



LAB 4 - Transmission Line Calculations

By: Greg Swick
Niagara College
Welland, Ontario
Canada

Equipment :

- Agilent Appcad 2.0 or 2.5
- A PC

Purpose:

To implement a software program for the computation of transmission line characteristics and confirm results with calculations.

PART A:

1. Select Appcad 2.0 from the program directory. Then select 'Passive Circuits'. Click on the 'Coax' icon. Use the program to solve the following problems:
 - a.) A 10 cm length of air dielectric line has an inner conductor diameter of 3 mm and an outer conductor diameter of 10 mm. Find the characteristic impedance of the line and electrical length at an operating frequency of 2 GHz. Confirm the electrical length in wavelengths and degrees as well as Z_o with CALCULATIONS.
 - b.) Change the operating frequency to 4 GHz, re-compute, and comment on the effect.
 - c.) Return to an operating frequency of 2 GHz and change the dielectric to polyethylene. Re-compute and explain the effect.
2.
 - a.) Return to main menu and select Parallel Line. Set to free space and assume 2 GHz operation. Determine the characteristic impedance of a parallel line with length 10m, separation of 1 cm and line diameter of 0.25 cm. CALCULATE characteristic impedance and compare with results. Are they exact. If not give a possible reason.
 - b.) Change S to 1.5 and note the change. Does this change anything other than Z_o ? (Ex. Electrical length)
3. Return to main menu and select the microstrip icon. Select the substrate FR4. Note the dielectric constant. The height of the FR4 is 2mm and the thickness of the trace is 0.1 mm. The length of the waveguide is 5 cm. Operating frequency is 4 GHz.
 - a.) What must the width of the transmission line be in order to present a characteristic impedance of 50 ohms?
 - b.) Determine the effective dielectric constant and CALCULATE the guide wavelength. Compare with the program calculation.
 - c.) Change the substrate to PTFE (teflon). What transmission line width gives a characteristic impedance of 50 ohms?
 - d.) Double the length of the transmission line. Note the effect on Z_o and electrical length.



$$Z_o = 276 \log D/r$$

$$Z_o = \frac{138}{\sqrt{\epsilon_r}} \log D/d$$

$$\epsilon_{\text{reff}} = 0.5 \left[(\epsilon_r + 1) + (\epsilon_r - 1) \left(1 + \frac{12h}{W} \right)^{-1/2} \right]$$

$$\lambda_g = \frac{C}{f \sqrt{\epsilon_{\text{reff}}}}$$

Microstrip
formulas

PART B:

4. Open windows explorer. Select the folder 'communic'. Open the directory AFEL2 and click 'GWBASIC'. Enter the command Run"vswrcalc". Solve the following problems:
 - a.) The incident voltage of 10 volts on a system develops a reflected voltage of 1 volt. Compute SWR.
 - b.) The incident power is 10 watts on a system and the reflected power is 1 watt. Compute the SWR.
 - c.) Explain the difference between a.) and b.) .