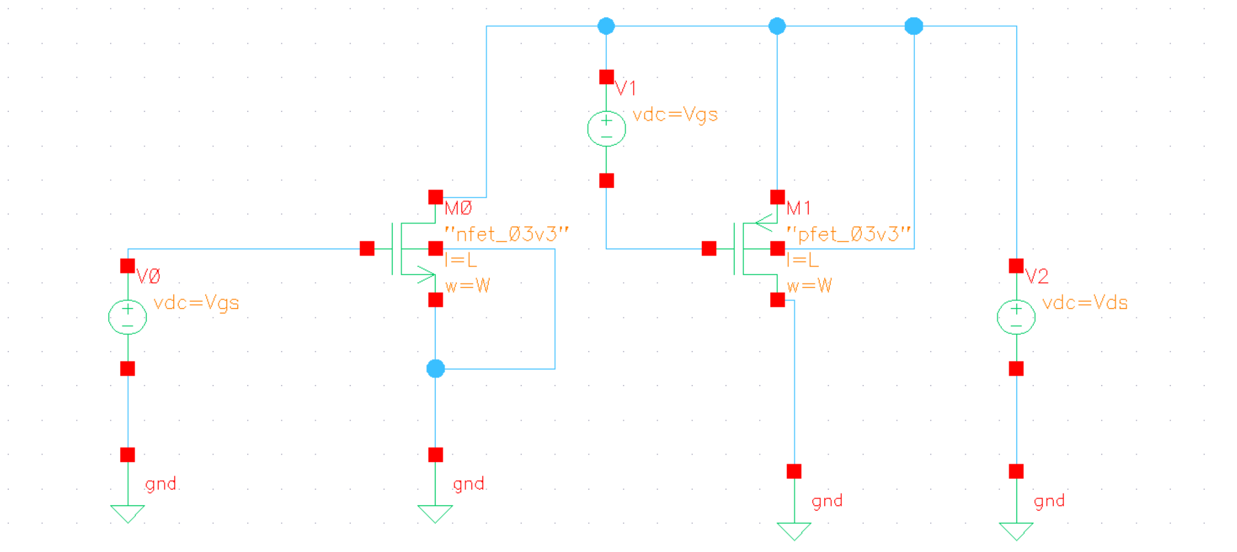
ITI
LAB3

Contents

Part1

Schematic

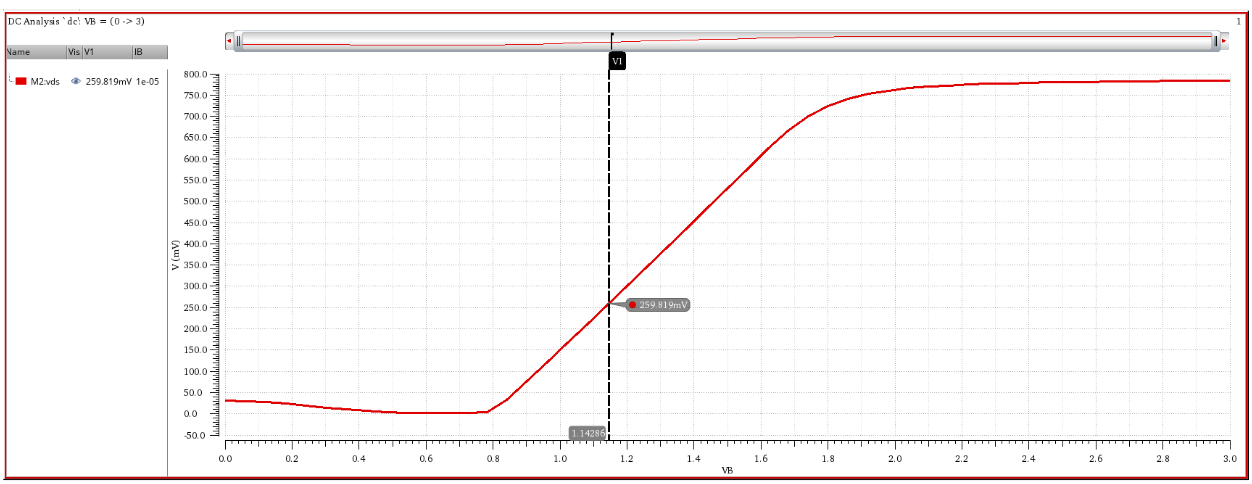


V_B

Since $V^* = 160\ mV$ and it was given that

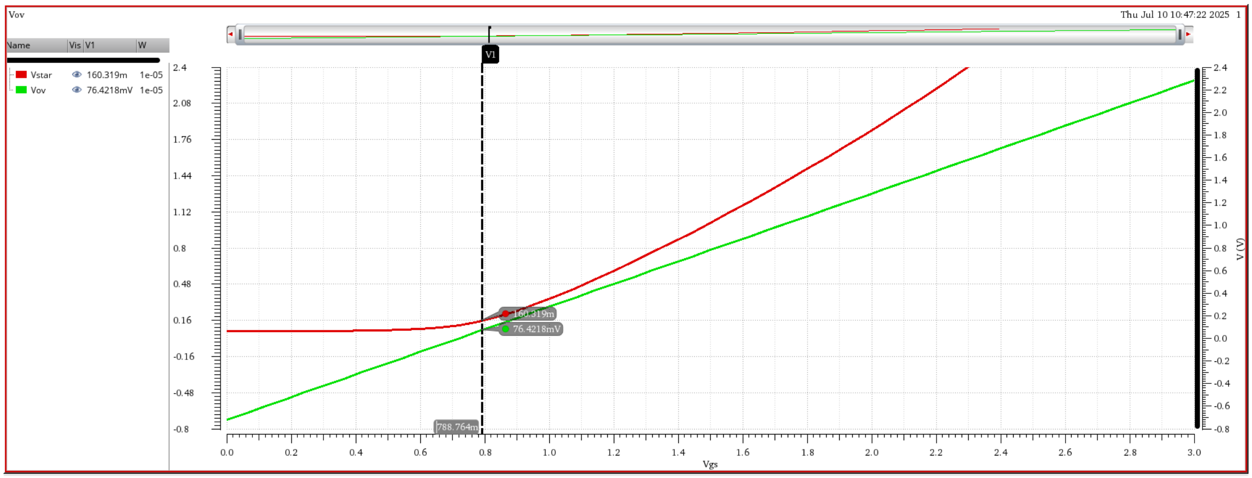
V_{DS}=0.1+V^*

Then V_{DS}=260 mV



And from the graph it was observed that

V_B=*1.142v*



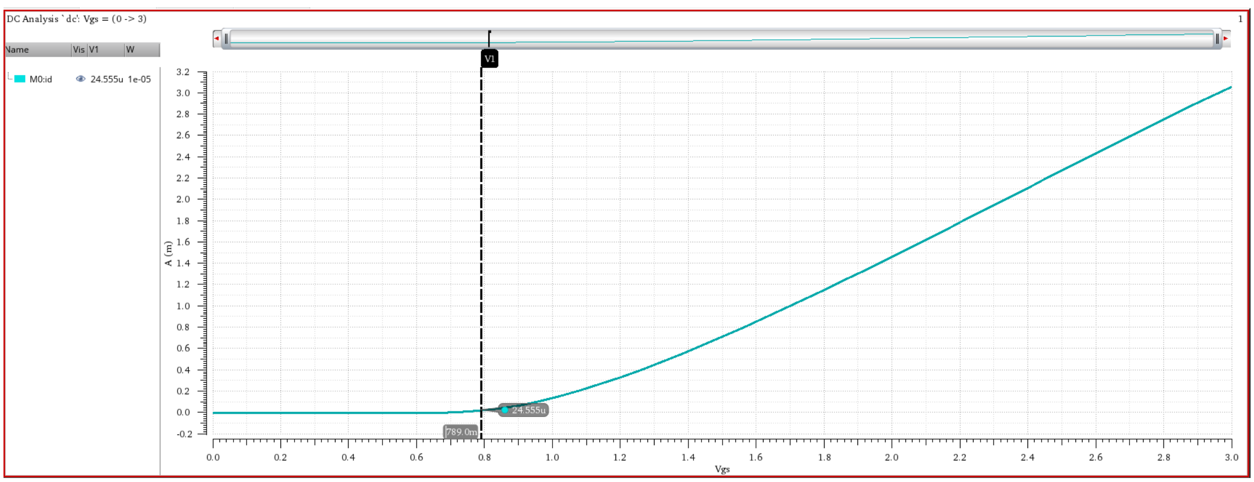
From the graph

V_{ov_Q} =76.42mV

V_{GS_Q} =788.8mV

I_{DX}, g_{mX} and g_{dsX}

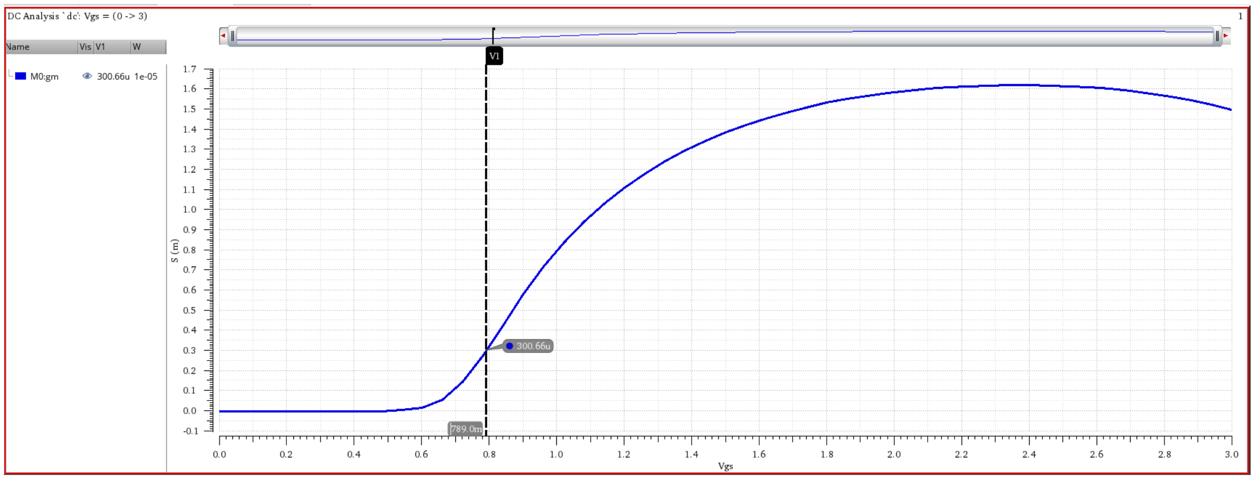
I_{DX}



From the obtained graph the value of

I_{DX} is $24.555\mu A$

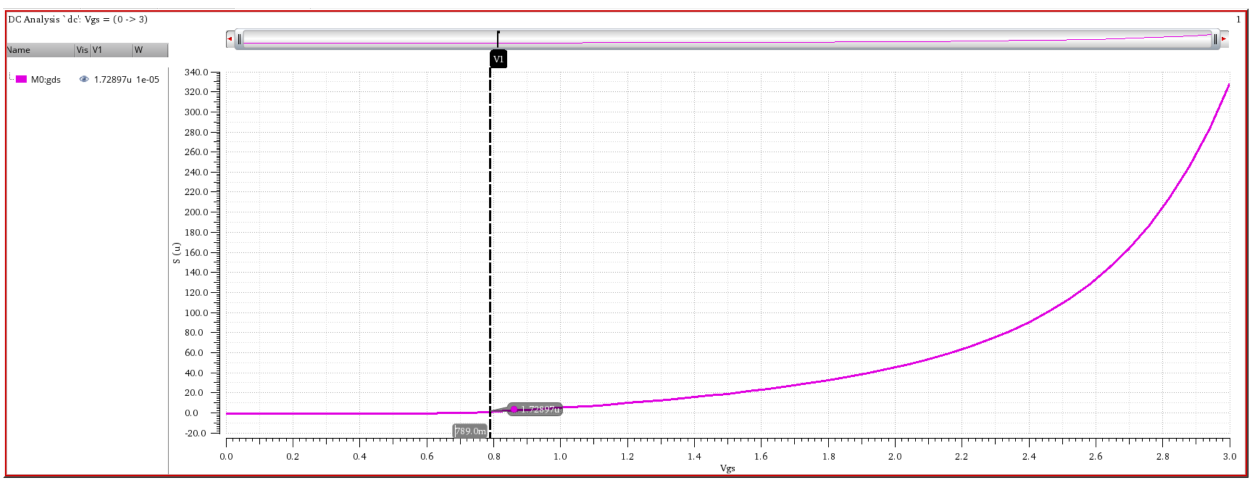
g_{mX}



From the obtained graph the value of

g_{mX} is 300.66 μS

g_{dsX}



From the obtained graph the value of

g_{dsX} is 1.73 μS

Cross-Multiplication

Using the cross multiplication

$$24.555\mu A \rightarrow 10\ \mu A$$

$$300.66\ \mu S \rightarrow g_{mQ}$$

g_{mQ}=122.44 μS

$$24.555\mu A \rightarrow 10\ \mu A$$

$$1.73\ \mu S \rightarrow g_{dsQ}$$

g_{dsQ}=0.705 μS

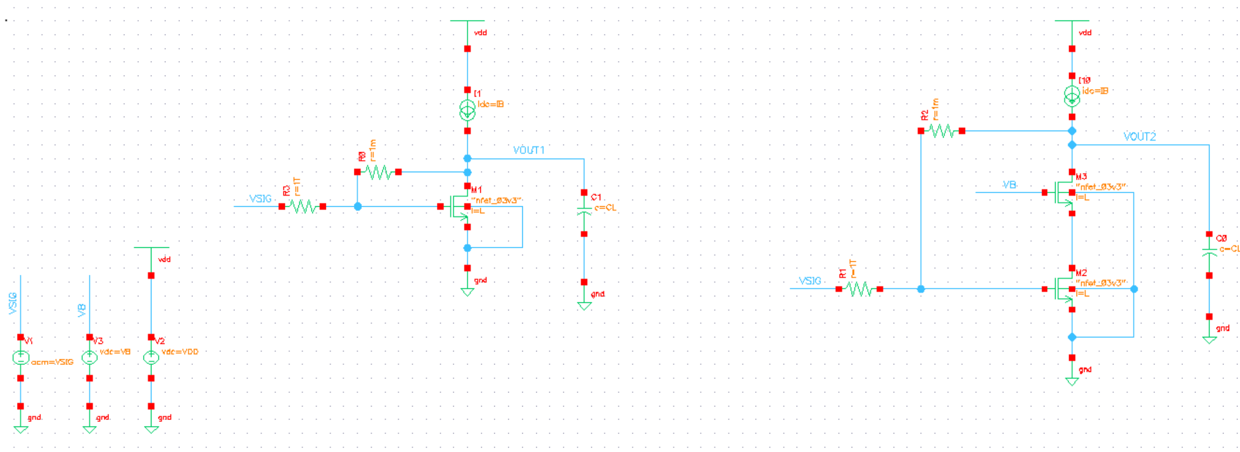
$$24.555\mu A \rightarrow 10\ \mu A$$

$$10\ \mu m \rightarrow W$$

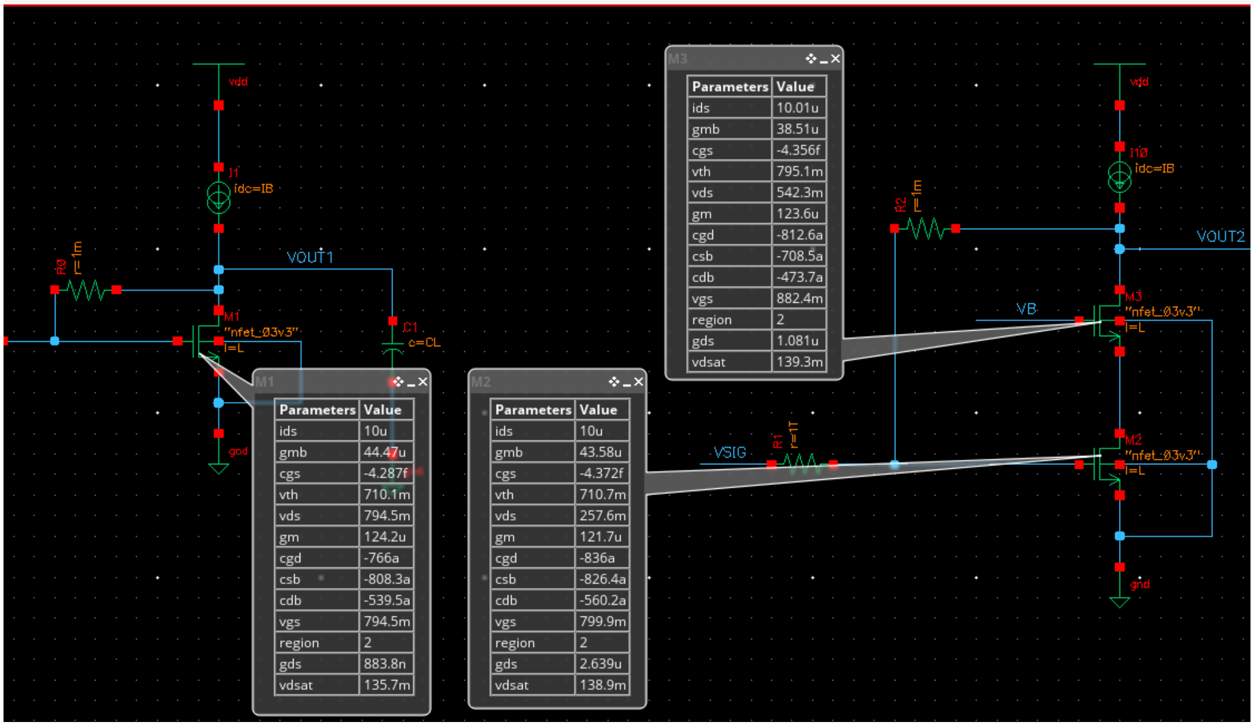
W=4.1 μm

Part2

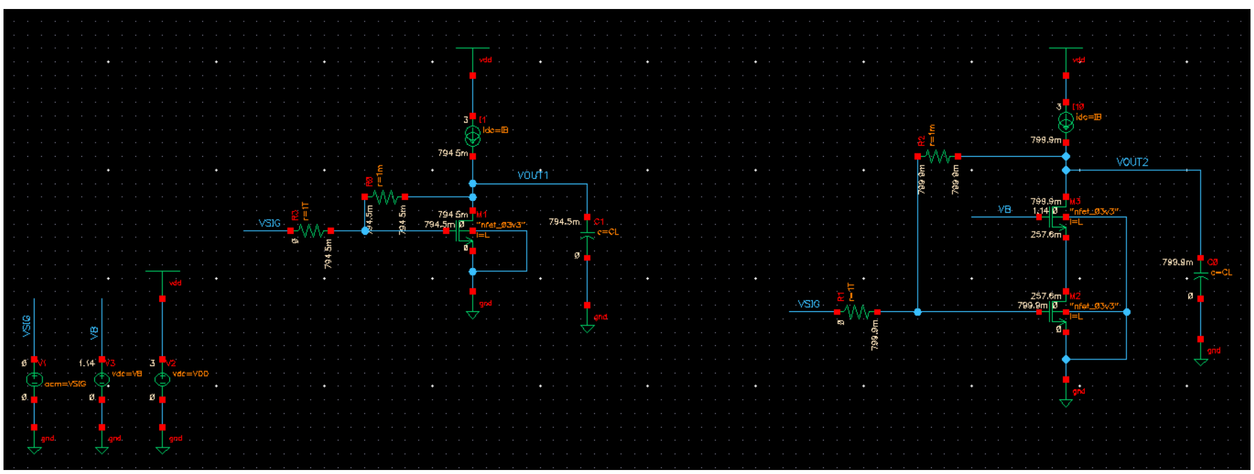
Schematic



DC-operating point



Voltage across all nodes

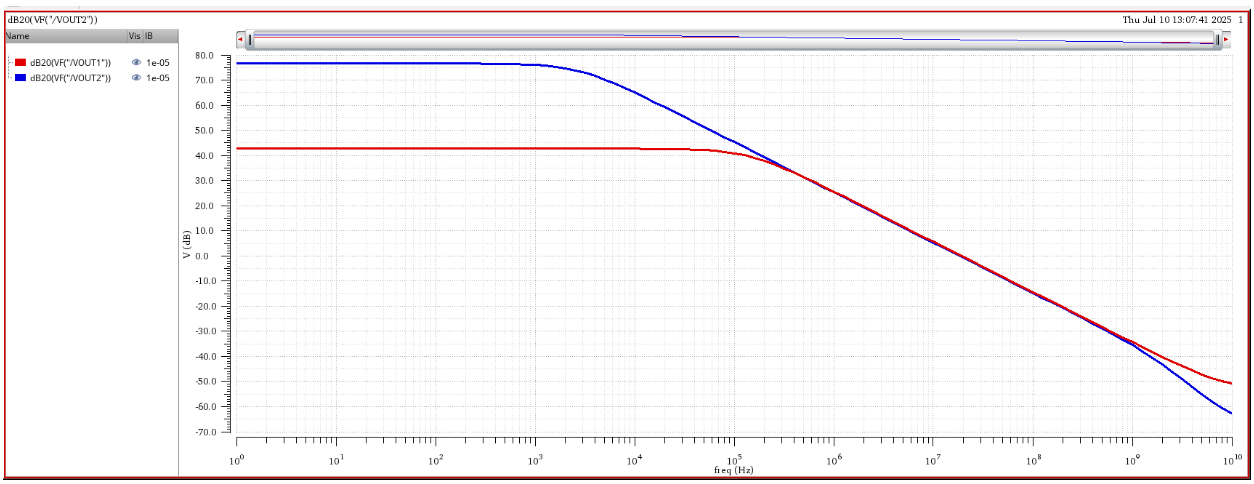


- The region of all transistors is 2 so all transistors operate at the saturation region.
- M1 and M2 have nearly the same threshold voltage because both transistors' bodies are connected to the ground which eliminates the body effect, resulting in minimal variation in V_{th} between them.
  Unlike M1 and M2, M3 exhibits a higher threshold voltage. This is because its body is not at the same potential as its source (which is the drain of M2), leading to a non-zero source-to-body voltage. As a result, the body effect is no longer negligible, causing an increase in V_{th} for M3.

- $g_m \gg g_{ds}$
- $g_m > g_{mb}$
- $C_{gs} > C_{gd}$
- $C_{sb} > C_{db}$

AC-analysis

Test	Output	Nominal	Spec	Weight	Pass/Fail
ITI:LAB3P2:1	dB20(VF("/VOUT1"))				
ITI:LAB3P2:1	ymax(dB20(VF("/VOUT1")))	42.96			
ITI:LAB3P2:1	ymax(mag(VF("/VOUT1")))	140.6			
ITI:LAB3P2:1	bandwidth(VF("/VOUT1") 3 "low")	140.2k			
ITI:LAB3P2:1	gainBwProd(VF("/VOUT1"))	19.75M			
ITI:LAB3P2:1	dB20(VF("/VOUT2"))				
ITI:LAB3P2:1	ymax(dB20(VF("/VOUT2")))	76.86			
ITI:LAB3P2:1	ymax(mag(VF("/VOUT2")))	6.963k			
ITI:LAB3P2:1	bandwidth(VF("/VOUT2") 3 "low")	2.728k			
ITI:LAB3P2:1	gainBwProd(VF("/VOUT2"))	19.04M			
ITI:LAB3P2:1	unityGainFreq(VF("/VOUT1"))	19.74M			
ITI:LAB3P2:1	unityGainFreq(VF("/VOUT2"))	19.14M			



Hand analysis
Gain of the CS=-$g_{m1}r_{o1}$
Gain of the Cascode=-$g_{m2}r_{o2} \times (g_{m3} + g_{mb3})r_{o3}$
Then
Gain of the CS=140.53
Gain of the Cascode=-6915.26

	Simulated Gain (Magnitude)	**Hand analysis Gain (Magnitude)**
CS	140.6	140.53
Cascode	6963	6915.26

Comments:

1. The results from hand analysis match perfectly with the simulation results, validating . This strong agreement confirms that the calculated values for gm, ro, and the overall gain accurately reflect the circuit behavior.
2. The gain of the cascode amplifier is significantly higher than that of a basic common-source amplifier. This is primarily due to the cascode configuration's ability to dramatically increase the output resistance which directly boosts the voltage gain.