Analysis of Circuit-Board-Level Radiation-Hardening Techniques for a Prompt-Dose Environment

Alex Manning Ryan Meuth Kevin Burger

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1 Topic Overview

The prompt-dose radiation environment provides a unique set of challenges for electronic design that can not always be solved using conventional rad-hardening (radiation hardening) methods. Prompt-dose refers to a radiation environment in which a high dose of radiation is delivered to a device over a very short period of time. A pragmatic approach to rad-hardening a device against prompt-dose radiation would be of particular interest to devices used in defense applications with a requirement to continue functionality in the event of a nuclear detonation. The prompt-dose environment threatens the functionality of electronics primarily due to gamma rays, high-energy neutron radiation, and the electromagnetic pulse (EMP) created due to reactions in Earth's upper atmosphere. These effects can cause component degradation, especially in semiconductors, as well as transients that can temporarily or permanently damage circuit operation if left unhandled.

A pragmatic approach to prompt-dose rad-hard design should provide future designers a set of practical tools to design a circuit that is resistant to prompt-dose radiation effects. This should include the following as necessary:

- An anlysis of the possible effects of prompt-dose radiation exposure on common electrical components based on previously published literature
- Guidelines and recommendations for selecting appropriate components
- Guidelines and recommendations for appropriate schematic design
- Guidelines and recommendations for appropriate circuit-board layout
- Guidelines and recommendations for Field-Programmable-Gate-Array (FPGA) design

2 Research Plan

Research will begin with a thorough literature review of prompt-dose radiation effects on electronics based on existing literature. Using the knowledge gained, a specification will be generated for a DC-DC converter with at least the following features:

- Support for a wide range of input voltages
- Multiple switchable output voltages
- Appropriate onboard command and monitoring circuitry
- An appropriate interface connect to an offboard monitor for circuit verification during test

The board will be manufactured, tested, analyzed, and iterated as resources permit. The project will culminate in a report as described in section 1.

3 Meetings

Meetings will occur upon request of any party as required to ensure successful completion of this project. A status update will be delivered at least every two weeks in the form of an email to all committee members. Participation in Ryan Meuth's Honors Thesis Organizational Canvas Course will be completed as required.

4 Timeline

Date	**Due**
09/27/2020	Literature Review
10/04/2020	Board Specification
11/01/2020	Board Design/Fabrication Files · Test Procedure
11/15/2020	Completed Board Units · Radiation Test Scheduled
11/22/2020	Board Functional Test Results
12/13/2020	Board Radiation Test Results
01/10/2021	Test Result Analysis
01/17/2021	Updated Board Specification
01/31/2021	Updated Board Design/Fabrication Files · Updated Test Procedure
02/14/2021	Completed Updated Board Units · Radiation Test Scheduled
02/28/2021	Board Functional Test Results
03/14/2021	Board Radiation Test Results
03/21/2021	Report Completed
04/02/2021	Defense Completed
04/16/2021	Thesis Submitted