Lab activities for the 3rd week of ECE 432/532

Spring 2016

Goal of this session is to explore the matching for gain and stabilization of transistors.

1. Read in one of the S-parameters datafiles for SAV-541+ and plot the frequency dependence of S_{21}, S_{11} and K (use dB plot). In which region is it unconditionally stable: i.e. where is K> 1 and $|\Delta|<1$, or $\mu > 1$? (one of criteria is sufficient) Hint: you can find datafiles here: http://www.minicircuits.com/MCLStore/ModelInfoDisplay?14603215275820.3180883846218724
2. Pick one frequency at which SAV-451+ is unconditionally stable and design input and output matching for maximum transducer gain (simultaneous conjugate match). Construct the circuit in ADS and verify your "hand" calculation. Plot the values of gain and of $|S_{21}|^2$ for the device alone around some (narrow) frequency range around the center frequency. Comment on your results.
3. If you are restricted to values available from IEEE store, what are the values and what will happen to the match? Here is a list of what they are supposed to have:
   a. Inductors: 1.3, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, 10, 12, 15, 18, 22 nH
   b. Capacitors: 1, 1.3, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, 10, 12, 15, 18, 22, 33 pF
4. Construct input and output stability circles at 2.4 GHz. Use these results to determine resistance to be placed in shunt on output that would make the device unconditionally stable. Search around ADS to find some "automated" ways of doing this and report what you found and how it can be used.
5. Implement this circuit in ADS and demonstrate that it is now unconditionally stable. If it is not, what would you do to fix that and demonstrate that your fix actually works. Report your results for stabilized transistor.
6. Plot |S21| before and after stabilization and comment on the gain reduction.

Do these two on your own or during the lab and report on what you found:

7. Transform the source impedance of 34 Ohms so that maximum power is delivered to the input of your amplifier which has input reflection coefficient $\Gamma_{in} = 0.644 \angle 172°$ (which is S_{11} of SAV-541+ at f=2.47175 GHz and VDS=3V and IDS=60 mA). Given the frequency of 2.47175 GHz, construct a single-stub matching network, implement it in ADS and verify that you obtained a "perfect" solution. You can use some tuning to get this matching just right. Use ideal microstrip lines for now.
8. Save your schematic and start another one. Your problem is now to design a matching network that will convert $\Gamma_{in} = 0.644 \angle 172°$ into 34 Ohms, which is the impedance of your source. You can use some tuning to get this just right. What do you observe when comparing this solution to solution for item 7 above?
9. Extra credit: many of the things mentioned in here can be done using some "advanced" feature(s) in ADS. If you find out how this is done and illustrate it on these examples you can get up to 25% extra points. One such tool is Smith-chart tool (utility) – experiment with it; I think you will find it useful. Hint: look up Smartcomponent under "Smith Chart Matching" in component Palette in ADS, as well as the "Smith-chart" utility under Tools.
10. As usual, in your report write a short paragraph about the two most interesting new things that you learned this week.