ICS 49.140 TECHNICKÁ NORMALIZAČNÁ INFORMÁCIA Máj 2022

TNI	Kozmická technika Príručka na posudzovanie najhoršieho prípadu nabíjania vo vesmíre	TNI CEN/TR 17603-20-06 31 0540

Space engineering - Assessment of space worst case charging handbook

Táto technická normalizačná informácia obsahuje anglickú verziu CEN/TR 17603-20-06:2022.
This Technical standard information includes the English version of CEN/TR 17603-20-06:2022.

Táto technická normalizačná informácia bola oznámená vo Vestníku ÚNMS SR č. 04/22

obsahuje
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134696

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 17603-20-06

January 2022

ICS 49.140

English version

Space engineering - Assessment of space worst case charging 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 FPGA

This Technical Report was approved by CEN on 29 November 2021. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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CEN-CENELEC Management Centre:
Rue de la Science 23, B-1040 Brussels

Ref. No. CEN/TR 17603-20-06:2022 E

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European Foreword

This document (CEN/TR 17603-20-06:2022) 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 16603-20.

This Technical report (CEN/TR 17603-20-06:2021) originates from ECSS-E-HB-20-06A.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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).

Introduction

Spacecraft charging occurs due to the deposition of charge on spacecraft surfaces or in internal materials due to charged particles from the environment. Resulting high voltages and high electric fields cause electrostatic discharges which are a hazard to many spacecraft systems. Broadly speaking, spacecraft charging can be divided into surface charging, which is caused by plasma particles with energy up to several 10s of keV and internal charging which is caused by trapped radiation electrons with energy around 0,2 MeV and above.

Both surface and internal charging have been associated with malfunctions and damage to spacecraft systems over many years.

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Scope

Common engineering practices involve the assessment, through computer simulation (with software like NASCAP 0 or SPIS 0), of the levels of absolute and differential potentials reached by space systems in flight. This is usually made mandatory by customers and by standards for the orbits most at risk such as GEO or MEO and long transfers to GEO by, for example, electric propulsion.

The ECSS-E-ST-20-06 standard requires the assessment of spacecraft charging but it is not appropriate in a standard to explain how such an assessment is performed. It is the role of this document ECSS-E-HB-20-06, to explain in more detail important aspects of the charging process and to give guidance on how to carry out charging assessment by computer simulation.

The ECSS-E-ST-10-04 standard specifies many aspects of the space environment, including the plasma and radiation characteristics corresponding to worst cases for surface and internal charging. In this document the use of these environment descriptions in worst case simulations is described.

The emphasis in this document is on high level charging in natural environments. One aspect that is currently not addressed is the use of active sources e.g. for electric propulsion or spacecraft potential control. The tools to address this are still being developed and this area can be addressed in a later edition.

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