**Lab 1: Analysis of a Dipole Antenna**

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| **Author** | Name： 吉辰卿 Student ID: 11911303 |
| **Introduction：**  In this experiment, we reviewed the basic modeling operation of HFSS learned in Microwave Engineering last semester, and tried to design a dipole antenna working at a specified frequency. After the modeling was completed, we plotted and analyzed various parameters of this antenna, and further optimized the length of the antenna through the optimization function of HFSS in order to make the performance of the antenna more excellent.  **Lab results & Analysis：**  **Question:**  Design a dipole antenna using HFSS for operating at ~ 2.1 GHz. Plot its S11,Gain, Directivity, Radiation pattern (Total and Co-pol& Cross-pol).  Note:  The length of each dipole width can be calculated as follows.  Length of total dipole (L) = c /2 *fo* (Where *fo* = Centre frequency, )  Length of each dipole (E): L / 2  **Result & Analysis:**  **Model diagram and Simulation Setup:**  20220302150349  Figure 1 The overall model  20220302154538  Figure 2 Port configuration  20220302154727  Figure 3 Air box setup  20220302214028  Figure 4 Set the frequency sweep range  **Parameter list:** **(After Optimization)**  20220302213431  Figure 5 All parameters in the model (after optimization)  **Analysis：**  For the modeling process of dipole antenna, we can easily complete it according to the document. Here I mainly introduce the method of selecting dipole antenna parameters.For the dipole antenna, the operating frequency band only affects the total length of the dipole antenna, but does not affect the bottom radius of the dipole cylinder or the size of the lumped port during modeling. Therefore, I will calculate the total length from the operating frequency of the dipole antenna.We know that the total length of a dipole antennais equal to half the wavelength at which it operates, that means:  Therefore, the total length of the antenna working is about 71.429 mm, then the length of each dipole should be about:  So, in our modeling, we can firstly set the value of h\_d as 35.7mm, and then optimize and adjust it according to the simulation results.(The final optimization result is h\_d = 31.4913185294)  **Optimization:**  The S-parameter image is a key point of this experiment simulation. The antenna we designed should have the minimum S parameter image at the 2.1GHz frequency point. If the above parameter Settings are followed, we found that the minimum value (valley value) of the antenna we designed was slightly deviated from 2.1GHz. Therefore, we need to optimize the length h\_d of each dipole. After simulation, The final optimization result is h\_d = 31.4913185294.  20220302213512  20220302154145 | |
| Figure 6 The Optimization of the dipole length  **Simulation results:**   1. **S-parameter**   **20220302154849**  Figure 7 S-parameter image of this antenna  As can be seen from the above image, the S11 parameter of the antenna reaches a minimum value at 2.1GHz, which proves that the working performance of the antenna designed by us meets the requirements of the question.   1. **Gain**   **20220302155540**  Figure 8 Gain total curve of this antenna   1. **Directivity**   **20220302155551**  Figure 9 Directivity total curve of this antenna  **Notes: 20220303223215**  Figure 10 Gain total curve of this antenna(When the air box size is changed)  **20220303222722**  Figure 11 Directivity total curve of this antenna (When the air box size is changed)  20220303224907  Figure 12 Revised dimensions of the air box  **When we reduced the size of the air box to half of the previous size(See the Figure 12), we found that the Gain total and Directivity total curve of the antenna were significantly changed from the previous image, which is what I found in this experiment.**By asking teachers and classmates, I understand that if the air box is drawn too small, the result will not be accurate. Therefore, we still use the size of the original air box for simulation.(See the Figure 5)   1. **Peak & Realized Gain**   **20220302161130**  Figure 13 Peak directivity/gain and realized gain curve of this antenna  As can be seen from the figure above, when the operating frequency is near 2.1GHz, the images of realized gain is almost coincide with those of peak gain. This proves once again that the antenna has a very small reflection and good working performance at 2.1GHz.   1. **Radiation Pattern**   **5.1 Gain Total**  **20220302175659**  Figure 14 The gain total radiation pattern of this antenna**(phi = 0 deg)**  **20220302175827**  Figure 15 The gain total radiation pattern of this antenna**(phi = 90 deg)**    **5.2 Gain Phi and Gain Theta(Co-pol & Cross-pol)**  **20220302210634**  Figure 16 The gain phi and gain theta radiation pattern of this antenna**(phi = 0 or 90 deg)**  **Experience**  In this experiment, we deepened the modeling process of HFSS and designed a simple dipole antenna by combining HFSS with theoretical calculation. Through the simulation of our model, we can get the images of various parameters of the antenna, and further deepen the understanding of the antenna properties with the theory. Finally, we should also know that there is always a little deviation between the software simulation and the theoretical calculation, so we need to further optimize the simulation results to achieve good performance at the specified working frequency point of our antenna. | |
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