

# 1 Objectives

Design a fully differential folded cascode single-stage opamp for the given specifications.

- VDD= 1.8V
- Differential output swing= 1.8V
- Power dissipation<sub>i</sub>=0.12mW
- Voltage Gain=2000V/V
- Technology=180nm
- CL=10pF

# 2 Tools Used

- LTspice IV

# 3 Design

- Since Power is 1.8mW total current will be  $60\mu A$
- Current in each arm will be  $30\mu A$
- $|V_{OD9}| + |V_{OD3}| + |V_{OD5}| + |V_{OD7}| = 1.8 - 0.9 = 0.9V$
- Assume  $V_{OD9} = 0.4V, V_{OD3} = 0.3V, V_{OD5} = 0.15V, V_{OD7} = 0.15V$
- $ICMR = \frac{1.2+0.3}{2} = 0.75V$
- $V_{GS1} + V_{OD0} = 0.75V$
- $V_{GS1} = 0.6V, V_{OD0} = 0.15V$
- $Gain = g_{m1}((g_{m5}r_{o5}r_{o7}) || (g_{m3}r_{o3}(r_{o1} || r_{o9})))$

# 4 Schematics and Outputs

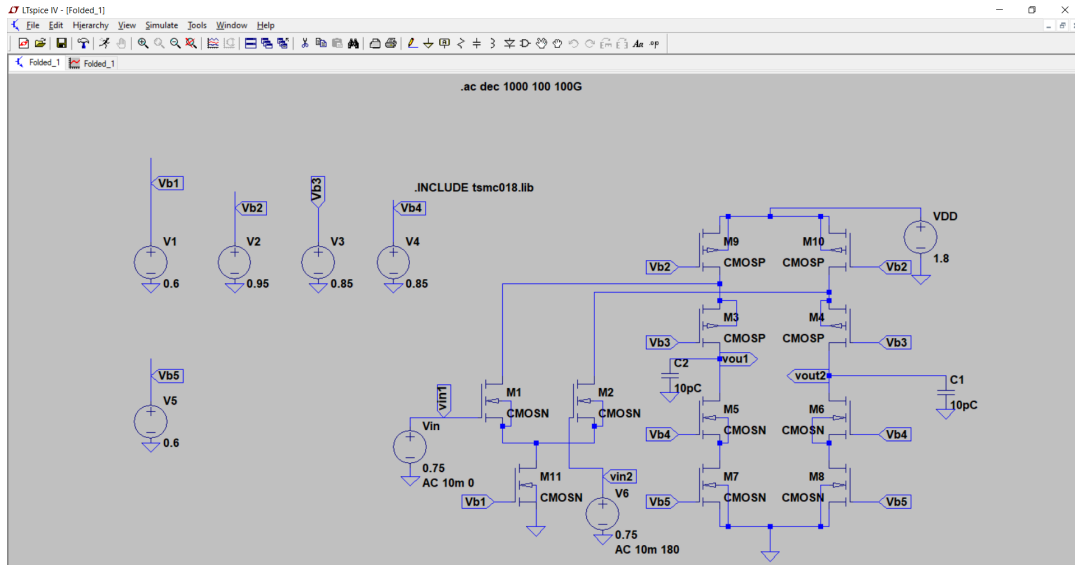


Figure 1: Gain schematic

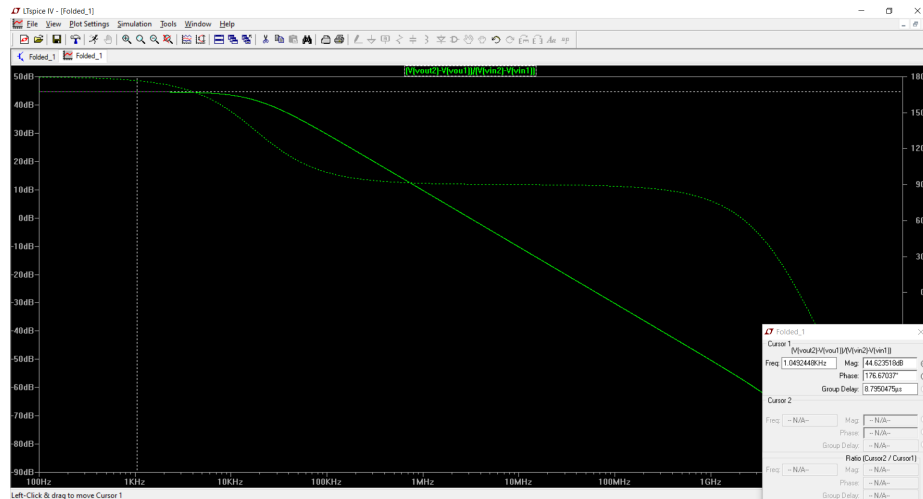


Figure 2: Gain

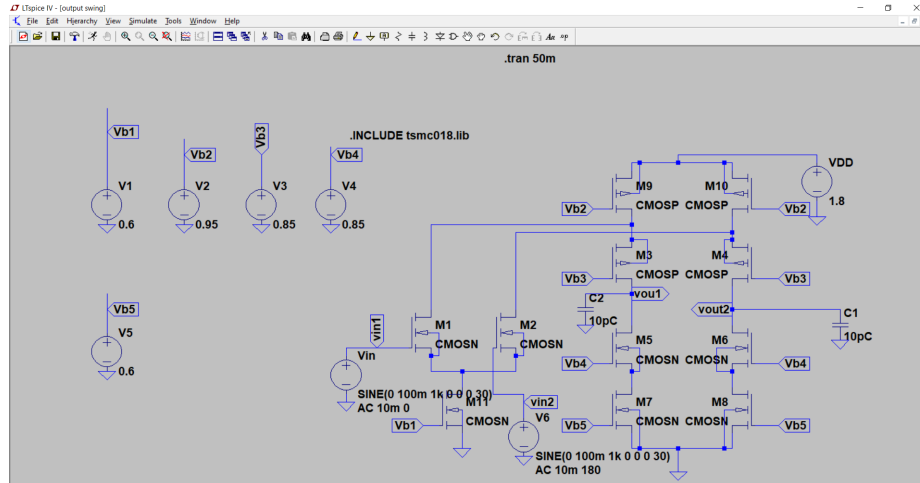


Figure 3: schematic for output swing

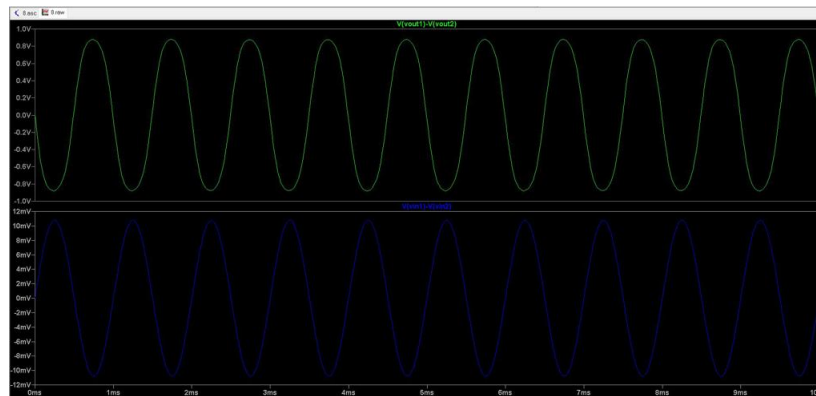


Figure 4: output swing

## 5 Results

- AC Gain = 44.62 dB

## 6 Observations

- The source voltage = 1.8 V.

- Load capacitance = 10 pF
- $\frac{W}{L}$  RATIOS

$(W : L)_{M1}$	$\frac{1999.8n}{180n}$
$(W : L)_{M2}$	$\frac{1999.8n}{180n}$
$(W : L)_{M3}$	$\frac{1927.8n}{180n}$
$(W : L)_{M4}$	$\frac{1927.8n}{180n}$
$(W : L)_{M5}$	$\frac{896.94n}{180n}$
$(W : L)_{M6}$	$\frac{896.94n}{180n}$
$(W : L)_{M7}$	$\frac{896.94n}{180n}$
$(W : L)_{M8}$	$\frac{896.94nn}{180n}$
$(W : L)_{M9}$	$\frac{963n}{180n}$
$(W : L)_{M10}$	$\frac{963n}{180n}$
$(W : L)_{M11}$	$\frac{1776n}{180n}$

- The input was given differential through NMOS transistors.
- The output was taken differentially at drains of NMOS and PMOS.

## 7 Conclusion

- Folded cascode op-amp has better high frequency
- It has better output voltage swing as there is less stacking of MOSFETs as compared to Telescopic Cascode Op-amp.
- It has better high frequency Power Supply Rejection Ratio (PSRR).
- The power consumption of this design is approximately the same as that of the two-stage design
- Folded cascode has two extra current legs, and thus for a given settling requirement, they will double the power dissipation.
- The folded cascode stage also has more devices, which contribute significant input Referred thermal noise to the signal.