California State University, Bakersfield

ECE 3320 – Fields and Waves

Lab 8 – Introduction to Microwave Propagation

Introduction:

In this lab, we will demonstrate some of the fundamental properties of electromagnetic waves. We will be using a microwave transmitter and receiver to observe the effects of wave propagation and the various behaviors these waves can exhibit.

The equipment we will be using utilizes an oscillator to modulate an input signal to very high frequencies. These frequencies are then sent to the transmitter, a horn antenna, and is sent through space. At the receiver side, a similar horn antenna intercepts the signal, and then demodulates the high frequency signal back to the original input signal. This concept is the basis of nearly all digital and analog telecommunication.

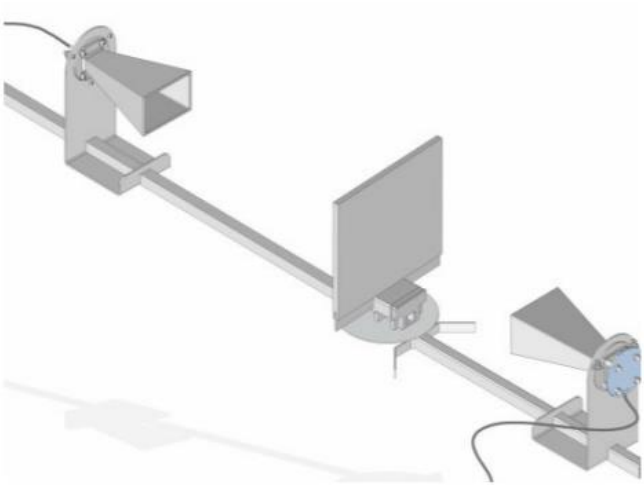
Procedure:

1. Ensure that all power switches are off. Transformer switch in the down position, speaker switch on the microwave unit to the left, and modulator switch on the microwave unit in the middle (0) position. Set the amplification dial to a quarter of the max. The dial should be facing toward the left.
2. Connect the transformer box to the outlet. Then connect the power adaptor to the microwave unit and the plug to the transformer. Note: The plug will be inserted on the right side, upside down. On the back of the transformer, ensure that the voltage selection plug is inserted in the 110V slot.
3. Next, set up the rails and the antennas. To connect the rails, insert the screw on the bottom of the base into the longer rail. This will allow you to easily move the longer rail around the base. Set the transmitter on the shorter rail and the receiver on the longer rail. Adjust the rail so that the arrow lines up with the “0”. The antennas should be directly in line with one another. Set the antennas as close to each other as possible.
4. Connect the transmitter and receiver to the control box. Connect the BNC to banana cables to the oscilloscope. The banana plugs should be inserted into the voltmeter plugs on the microwave box. The oscilloscope will allow us to view the received signal.

5. Now that all of the equipment is set up, we are ready to turn the equipment on. Turn on the transformer, then flip the speaker switch to the on position, and set the modulation switch to “INT”. The INT switch uses an internal signal, we will be using an external signal later. At this point you should be hearing a sound coming from the microwave box as well as a signal on the oscilloscope.
6. Turn off the speaker, but keep the modulation on. Use the oscilloscope to measure the frequency of the input signal. Also, use the oscilloscope to find the RMS of the signal. You can achieve both of these using the “Measure” button on the oscilloscope.
7. Adjust the amplification dial so that your RMS is approximately 10V. We will be using this value as a baseline to compare against our other results.
8. Move the receiver antenna away from the transmitter along the rail. What do you observe?
9. Take the receiver off of the rail. Point it towards the transmitter so that it receives the signal. Move the receiver perpendicular to the rail as shown.

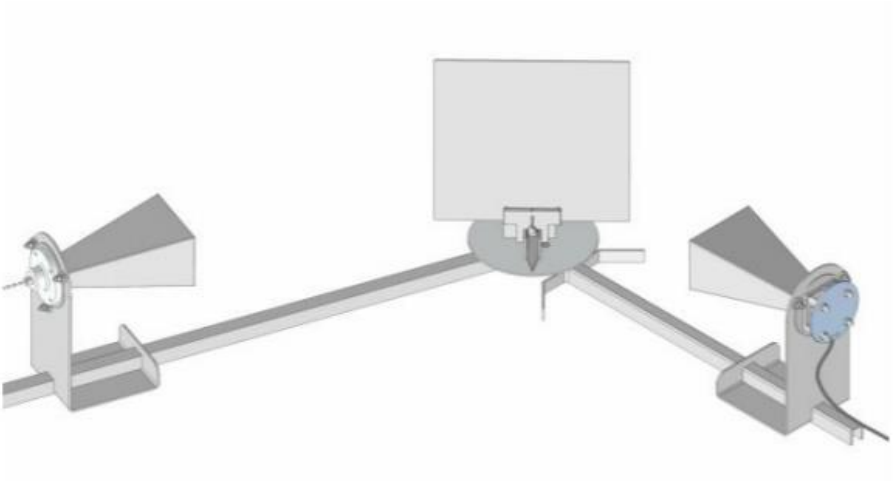
What do you observe? What does this tell you about electromagnetic waves and the behavior of the horn antenna? Does your observation agree with the expected radiation pattern for a horn antenna?

10. Replace the antenna on the rail. Now take the cork board (insulator) and connect it to the base as shown.



Record your observation. Explain this phenomenon. How is this concept beneficial for the transmissions of signals?

11. Repeat the previous step, but with the metal (conductor) plate. How is this different than the corkboard? What can you conclude about the effect of these two materials on electromagnetic waves?
12. Now, with the metal plate still on the base, set up the configuration as shown.



Set up the reflector plate at an angle of 30° using the indicators on the base. Adjust the receiver so that the received signal is at its maximum and measure this angle on the base. Repeat this with, 40°, 50° and 60°. What can you conclude about the relationship between the angle of reflection and the angle of incidence for electromagnetic waves?

Explain all observations in your lab report.