实验四　CST 仿真软件学习和矩形波导仿真

1. Experimental Objective

（1）　Learn how to use the 3D electromagnetic simulation software CST;

（2）　Master the basic setup of electromagnetic simulation;

（3）　Master the methods of drawing objects with simple geometries;

（4）　Master the methods of setting material properties;

（5）　Master the methods of checking simulation results;

（6）　Enhance the understanding of properties of rectangular waveguides.

2. Experimental Device

A desktop computer with CST installed.

3. Experimental Contents

（1）　Learn fundamentals of operating CST software;

（2）　Simulate an X-band rectangular waveguide. You can find its dimension online. Make propagation direction in z, long side in x and short side in y. For the walls of the waveguide, make it very thin and simply set them to be PEC. Calculate the cutoff frequency fc of the TE_{10} mode and simulate using two different frequencies $1.5f_c$ and $2.5f_c$. Make the length of the waveguide to be 2 guide wavelengths (λ_g) at $1.5f_c$. Set two wave ports at the two apertures of the waveguide. Plot the electric and magnetic field distributions in the xy, xz and yz cross sectional planes for the two cases. Plot electric current densities on two walls (one horizontal and one vertical) of the waveguide for the two cases.

（3）　Still use the waveguide as that in step 2, but fill the waveguide with a lossless material having a dielectric constant of 4. Simulate using the frequency of 1.5fc (the same as you calculated in step 2). Plot the electric and magnetic field distributions in the xy, xz and yz cross sectional planes.

（4）　Still use the waveguide as that in step 2, but change the mode to TE_{20}. Make TE_{20} the **ONLY** propagating mode (get rid of all other modes). Calculate the cutoff frequency f_c of the TE_{20} mode and simulate using the frequency of $1.5f_c$. Plot the electric and magnetic field distributions in the xy, xz and yz cross sectional planes.

(5) Simulate an X-band rectangular waveguide fed by a coaxial probe. Use the waveguide in step 2 and frequency $1.5f_c$. Block one end (at $z = 0$) of the waveguide with PEC and make the other aperture (at $z = 2\lambda_g$) a radiating one. Make the inner diameter of the outer conductor of the coaxial probe to be 8 mm and calculate the outer diameter of the inner conductor to give a characteristic impedance of 50 Ω. You can find the way to derive the characteristic impedance of a coaxial transmission line from a lot of resources. Specify the outer diameter of the inner conductor. The length of the probe inside the waveguide can be half of its dimension in the y axis. In the x direction, place the probe at the center of the waveguide. In the z direction, place the probe at $z = \lambda_g/4$ and **explain the reason for doing this**. Excite the waveguide by a wave port at the end of the coaxial probe. Put some field monitor planes at $z = 3\lambda_g/8$, $\lambda_g/2$, λ_g, $2\lambda_g$ and plot the electric fields on these four planes. If you observe something strange, think about it carefully and try to explain.

(6) Simulate a coaxial-probe fed X-band rectangular waveguide. Design the feeding probe to generate TE_{20} mode but meanwhile no TE_{10} mode is produced. Use the same waveguide dimension and frequency in step 4. Block one end of the waveguide with PEC and make the other a radiating one. Place a field monitor plane in a xy cross sectional plane in the waveguide and plot the electric fields on it to show that it is a TE_{20} mode.

4. Experimental Reports

(1) For steps 2 to 6, provide all the required plots;

(2) For steps 2 to 6, provide the simulation frequencies and plots of the CST models;

(3) For steps 2 to 6, provide answers to all questions.