• 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

\[ y(t) = \alpha_1 x(t) + \alpha_2 x^2(t) + \alpha_3 x^3(t) \quad (1) \]

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 \( \omega_1 = 500 \text{MHz} \) and \( \omega_2 = 520 \text{MHz} \).

• Initially set \( A_1 = A_2 = 10 \text{mV} \). Plot the time domain signal and spectrum of the output.

• Increase the value of \( A_2 \) till the signal at \( \omega_1 \) becomes zero. Report this value of \( A_2 \).

• Calculate the value of \( \alpha_1 \) and \( \alpha_3 \) based on this simulation.

2 Harmonic Distortion

Objective of this problem is to estimate the value of \( \alpha_2 \) and \( \alpha_3 \) using Harmonic Distortion analysis. Use “NonLinear” amplifier for this problem.

• Let the input of the amplifier \( A \cos(\omega t) \). Set \( \omega = 500 \text{MHz} \) and \( A=500 \text{mV} \).
• Plot the spectrum of the output of the amplifier.

• Calculate $\alpha_2$ and $\alpha_3$ based on the power at second and third harmonics. Report these values.

3 Two-Tone Test

In this problem, the values of $\alpha_2$ and $\alpha_3$ 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 $\alpha_2$ and $\alpha_3$ based on these values.

Do the values of $\alpha_2$ and $\alpha_3$ 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.