3-Bit Current Steering DAC

Design a 3-bit DAC based on identical current mirrors (thermometer code) and differential switch cells based on the following specifications.

- Maximum conversion time: T_{c_max} = 100 ns
- Output voltage settled to within 0.5 LSB of the ideal output:

$$V_o = \left(\frac{b_2}{2} + \frac{b_1}{4} + \frac{b_0}{8} \right) \cdot 1V$$

- Output based on selection of seven identical current outputs (i.e. use a thermometer code to select output currents)
- I/O: binary input word: [b_2 b_1 b_0], output voltage, V_o, and power supplies

With the following design constraints:

- Power supplies: $Vdd = 3.3V$, $Vss = 0V$
- Place two resistors in your design: one for generating the bias current and one for converting the output current to an output voltage.
- Use as many nmos and pmos devices as desired.

Procedure

- Design the 3-bit DAC according to the specifications and constraints. If desired, Verilog code may be used initially for converting the binary input to thermometer code. An example for 4 bits is given in the ams_5007_ref library.
- Modify the 4-bit "dac_tst_fix" test fixture cell in the ams_5007_ref library to perform an automated check of your 3-bit DAC (for offset and gain error, INL and DNL).
- Test your DAC using the test fixture and modify your design if needed.
- Complete your design with full schematic and layout (including digital logic for binary to thermometer cell).
- Test your extracted DAC with the test fixture.

Turn in

- Complete schematics and layout, with results showing LVS clean (specify operating directory and leave DRC check file in your directory)
- Transient response with 100ns conversion time steps, sequencing through all inputs from 0 to 7, showing the output voltage and thermometer code drive signals
- Text output from test fixture output file, showing offset and gain errors, data from each input, and INL and DNL errors.
- Answer the following questions:
    - Based on your measured results, what is the maximum number of bits you could achieve in your DAC by simply increasing the number of your current output cells? Explain.
    - What is the maximum frequency for your input data?