SLOTTED LINE MEASUREMENTS

Objective: To familiarize with the measurement technique using slotted line.

a) Measurement of standing wave distribution on a slotted line, with short circuit and open circuit termination.

b) Measurement of high VSWR by double minimum method

List of Equipment:

1. Microwave source with square wave modulation
2. Variable attenuator
3. Crystal detector
4. VSWR Meter
5. Ferrite Isolator
6. Matched load

Theory:

a) **Standing Wave Distribution:** If a transmission lines is terminated in an independence not equal to its characteristic impedance, the termination is said to be ‘not matched’ to the line. Waves traveling down the line are partially or wholly reflected from the termination. Total reflection occurs when the terminal impedance is not dissipative, i.e. a short, open or reactive termination. Standing waves are the result of two wave trains of equal wavelength incident and reflected along the line in opposite directions.

b) **High VSWR by Double Minimum Method:** The voltage standing wave ratio of a transmission line terminated in a load is defined as,

$$VSWR = \frac{V_{max}}{V_{min}} \qquad (1)$$

where V_{max} and V_{min} are the voltage at the maxima and minima of voltage standing wave distribution. When the VSWR is high (≥ 5), the standing wave pattern will have a high maxima and low minima. Since the square law characteristic of a crystal detector is limited to low power, an error is introduced if

V_{max} is measured directly. This difficulty can be avoided by using the 'double minimum method' in which measurements are take on the standing wave pattern near the voltage minimum. The procedure consists of first finding the value of voltage minima. Next two positions about the position of V_{max} are found at which the output voltage is twice the minimum value. If the detector response is square law, VSWR is given by

$$VSWR = [1 + \frac{1}{\sin^2(\frac{\pi d}{\lambda_g})}]^{1/2} \qquad (2)$$

where λg is the guide wavelength and d is the distance between the two points where the voltage is $2V_{min}$.

Procedure:

(a) Measurement of standing wave distribution:

1. Click "**Run continuously**" to run the experiment.
2. Set up the equipments as shown in fig1. Set the frequency and amplitude of the source by using slider and knob respectively. Modulate the signal by using square modulator.
3. Select "forward direction" in isolator and adjust the attenuation by using slider in attenuator.
4. To analyze the standing wave pattern terminate the slotted line with given loads i.e "**Short circuited**", "**Open circuited**" and "**Unmatched Load**".
5. In simulation slider pays a role of tuning probe of slotted line. So move slider of slotted line to measure maxima and minima in the standing wave pattern.
6. The voltage corresponding to the distance is shown in the given button of slotted line window.

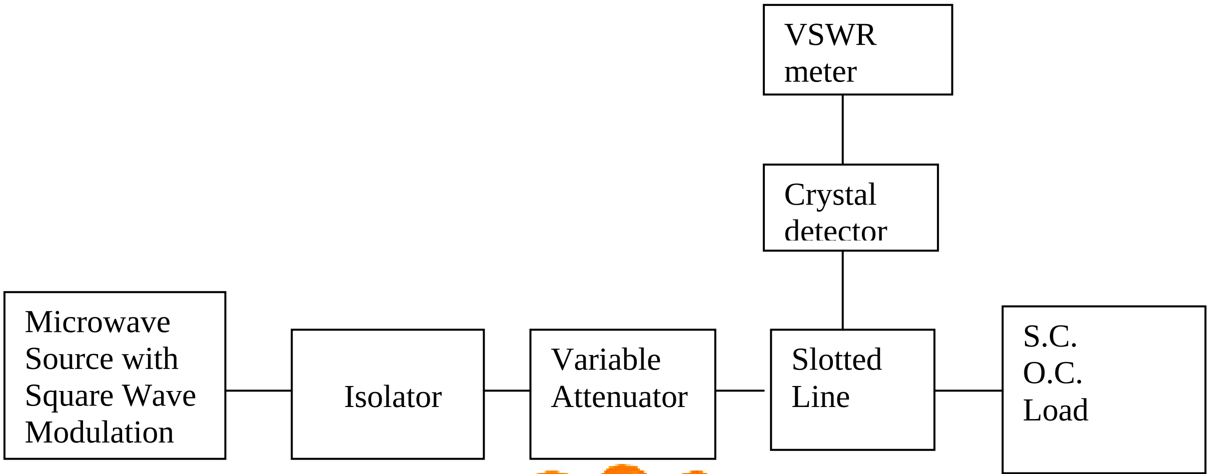

Figure 1. Experimental arrangment for measuring VSWR

(b) Measurement of high VSWR:

1. Select "**Unmatched Load**" to terminate the slotted line by pressing the button.
2. Use slider to fix the value of "**Resistance**" and "**Reactance**" of the load.
3. Locate the position of V_{min} and take it as a reference.(If VSWR meter is used in actual experiment, set the output so that meter reads 3dB).
4. Move the slider (probe of slotted line) along the slotted line on either side of V_{min} so that the reading is 3 db below the reference i.e. 0 db. Record the probe positions and obtain the distance between the two. Determine the VSWR using equation (2).
5. The simulated value for VSWR can be seen by clicking the buttons "**Technique used to calculate VSWR 1 & 2**".
6. Then match the calculated value with the value displayed in the simulated VSWR meter.

Discussions:

1. Why the slot is cut in the centre of the waveguide not off centre?
2. What types of errors are introduced in measurement due to finite probe depth and a slot in a waveguide?
3. Why detector is required to have a square law response? If it has response proportional to the cube of the input what correction you will need to apply.

4. If the excitation of the waveguide is changed to TE_{mn} mode, can we continue with this set up? What will be the effect of multimode in measurement?

References

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