Object:- Study of various microwave Components and instruments like frequency meter, attenuator and detector & VSWR meter.

Apparatus Required:- Gunn power supply, Klystron power supply, SWR meter, Reflex klystron, Klystron mount, Isolator, Attenuator, Direct reading frequency meter, Slotted section, Tunable probe, Matched termination, Moveable short, Detector mount, S.S. tuner, Directional Coupler, E-plane tee, H-plane tee, Magic tee, circulator etc.

Theory:

(1.1) Gunn power Supply:

Gunn Power Supply Comprises of an electronically regulated DC power supply and a square wave generator designed to operate Gunn oscillator and PIN modulator simultaneously. The DC Voltage is Variable from 0 to 10 volts. The frequency of square wave Can be Continuously Varied from 800 to 1200 Hz. The front panel meter Can read the Gunn voltage and the current drawn by the Gunn diode

The Power Supply is designed to protect Gunn diode from reverse voltage application from over voltage transients and from low frequency oscillations.

1.2 Gunn Oscillator:
Gunn oscillator has been designed as a stable and spectrally pure microwave source. The oscillator has a Gunndiode mounted in a waveguide cavity which is tunable over the range 8.5 to 11.5 GHz by a micrometer controlled tuning plunger. Output power available is 5mW-10mW.

1.3 PIN Modulator:
The CW output of the Gunn oscillator can be a square wave pulse modulated by superimposing the modulating voltage on the Gunn diode bias voltage. It is however rather difficult to achieve good modulation due to varying impedance of Gunn diode with temperature Moreover the generating circuit of modulating voltage should have low output impedance and should be able to deliver as much

Scanned by TapScanner

as 300 to 500 mA. These disadvantages can be overcome by using an external PIN diode modulator operating on the CW output of the Gunn oscillator.

The PIN Modulator is a transmission line i.e. Wave guide shunted with a PIN Diode. The impedance of diode varies with the bias applied to it. At negative or zero bias the diode presents very low impedance, thus reflecting the signal. At positive bias, the diode presents very high impedance and therefore does not affect the signal propagating along the transmission line.

Since the propagating power is reflected during the period when positive voltage is on the ~~PIN~~ Diode. it is advisable to place an isolator between the Gunn Oscillator and PIN modulator protect the former.

Switch Description

1. Power: push switch to supply the power to the instrument.

(2) Mode select: By this selection switch one can select CW/Int Modulation/pc data Audio Input signal as PIN supply output. In CW mode no signal provide from PIN Supply output i.e no modulation take plase. In Internal mode output of PIN supply is data from pc. In Audio Mode output of PIN Supply is Audio wave.

(3) Audio Input: We can connect a Mic to give audio signal as a PIN supply to PIN modulator.

(4) Gunn supply: 0-10V Gunn supply output is available here.

(5) PIN supply: Selected output for modulation is available here.

(6) PIN Bias: Amplitude control for the PIN supply (square wave) from 0 to 10 Vpp.

(7) Mod. frequency: Frequency control for the PIN supply (square wave)

(8) LCD Display: 16 X 2 LCD display for Gunn supply voltage and current measurements

(9) Gunn Bias: Amplitude control for Gunn supply.

1.4 Klystron Power Supply NV102

Klystron power supply, is state-of-the-art solid-state, regulated power supply for operating low power klystrons such as 2K25.

It incorporates a number of proprietary

(1) Regulated Beam supply and Repeller supply voltages.

(2) LED Digital metering for Beam voltage, current and Repeller voltage.

(3) Compact and Reliable.

(4) Modular Construction for easy maintanance

In addition to AM and FM modulation of Beam current. a provision for externally modulating the klystron supply with desired signal waveform has been provided. Klystron Power supply Utilizes the quality components and rugged construction.

Switch Description:

1. Power: Push button switch for supplying the power to instrument.

2. Display: for monitoring beam Voltage (in volts), Repeller Voltage and beam Current (mA).
   Beam Voltage: 240V to 420V DC
   Repeller Voltage: 18V to 270V DC
   Beam Current: 0 to 50mA

3. Meter select switch: For selecting display mode in V - shows Beam Voltage (volts Shows Beam Current (mA) and REP - shows Repeller Voltage in volts.

4. HT: Output 'on/off' switch.
5. Beam Voltage: Adjust potentiometer, it is vary from 240 to 420V DC.
6. Repeller Voltage: Adjust potentiometer, it is vary from 40V to 270V DC
7. 8 pin octal socket: pin 8-1 = Beam Voltage
   pin 8-5 = Rep. Voltage
   pin 2-7 = Heater Voltage.
8. External mode: To provide external modulating signal.

Scanned by TapScanner

(9) FM modulation: Frequency potentiometer controls the frequency or the sweep modulating signal (50-150 Hz). Amplitude potentiometer controls the amplitude or sweep modulating signal (0-60 vpp)

(10) AM modulation: frequency potentiometer controls the frequency ~~or~~ of the square wave modulating signal (500-2000 Hz). Amplitude potentiometer controls the amplitude or square wave modulating signal (0-110 vpp).

(11) Modulation selection switch: For selecting modulation types CW mode - No modulation signal applied to the beam voltage. FM mode - A sweep modulation is applied to the beam voltage, Ext mode - External modulating signal is accepted for modulation or beam current through BNC Connector.

(12) Earphone socket: Here we can connect a MIC to give audio signal as a modulating signal.

Rear Panel Control:

(1) External/Audio: If EXT selected then you can give an external modulating signal

to External BNC given at a front panel. If Audio is seleted you can connect a microphone for giving modulating signal to Audio input socket on front panel.

(2) FM/o/p :- For observing saw tooth signal which is used for FM.

(3) Heater adjusts: After unsealing the cap we can charge the heater supply

1.5 SWR Meter NV103 A

The model NV 103A SWR meter, is a high gain low noise, tuned voltmeter operating at fixed frequency. It is designed for making standing wave measurement in conjunction with a suitable detector and slotted line or wave guide section. It may be used as null detector in bridge circuit and as fixed frequency indicator. It is calibrated to indicated directly SWR or dB when used with square law devices such as crystal diode. It is adjusted for operation at 980 Hz to 1020 Hz to avoid harmonics of the line frequency.

Scanned by TapScanner

(1) Power: Push button switch for supplying power to instrument.

(2) Audio Output: This Socket is provided for connecting head phone.

(3) Mode Select: This switch is given to select different modes of SWR meter mode are

Normal: In this mode the 1 kHz square wave detected output is given to input of SWR meter. All the measurement of gain and SWR should be measure in this mode.

Audio: Select this mode is the input of pin modulator is a audio signal.

DC: Select this mode if the input of PIN modulator is DC data.

(4) Crystal: It is an input impedance selector switch for low and high inputs i.e. High 200k - Low 200Ω

(5) SWR/dB: This switch provided to select display modes either it reads in dB power or SWR of device.

(6) Input: BNC (female) Connector for connecting signal to be measured.

(7) Range Switch: A seven position attenuator minimum in 10 dB steps.

(8) Gain Coarse: Control for adjustments of meter or any other convenient reading.
Gain fine: Control for fine adjustments of meter or any other convenient reading.

(9) LCD display in SWR & dB: LCD display, for measuring SWR and gain.

1.5.2 Rear Panel Control

(1) PC Interface: This is provided for connecting RS232 cable for PC Communication

(2) Comparator Adjust: For PC to PC communication adjusts the potentiometer such that output BNC should give the received PC signals which are transmitted from transmitter PC.

(3) Output: Detected signal can be observed on CRO from output BNC.

1.5.3 Auxiliary equipment required:

For SWR measurement, following are required:

(1) Signal Source:

The signal source should cover the desired frequency range and be amplitude modulated at operating frequency of the

SWR meter. Generally square wave modulation is used which reduces to a minimum the effects of ~~of~~ harmonic and frequency modulation. In any application, it is necessary to minimize interaction between the oscillator and the load. In these cases, an isolation device should be used.

(2) Cables or waveguides:
The cable or the wave guide used for connecting the source to a slotted match the source impendance over the desired frequency range.

(3) Slotted section:
The slotted section should cover the desired frequency and be equipped with an accurate scale on indicator.

(4) Detector:
The detector should be square law (output proportional to RF power input) device such as a Barretter or a crystal diode operated at low signal level. A Barretter is ~~reap~~ reasonable square law when used at low signal level but in general this cannot be said in all cases

with crystal diode However the sensibility of crystal is considerably better than with Barretters so that crystals are widely used as detectors for SWR measurements.

(5) Known loads:-

Various termination are required (i.e. a fixed and a movable short circuit) to establish reference point and to aid in calibrating the test setup.

Results

Hence, we have ~~started~~ study listed components.

11/10/26

Experiment No. 1 (a)

Date

object: Measurement of guide wavelength and frequency using a X-band slotted line setup.

Apparatus Required:
1. klystron tube
2. klystron power supply
3. klystron mount
4. Isolator
5. frequency meter
6. Variable attenuator
7. slotted section
8. Tunable probe
9. VSWR meter
10. wave guide stand
11. Movable short
12. matched termination.

Theory:-
The cut-off frequency relationship shows that the physical size of the wave guide will determine the propagation of the particular modes of specific orders determined by value of m and n. The

Minimum cut-off frequency is obtained for a wave guide having dimension a>b, for value of m = 1, n=0, i.e. TE_{10} mode is the dominant mode since for TM_{mn} modes m ≠ 0 or n ≠ 0 the lowest-order mode possible is TE 10, called the dominant mode in a ~~reg~~ retangular wave for a>b.

For dominant TE_{10} mode rectangular wave guide λ_0, λ_g and λ_c are related as blows

$$1/\lambda_0^2 = 1/\lambda_g^2 + \frac{1}{\lambda_c^2}$$

Where λ_0 is free space wave length
λ_g is guide wave length
λ_c is cut off wave length
For TE 10 mode λ_c – 2a where a is brode dimention of wave guide.

Result:-

Objectives: To determine the low, medium and high, voltage standing, wave ratio (VSWR)

Equipments: Klystron tube, Klystron power supply, Isolator, frequency meter, variable attenuator, Klystron mount, waveguide stand SWR meter, slotted line, Tunable probe, Movable short/termination or any unknown load and BNC cables, S-S Tuner and accessories.

Theory:

The electromagnetic field at any point of transmisson line or waveguide maybe considered as the sum of two traveling wave: the 'incident wave' propagate from generator and the 'reflected wave' propagates towards the generator. The reflected wave is set up by reflection of incident wave from a discontinuity on the line or from the load impedance. The magnitude and phase of reflected wave depends upon amplitude and phase of the reflecting impedance. The presence of two traveling wave gives rise to standing wave along the line. The maximum field strength is found where two waves are in phase and minimum where they are in opposite phase. The distance between two successive (minimum to maximum) is half the guided wave-length on the line. The ratio of electrical field strength of reflected and incident wave is called reflection coefficient. The VSWR is defined as ratio between maximum and minimum field strength along the line. Hence, VSWR is

$$S = \frac{E_{max}}{E_{min}} = \frac{|E_I| + |E_R|}{|E_I| - |E_R|}$$

Where $|E_I|$ and $|E_R|$ are respectively the amplitude of the incident and reflected electric field strength. Standing wave ratio is frequently expressed in density VSWR (dB) $= 20 \log(S)$.

further, the ratio of the reflected to the incident to field defined as reflected coefficient

$$\Gamma_R = \frac{E_R}{E_I} = \frac{Z_L - Z_0}{Z_L + Z_0}$$

Where Z_L is the load impedance and Z_0 is the characteristic impedance. Hence, VSWR can be expressed in term of reflection coefficient as follows:

$$S = \frac{1 + \Gamma_R}{1 - \Gamma_R}$$

When $E_{max} = E_{min}$, i.e there is no reflection $[E_R = 0]$ the resulting VSWR = 1.00, this is the requirement of a 'matched circuit'. In other words, under given ideal conditions, the VSWR of a matched load is 1.00. Under extreme mismatch conditions, $E_{min} = 0$ total reflection $[E_R = E_I]$, the resulting VSWR $= \infty$. However, in most of the cases, VSWR is greater than 1.00, It is not rare to obtain VSWR as low as 1.02, in well-designed set-up having matched components.

Experiment No. 2

Date 25/10/21

Aim of Expariment:- Observe the transient phenomenon of terminated coaxial transmission lines in order to study their time domain behavior.

Theory:-

This experiment is about transisent response of lossless transmission lines ($R = G = 0$), $R_0 = \sqrt{(L/C)}$ and $u = 1/\sqrt{(LC)}$

where R_g is the source resistance the circuit is excited with voltage (V_0) at $t=0$. Because of mismatch in impedance at source and load end ($R_g \neq R_0$; $R_L \neq R_0$) the reflection can be observed in voltage wave on transmission line, and little external interference is coupled into the line.

This experiment deals with transient phenomenon of terminated coaxial transmission line in time domain. Let us consider that the transmission line is lossless i.e., $R=0$, $G=0$. Therefore the characteristic impedance becomes pure resistance, $R_0 = \sqrt{(L/C)}$ and voltage and current waves propagate along the line

with a velocity u, where $u = 1/\sqrt{(LC)}$
a voltage wave of magnitude
$V_1^+ = [R_0/(R_0+R_g)] * V_0$ travels down the line in the +z direction with a velocity u, where $u = 1/\sqrt{(LC)}$

If we plot voltage across the line at $z = z_1$ as function of time, we obtain a delayed step function at $t = z_1/u$ as

When the switch is closed at $t=0$, the dc source sends a voltage wave of magnitude $V_1^+ = [R_0/(R_0+R_g)] * V_0$ in the +z direction with a velocity $u = 1/\sqrt{LC}$ as before because the V_1^+ wave has no knowledge about the nature of the load at the other end. This wave reaches the load end $z=l$ at $T = l/u$. Since $R \neq R_0$, a reflected wave will travel in the z-direction with a magnitude.

$V_1^- = \Gamma_L V_1^+$

where $\Gamma_L = (R_L - R_0)/(R_L + R_0)$ is the reflection coefficient of the load resistance R_L.

Procedure :-

- set the source voltage (Vs) in volts and generator resistance (Rg).
- set the number of cycle, number of points in distance scale and location of point (in meter) at which voltage has to be measured w.r.t time.
- Enter the value of properties of transmission line i.e length of transmission line (L) in meters, characteristic impedance of transmission line (R0) and epsilon.
- In the output you will see two plots, one showing variation for the voltage vs distance in transmission line and other shows the variation of voltage at a point vs time (ns). Enter the value of load resistance (RL)
- Run the set up to see the results and if you wish to verify it for other parameters then click stop and repeat steps 1-4 and again run the set up.

Enter the source specification

Source specification

Source voltage (V0) in volts :- 30

Generator resistance (Rg) in ohms :- 25

Enter the load specification

Load specification

Load resistor(RL) in ohms = 0

Enter the properties of transmission line

properties of Transmission Line

Length of the Transmission Line(L) in meters :- 60

Characteristic Impedance of Transmission Line (Zo) in ohms :- 50

Relative Dielectric constant (Epsilon) of Transmission Line :- 1.5

Enter the observation specifications

OBSERVATION SPECIFICATIONS

No. of cycles :- 5

No. of points in distance scale :- 50

Location of point (in meters) at which voltage has to be measured w.r.t time :- 0

Result :- We got graphs of voltage vs distance and Transmission vs time.

AIM: Study the behaviour of terminated coaxial transmission line in frequency domain.

Theory:

For the efficient transmission of power and information the source energy must be directed or guided. TEM waves are guided by transmission line.

• Coaxial transmission line

It is the most common type of transmission line used for signal transfer, pulse generation stub filters etc. This consists of an inner conductor and a coaxial outer conducting sheath separated by a dielectric medium of dielectric constant epsilon.

In this experiment at the terminal we have AC voltage source, and transmission line is considered as lossless, i.e. $R=0, G=0$. Therefor the characteristic impedance becomes pure resistance ($R_0=\sqrt{(L/C)}$). Since we know that the general solution for the transmission line are:

$$V(z) = V_0^+ e^{-\gamma z} + V_0^- e^{\gamma z} \quad (1)$$

$$I(z) = I_0^+ e^{-\gamma z} + I_0^- e^{\gamma z} \quad (2)$$

where,

$$V_0^+/I_0 = -V_0^-/I_0 = Z_0 \quad (3)$$

Procedure:

Step1:- Set the incident voltage (V_0) in volts and frequency (f) of incident wave in Giga Hertz.

Step2:- Set the number of cycles, number of points in distance scale and location of point (in meter) at which voltage has to be measured w.r.t time.

Step3:- Enter the value of properties of transmission line i.e length of transmission line (l) in meters, characteristic impedance of transmission line (R_0) in ohm and relative dielectric constant ~~ϵ_r~~ (epsilon) of transmission line.

Step4:- Enter the value of load resistance (R_L) in ohm.

Step5: In the output you will see three plots, first one showing the incident voltage travelling along transmission line, Second plot shows the reflected voltage wave travelling along transmission line and the third plot shows the voltage standing wave along the transmission line.

Step 6: Run the VI to see the results. Incase, you wish to see the result for different values then click stop and repeat steps 1-5 before running the program again.

Enter the source specification

Source specification

Incident voltage (Vo) in volts:- 15

Frequency (f) in Giga Hertz :- 0.03

Observation specification

No. of cycles:- 4

No. of points in distance scale:- 10000

Load specification

Load Resistance (RL) in ohm:- 25

PROPERTIES OF TX LINE

Length of Tx line (L) in meter :- 40

Characteristic Impedance (Ro) in ohm :- 50

Relative Dielectric constant (epsilon) of transmission Line :- 1.9

Result :- we got graph of TRAVELLING, REFLECTED, STANDING VOLTAGE VS DISTANCE IN TX LINE.

Experiment No. 4
Date

AIM: Introduction to smith chart and its application for the unknown impedance measurement

Theory:-

Smith chart:-

Smith chart devised by P.H Smith is the most widely used graphical chart for transmission line calculations. It is a chart of resistance (r) and reactance (x) circles in the Γ_r-Γ_i plane for $|\Gamma| \le 1$ where, r- and x-circle are everywhere orthogonal to one another. The intersection of an r-circle and an x-circle defines a point that represents normalized load impedance $z_L = r + jx$. This can be obtained on the labview programme by selecting option 3 from menu and providing the value of r and x in the space specified. The actual load impedance is $Z_L = R_o(r + jx)$. Since a smith chart plots the normalized impedance for $|\Gamma| \le 1$, It. The smith chart in the figure below is marked with Γ_r and Γ_i rectangular

Scanned by TapScanner

The Same chart can be marked with polar Coordinates, Such that every point in the Γ-plane is specified by a magnitude |Γ| and a phase angle θ_r this is also show in the figure below. All |Γ| circle are Centered at the origin, and their radii vary Uniformly from 0 to 1. the |Γ|-circles can be drawn in the labview programme provided with the experiment by selecting option 6 from the menu and giving desired value of |Γ| in the column specified. the radius of the VSWR circle is equal to the magnitude |Γ| of the load reflection coefficient.

Each |Γ|-circle intersects the real axis (Γ_r) at two points. The points are marked in the above figure as Pm on the positive real axis (OPoc) and Pm on the negative-real axis (OPsc). Since X=0 along the real axis, Pm and Pm both represent situations with a purely resistive load, $Z_L = R_L$. obviously, $R_L < R_0$ at PM, where r>1; R_L 0 at Pm, where r<1. Value of the r-circle passing through the point Pm is numerically equal to the Standing-wave ratio(s). Similarly, the value of the r-circle passing through the point Pm on the negative-real axis is numerically equal to 1/S.

Procedure:-
please download the file shown on the left to perform the actual experiment.

Step1: select the option from menu according to you requirement.

Step2: Enter the values corresponding to the option provided in previous step.

Step3: Run the VI to see the desired plot in smith chart. In case, you wish to see the other plot then click stop and repeat, steps 1-2 before running the program again.

menu - 6 Load point
Load resistance :-8 Load reactance :-12
VSWR circle:- 1
Characteristic Impedance (Zo)

Result: We got the smith chart.