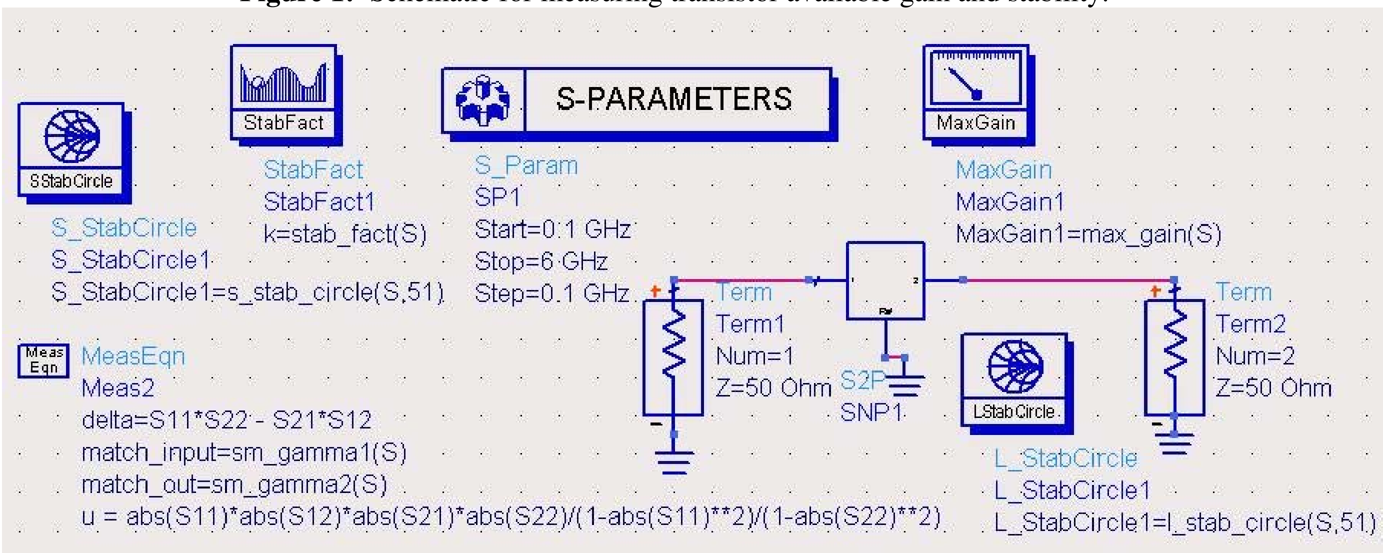
ECE 166- Microwave Circuits
Example: Bilateral Conjugate Match, June 9, 2006

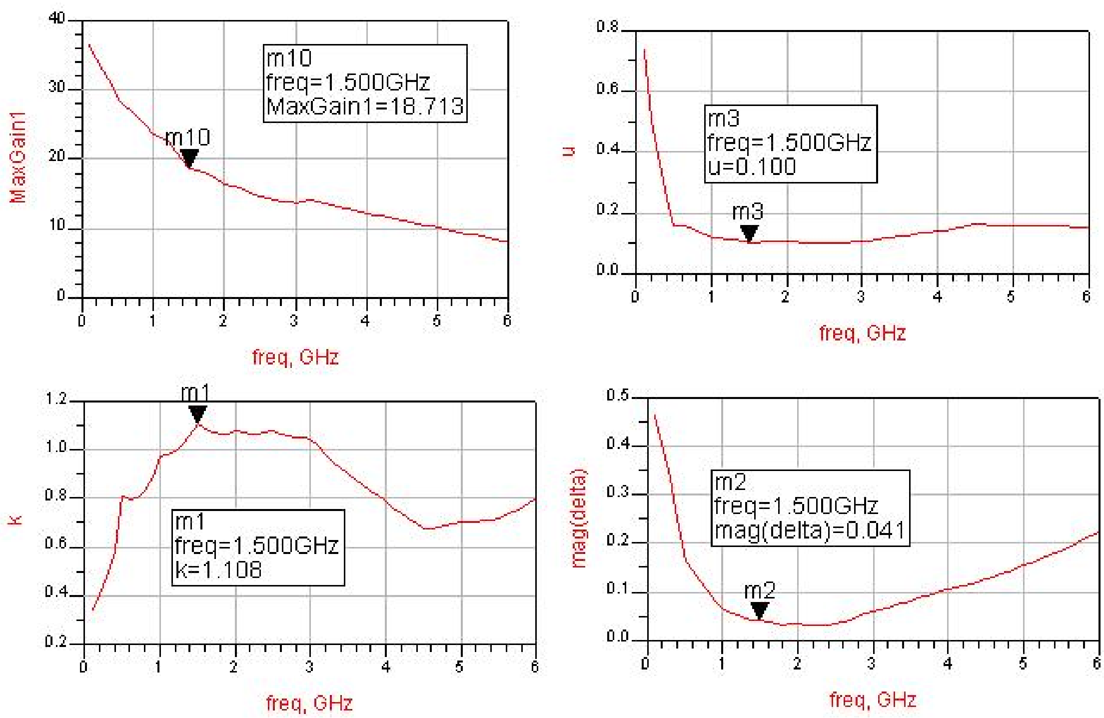
In this example, we'll design a 1.5GHz high-gain amplifier using the Agilent Silicon AT-41486 transistor and the S-parameter file t414868s_25m.s2p (details for using the s2p file are provided at the end of the document). Figure 1 shows the schematic used to characterize the transistor.

Figure 1: Schematic for measuring transistor available gain and stability.



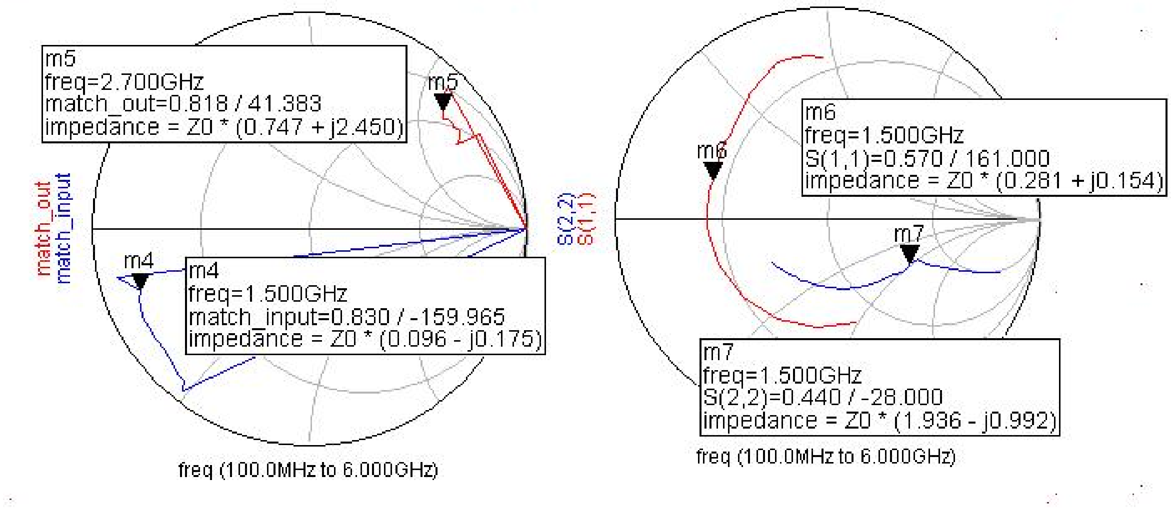
First, let's look at the maximum gain available from the transistor, as shown in Figure 2. We can measure this using the **MaxGain** block from Figure 1 (this calculates MSG or MAG depending on K). At 1.5GHz, we can get about 18dB of gain from the transistor with the right matching networks. Also, we can plot K (using the **StabFact** block) and delta, and we see that the transistor is unconditionally stable at 1.5 GHz.

Figure 2: Max Gain, U, K, delta



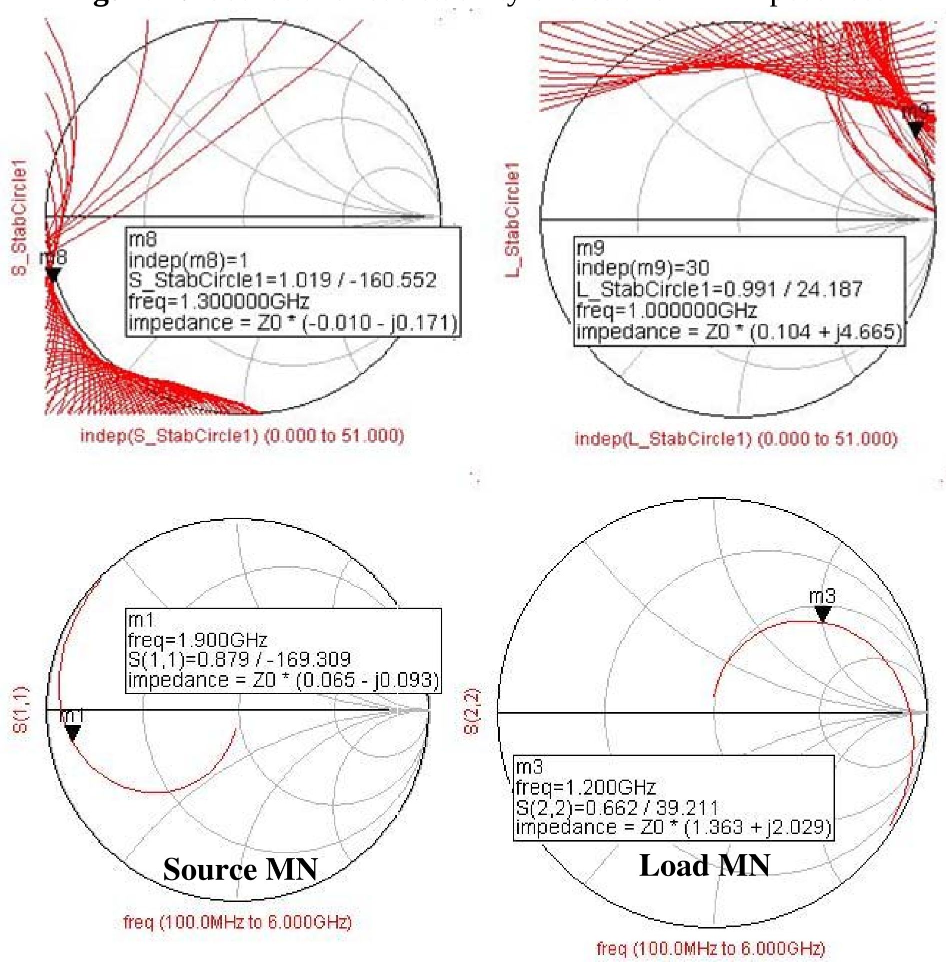
Note that U = 0.1 at 1.5GHz, so a unilateral design may or may not be acceptable for this design. We will first create a bilateral conjugate match and later compare with a unilateral design. The command **sm_gamma1(S)** in the MeasEqn block to calculate the simultaneous **Gamma(S)** and **Gamma(L)** required for the bilateral conjugate match, as shown in Figure 3.

Figure 3: Gamma(S), Gamma(L), S11,S22,



Note that Gamma(S) and Gamma(L) are shown looking towards the generator and we need to transform 50 Ohms to these impedances using matching networks (MN's not shown – it is left as an exercise for the reader to create the matching networks). We also need to check the stability of the amplifier at frequencies where K < 1 by plotting stability circles (Fig. 4) for the transistor and ensuring that our matching network impedances are not inside these circles.

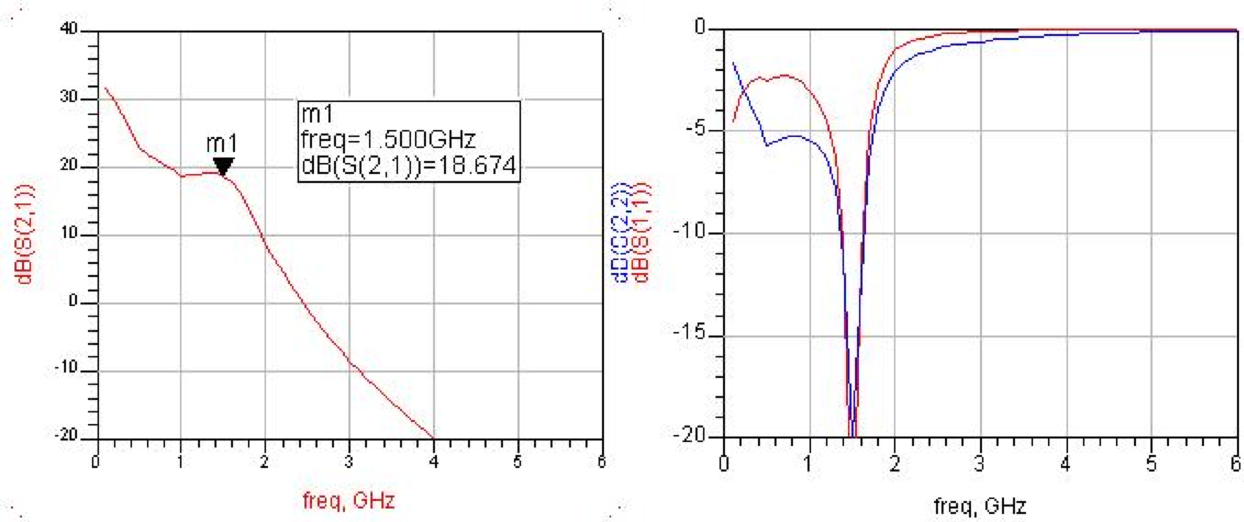
Figure 4: Source and load stability circles and MN impedances



The source and load MN impedances do not cross the stability circles at the corresponding frequencies, so the amplifier should be stable.

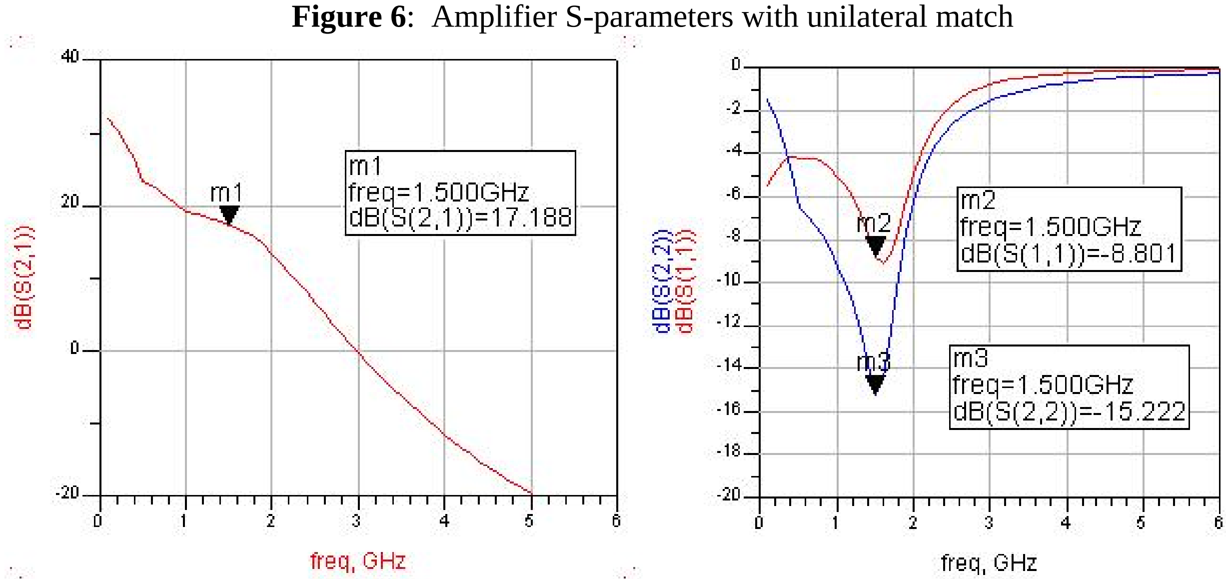
Now, we've designed our amplifier – how well does it work? Figure 5 shows the simulated S-parameters (S12 < -20 dB and is not shown). Note that we have extracted virtually all of the available gain from the transistor at this frequency. The narrow bandwidth of S22 and S11 should be acceptable in a communications environment, and could be extended using different matching networks.

Figure 5: Amplifier S-parameters with bilateral conjugate match



Compare this to the results if we create our matching networks assuming a unilateral device (Fig. 6). The input and output match is severely degraded, and the output power has been reduced by about 1.5 dB.

Figure 6: Amplifier S-parameters with unilateral match



Using S2P file

Your circuit must contain the two-port S-parameter block S2P, as shown in figure 1, which corresponds to the given .S2P file. To add the S2P component to your schematic in ADS,

a) Select **Data Items** from the **Component Palette List**.
b) Select the button **S2P: 2-port S-parameter file** from the component palette on the left-hand-side. Place the component on the schematic.

c) After placing the component, double click on the component. A **2-Port S-parameter File** dialog box pops up.
d) Specify the corresponding S-parameter file for the file parameter in the dialog box. You can also browse and select the desired file. To browse for a file, click on the **Browse** button in the dialog box.
e) Click **Apply** then **OK** in the **2-Port S-parameter File** dialog box.

Note: Text regarding .S2P adapted from Bradley University Tutorials: http://cegt201.bradley.edu/tutorial/