**Lab 6：Branch-line coupler**

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| **Introduction**   1. Introduction to the principle of the branch-line coupler.   A branch line coupler, also known as a quadrature hybrid, is a passive microwave device that is used to split an input signal into two output signals with equal amplitude and a 90-degree phase difference between them.  The basic principle behind the operation of a branch line coupler involves using a combination of transmission lines and couplings to achieve the desired signal division. It typically consists of four ports: one input port, two output ports, and a coupled port.  When an input signal is applied to the input port of the branch line coupler, it is divided into two paths. The design of the transmission lines and coupling elements ensures that the two output signals have equal amplitude and a phase difference of 90 degrees.  This 90-degree phase difference between the output signals is a key feature of the branch line coupler and is achieved through the careful design of the transmission line lengths and the configuration of the couplings. This phase relationship makes the branch line coupler particularly useful for applications such as signal combining, power splitting, and signal detection in microwave circuits.  (2) Theoretical basis: parity mode analysis of the branch-line coupler.    **Lab results & Analysis**：  1. ADS simulation results, optimisation  a. calculate the w0 and w1 we use in the branch-line coupler in 1.45GHz    w0=2.936010mm, w1=5.047610mm  b. circuit diagram    Simulate, we get:    There are many results that is wrong.  c. optimize  set goals:    And then we simulate again:    All is correct. And we get good l:    2. HFSS simulation results (S parameters: S11, S21, S31, S41)      Compared with ADS, the S-parameters is similar to HFSS. | |
| **Experience**  First I forget to set the airbox, and I can’t get the results whole one night, then I found that if the boundary of the port is directly connected to the boundary of the TL, the S-parameter is chaotic. And I know that the boundary conditions for the simulation are set to accurately represent the physical environment, such as ensuring perfect electric conductor (PEC) conditions for the metal surfaces and defining appropriate radiation boundaries for outer boundaries to prevent reflections.The excitation is applied by defining the input and output ports through which the electromagnetic wave is injected and extracted, typically using waveguide or coaxial ports with appropriate mode excitations.The frequency sweep settings are configured to capture the response of the branch line coupler over a range of frequencies, allowing the simulation to generate a set of S-parameters for the device. This typically involves specifying the start and stop frequencies, as well as the number of frequency points for the sweep.The S-parameters obtained from the simulation provide valuable insights into the behavior of the branch line coupler, including its insertion loss, return loss, and degree of coupling, which can be used to analyze and optimize the performance of the device. | |
| **Score** | 100 |