EE214A Design Project

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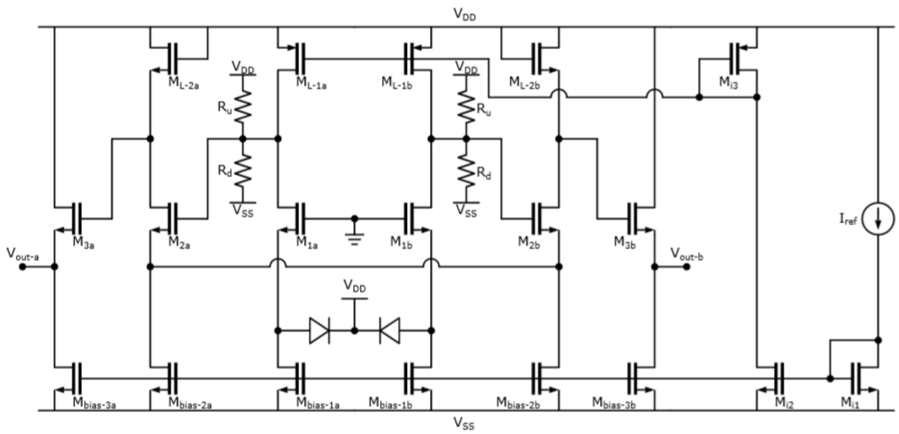
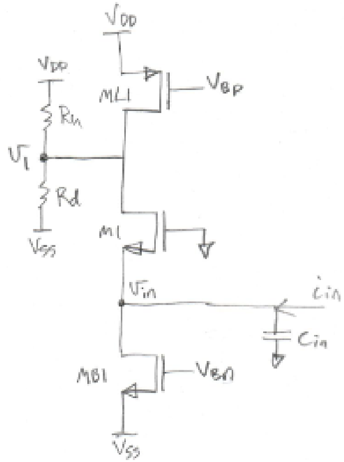
November 26, 2019

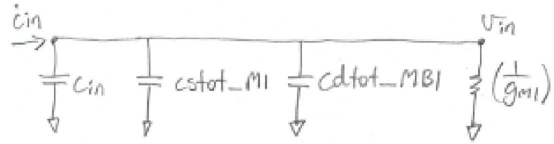


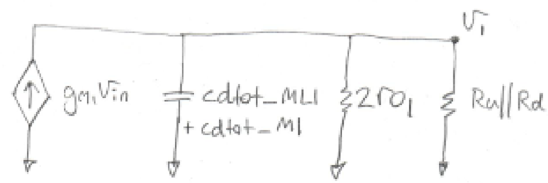
The amplifier under evaluation has 3 stages: Common Gate (CG), Common Source (CS), and Common Drain (CD). In order to analyze, the circuit is broken down into its 3 stages and key parameters are summarized.

Parameter	Spec
Transresistance gain	42.5k
power consumption	≤2mW
bandwidth	≥75MHz
Output load resistance	20k
Output load capacitance	250fF

Common Gate:

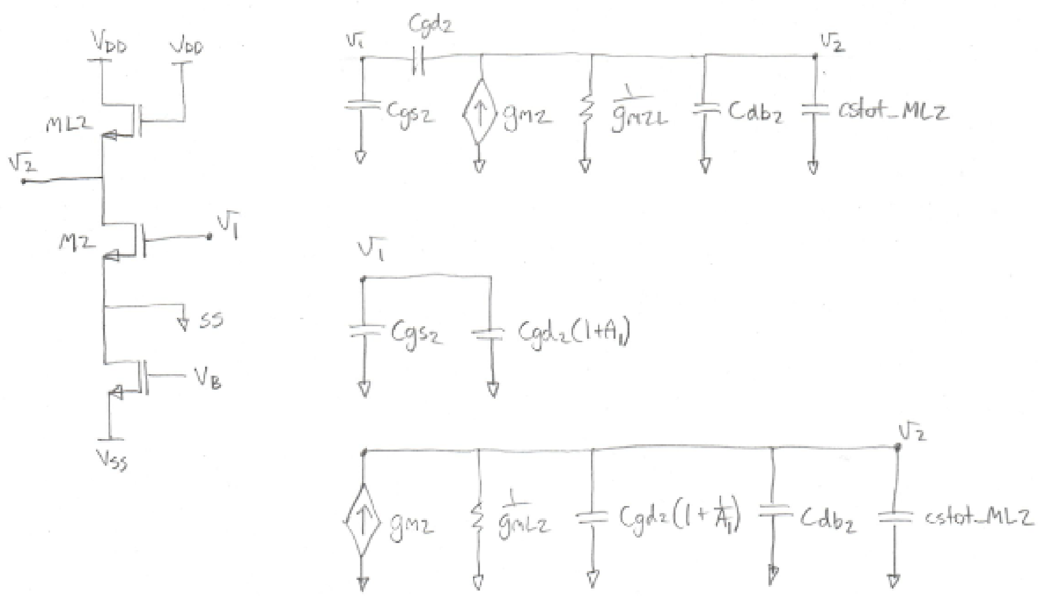






Low Frequency Characteristics		
Transimpedance Gain	R_u parallel R_d	
Rin	1/gm1	$Vov_1/(2*I_{D1})$
Rout	$2*ro_1$	$2/(lambda*I_{D1})$

Common Source:
The source of the common source stage is referenced to virtual, small-signal ground in the DM half circuit.



$$A_1 = \frac{gm_2}{gm_{\mathrm{L2}}} \tag{1}$$

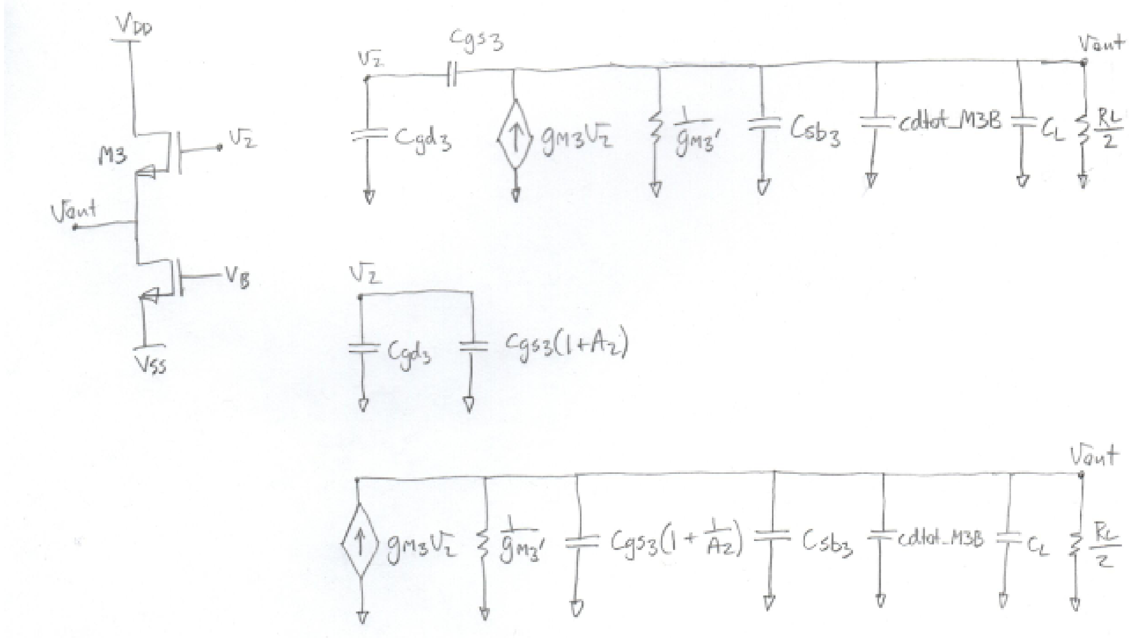
$$A_1 = \frac{\frac{W}{L}_2 * Vov_2}{\frac{W}{L}_{2L} * Vov_{2L}} \tag{2}$$

$$A_1 = \sqrt{\frac{\frac{W}{L}_2}{\frac{W}{L}_{2L}}} \tag{3}$$

$$A_1 = \frac{Vov_{2L}}{Vov_2} \tag{4}$$

Low Frequency Characteristics	
Av	$-gm_2/gm_{L2}$
Rin	inf
Rout	$1/gm_{L2}$

Common Drain:



$$C_{LDM} = 500fF \tag{5}$$

$$R_{LDM} = 10k\Omega \tag{6}$$

Assuming $R_L/2$ much less than $1/gm_3$

$$A_2 = -g_{m3} * \frac{1}{g'_{m3}} || R_{LDM} \approx -0.84 \tag{7}$$

Low Frequency Characteristics	
Av	approx. 0.84
Rin	inf
Rout	$1/gm_3$’

TIA amp:

Small-Signal Model
Low Frequency Transimpedance Gain:

$$\frac{v_{out}}{i_{in}} = (R_u||R_d) * (-\frac{gm_2}{gm_{\mathrm{L2}}}) * 0.84 \tag{8}$$

BW

$$C_{LDM} = 500fF \tag{9}$$

$$R_{LDM} = 10k\Omega \tag{10}$$

$$C_1 = 100fF + cstot\_M1 + cdtot\_MB1 \tag{11}$$

$$C_2 = cdtot\_ML1 + cdtot\_M1 + C_{gs2} + (1 + A_1) * C_{gd2} \tag{12}$$

$$C_3 = (1+1/A_1)*C_{gd2}+C_{db2}+cstot\_ML2+C_{gd3}+(1+A_2)*C_{gs3} \tag{13}$$

$$C_4 = (1 + 1/A_2) * C_{gs3} + C_{sb3} + cdtot\_M3B + 500fF \tag{14}$$

$$A_1 = \frac{gm_2}{gm_{\mathrm{L2}}} \tag{15}$$

$$A_1 = \frac{\frac{W}{L}_2 * Vov_2}{\frac{W}{L}_{2L} * Vov_{2L}} \tag{16}$$

$$A_1 = \sqrt{\frac{\frac{W}{L}_2}{\frac{W}{L}_{2L}}} \tag{17}$$

$$A_1 = \frac{Vov_{2L}}{Vov_2} \tag{18}$$

$$A_2 = -g_{m3} * \frac{1}{g'_{m3}}||R_{LDM} \approx -0.84 \tag{19}$$

ZVTC bandwidth (conservative approximation)

$$b1 = \frac{1}{g_{m1}}*C_1+(R_u||R_d)*C_2+gm_{L2}*C_3+(gm'_3||R_L/2)*C_4 \tag{20}$$