MICROWAVES AND POLARIZATION

Object: To investigate the phenomenon of polarization and discover how a polarizer can be used to alter the polarization of microwave radiation.

Apparatus: Transmitter, receiver, goniometer, component holder, polarizer.

Theory: The microwave radiation from the transmitter is linearly polarized along the axis of the transmitter diode; that is, as the radiation propagates through space, its electric field remains aligned with the axis of the diode. If the transmitter diode were aligned vertically, the electric field of the transmitted wave would be vertically polarized, as shown in Figure 1. If the detector diode were at an angle B to the transmitter diode, as shown in Figure 2, it would only detect the component of the incident electric field that was aligned along its axis.

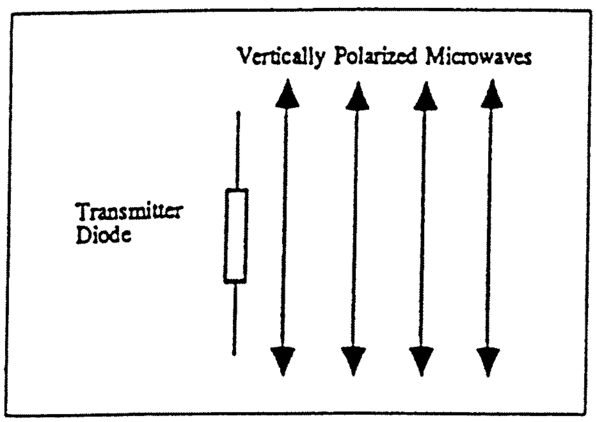

Figure 1 Vertical Polarization

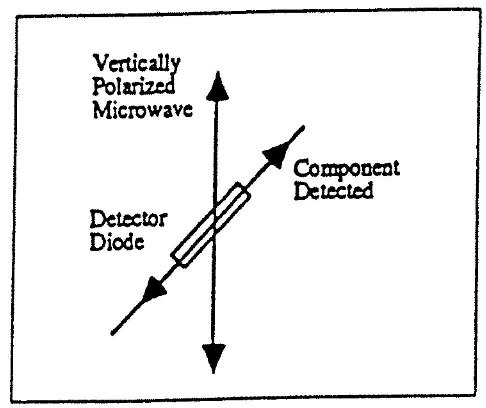

Figure 2 Detecting Polarized Radiation

Procedure:

1) Arrange the equipment as shown in Figure 3 and adjust the receiver controls for nearly full-scale meter deflection.

2) Loosen the hand screw on the back of the receiver and rotate the receiver in increments of ten degrees. At each rotational position, record the meter reading in Table 1.

3) What happens to the meter readings if you continue to rotate the receiver beyond l80 degrees?

4) Setup the equipment as shown in Figure 4, and reset the angle of rotation of the receiver for horizontal polarization (the horn should be oriented as shown in the figure).

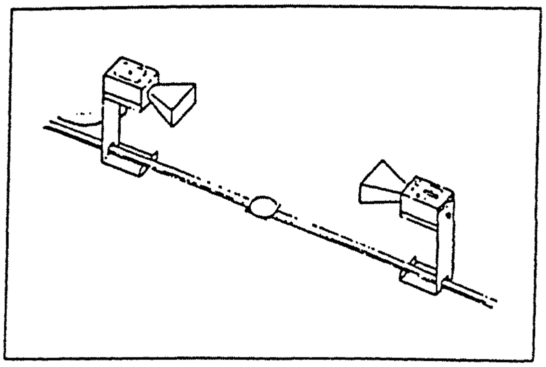

Figure 3 Equipment Setup

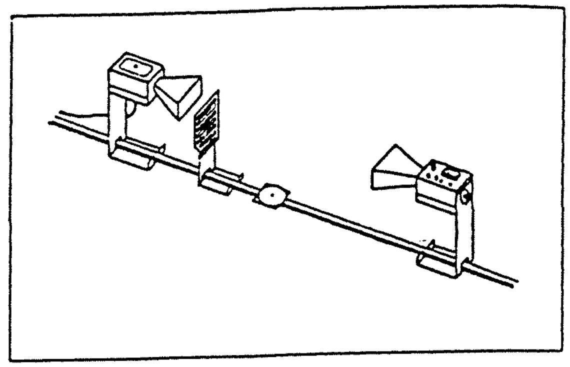

Figure 4 Equipment Setup

5) Align the slits of the polarizer horizontally as shown in figure 4. Record the meter reading in table 2 with the slits aligned at 22.5, 45, 67.5, and 90-degrees with respect to the horizontal. At what angle of polarization does the receiver show a minimum meter deflection?

Table 1

Angle of Receiver	Meter Reading	Angle of Receiver	Meter Reading	Angle of Receiver	Meter Reading
0		70		140	
10		80		150	
20		90		160	
30		100		170	
40		110		180	
50		120			
60		130			

Table 2

Angle of Slits	Angle of Receiver	Meter Reading
0 (Horizontal)		
22.5		
45		
67.5		
90 (Vertical)		

6) Remove the polarizer. Rotate the receiver so its polarization is at right angles to that of the transmitter. Record the meter reading. Then replace the polarizer and record the meter readings with the polarizer slits horizontal, vertical, and 45-degrees.

Table 3

Angle of Slits	Meter Reading
Horizontal	
Vertical	
45	

Questions:

1) If the meter reading of the receiver (M) were directly proportional to the component of the electric field (E) along its axis, then the meter reading would be given by the relationship $M = M_0 \cos\theta$, where θ is the angle between the detector and transmitter diodes and M_0 is the meter reading when $\theta = 0$ (see Figure 2). Graph your data from step 2 of the experiment. On the same graph, plot the relationship $M = M_0 \cos\theta$. Compare the two graphs.

2) The intensity of a linearly polarized electromagnetic wave is directly proportional to the square of the electric field (e.g. $I = kE^2$). If the meter reading of the receiver was directly proportional to the intensity of the incident microwave, then the meter reading would be given by the relationship $M = M_0 \cos^2\theta$. Plot this relationship on your graph from question 1. Based on your graphs, discuss the relationship between the meter reading of the receiver and the polarization and magnitude of the incident microwave.

3) On the basis of your data from step 5, how does the polarizer affect the incident microwave?

4) Can you explain the results of step 6 of the experiment? How can the insertion of an additional polarizer increase the signal level at the detector? (Hint: Construct a diagram like that shown in Figure 2 showing (1) the wave from the transmitter; (2) the wave after it passes through the polarizer; and (3) the component detected at the detector diode.)