EE 442 Microwave Engineering Laboratory,
Dept. of EEE, IIT Guwahati

Experiment 1

Measurement of frequency and wavelength

OBJECTIVE

To determine the frequency and wavelength in a rectangular waveguide working in TE_{10} mode

EQUIPMENTS

Klystron tube, Klystron power supply, Klystron mount, Isolator, Frequency meter, Variable attenuator, Slotted section waveguide, Tunable probe, VSWR meter, Waveguide stand, Movable short/matched termination.

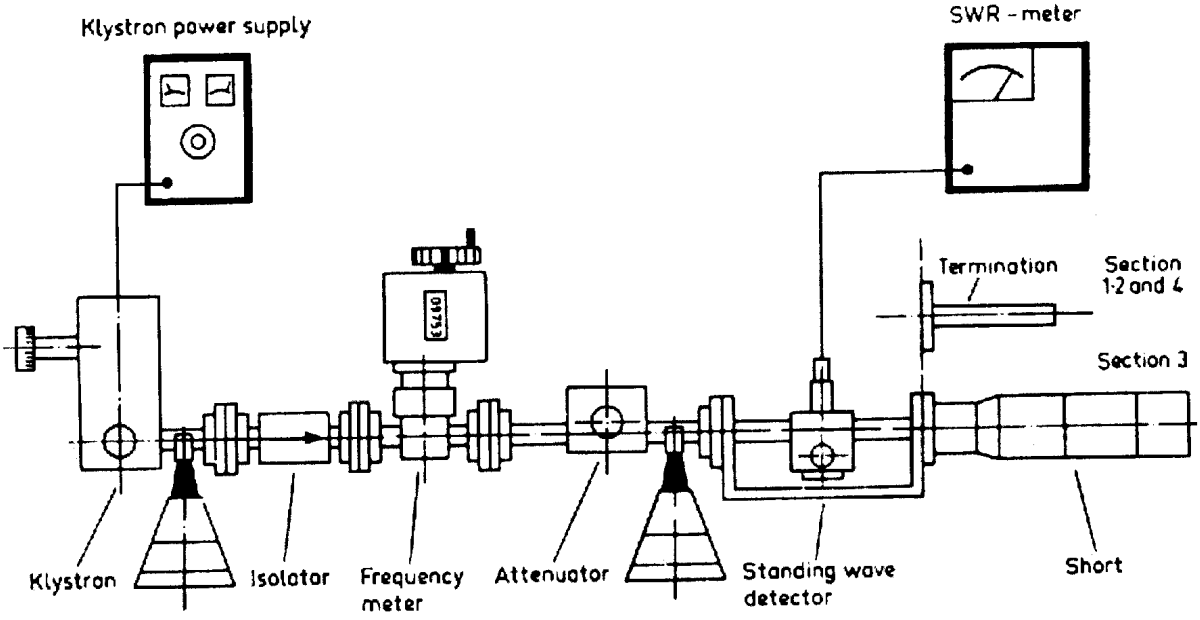
THEORY

For dominant TE_{10} mode in rectangular waveguide λ_0, λ_g, and λ_c are related as below:

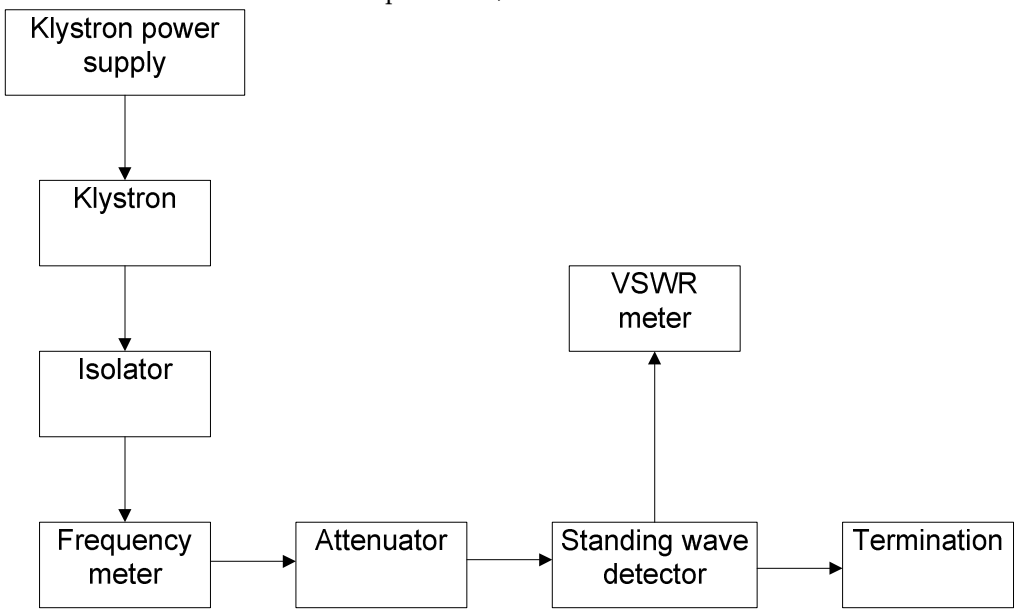
$$\frac{1}{\lambda_o^{\,2}} = \frac{1}{\lambda_g^{\,2}} + \frac{1}{\lambda_c^{\,2}}$$

where λ_o is free space wavelength, λ_g is guide wavelength and λ_c is cutoff wavelength.

For TE_{10} mode, $\lambda_c = 2a$, where 'a' is the broad dimension of waveguide.



(a)



(b)

Fig.1.1 Setup for measurement of wavelength and frequency (a) Schematic and (b) Block diagram

PROCEDURE

1. Set up the components and equipments as shown in Fig. 1.1.
2. Set the variable attenuator at maximum position.
3. Keep the control knobs of VSWR meter as below:

Range dB	50 dB position
Input switch	Crystal low impedance
Meter switch	Normal position
Gain (coarse & fine)	Mid Position

4. Keep the control knobs of Klystron power supply as below:

Meter switch	'Off'
Mod-switch	AM
Beam voltage knob	Fully anticlockwise
Reflector voltage	Fully clockwise
AM-Amplitude knob	Around fully clockwise
AM-Frequency knob	Around mid Position

5. Switch 'ON' the Klystron power supply, VSWR meter and cooling fan.
6. Rotate the meter switch of power supply to beam voltage position and set beam voltage at 300 V (you should not make beam voltage higher than 300V) with help of beam voltage knob (you should not touch this knob till the end of the experiment).

7. Adjust the reflector voltage to get some deflection in VSWR meter.
8. Maximize the deflection with AM amplitude and frequency control knob of power supply.
9. Tune the plunger of Klystron mount for maximum deflection.
10. Tune the reflector voltage knob for maximum deflection.
11. Tune the probe for maximum deflection in VSWR meter.
12. Tune the frequency meter knob to get a 'dip' on the VSWR scale and note down the frequency directly from the frequency meter.
13. Replace the termination with movable short, and detune the frequency meter.
14. Move probe along with the slotted line, the deflection in VSWR meter will vary. Move the probe to a minimum deflection position, to get accurate reading; it is necessary to increase the VSWR meter range dB switch to higher position. Note and record the probe position.
15. Move the probe to next minimum position and record the probe position again.
16. Calculate the guided wavelength as twice the distance between two successive minimum positions obtained as above.
17. Measure the waveguide inner broad dimension 'a', which will be around 2.286cm for X-band waveguide.
18. Calculate the frequency by following equation:

$$f = \frac{c}{\lambda_0} = c\sqrt{\frac{1}{\lambda_g^2} + \frac{1}{\lambda_c^2}}$$

where c = 3×10^8 meter/sec is velocity of light in free space.

19. Verify with frequency obtained by frequency meter.
20. Above experiment can be verified at different frequencies.
21. Record the experimental results in a tabulated form as per format given below (take at least 5 readings):

Measured Guided wavelength (λ_g)	Calculated f_0	Phase velocity $(f_0\lambda_g = v_p)$	Group velocity $\left(\frac{(f_0\lambda_0)^2}{f_0\lambda_g} = v_g\right)$	Remarks

(N.B. Same experiment can be done using Gunn diode as a microwave power source)

Group No.:

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Name: