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Abstract

Field Programmable Gate Arrays (FPGAs) are getting more attention in safety related and safety critical application development of nuclear power plant instrumentation and control (I&C) systems. The high logic density and advancements in architectural features make SRAM based FPGAs suitable for complex design implementations. Devices deployed in the nuclear environment faces radiation particle strike causes transient and permanent failures. The major reasons for failures are total ionization dose (TID) effects, displacement damage dose (DDD) effects and single event effects (SEE). Different from the case of space applications, soft errors are the major concern in terrestrial applications. In this paper, a review of radiation effects in FPGAs is presented, especially soft errors in SRAM-based FPGAs. Single event upset (SEU) shows a high probability of error in the dependable application development in FPGAs. This survey covers the main sources of radiation and its effects on FPGAs, with emphasis on SEUs as well as on the measurement of radiation upset sensitivity and irradiation experimental results at various facilities. This paper also gives a comparison of the major SEU mitigation techniques in the configuration memory and user logics of SRAM-based FPGAs.

Keywords: Configuration memory; Fault Tolerance; FPGAs; Nuclear Power Plant I&C Systems; Radiation effects; Single event effects; Single Event Upset; SEU Mitigation; Soft Errors; TID effects

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