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Experiment No:

Title: - Measurement of the free space wavelength of the microwave (for TE 10 mode) with the help of the X-band microwave test bench and verify with its theoretical calculation.

Objective: -
To determine the frequency & wavelength in a rectangular waveguide working on TE10 mode.

Instruments & Components: -

- Gunn power supply
- Gunn Oscillator
- Isolator
- PIN modulator
- Frequency meter
- Slotted section
- Tunable probe
- Wave guide stand
- SWR meter
- Matched termination.

Theory: -

Mode represents in wave guides as either

$$TE_{m,n} / TM_{m,n}$$

Where,
TE – Transverse electric,
TM – Transverse magnetic
m – Number of half wavelength variation in x directionn- Number of half wavelength variation in y direction

$$\lambda g/2 = d1-d2$$

where d1 and d2 are the distance between two minima and maxima.

It is having highest cutoff frequency hence dominant mode.For dominant mode TE10 mode in rectangular wave guide $\lambda 0$, λg and λc are related below.

$1/\lambda_0^2 = 1/\lambda_g^2 + 1/\lambda_c^2$

Where
λ_0 *is* free space wavelength
λ_g *is* guide wavelength
λ_c *is* cutoff wavelength
For TE10 mode, $\lambda_c = 2a/m$
where m = 1 in TE10 mode and ‘a' is broad dimension of waveguide.

The following Relationship can be proved

$$C = f\lambda$$

Where
$C = 3 \times 10^8$ m/s is velocity of light

Procedure: -

1) Set up the components and equipments as shown in fig.
2) Set the variable attenuator at no attenuation position.
3) First connect the matched termination after slotted section.
4) Keep the control knob of Gunn power supply as shown.
   Gunn bias knob : fully anti- clockwise direction
   PIN bias knob : fully anti- clockwise direction
   PIN Mod frequency : mid position
   Mode switch : Int. mode
   Keep the control knob of SWR meter as shown.
   Range dB : 50 dB
   Crystal : 200 ohm
   Mode switch : Normal mode
   Gain (coarse & fine) : mid position
   SWR/dB : dB position
5) Set the micrometer of Gunn oscillator at 10 cm position.

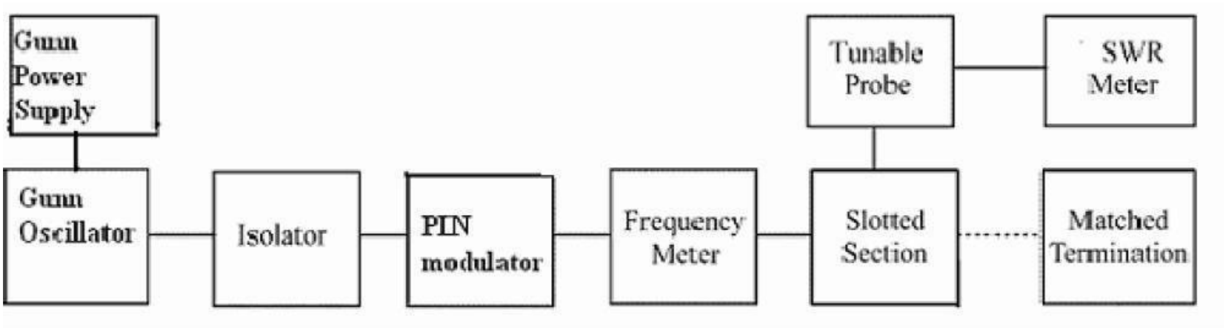

Figure: Setup for study of frequency & wave length measurement.

6) Switch on the Gunn power supply, SWR meter and cooling fan.
7) Observe the Gunn diode current corresponding to the various voltages controlled by the Gunn bias knob through the LCD, don’t exceed the bias voltage above 10.5 volts.
8) Turn the meter switch of power supply to beam voltage position and set beam voltage at 300V with help of beam voltage knob, current around 15 to 20mA.
9) Tune the probe for maximum deflection in SWR meter.
10)Tune the frequency meter to get a 'dip' minimum reading on SWR LCD display and note down the frequency directly from frequency meter. Now you can detune the DRF meter.
11) Move the tunable probe along with the slotted line to get the maximum reading in SWR meter.

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12) Move the tunable probe to a minimum gain position record the probe position i.e. d1.
13) Move the probe to next minimum position and record the probe position again i.e. d2.
14) Calculate the guide wavelength as twice the distance between two successive minimum positions obtained as above.

$$\lambda g = 2(d1\text{-}d2)$$

15) Measure the wave-guide inner broad dimension 'a' which will be around 22.86mm for X band.

$$\lambda c = 2a$$

16) Calculate the frequency by following equation: $F= c/\lambda = c\ (1/ \lambda_g{}^2 + 1/ \lambda_c{}^2)^{1/2}$
Where
c =3 x 108 meter/sec. i.e. velocity of light.

17) Verify with frequency obtained by frequency meter.
18) Above experiment can be verified at different frequencies

Calculations:

Conclusion:

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