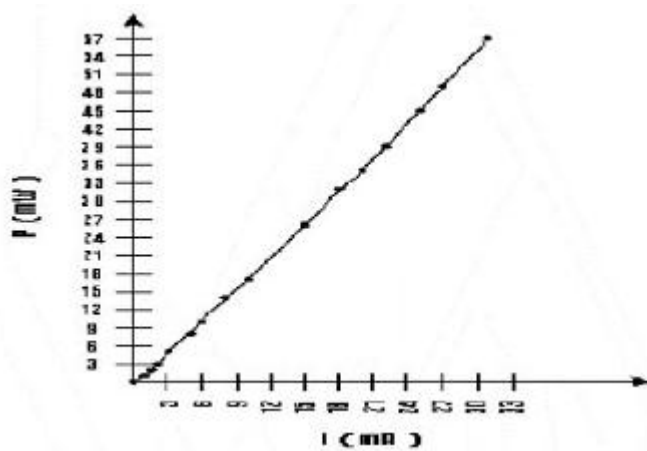
- Make the jumper and switch settings as shown in the jumper diagram. Keep pot P4 in fully clockwise position.
- Connect the ammeter with the jumper connecting wires (provided along with the kit) in jumpers JP3 as shown in the diagram.
- Connect the voltmeter with the jumper wires to JP5 and JP2 at positions as shown in the diagram.
- Connect the ammeter with the jumper connecting wires (provided along with the kit) in jumpers JP7 as shown in the diagram.
- Switch on the power supply. Keep the potentiometer P3 in its minimum position (fully anticlockwise position), P4 is used to control biasing voltage of the LED. To get the VI characteristics of LED, rotate P3 slowly and measure forward current and corresponding forward voltage of the LED, Take number of such readings for forward voltage, forward current & optical power. Keep SW towards VI position. Connect 1Meter Fiber between TX1 & RX1.
- For each reading taken above, find out the power, which is product of I and V. This is the electrical power supplied to the LED. Data sheets for the LED specifies optical power coupled

into plastic fiber when forward current was 10 microA as 200microW. This means that the electrical power at 10mA current is converted into 200 microW of optical energy. Hence the efficiency of the LED comes out to be approx. 1.15%.

- find out optical power coupled into plastic optical fiber for each of the reading in step 4. Plot the graph of forward current v/s output optical power of the LED.
- Measure the current flowing through Detector (RX1) SFH250V at corresponding optical power output (Normally in u A).
- We can observe that as incident optical power on detector increases, current flowing through the detector increases.

BLOCK DIAGRAM:





RESULT:

Thus the characteristics of fiber optic LED and photo detector was obtained.

CONNECTORISATION OF JACKETED GLASS FIBER

Ex. No: 07

Date :

OBJECTIVE :

To study to terminate one meter of jacketed glass fiber with ST Connector at both the ends. Measurement of Connectorisation Loss.

EQUIPMENTS:

- 1 meter Jacketed Glass Fiber.
- CSK- Connector and Splice installation Kit
- 1 meter Standard Glass Patchcord
- Optical Power Source.
- Optical Power Meter

PROCEDURE:

PRECAUTIONS: Please note the following instructions carefully.

- The Connectorisation Kit contains precision mechanical items. Handle the tools with great care.
- Avoid direct skin contact with the chemicals. Irritation and sensitization might occur on contact, wash areas immediately with water. Do not use solvents for washing in case of eye contact. Wash with water for atleast Fifteen minutes and get medical attention.
- Carry out the experiment in a dust-free & dry environment. During the process, absolute care should be taken to keep the bare fiber free from impurities, in order to minimize losses.
- Be careful to dispose of the chips of glass fiber while cutting.
- Cut one meter of jacketed glass fiber optic cable. The fiber consists of core & clad of glass fiber, buffer coating, fibrous (Kevlar) material and outer jacket.
- Place the conical strain relief sleeve over the end of fiber such that broader end of sleeve should be kept towards the fiber tip.
- Remove the outer jacket coating of about ½ inch using fiber optic jacket stripper.
- Cut the fibrous (Kevlar) material using blade or scissors.
- Remove ½ inch of buffer coating using the fiber optic buffer stripper. Select the stripper hole of smaller diameter while removing the buffer. The buffer coating can also be removed chemically.
- Dip the fiber end in Methylene Chloride so that the coating get dissolved.

CAUTION: Care should be taken to avoid cutting the bare fiber of while trying to remove the outer and buffer coating.

- Wipe the bare fiber end with optic prep to remove the dust particles, which may have adhered to the fiber. To minimize losses one should ensure to remove all traces of impurities.

- Insert the fiber end into the connector and ensure that bare fiber emerges out from the ferrule of the connector smoothly. Remove the fiber from the connector.
- Take an equal amount of resin from each part of the epoxy and mix it thoroughly.
- Apply a small amount of epoxy inside the housing of the connector and fill it completely using syringe with needle.
- Insert the stripped fiber into the connector and gently manipulate the cable without exerting any pressure so that the bare fiber finally emerges from the ferrule. Ensure that all the extra part of bare fiber should protrude out from the ferrule.
- Clean the connector with cotton swabs to remove the additional epoxy that has come out of the connector.
- Allow the epoxy to cure for four hours. Take care that the position of the fiber remains unchanged during this process. The fiber is not fixed in that position inside the connector. Curing process can be accelerated by heating at 1400F for about one hour. One can use Hair dryer for this purpose.
- CAUTION: Care should be taken while applying epoxy to prevent any of it from reaching the connector ferrule. This would block the hole in the ferrule face and render the connector useless.
- Do not apply pressure while inserting the fiber in the connector. If the fiber breaks, pieces of glass could clog the hole in the connector ferrule.
- Crimp the back shell of the connector using the crimp tool. Care should be taken for selecting the proper cavity diameter.
- Slide the conical protective sleeve over the housing of the connector.
- Cut the bare fiber part emerging out of the ferrule using the diamond scribe. Extreme care should be taken while scribing and ensure that the cut is made perpendicularly and about 1 mm of the fiber still protrude out of the ferrule.
- Wipe the tip of the ferrule with optic prep.
- Clean the Polishing pad and Polishing tool using tissue paper.
- Place one sheet of polishing paper on the pad, taking care to avoid wrinkles and bubbles on the sheet. If these sheets are not being used for the first time, ensure that there are no remnants of glass or other impurities on them. Clean them with tissue paper if necessary.
- Hold the connectorised fiber inside the ST polishing disc. This will ensure that the fiber is held at 90° while polishing. Rotate the disc over the polishing sheet in the manner of figure of eight pattern. For about 40-50 times or more than that if required.
- Observe the tip of the fiber under Microscope. Switch on the lights of microscope. Concentrate the light beam on the ferrule. Turn the focusing wheel & zoom switch for better visibility. One can view two concentric circle (core and clad) along with some dark spot.
- Polish the fiber until there are no dark spot observed under the microscope. The core and the clad regions should be clearly visible. The absence of this would mean that either the fiber has slipped inside the ferrule while polishing as the bonding was inadequate or the fiber end has broken inside ferrule, in which case the complete process should be repeated. The perfect mirror finish will ensure maximum coupling of light through the fiber.
- Repeat the above procedure to terminate the other end of the fiber. The ST connectorised patchcord can now be used as a link between an optical transmitter and a optical receiver. Another patchcord can be connected to this patchcord using an adapter.

MEASUREMENT OF CONNECTORISATION LOSS

PROCEDURE:

- Take one meter standard glass Patchchord
- Connect one end of the patchchord to optical power source and other end to optical power meter.
- Switch on the power source and power meter. Select the wavelength in power meter in accordance with the wavelength of the source.
- Note the reading in power meter.
- Replace the standard patchchord with the patchchord under test.
- Note the reading in power meter and find out the difference of the readings.
- The difference will denote connector loss.

RESULT:

Thus the end of fiber optic cable is prepared to make joints between SJ connectors

And fiber to fiber.

STUDY OF MICROWAVE COMPONENTS

Ex. No: 08

Date :

OBJECTIVE :

To study the microwave components.

RECTANGULAR WAVEGUIDE:

Waveguides are manufactured to the highest mechanical and electrical standards and mechanical tolerance to meet internal specifications, L and S band waveguides are fabricated by precision brazing of brass plate and all other waveguides are in extrusion quality. Waveguide sections of specified length can be supplied with flanges, painted outside and silver or gold plated inside.

VARIABLE ATTENUATOR:

Model 5020 is a simple and conveniently variable type set level attenuators to provide at least 20db of continuously variable attenuation. These consist of a movable lossy vane inside the section of a waveguide by means of a micrometer. The configuration of lossy vane is so designed to obtain the low VSWR characteristics over the entire frequency band. These are meant for adjusting power levels and isolating a source and load.

FREQUENCY METER MICROMETER TYPE:

Model 4055 are absorption type cavity wavemeter called frequency meter. These are made of tunable resonant cavity of particular size. The cavity is connected to the source of energy through a section of waveguide. The cavity absorbs some power at resonance, which is indicated as a dip in the output power. The tuning of the cavity is achieved by means of a plunger connected to a Microcontroller. The readings of the micrometer at resonance gives frequency from the calibration chart, provided calibration is normally provided at 200Mhz intervals.

TUNABLE PROBE:

Model 6055 tunable probes are designed for use with model 6051 slotted sections. These are meant for exploring the energy of the electric field in a suitable fabricated section of the waveguide. The depth of penetration into a waveguide section is adjustable by knob of the probe. The tip picks up the RF power from the line and this power is rectified by crystal detector, which is then fed to the VSWR meter or indicating instrument.

WAVEGUIDE DETECTOR MOUNT:

Model 4051 tunable detector mounts are simple and easy to use instruments for detecting microwave power through a suitable detector. It consists of a detector crystal mounted in a section of waveguide and a shorting plunger for matching purpose. The output of the crystal may be fed to an indicating instrument. In K and R band detector mounts, the plunger is driven by a micrometer.

THREE PORT FERRITE CIRCULATOR:

Model 6021 and 6022 are T and Y type of the three port ferrite circulators respectively. These are precisely machined and matched three port devices and these are meant for allowing microwave energy to flow in clockwise direction with negligible loss but almost no transmission in anticlockwise direction. Purpose and for measuring reflections and impedance. These consist of a section of waveguide thus making it a four-part network. However, the fourth port is terminated with a matched load. These two parallel sections are coupled to each other through many holes almost to give uniform coupling minimum frequency sensitivity and high directivity. These are available in 3,6,10,20 and 40 db couplings.

E-PLANE BEND:

Model 7071 E-plane bends are fabricated from a section of waveguide to provide one $90^\circ \pm 1$ bend in E-plane. The cross section of bent waveguide is kept throughout uniform to give VSWR less than 1.05 or 1.08 or 1.02 over the entire frequency band. Bends other than 90° can also be fabricated.

KLYSTRON POWER SUPPLY:

Model KP-1010 power supply has been designed to operate low power klystrons such as 2K25, 756A, RK5976 etc. Beam voltage may be continuously varied and is indicated on the front panel meter which can be read the beam supply current and repeller supply volts also by changing the switch. Internal modulation square waves with continuous variable frequency and amplitude are provided. An external modulation may be used through the UHF(F) connector provided on front panel.

GUNN POWER SUPPLY: Model X-110 Gunn power supply comprises of a regulated DC power supply and a square wave generator, designed to operate Gunn oscillator model 2151 or 2152 and pin modulate model 451 respectively. The DC voltage is variable from 0 to 10v. The front panel meter monitors the gunn voltage and the current drawn by the Gunn diode. The square waves of the generator are variable from 0 to 10v in amplitude and 900 to 1100Hz in frequency. The power supply has been so designed to protect Gunn diode from reverse voltage application, over transit and low frequency oscillators by negative resistance of Gunn diode.

RESULT: Thus the various microwave components were studied.

CHARACTERISTICS OF GUNN DIODE OSCILLATOR

Ex. No: 09

Date :

OBJECTIVE :

To plot the characteristics of Gunn diode oscillator.

Apparatus/Components Required :

1. Gunn Power supply
2. Gunn oscillator with mount
3. PIN modulator
4. Isolator
5. Variable Attenuator
6. Frequency meter
7. Detector Mount
8. CRO
9. Probes
10. Cooling Fan
11. Stands

Theory :

Gunn diodes are made up of bulk semiconductor materials like Gallium Arsenide[GaAs], Indium Phosphide[InP] and Cadmium Telluride[CdTe] which exhibit negative resistance. Initially for a range of bias voltages the current increases with voltage and later starts decreasing with increase in bias voltage. In this negative resistance region they exhibit Gunn effect or transfer electron effect and generates microwave oscillations. Gunn diode operates in 4 different modes viz. Gunn or TT mode, LSA mode, quenched domain mode and delayed mode. Microwave oscillations are generated in Gunn or TT mode. A Gunn diode oscillator is designed by mounting the diode inside a waveguide cavity formed by a short circuit termination at one end and by an Iris at the other end.

Precautions :

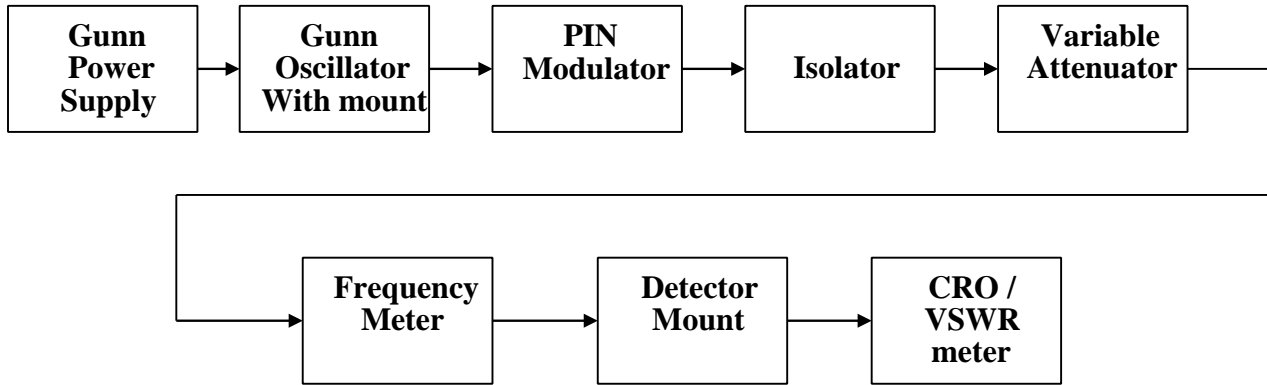
1. Before switching **ON** the Gunn power supply ensure that the Gunn Bias voltage knob is in the minimum position[Left extreme] and the PIN Bias voltage knob is in the middle position.
2. While doing the experiment ensure that the Gunn Bias voltage does not exceed **9 Volts**.
3. Before switching **OFF** the Gunn Bias power supply ensure that the Gunn Bias voltage knob is in the minimum position[Left extreme].

1. V-I Characteristics :

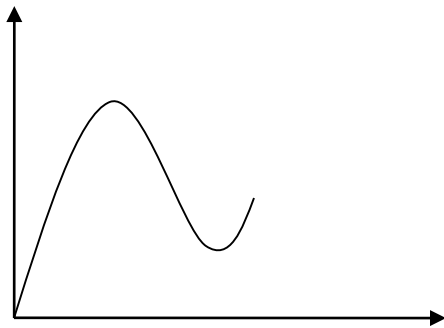
Sl.No	Gunn Bias [Volts]	Current [mA]
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		

Sl.No	Gunn Bias [Volts]	Output Power [dB]	Micrometer reading [Divisions]	Frequency [GHz]
1.				
2.				
3.				
4.				
5.				

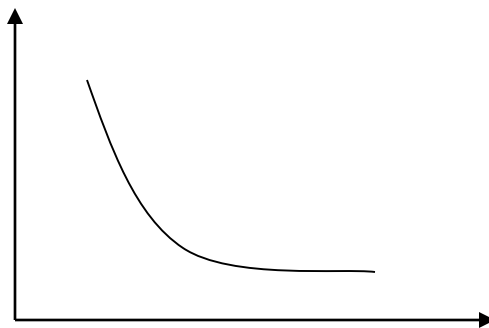
BLOCK DIAGRAM



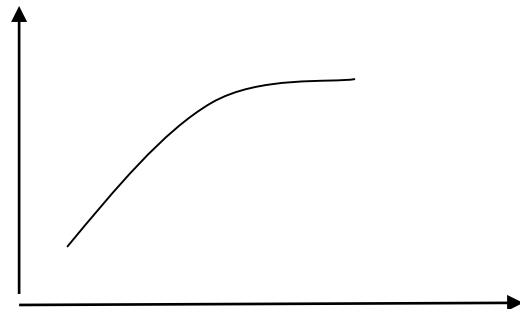
MODEL GRAPH



G U N N B I A S [V O L T S]



G U N N B I A S [V O L T S]



G U N N B I A S [V O L T S]

Procedure :

1. Obtain square wave output by setting the Gunn bias voltage around 6 volts or above and maximize the output by adjusting the micrometers attached to the short-circuit plunger of the gunn diode mount and the detector mount.
2. Now starting from 0 Volt vary the Gunn bias in steps of 1 Volt up to a maximum of 9 Volts. Note down the corresponding currents from the milliammeter.
3. Tabulate the readings and plot the V-I characteristics.
4. In the region of oscillations i.e. for Gunn bias voltages in the range 6-9 Volts, for different bias voltages tune the frequency meter and observe **dip** in the output and the corresponding micrometer position. After noting down the micrometer reading, release[detune] the frequency meter and connect the detector output to VSWR/POWER meter and note down the output power.
5. Tabulate the readings and plot the input-output characteristics[output power Vs Gunn bias voltage] and the frequency response[Frequency Vs Gunn bias voltage].

Result :

Thus the characteristics of Gunn diode has been plotted

RADIATION PATTERN OF HORN/PARABOLIC REFLECTOR ANTENNA

Ex. No: 10

Date :

OBJECTIVE :

: To plot the radiation pattern of horn and parabolic reflector antenna.

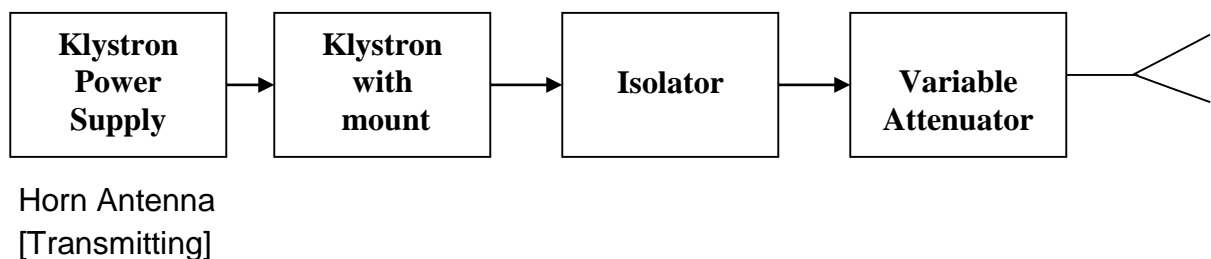
Apparatus/Components Required :

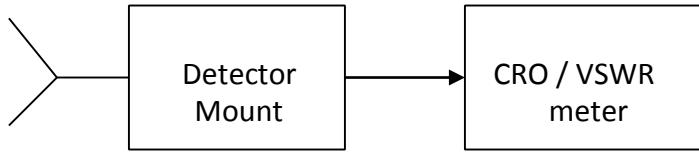
1. Klystron Power supply
2. Klystron with mount
3. Isolator
4. Variable Attenuator
5. Horn Antenna[2 nos]
6. Detector Mount
7. CRO
8. Probes
9. Cooling Fan
10. Stands
11. Parabolic reflector antenna

Theory :

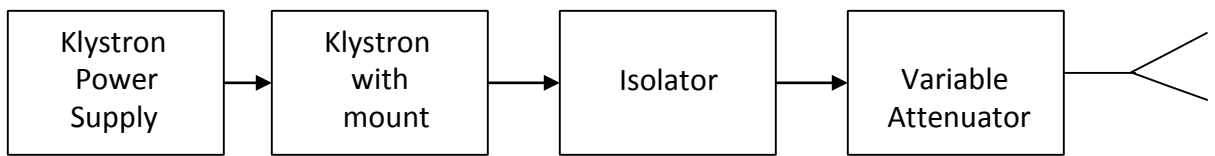
Radiation pattern of an antenna is obtained by plotting the voltage or power or gain at various angles from the antenna. Both horn and parabolic reflector antenna the radiation pattern is uni-directional i.e. maximum energy is radiated in a particular direction and in other directions minimum or zero radiation. In addition to the major lobe there may be few minor side lobes existing. Half-power or 3-dB beam width may be found by measuring the angle between the two half-power points or the 3-dB points or the angle between two points where the voltage is $V_{max}/\sqrt{2}$. Similarly the beam width between first nulls[BWFN] may be found by measuring the angle between two tangential lines to the major lobe from the origin.

BLOCK DIAGRAM

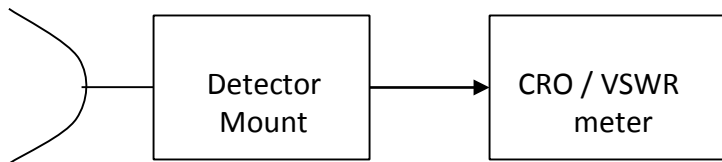




Horn Antenna
[Receiving]

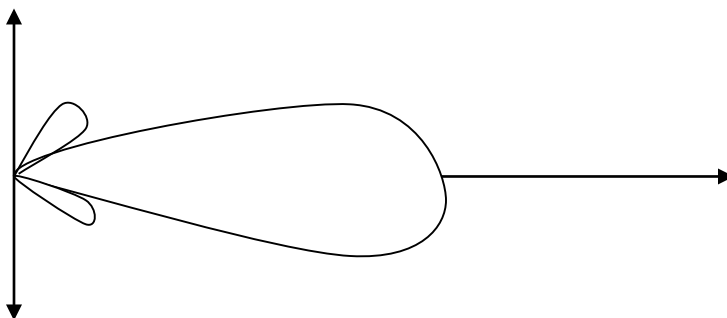


Horn Antenna
[Transmitting]



Parabolic reflector
[Receiving]

MODEL GRAPH



Tabulation :

1. Horn Antenna & PARABOLIC ANTENNA:

Vin= Volts d= cms

Sl.No	Angle in degrees	Output Voltage [Volts]	Angle in degrees	Output Voltage [Volts]
1.	0		350	
2.	10		340	
3.	20		330	
4.	30		320	
5.	40		310	
6.	50		300	
7.	60		290	
8.	70		280	
9.	80		270	
10.	90		260	
11.	100		250	
12.	110		240	

Precautions :

1. Before switching **ON** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].
2. While doing the experiment ensure that the beam voltage and beam current do not exceed **250 Volts** and **20 mA** respectively.
3. Before switching **OFF** the Klystron power supply ensure that the beam voltage knob is in the minimum position [Left extreme] and the repeller voltage knob is in the maximum position [right extreme].

Procedure :

1. Obtain square wave output without the antenna in the set-up and maximize the output by adjusting beam voltage, repeller voltage, modulating amplitude and the attenuator and note down this voltage as Vin.

2. Now connect the two horn antenna in the set-up and align the two antenna both vertically and horizontally for maximum output. Ensure a minimum distance(end to end) of 15 cms between the antenna.
3. Set the angle where maximum output obtained as zero degrees and note down the output voltage.
4. Vary the angle from zero degrees through 360 degrees and note down the corresponding output voltages. Tabulate the readings.
5. Plot the Output voltage Vs Angle in degrees in a polar sheet.
6. Find the 3dB beam width and BWFN.
7. Repeat steps 1 to 6 with parabolic reflector antenna in the **receiving antenna** position instead of horn antenna.

Result :

Thus the radiation pattern of horn and parabolic reflector antenna were plotted and the 3-dB beamwidth and BWFN were found to be :

3-dB beamwidth = degrees

BWFN = degrees

MEASUREMENT OF WAVELENGTH AND FREQUENCY

Ex. No:11

Date :

OBJECTIVE :

To measure wavelength and the frequency of the microwave signal by both direct and indirect methods.

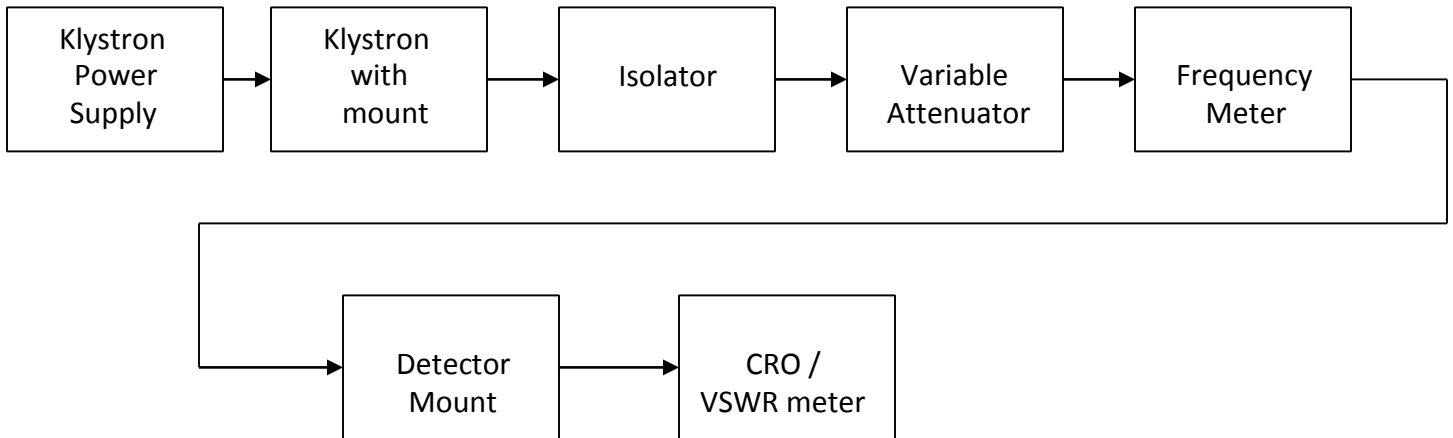
Apparatus/Components Required :

- | | |
|------------------------------------|------------------------|
| 1. Klystron Power supply | 2. Klystron with mount |
| 3. Isolator | 4. Variable Attenuator |
| 5. Frequency meter | 6. Detector Mount |
| 7. slotted line with tunable probe | 8. Matched Termination |
| 9. CRO | 10. Cooling Fan |
| 11. Probes | 12. Stands |

Theory :

I. DIRECT METHOD:

Frequency meter is made up of a cylindrical cavity[absorption type]. By varying the effective height(d) of the cavity its resonance frequency (f_r) may be varied. At resonance i.e. when the incoming signal frequency matched with the

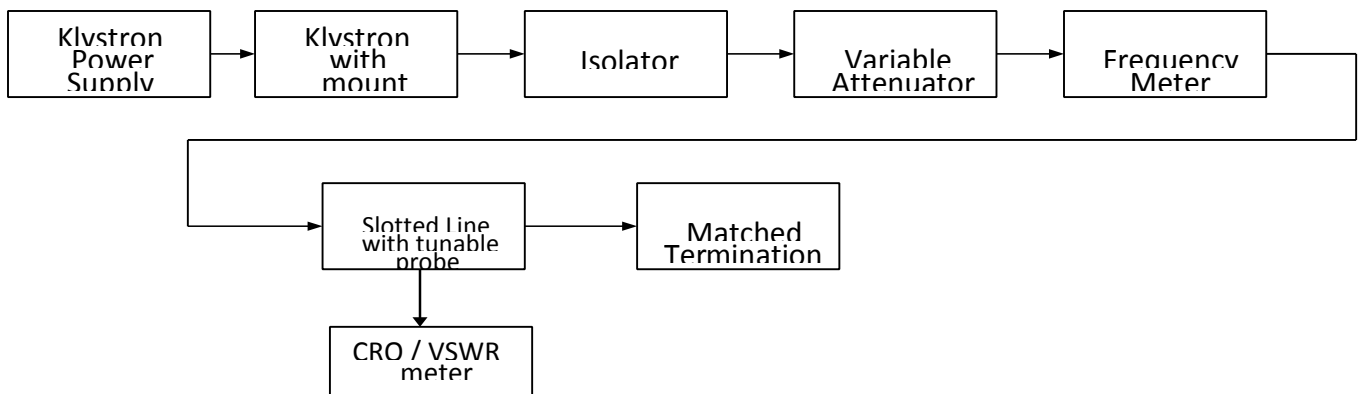


' f_r ' of the cavity, maximum energy is stored in the cavity resulting in a minimum transmitted output.

II. INDIRECT METHOD:

While studying the standing wave pattern, the distance between two successive minima or maxima corresponds to ' $\lambda_g/2$ ' or $\lambda_g = 2 \times (\text{distance between successive minima or maxima})$. The cutoff wavelength of rectangular wave guide for dominant $[TE_{10}]$ mode is given by $\lambda_c = 2 \times a$.

Then the free space wavelength ' λ_0 ' can be found using the formula: $\lambda_0 = \lambda_g \lambda_c / \sqrt{\lambda_g^2 + \lambda_c^2}$
 and the frequency of the signal is given by : $f = C / \lambda_0$ where $C = 3 \times 10^8$ m/sec [Velocity of EM waves in free space].



Tabulation :

I. DIRECT METHOD:

Sl.No	Micrometer Reading	Frequency [GHz]

I. INDIRECT METHOD:

a = cms

Sl.No.	d1 [cms]	d2 [cms]	λ_g [cms]	$\lambda_c = 2*a$ [cms]	λ_o [cms]	Frequency [GHz]

Precautions :

1. Before switching **ON** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].
2. While doing the experiment ensure that the beam voltage and beam current do not exceed **250 Volts** and **20 mA** respectively.
3. Before switching **OFF** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].

Procedure :

I.DIRECT METHOD :

1. Obtain square wave output and maximize the output by adjusting beam voltage, repeller voltage, modulating amplitude and the attenuator.
2. Adjust the micrometer attached to the frequency meter till the output becomes minimum or a dip is observed in the CRO. Now, note down the micrometer reading.
3. Refer to the conversion chart and note down the corresponding frequency in GHz.

II.INDIRECT METHOD :

4. Without disturbing the settings remove the detector mount from the setup and connect the slotted line with tunable probe and the the matched termination as in the diagram.
5. Observe the variation in the output in the CRO by moving the probe along the slotted line from left to right.
6. Note down two successive minima or maxima points as d1 and d2.
7. Find λ_g from $\lambda_g = 2*(d1 - d2)$
8. Calculate λ_c from $\lambda_c = 2*a$ where 'a' is the broader inner dimesion of the wave guide.
9. Calculate λ_o from $\lambda_o = \lambda_g \lambda_c / \sqrt{\lambda_g^2 + \lambda_c^2}$
10. Calculate 'f' from $f = C / \lambda_o$ where $C = 3 \times 10^8$ m/sec [Velocity of EM waves in free space].
11. Obtain signal with a different frequency[mode] by adjusting the repeller voltage.
12. Repeat steps 1 to 10 for the new frequency.

Result :

Thus the wavelength and frequency of the signal is measured by both direct and indirect methods and are :

	f1 GHz	f2 GHz
Direct method		
Indirect Method		

CHARACTERISTICS OF REFLEX KLYSTRON

Ex. No: 12

Date :

OBJECTIVE :

To plot the characteristics of reflex klystron oscillator.

Apparatus/Components Required :

- | | |
|--------------------------|------------------------|
| 1. Klystron Power supply | 2. Klystron with mount |
| 3. Isolator | 4. Variable Attenuator |
| 5. Frequency meter | 6. Detector Mount |
| 7. CRO | 8. Probes |
| 9. Cooling Fan | 10. Stands |

Theory :

Reflex Klystron Oscillator works on the principle of **Velocity Modulation**. The velocity of the electrons[electron beam] vary in accordance with the variation of the RF field setup in the cavity. By varying the repeller voltage the frequency of the signal and also the output power/voltage varies. While varying repeller voltage continuously the output waveform[square wave] appears and disappears several times. Each appearance of the output within a given range of repeller voltage is called a “**mode**”. The method of varying the output frequency by varying the repeller voltage is called “ **Electronic tuning** of reflex klystron”.

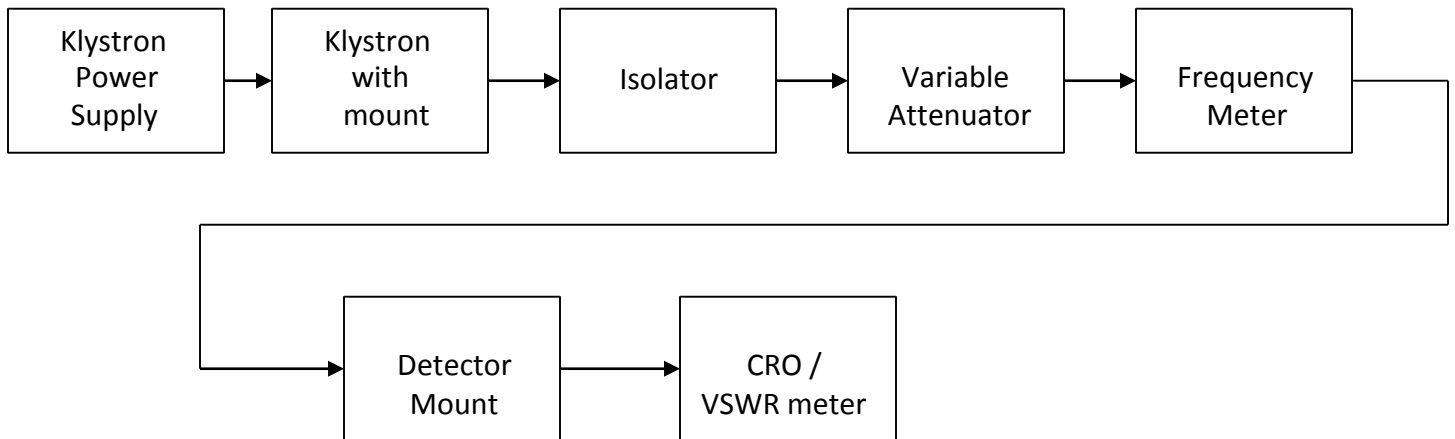
Precautions :

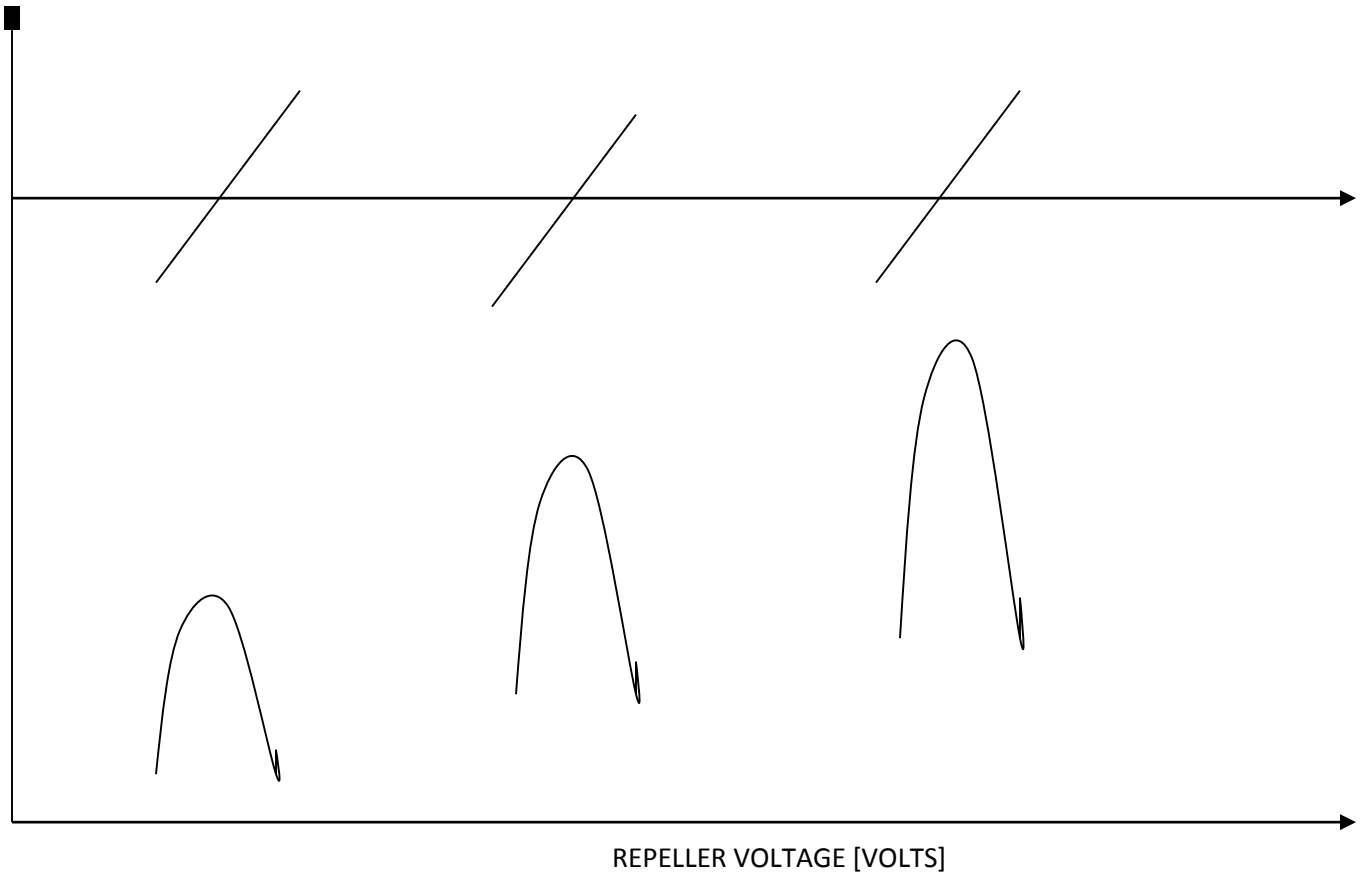
1. Before switching **ON** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].
2. While doing the experiment ensure that the beam voltage and beam current do not exceed **250 Volts** and **20 mA** respectively.
3. Before switching **OFF** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].

Procedure :

1. Obtain square wave output and maximize the output by adjusting beam voltage, repeller voltage, modulating amplitude and the attenuator.
2. For each mode note down the maximum output voltage and the corresponding repeller voltage [X Volts] and the micrometer position for which the output becomes minimum/disappears. Also note down the above values for repeller voltages: X+5V and X-5V.
3. Repeat step 2 for atleast 3 different modes.
4. Tabulate the readings.
5. Plot the Output Vs repeller voltage and Frequency Vs repeller voltage.

BLOCK DIAGRAM





MODEL GRAPH

Tabulation :

Sl.No	Repeller Voltage [Volts]	Output Voltage [Volts]	Micrometer reading [Divisions]	Frequency [GHz]
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				

Result :

Thus the characteristics of reflex klystron has been plotted

STUDY OF DIRECTIONAL COUPLER

Ex. No: 13

Date :

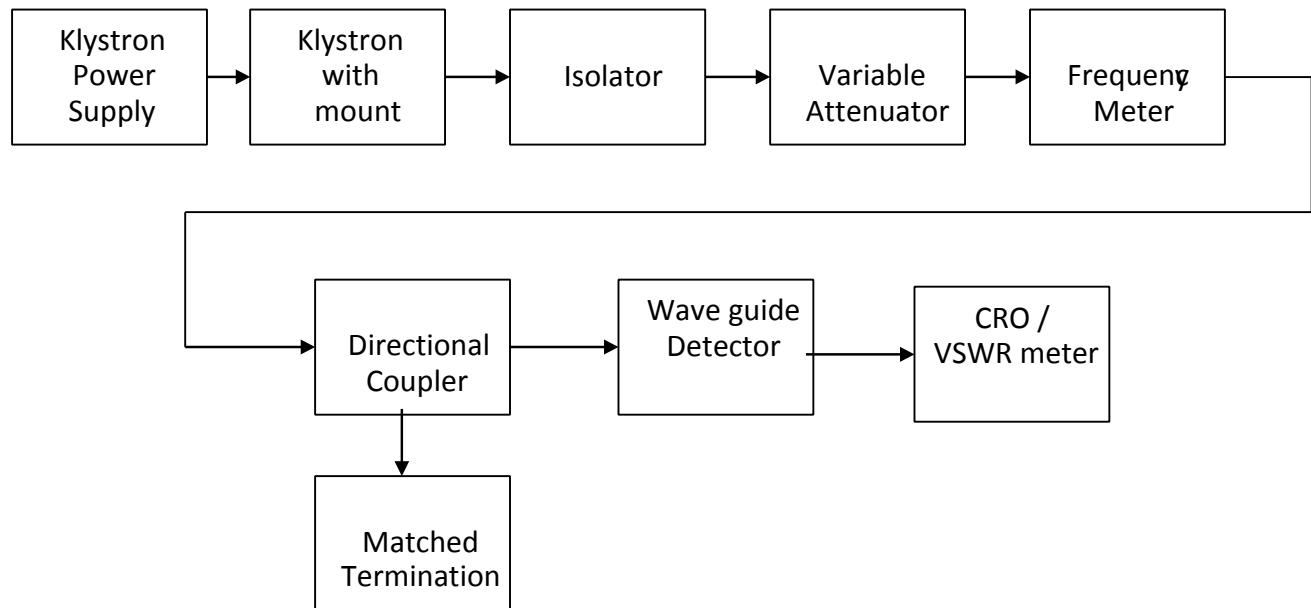
OBJECTIVE :

To study the characteristics of directional coupler and find its S-matrix.

APPARATUS REQUIRED:

1. Klystron Power supply
2. Klystron with mount
3. Isolator
4. Variable Attenuator
5. Frequency meter
6. Slotted line with tunable probe
7. Matched Termination__ Nos
8. Directional Coupler
9. VSWR meter
10. CRO
11. Stands
12. Probes
13. Cooling Fan

BLOCK DIAGRAM : to measure VSWR :



Theory :

Directional Coupler is used to couple a fraction of the input power in either the forward or backward directions. It works on the principle of aperture coupling. In a forward coupler desirable amount of power is coupled in the forward direction through single, two or multiple holes[apertures]. In the backward direction the amount of power coupled is ideally zero, but practically there may be a meager[negligible] amount of

power which is absorbed by the matched termination connected internally. Hence practically it remains a closed port. Ideal values for the parameters are as below :

Main line VSWR = 1

Transmission loss = $10 \log[P_1/P_2] = 20 \log[V_1/V_2] = 0 \text{ dB}$

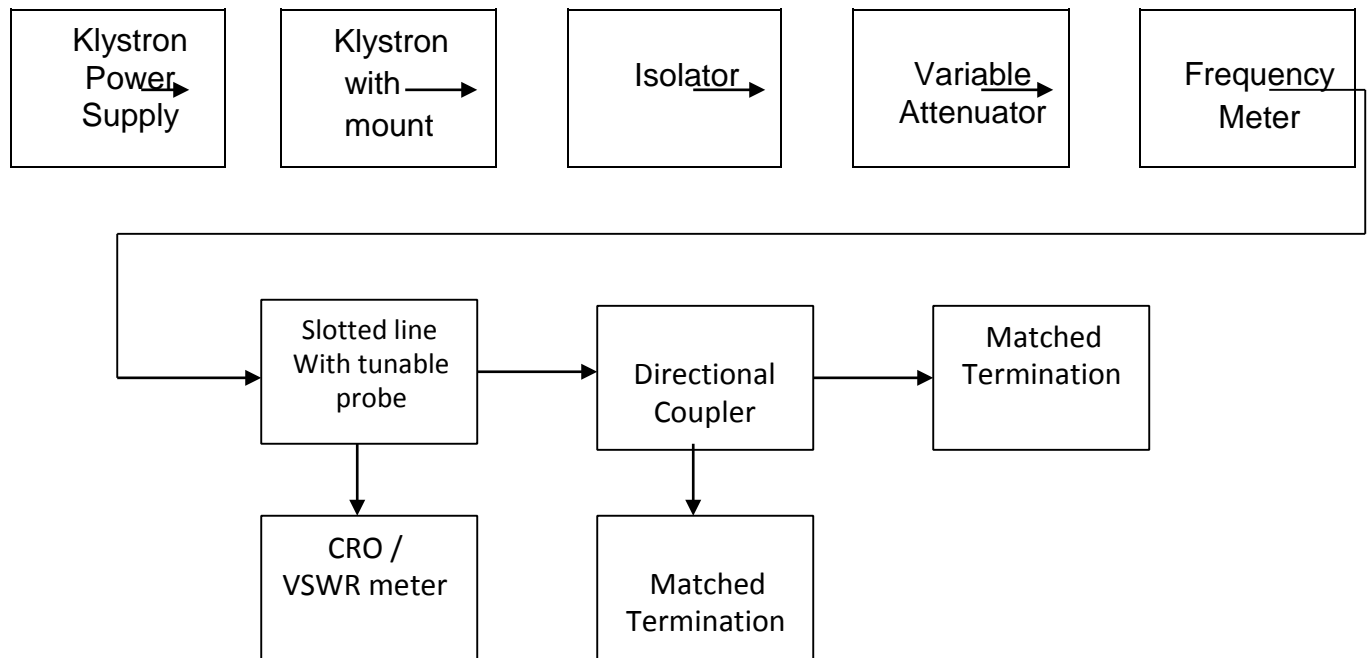
Coupling coefficient = $10 \log[P_1/P_4] = 20 \log[V_1/V_4]$ is a design parameter

Directivity = $10 \log[P_4/P_3] = 20 \log[V_4/V_3] = \infty \text{ dB}$

31

42

BLOCK DIAGRAM : to measure voltages :



Precautions :

1. Before switching **on** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].
2. While doing the experiment ensure that the beam voltage and beam current do not exceed **250 Volts** and **20 mA** respectively.
3. Before switching **off** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].

Tabulation :

VSWR	Input	Output
	<u>At port -1</u> = _____ V	<u>At port -2</u> = _____ V
		<u>At port -3</u> = _____ V
		<u>At port -4</u> = _____ V

Procedure :

To measure VSWR :

1. Make the microwave set-up as in the diagram-I, with the directional coupler with matched terminations at appropriate ports as the terminating load. Obtain square wave output and maximize the output by adjusting beam voltage, repeller voltage, modulating amplitude and the attenuator.
2. VSWR measurement : First identify the maxima position in the slotted line with the help of CRO. Now, without disturbing the set-up connect the probe output to VSWR meter. Select the appropriate range where deflections in the meter are obtained. Now using the gain control [Course and Fine] set the VSWR to 1 [i.e. 0 dB]. Now move the slotted line to a nearest minima position on either side. The maximum deflection in the meter gives the VSWR directly.
3. From the value of VSWR[S], find the reflection coefficient using :

$$\Gamma = [S-1]/[S+1] = S_{11}=S_{22}=S_{33}=S_{44} \quad \text{To measure}$$

voltages :

1. Without disturbing the setup, remove the slotted line and connect a waveguide detector and measure its output without directional coupler as the input voltage V_1 .
2. Now again without disturbing the setup, insert the directional coupler into the setup as shown in the diagram-II.
3. Measure the voltage at port-2 [V_2] with the detector at port-2 and a matched termination at port-4.
4. Interchange the detector and matched termination without disturbing the setup. Measure the voltage at port-4 [V_4].
5. Without disturbing the setup reverse the directional coupler and measure voltage at port-3 [V_3], with detector at port-3 and matched termination at port-2.
6. Tabulate the readings and calculate the s-parameters from :

$$S_{21} = V_2/V_1 ; S_{31} = V_3/V_1 ; S_{41} = V_4/V_1$$

Transmission loss[T] in dB = $20 \log [1/S_{21}]$
 Coupling Coefficient [C] in dB = $20 \log [1/S_{31}]$ and
 Directivity [D] in dB = $20 \log [S_{41}/S_{31}]$

Result :

The characteristics of directional coupler is studied and the S – parameters and the other parameters are found as below:

S₁₁		S₂₁		S₃₁		S₄₁	
Transmission Loss [dB]			Coupling Coefficient [dB]				
Directivity [dB]							

VSWR MEASUREMENT

Ex. No: 14

Date :

OBJECTIVE :

To measure VSWR introduced by the wave guide in dominant mode of propagation.

COMPONENTS REQUIRED:

1. Microwave source (klystron power supply)
2. Klystron Mount
3. Isolator
4. Variable Attenuator
5. Slotted section
6. Matched Termination
7. VSWR meter (or) CRO

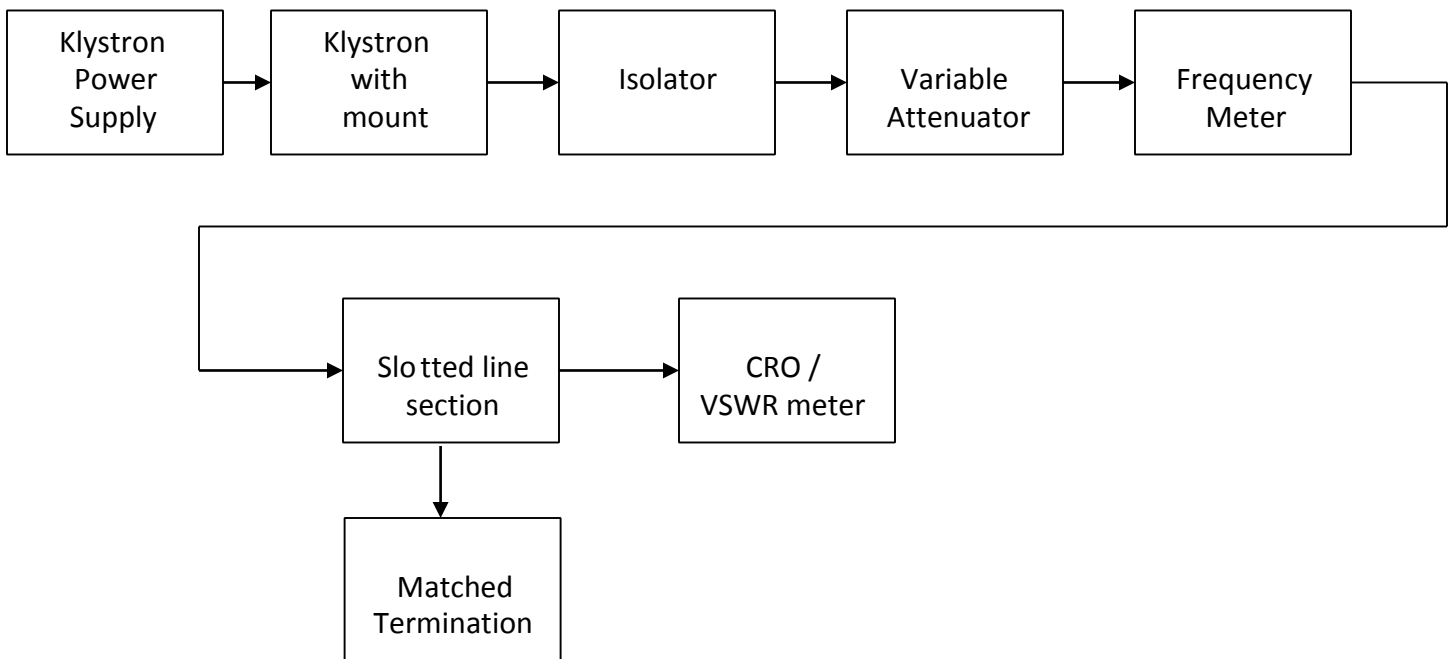
FORMULA:

$$\text{VSWR} = V_{\text{max}} / V_{\text{min}}$$

Precautions :

1. Before switching **on** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].
2. While doing the experiment ensure that the beam voltage and beam current do not exceed **250 Volts** and **20 mA** respectively.
3. Before switching **off** the Klystron power supply ensure that the beam voltage knob is in the minimum position[Left extreme] and the repeller voltage knob is in the maximum position[right extreme].

BLOCK DIAGRAM : VSWR measurement



PROCEDURE:

1. Arrange the bench setup as shown in figure.
2. Adjust the probe carriage to measure V_{max} and note the readings.
3. Adjust the probe carriage to measure V_{min} and note the readings.
4. Use the formula to find VSWR.

RESULT:

Thus the VSWR introduced by the wave guide in dominant mode of propagation was determined and verified

ATTENUATION AND POWER MEASUREMENT

Ex. No: 15

Date :

OBJECTIVE :

To measure the output of a variable attenuator and to verify its attenuation characteristics.

APPARATUS REQUIRED:

Klystron power supply, Klystron with mount, Isolator, Variable attenuator, Frequency meter, Detector mount, CRO, cooling fan, probes, stands

PRECAUTIONS:

1. Before switching on the klystron power supply ensure that beam voltage knob and repeller voltage knob are in the min and max position respectively.
2. At no point should voltage or current exceed 250 mA and 20mA respectively.
3. Ensure that knobs are at the original position before switching off.

THEORY:

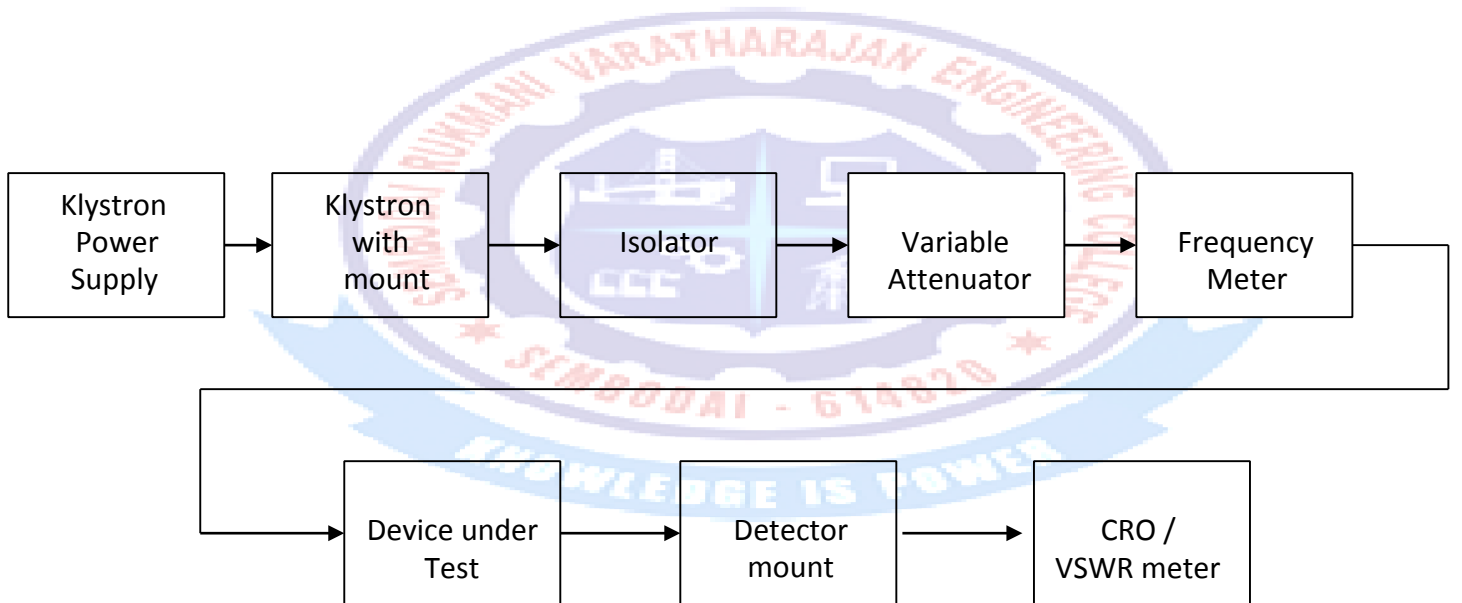
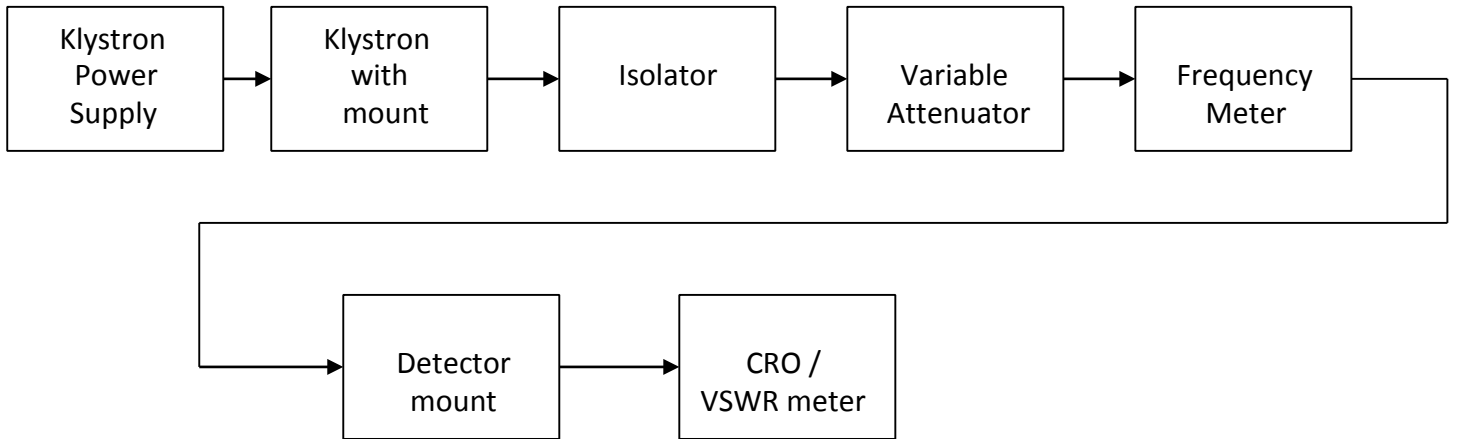
THERMOCOUPLE:

Thermocouples are based on the fact that dissimilar metals generate a voltage due to temperature difference at a hot and a cold junction of the two metals. The increased density of free electrons at the left causes diffusion towards the right. The migration of electrons towards the right is by diffusion, the same physical phenomenon that tends to equalize the partial pressure of a gas throughout the space. The rod reached equilibrium when the rightward force of heat induced diffusion.

MODERN POWER METER:

A 16-bit analog digital converter (ADC) processes the average power signal. A highly sophisticated video amplifier design is implemented for the normal path to pressure envelop fidelity and accuracy. The central gun for peak and average power meters is to provide reliable accurate and fast characteristics of pulsed and complex modulation envelops. The meters excel in versatility featuring a techniques called time gated measurements.

BLOCK DIAGRAM : ATTENUATION MEASUREMENT



PROCEDURE:

1. Set the micro bench as per the block diagram.
2. Initial setting in the power meter is set.
3. Resolution→ 0.1 db]
4. Select absolute unit option and select dbm.
5. Select bar graph required.
6. Select the band as X
7. Select the number of samples/sec as 100/sec.
8. Enter the switch, which is used to store the selected mean option.
9. Escape switch is used to cancel any command.
10. The maximum output power is obtained by properly adjusting the klystron power supply.
11. By varying the variable attenuator corresponding output power is measured from the power meter.
12. A graph is drawn between micrometer reading of VA and power meter.

RESULT:

Thus the output of a variable attenuator was measured and its characteristics were verified.