INDIAN INSTITUTE OF TECHNOLOGY ROPAR

EE-301: Analog Circuits
PROJECT REPORT

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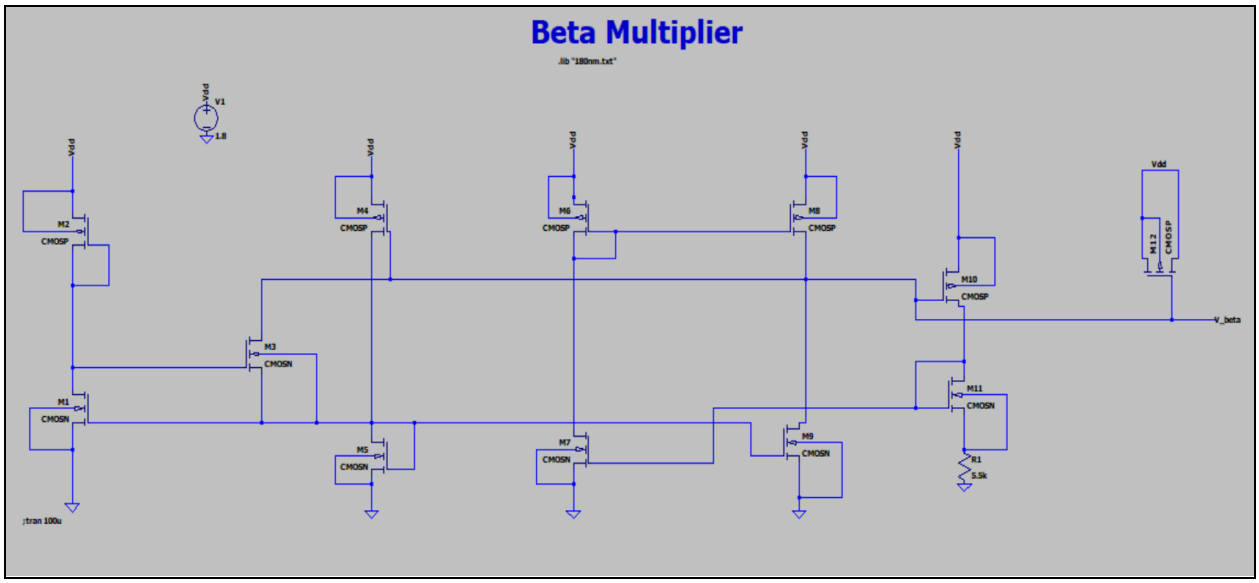
Objective: Design of cascode amplifier and cascode current mirror in schematic and layout using LTSpice and Magic tools in 180 nm (supply 1.8 V) technology and only schematic of cascode amplifier, beta multiplier and cascode current mirror in 22 nm (supply 0.8 V) technology node to see the effect of lowering the technology node.

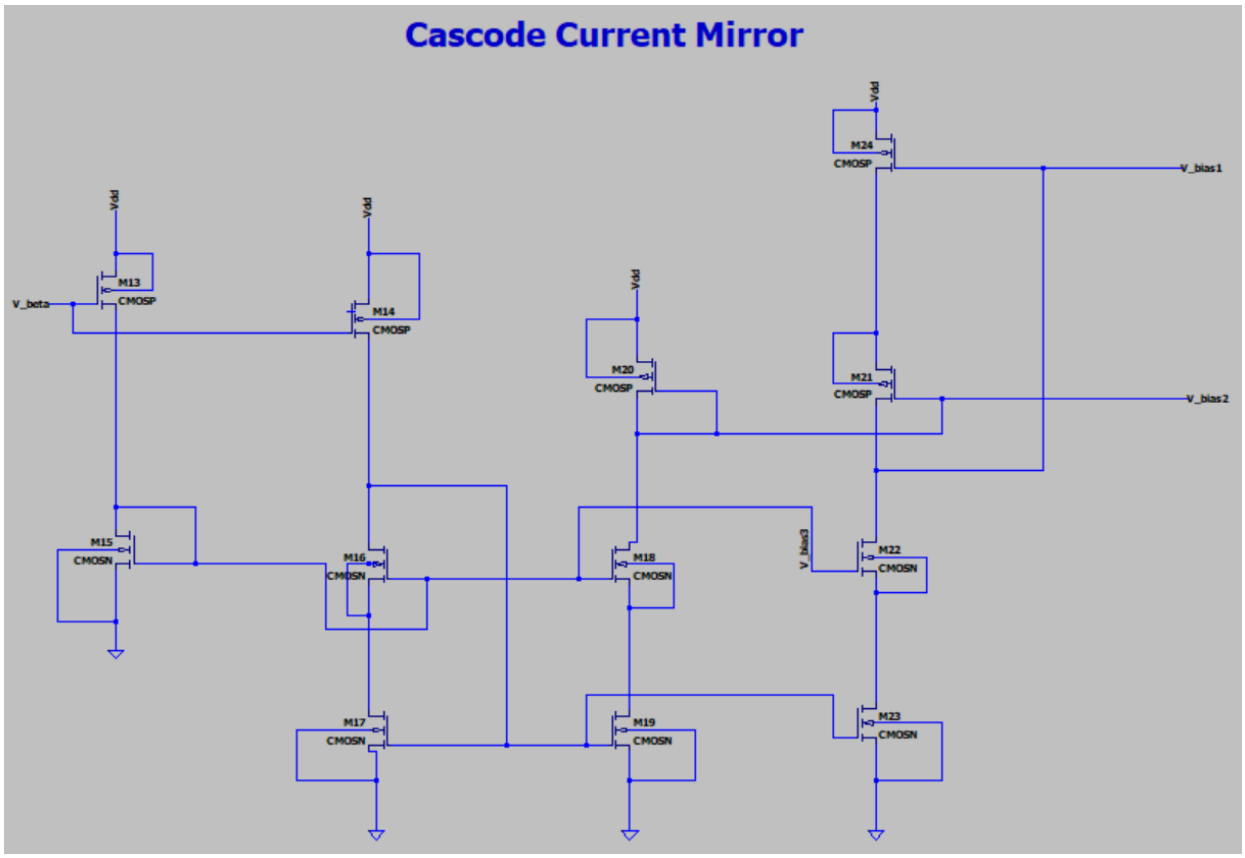
Circuits [180nm]:

Beta Multiplier:



The Vbeta obtained via simulation was *1.197V.*

Cascode Current Mirror:

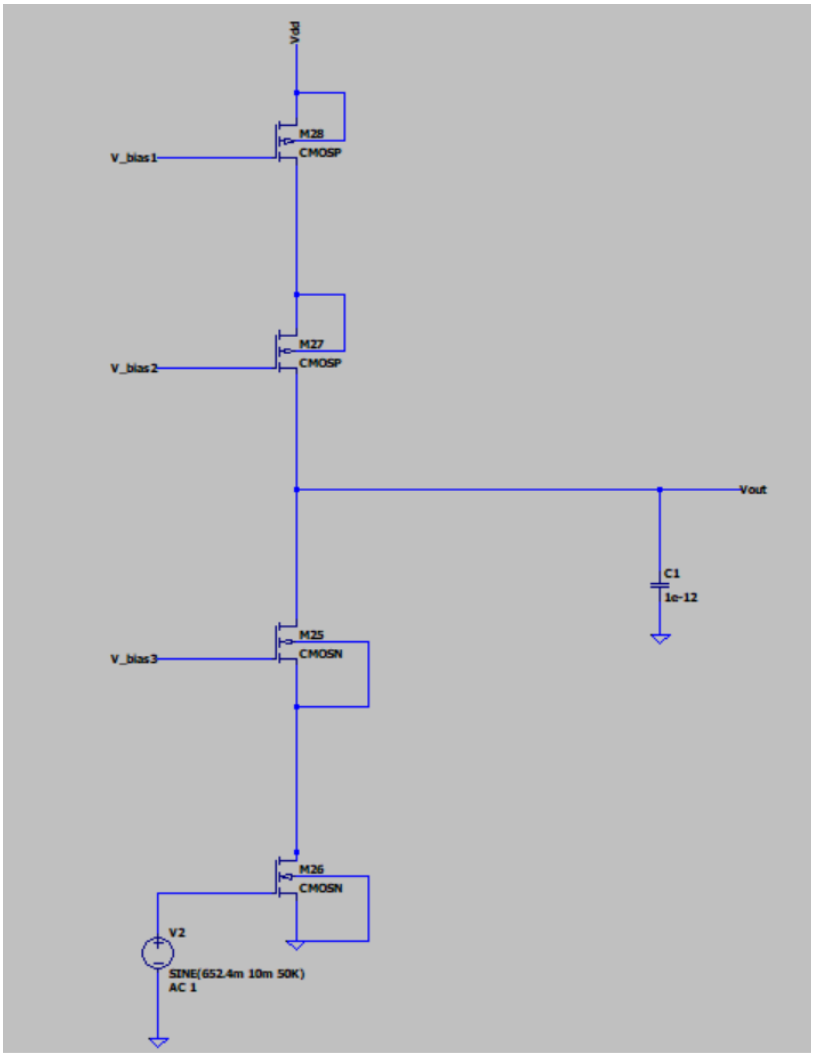


After Simulation:

Vbias1 = 1.16V **Vbias2 = 1.06V**

Vbias3 = 629mV **Vbias4 = 652mV**

Cascode Amplifier:



Calculations:

Given: Gain, $A_v = 20$ V/V ; $C_L = 1pF = 10^{-12}F$; $V_{DD} = 1.8V$ (for 180nm)

Power Dissipation $\leq 5mW$

$\Rightarrow I_D(max) = \frac{5}{1.8} = 2.78mA$

$\Rightarrow \boxed{I_D < 2.78mA}$

for UGB [Unity Gain Bandwidth] more than 500 kHz.

$f_{cutoff} = \frac{1}{2\pi R_{out} C} > 500kHz$

$\Rightarrow \boxed{R_{out} < 318.4k\Omega}$

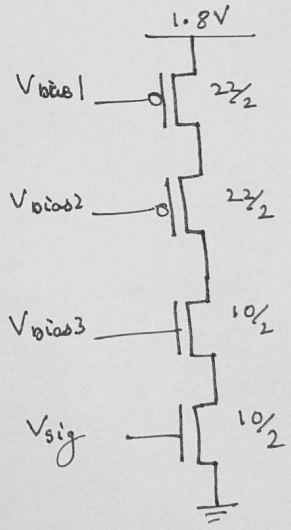
To operate in saturation

$V_{ds} > V_{gs} - V_{thn}$ → (NMOS)

$|V_{ds}| > |V_{gs}| - |V_{thp}|$ → (PMOS)

Now, $A_v = g_{m(max)} \cdot R_{out}$

$\boxed{g_m > 62.84\mu S}$



As per the simulation results.

Gain is 26 dB & has UGB = 5.32 MHz

⇒ All conditions satisfied

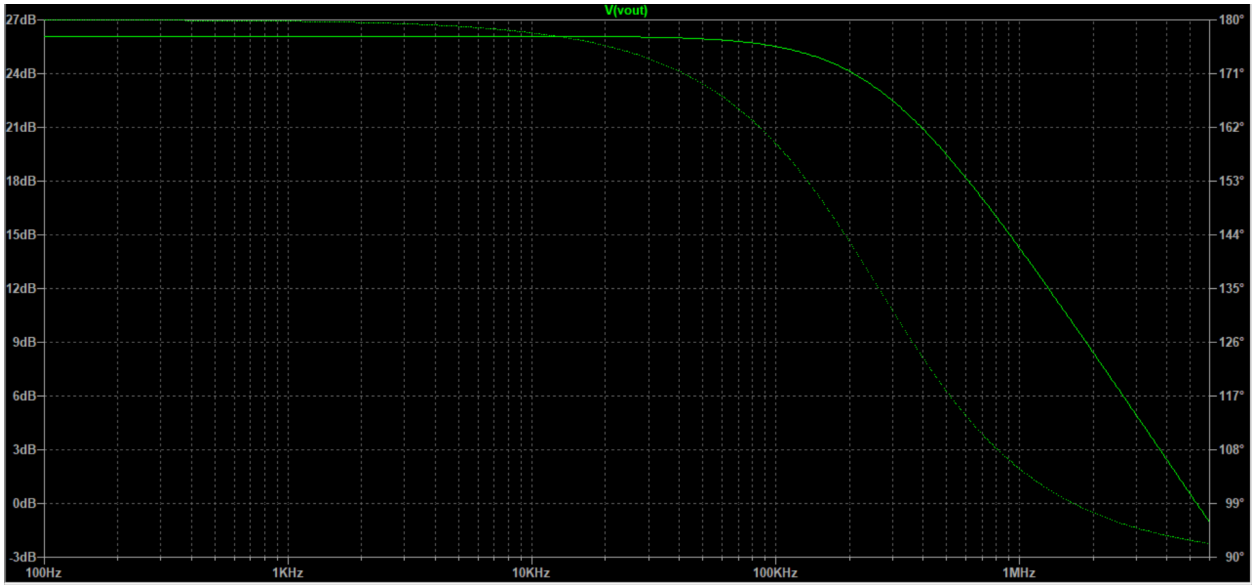
Power Dissipation 10.7μA

$\boxed{I_D \text{ (swings)} = 10.7\mu A}$

Results:

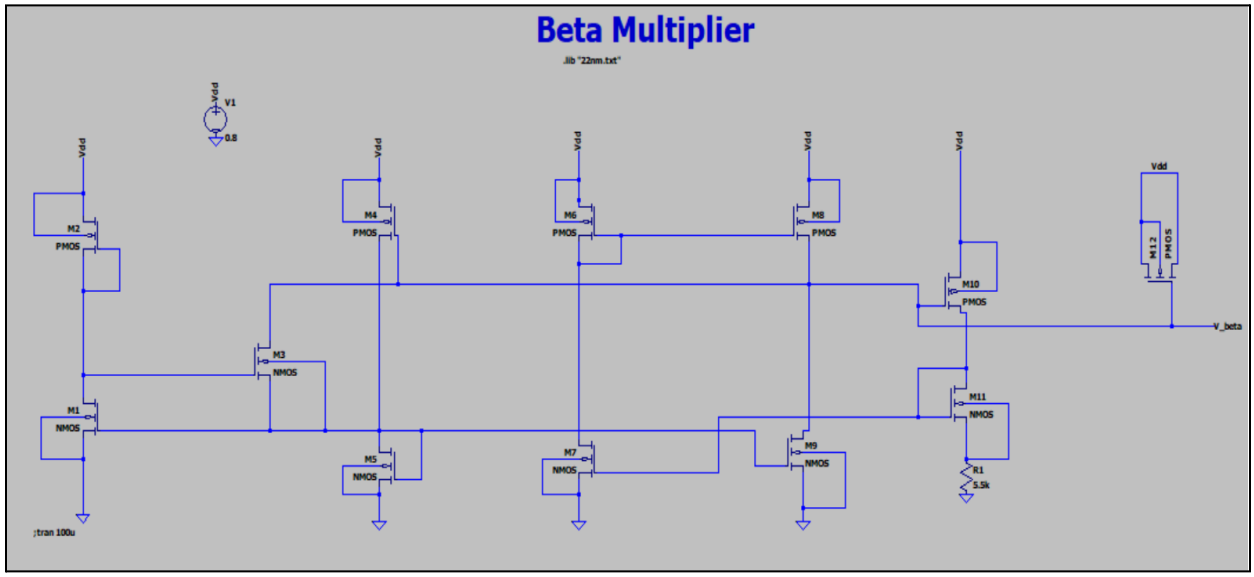
Gain = 26 dB = 20 V/V
Unity Gain Bandwidth = 5.32 MHz
Power Dissipation = 19.4 µW

The frequency response is shown below:



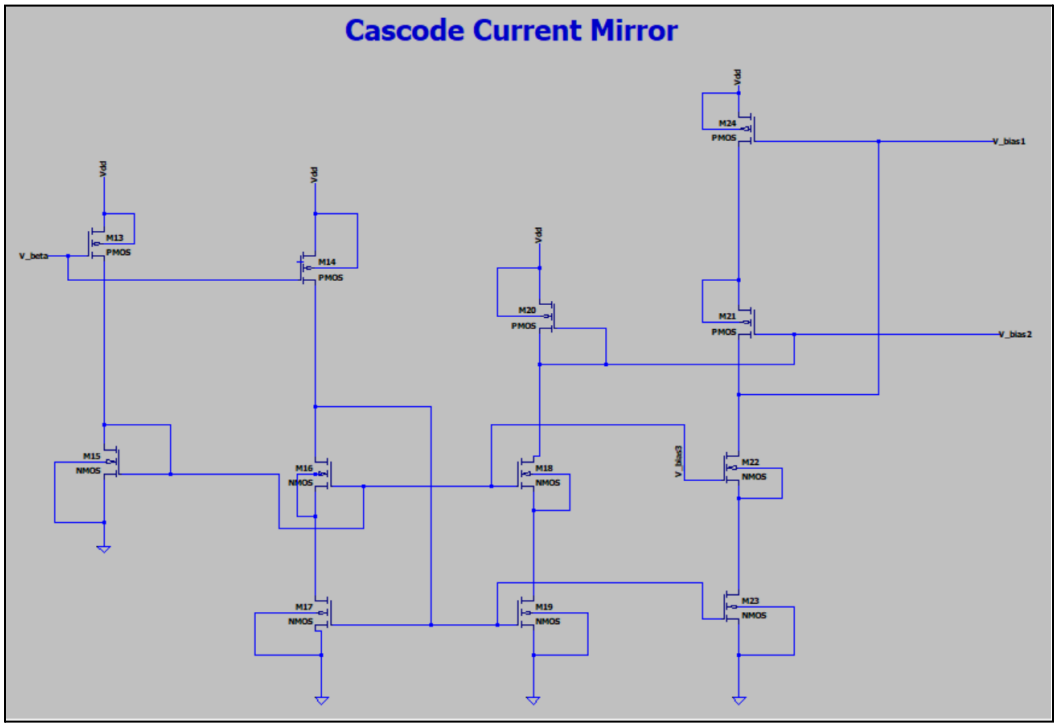
Circuits [22nm]:

Beta Multiplier:



The Vbeta is *228.9mV.*

Cascode Current Mirror:



The bias voltages obtained were:

Vbias1 = 225.4mV

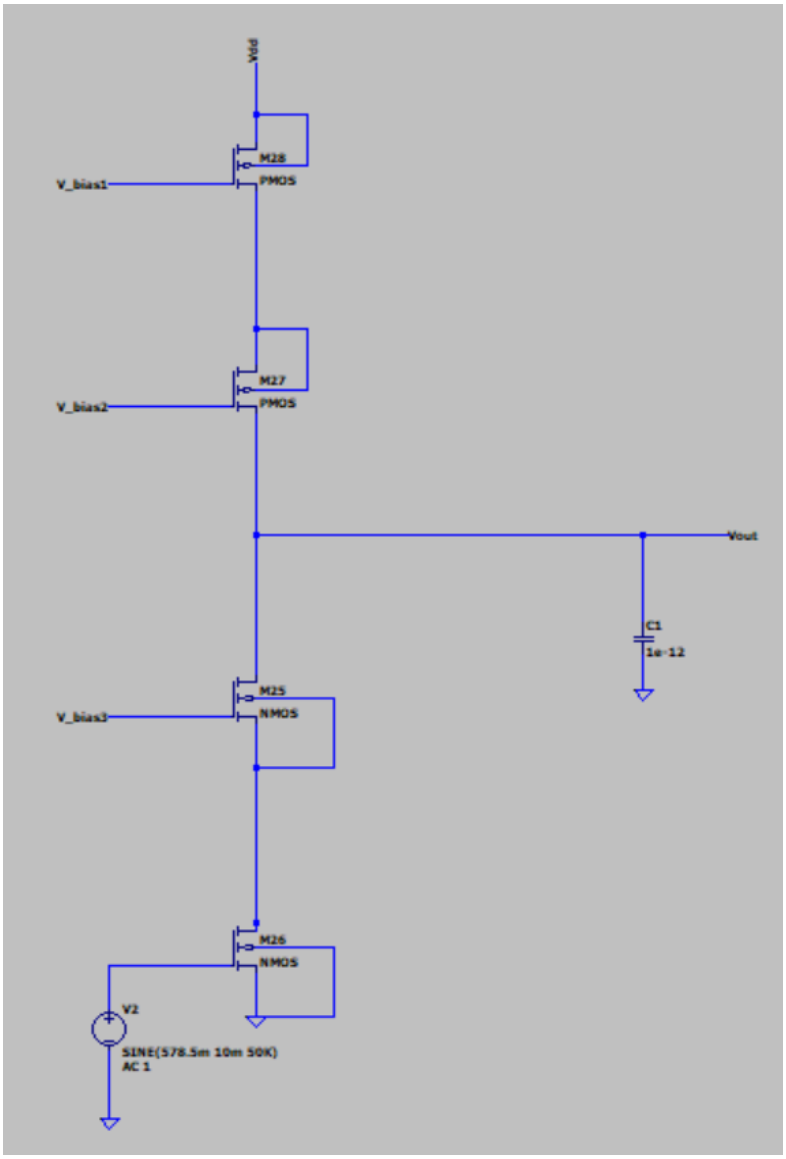
Vbias2 = 118.05mV

Vbias3 = 612.83mV

Vbias4 = 605.12mV

These are the voltages used to bias the transistors in the cascode amplifier.

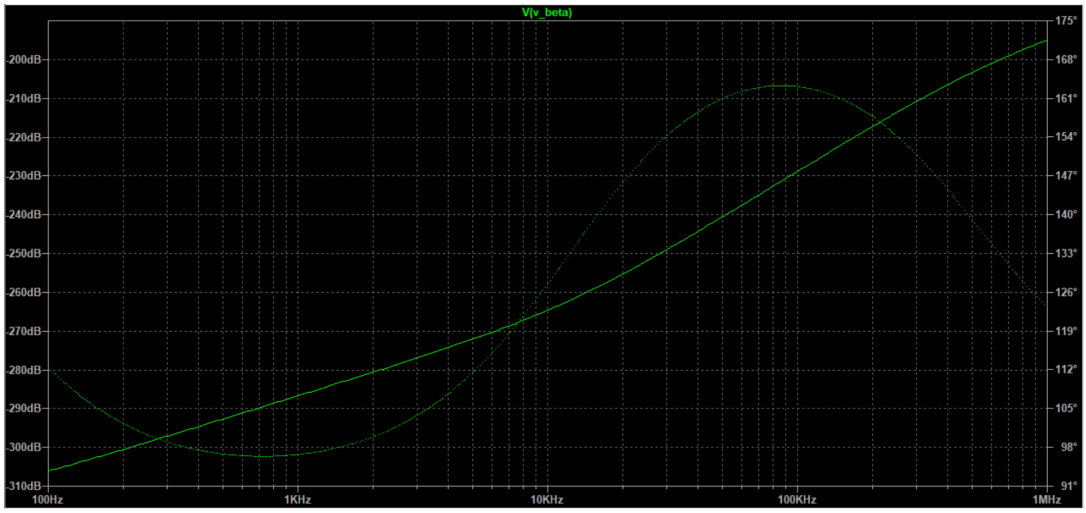
Cascode Amplifier:



Results:

Gain = 26 dB = 20 V/V
Unity Gain Bandwidth less than 500kHz
Power Dissipation = 83.1 µW

Here is the frequency response:



MAGIC LAYOUT SNAPSHOTS:

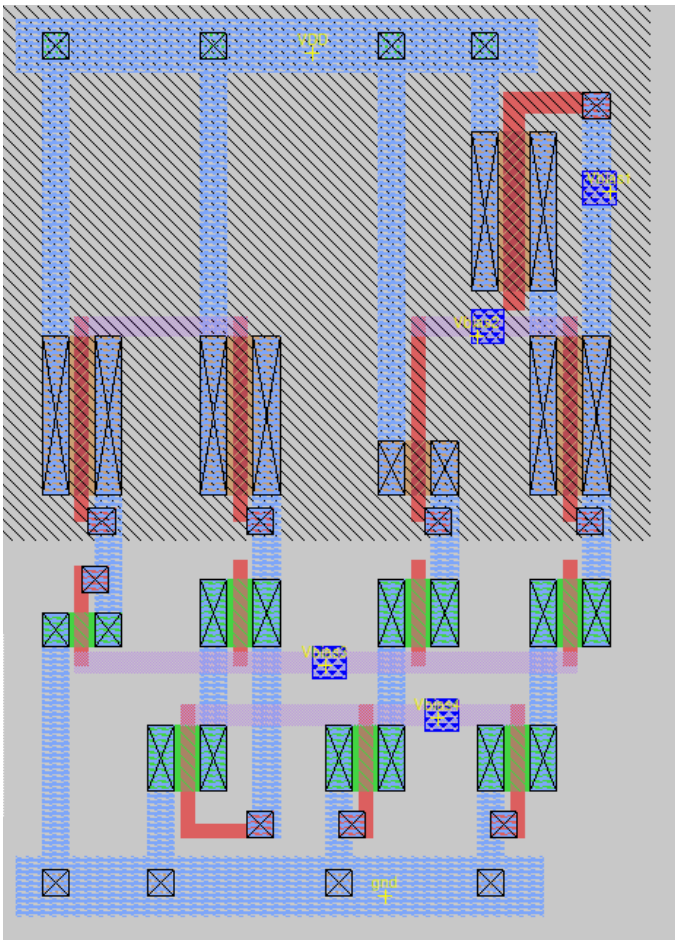


Fig: Magic Layout Cascode Current Mirror

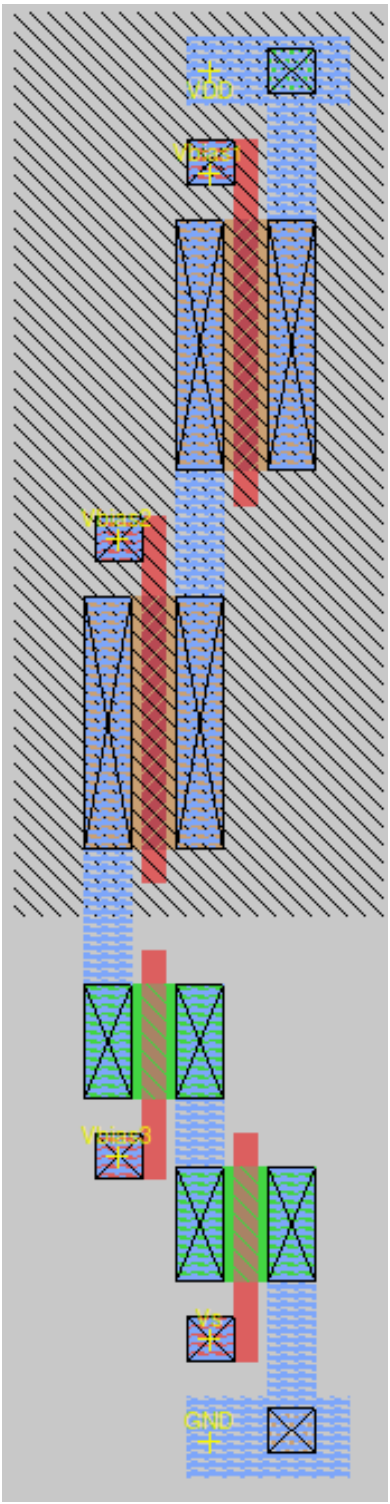


Fig: Magic Layout Cascode Amplifier