EE133 - Final Project
Guidelines and Specifications

In this handout is a list of quantities we would like to see summarized in your final report. Just before it, we describe a few ways of performing measurements. If you are at all confused about how you should go about measuring a parameter, please consult your TA.

Note that many of these values should have been recorded in your lab reports. You may reuse these values so long as there have been no major changes to that block since you measured them.

Here are some helpful tips for measuring these values:

- **DC Power** - Place a multimeter in series with the circuit and the power supply. Remember that the multimeter requires one of the wires to be in a different plug-in to measure current. Also remember to check that you are not current limiting your circuit with the power supply.
- **Gain** - In general, the circuits we have are not matched to 50 Ω. Use the following procedure to measure values. First, use a BNC cable through a BNC connector directly to the input of interest. Then use this cable to direct your signal from one of the signal generators appropriate for your frequency and amplitude requirements. Record the settings of the machine, but use the active probes to measure the input and the output. For consistency, we are defining the output as the signal just *after* the DC blocking cap of any block. Also please remember to ground your active probes properly.

  In the cases where you have designed for a 50 Ω load, you may use the spectrum analyzer or oscilliscopes. Please avoid using the passive probes that come with the Infinium unless all else has failed.
- **Power** - This measurement requires that you know two of three parameters: voltage, current, load resistance. Please keep in mind that you need to load your system in order to figure out how much power it is delivering. For these cases, the active probe is a requirement whenever your block requires a non-standard (not 50 Ω) load.
- **Frequency Response** - We recommend that you take at least 7-10 data points to chacterize the frequency response: Center frequency, 3dB points, and 4-7 other points to describe the slope to either side. However, if your block has multiple peaks, you should add additional points to describe their peaks and bandwidths. These measurements are gain measurements of some type, so please keep mind the same rules apply (See the bullet on measuring gain).
- **Linearity** - The Third-Order Intermodulation Point (IIP3) and 1dB Gain Compression Point (CP1) measuremnts have been specified in lecture. In lab 6 we tell you how to measure IIP3, which is a measure of how easily higher order harmonics can interfere with your signal. CP1 is a measure of your amplifier's gain limitations. To measure this value, please input a signal with a low amplitude value. Measure the input and then measure the output. Under normal circumstances you would expect that for every 1 dB increase in the input, you should get a 1dB increase in your output. To find CP1, simple increase the amplitude until the gain of the system is 1dB lower than what you would expect if there was no gain limitation. Note that a way to speed up this measurement is to quickly confirm by eye that your input changes porportionally with your voltage source,and then concentrate on measuring the output and when it falls off.
- **Noise Figure** - Use the handout on Noise Figure to measure the noise figure of your LNA. Note that if you have redesigned your LNA for an output impedance other than 50Ω it might be difficult to characterize this figure accurately.
- **Battery Life** - This is a very rough estimate, but we would like you to look up how much energy your battery stores. With this information you should be able to calculate how long your battery will last with your circuit's power drain.

Receiver

- Overall DC Power Drain(mW)
- System Gain (Pre-PLL)
- System Bandwidth (kHz)
- System THD (dB or %)
- 9V Battery Lifetime (minutes)
- Minimum Detectable Signal (dBm)

1. **LNA**
   - DC Power (mW)
   - Power Gain (mW/mW) or (dBm)
   - Frequency Response (dBuV vs. Freq.)
   - Linearity (1dB Compression Pt)
   - Linearity (Third Intermodulation Pt)
   - Noise Figure
   - Input Impedance (Ω)
   - Output Impedance (Ω)
2. **Mixer**
   - DC Power (mW)
   - Conversion Gain (V/V)
   - Frequency Response (dBuV vs. Freq.)
   - Linearity (1dB Compression Pt)
   - Linearity (Third Intermodulation Pt)
   - LO Input Voltage (mV)
3. **IF Amplifier**
   - DC Power (mW)
   - Voltage Gain (V/V or dBuV)
   - Filter Frequency Response (dBuV vs. Freq.)
4. **PLL**
   - DC power (mW)
   - Minimum Input Signal (mV)
   - Lock/Hold Frequency Range (Hz)
   - Center Frequency (Hz)
   - Sensitivity Parameter k_{PLL} (V/Hz)
   - Linearity (THD)

Transmitter

- Overall DC Power (mW)
- Output Power (mW,dBm)
- Transmittable Audio Range (Hz-kHz)
- Signal Bandwidth (kHz)
- 9V Battery Lifetime (min)
- Maxmium Receivable Distance (ft) or (m)

1. **Mic/Audio Input**
   - DC Power (mW)
   - Gain (V/V)
   - Linearity (THD)
2. **VCO**
   - DC Power (mW)
   - Output Power (mW,dBm)
   - Tuning Range (kHz)
   - Sensitivity Parameter k_{vco} (Hz/V)
   - Bandwidth (kHz)
3. **Power Amp**
   - DC Power (mW)
   - Power Gain
   - Freq. Response (dBm vs. Freq.)
   - Efficiency (Output Power/Power Consumed)
   - Input Match (Ω)
   - Output Match (Ω)