Reference Voltage Generation Circuit Insensitive to Temperature

Lei Sha, Anna Kuwana, Haruo Kobayashi

Division of Electronics and Informatics, Gunma University, Japan Email: t191d031@gunma-u.ac.jp

1. Research Objective

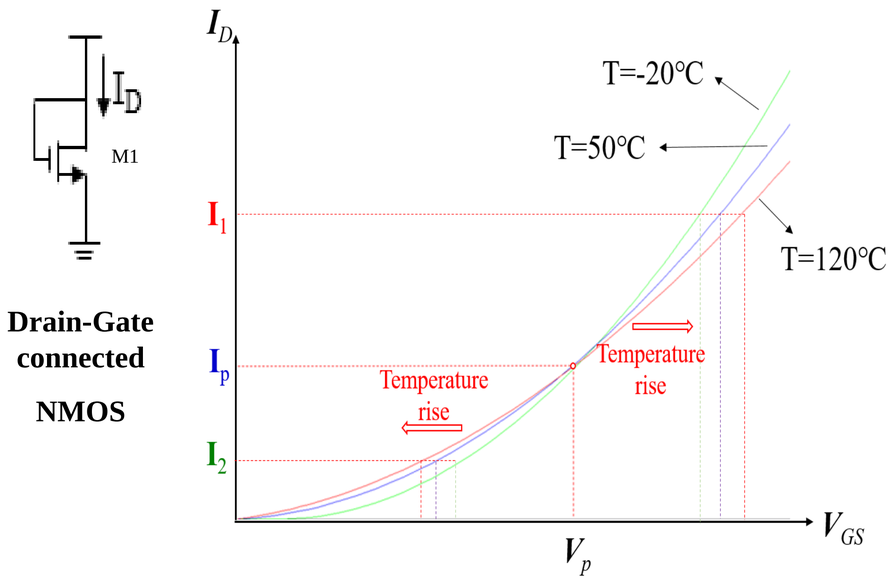
- Analog IC requires
  - Operation in wide temperature range
  - One voltage reference

Proposed a reference voltage generator

- Insensitive to temperature
- Simple
- Based on

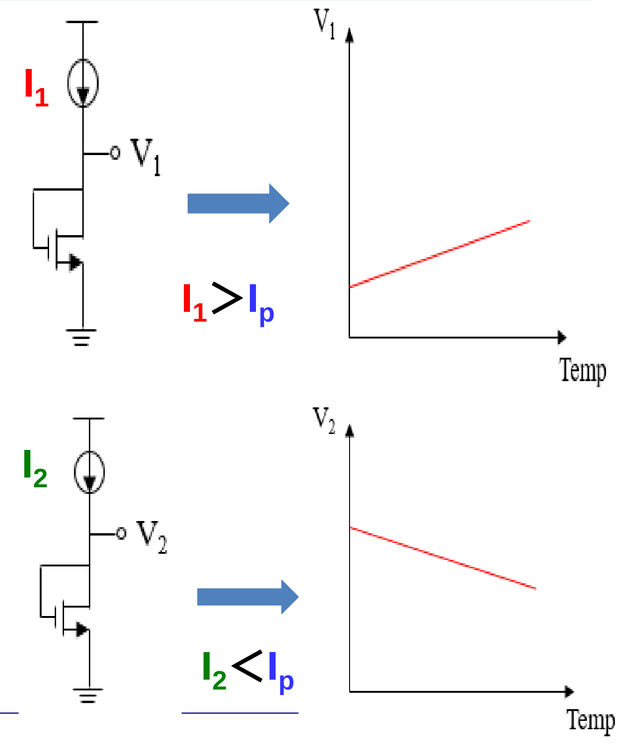
MOS temperature characteristics

2. Point of Our Work

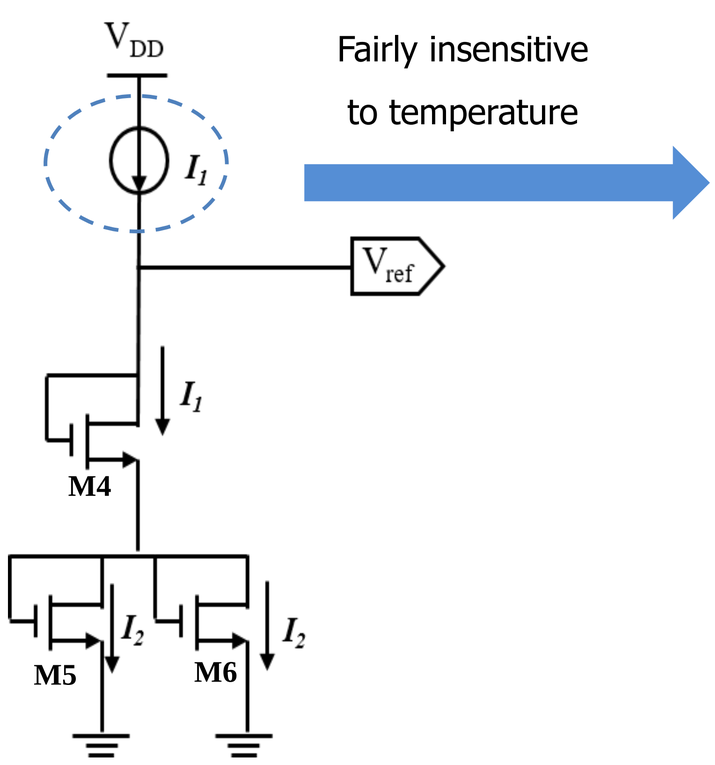


I_D-V_{GS} characteristic of M1

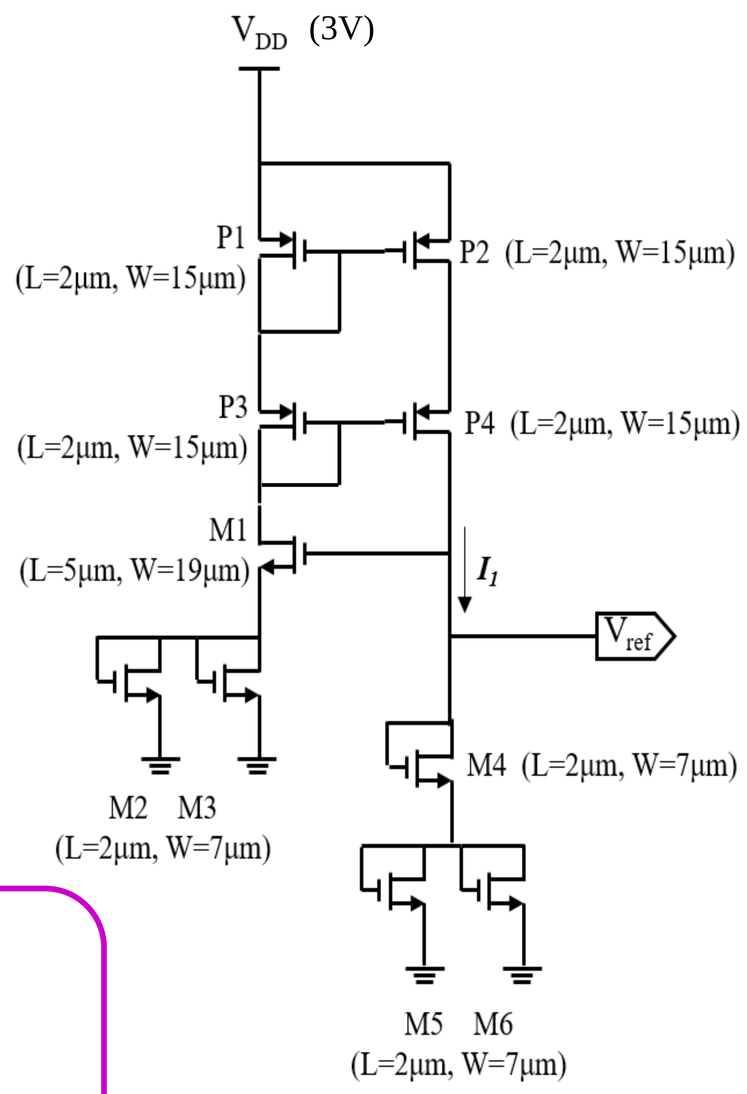
Temperature characteristics of NMOSFET



3.Proposed Circuit



Fairly insensitive to temperature



As temperature becomes high

- $I_1 > I_p$, gate-source voltage increases
- $I_2 < I_p$, gate-source voltage decreases

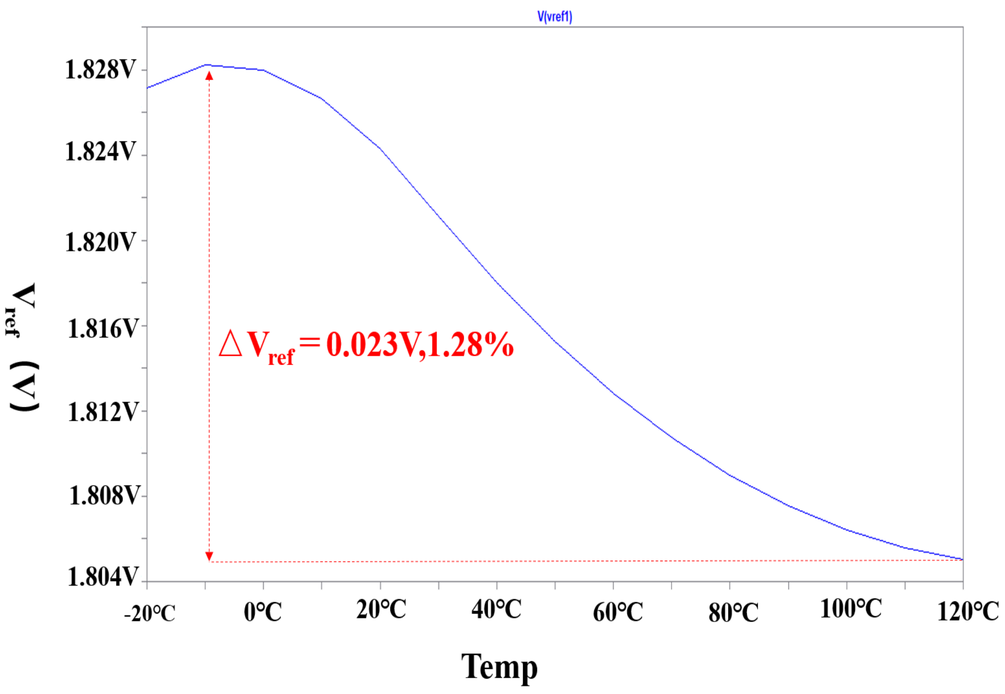
- P1, P2, P3, P4, M1, M2, M3 compose a constant current source
- Utilizing M2, M3 for current source
- M4, M5, M6 are used to compensate for temperature sensitivity of V_{ref}.

- Large current(I_1) through M4
- Small current(I_2) through M5, M6

Two gate-source voltages are added

Temperature characteristics are cancelled.

4. SPICE Simulation Result



Supply voltage＝3V

Small temperature coefficient

5.Conclusion

- Small reference voltage deviation

  → 0.017V from -20℃ to 120℃ for supply voltage of 3V.

- Next step：focus on supply voltage

  → Make reference voltage insensitive to power supply voltage.

References

[1]I. Lee, D. Blaauw, “A 31 pW-to-113nW Hybrid BJT and CMOS Voltage Reference with 3.6% ±3δ-inaccuracy from 0℃ to 170℃ for Low-Power High-Temperature IoT Systems”, VLSI Circuit Symp (2019)

[2]T. Ida, N. Tsukiji, Y. Shibasaki A. Kuwana, H. Kobayashi, “MOS Reference Current Source Insensitive to Temperature Variation”, ICMEMIS, Kiryu (Nov. 2018)