Lab activities for the 4th week of ECE 432/532

Spring 2016

Goal of this session is to explore simulation tools (ADS) usage in design for stability, noise and gain. We will use SAV-541+ transistor and you should have its S2P parameters stored somewhere that's easily accessible. We will follow the first 30 pages or so from reference [1]. Basic idea is to apply the same techniques explained in there but to our own transistor. For our overall FSK receiver project your design has to cover 2.4 – 2.6 GHz range with at least 10dB of gain. Noise figure should be minimized but it is not of primary importance, i.e. it can be sacrificed for gain.

1. Design a bias network for SAV-541+ transistor with V_{DS}=3V and I_{DS}=60 mA. Present schematic and result for your design. You can use any of the several designs in various application notes but you may want to start with a simple resistive design.
    a. Investigate and comment on sensitivity of your bias to variations of component values.
    b. Comment on how well your design will "integrate" with future matching network that you will design (i.e. think about this as you design your bias circuit).
2. Do a "quick" comparison between S-parameters given by the manufacturer and S-parameters you get from a model that was distributed. Report back if you find any significant discrepancies, in particular in $|S_{21}|$.
3. Using ADS design guide for amplifiers, reproduce figure 13 from [1]. In your report comment on the amount of gain and stability. Limit your frequency range to 0.1 – 6 GHz. Do you anticipate any problems based on these results?
4. Decide on circuit that you will use to stabilize your transistor and make appropriate changes in DesignGuide, as explained in [1]. Examine your results carefully – just because simulation is converging (or appears to be converging!) does not mean that the results make sense. Once you are satisfied with your design, include schematic (Figure 14) and results (Fig 15). If possible, use "standard" component values or, even better, components that are available in IEEE store.
5. Add SMD component models from the library and see if parasitic effects change your results – see pages 18 – 21 in [1]. Re-optimize your stability circuit, as needed.
6. Add ground inductance into source lead of SAV 541+. Start with 0.4 nH and increase it to 1 nH. What effect does it have on noise, gain and stability?
7. Design a "final" stabilizing circuit that will ensure stability across 0.1 – 6 GHz range and satisfy the criteria for gain and NF in our LNA project.
8. Final step involves designing either for maximum gain or some smaller value. Now that you have unconditionally stable device you can do simultaneous conjugate match. What gain do your simulations predict?
9. This may have to be done after the lab session: integrate your bias and matching networks and produce a layout. Our SAV-541+ model should have an associated footprint but if it does not work well for you you can replace it with some other "dummy" device that uses the same package (one option may be Avago Technologies ATF-34143 that Payne uses). Remember what you learned from your previous project with respect to placement of SMD components and effects of even small length of transmission line that appears in signal path. Make sure that you include DC blocking capacitor on input and output.

[1] K. Payne, "Practical RF Amplifier Design Using the Available Gain Procedure and the Advanced Design System EM/Circuit Co-Simulation Capability," Agilent Technologies (5990-3356EN), 2008.