SLOVENSKI STANDARD
SIST EN 16603-20-01:2020

01-december-2020

Nadomešča:
SIST EN 14777:2005

Vesoljska tehnika - Multipaction, zasnova in preskušanje

Space engineering - Multipaction, design and test

Raumfahrttechnik - Multipaction-Konzeption und -Test

Systèmes sol et opérations - Conception et test prenant en compte l'effet Multipactor

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ICS:

49.140	Vesoljski sistemi in operacije	Space systems and operations

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NORME EUROPÉENNE

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ICS 49.140

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English version

Space engineering - Multipactor, design and test

Ingénierie spatiale - Multipactor, conception et tests

Raumfahrttechnik - Multipaction, Konzeption und Test

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

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European Foreword

This document (EN 16603-20-01:2020) has been prepared by Technical Committee CEN-CENELEC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-20-01:2020) originates from ECSS-E-ST-20-01C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2021, and conflicting national standards shall be withdrawn at the latest by March 2021.

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

This document supersedes EN 14777:2004.

This document has been prepared under a standardization request 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 EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

In the context of increased RF power and equipment or component miniaturization, more and more attention shall be paid to multipactor which is critical for space missions based on satellite telecommunication or navigation payloads, or active microwave instruments for Earth Observation or Science. The multipactor phenomenon is an electron avalanche discharge occurring in high vacuum initiated by primary electrons inside a RF component in presence of a high local RF voltage or electric field.

In order to verify by analysis that a RF equipment or component is multipactor free, accurate EM modelling tools are required. These tools need more and more computation resources to cope with RF equipment or components with complex geometries, advanced manufacturing techniques, new materials and processes, and complex RF signals. The verification by test also requires some up-to-date test facilities, that provide high power amplification, electron seeding techniques, multiple and accurate detection methods, ability to generate complex signals, and the ability to reproduce the space representative environment conditions.

This standard is an update of previous version of ECSS-E-20-01A Rev.1, that includes the state-of-art of new verification approaches, and associated margins.

1 Scope

This standard defines the requirements and recommendations for the design and test of RF components and equipment to achieve acceptable performance with respect to multipactor-free operation in service in space. The standard includes:

- verification planning requirements,
- definition of a route to conform to the requirements,
- design and test margin requirements,
- design and test requirements, and
- informative annexes that provide guidelines on the design and test processes.

This standard is intended to result in the effective design and verification of the multipactor performance of the equipment and consequently in a high confidence in achieving successful product operation.

This standard covers multipactor events occurring in all classes of RF satellite components and equipment at all frequency bands of interest in high vacuum conditions (pressure lower than 10^{-5} hPa). Operation in single carrier CW and pulse modulated mode are included, as well as unmodulated multi-carrier operations. A detailed clause on secondary emission yield is also included.

This standard does not include breakdown processes caused by collisional processes, such as plasma formation.

This standard is applicable to all space missions.

This standard may be tailored for the specific characteristic and constrains of a space project in conformance with ECSS-S-ST-00.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revision of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the more recent editions of the normative documents indicated below. For undated references, the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00	ECSS-S-ST-00-01	ECSS – Glossary of terms
EN 16603-10-02	ECSS-E-ST-10-02	Space engineering –Verification
EN 16603-10-03	ECSS-E-ST-10-03	Space engineering - Testing
EN 16602-20	ECSS-Q-ST-20	Space product assurance – Quality assurance
EN 16602-20-08	ECSS-Q-ST-20-08	Space product assurance – Storage, handling and transportation of spacecraft hardware
EN 16602-70-01	ECSS-Q-ST-70-01	Space product assurance – Cleanliness and contamination control
EN 16602-70-02	ECSS-Q-ST-70-02	Space product assurance – Thermal vacuum outgassing test for the screening of space materials
	ESCC-20600	Preservation, packaging and despatch of ESCC component
	ISO 14644–1:2015	Cleanrooms and associated controlled environments – Part 1: Classification of air cleanliness by particle concentration

3
Terms, definitions and abbreviated terms

3.1 Terms and definitions from other standards

a. For the purpose of this standard, the terms and definitions from ECSS-S-ST-00-01 apply, in particular the following terms:

1. acceptance
2. assembly
3. bakeout
4. batch
5. component
6. development
7. equipment
8. integration
9. uncertainty
10. validation
11. verification

b. For the purpose of this standard, the terms and definitions from ECSS-E-ST-10-02 apply, in particular the following terms:

1. acceptance stage
2. analysis
3. inspection
4. model philosophy
5. qualification stage
6. review of design
7. test
8. verification level

c. For the purpose of this standard, the terms and definitions from ECSS-E-ST-10-03 apply, in particular the following terms:

1. acceptance margin
2. qualification margin

d. For the purpose of this standard, the terms and definitions from ECSS-Q-ST-70-02 apply, in particular the following terms:

1. outgassing

3.2 Terms and definitions specific to the present standard

3.2.1 analysis margin

required margin of the nominal power with respect to the theoretical threshold power resulting from a Multipactor analysis

3.2.2 assembly

process of mechanical mating of hardware after the manufacturing process

3.2.3 backscattered electron

incident electron that was re-emitted from the material surface with or without energy loss.

3.2.4 batch

group of equipment or component produced in a limited amount of time with the same manufacturing tools, that originates from the same manufacturing lot, and followed the same manufacturing processes

NOTE This definition is more specific than the one from the ECSS Glossary ECSS-S-ST-00-01.

3.2.5 batch acceptance margin

allowance of the power level above the nominal power over the specified equipment or component lifetime, excluding testing, to be applied to equipment or component of the same batch

3.2.6 critical gap

Vacuum region within a component or equipment, surrounded by surfaces of any material at which the discharge occurs at the lowest input power for a given frequency within the operating frequency band.

NOTE Critical gap does not correspond necessarily to the smallest gap.

3.2.7 discharge

<CONTEXT: multipactor testing> simultaneous response on two or more independent detection methods

NOTE The term "multipactor discharge" is synonymous.

3.2.8 event

<CONTEXT: multipactor testing> short time response on one detection method

3.2.9 ferromagnetic material

substances which have a large, positive susceptibility to an external magnetic field, exhibit a strong attraction to magnetic fields and are able to retain their magnetic properties after the external magnetic field has been removed.

3.2.10 gap voltage

voltage over the critical gap

3.2.11 heritage

status of verification based on previously verified reference component or equipment including all relevant parameters

NOTE The relevant parameters are listed in Table 4-1.

3.2.12 multicarrier average power

sum of the average power of each carrier

$$P_{avg} = \sum_{i=1}^{N} P_i$$

where:

P_i is the average power of each individual carrier

N is the number of carriers

3.2.13 minimum inflexion point

frequency times gap distance product, corresponding to multipactor order one, at which there is a change in the slope of the breakdown voltage curve and the breakdown voltage is minimized

NOTE Figure 3-1 is given as example. See for more information the Multipactor handbook ECSS-E-HB-20-01.

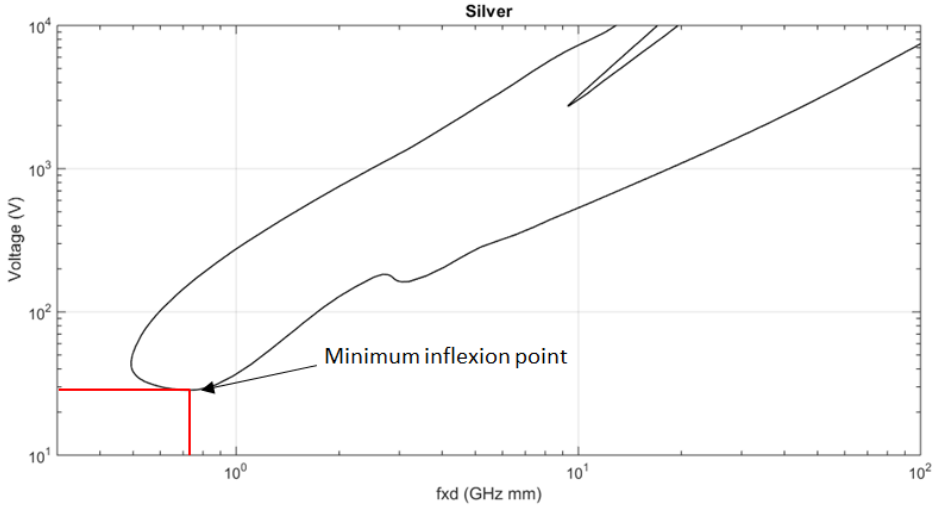

Figure 3-1: Minimum inflexion point for Silver multipactor chart.

3.2.14 multipactor discharge

see "**discharge**"

3.2.15 multipactor threshold

<CONTEXT: multipactor testing> lowest power level for which a multipactor discharge has occurred

3.2.16 multicarrier signal

<CONTEXT: multipactor testing> signal composed of a number of independent CW signals at different frequencies

3.2.17 qualification test

test performed on a single unit for establishing that a suitable margin exists in the design and built standard

NOTE Such suitable margin is the qualification margin.

3.2.18 RF boundary conditions

impedance matching conditions at all RF ports of the equipment or component

3.2.19 secondary electron emission yield (SEY)

see "**total secondary electron emission coefficient**"

3.2.20 total secondary electron emission coefficient

ratio of the number of all emitted electrons to the number of incident electrons of defined incident kinetic energy and angle, specific of a material surface under electron irradiation under high vacuum conditions

NOTE 1 The total secondary electron coefficient is the sum of the true secondary electron coefficient and the backscattered electron coefficient.

NOTE 2 The term "**secondary electron emission yield**" is synonymous.

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AC/DC	alternating current/direct current
BAT	batch acceptance test
BSE	back-scattered electron emission
CDR	Critical Design Review
CFRP	carbon-fibre-reinforced plastic
CW	continuous wave
DC	direct current