Problem Set 4
Due Friday Oct. 31, 2014

For simulations, use the transistor model card from the PTM 65nm node
(http://ptm.asu.edu/latest.html). In particular, use the BSIM4 model cards released

1. Derive the noise figure for a mixer consisting of an ideal Gm stage (1mA/V, with
current noise $4kTg_m\gamma$) and model the double-balanced switching quad as ideal
passive commutator with an input referred LO port noise of $4kTR_m$ (200 ohms). The
LO waveform is a square wave with sharp rise/fall times of 50ps. The baseband is an
op-amp with a gain of 100 with shunt feedback $R_F = 10$ kohm. The input referred
noise of the op-amp is $4kTR_o$ (1 kohm). Calculate the overall noise figure DSB, SSB,
and using the IEEE definition. How is your answer different if direct conversion is
used?

2. Assume that the above mixer is embedded in a image reject Hilbert mixer. Derive
the noise figure for the overall system.

3. Simulate the conversion gain of a simple passive voltage mixer with 50% duty cycle
LO in both voltage and sampling mode (for voltage mode, assume the load is a
matched resistor, for sampling mode use a capacitor in parallel). Verify with PSS or
HB simulations. For the sampling mode, simulate the input impedance at RF and
verify that it is bandpass as predicted from theory.

4. Please provide a 2 page project progress report. Outline what you have done to date,
how your plans have changed from the initial proposal, and what you plan to do for
the remainder of the semester.