Design of a High Performance Bandgap Reference with a stable DC variation in Power Management IC's Applications

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Design of a High Performance Bandgap Reference with a stable DC variation in Power Management IC's Applications.

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Abstract— **In this paper, we described a high-performance Bandgap reference (BGR) circuit to provide a constant voltage of 1.2 V. In the proposed circuit NPN BJT is used along with MOSFETs to improve the performance and stable DC variation. The proposed BGR results have been checked for three temperature range i.e. -40^{O}C, 27^{O}C and 125^{O}C. Bearing in mind the mismatches between transistors and process variations Monte Carlo simulation has been done for 200 samples. ΔV of 1.8 mV has been achieved with the DC simulation results. Power supply rejection ratio of -66 dB has been attained. The output voltage of BGR from a 5 V supply is 1.2 V. The proposed circuit is implemented on the CMOS 0.18um process.**

Keywords; Power Management integrated ciruits(PMICs); Bandgap Reference(BGR); proportional to absolute temperature (PTAT); complementary to absolute temperature (CTAT);

I. INTRODUCTION

In the recent years Power management ICs are a major trend in the portable electronics. Supply voltage to PMICs are generated by different switching regulators. DC-DC Buck converter is a major switching regulator used to convert the battery voltage to the regulated step-down voltage. All the analog circuits need a reference voltage or a bias current that must be unresponsive to process, temperature, and supply variations. Therefore Bandgap reference (BGR) forms a key building block in the power management ICs (PMICs) to produce a reference voltage. By the Bandgap reference a fixed dc reference voltage is provided to the other blocks of PMICs that does not vary with power supply voltage, temperature or process variations. Previously BGR provided the reference current and the reference voltage to the PMICs and analog blocks using resistors which occupies large area and consumes power. The proposed BGR introduces fewer resistors to obtain a high performance Bandgap reference for the effective operation of the PMICs.

II. PROPOSED STRUCTURE

Figure 1. Presents the block diagram of the proposed Bandgap circuit. The output voltage Vref of the Bandgap reference is aimed to be 1.2V. The proposed BGR is composed of a start-up circuit, low voltage high gain operational amplifier, Proportional to Absolute Temperature (PTAT), Complementary To Absolute Temperature (CTAT), and a low pass filter.

The start-up circuit produces the voltage to start the BGR circuit. In order to obtain a stability characteristics of the BGR, low voltage high gain operation amplifier regulates the start-up voltage. Control to the NPN BJTs collector current is provided by BGR trimming blocks. TRIM<3:0> trimming bits are delivered to BGR_TRIM_1 and TRIM<5:4> trimming bits are delivered to BGR_TRIM_2. Compensation circuit compensates the slope of the PTAT and CTAT voltages. Low pass filter is used to remove the excess noise. The performance of BGR is specified by Line and Load Regulation. Power Supply Rejection ratio (PSRR) satisfy the performance requirements of the BGR.

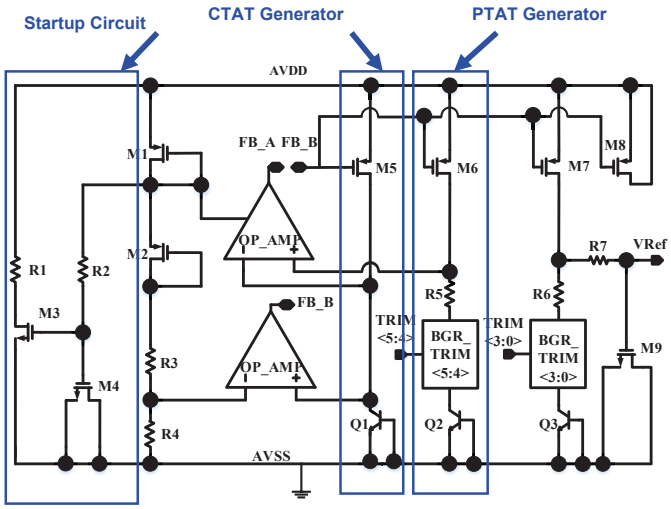

Figure 1. Proposed Bandgap reference (BGR) circuit

III. EXPERIMENTAL RESULTS

The BGR is implemented in a 180 nm CMOS process. Figure below shows the simulation results. All the simulation results have been plotted for temperature of -40°C, 27°C and 125°C. Figure 2. Presents the Transient Simulation Results of Bandgap reference for temperature range of -40°C, 27°C and 125°C. The results clearly shows the BGR output voltage to be 1.198V, 1.206V and 1.193V respectively. Figure 3. Presents the DC Simulation Results of BGR for the before mentioned

temperatures. The ΔV is recorded as 1.8mV, 2.27mV and 1.48mV for the three temperature regions mentioned before. Figure 4. Presents the power supply rejection ratio (PSRR) of the Bandgap reference (BGR). The PSRR is -66dB, -58.6dB and 68.4 dB for the three temperature ranges. Figure 5. Presents the Loop Gain & Phase Margin of Bandgap Reference. Bearing in mind the mismatches between transistors and process variations Monte Carlo simulation has been done for 200 samples. Figure 6. Presents the Monte Carlo simulation. The mean value of the 200 number of samples is achieved to be 1.19785V and the σ is 16.89 mV

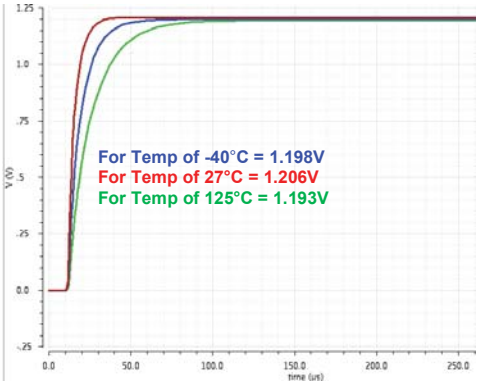

Figure 2. BGR Transient Simulation Results for temperature of -40ºC (in blue), 27ºC (in Red) and 125ºC (in Green).

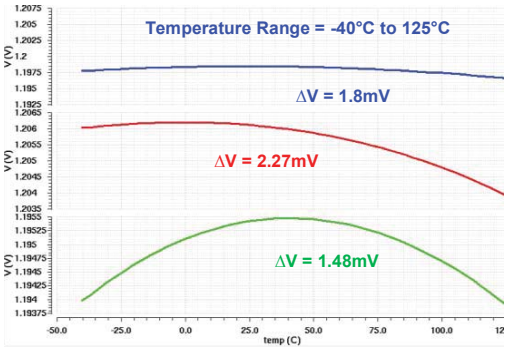

Figure 3. DC Simulation Results of Bandgap reference (BGR) for temperature of -40ºC (in blue), 27ºC (in Red) and 125ºC (in Green).

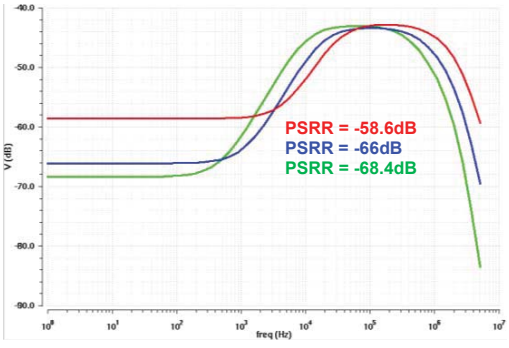

Figure 4. Power Supply Rejection Ratio (PSRR) of Bandgap reference (BGR) for temperature of -40ºC (in blue), 27ºC (in Red) and 125ºC (in Green).

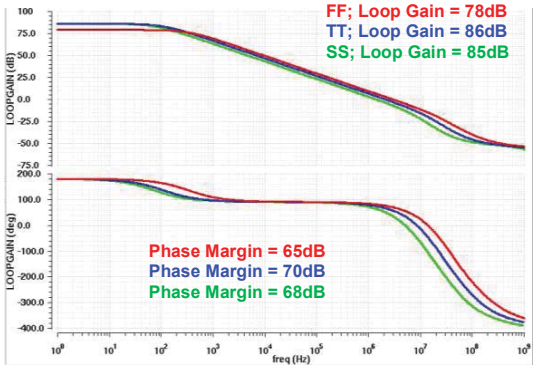

Figure 5. Loop Gain & Phase Margin of Bandgap reference (BGR) for temperature of -40ºC (in blue), 27ºC (in Red) and 125ºC (in Green).

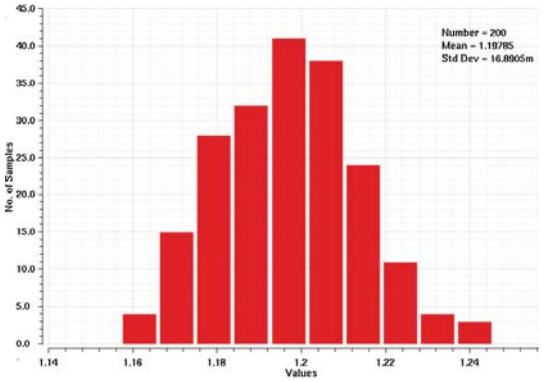

Figure 6. Monte Carlo simulation results of Bandgap reference for 200 number of samples.

IV. Conclusion

A high performance Bandgap reference (BGR) circuits is presented to generate a stable voltage of 1.2 V. NPN BJT is used along with MOSFETS to improve the performance and stable DC variation. ΔV of 1.8 mV has been achieved with the DC simulation results. Power supply rejection ratio of -66 dB has been attained. The output voltage of BGR from a 5 V supply is 1.2 V. The proposed circuit is implemented on CMOS 0.18um process.

Acknowledgment

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