Cairo University

PREDICTIVE CIRCUIT MODELING OF TOTAL IONIZING DOSE EFFECTS ON BULK CMOS TECHNOLOGIES

By

Hesham Hassan Hassan Salah El Din Shaker

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Electronics and Communications Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

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Title of Thesis:

Predictive Circuit Modeling of Total Ionizing Dose Effects on Bulk CMOS Technologies

Key Words:
Gamma rays; nuclear facilities; total ionizing dose; bulk CMOS; modeling

Summary:

Most activities inside nuclear facilities are carried out in well-shielded areas to achieve the needed safety requirements against the exposure to ionizing radiation. This implies the necessity of employment of remote inspection and handling electronic equipment inside these areas. Therefore, these electronic equipment should be radiation tolerant to be able to work properly over its expected lifetime. The gamma rays are the main threatening ionizing radiation on electronic equipment mounted in nuclear facilities. Total Ionizing Dose (TID) introduced by the gamma radiation into silicon dioxide portions of MOS devices can cause their functionality failure.

This work discusses a modeling methodology of the TID effects. These effects are introduced due to the absorption of gamma rays into shallow trench isolation oxides in bulk CMOS devices. The benefit of this modeling methodology is to provide the circuit designers with a tool to test the performance of their circuits at high absorbed doses and to develop radiation tolerant circuit designs suitable for different nuclear facilities. This modeling approach is applied to 130nm predictive technology model for bulk FET devices as a case study and the results show a good agreement with published measured data.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree of qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Hesham Hassan Hassan Salah El Din Date:

Signature:

Dedication

I would like to dedicate this research work to my parents.

Acknowledgments

First of all, I have to thank God for guiding me to finish this work.

I would like to thank my father who taught me the engineering thinking and made me love electronics. I would like to thank my mother for her support and encouragement.

I would like to thank my supervisors Prof. Serag, Dr. Mohammed, and Dr. Alaa for their continuous guidance and effective support throughout this research work. They taught me how to do research, and how to present my work.

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