IMPACT OF RADIATION ON CMOS VOLTAGE CONTROLLED OSCILLATOR

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ABSTRACT

Single Event Effects (SEEs) have been primary concern in the study of radiation effects since the late 1970's for the device operating in deep space of inter planetary space missions. The single event effect is due to strike of a single particle, and this interaction of this individual particle may lead to functional failure of an electronic circuit. Due to technology scaling, the transistors are so tiny that a single charge induced by cosmic rays can upset the information in the storage cell. Today it takes only 0.1pC of charge to change the bit state of a memory cell node and 0.1pC charge can be generated with around 10_6 electrons. This work focuses on designing radiation tolerant Voltage-controlled oscillators (VCOs) that can be employed as an accurate oscillator in PLL for high frequency clock generators in space applications. Here, TRIM and Silvaco's Atlas tool are used to evaluate the impact of heavy ions on CMOS technology and further its impact on Voltage controlled Oscillator (VCO) is analysed. 180nm CMOS inverter is designed in Victory process and Athena by using masks generated by DRC and LVS clean GDSII file from cadence virtuoso. The current profile obtained from CMOS inverter under influence of Single Event Upset (SEU) is applied to VCO at different nodes and impact of SEU is observed. Later on a radiation hardened VCO design is proposed in this work.

This work suggests alteration of device width to achieve linearity and desired input and output capacitance. The SEU has significant impact on the logic state of Ring Oscillator stage invertors compared to current starving/biasing stage. The current profile of CMOS device has strong dependence on the energy of ion, its track, angle of incidence and the material. When angle of incidence is very less (7º- 14º) the channel will be occupied by funnel of charge and it leads to maximum degradation of device. This work shows that a device operating at high frequency is more susceptible to SEU. It is found that the Triple Modular redundancy (TMR) consumes more power and is less accurate as compared to Radiation Hardened by Design (RHBD) approach.