**Lab 2：ADS**

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| **Introduction**  **1. experimental goal**  Understanding ADS software through impedance converters.  **2. Principle of the Quarter-wave Transformer Principle**  To 'impedance match' an RF network is to design the structure and parameters of the impedance matching network to achieve the goal of eliminating reflections from the transmission line.  A quarter-wavelength converter is a section of transmission line with a length equal to one-fourth of the wavelength of the transmitted signal, and it is a simple and practical impedance matching circuit for a single frequency point.  Let us first discuss impedance matching when the impedance of the load is a real number. The impedance of the load is , the impedance of the transmission line is , and the impedance of the quarter-wavelength converter, which is an impedance matching network, is , which is 1/4 of the wavelength of the propagating signal.Our task is to find the right value of to match the impedance of the load to that of the transmission line.    Because we have the transmission line impedance equation：  So can beshow as：  Divide the numerator and denominator on the right side of the equal sign by , and you get  Because ·，  Then we can write  Let ，so we get  Impedance matching when the impedance of the transmission line is real and the impedance of the load is complex, at this point . The quarter-wavelength converter can only match the real impedance to the transmission line, the idea is to try to convert the complex impedance of the load to a real impedance, which can be accomplished by paralleling the quarter-wavelength converter and the load with a shorted or open terminated stub between the quarter-wavelength converter and the load.    A shorted line with a shorted terminal is equivalent to a load with impedance equal to 0 connected at the terminal, so:  Therefore, the input impedance of the terminated short-circuited stub is purely imaginary and can take on any value between to +.  A short cut-off line with open terminals is then equivalent to a load with infinite impedance connected at the terminals, and the same can be deduced to give an input impedance of:  The input impedance of the terminated short-circuited stub is purely imaginary and can take on any value between to +.  Because Converting it to the conductive form, then  The input impedance of a parallel terminated open-circuit stub , which is similarly converted to an inductive form:  At this point, look to the input conductance of the parallel network of the load and the truncated line . By taking a suitable length for the truncated line, it is always possible to make , canceling out the imaginary part of the load impedance, thus realizing the transformation of the complex impedance of the load into a real impedance:  =  Turning back to the impedance form:  So we get :  Let ，so we get  In this way, the complex load impedance is matched to the transmission line by paralleling the terminated open-circuit shorting line and the quarter-wavelength converter.  **3. Principle of the Smith Chart**  The Smith chart diagram is a polar coordinate diagram of the reflection coefficient, which is used to do impedance matching between high frequency circuits. It is equivalent to a map, and each point on it, represents an impedance value in complex form, while its center of the circle is called the matching point, which represents the ideal impedance of the real part of 50ohm and the imaginary part of 0ohm. To do impedance matching using Smith chart is to plan a line from the impedance point to the matching point.  **Lab results & Analysis**：  **1. Design impedance transformers to match a source of 50 2 to a load of 100 2 at a frequency of 2 GHz. Plot the reflection coefficient magnitude (also in dB) versus frequency for the designs using 2, 3, and 4 sections in a single rectangular plot.**  **a. Use 2 sections**  ADS circuit diagram    LineCalc tool calculation results chart (each microstrip line length)      S11 parameter diagram    **b. Use 3 sections**  ADS circuit diagram    LineCalc tool calculation results chart (each microstrip line length)        S11 parameter diagram    **c. Use 4 sections**  ADS circuit diagram    LineCalc tool calculation results chart (each microstrip line length)          S11 parameter diagram    **Conclusion:**  By comparison, it can be concluded that with an increase in the number of microstrip lines, a more complex and wider range of impedance variations are realized. By introducing more microstrip segments into the impedance matching structure, impedance transitions can be more precisely controlled, resulting in higher impedance matching accuracy.  **2.Design of L-Section Impedance Transformer**  Design a L-section impedance transformer to transform a load impedance of Z1 = 80+j60 Ω  to a source impedance of Zs = Zo = 50 Ω at the center frequency of 1.0 GHz. Microstrip  technology can be used to develop the impedance transformer and Advanced Design System  15.01 software can be used to nerform the simulation.  a. ADS circuit diagram        **b. LineCalc tool calculation results chart (each microstrip line length)**        **S-parameter diagram** | |
| **Experience**  screenshot    Experience  Gained a direct understanding of the principles of 1/4 wavelength impedance matching converters and a better understanding of the role of the reflection coefficient s in transmission lines. | |
| **Score** | 100 |