

E3-277 Introduction to Integrated Circuit Design

Lab Assignment 3

Submitted

by

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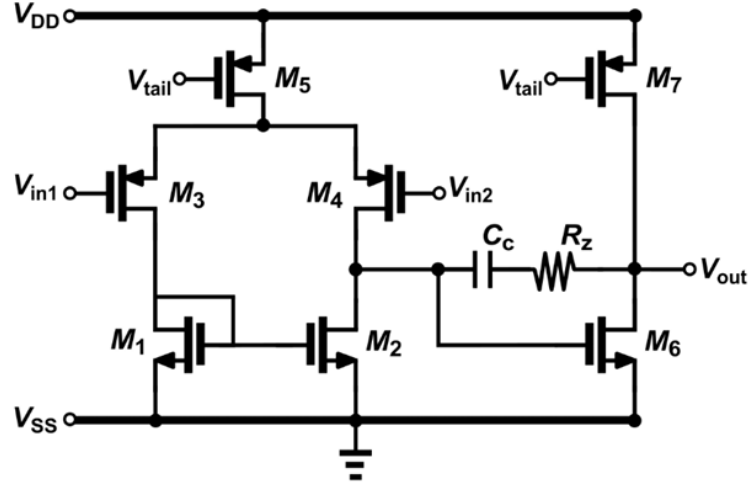


FIGURE 1: A basic two-stage operational amplifier.

TABLE 1: Design specifications @ supply voltage = 1.2V, Load = 100pF, and temperature = 27°C

S.N.	Parameter	Symbol	Value
1.	Open-loop, differential-mode, DC voltage gain	A_0	$\geq 100 \text{ V/V (40 dB)}$
2.	-3dB-Bandwidth	f_{-3dB}	$\geq 5 \text{ MHz}$
3.	Phase margin	PM	$\geq 60^\circ$
4.	Common-mode rejection ratio	$CMRR$	$\geq 30 \text{ dB}$
5.	Power dissipation	P_d	$\leq 800 \text{ } \mu\text{W}$

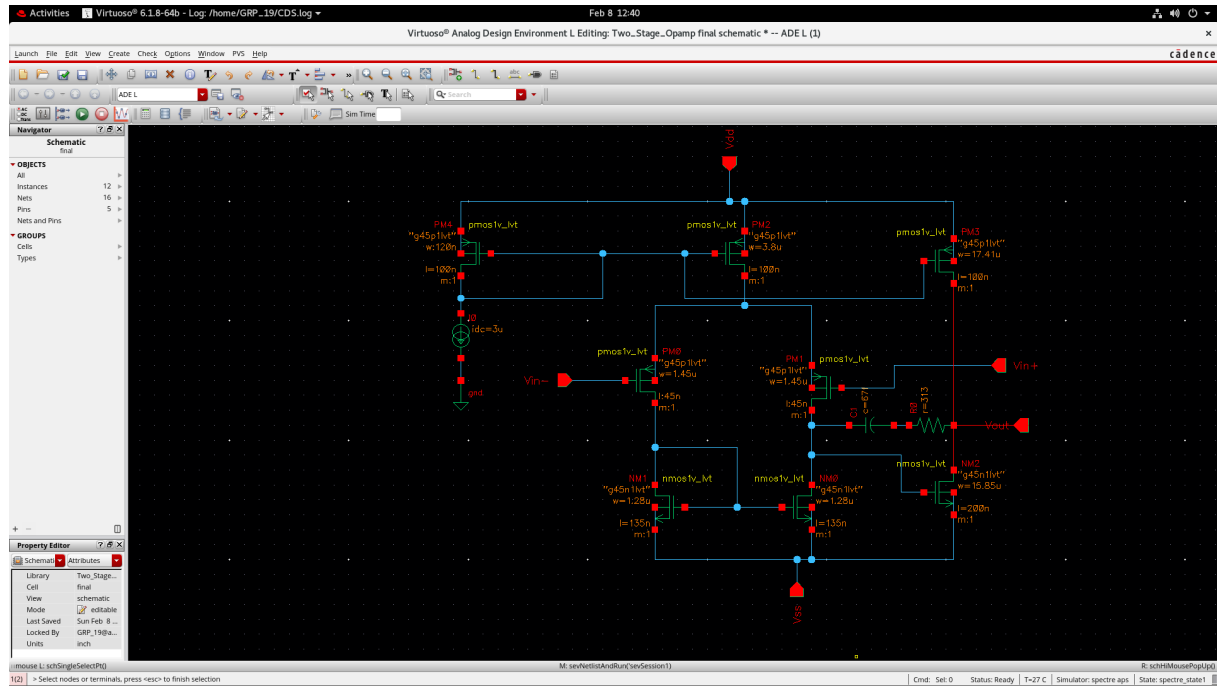


FIGURE 2: Two-stage Opamp

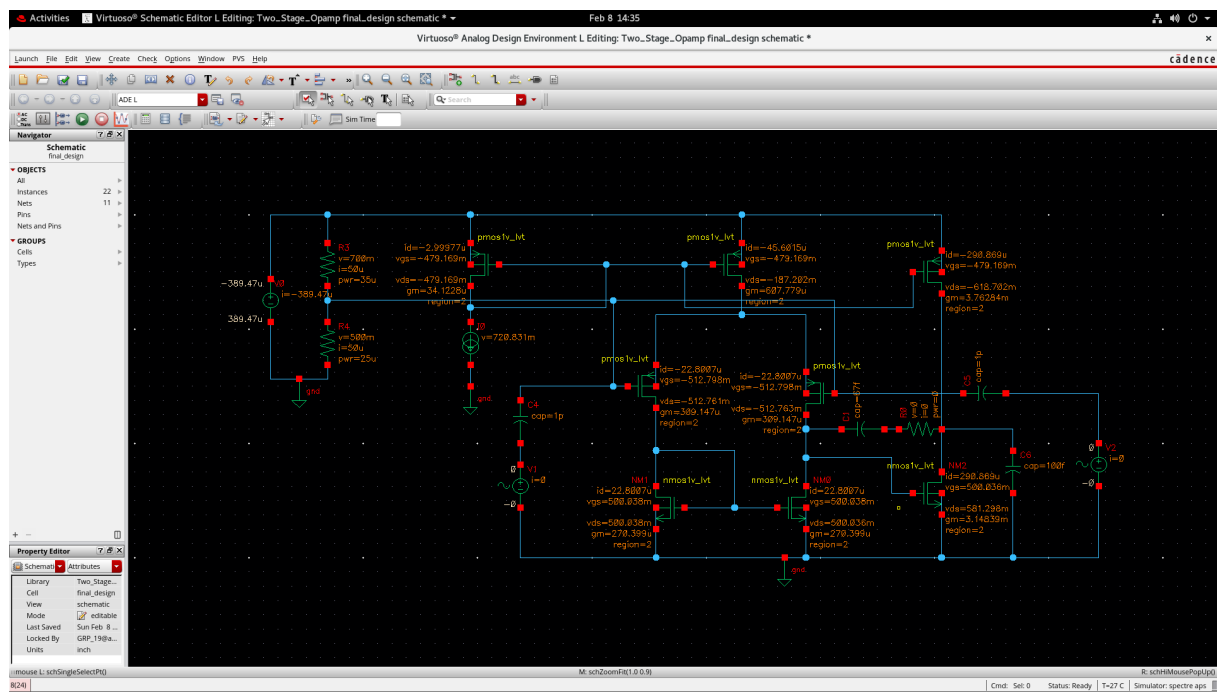


FIGURE 3: DC operating points

0.1 DC Testbench results

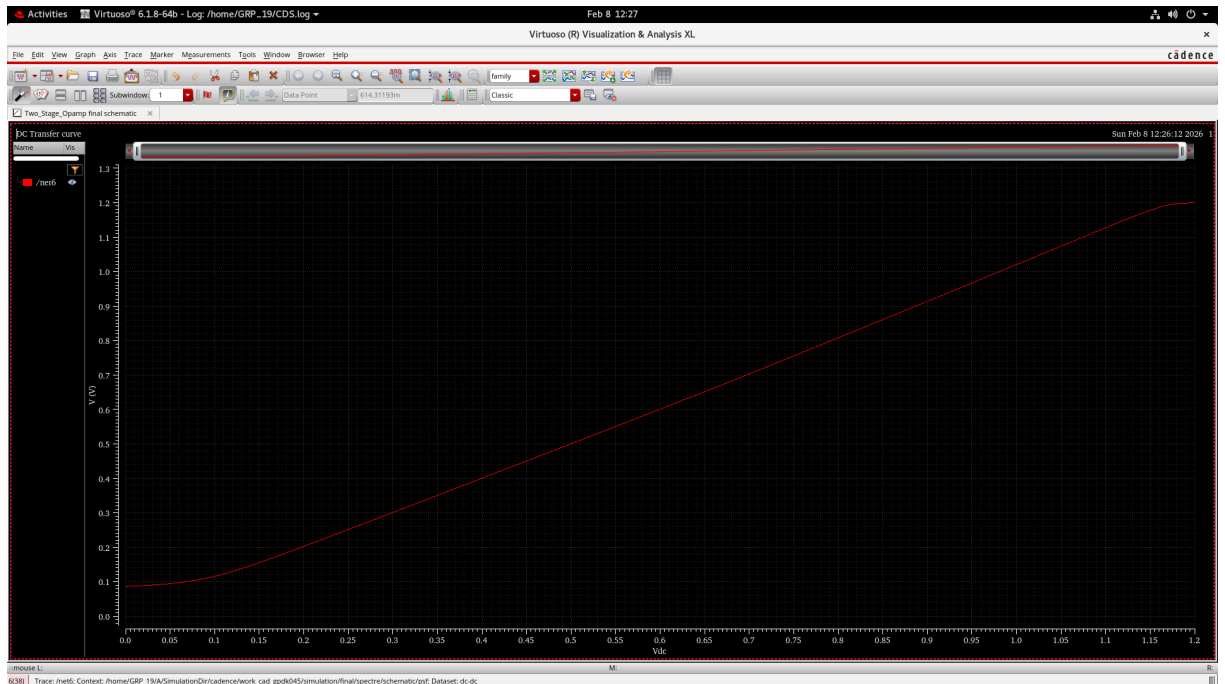


FIGURE 4: DC Transfer curve

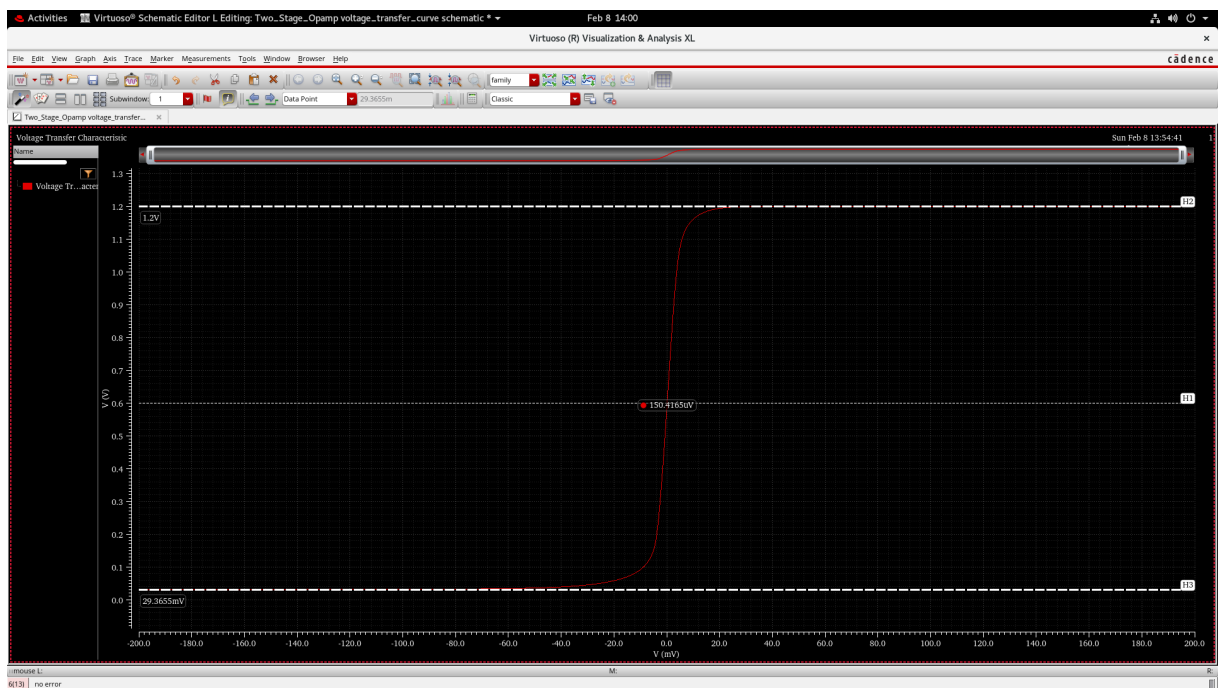


FIGURE 5: Voltage Transfer Characteristic

- $V_{\text{offset}} = V_{\text{id}}$ at which $V_{\text{out}} = V_{\text{dd}}/2 = 600\text{m}$
- $V_{\text{offset}} = \mathbf{150.4165\mu V}$...from VTC
- Power dissipation = $1.2\text{V} \times 389\mu\text{A} = \mathbf{467.364\text{ uW}}$

0.2 AC Testbench results

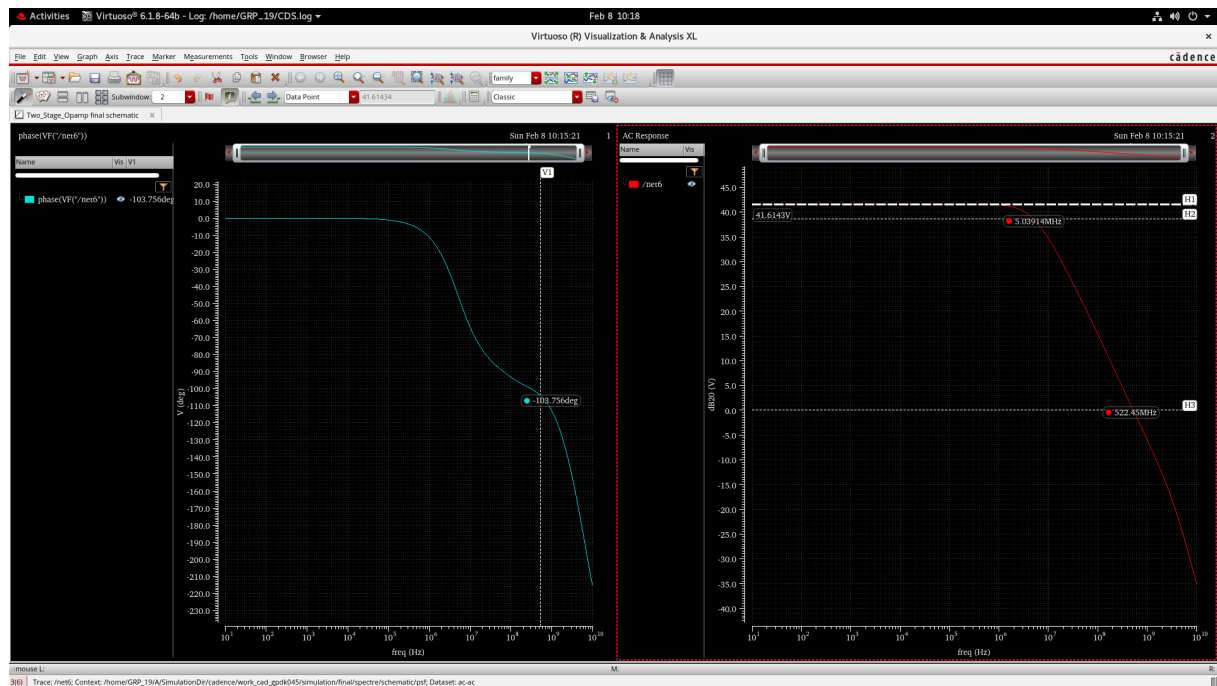


FIGURE 6: AC response of compensated opamp

- DC Voltage gain (A_o) = **41.6143dB**
- -3dB Bandwidth ($f_{-3\text{db}}$) = **5.039MHz**
- Gain Bandwidth product (GBW) = **522.45MHz**
- $\text{Phase}_{0\text{db}} = -103.765^\circ$
- $\text{Phase Margin} = 180 - 95.58 = 76.235^\circ$

0.3 Transient Testbench analysis

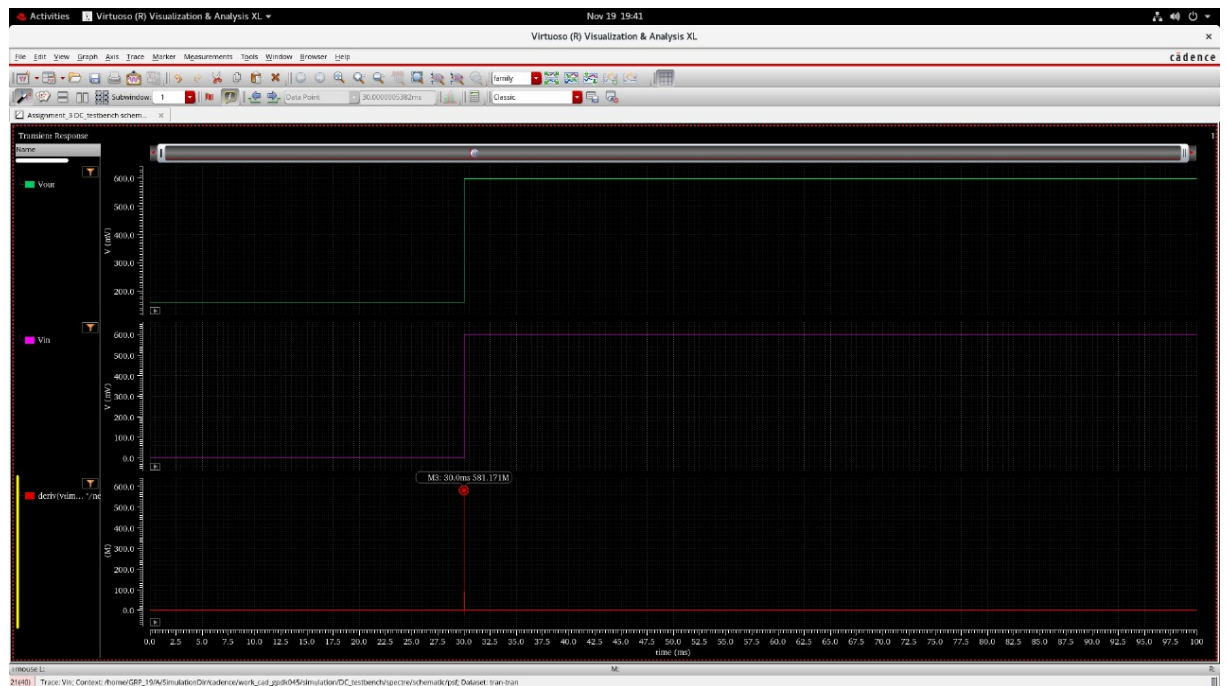
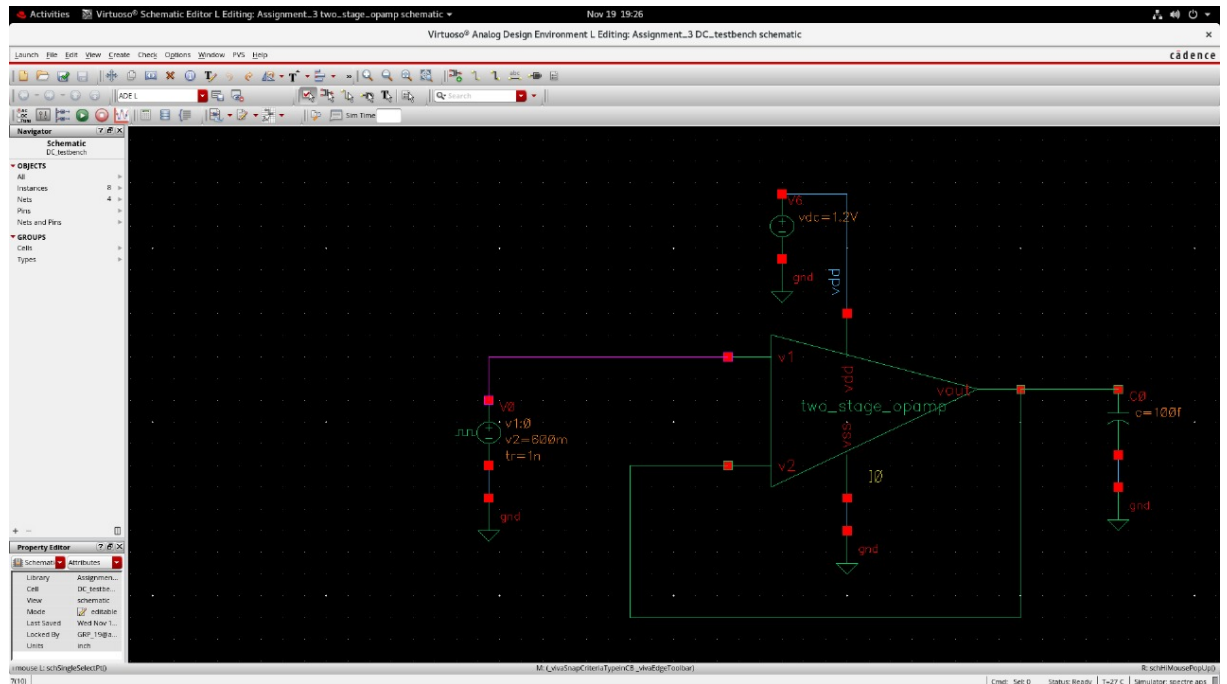


FIGURE 7: Positive step response of compensated opamp

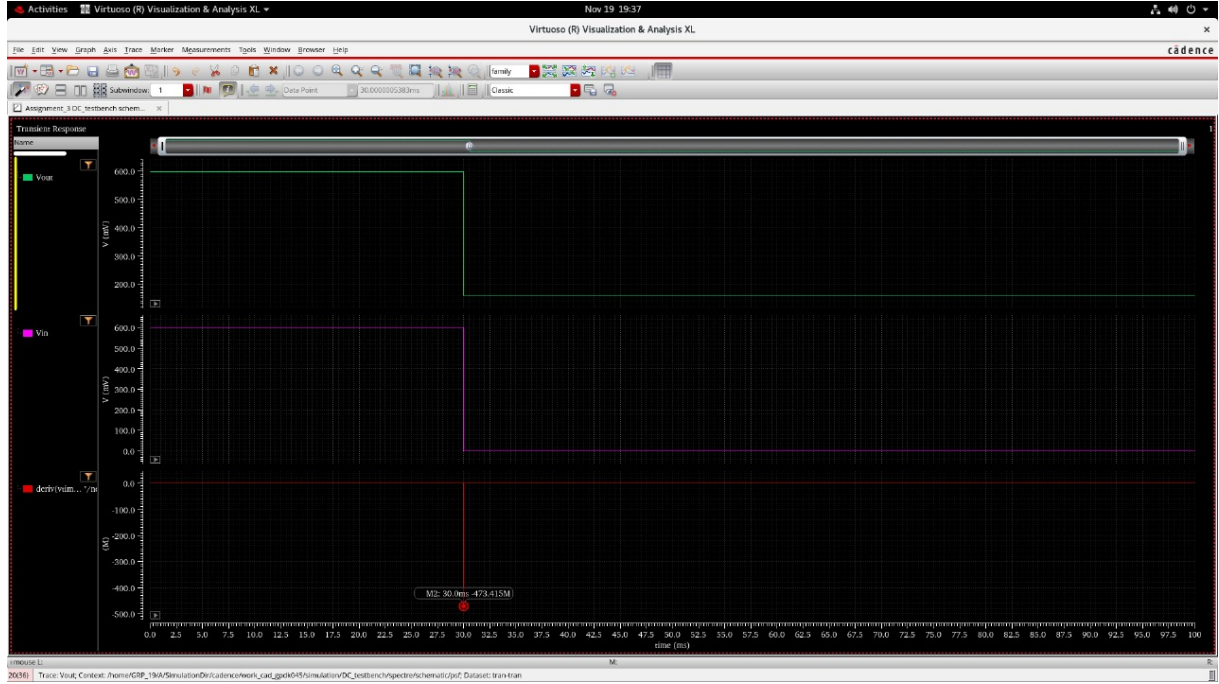


FIGURE 8: Negative step response of compensated opamp

- $SR^+ = 581.171 \text{ V/us}$
- $SR^- = 473.415 \text{ V/us}$

TABLE 2: Performance parameters of designed two stage op-amp @ $[V_{DD} = 1.2 \text{ V}, C_L = 100 \text{ fF}, T = 27^\circ\text{C}, V_{ic} = 0.6 \text{ V}]$.

S.N.	Parameter	Symbol	Value
1.	Open-loop, differential-mode, DC voltage gain	A_0	41.6143dB
2.	Open-loop, -3 dB bandwidth (with frequency compensation)	$f_{-3\text{dB}}$	5.039 MHz
3.	Unity-gain frequency or magnitude crossover frequency	f_T or $f_{0\text{dB}}$	522.45 MHz
4.	Phase margin	PM	76.235°
5.	Low-frequency common-mode rejection ratio	$CMRR$	53.03 dB
6.	Power dissipation	P_{diss}	$467.364 \mu\text{W}$
7.	Input-referred offset voltage (systematic)	V_{offset}	$150.4165 \mu\text{V}$
9.	Slew rate @ 600 mV step	SR^+ SR^-	581.171 V/us 473.415 V/us