Design of a Radiation Tolerant System for Total Ionizing Dose Monitoring Using Floating Gate and RadFET Dosimeters

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1. Abstract

The Total Ionizing Dose Monitor (TIDMon) is a radiation tolerant system designed to measure the effect of the TID on a new prototype of Floating Gate Dosimeter (FGDOS) and compare it against the Radiation-sensing Field Effect Transistors (RadFETs) dosimeter. In this work we present the design strategy adopted for the control of the sensors and the architecture, the radiation reliability and the performance achieved by the system.

2. Design Choices

Two parts compose the system:

- **The tester part** which is a generic radiation tolerant architecture able to acquire mixed-signals from the DUT and perform complex data processing.
- **The DUTs part** that contains the dosimeters sensors and the circuitry needed to manage them.

3. TID Monitoring procedure

The TIDMon measures every second the TID sensors and also the voltage regulators and the current source of the board in order to monitor the level of degradation of the tester.

4. Radiation Assurance

A Triple Modular Redundancy (TMR) mitigation technique is applied on the FPGA IP and compare it against the Radiation-sensing Field Effect Transistors (RadFETs) dosimeter. Two IP cores are dedicated to the sensors:

- A Flash-based FPGA which offers us the possibility to improve continuously the embedded sensor controllers and to manage online different test configurations.
- A 16-bit ADC and Op-Amps that allow the measuring of the DUT values: RadFET voltages, RadFET current source and floating gate current values.

5. Results

- **FGDOS Controller** performs the frequencies of the analogue values of the sensors and the reference values of the board.
- **The test architecture proved to be robust against various harsh radioactive environments with the maximum of performance as a TID sensor for CERN dosimetry purposes.**

6. Conclusions

- The TIDMon allows us to finely characterize and test conditioning to use the FGDOS with the maximum of performance as a TID sensor for CERN dosimetry purposes.
- The tester architecture proved to be robust against various harsh radioactive environments and can operate up to 30 krad(Si).
- The next step for the TIDMon is to extend the lifetime of the architecture actually limited by the increase of the ADC current consumption as a result of the accumulated dose.
- The performances and the modularity of the test architecture provides us a quick and robust, ready-to-use test system able for other CERN radiation testing activities.