Spec.			
5T - OTA			
Supply Voltage	1.2 V	Power Consumption	≤ 30 uW
Open loop DC voltage gain	≥ 32 dB	Reference current	10 uA
CMRR @ DC	≥ 70 dB	CM input range low	≤ 0.6 V
BW	≥ 200 kHz	CM input range high	≥ 1 V
Phase Margin	≥ 70°	Load	2 pF

- Steps

Sizing of M1,2

01 | As CMIR is closer to the V_{DD} rail → use NMOS input pair

02 | $P_{cons} = V_{DD}\, I_D \leq 30\ uW \rightarrow I_{SS} \leq 25\ uA \rightarrow I_{SS} = 20\ uA \rightarrow I_D = 10\ uA$

03 | $GBW = \frac{g_{m1,2}}{2\pi C_L} \geq 40 \times 200k = 8\ MHz \rightarrow g_m \geq 100.5\ uS \rightarrow g_m = 150\ uS \rightarrow \frac{g_m}{I_D} = 15$

04 | $A_v = g_m \times (r_{o1,2} \parallel r_{o3,4}) \geq 40 \rightarrow R_{out} \geq 266.7\ k\Omega \rightarrow$ Assume $r_{o1,2} = r_{o3,4} = r_o \rightarrow r_o \geq 534\ k\Omega$

05 | $\therefore g_m r_o \geq 80$ and Assume $V_{DS1,2} = {}^{V_{DD}}/_{3} = 400\ mV \rightarrow L_{1,2} = 1.5\ um$ and $W_{3,4} = 7.341\ um$

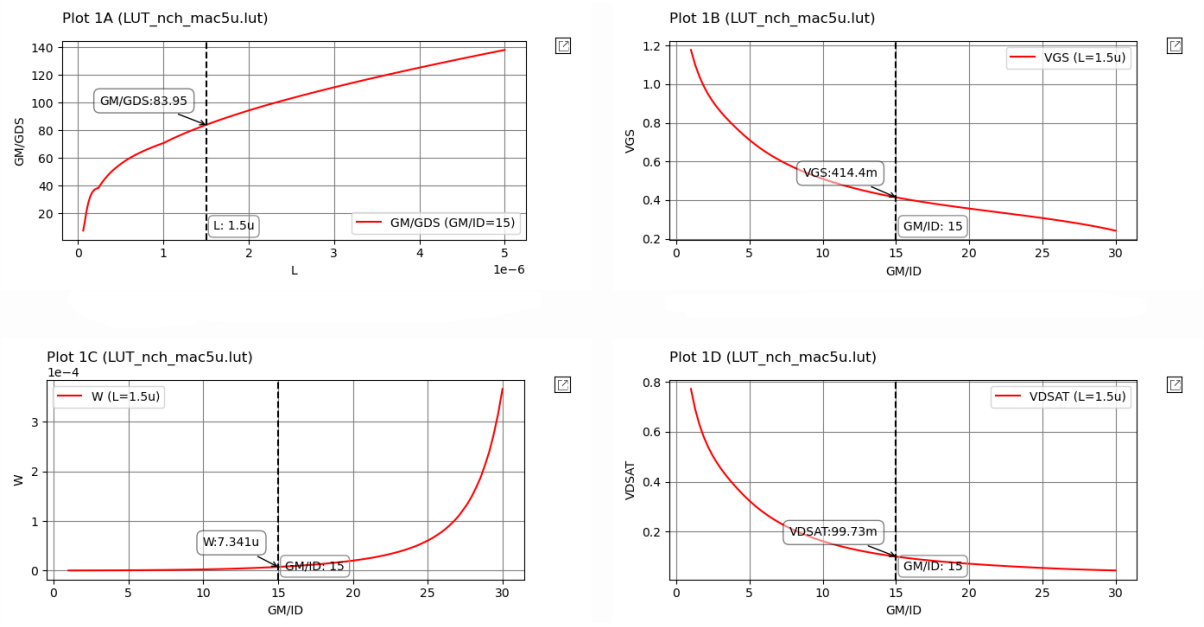
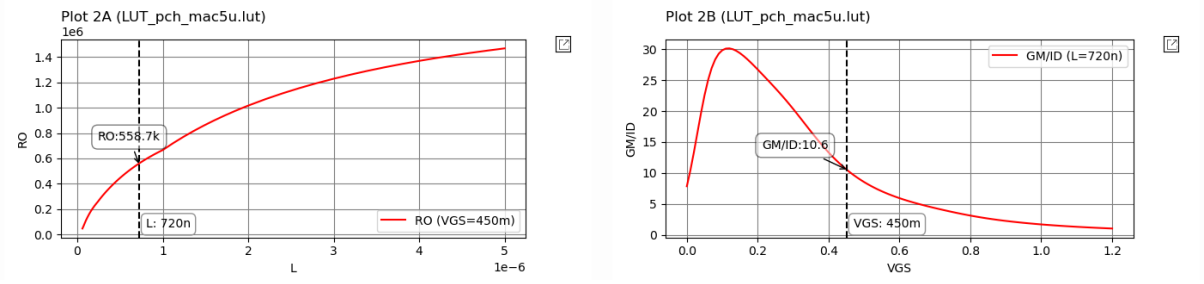


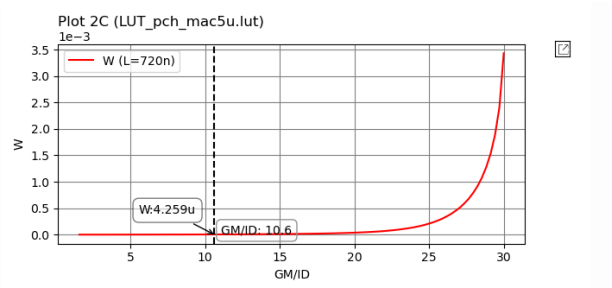
Fig. Sizing of M1,2

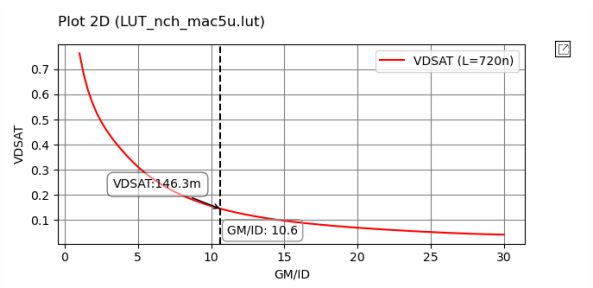
Sizing of M3,4

06 | $CMIR_H \geq 1 \rightarrow V_{GS1,2} - V^*_{1,2} - V_{SG3,4} + V_{DD} \geq 1 \rightarrow V_{SG3,4} \leq 481mV$

07 | If : Choose $V_{SG3,4} = 450m$ and $r_o = 534\ k\Omega \rightarrow L_{3,4} = 720\ nm$ and $W_{3,4} = 4.259\ um$







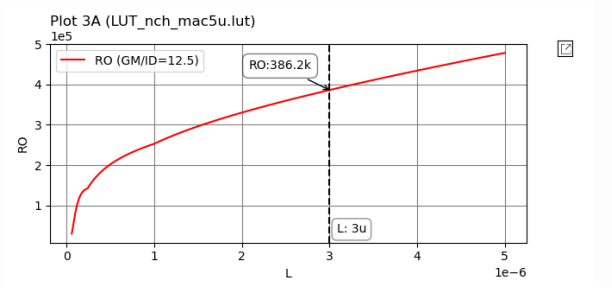
Sizing of Current Source

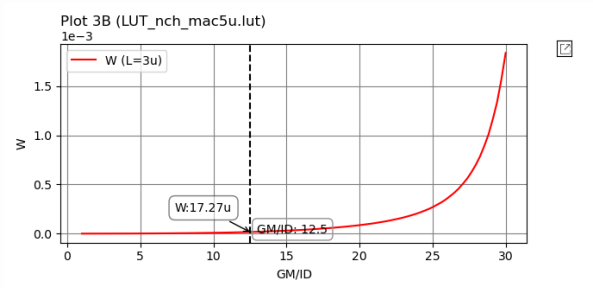
08 | $A_{VCM} = \frac{1}{2g_{m3,4}R_{ss}} = (70 - 32)\ \text{dB} = 0.01259 \rightarrow R_{ss} = 380\ \text{k}\Omega$

09 | $CMIR_L < 0.6 \rightarrow V_{GS1,2} + V_p \leq 0.6 \rightarrow V_p \leq 185\ \text{mV}$

10 | R_{ss} and V_p are small → can be achived using simple Current mirror

11 | Choose $V_p = V_5^* = 160\ \text{mV} \rightarrow \left(\frac{g_m}{I_D}\right)_3 = 12.5 \rightarrow L_5 = 3\ \text{um}$ and $W_5 = 17.27\ \text{um}$



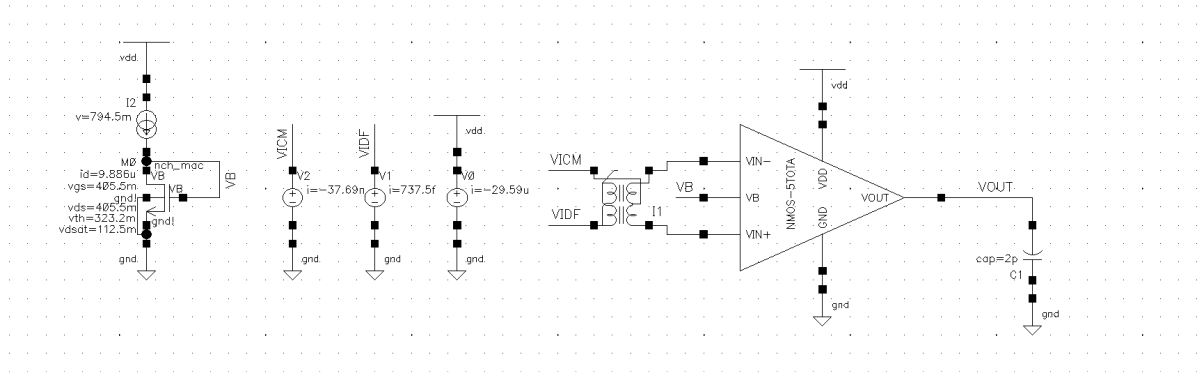


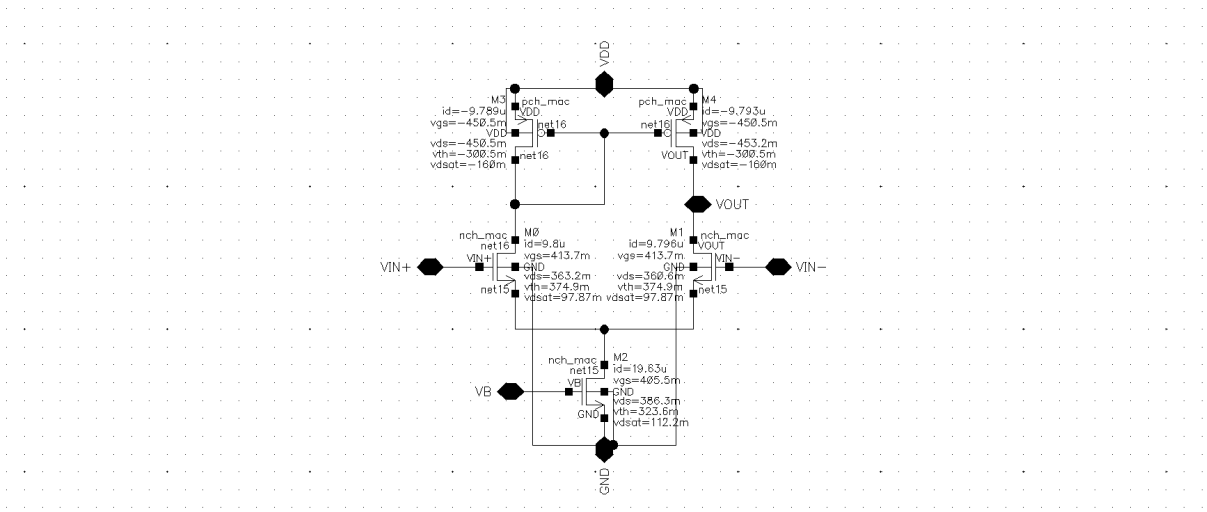
- Sizing Summary

Sizing Summary			
M	M1,2	M3,4	M5
Rule	Input pair	Active load	Current mirror
L	1.5 um	720 nm	3 um
W	7.341 um	4.259 um	17.27 um
Gmoverid	15	10.6	12.5

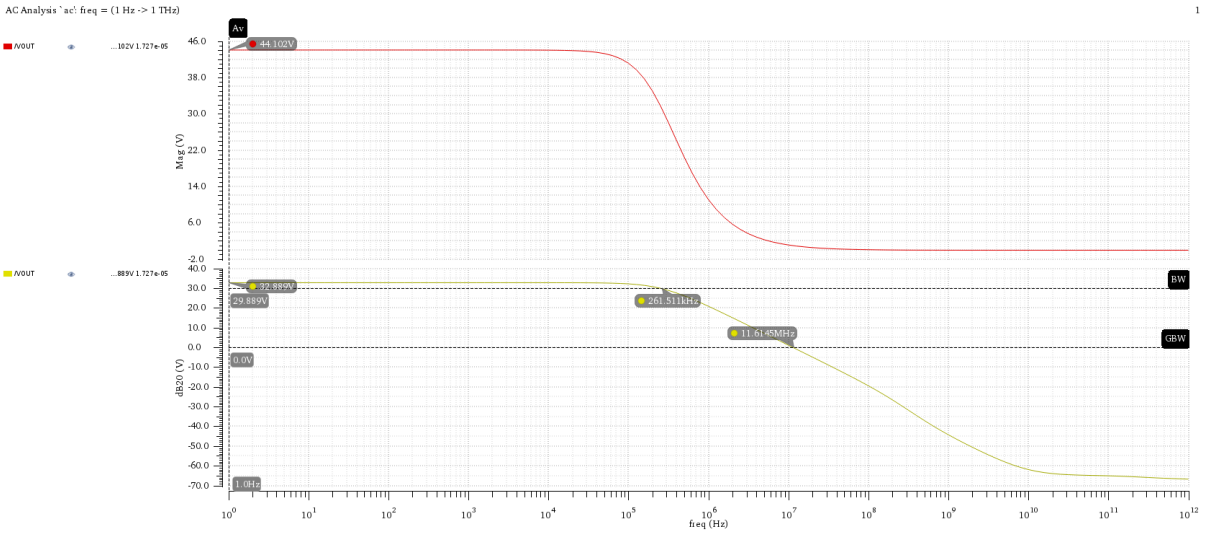
- Results

1. TB and DC Operating Point



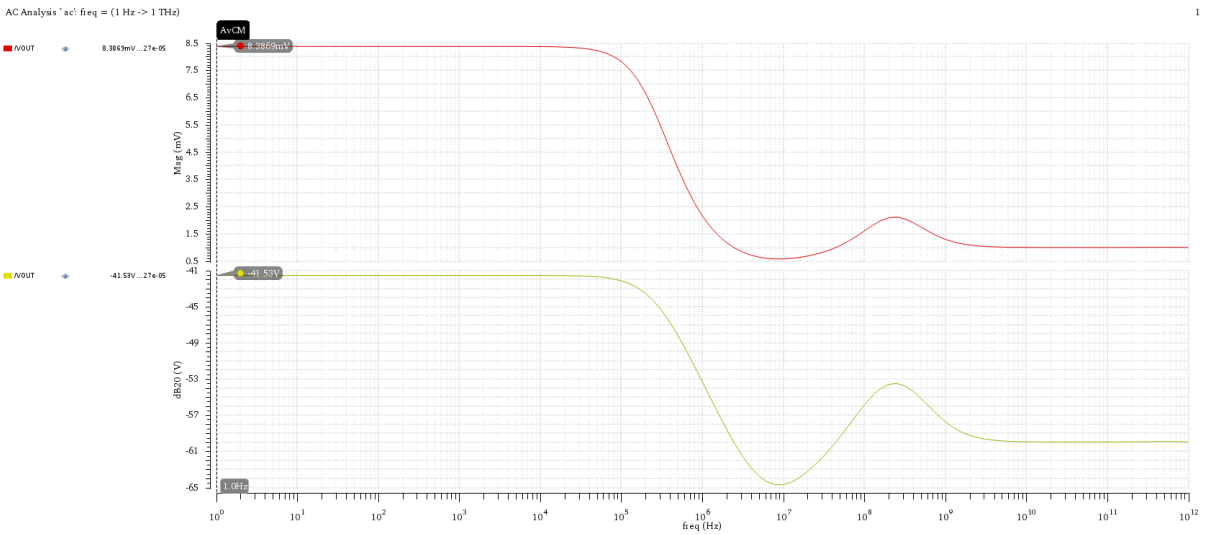


2. Differential Small Signal Analysis

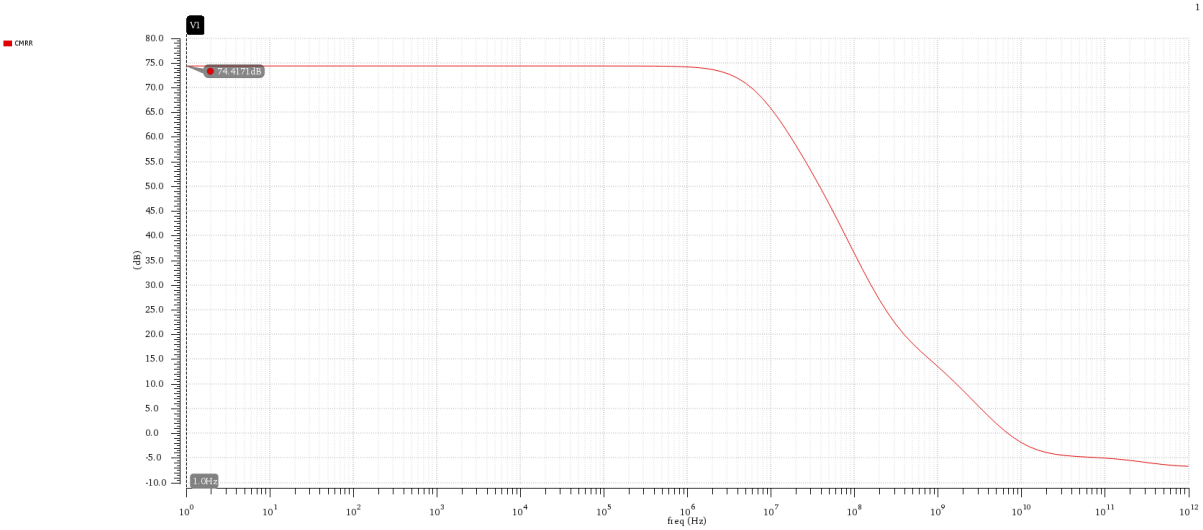


3. Common Mode Small Signal Analysis

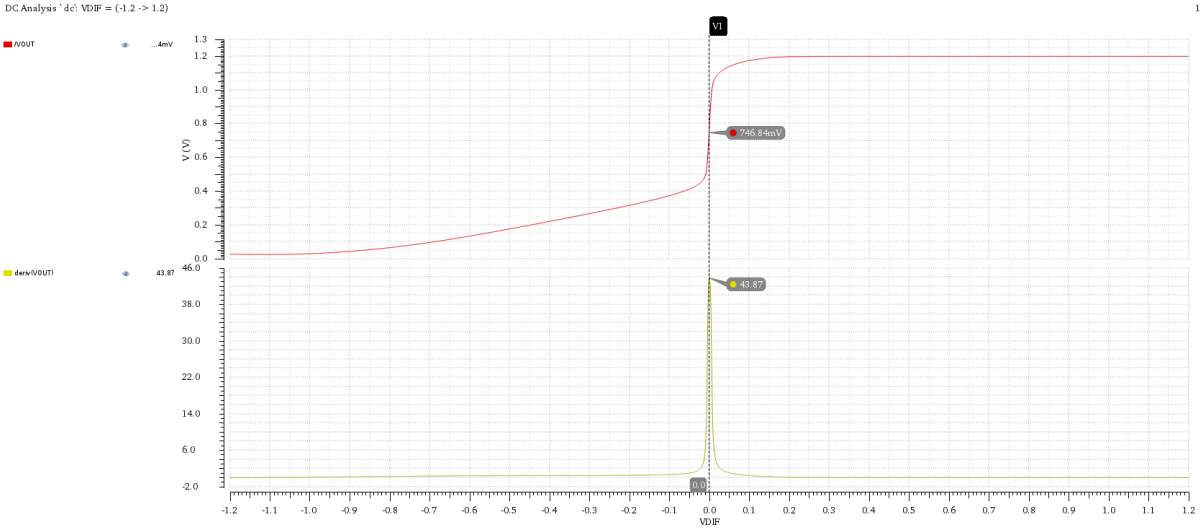
- AVCM



- CMRR



4. Differential Large Signal Analysis



5. Common Mode Large Signal Analysis