

ECE 435

Microwave Waveguide and Component Measurement

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Introduction

In this laboratory, you will investigate fundamental properties of guided waves at microwave frequencies and the use of waveguide components (e.g. a slotted waveguide) to measure the input impedance of an unknown load. You will learn how to operate a sweep oscillator, a Power Meter, and an SWR meter. These experiments will be conducted using X-band (8-12 GHz) sources and components.

Theory

Fundamental theory for guided waves is presented concurrently in class lectures. In addition, you should refer to your ECE 306 and ECE 307 notes. Also, Microwave Engineering by David Pozar is an excellent reference for this laboratory.

Procedure

1. Calibrate the Power Meter
 - 1.1. Turn on HP 437B power meter.
 - 1.2. Attach the power sensor to the reference port of the HP 437B. The reference port puts out 1 mW at 50 MHz.
 - 1.3. Press the <shift> <Cal> button.
 - 1.4. Press the <enter> button. The result should show 0.0 dBm.
2. Make sure a cable connects the output of the RF Plug-in to the input port (near the wave meter) of the test fixture.
3. Make sure the variable attenuator is set to 0 dB.
4. Turn on the HP 8620C Sweep Oscillator Control Unit. Make sure the CW and CW Vernier lights are on (if not, press those buttons). The RF power is controlled by the switch on the HP 86250D RF Plug-in.
5. Connect power sensor to the output port of the slotted waveguide.
6. Set sweep oscillator to 10 GHz.
7. Use wavemeter to verify and adjust the actual frequency to 10 GHz.
8. Measure the guided wavelength using the slotted waveguide. Connect the SWR Meter to the slotted waveguide probe (turn on the SWR meter).
9. Turn off the RF power and replace the waveguide-to-coax adapter with a shorting plate. The

input dial of the SWR meter should be set on “low”.

10. Turn on the RF power and measure the guided wavelength by determining the distance between adjacent voltage nulls. Compare measured guided wavelength with theory and calculate the phase velocity.
11. Repeat the wavelength measurements at 9 GHz and at 11 GHz. Turn off the RF power.
12. Remove the shorting plate and measure the guided wavelength with an open at 10 GHz. Is the open waveguide a good open at this frequency? Turn off the RF power.
13. Attach the waveguide-to-coax adapter and the Power Meter to approximate a matched load. Measure the SWR at 10 GHz. Turn off the RF power.
14. Connect the X-band horn antenna and measure the input impedance of the antenna using the minimum shift method. Turn off RF power.
 - 14.1. Put short on measure position of any null. Put load on measure new position of the closest null moving towards the generator. Measure the SWR with the load in place. The distance between the two minima is L . Plot SWR circle on Smith chart. Move from negative real axis (voltage is a minimum) towards the load a distance L in wavelengths. This is the normalized impedance. The guided wave impedance is the normalization load, not necessarily 50 Ohms! (See example 3.7 in Pozar for more details).
15. Attach unknown load and short to a T-waveguide. Measure the load impedance.
16. Attach E-H tuner to match the unknown load (on the T) to the waveguide. Adjust the lengths of the stubs to match.

Report

In your report, you should minimally address the following questions.

1. Compare the theoretical guided wavelength with your measured result. How does this wavelength compare with the free-space wavelength? Why are they different?
2. Compute the phase velocity of the guided wave. How does this compare to the velocity of electromagnetic waves in free-space? How do you explain the differences (if any)?
3. How does the T-waveguide section function in task 15?
4. How does the E-H tuner function to allow matching the unknown load to the waveguide?