Design of Bulk Built-In Current Sensors to Detect Single Event Effects and Laser-Induced Fault Injection Attempts

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Bulk Built-In Current Sensors (BBICS) are fault detection mechanisms embedded in integrated systems. BBICS are able to monitor anomalous transient currents like the so-called single event effects induced by radiation or even malicious injection sources. This work reviews BBICS principles and introduce new sensor architectures that improve the transient-fault detection sensitivity. In addition, a test chip is presented for the validation of the sensor concept under the laser-induced effects.

**Integrated circuits are more and more** **Transient-Fault (TF) sensitive through** **new technologies**

**The today's trend in efficient protections against transient faults:**
- Concurrent Error Detection (CED) mechanisms
- Recovery-based Error Correction Procedures

**Mitigation of Transient faults by using CED schemes based on Bulk Built-In Current Sensors (BBICS):**

**Analysis of laser-induced currents in NMOS and PMOS transistors:**
- Test chip composed of single NMOS and PMOS transistors designed with classic and triple-well 90-nm CMOS technology.
- Experiment settings: measure of laser-induced currents at $A = 1064 \text{nm}$, laser spot $\Omega = 5 \mu m$, pulse duration = 20 ps, 1.25 W

**Improving the transient-fault detection sensitivity of BBICS by using triple-well CMOS technology:**
- Lasers beams
- Laser-induced NMOS current
- Laser-induced PMOS current

**Conclusions and Perspectives:**
- Laser-based experiments revealed:
  1. Classic PMOS transistors drive bulk currents much higher than drain currents, limiting efficiently transient-fault-detection sensitivity of PMOS-BBICS.
  2. Use of triple-well CMOS technology allows a distinction of the bulk current and improves the transient-fault detection sensitivity of NMOS-BBICS. A 65-nm CMOS test chip is being tested to validate BBICS approach in such a technology.