



Institut luxembourgeois de la normalisation
de l'accréditation, de la sécurité et qualité
des produits et services

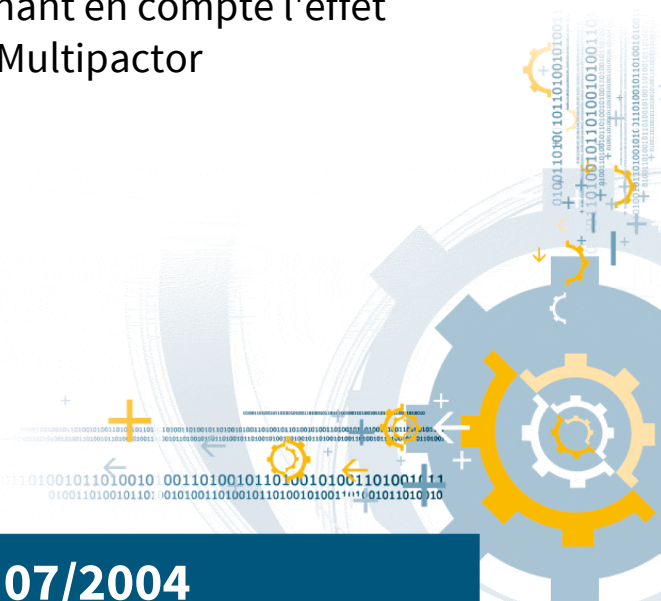
ILNAS-EN 14777:2004

**Space engineering - Multipaction
design and test**

Raumfahrttechnik - Multiplication
Konzeption und Test

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

07/2004



National Foreword

This European Standard EN 14777:2004 was adopted as Luxembourgish Standard ILNAS-EN 14777:2004.

Every interested party, which is member of an organization based in Luxembourg, can participate for FREE in the development of Luxembourgish (ILNAS), European (CEN, CENELEC) and International (ISO, IEC) standards:

- Participate in the design of standards
- Foresee future developments
- Participate in technical committee meetings

<https://portail-qualite.public.lu/fr/normes-normalisation/participer-normalisation.html>

THIS PUBLICATION IS COPYRIGHT PROTECTED

Nothing from this publication may be reproduced or utilized in any form or by any mean - electronic, mechanical, photocopying or any other data carries without prior permission!

EUROPEAN STANDARD ILNAS-EN 14777:2004 **EN 14777**
NORME EUROPÉENNE
EUROPÄISCHE NORM July 2004

ICS 49.140

English version

Space engineering - Multipaction design and test

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

Raumfahrttechnik (Engeneering) - Multipaction
Konzenption und Test

This European Standard was approved by CEN on 29 April 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

	page
Foreword.....	5
Introduction	6
1 Scope	7
2 Normative references	7
3 Terms, definitions and abbreviated terms	8
3.1 Terms and definitions	8
3.2 Abbreviated terms	10
4 Verification	10
4.1 Verification process	10
4.2 Verification levels	11
4.3 Verification plan	11
4.3.1 Introduction	11
4.3.2 Generation and updating	11
4.3.3 Description	11
4.4 Verification routes	12
4.5 Classification of component type	12
4.6 Single carrier	13
4.6.1 General.....	13
4.6.2 Margins	13
4.6.3 Route to demonstrate conformance.....	14
4.7 Multi-carrier	16
4.7.1 General.....	16
4.7.2 Threshold above equivalent CW peak power	16
4.7.3 Threshold below equivalent CW peak power	16
4.7.4 Route to demonstrate conformance.....	17
5 Design analyses.....	19
5.1 General.....	19
5.2 Field analysis	19
5.3 Critical region identification	19
5.4 Multipaction sensitivity analysis.....	20
5.5 Venting analysis.....	21
5.6 Inspection	21
6 Test conditions	21
6.1 Cleanliness	21
6.2 Pressure.....	21
6.3 Temperature	21
6.4 Frequencies	22
6.5 Pulse duration	22
6.5.1 General.....	22
6.5.2 CW units	22
6.5.3 Pulse units.....	23
6.6 Electron seeding	23
6.6.1 CW test.....	23
6.6.2 Pulsed test.....	23
6.6.3 Multi-carrier test.....	23
6.6.4 Seeding sources	23

7	Methods of detection	24
7.1	General	24
7.2	Detection methods	24
7.3	Detection method parameters.....	24
7.3.1	Sensitivity.....	24
7.3.2	Rise time.....	25
8	Test procedures.....	25
8.1	Test configurations	25
8.2	Test facility validation	25
8.3	Test execution	26
8.3.1	General	26
8.3.2	Test procedure.....	26
8.4	Acceptance criteria	27
8.4.1	General	27
8.4.2	Multi-carrier test	27
Annex A	(informative) Multipaction background	28
A.1	Physics of multipaction	28
A.2	Other physical processes.....	29
A.3	RF operating environment.....	29
A.4	Parallel plate multipaction	35
A.5	Coaxial line multipaction	40
Annex B	(informative) Component venting	43
B.1	Introduction.....	43
B.2	Discharge dependence on pressure	43
B.3	Test example.....	43
B.4	Venting dimensions	44
B.5	Venting hole calculations	44
B.6	Payload vacuum	44
B.7	Venting model used	44
B.8	Pumping conductance of a venting hole	45
B.9	Ultimate pressure	46
B.10	Venting experiment	48
B.11	Venting guidelines.....	48
Annex C	(normative) Cleaning, handling, storage and contamination.....	50
C.1	Generic processes	50
C.2	Cleaning, handling and storage.....	50
C.3	Contaminants.....	52
Annex D	(normative) Electron seeding	55
D.1	Introduction.....	55
D.2	CW test	55
D.3	Pulsed test	55
D.4	Multi-carrier test	55
D.5	Types of seeding source	57
Annex E	(informative) Test methods.....	58
E.1	Introduction.....	58
E.2	General test methods.....	58
E.3	Transient tests methods	62
E.4	Test facility validation	69
Bibliography		70

Figures

Figure 1 — Routes to conformance for single carrier.....	15
Figure 2 — Routes to conformance for multi-carrier case	18

Figure 3 — The susceptibility zone boundaries for aluminium, copper, silver, gold and alodine 1200.....	20
Figure A.1 — Total secondary electron emission as a function of energy of the incident electron.....	36
Figure A.2 — Multipaction susceptibility zones for parallel plates of aluminum	37
Figure A.3 — Multipaction thresholds for all materials studied, plotted in a single graph as labeled.....	42
Figure B.1 — The basic venting model.....	45
Figure E.1 — Generic close to carrier noise multipaction test site	59
Figure E.2 — Principal multipaction test set-up for nulling detection method	61
Figure E.3 — Test configuration (mode 1).....	63
Figure E.4 — Test configuration (mode 2).....	64
Figure E.5 — Detected envelope of a five carrier waveform	66
Figure E.6 — Charge probe	68

Tables

Table A.1 — Worst case mode order for susceptible gaps for gold	31
Table A.2 — Worst case mode order for susceptible gaps for silver	32
Table A.3 — Worst case mode order for susceptible gaps for aluminium	33
Table A.4 — Worst case mode order for susceptible gaps for alodine	34
Table A.5 — Worst case mode order for susceptible gaps for copper	35
Table A.6 — Constants for the most used materials	40
Table A.7 — Critical voltages for multipaction in 50 Ω coaxial lines.....	41
Table B.1 — Outgassing rate for space components used in space applications	46

Foreword

This document (EN 14777:2004) has been prepared by CEN.

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 January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

It is based on a previous version¹⁾ originally prepared by the ECSS E-20-01 Working Group, reviewed by the ECSS Engineering Panel and approved by the ECSS Steering Board. The European Cooperation for Space Standardization (ECSS) is a cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards.

This European Standard is one of the series of space standards intended to be applied together for the management, engineering and product assurance in space projects and applications.

Requirements in this European Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this European Standard takes into account the existing EN ISO 9000 family of documents.

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

¹⁾ ECSS-E-20-01

Introduction

Single carrier multipaction has well-established theoretical and testing procedures, and the heritage from proven components enables to define testing margin values as requirements for European space missions. Applying the single carrier margin to peak in-phase multi-carrier signals is recognized as excessively onerous in many cases, but the present understanding of multipaction for multicarrier signals is not well enough established for a reduced limit to be specified. For this reason, the margins for the multi-carrier case are stated as recommendations, with a view to their evolving to requirements in the longer term.

1 Scope

This document specifies the requirements and recommendations for the design and test of RF components and equipment to achieve acceptable performance with respect to multipaction-free operation in service in space. The document 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 document is intended to result in the effective design and verification of the multipaction performance of the equipment and consequently in a high confidence in achieving successful product operation.

This document covers multipaction events occurring in all classes of RF satellite components and equipment at all frequency bands of interest. Operation in single carrier CW and pulse modulated mode are included, as well as multi-carrier operations. This document does not include breakdown processes caused by collisional processes, such as plasma formation.

This document is applicable to all space missions.

When viewed in a specific project context, the requirements defined in this document should be tailored to match the genuine requirements of a particular profile and circumstances of a project.

NOTE Tailoring is a process by which individual requirements of specifications, standards and related documents are evaluated and made applicable to a specific project, by selection and in some exceptional cases, modification of existing or addition of new requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13701:2001, *Space systems — Glossary of terms*.

EN 14725, *Space engineering — Verification*.

EN ISO 14644-1, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness (ISO 14644-1:1999)*.

ESCC Basic Specification No. 24900, *Issue 1, October 2002, Minimum requirements for controlling environmental contamination of components*.

ESCC Basic Specification No. 20600, *Issue 1, February 2003, Preservation, packaging and despatch of ESCC electronic components*.