DETERMINATION OF UNKNOWN IMPEDANCE

Objective: To determine the impedance of the given load.

List of Components:

1. Microwave source with square wave modulation
2. Isolator
3. Variable attenuator
4. Detector
5. VSWR meter
6. Slotted line
7. Matched Termination
8. Slide screw Tuner.

Theory:

The unknown terminating impedance can be determined by measuring standing wave ratio & distance of a convenient maxima or minima from the load. Normally for distance measurement minima is used because it is more sharply defined. The unknown load admittances is given by the transmission equation as

$$Y_L = \frac{S - j\tan\left(2\pi d_{\min} / \lambda_g\right)}{1 - jS\tan\left(2\pi d_{\min} / \lambda_g\right)}$$

where, S = VSWR

$d_{\min}$ = distance of first minima from the load.

A screw projecting into the waveguide offers variation in the admittance with the insertion of the screw. The depth of screw, changes only the reactive part of the admittance, so if the line is matched, the load offered by the screw for a certain depth is

$$Y_L = 1 + j\,b$$

where b is the susceptance due to the screw. The unknown impedance can also be determined by using chart, once the VSWR and position of minima is known with the load.

Procedure:

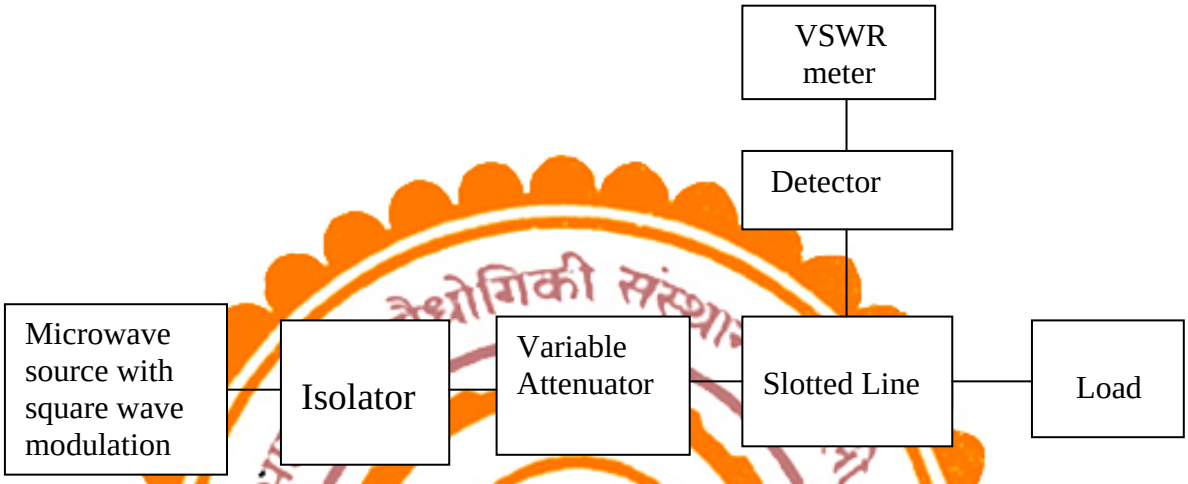

Fig 1. Experimental arrangement for measuring impedance

1. Set up the circuit as shown in the fig1. Fix the frequency and amplitude of the source with the help of slider and knob. Fix the modulator frequency using slider. Select "**Forward direction**" in isolator and adjust the attenuation using slider.
2. Four types of loads i.e. matched load, short circuit, open circuit and unmatched load are used here. Realizing a screw whose reactance vary with insertion is not feasible. Hence we are using distance of minima to find the impedance.
3. Choose "**Unmatched Load**" to perform the experiment from the Loads given in Loads window. We can vary the resistance and reactance of load by using sliders in case of "**Unmatched Load".**
4. Use toggle button to select between "**Short Circuit"** and other "**load"**. First select "**Short Circuit**".
5. Find first and second minima by using slider. Fix the first minima by clicking "**First minima from load (Short Circuited)**" and second minima by clicking "**Second minima from load (Short Circuited)**".

6. Use toggle button to switch to "**Load**" mode.
7. Again find the first minima for load condition by using slider and fix it by pressing the button "**First minima from load (Unknown Impedance)**".
8. Fix the value of VSWR by pressing "**VSWR value of unknown impedance"**. Now press the "**Value of Unknown Impedance**" button.
9. The resistance and reactance for the unknown impedance can be seen in the visible tabs. That can be matched with the chosen one.

Discussion

1. Explain qualitatively the impedance variation with the depth of screw and with frequency?
2. The smith chart calculations and the transmission line equation calculations for impedance are valid under what mode conditions?

References:

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