Experiment # 9

EM WAVE TRANSMISSION AND REFLECTION

OBJECTIVE

To demonstrate the phenomena of reflection and transmission of electromagnetic fields.

EQUIPMENT REQUIRED

1. Signal Generator, with square wave modulation.
2. Directional Coupler and matched termination.
3. Oscilloscope.
4. Detectors (two).
5. Horn antennas (two).
6. Waveguide sections.
7. Several sheets of different materials.

INTRODUCTION

When a time-varying electromagnetic wave propagating in one medium encounters another medium of different electric parameters, part of the energy will reflect back at the interface and part will continue to propagate. Further, some of the field characteristics may change (for example, the direction of the power flow, the field polarization, etc.). These changes in the field characteristics and the ratio of the reflected field to the incident field (the reflection coefficient) depend on the electromagnetic parameters of the materials (μ and ε).

In this experiment, the effect of μ and ε on the value of the reflection coefficient and the transmission coefficient will be studied for the case of normal incidence.

The reflection and transmission coefficients are related to the material parameters in the case of normal incidence by the following relations:

$$\text{Reflection coefficient} = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} \quad \text{..... (1)}$$

$$\text{Transmission coefficient} = \frac{2\eta_2}{\eta_2 + \eta_1} \quad \text{..... (2)}$$

where η_1 and η_2 are the characteristic impedances of the media at the interface.

PROCEDURE

PART A: Demonstration of microwave components

The instructor will explain the function of some microwave components used in this experiment This include the directional coupler and matched termination. The instructor will also explain the basic concept of reflection and transmission.

PART B: EM wave reflection and transmission

1. Bring the transmitting and the receiving antennas in close proximity with a separation small enough to insert a sheet between them.
2. Align the two antennas for maximum reception. Adjust the received power to maximum reading on the meter. Record this value.
3. Insert a sheet between the two antennas and adjust it such that best transmission can be obtained. Record the transmitted value.
4. Repeat step (3) for different sheets (A mix between dielectric and metallic sheets).

Table 1: Rotating Receiver in a semicircle around the transmitter

Material	**Transmitter V_{pp} (mV)**	**Receiver V_{pp} (mV)**
Air		
Glass		
Black Plastic		
White Plastic		
Steel		

Ask your lab instructor to show the demonstration video related to this topic.

QUESTIONS FOR DISCUSSION

1. From the results of *PART B* obtain a rough estimate of the permittivity of the material of the dielectric sheets (Note: $\mu_r = 1$ and $\sigma \approx 0$ for most dielectric materials). Compare with textbook values.
2. What is tile main reason for the discrepancy in the answers of question (1)?
3. Suggest another method to measure reflection and transmission coefficients.