# EE214A Design Project

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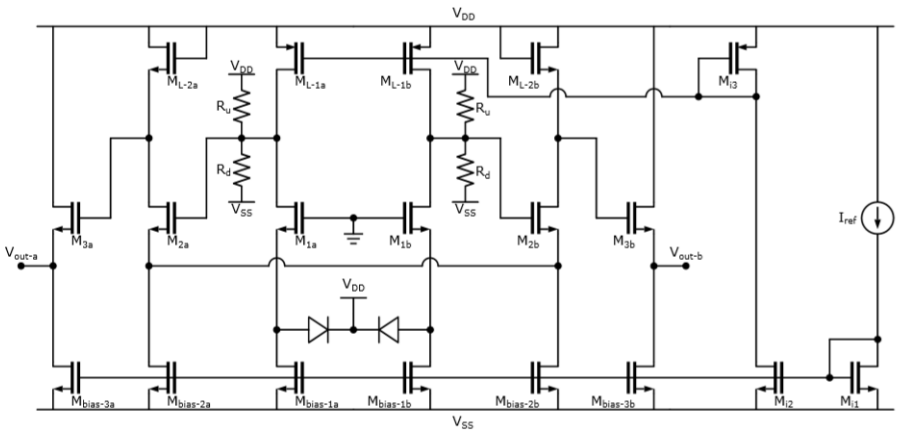
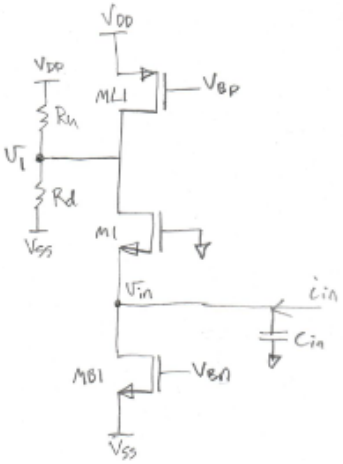
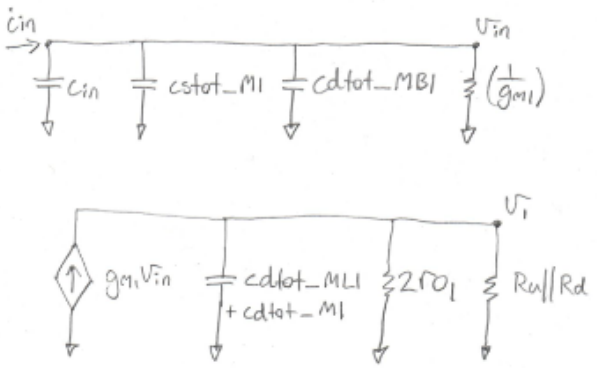



The amplifier under evaluation has 3 stages: Common Gate (CG), Common Source (CS), and Common Drain (CD). In order to analyze, the circuit is broken down into its 3 stages and key parameters are summarized.

| Parameter | Spec |
|---|---|
| Transresistance gain | 42.5k |
| power consumption | $\leq$2mW |
| bandwidth | $\geq$75MHz |
| Output load resistance | 20k |
| Output load capacitance | 250fF |

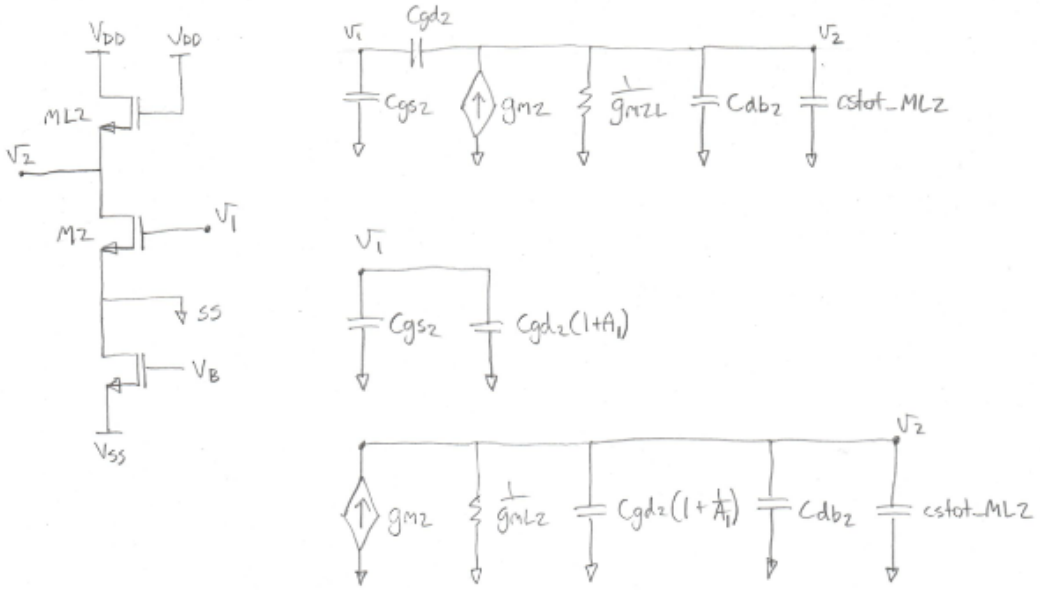
**Common Gate:**




| 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.



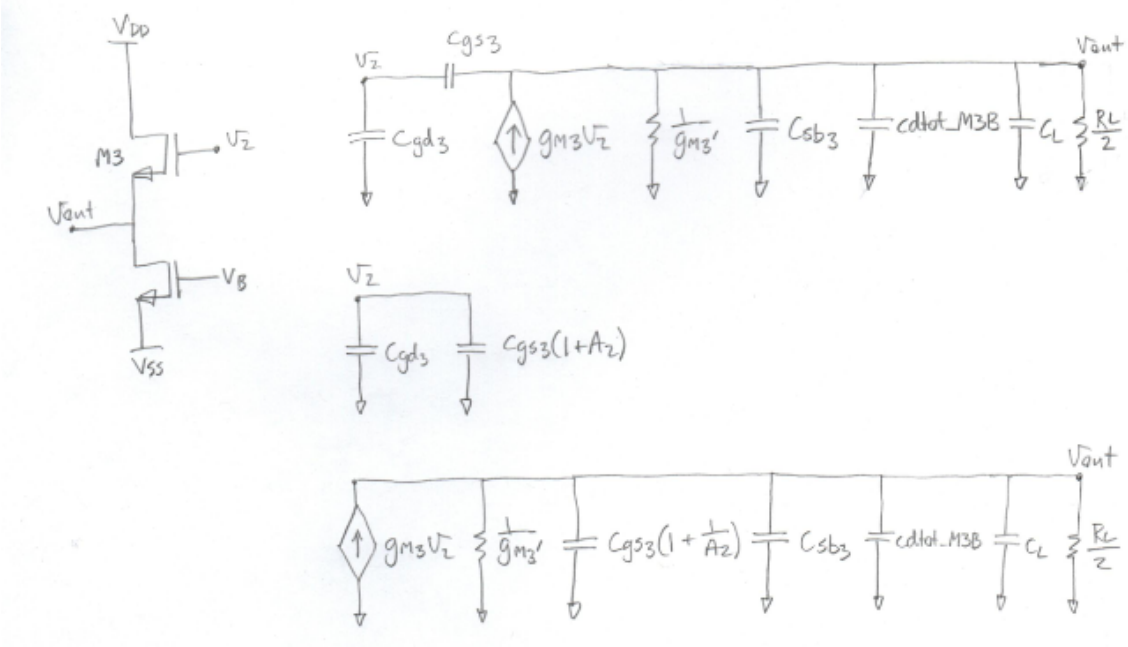

$$A_1 = \frac{gm_2}{gm_{\mathrm{L2}}} \tag{1}$$

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

$$A_1 = \frac{\frac{W}{L}_2}{\frac{W}{L}_{2L}} * \frac{2}{Vov_{2L} * (\frac{gm}{I_D})_2} \tag{3}$$

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

**Common Drain:**




$$C_{LDM} = 500fF \tag{4}$$

$$R_{LDM} = 10k\Omega \tag{5}$$

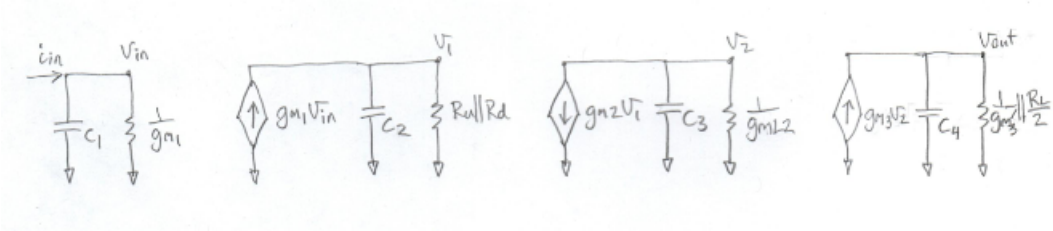
Assuming $R_L/2$ much less than $1/gm_3$

$$A_2 \approx -\frac{g_{m3}}{g'_{m3}} \approx -0.84 \tag{6}$$

| Low Frequency Characteristics | |
|---|---|
| Av | approx. 0.84 |
| Rin | inf |
| Rout | $1/gm_3$' |

**TIA amp:**

Small-Signal Model




Low Frequency Transimpedance Gain:

$$\frac{v_{out}}{i_{in}} = (R_u||R_d) * (-\frac{gm_2}{gm_{\mathrm{L2}}}) * 0.84 \tag{7}$$

BW

$$C_1 = 100fF + cstot\_M1 + cdtot\_MB1 \tag{8}$$

$$C_2 = cdtot\_ML1 + cdtot\_M1 + C_{gs2} + (1 + A_1) * C_{gd2} \tag{9}$$

$$C_3 = (1+1/A_1)*C_{gd2}+C_{db2}+cstot\_ML2+C_{gd3}+(1+A_2)*C_{gs3} \tag{10}$$

$$C_4 = (1 + 1/A_2) * C_{gs3} + C_{sb3} + cdtot\_M3B + 500fF \tag{11}$$

$$A_1 = \frac{gm_2}{gm_{\mathrm{L2}}} \tag{12}$$

$$A_2 \approx -\frac{g_{m3}}{g'_{m3}} \approx -0.84 \tag{13}$$

ZVTC bandwidth (conservative approximation)

$$b1 = \frac{1}{g_{m1}} * C_1 + (R_u||R_d) * C_2 + gm_{L2} * C_3 + (gm'_3||R_L/2) * C_4 \tag{14}$$