S-Parameter Simulation: Schematic Simulator

Agilent Advanced Design System (ADS) is an industry standard microwave engineering computer-aided-design (CAD) program. Agilent ADS allows microwave engineers to analyze, design, and simulate active and passive microwave components and systems. In this tutorial, a Microstrip transmission line will be designed and analyzed. It should be noted that there are two ways to design/simulate in Agilent ADS; schematic (equation-based) or full-wave (Method-of-Moments). The Microstrip line will be designed and simulated using the schematic simulator in this tutorial, while in Tutorial 2 a full-wave simulation will be performed using Agilent ADS's full-wave simulator, Momentum.

Microstrip Transmission Line Design Values

- Operational Frequency: 1 GHz to 5 GHz
- Substrate: 2.2 Permittivity and Height of 1.57 mm
- Characteristic Impedance: 50 Ohm
- Electrical length: 90 degrees at 2.4 GHz.

Simulation Setup

Open up Agilent ADS, the window shown in Fig. 1 will pop-up onto the main screen. Click on Create a new project and give it a name; make sure not to use any spaces and choose the units for the design.

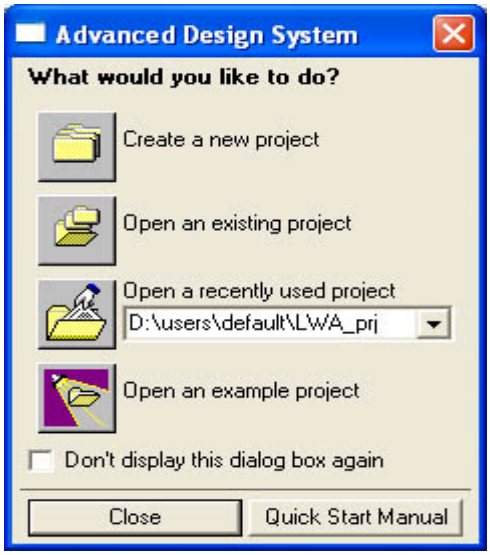

Figure 1. Agilent ADS window.

Once you have given a name to the new project a new schematic window will appear as shown in Fig. 2. On the left side of the schematic window is the Palette List and Component Palette, the Palette List allows you to chose different simulation and microwave circuit components.

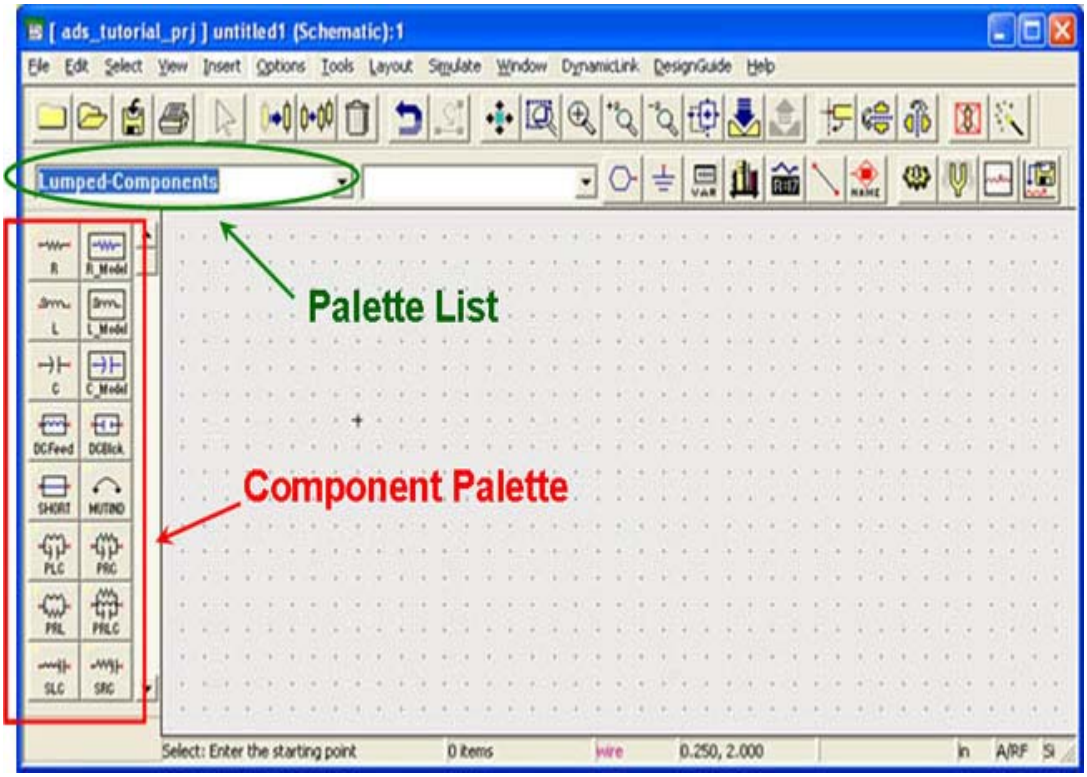

Figure 2. Schematic layout window.

An S-Parameter simulation will be performed on the Microstrip transmission line. Therefore, use the *Palette List* and pick Simulation-S_Param, the *Component Palette* will change and S-Parameter simulation components can now be chosen. Place a **SP** and two **Term** components onto the layout region. The **Term** component lets ADS know how many ports and the port impedance (50 Ohms in our case) for the S-Parameter simulation. An S-Parameter simulation from 1 GHz to 5 GHz with 401 points will be performed, therefore double-click the **SP** component and change the necessary values. After placing the S-Parameter components, your schematic window should look like Fig. 3.

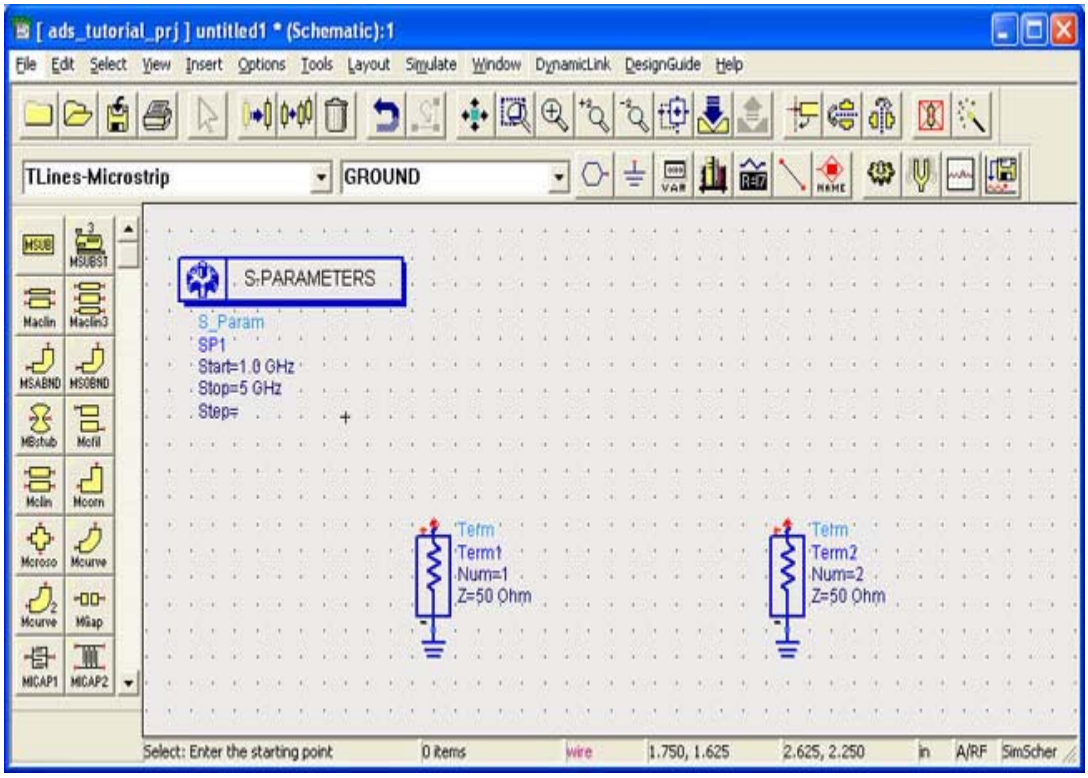

Figure 3. Schematic layout window showing required S-Parameter components.

Next, the Microstrip line has to be defined and placed onto the schematic layout window. To do this, click on the *Palette List* and choose TLines-Microstrip. The substrate on which the Microstrip line will be designed on has to be defined. To do this, place the **MSUB** component onto the layout region and double-click on it. The properties of the Microstrip substrate can be changed; change the substrate height (H) to 1.57 mm and the dielectric permittivity (Er) to 2.2.

Next, place a **MLIN** component onto the layout region and connect it to the two **Term** components. The width (W) and length (L) of the **MLIN** component has to be changed to obtain the correct characteristic impedance and phase shift, respectively. To calculate the required width (W) to provide a 50 Ohm characteristic impedance, select the **MLIN** component and then go to *Tools>LineCalc>Send Selected Component to LineCalc* enter a design frequency of 2.4 GHz. Fig. 4 shows the LineCalc window. It is important to double check the substrate definition. For the Electrical properties enter 50 for the impedance and 90 for the E_Eff (effective electrical length). Once you are done click on synthesize and the width (W=4.84 mm) and length (L=22.70 mm) will be calculated. Enter these values for the **MLIN** component. The finished layout window should look like Fig. 5.

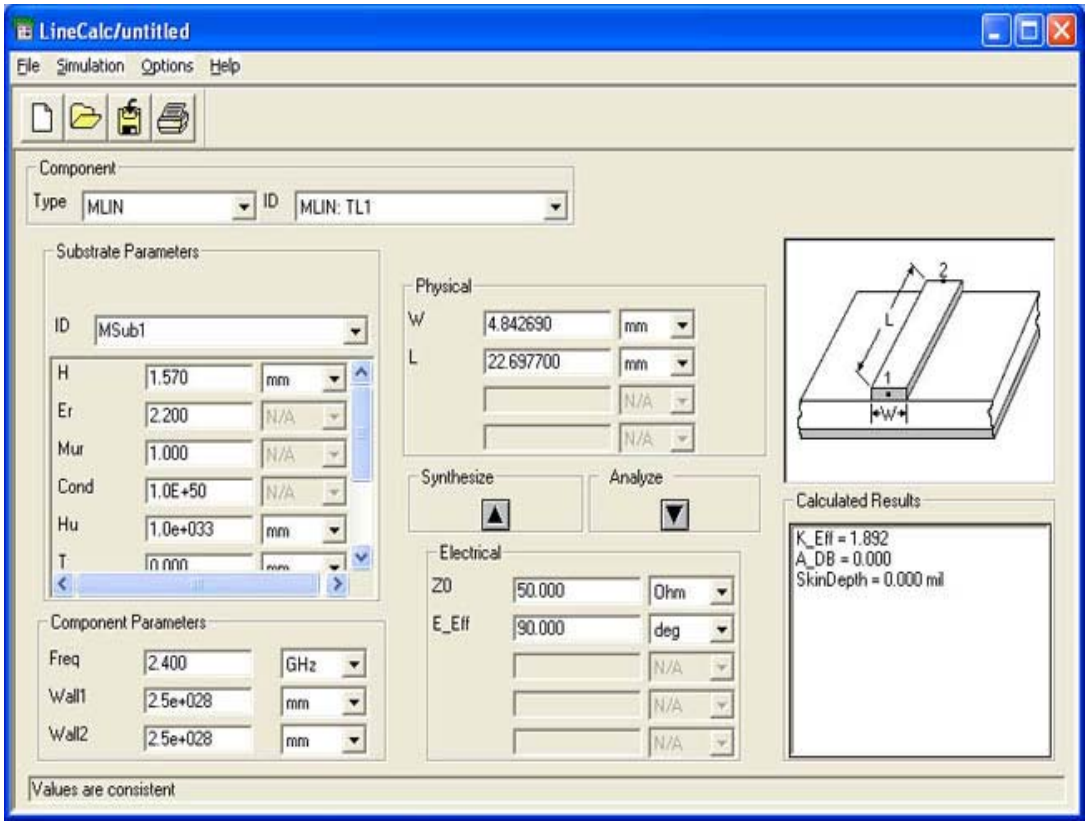

Figure 4. LineCalc window.

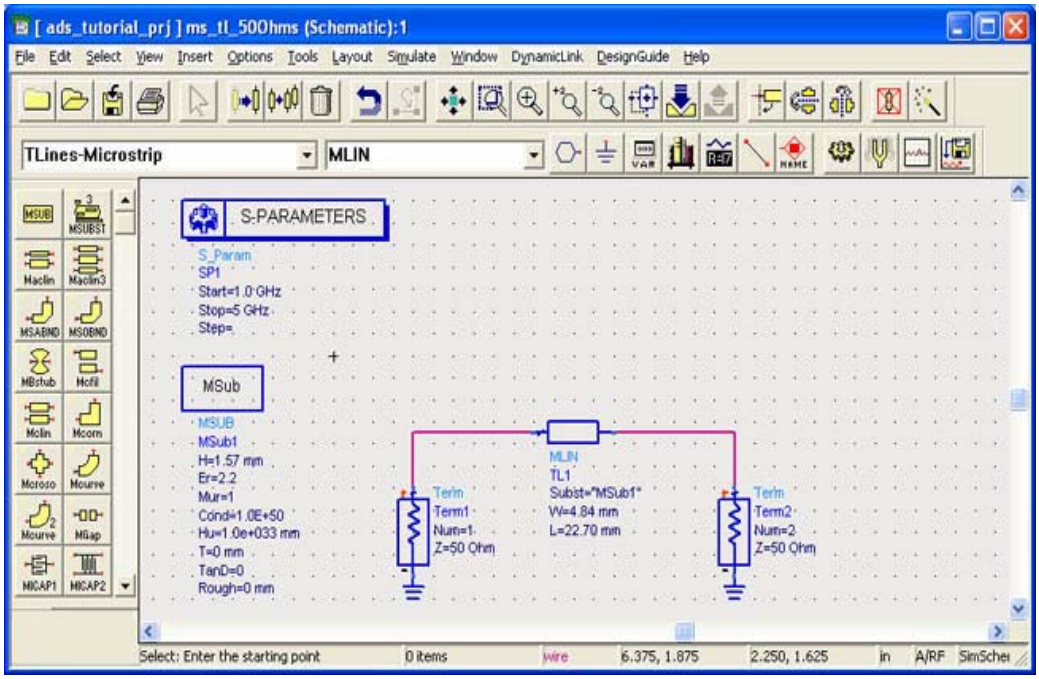

Figure 5. Completed layout.

At this point, you should save your design. To simulate the design, go to *Simulate>Simulate*. After simulation is complete, a data window will appear. Here you can plot the S-parameter data in different formats and in different types of charts. Fig. 6 shows the data window with a plot of S11 and S21 magnitude and a plot of the phase between Port 1 and Port 2 of the Microstrip line component. The magnitude

plot confirms that the Microstrip line is indeed 50 Ohms, while the phase plot confirms that at 2.4 GHz the electrical length is 90 degrees.

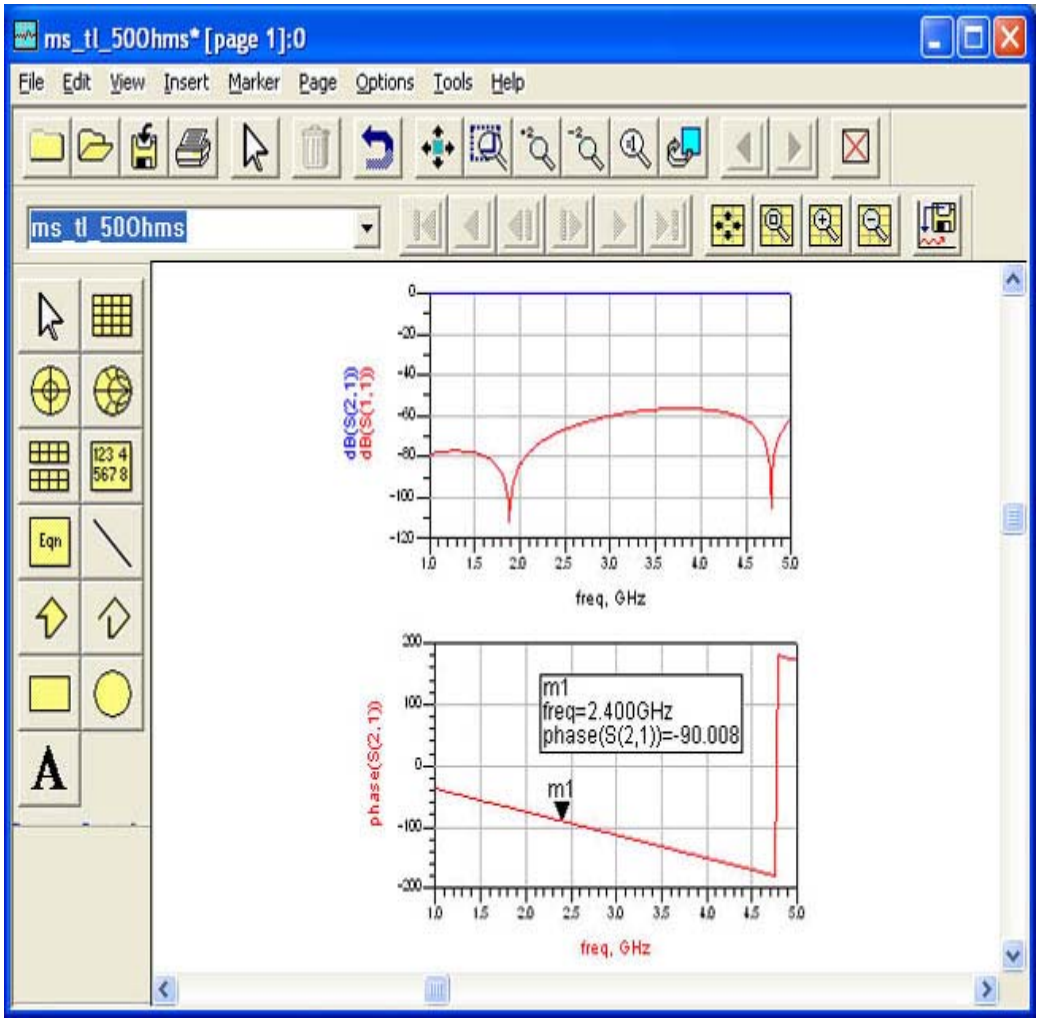

Figure 6. Data plot window showing S-parameter results.