Bandgap reference circuit using simple current mirror architecture.

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Abstract

This paper presents the design of a bandgap voltage reference circuit using a simple current mirror and startup circuit to prevent the circuit from resting at the undesirable zero bias condition. Usually, it has an output voltage of around 1.2V, close to the theoretical 1.22eV bandgap of silicon at 0K. Bandgap references are widely used to generate a constant output reference voltage being insensitive to temperature, process and supply variations. The performance of the current source can be enhanced using a current mirror. It is an important analogue building block used in various applications like Low dropout voltage regulator, analogue to digital converter, Buck converters etc.

1 Circuit Details

This bandgap reference circuit utilizes two PN junction diodes to generate both PTAT and CTAT and combines them to eliminate the temperature sensitivity. PTAT means the output voltage increases with temperature, which is obtained by taking the difference between the voltages of two diodes when a constant current is applied to both the diodes and CTAT means the output voltage decreases with the temperature, this is the characteristic of the voltage across a diode when a constant current source is applied across it. When we add voltage having a negative slope with a voltage having a positive slope the slopes of both the voltages cancel out and we get a constant reference voltage concerning temperature. But the slope of the CTAT and PTAT may not be equal to each other, so we have to multiply by a constant scalar to make them equal and then we should add them to get a constant voltage reference independent of temperature. The ratio of the first and second resistor should be selected very carefully. Here the startup circuit is used to disturb the circuit once zero current operating region happens and in the normal state, the start-up circuit will not affect the bandgap reference circuit.This circuit uses a cascode current mirror which is best suited for bandgap reference circuits as it provides medium input and output voltage and very high output resistance.The obtained output voltage is around 1.2V, depending on resistors ratio and circuit design, close to the theoretical 1.22eV bandgap of silicon for input power supply voltage of 3.3V and 100 Mohm load resistance.

2 Implemented Circuit

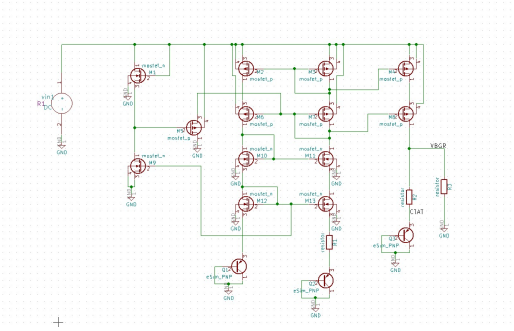

Figure 1: Implemented circuit diagram.

3 Implemented Waveforms

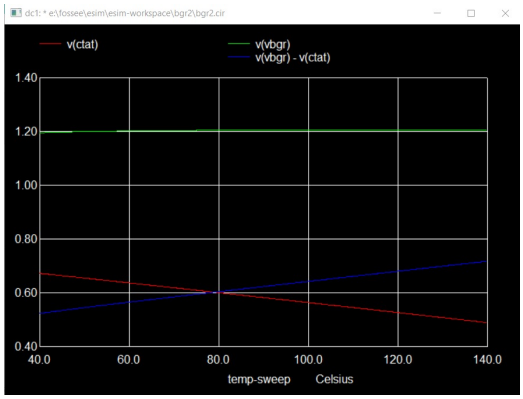

Figure 2: Implemented waveform.

References

[1] S. Pulujkar. General purpose bandgap. https://github.com/vsdip/avsdbgp_3v3_sky130_v1.

[2] A. Purty. General purpose bandgap. https://github.com/vsdip/avsdbgp_3v3_sky130_v2.