

# **EEL 6936; RF & MICROWAVE CIRCUITS II**

## CAD EXERCISE #5 (DUE 4/7/03)

### ANALYSIS OF A SIMPLE SINGLE-STAGE AMPLIFIER

The purpose of this exercise is to provide an opportunity to become familiar with the simulation and analysis of a transistor amplifier including input and output matching networks. The device from CAD Exercise #4 will be used. Familiarity with the material in Prof. Weller's WAMI application notes "*ADS Basics*", "*Simulation of Multiple DUT's Using ADS*", and "*Creating A Circuit Element With Measured Data In Libra*" is a prerequisite. The files are on the course web page: p01-010904.pdf, p02-000926.pdf, p03-000730.pdf.

#### PART 1. Simulation Procedure; Matching Networks

1. Design simultaneous conjugate input ( $\Gamma_S = 0.796/-166^\circ$ ) and output ( $\Gamma_L = 0.710/40.4^\circ$ ) matching networks for the transistor from CAD Exercise #4. Use ideal 50-ohm transmission line segments and minimum length ( $\leq \lambda/4$ ) open-circuit stubs for operation at 1.0 GHz.
2. Construct a schematic for each matching network. Simulate  $\Gamma_S$  for the input matching network and  $\Gamma_L$  for the output matching network to verify your solutions. See Figure 1, Figure 2, Figure 3 and Figure 4.

#### PART 2. Simulation Procedure; Transistor MRF901

Retrieve your CAD Exercise #4 files and verify that they are still usable.

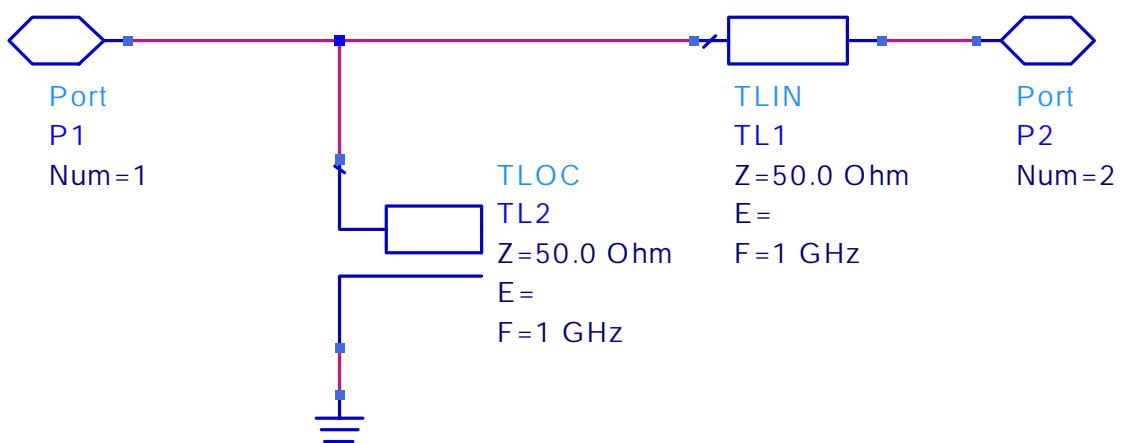
#### PART 3. Simulation Procedure; Transistor and Matching Networks

Construct a schematic for the cascade of input matching, device and output matching 2-ports that you have created. See Figure 5. Simulate K and  $B_1$ ,  $S_{11}$ ,  $S_{22}$ , and  $G_T$  for the complete amplifier. See Figure 6, Figure 7 and Figure 8. Observe that the amplifier is stable, but not unconditionally stable over the simulated frequency range. What is the basis for this observation?

#### PART 4. Write-up

Submit printed copies of your Mathcad analysis, all schematics, and simulation results. Your name should be included on each page.

# EEL 6936; RF & MICROWAVE CIRCUITS II



CLASS EXHIBIT

Figure 1. Schematic Diagram for Input Matching Network Simulation.

# EEL 6936; RF & MICROWAVE CIRCUITS II

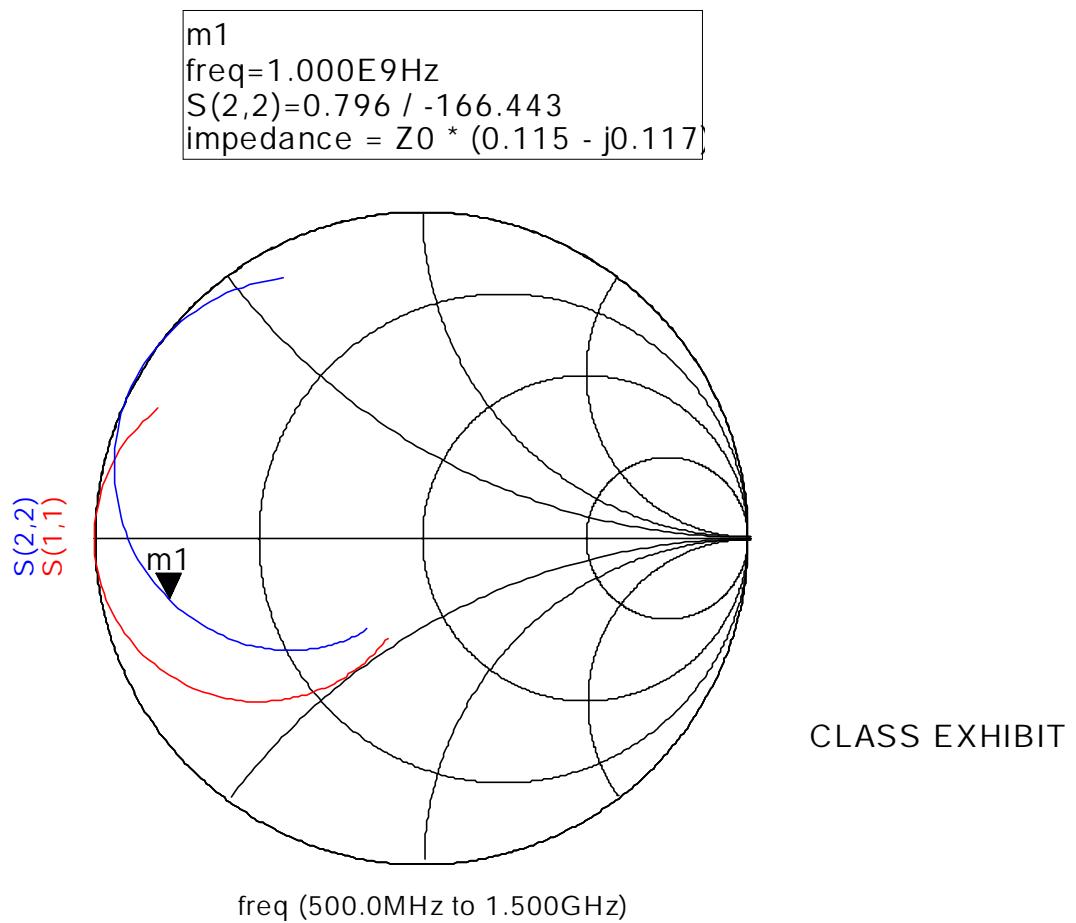
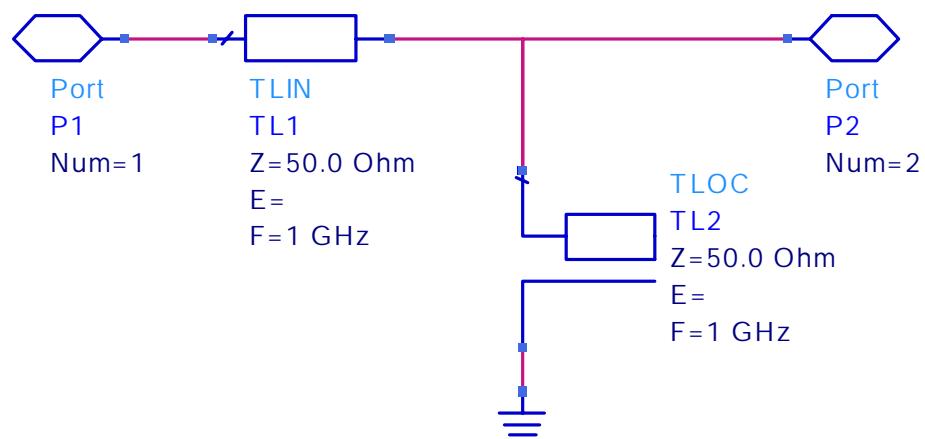


Figure 2. Frequency Response for  $S_{11}$  and  $S_{22}$  for Input Matching Network.

# EEL 6936; RF & MICROWAVE CIRCUITS II



CLASS EXHIBIT

Figure 3. Schematic Diagram for Output Matching Network Simulation.

## EEL 6936; RF & MICROWAVE CIRCUITS II

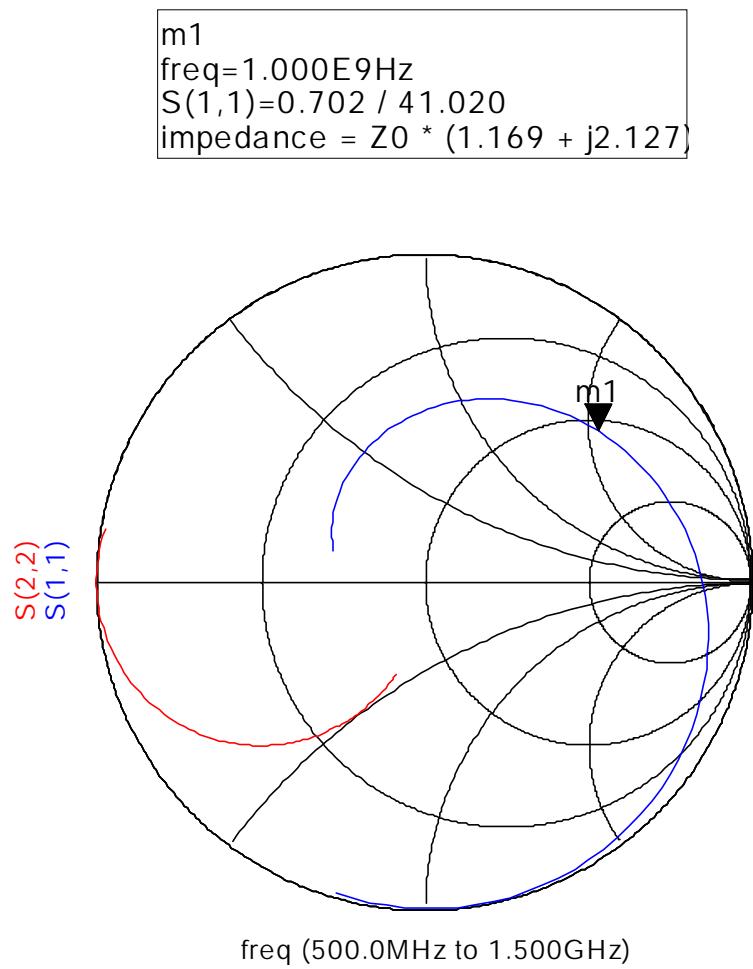


Figure 4. Frequency Response for  $S_{11}$  and  $S_{22}$  for Output Matching Network.

# EEL 6936; RF & MICROWAVE CIRCUITS II

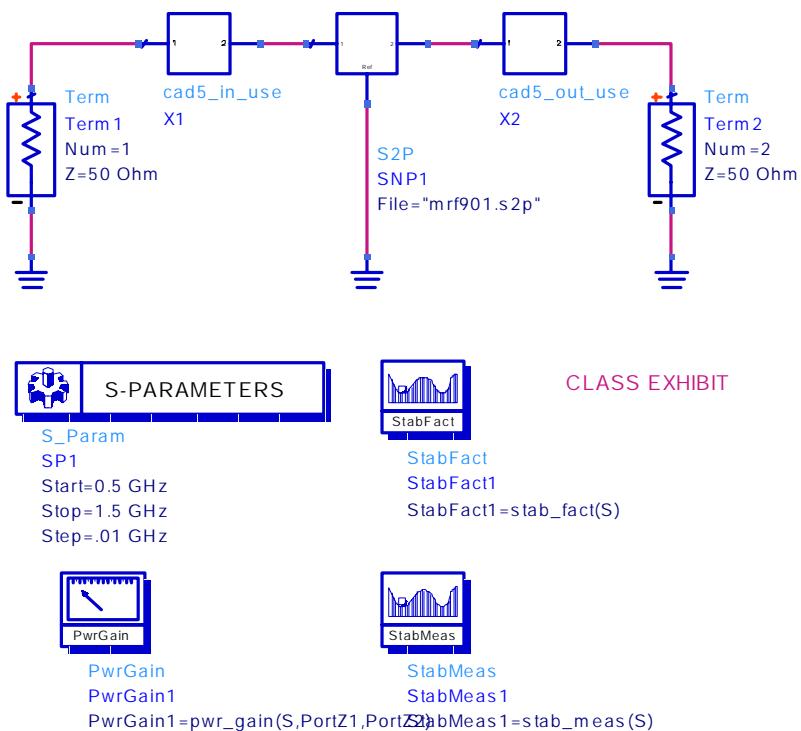


Figure 5. Schematic Diagram for Complete Amplifier Simulation.

## EEL 6936; RF & MICROWAVE CIRCUITS II

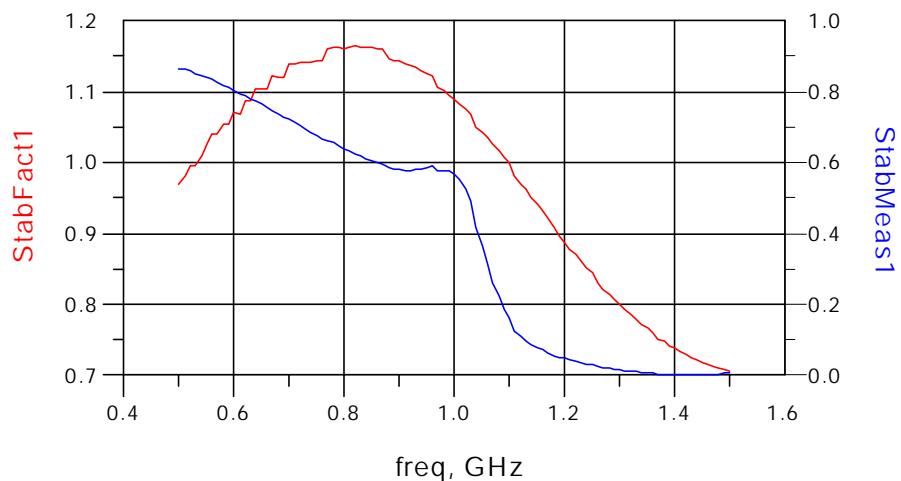


Figure 6. Frequency Response for K1 (Stabfact1) and B1 (StabMeas1).

## EEL 6936; RF & MICROWAVE CIRCUITS II

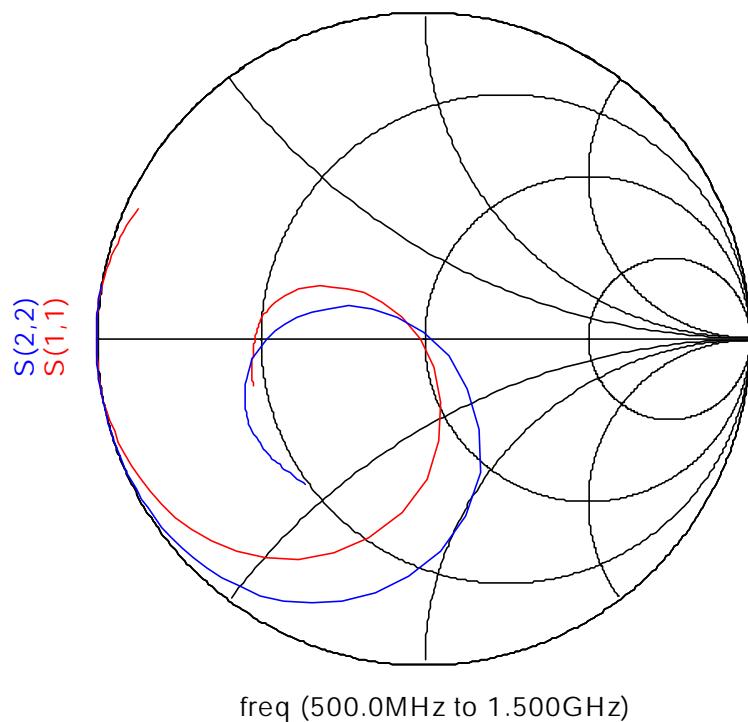


Figure 7. Frequency Response for  $S_{11}$  and  $S_{22}$  for Complete Amplifier.

## EEL 6936; RF & MICROWAVE CIRCUITS II

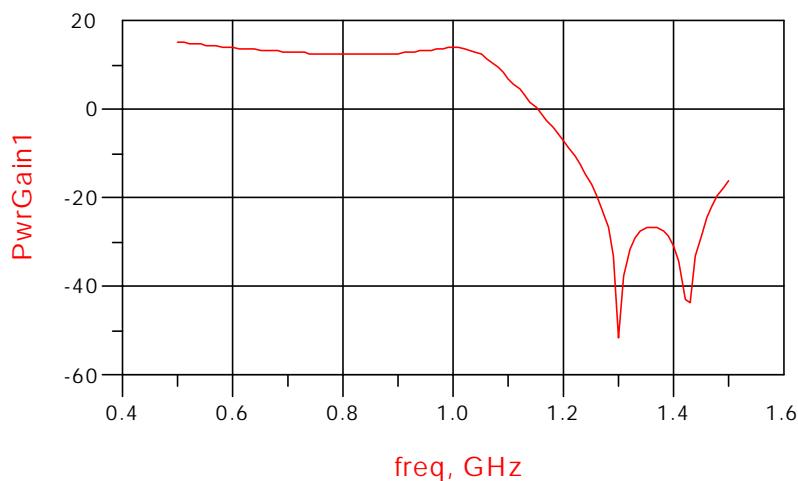


Figure 8. Power Gain (PwrGain1) for Complete Amplifier.