Wavelength Measurement

Aim :- To find the wavelength measurement in rectangular wave-guide working in TE_{10} mode.

Apparatus :

- Klystron power supply
- Isolator
- Variable attenutor
- Match termination
- Slotted section
- Tunnable probe
- Short Waveguide stands
- Cathode Ray Oscilloscope (CRO)
- BNC cable
- VSWR meter
- Cooling Fan.

Theory :-

For dominant TE_{10} mode rectangular waveguide $\lambda_o, \lambda_g, \lambda_c$ are related or below.

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

where

λ_o = free space wavelength
λ_g = Waveguide wavelength
λ_c = cutt off wavelength

For TE_{10} mode, $\lambda_c = 2a$ where 'a' breadth/width dimension of waveguide.

a (breadth/width) : Larger dimension of the inner waveguide cross-section; Used as the key parameter for cutoff.

b (height) : shorter dimension of the cross-section.

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For example, in a WR90 waveguide

$a = 22.86mm$ and $b = 10.16mm$

~~Frequency measurement meter is an instrument that displays the~~
In a rectangular waveguide, when microwave energy is propagated, standing waves are formed due to reflections from the short-circuited or mismatched load. The measurement of wavelength in a waveguide is based on locating the positions of voltage minima (or maxima) along the slotted section of the waveguide.

The distance between two successive minima (or maxima) represents half of the guide wavelength ($\lambda g/2$). Hence, the guide wavelength (λg) is calculated as:

$$\lambda g = 2d$$

Where 'd' is the distance between two consecutive minima or maxima, measured using a micrometer connected to the probe in the slotted line section.

For the dominant TE10 mode in a rectangular waveguide, the cutoff wavelength (λc) is related to the broad dimension of the wavelength as: ($\lambda c = 2a$).

The wavelength measurement setup generally consists of a klystron power supply, Isolator, Variable Attenuator, slotted line section, Tunable probe and Micrometer. The probe detects the standing wave pattern along the waveguide. By moving the probe, the points of minima and maxima are located, and the distance between them is used to compute the guide wavelength.

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procedure :

→ connect the components and equipment as shown in figure.

→ set the variable attenuator at the minimum position.

→ keep the control knobes of klystron power supply as below.

Meter Switch : OFF
Mode switch : AM
Beam Voltage knob : Fully anti-clock wise
Reflection Voltage : Fully clockwise
AM-amplitude : Maximum
AM-Frequency knob : Mid position

→ set on the klystron power supply

→ set Beam Voltage as 300V.

→ Adjust the reflector voltage to get some amplitude of signal in CRO.

→ Move the phase carrier along the slotted line and find the distance between two successive minimum deflection positions. Then find wave length of waveguide. ($\lambda g = 2d$)

→ calculate the wavelength by following equation.

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

$$\Rightarrow \lambda_0 = 1 \Big/ \sqrt{1/\lambda_g^2 + 1/\lambda_c^2}$$

→ Verify the wavelength obtained by output.

→ Repeat the steps for three different values.

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precautions :-

→ Connect the components in the bench set up tightly loose connections may lead to signal escape.

→ First switch on the cooling fan and then switch on klystron power supply.

→ Power off the klystron supply whenever AC power suddenly went off

→ Reduce the beam voltage to zero volts whenever AC power suddenly went off

→ Handle the equipment carefully

Result :-

Hence the wavenlength in rectangular waveguide working in TE_{10} mode has been measured.

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