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TNI	**Zabezpečovanie výrobkov kozmického programu Techniky zmierňovania účinkov žiarenia v príručke ASIC a FPGA**	**TNI CEN/TR 17602-60-02** 31 0539

Space product assurance - Techniques for radiation effects mitigation in ASICs and FPGAs handbook

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Space product assurance - Techniques for radiation effects mitigation in ASICs and FPGAs handbook

Ingénierie spatiale - Guide sur les techniques de durcissement des ASICs et FPGAs vis-à-vis des effets des radiations

Raumfahrtproduktsicherung - Handbuch zu Minderungsmethoden von Strahlungseffekten auf ASICs und FPGAs

This Technical Report was approved by CEN on 22 November 2021. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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European Foreword

This document (CEN/TR 17602-60-02:2021) has been prepared by Technical Committee CEN/CLC/JTC 5 “Space”, the secretariat of which is held by DIN.

It is highlighted that this technical report does not contain any requirement but only collection of data or descriptions and guidelines about how to organize and perform the work in support of EN 16602-60.

This Technical report (CEN/TR 17602-60-02:2021) originates from ECSS-Q-HB-60-02A.

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any TR covering the same scope but with a wider domain of applicability (e.g.: aerospace).

1 Scope

This ECSS-Q-HB-60-02 handbook provides a compilation of different techniques that can be used to mitigate the adverse effects of radiation in integrated circuits (ICs), with almost exclusive attention to Application Specific Integrated Circuits (ASICs) and Field Programmable Gate Arrays (FPGAs) to be used in space, and excluding other ICs like power devices, MMIC or sensors.

The target users of this handbook are developers and users of ICs which are meant to be used in a radiation environment. Following a bottom-up order, the techniques are presented according to the different stages of an IC development flow where they can be applied. Therefore, users of this handbook can be IC engineers involved in the selection, use or development of IC manufacturing processes, IC layouts and ASIC standard cell libraries, analogue and digital circuit designs, FPGAs, embedded memories, embedded software and the immediate electronic system (printed circuit board) containing the IC that can experience the radiation effects.

In addition, this handbook contains an overview of the space radiation environment and its effects in semiconductor devices, a section on how to validate the good implementation and effectiveness of the mitigation techniques, and a special section providing some general guidelines to help with the selection of the most adequate mitigation techniques including some examples of typical space project scenarios.

The information given in this ECSS Handbook is provided only as guidelines and for reference, and not to be used as requirements. ECSS Standards provide requirements that can be made applicable, while, ECSS Handbooks provide guidelines.

2 References

EN Reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system - Glossary of terms
EN 16603-10-04	ECSS-E-ST-10-04	Space engineering - Space environment
EN 16603-10-12	ECSS-E-ST-10-12	Space engineering - Methods for the calculation of radiation received and its effects, and a policy for design margins
TR 17603-10-12	ECSS-E-HB-10-12	Space engineering - Calculation of radiation and its effects and margin policy handbook
EN 16602-60	ECSS-Q-ST-60	Space product assurance - Electrical, electronic and electromechanical (EEE) components
EN 16602-60-02	ECSS-Q-ST-60-02	Space product assurance - ASIC and FPGA development
EN 16602-60-15	ECSS-Q-ST-60-15	Space product assurance - Radiation hardness assurance - EEE components
	ESCC 22900	ESCC Basic Specification: Total dose steady-state irradiation test method
	ESCC 25100	ESCC Basic Specification: Single event effects test method and guidelines
	JEDEC JESD57	Test Procedures for the Management of Single-Event Effects in Semiconductor Devices from Heavy Ion Irradiation
	JEDEC JESD89A	Measuring and Reporting of Alpha Particle and Terrestrial Cosmic Ray-Induced Soft Errors in Semiconductor Devices
	MIL-STD-883/ 1019	Test Method Standard Microcircuits / Ionizing radiation (total dose) test procedure