**Lab 1：Introduction to HFSS**

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| **Introduction**   1. **Experimental Objective**   To master ANSYS HFSS modeling, simulation as well as optimization design by T-waveguide and complete the magic tee design.   1. **Introduction to Magic Tee**   A [Waveguide Magic Tee](https://www.pasternack.com/nsearch.aspx?Category=Waveguide%20Magic%20Tees&sort=y) is a 180-degree hybrid [power divider](https://www.pasternack.com/power-dividers-category.aspx) with 4 ports made from a single waveguide structure. The Magic Tee has been around for over 70 years and was a product of development during World-War II. The structure of a Magic Tee is a combination of an E-plane waveguide arm meeting a H-plane waveguide arm meeting at a junction with two other perpendicular collinear ports. As a Magic Tee is passive and ideally lossless, this component can be used as a power combiner, divider, or for RF computation.  It is important to note with Magic Tees that there isn’t a single conventional port allocation, and some vendors or descriptions may dictate different port allocations than the one used in this blog post. Port 1 and Port 2 are designated as the two collinear ports, of which Port 3 is the E-plane port, and Port 4 is the H-plane port.  The basic function of a Magic Tee can be broken down into three basic cases. In case 1, two signals are injected into port 1 and port 2. In this case, the sum of ports 1 and 2 exits port 4 and the differences exit port 3. Case 2 is where a signal is injected into port 4, and the signal is divided equally between port 1 and port 2, with port 3 with a 0 level output. In case 3, a signal is injected into port 3, where equal in amplitude but opposite in phase signals are incident on port 1 and port 2, with port 4 having zero output. This behavior is why port 4 is often designated as the Sum port and port 3 is designated as the difference port. In some cases, the E-plane port is denoted as port 4, the H-plane port is denoted as port 1, and the collinear ports are denoted as port 2 and port 3, respectively.  An ideal Magic Tee exhibits no loss and complete isolation between the non-stimulated ports, In the non-ideal cases, there is some loss, reflections, and non-perfect isolation between the ports due to impedance mismatch. As this is the case, the match between the E-plane and H-plane Tees dictates the bandwidth of the Magic tee and the isolation between the colinear ports. Another thing to note is that the E-plane and H-plane ports are perpendicular to the long wall of the waveguide, which results in orthogonal polarization of the E-plane and H-plane ports dominate electric field mode.  The most significant electric specification parameters for Magic Tees tend to be the frequency range in hertz, the insertion loss in decibels, the isolation between the E-H ports in decibels, and the isolation between the collinear ports in decibels.  **Lab results & Analysis**：   1. **Magic tee model diagram**      1. **S-parameters of Magic tee**        1. **Magic tee's three-dimensional electric field distribution map** | |
| **Experience**   1. **screenshot**          1. **Question**   There was a question about the choice of frequency in the setup when generating the 3D electric field, and I don't know why an error occurred in the results after changing from 5GHz to 10GHz.   1. **Experience**   Learned the application of Ansys HFSS, got a more intuitive understanding of how the T-waveguide splits the microwave energy from the main waveguide, and also gained some understanding of magic tee. | |
| **Score** | 100 |