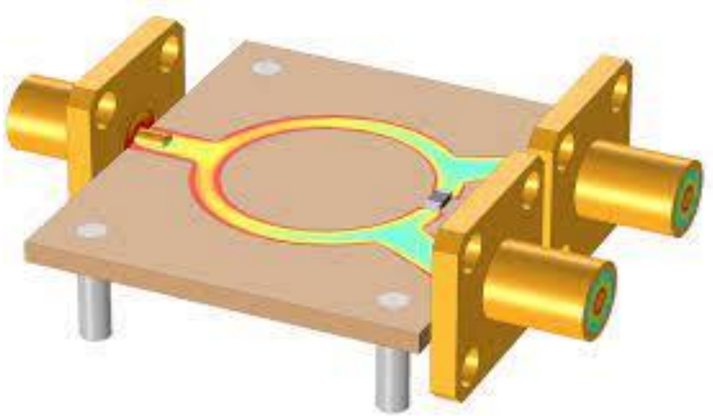
SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19EC602- MICROWAVE AND OPTICAL ENGINEERING

UNIT-3
POWER & IMPEDANCE MEASUREMENTS



Measurement of Power

The Microwave Power measured is the average power at any position in waveguide. Power measurement can be of three types.

Measurement of Low power 0.01mWto10mW

Example − Bolometric technique

Measurement of Medium power 10mWto1W

Example − Calorimeter technique

Measurement of High power >10W

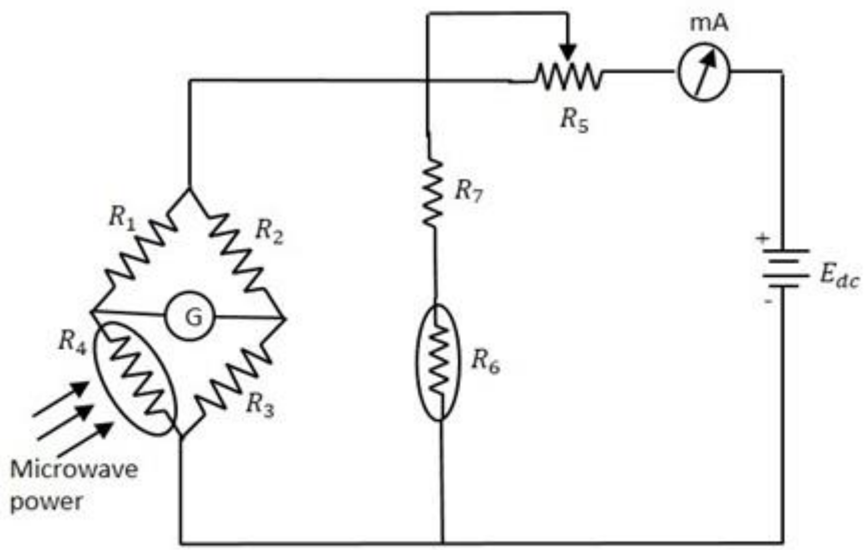
Example − Calorimeter Watt meter

Measurement of Low Power

The measurement of Microwave power around 0.01mW to 10mW, can be understood as the measurement of low power.

Bolometer is a device which is used for low Microwave power measurements. The element used in bolometer could be of positive or negative temperature coefficient. For example, a barrater has a positive temperature coefficient whose resistance increases with the increase in temperature. Thermistor has negative temperature coefficient whose resistance decreases with the increase in temperature.

Any of them can be used in the bolometer, but the change in resistance is proportional to Microwave power applied for measurement. This bolometer is used in a bridge of the arms as one so that any imbalance caused, affects the output. A typical example of a bridge circuit using a bolometer is as shown in the following figure.



The milliameter here, gives the value of the current flowing. The battery is variable, which is varied to obtain balance, when an imbalance is caused by the behavior of the bolometer. This adjustment which is made in DC battery voltage is proportional to the Microwave power. The power handling capacity of this circuit is limited.

Measurement of Medium Power

- The measurement of Microwave power around 10mW to 1W, can be understood as the measurement of medium power.
- A special load is employed, which usually maintains a certain value of specific heat. The power to be measured, is applied at its input which proportionally changes the output temperature of the load that it already maintains. The difference in temperature rise, specifies the input Microwave power to the load.

- The bridge balance technique is used here to get the output. The heat transfer method is used for the measurement of power, which is a Calorimetric technique.

Measurement of High Power

- The measurement of Microwave power around 10W to 50KW, can be understood as the measurement of high power.
- The High Microwave power is normally measured by Calorimetric watt meters, which can be of dry and flow type.

- The dry type is named so as it uses a coaxial cable which is filled with di-electric of high hysteresis loss, whereas the flow type is named so as it uses water or oil or some liquid which is a good absorber of microwaves.
- The change in temperature of the liquid before and after entering the load, is taken for the calibration of values. The limitations in this method are like flow determination, calibration and thermal inertia, etc.

Measurement of Impedance

Apart from Magic Tee, we have two different methods, one is using the slotted line and the other is using the reflectometer.

Impedance Using the Slotted Line

In this method, impedance is measured using slotted line and load ZL and by using this, Vmax and Vmin can be determined. In this method, the measurement of impedance takes place in two steps.

- **Step 1** − Determining Vmin using load ZL.
- **Step 2** − Determining Vmin by short circuiting the load.

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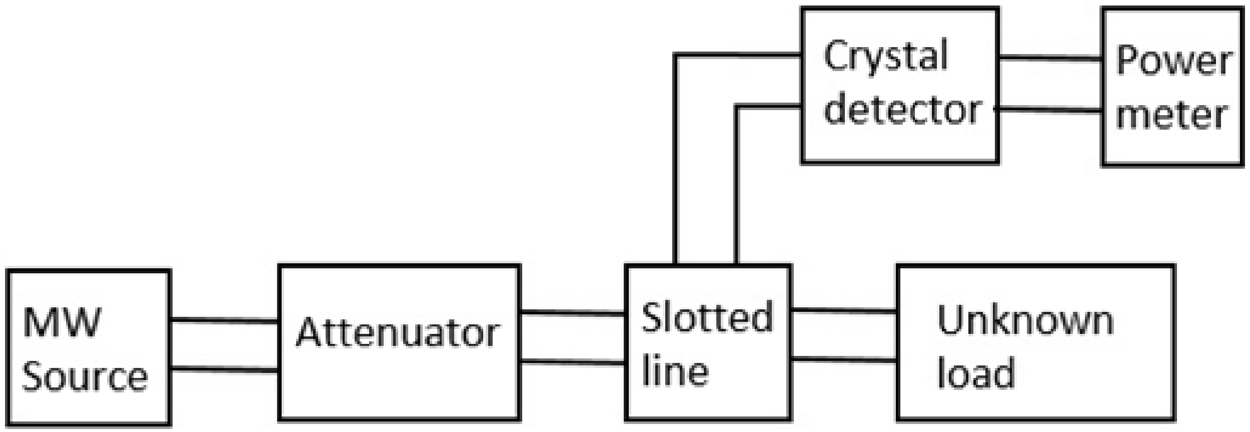
This is shown in the following figures.



Set up 1, Impedance measurement using slotted line

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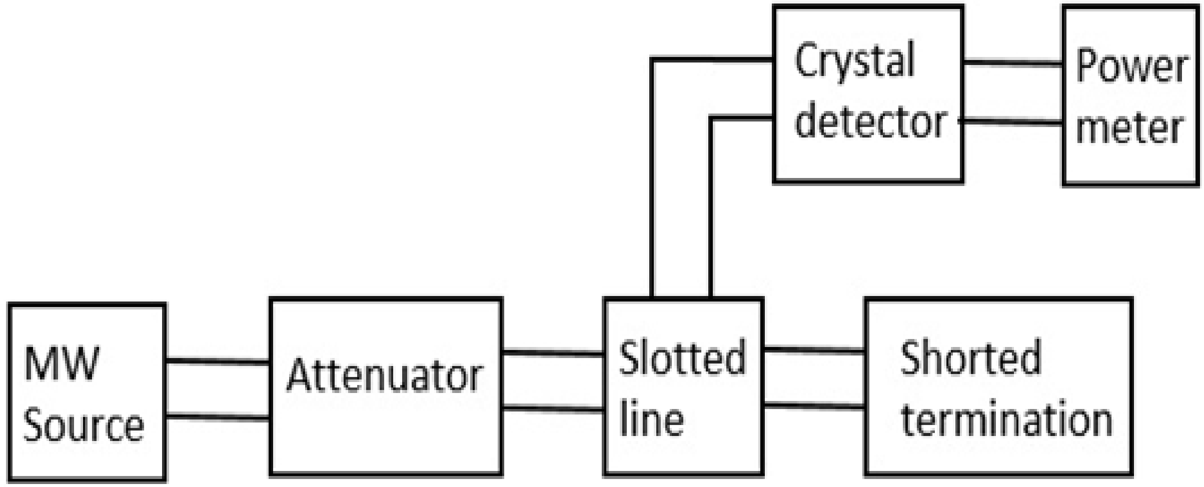

Set up 2, Impedance measurement using slotted line

When we try to obtain the values of Vmax and Vmin using a load, we get certain values. However, if the same is done by
short circuiting the load, the minimum gets shifted, either to the right or to the left. If this shift is to the left,
it means that the load is inductive and if it the shift is to the right, it means that the load is capacitive in nature. The following figure explains this.

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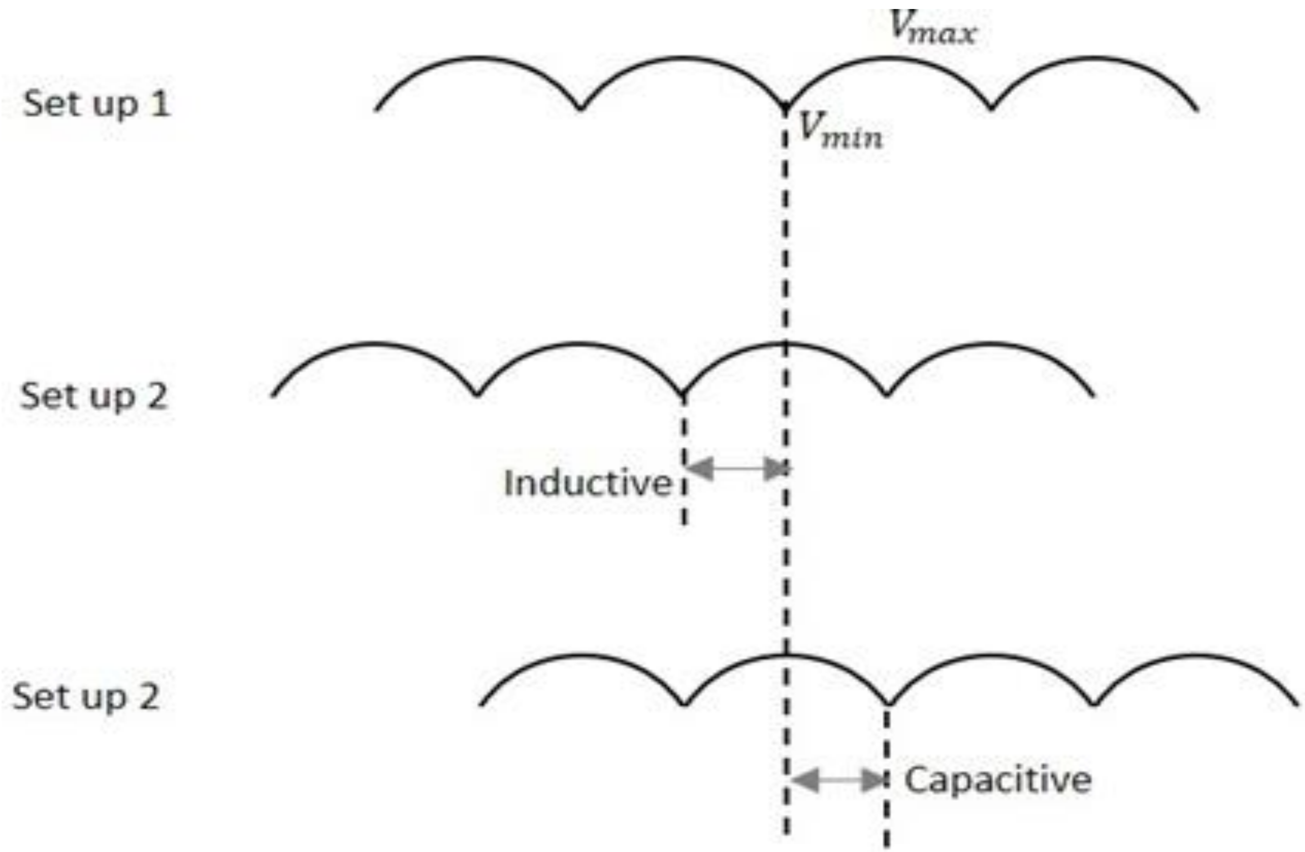

Output standing waves of set up 1 and 2

By recording the data, an unknown impedance is calculated. The impedance and reflection coefficient ρ can be obtained in both magnitude and phase.


Thank you