DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE NAME : 19EC602 – Microwave and Optical Engineering

III YEAR / VI SEMESTER

Unit III- MICROWAVE MEASUREMENTS

Topic : Impedance Measurement

INTRODUCTION

- Microwave impedance measurement, the slotted line method uses standing waves to determine impedance by measuring the Voltage Standing Wave Ratio (VSWR) and calculating the reflection coefficient, which is then used to determine the impedance.

- It can be measured by using any of the following method:

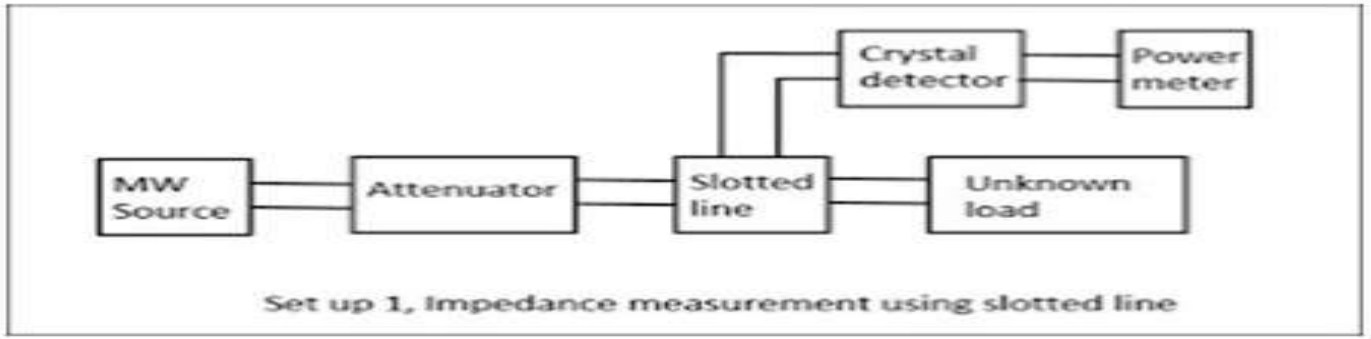
➢ Using magic T
➢ Using slotted line
➢ Using reflectometer

Impedance Using the Slotted Line

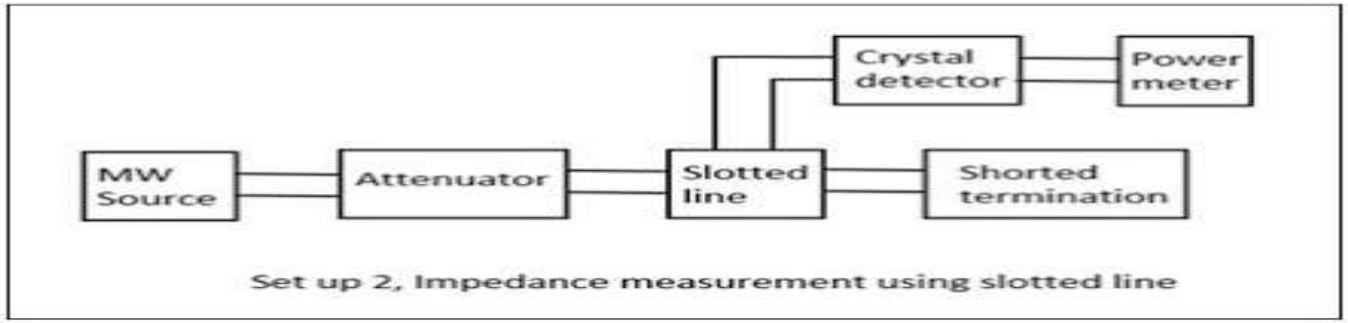
In this method, impedance is measured using slotted line and load ZL and by using this, determined. In this method, the measurement of impedance takes place in two steps.

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

Impedance using slotted line

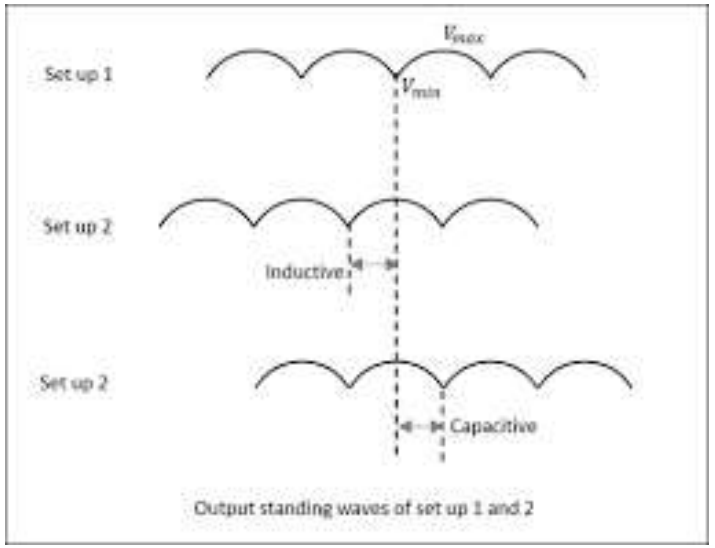


Set up 1, Impedance measurement using slotted line



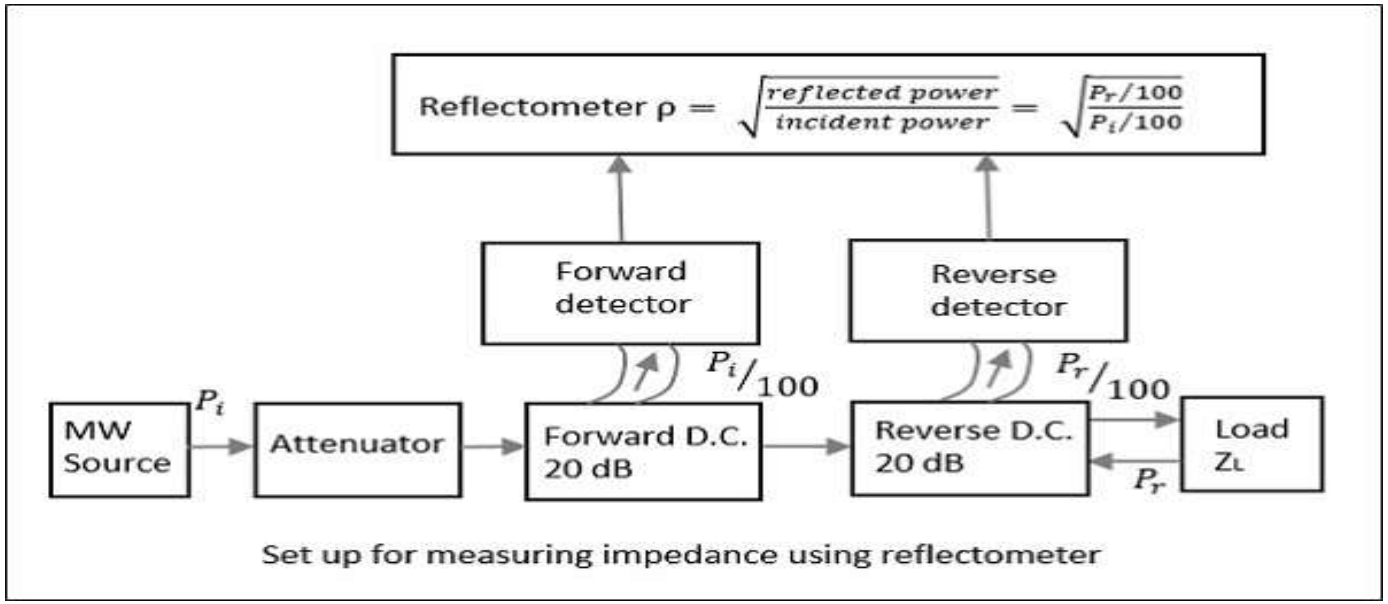
Set up 2, Impedance measurement using slotted line

If minimum shifted to left then impedance is inductive. If minimum shifted to right then impedance is capacitive. Both impedance and reflection coefficient can be obtained in magnitude and phase



Impedance using Reflectometer

Gives only magnitude of impedance but not phase angle. Employs two directional couplers to sample Pi and Pr from load



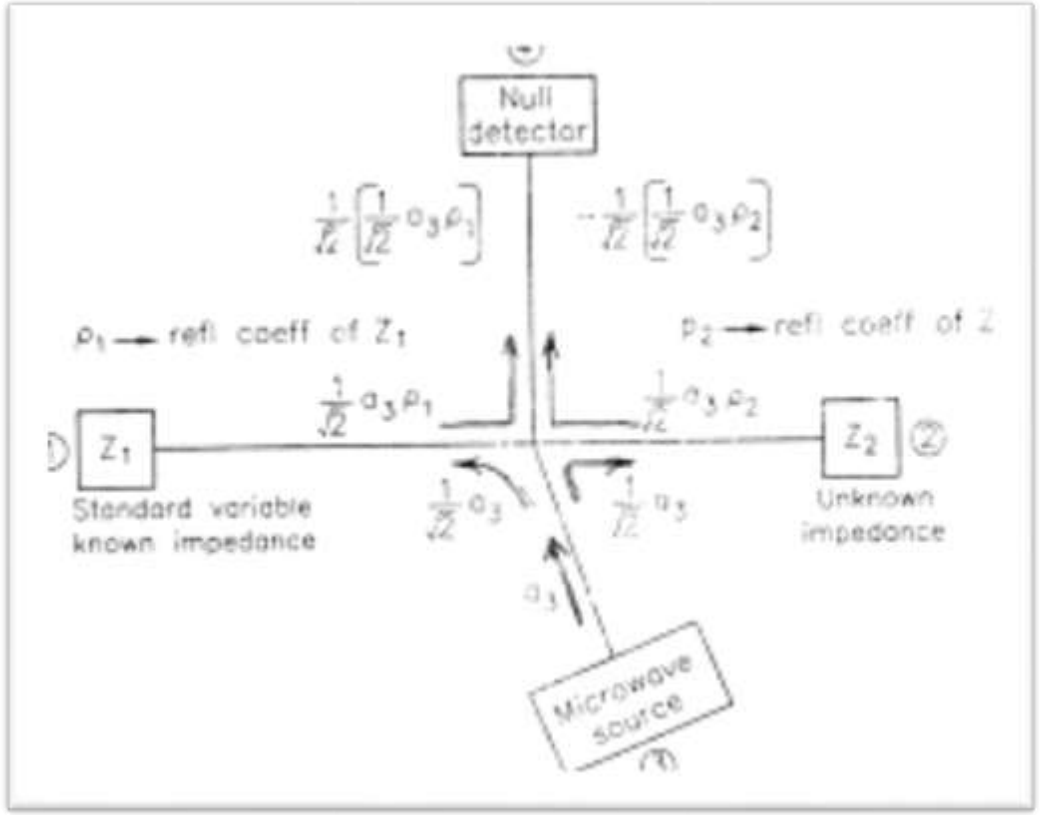
Set up for measuring impedance using reflectometer

In this method, two directional couplers which are identical but differs in direction are taken.

- The two couplers are used in sampling the incident power Pi power Pr from the load and reflected
- The reflectometer is connected as shown in the figure.
- It is used to obtain the magnitude of reflection coefficient ρ, from which the impedance can be obtained.

$$Z1 = Z0 (1+p/1- p)$$
$$Z1 = Z0 (S)$$

Impedance using magic Tee



Working

In this method, std. known impedance device and unknown load are connected at port 1 and port 2,respectively.

• Port 3 is connected with microwave source and a null detector is connected to port 4.

• Apply a random signal through microwave source and allow to pass to the null detector, which is nothing but a difference port of a magic TEE.

• A non-zero will be displayed, as long the unknown load impedance is not matching its impedance with the known std. impedance.

• Now, vary the std. known impedance so as to get the null in the null detector.

• In this state, the value of impedance displayed by a std. known impedance (ie., port 1) is matching with unknown load impedance(port 2).

ADVANTAGES

- **AC Analysis and Frequency Dependence:** Impedance is particularly useful for analyzing alternating current (AC) signals because it considers both resistance and reactance (which depends on frequency).
- **Material Characterization:** Impedance measurements can provide insights into the electrical properties of materials, including their resistance, capacitance, and inductance.
- **Cell and Biosensor Studies:** Impedance measurements are non-invasive and label-free, making them ideal for studying cells, especially for live cell analysis and long-term monitoring.
- **Safety and Fault Detection:** Impedance meters can detect load-sensitive and neutral faults, hidden flaws, which are crucial for ensuring the safety and reliability of electrical systems.

DISADVANTAGES

Component Variability & Parasitic Effects: Even identical components can exhibit slight variations in impedance, making it difficult to obtain consistent measurements.

Environmental Factors: Temperature and humidity can influence the behavior of components, particularly capacitors and inductors, leading to changes in impedance.

Measurement Method Limitations : Some measurement methods have limited frequency ranges, restricting their applicability.

Non-Linear Behavior**:** Many biological objects exhibit non-linear electrical behavior, making simple impedance measurements less meaningful.

Any Query????

Thank you……