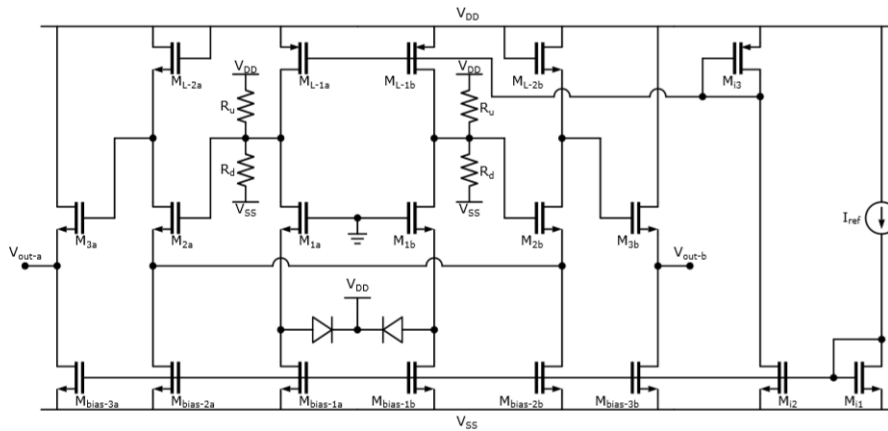


EE214A Design Project

Jay Smith

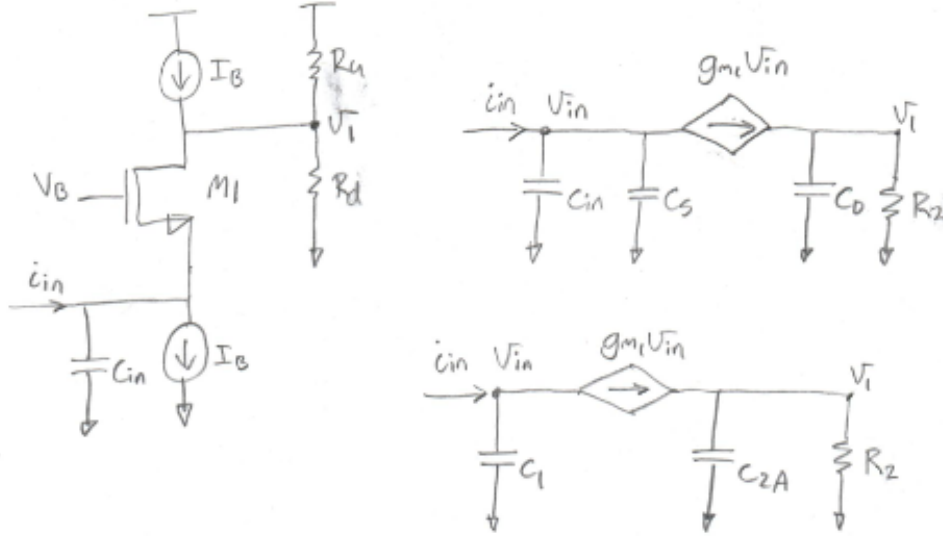
November 12, 2019



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
Output load resistance	20k
Output load capacitance	250fF

Common Gate:



$$C_{in} = 100fF \quad (1)$$

$$C_S = C_{gs1} + C_{sb1} = cstot(Hspice) \quad (2)$$

$$C_D = C_{gd1} + C_{db1} = cdtot(Hspice) \approx 0.58 * C_{gs1} = 0.58 * (2/3) * (W/L)_1 * C_{ox} \quad (3)$$

Condensed

$$C_1 = 100fF + C_S \quad (4)$$

$$C_{2A} = C_D \quad (5)$$

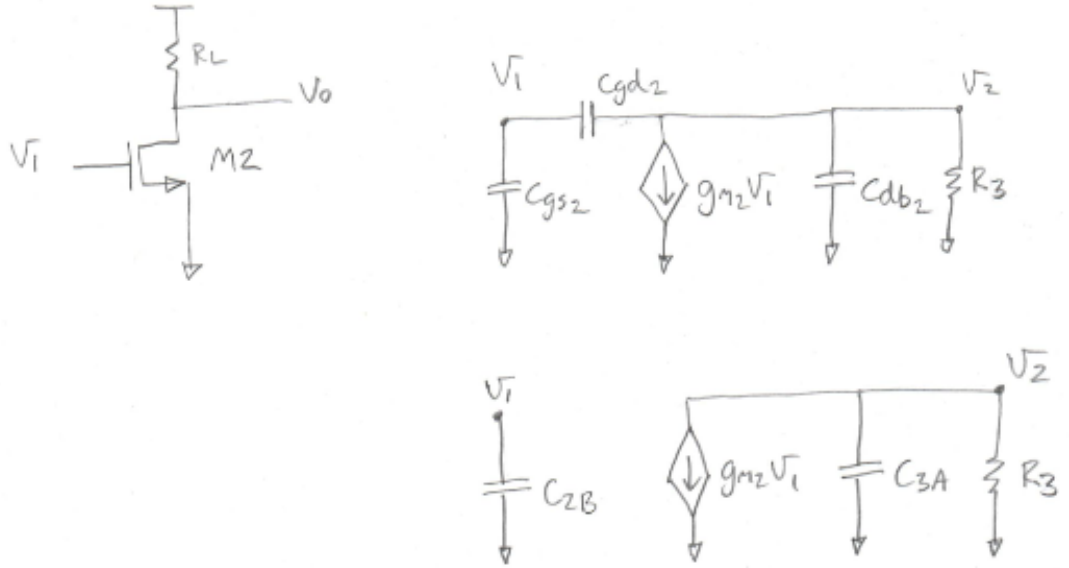
Setting $R_u = R_d = R$

$$R_{L1} = 2 * R \quad (6)$$

Low Frequency Characteristics	
Transimpedance	R_{L1}
R_{in}	$1/gm1$
R_{out}	r_o

Common Source:

The source of the common source stage is referenced to virtual, small-signal ground in the DM half circuit, so parasitic capacitances to base can be neglected.



Using Miller Approximation:

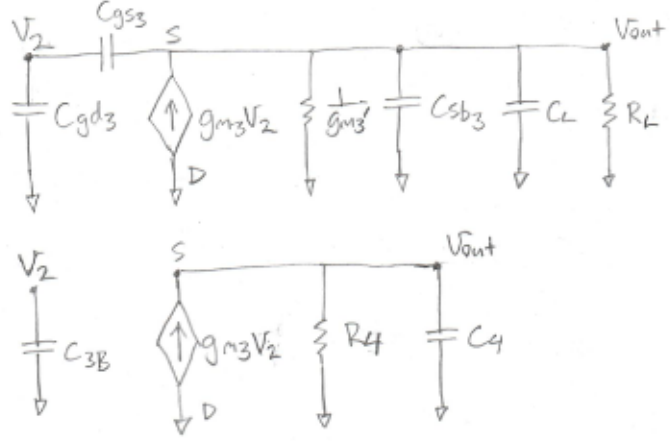
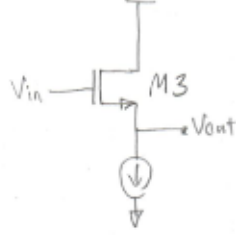
$$A = g_{m2} * R_{L2} \quad (7)$$

$$C_{2B} = C_{gs2} + (1 + A) * C_{gd2} \quad (8)$$

$$C_{3A} = C_{db2} + (1 + 1/A) * C_{gd2} \quad (9)$$

Low Frequency Characteristics	
A_v	$-g_{m2} * R_{L2}$
R_{in}	∞
R_{out}	R_{L2}

Common Drain:



$$C_L = 250 \text{ fF} \quad (10)$$

$$R_L = 20 \text{ k}\Omega \quad (11)$$

Using Miller Approximation:

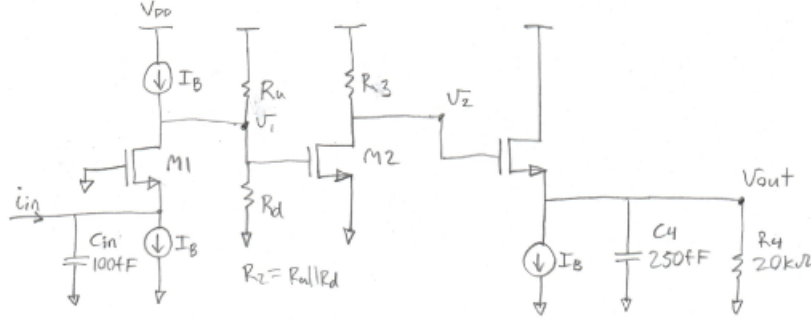
$$A \approx -\frac{g_{m3}}{g'_{m3}} \approx -0.84 \quad (12)$$

$$C_{3B} = C_{gd3} + 0.14 * C_{gs3} \quad (13)$$

$$C_4 = -0.2 * C_{gs3} + C_{sb3} + C_L \quad (14)$$

$$R_L = 20 \text{ k}\Omega \quad (15)$$

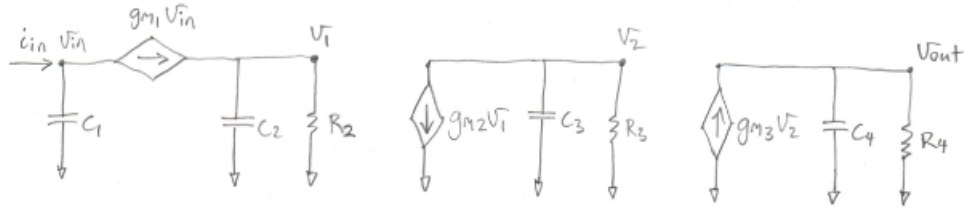
Full Schematic



Low Frequency Transresistance:

$$\frac{v_{out}}{i_{in}} = 0.84 * (R_1) * (-g_{m2} * R_2) \quad (16)$$

Full Small-Signal Model



ZVTC bandwidth (conservative approximation)

$$b1 = \frac{1}{g_{m1}} * C_1 + R_2 * C_2 + R_3 * C_3 + R_4 * C_4 \quad (17)$$

where

$$C_1 = 100fF + cstot1(Hspice) \quad (18)$$

$$R_2 = variable \quad (19)$$

$$C_2 = cdtot1(Hspice) + C_{gs2} + (1 + A) * C_{gd2} \quad (20)$$

$$R_3 = variable \quad (21)$$

$$C_3 = C_{db2} + (1 + 1/A) * C_{gd2} + C_{gd3} + 0.14 * C_{gs3} \quad (22)$$

$$R_4 = 20k\Omega \quad (23)$$

$$C_4 = -0.2 * C_{gs3} + C_{sb3} + 250fF \quad (24)$$

Parameters To Sweep

APPENDIX

The following assumptions are used throughout to simplify analysis.

Simplification of Parasitic Capacitance	
C_{db} / C_{gs}	0.33
C_{gd} / C_{gs}	0.25
g_m / g_m'	0.84