Bandgap Reference in BiCMOS Process

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Abstract – The design of a 1V bandgap reference (BGR) circuit using a silicon-germanium heterojunction bipolar transistor (SiGe-HBT) from the IHP 130nm BiCMOS open source PDK. The circuit operates with a temperature coefficient (TC) of 6.85ppm/ºC in the temperature range of -20ºC to 85ºC at a 1.3V supply.

Index Terms – Bandgap reference, heterojunction bipolar transistor, temperature coefficient.

INTRODUCTION

Bandgap reference (BGR) circuits provide stable reference voltage over variation in temperature, supply and process. The circuit has two blocks, BGR core and startup. The core contains a simple pMOS transistor current mirror (M_4 and M_5), HBT (Q_1 and $Q_{2\text{-}9}$), flicker noise reduction resistor (R_3) and biasing resistors (R_1 and R_2). Transistor M_1, M_2 and M_3 are part of P-startup circuit.

CIRCUIT DIAGRAM

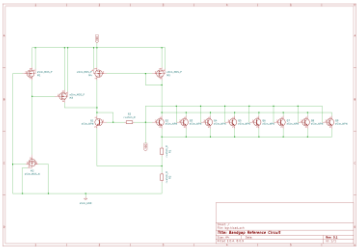

FIGURE 1 SCHEMATIC OF BGR

CIRCUIT SIMULATIONS

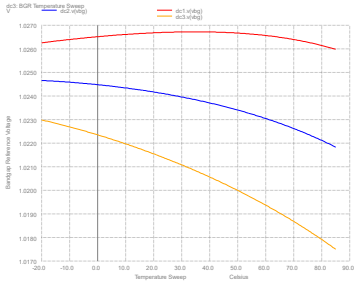

FIGURE 2 TEMPERATURE SWEEP

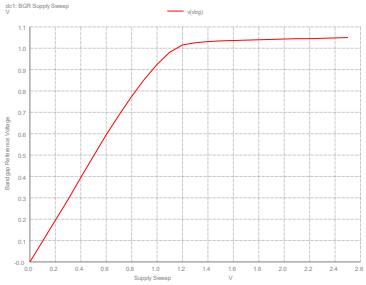

FIGURE 3 SUPPLY SWEEP

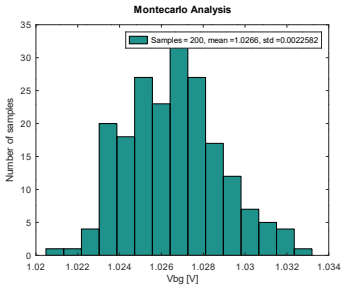

FIGURE 4 MONTECARLO ANALYSIS

The temperature sweep from -20ºC to 85ºC shows a stable BRG voltage of 1.02V at 1.3V supply with temperature coefficient (TC) of 6.85 ppm/ºC. A stable BRG voltage of 1V is observed in a supply sweep ranging from 1.3V to 2.5V.

Montecarlo analysis of process variation of 200 samples results in a mean of 1.02 V and a standard deviation of 2 mV.

REFERENCES

[1] J. M. Loché, A. Abarca, T. Darós, R. Wrege, C. Marques and J. Piteira, "A Low-Noise and Small-Area 0.9 V Bandgap Reference in Standard 180 nm CMOS Process for Neural Applications," 2025 IEEE 16th Latin America Symposium on Circuits and Systems (LASCAS), Bento Gonçalves, Brazil, 2025, pp. 1-5, doi: 10.1109/LASCAS64004.2025.10966327.

GitHub Link:
https://github.com/Knavere29/Bandgap-Reference-Circuit

Readme File Link:
https://github.com/Knavere29/Bandgap-Reference-Circuit/blob/master/README.md