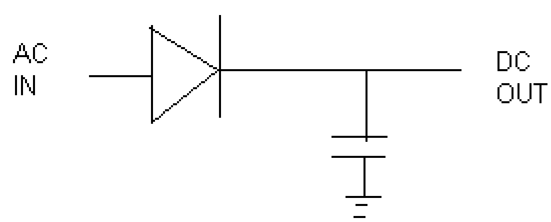
Diode Detector Lab(s)

(Initial version was based on lab writeup by C. Furse at U. of Utah)

You will have two weeks to finish this assignment which includes design and simulation (week 1) and fabrication and testing (week 2).

A diode detector is used to convert AC voltage to DC voltage. You will use this in your FSK receiver to measure the voltage after the filters to determine which frequency was passed (corresponding to a 1 or a 0).



Objective: Design, build, and test two diode detectors, one for 2.4 GHz and another one for 2.6 GHz.

Equipment:
- Signal Generator
- Network analyzer
- Digital Voltmeter

Parts:
- Two 33 pF Capacitors with low ESR*
- Two HSMS-2855 zero-biased Schottky Barrier Diodes** (alternatively, use HSMS-2860 diodes)

Design and simulation:

1. Outline of the detector design steps:
    a. First you will replicate some simulation results. Follow the steps outlined in the application note(s) to simulate the diode circuit. To be discussed in class; based on Avago App note 1156 "Diode Detector Simulation using Avago …", and 1124 "Linear Models for Diode Surface Mount Packages." Note that AN 1156 uses HSMS 2865 for their example – start with using it as well. Replicate Figures 7 and 8 from the app note.
    b. Design a matching network for the diode detector using a diode of your choice and circuit of your choice. Use the simulation setup from part a. above but modified for your choice of diode (and maybe bias). Do this for a 2.4 GHz

detector, and repeat the process for a 2.6 GHz detector. Consult Avago app note 1089 “Designing Detectors for RF/ID Tags.”

c. (More information is in Avago app note 1187 “Design of an Input Matching Network for a DC biased …” which uses another series of diodes HSMS-2820; several other app notes are available.)

d. Simulate the linear and nonlinear operation of the circuit.

Prototyping:

2. Detector Layout:
   a. Follow the steps that we have used so far to generate layout.
      Note: If you use stub design then put a via in your stub to make is a short circuited stub but be sure to put it right at the end of the stub. The location of the via is the "end" of the stub.
   b. Consult layouts in various app notes, in particular AN 1089.
3. Prototyping:
   a. Generate your board in LID/EPL.
   b. Solder on the diode and capacitor using the surface-mount soldering equipment.
   c. Be very careful when handling and soldering Schottky diodes – they can be destroyed very easily. (Skyworks has more details in app note on “Handling Precautions for Schottky Barrier Mixer and Detector Diodes.”)
   d. Provide some convenient way to measure output DC voltage (connector (SMA?), pad, header … - don’t forget the ground.)

Measurements

4. Test your circuit on the network analyzer.
   a. Measure S_{11} for the diode detector. It should be below -10 dB at the frequency you matched it for.
   b. Plot your expected and observed values on the same plot.
   c. **IF** you circuit does not work as expected
      1. Check the solder connections
      2. If you used stubs, remove the matching stubs (with exacto knife), measure the input impedance of the diode (accounting for the length of the input lines). Use the new S-parameters in your ADS simulation, design new stubs, and try again.
5. Test your circuit with the signal generator.
   a. Solder a wire (about 2" long) to the end of your detector. You will connect this wire to a DC voltmeter. Connect the ground of the DC voltmeter to the bottom (ground plane) of your circuit board. You can use a header to get the contact out or just use an alligator clip to the edge of your board. For the latter, make sure the top of the alligator clip is some distance from other parts of your circuit.).
   b. Connect signal generator to your detector circuit and adjust the frequency to 2.4GHz or 2.6 GHz. Set the magnitude to -30 dBm and increase it to 0 dBm. You should see a voltage of about 1 V on the DC voltmeter for 0 dBm on input.

Items to turn in for lab report:

1. Replicate Figs. 7 and 8 from App note 1156, but without temperature dependence. Include schematics of circuits used.
2. Design of matching networks for your detector (Smith Charts and/or ADS)
3. Layouts
4. ADS simulation results (S_{11})
5. Network analyzer results (S_{11})
6. Signal generator results (DC voltages)
7. Comments and summary on the diode detector and your results.