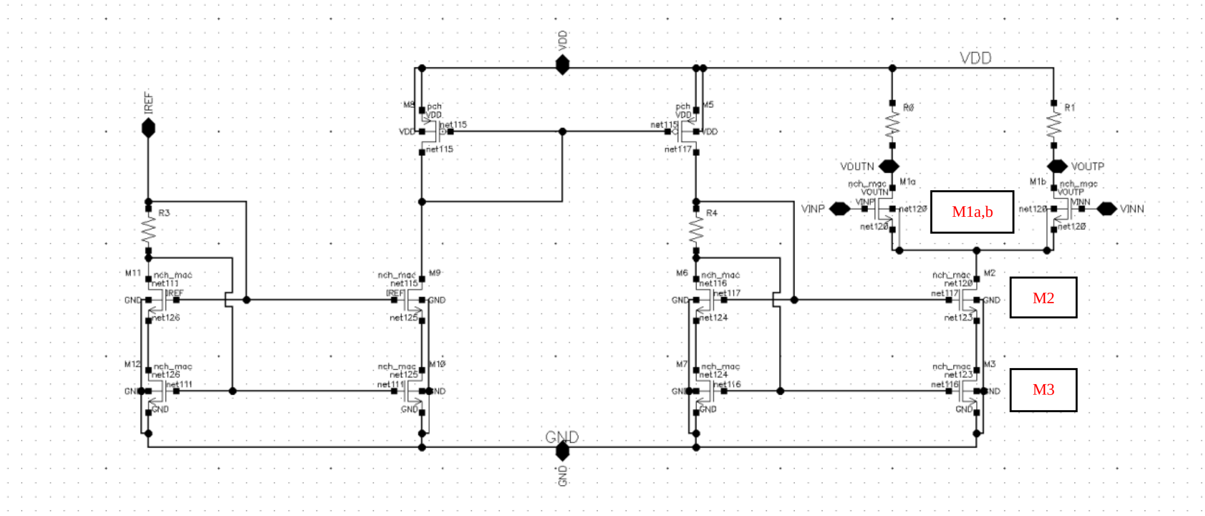
Use gm/ID methodology to design a diff input diff output operational transconductance amplifier (OTA) that achieves the following specs.

Spec.			
DC Gain	0 dB	Linear Range	300 mVpp
BW	≥ 15 GHz	CMRR	≥ 40 dB
Power Consumption	≤ 2.5 mW	Cap Load	100 fF
Reference Current	10 uA		



<u>Design of the input pair</u>

$$P_{cons} = V_{DD}\, I_{ss} \leq 2.5\ \text{mW} \rightarrow I_{ss} \leq 2\ \text{mA}$$

$$GBW = \frac{g_{m1}}{2\pi C_L} \geq 15\ \text{GHz} \rightarrow g_{m1} \geq 9.43\ \text{mS}$$

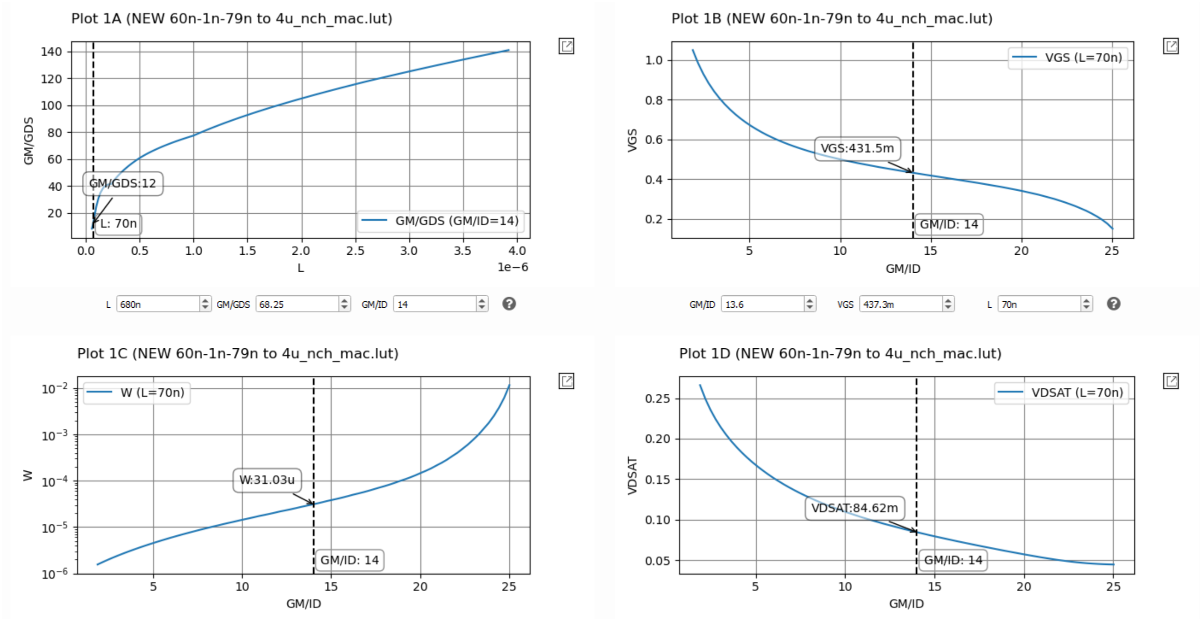
$$g_{m1} = 14\ \text{mS} \rightarrow \frac{g_{m1}}{I_D} = 14$$

$$A_v = g_{m1} R_{out} = 1 \rightarrow R_{out} = 71.5\ \Omega \rightarrow R_D = 80\ \Omega \rightarrow r_{o1} \geq 673\ \Omega \rightarrow \frac{g_{m1}}{g_{ds}} \geq 9.5$$

$$V_{out} = V_{DD} - I_{D1} * R_D = 1.12\ \text{V}$$

$$\text{Assume } V_{DS1} = 500\ \text{mV}$$

$$L_1 = 70\ \text{nm}, V_{GS1} = 431.5\ mV, W_1 = 31.03\ um$$



Designing the Current Mirror circuit

$$I_{SS\,max} = 2\text{ mA} = a1 * a2 * I_{REF} \rightarrow a1 * a2 = 200 \rightarrow \text{Choose } a1 = 20 \text{ and } a2 = 10$$

$$CMRR = 2g_m * R_{SS} = 100 \rightarrow R_{SS} \geq 4.4\text{ k}\Omega \rightarrow R_{SS} = 4.5\text{k}\Omega$$

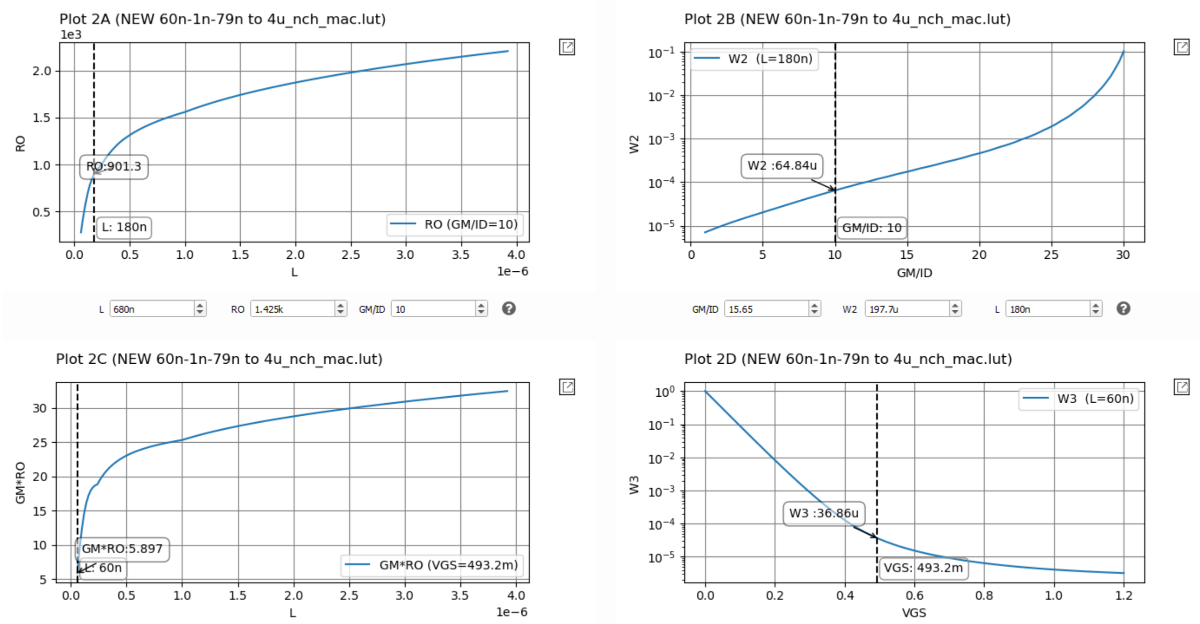
$$\text{use } L_{CM} = 3 * L_{min} = 180\text{ nm} \rightarrow \text{reduce } \frac{1}{f} \text{ noise and bias it in SI: } \left(\frac{g_m}{I_D}\right)_3 = 10$$

$$W_3 = 64.84\text{ um}, r_{o3} = 901.3\ \Omega, V_{GS3} = 493.2\text{ mV}$$

$$(g_m.r_o)_2 = 5 \rightarrow L_2 = 60\text{ nm}$$

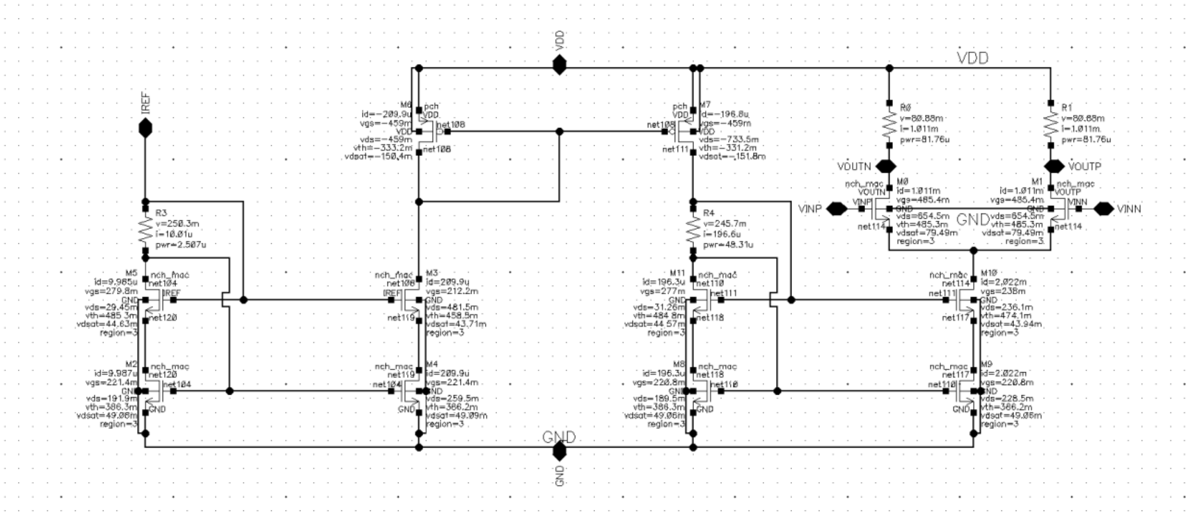
$$\text{Assume } V_{GS2} = V_{GS3} = 493.2\text{ mV} \rightarrow W_2 = 36.86\text{ um}$$

$$\text{For } R_{CM} = \frac{V_{DS3}}{I_{ref}} = 25000$$

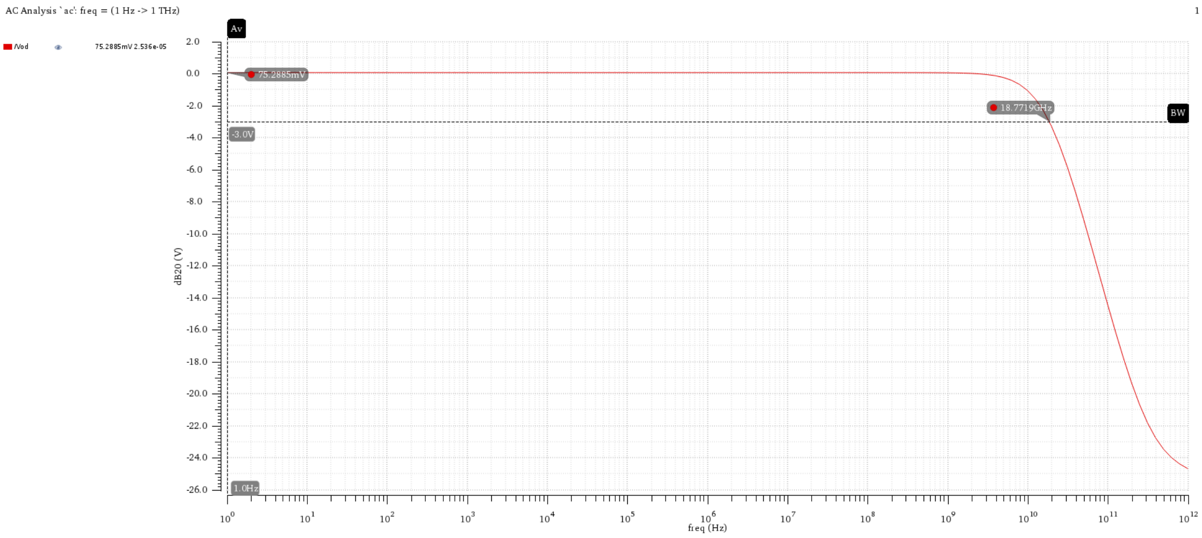


<u>Simulations</u>

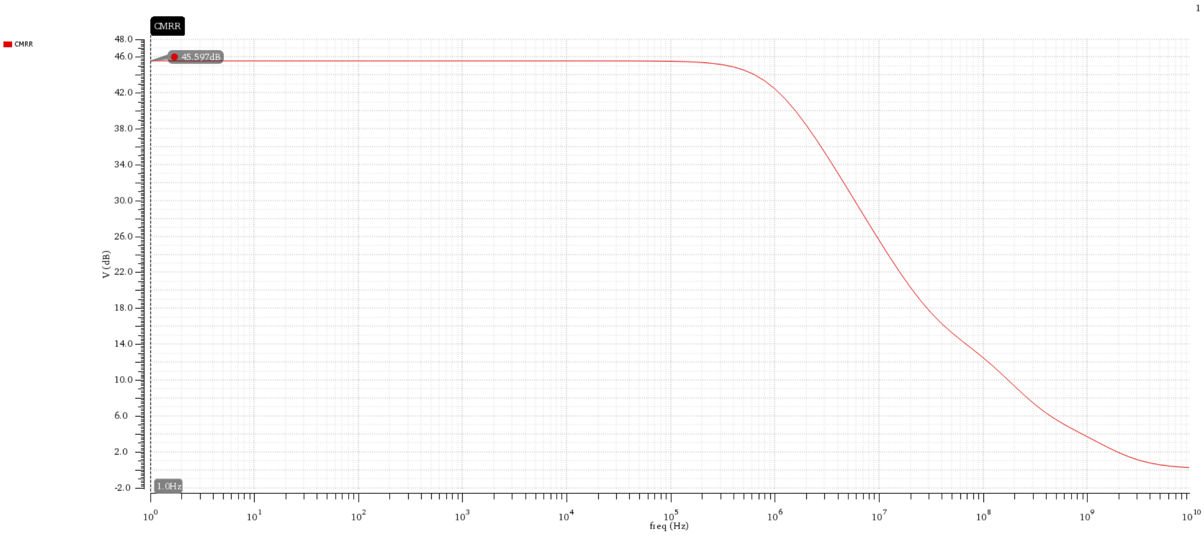
DC OP



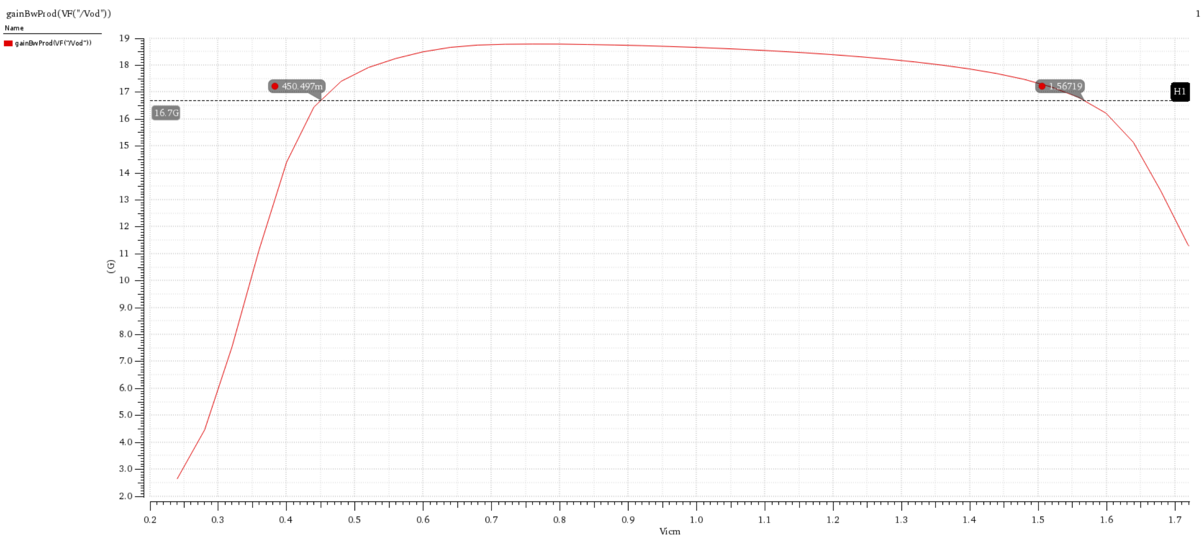
Av Differential



CMRR


CMRR
CMRR
45.597dB
1.0Hz
V (dB)
freq (Hz)
1

CMIR


gainBwProd(VF("/Vod"))
Name
450.497m
1.56719
16.7G
H1
(G)
Vicm
1