(2-stage Op-Amp) Instrumentation Amplifier using 2 stage OP-AMP in gpdk 180nm

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Abstract

- ✔ Designed a 2-opamp instrumentation amplifier using a two-stage CMOS opamp in 180nm technology, achieving gain >60 dB with CMRR & PSRR >60 dB.
- ✔ Verified through simulations and layout checks (DRC & LVS), making it suitable for precision analog and biomedical applications.

Device Structure and Calibration

This is the two-stage CMOS opamp schematic used in our instrumentation amplifier. It achieves high gain with Miller compensation, ensuring stable operation and excellent CMRR/PSRR for precision analog use.

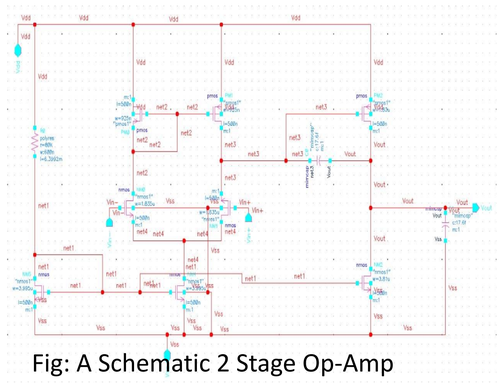

Fig: A Schematic 2 Stage Op-Amp

Parameter	w/L
M1, M2	1.835/0.5
M3, M4	0.925/0.5
M5	3.81/0.5
M6, M7	3.995/0.5

Table 1: Parameter Table

Device Configurations

Technology Node: GPDK 180nm CMOS, Supply Voltage (VDD): 1.8 V, Gain Target: > 60 dB, CMRR & PSRR Target: > 60 dB, Load Capacitance: 1–5 pF, Input Common Mode Range: Rail-to-Rail (approx.), Compensation Capacitance: 1.77 pF (Miller Cap), Simulation Tools: Cadence Virtuoso, Spectre

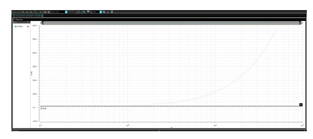

Fig: Parametric Extraction graph

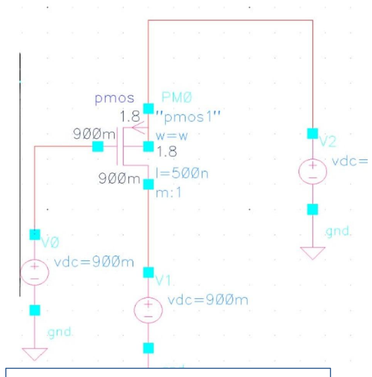

Fig: Schematic View

2 Stage OP-AMP GAIN

The two-stage CMOS op-amp achieves a gain of 72.4 dB using a differential input stage followed by a common-source gain stage. Optimized W/L ratios and Miller compensation ensure high gain and stable operation for precision analog applications.

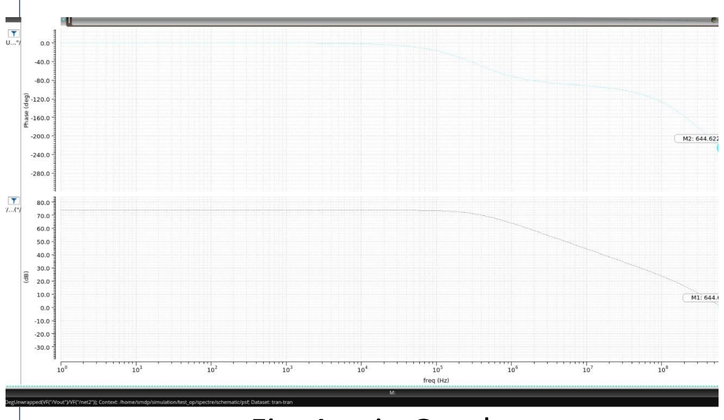

Fig: A gain Graph

Slew Rate, PSRR and CMRR

The op-amp demonstrates a slew rate of 0.211 V/µs, ensuring moderate speed for signal transitions. It achieves a CMRR of 80.2 dB and a PSRR of 77.9 dB, reflecting strong rejection of common-mode and supply noise. These characteristics support stable and accurate operation in precision analog systems.

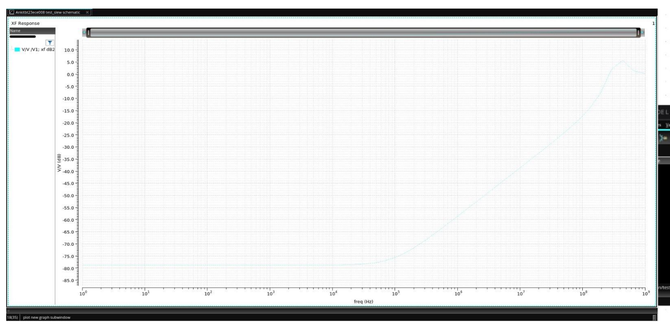

Fig: A PSRR Graph

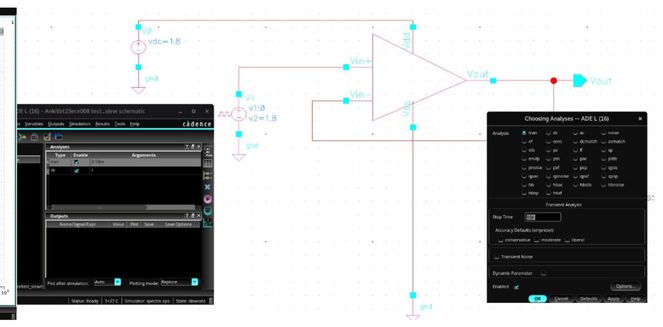

Fig: A Schematic View of PSRR Circuit

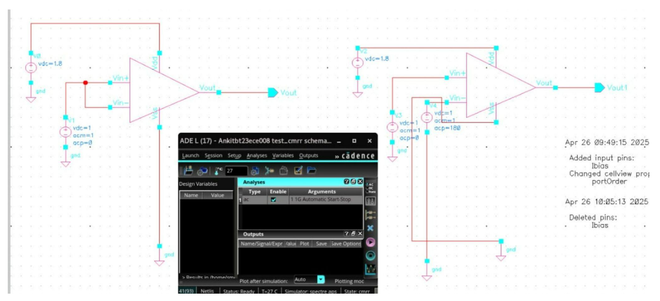

Fig: A Schematic View of CMRR Circuit

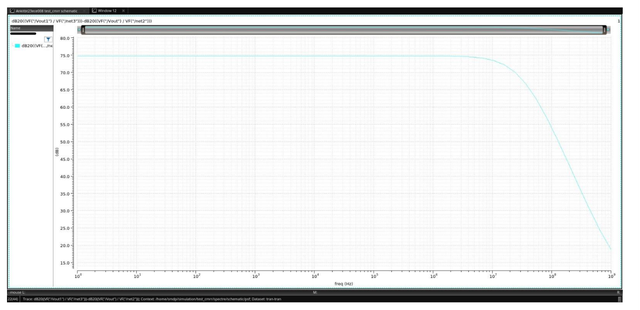

Fig: A CMRR Graph

Instrumentation Amplifier

(The instrumentation amplifier is built using two identical two-stage CMOS op-amps to achieve high gain and precision. It is designed to amplify low-level differential signals while rejecting common-mode noise, making it ideal for sensor and biomedical applications. The amplifier achieves a gain greater than 60 dB, with high CMRR and PSRR ensured by careful matching and layout symmetry. This configuration enables accurate signal processing in noisy environments.

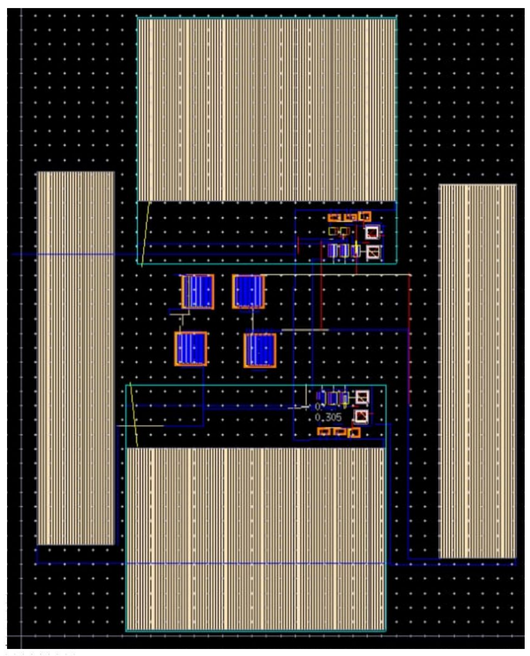

Fig: A Layout View of Instrumentation Amplifier

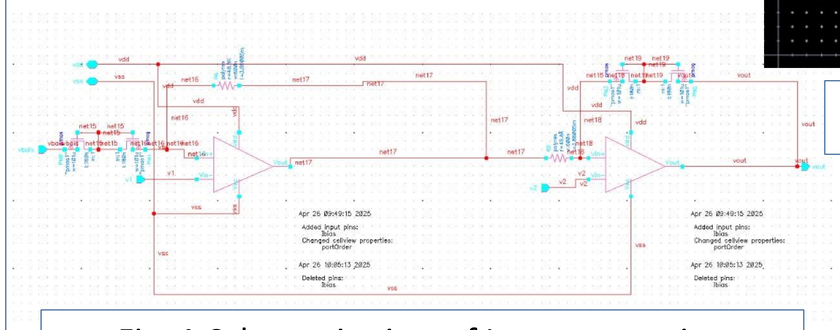

Fig: A Schematic view of Instrumentation Amplifier

CMRR and PSRR of Instrumentation Amplifier

The instrumentation amplifier boasts a high Common Mode Rejection Ratio (CMRR) of 85.3 dB for excellent noise immunity and a Power Supply Rejection Ratio (PSRR) of 78.6 dB for stable operation despite power fluctuations, ensuring reliability and precision.

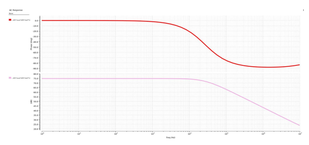

Fig: A Gain Graph (IA)

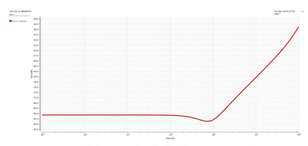

Fig: PSRR of IA

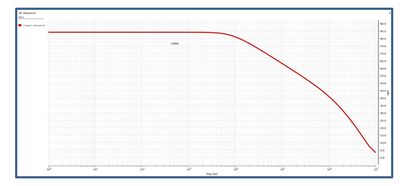

Fig: CMRR of IA

Conclusion

- ✔ The 2-opamp instrumentation amplifier met the target gain of over 60 dB.
- ✔ Simulations confirmed CMRR and PSRR above 60 dB.
- ✔ The layout passed DRC and LVS checks, ensuring design accuracy.
- ✔ The design is suitable for precision analog applications requiring high gain and noise rejection.

Acknowledgement

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Reference

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