

# TWO STAGE OTA DESIGN ASSIGNMENT REPORT

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## DC CALCULATIONS :-

### Analog Assignment

$$I_{ref} = 5 \mu A$$

$$\left(\frac{W}{L}\right)_{M_{ref}} = \frac{2 \mu m}{1 \mu m}$$

For all mosfets  
 $(L) = 1 \mu m$

∴ Current mirroring  
 $\left(\frac{W}{L}\right)_{M_0} = \frac{8 \mu m}{1 \mu m}$

Assumption :  $I_{tail} = 20 \mu A$

Current flowing through

$$M_1, M_3 = 10 \mu A$$

$$M_2, M_4 = 10 \mu A$$

$$\boxed{M_1, M_2} \quad I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{th})^2$$

$$\left(\frac{W}{L}\right)_{M_1} = \left(\frac{W}{L}\right)_{M_2} = \frac{2 I_D}{\mu_n C_{ox} (V_{OV})^2}$$

assuming  $V_{OV} = 0.1$

$$\left(\frac{W}{L}\right)_{M_1} = \left(\frac{W}{L}\right)_{M_2} = \frac{2 \times 10 \mu A}{\frac{230 \mu A}{V^2} \times (0.1)^2}$$

$$= 8.69$$

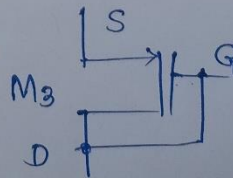
$$\left(\frac{W}{L}\right)_{M_1} = \left(\frac{W}{L}\right)_{M_2} = \frac{8.7 \mu m}{1 \mu m}$$

$$\boxed{M_3, M_4} \quad I_D = \frac{1}{2} \mu_p C_{ox} \frac{W}{L} (V_{SG} - |V_{thp}|)^2$$

$$\left(\frac{W}{L}\right)_{M_4} = \left(\frac{W}{L}\right)_{M_3} = \frac{2 I_D}{\mu_p C_{ox} (V_{OV})^2}$$

assuming  $V_{OV} = 0.91$

To get max voltage swing  
 $V_S = 1V$



## DC CALCULATIONS :-

$$V_{SG} = 1.8 - 1 = 0.8V$$

$$V_{SG} - |V_{tp}| = 0.8 - 0.39 = 0.41$$

$$\therefore \left(\frac{W}{L}\right)_{M3} = \left(\frac{W}{L}\right)_{M4} = \frac{2 \times 10 \mu}{100 \mu \times 0.41 \times 0.41} = 1.189$$

M5 assuming current through =  $60 \mu A$  (3 times tail current)  
taking  $(V_{ov})_{M5} = 0.41V$

$$\left(\frac{W}{L}\right)_{M5} = \frac{2 \times 60 \mu A}{100 \mu A \times 0.41 \times 0.41} = 7.138$$

$$\left(\frac{W}{L}\right)_{M5} = \frac{7.138 \mu m}{1 \mu m}$$

M6 Current mirroring with  $M_{ref}$

(12 times)  $M_{ref}$   
 $\therefore \left(\frac{W}{L}\right)_{M6} = \frac{24 \mu m}{1 \mu m}$

To have 1st stage gain  $\geq 40 dB$   
and 2nd stage gain  $\geq 60 dB$

After fine tuning

$$\left(\frac{W}{L}\right)_{M_{ref}} = \frac{8.5 \mu m}{1 \mu m}$$

$$\left(\frac{W}{L}\right)_{M1} = \left(\frac{W}{L}\right)_{M2} = \frac{9 \mu m}{1 \mu m}$$

## DC CALCULATIONS :-

$$\left(\frac{w}{L}\right)_{m3} = \left(\frac{w}{L}\right)_{m4} = \frac{1.12 \mu\text{m}}{1 \mu\text{m}}$$

$$\left(\frac{w}{L}\right)_{m5} = \frac{7.138 \mu\text{m}}{1 \mu\text{m}}$$

$$\left(\frac{w}{L}\right)_{m6} = \frac{25 \mu\text{m}}{1 \mu\text{m}}$$

I have attached

OLTF 1<sup>st</sup> stage gain

2 — stage gain

Magnitude Bode plot

Phase Bode plot

Operating points

Phase margin

CLTF 2-stage gain (to have gain = 2)

frequency response

operating points

Step-input transient response