EE6314, Fall 2009
Homework 2
Distortion Analysis and Simulation

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- Clearly explain the methods/ procedures. Most of the credit is for such explanations.
- You can make any reasonable assumptions. However, state them clearly.
- Veriloga blocks have been uploaded on the website. Use them for the simulations in this homework.
- Read ".pss" analysis from cadence manuals. There are examples to illustrate techniques to simulate IIP3. Refer to the ones in the section "Simulating Low Noise Amplifier".
- The amplifiers need to be modeled as

$$y(t) = \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t) \tag{1}$$

  where $x(t)$ is the input and $y(t)$ is the output.

1 Gain Blocking

Use the block "GainBlocking" for this problem.

- Let the input to the amplifier be $v(t) = A_1 cos(\omega_1 t) + A_2 cos(\omega_2 t)$. Let $\omega_1 = 500MHz$ and $\omega_2 = 520MHz$.
- Initially set $A_1 = A_2 = 10mV$. Plot the time domain signal and spectrum of the output.
- Increase the value of A_2 till the signal at ω_1 becomes zero. Report this value of A_2.
- Calculate the value of α_1 and α_3 based on this simulation.

2 Harmonic Distortion

Objective of this problem is to estimate the value of α_2 and α_3 using Harmonic Distortion analysis. Use "NonLinear" amplifier for this problem.

- Let the input of the amplifier $Acos(\omega t)$. Set $\omega = 500MHz$ and A=500mV.

- Plot the spectrum of the output of the amplifier.
- Calculate α_2 and α_3 based on the power at second and third harmonics. Report these values.

3 Two-Tone Test

In this problem, the values of α_2 and α_3 will be estimated based on the IIP2 and IIP3 information. Illustration of IIP3 simulation is available in the spectreRF manual. Use "NonLinear" amplifier for this problem.

- For the two-tone test, let the tones be at 500MHz and 520MHz.
- At what frequencies are the second order and third order inter-modulation products located?
- Plot the IP2 and IP3 curves and report the IIP2 and IIP3 values.
- Calculate α_2 and α_3 based on these values.

Do the values of α_2 and α_3 from problem 2 and problem 3 match? Justify your answer.

4 Extra Credit - 25%

- Repeat Problem 2. You are required to plot the spectrum of the input and output of the amplifier. Perform transient analysis and then use DFT to calculate the spectrum.
- Using an input power of -20 dBm, perform the two tone analysis described in Problem 3 using transient simulation. Plot the spectrum of input and output of the amplifier.
- In each case, explain the settings used in transient analysis.

Notes for Transient Analysis

- Read about strobe period in transient simulation. You need to understand this to calculate DFT correctly.
- Using 2^N points for calculating DFT in Cadence has been found to give more accurate results.