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Characterization of Bandgap Reference Circuits designed for High Energy Physics Applications

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Bandgap reference circuits (BGR) in a commercial 65nm CMOS technology were designed and fabricated in view of potential use in high-energy physics (HEP) applications. Since in bandgaps the dominant radiation-susceptibility is due to the bipolar devices or diodes, a few different versions employing MOSFETs with standard and special layout techniques have been designed. Trimming techniques to adjust the reference voltage as a function of temperature and irradiation are not included in the circuits. Measurement results show a temperature variation as low as ±3.4 mV over a temperature range of 170℃ (-30℃ to 140℃) and a line regulation at room temperature of 7.6%/V. Measured Vref is 690 mV ±15 mV (3σ) for 26 samples on the same wafer. Circuits correctly operate with supply voltages in the range from 1.32 V down to 0.78 V. A reference voltage shift of only 4.1 mV (around 0.6%) was measured after irradiation with 10 keV X-rays up to an integrated dose of 90 Mrad (SiO2). Irradiation to higher integrated doses and with different sources are already planned. This work discusses the measurements results and their relation with the particular semiconductor device (BJT, diode, MOSFET) employed in the design of the bandgap.

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