

Wireless Circuits and Systems Laboratory

Procedure #11 Circuit Tuning using ADS

This procedure provides a demonstration of how to use the “tuning” feature of ADS. Tuning is similar to optimization (the topic of Procedure #10) except in this case you manually adjust circuit parameters, rather than having ADS adjust parameters automatically.

In this procedure you will create a microstrip circuit comprised of input/output 50 Ohm lines, a tee-junction and a microstrip radial stub (Figure 1). Using the “tune” feature in ADS you will adjust the stub length until the desired response is obtained. Specifically, the objective is to create a stub that presents a high reflection at a specified frequency (4 GHz in this example).

In order to keep this procedure brief, extensive references are made to Procedures #1 and 6.

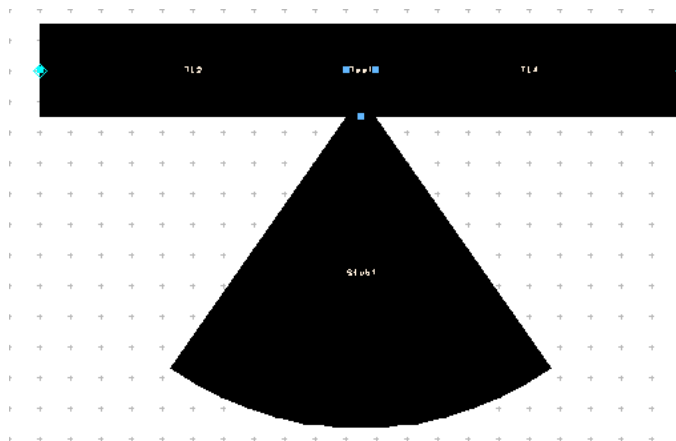


Figure 1. Microstrip circuit with input/output 50 Ohm lines and a radial shunt stub.

Setting up the Schematic

- 1) Use the approach outlined in Procedure #6 to create the circuit schematic given in Figure 2. The specifics are as follows:
 - a) Include the microstrip substrate definition (**H=1.575 mm, Er = 4.3, T = 0.043, TanD=0.022**).
 - b) Include the Variable block with **W50=3.058** (width of a 50 Ohm line in mm), **Wstub=1, Lstub=10**. (The stub length given is approximately a quarter-wavelength at 4 GHz. The tuning feature will allow us to compensate for the radial nature of the stub, as well as the effects of the tee junction.)
 - c) Include the two microstrip transmission line sections, specifying the width $W=W50$ mm and the length $L=10$ mm.
 - d) Include the microstrip tee-junction, specifying $W1$ and $W2=W50$ mm and $W3=Wstub$ mm. (These parameters define the width of the tee-junction at the three pins. If you need to see the pin numbers displayed on the schematic, click on Options -> Preferences, select the Pin/Tee tab and select the Pin Numbers to be visible.)
 - e) Include the microstrip radial stub, specifying $W=Wstub$, $L=Lstub$ and Angle=70 degrees.

- f) Include 50 Ω terminations at ports 1 and 2, and terminate each with a ground.
 - g) Include the S-parameter simulation control block, specifying **Start=0.5 GHz, Stop=5 GHz and Step=0.1 GHz**.
 - h) Connect all the elements together. Save your design.
- 2) Perform the S-parameter simulation.
 - 3) Open a data display window and create a graph that includes S_{11} and S_{21} in dB format. At this point, the results should resemble those shown in Figure 3.

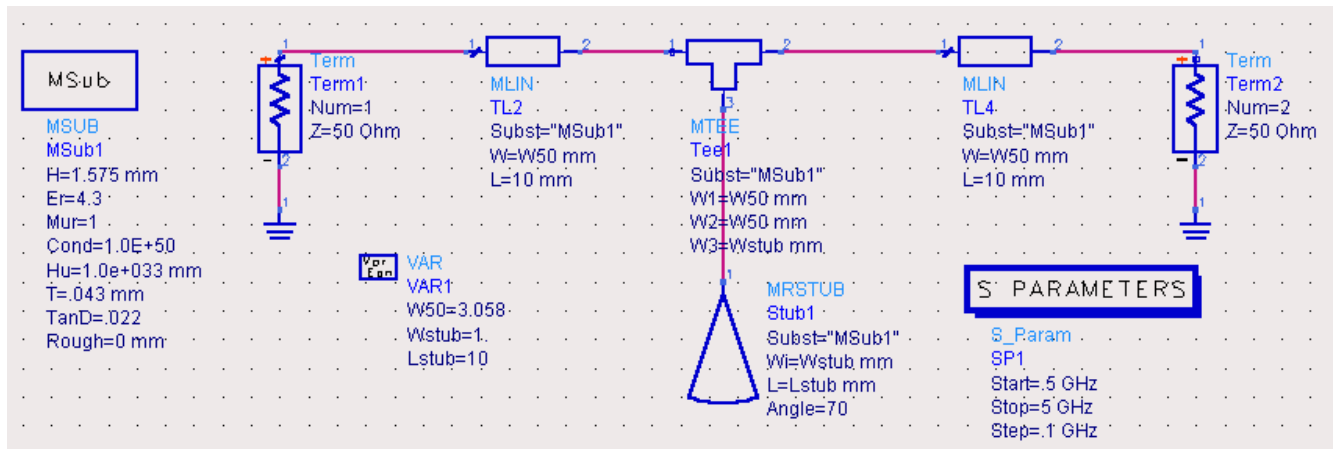


Figure 2. Initial circuit schematic.

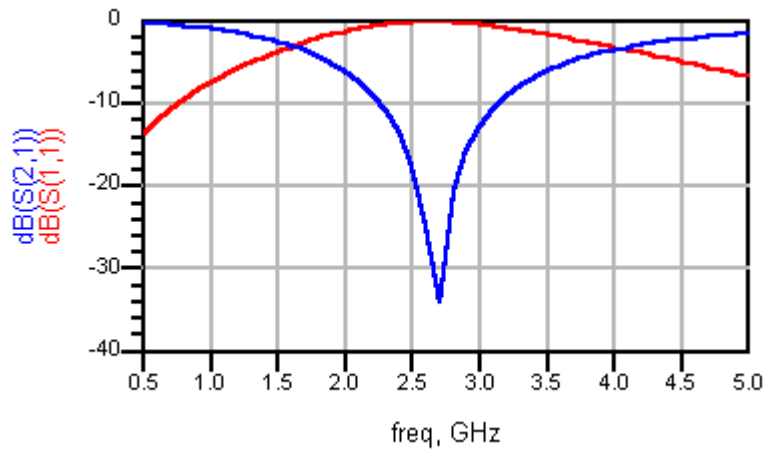


Figure 3. Initial S-parameter results before tuning is performed.

Performing Circuit Tuning

- 1) In the circuit schematic window, click on the Var block symbol such that it is highlighted.
- 2) Click on Simulate -> Tuning at the top of the schematic window.
- 3) At this point, the tune control pop-up window shown in Figure 4 should appear. You can change the settings so that a new simulation is performed after each parameter change is made, after pressing the Tune button, or as the sidebar is moved. (Note that the Tune button is not activated unless you choose the second option.) You can also set the Trace History – this parameter controls how many traces (corresponding to different sets of circuit parameter values) are retained in the graph window. For example, if you set the Trace History to 7 then you will see up to 7 different plots of S_{11} and S_{21} on the graph at any one time, as you continue to tune the various parameters.
- 4) Before we begin tuning set up the display so that you can see the tune control pop-up window and the graph at the same time.
 - a) With the schematic window active and the tune control pop-up window visible, place the mouse near the bottom of the schematic window and reduce its height to only one or two inches. Drag it and the pop-up window near the top of the display.
 - b) Now activate the graph window and drag it toward the lower right portion of the display. Resize this window so that the tune control pop-up window and the graph window are visible.
 - c) As you do these steps, be sure not to click WITHIN the schematic window. If you do so the Var block symbol may no longer be highlighted.
- 5) In the tune control pop-up window, set the option to simulate while slider moves, and set the trace history to 1. These settings are only chosen for the purpose of demonstration; in general, any options you are most comfortable with will work.
- 6) Drag the slide tuner for the Lstub variable and adjust it to obtain a maximum S_{11} and minimum S_{21} at 4 GHz.
- 7) When you have found the correct value for Lstub (which should be between 6 and 8 mm) click on the Update button. This action will cause the Lstub variable in the circuit schematic to be modified.
- 8) Cancel the tune control pop-up window and save your circuit schematic and the plot in the display window.
- 9) The response of the “tuned” circuit should resemble the results shown in Figure 5.

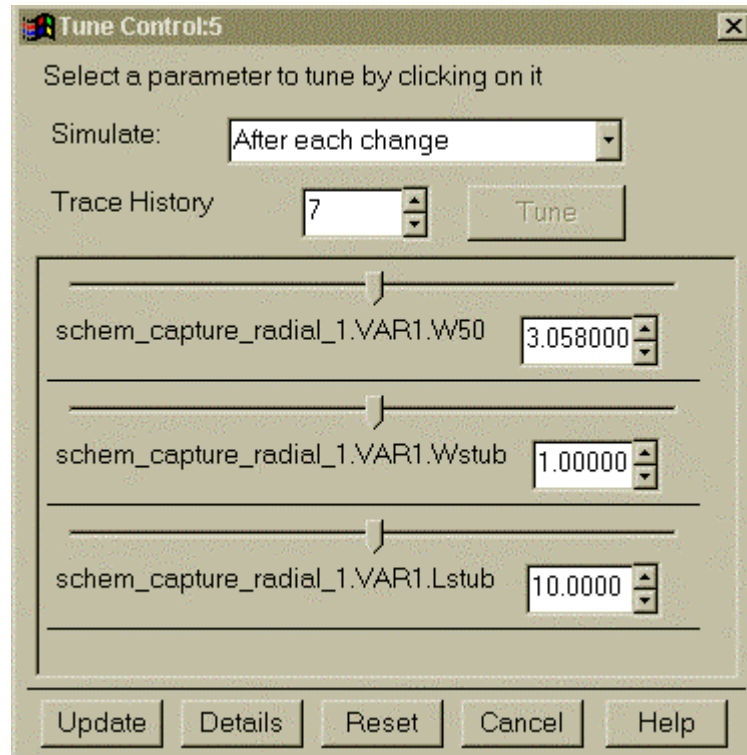


Figure 4. Tune control pop-up window.

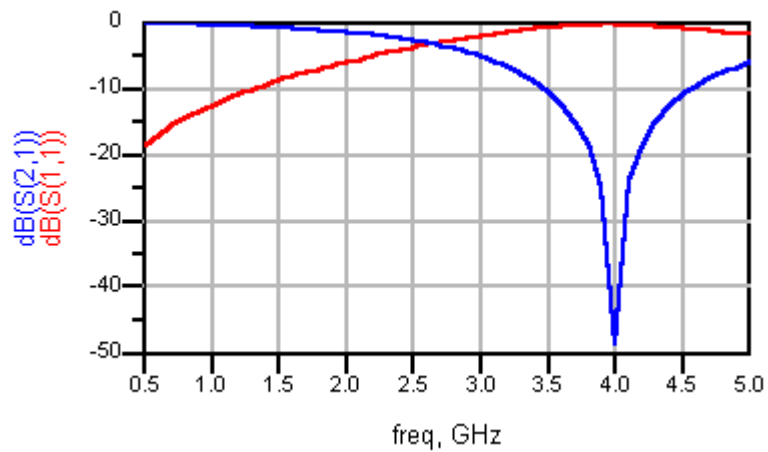


Figure 5. Simulated S-parameters of the "tuned" circuit.