

# INTERNATIONAL STANDARD



**Process management for avionics – Atmospheric radiation effects –  
Part 1: Accommodation of atmospheric radiation effects via single event effects  
within avionics electronic equipment**

Document Preview

[IEC 62396-1:2016](#)

<https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016>



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2016 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [csc@iec.ch](mailto:csc@iec.ch).

[IEC 62396-1:2016](https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016)

<https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016>



IEC 62396-1

Edition 2.0 2016-01  
REDLINE VERSION

# INTERNATIONAL STANDARD



**Process management for avionics – Atmospheric radiation effects –  
Part 1: Accommodation of atmospheric radiation effects via single event effects  
within avionics electronic equipment**

Document Preview

[IEC 62396-1:2016](#)

<https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016>

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 03.100.50; 31.020; 49.060

ISBN 978-2-8322-3133-3

**Warning! Make sure that you obtained this publication from an authorized distributor.**

# CONTENTS

FOREWORD.....	6
INTRODUCTION.....	2
1 Scope.....	10
2 Normative references .....	10
3 Terms and definitions .....	11
4 Abbreviations and acronyms.....	17
5 Radiation environment of the atmosphere.....	22
5.1 Radiation generation.....	22
5.2 Effect of secondary particles on avionics .....	23
5.3 Atmospheric neutrons .....	23
5.3.1 General .....	23
5.3.2 <del>Energy spectrum of atmospheric neutrons</del> Atmospheric neutrons energy spectrum and SEE cross-sections.....	23
5.3.3 Altitude variation of atmospheric neutrons .....	26
5.3.4 Latitude variation of atmospheric neutrons.....	27
5.3.5 Thermal neutrons within aircraft.....	29
5.4 Secondary protons.....	29
5.5 Other particles .....	30
5.6 Solar enhancements .....	30
5.7 High altitudes greater than 60 000 ft (18 290 m) .....	31
6 Effects of atmospheric radiation on avionics .....	32
6.1 Types of radiation effects.....	32
6.2 Single event effects (SEEs) .....	32
6.2.1 General .....	32
6.2.2 Single event upset (SEU).....	33
6.2.3 Multiple bit upset (MBU) and multiple cell upset (MCU).....	33
6.2.4 Single effect transients (SETs) .....	35
6.2.5 Single event latch-up (SEL) .....	36
6.2.6 Single event functional interrupt (SEFI) .....	36
6.2.7 Single event burnout (SEB) .....	36
6.2.8 Single event gate rupture (SEGR).....	36
6.2.9 Single event induced hard error (SHE).....	37
6.2.10 SEE potential risks based on future technology .....	37
6.3 Total ionising dose (TID).....	38
6.4 Displacement damage.....	39
7 Guidance for system designs.....	39
7.1 Overview.....	39
7.2 System design .....	42
7.3 Hardware considerations.....	43
7.4 <del>Parts</del> Electronic devices characterisation and control.....	44
7.4.1 Rigour and discipline .....	44
7.4.2 Level A systems .....	44
7.4.3 Level B .....	44
7.4.4 Level C.....	45
7.4.5 Levels D and E .....	46

8	Determination of avionics single event effects rates.....	46
8.1	Main single event effects .....	46
8.2	Single event effects with lower event rates.....	46
8.2.1	Single event burnout (SEB) and single event gate rupture (SEGR) .....	46
8.2.2	Single event transient (SET) .....	47
8.2.3	Single event hard error (SHE).....	47
8.2.4	Single event latch-up (SEL) .....	47
8.3	Single event effects with higher event rates – Single event upset data.....	48
8.3.1	General .....	48
8.3.2	SEU cross-section .....	48
8.3.3	Proton and neutron beams for measuring SEU cross-sections .....	48
8.3.4	SEU per bit cross-section trends in SRAMs .....	53
8.3.5	SEU per bit cross-section trends and other SEE in DRAMs.....	54
8.4	Calculating SEE rates in avionics.....	56
8.5	Calculation of availability of full redundancy.....	57
8.5.1	General .....	57
8.5.2	SEU with mitigation and SET .....	57
8.5.3	Firm errors and faults .....	58
9	Considerations for SEE compliance .....	58
9.1	Compliance.....	58
9.2	Confirm the radiation environment for the avionics application .....	58
9.3	Identify the system development assurance level.....	58
9.4	Assess preliminary electronic equipment design for SEE .....	58
9.4.1	Identify SEE-sensitive electronic components .....	58
9.4.2	Quantify SEE rates .....	59
9.5	Verify that the system development assurance level requirements are met for SEE.....	59
9.5.1	Combine SEE rates for the entire system.....	59
9.5.2	Management of parts electronic components control and dependability .....	59
9.6	Corrective actions .....	59
	Annex A (informative) Thermal neutron assessment .....	60
	Annex B (informative) Methods of for calculating SEE rates in avionics electronics.....	61
B.1	Proposed in-the-loop system test – Irradiating avionics LRU in neutron/proton beam, with output fed into aircraft simulation computer .....	61
B.2	Irradiating avionics LRU in a neutron/proton beam .....	61
B.3	Utilising existing SEE data for specific parts electronic components on LRU.....	62
B.3.1	Neutron proton data.....	62
B.3.2	Heavy ion data .....	63
B.4	Applying generic SEE data to all parts electronic components on LRU.....	64
B.5	Component level laser simulation of single event effects.....	65
B.6	Determination of SEU rate from service monitoring .....	66
	Annex C (informative) Review of test facility availability.....	68
C.1	Facilities in the USA and Canada.....	68
C.1.1	Neutron facilities.....	68
C.1.2	Proton facilities.....	70
C.1.3	Laser facilities .....	72
C.2	Facilities in Europe .....	73
C.2.1	Neutron facilities.....	73
C.2.2	Proton facilities.....	75

C.2.3	Laser facilities .....	77
Annex D (informative)	Tabular description of variation of atmospheric neutron flux with altitude and latitude .....	78
Annex E (informative)	Consideration of effects at higher altitudes .....	80
Annex F (informative)	Prediction of SEE rates for ions .....	85
Annex G (informative)	Late news as of <del>2011</del> 2014 on SEE cross-sections applicable to the atmospheric neutron environment .....	88
G.1	SEE cross-sections key to SEE rate calculations .....	88
G.2	Limitations in compiling SEE cross-section data.....	88
G.3	Cross-section measurements (figures with data from public literature) .....	89
G.4	Conservative estimates of SEE cross-section data .....	89
G.4.1	General .....	89
G.4.2	Single event upset (SEU).....	90
G.4.3	Multiple cell upset (MCU).....	93
G.4.4	Single event functional interrupt (SEFI) .....	94
G.4.5	Single event latch-up (SEL) .....	95
G.4.6	Single event transient (SET) .....	97
G.4.7	Single event burnout (SEB) .....	98
Annex H (informative)	Calculating SEE rates from non-white (non-atmospheric like) neutron cross-sections for small geometry electronic components .....	100
H.1	Energy thresholds .....	100
H.2	Nominal neutron fluxes .....	100
H.3	Calculating event rates using non-atmospheric like cross-sections for small geometry electronic devices .....	101
Bibliography	.....	102
Figure 1	– Energy spectrum of atmospheric neutrons at 40 000 ft (12 160 m), latitude 45° .....	24
Figure 2	– Model of the atmospheric neutron flux variation with altitude (see Annex D).....	26
Figure 3	– Distribution of vertical rigidity cut-offs around the world.....	28
Figure 4	– Model of atmospheric neutron flux variation with latitude.....	28
Figure 5	– Energy spectrum of protons within the atmosphere .....	30
Figure 6	– System safety assessment process .....	40
Figure 7	– SEE in relation to system and LRU effect.....	42
Figure 8	– Variation of RAM SEU cross-section as function of neutron/proton energy .....	50
Figure 9	– Neutron and proton SEU bit cross-section data .....	52
Figure 10	– SEU cross-section in SRAMs as function of the manufacture date.....	54
Figure 11	– SEU cross-section in DRAMs as function of manufacture date .....	55
Figure E.1	– Integral linear energy transfer spectra in silicon at 100 000 ft (30 480 m) for cut-off rigidities ( $R$ ) from 0 GV to 17 GV .....	81
Figure E.2	– Integral linear energy transfer spectra in silicon at 75 000 ft (22 860 m) for cut-off rigidities ( $R$ ) from 0 to 17 GV .....	81
Figure E.3	– Integral linear energy transfer spectra in silicon at 55 000 ft (16 760 m) for cut-off rigidities ( $R$ ) from 0 GV to 17 GV .....	82
Figure E.4	– <del>The</del> Influence of solar modulation on integral linear energy transfer spectra in silicon at 150 000 ft (45 720 m) for cut-off rigidities ( $R$ ) of 0 GV and 8 GV.....	82
Figure E.5	– <del>The</del> Influence of solar modulation on integral linear energy transfer spectra in silicon at 55 000 ft (16 760 m) for cut-off rigidities ( $R$ ) of 0 GV and 8 GV.....	83

Figure E.6 – Calculated contributions from neutrons, protons and heavy ions to the SEU rates of the Hitachi-A 4 Mbit SRAM as a function of altitude at a cut-off rigidity ( $R$ ) of 0 GV .....	84
Figure E.7 – Calculated contributions from neutrons, protons and heavy ions to the SEU rates of the Hitachi-A 4 Mbit SRAM as a function of altitude at a cut-off rigidity ( $R$ ) of 8 GV .....	84
Figure F.1 – Example differential LET spectrum .....	86
Figure F.2 – Example integral chord length distribution for isotropic particle environment .....	86
Figure G.1 – Variation of the high energy neutron SEU cross-section per bit as a function of <b>electronic</b> device feature size for SRAMs and SRAM arrays in microprocessors and FPGAs .....	91
Figure G.2 – Variation of the high energy neutron SEU cross-section per bit as a function of <b>electronic</b> device feature size for DRAMs .....	92
Figure G.3 – Variation of the high energy neutron SEU cross-section per <b>electronic</b> device as a function of <b>electronic</b> device feature size for NOR and NAND type flash memories .....	93
Figure G.4 – Variation of the MCU/SBU percentage as a function of feature size based on data from many researchers in SRAMs [43, 45] .....	94
Figure G.5 – Variation of the high energy neutron SEFI cross-section in DRAMs as a function of <b>electronic</b> device feature size .....	95
Figure G.6 – Variation of the high energy neutron SEFI cross-section in microprocessors and FPGAs as a function of <b>electronic</b> device feature size .....	96
Figure G.7 – Variation of the high energy neutron single event latch-up (SEL) cross-section in CMOS devices (SRAMs, processors) as a function of <b>electronic</b> device feature size .....	97
Figure G.8 – Single event burnout (SEB) cross-section in power <b>electronic</b> devices (400 V to 1 200 V) as a function of drain-source voltage ( $V_{DS}$ ) .....	98
<a href="http://www.ecpi.com/standards/iec/62396-1-2016">http://www.ecpi.com/standards/iec/62396-1-2016</a>	
Table 1 – Nomenclature cross reference .....	41
Table B.1 – Sources of high energy proton or neutron SEU cross-section data .....	63
Table B.2 – Some models for the use of heavy ion SEE data to calculate proton SEE data .....	64
Table D.1 – Variation of 1 MeV to 10 MeV neutron flux in the atmosphere with altitude .....	78
Table D.2 – Variation of 1 MeV to 10 MeV neutron flux in the atmosphere with latitude .....	79
Table G.1 – Information relevant to neutron-induced SET .....	98
<b>Table H.1 – Approximate SEU energy thresholds for SRAM-based devices .....</b>	<b>100</b>
<b>Table H.2 – Neutron fluxes above different energy thresholds (40 000 ft, latitude 45°) .....</b>	<b>100</b>



## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PROCESS MANAGEMENT FOR AVIONICS –  
ATMOSPHERIC RADIATION EFFECTS –****Part 1: Accommodation of atmospheric radiation effects via  
single event effects within avionics electronic equipment**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**



International Standard IEC 62396-1 has been prepared by IEC technical committee 107: Process management for avionics.

This second edition cancels and replaces the first edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) removed, in Clause 7 related to system design, reference to level A Type I and Type II (system and references). As Clause 7 is now for guidance, "shall" statements have been changed to "should" and in 9.5.2 the requirement for electronic component management is clarified;
- b) all current definitions included in Clause 3 are those used within the IEC 62396 family of documents;
- c) incorporated in Annex G related to new technology or latest news reference to some new papers and issues which have appeared since 2011;
- d) solar flares and extreme space weather reference added in 5.6 to a proposed future Part 6;
- e) reference added in 7.1 to a proposed new Part 7 on incorporating atmospheric radiation effects analysis into the system design process;
- f) reference added in 6.2.10 d) to a proposed future Part 8 on other particles including protons, pions and muons;
- g) clarification on calculating event rates where cross-sections have been obtained with non-atmospheric radiation like neutron sources, addition of a new Annex H, and changes to 5.3 and 8.2.

The text of this standard is based on the following documents:

FDIS	Report on voting
107/271/FDIS	107/275/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62396 series, published under the general title *Process management for avionics – Atmospheric radiation effects*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

**iTeh Standards**  
**(<https://standards.iteh.ai>)**  
**Document Preview**

[IEC 62396-1:2016](#)

<https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016>

## INTRODUCTION

This industry-wide ~~technical specification~~ International Standard informs avionics systems designers, electronic equipment manufacturers, component manufacturers and their customers of the kind of ionising radiation environment that their devices will be subjected to in aircraft, the potential effects this radiation environment can have on those devices, and some general approaches for dealing with these effects.

The same atmospheric radiation (neutrons and protons) that is responsible for the radiation exposure that crew and passengers acquire while flying is also responsible for causing the single event effects (SEE) in the avionics electronic equipment. There has been much work carried out over the last few years related to the radiation exposure of aircraft passengers and crew. A standardised industry approach on the effect of the atmospheric neutrons on electronics should be viewed as consistent with, and an extension of, the on-going activities related to the radiation exposure of aircraft passengers and crew.

Atmospheric radiation effects are one factor that could contribute to equipment hard and soft fault rates. From a system safety perspective, using derived fault rate values, the existing methodology described in ARP4754A (accommodation of hard and soft fault rates in general) will also accommodate atmospheric radiation effect rates.

In addition, this International Standard refers to the JEDEC Standard JESD 89A, which relates to soft errors in electronics by atmospheric radiation at ground level (at altitudes less than 10 000 ft (3 040 m)).

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

[IEC 62396-1:2016](https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016)

<https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016>

## PROCESS MANAGEMENT FOR AVIONICS – ATMOSPHERIC RADIATION EFFECTS –

### Part 1: Accommodation of atmospheric radiation effects via single event effects within avionics electronic equipment

#### 1 Scope

This part of IEC 62396 is intended to provide guidance on atmospheric radiation effects on avionics electronics used in aircraft operating at altitudes up to 60 000 ft (18,3 km). It defines the radiation environment, the effects of that environment on electronics and provides design considerations for the accommodation of those effects within avionics systems.

This International Standard is intended to help ~~aerospace~~ avionics equipment manufacturers and designers to standardise their approach to single event effects in avionics by providing guidance, leading to a standard methodology.

Details of the radiation environment are provided together with identification of potential problems caused as a result of the atmospheric radiation received. Appropriate methods are given for quantifying single event effect (SEE) rates in electronic components. The overall system safety methodology should be expanded to accommodate the single event effects rates and to demonstrate the suitability of the electronics for the application at the component and system level.

#### 2 Normative references

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

~~IEC/TS 62239:2008, Process management for avionics – Preparation of an electronic components management plan~~

~~NOTE IEC TS 62239-1:2015, Process management for avionics – Management plan – Part 1: Preparation and maintenance of an electronic components management plan is under study and will supersede IEC/TS 62239.~~

~~IEC/TS 62396-2:2008 2012, Process management for avionics – Atmospheric radiation effects – Part 2: Guidelines for single event effects testing for avionics systems~~

~~IEC/TS 62396-3, Process management for avionics – Atmospheric radiation effects – Part 3: Optimising System design optimization to accommodate the single event effects (SEE) of atmospheric radiation~~

~~IEC/TS 62396-4:2008 2013, Process management for avionics – Atmospheric radiation effects – Part 4: Guidelines for designing with Design of high voltage aircraft electronics managing and potential single event effects~~

~~IEC/TS 62396-5, Process management for avionics – Atmospheric radiation effects – Part 5: Guidelines for assessing Assessment of thermal neutron fluxes and single event effects in avionics systems~~

### 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE Users of this international standard ~~may~~ can use alternative definitions consistent with convention within their companies.

#### 3.1

##### **aerospace recommended practice**

documents relating to avionics which are published by the Society of Automotive Engineers (SAE)

#### 3.2

##### **analogue single event transient**

##### **ASET**

spurious signal or voltage produced at the output of an analogue ~~device~~ component by the deposition of charge by a single particle

#### 3.3

##### **availability**

probability that a system is working at instant  $t$ , regardless of the number of times it may have previously failed and been repaired

Note 1 to entry: For equipment, **availability** is the fraction of time the equipment is functional divided by the total time the equipment is expected to be operational, i.e. the time the equipment is functional plus any repair time.

#### 3.4

##### **avionics equipment environment**

<aeronautical equipment> applicable environmental conditions (as described per the equipment specification) that the equipment is able to withstand without loss or degradation in equipment performance during all of its manufacturing cycle and maintenance life

<https://standards.iteh.ai/catalog/standards/iec/b92a9853-63be-411f-9401-50bae964aa22/iec-62396-1-2016>

Note 1 to entry: The length of the maintenance life is defined by the equipment manufacturer in conjunction with customers.

#### 3.5

##### **capable**

ability of a component to be used successfully in the intended application

#### 3.6

##### **certified**

~~assessment and compliance~~ assessed and compliant to an applicable ~~third party~~ standard, with maintenance of a certificate and registration ~~(i.e. JAN, IECQ)~~

#### 3.7

##### **characterisation**

process of testing a sample of components to determine the key electrical parameter values that can be expected of all produced components of the type tested

#### 3.8

##### **component application**

process that assures that the component meets the design requirements of the equipment in which it is used

#### 3.9

##### **component manufacturer**

organisation responsible for the component specification and its production

### 3.10 could not duplicate CND

reported outcome of diagnostic testing on a piece of equipment

Note 1 to entry: Following receipt of an error or fault message during operation, the error or fault condition could not be replicated during subsequent equipment testing (see IEC 62396-3).

### 3.11 critical charge

smallest charge that will cause an SEE if injected or deposited in the sensitive volume

Note 1 to entry: For many ~~devices~~ **electronic components**, the unit applied ~~was~~ **is** the pico coulomb (pC); however, for small geometry ~~devices~~ **components**, this parameter is measured in femto coulomb (fC).

### 3.12 cross-section

$\sigma$

<in proton and neutron interactions> combination of sensitive area and probability of an interaction depositing the critical charge for a SEE

Note 1 to entry: The cross-section may be calculated using the following formula:

$\sigma$  = number of errors/particle fluence

Note 2 to entry: The units for cross-section are cm<sup>2</sup> per ~~device~~ **electronic component** or per bit.

### 3.13 double error correction triple error detection DECTED

system or equipment methodology to test a digital word of information to determine if it has been corrupted, and if corrupted, to conditionally apply a correction

Note 1 to entry: This methodology can correct two-bit corruptions and can detect and report three-bit corruptions. (Used within IEC 62396-3.)

### 3.14 digital single event transient DSET

spurious digital signal or voltage, induced by the deposition of charge by a single particle that can propagate through the circuit path during one clock cycle

Note 1 to entry: See 6.2.4.

### 3.15 electron

elementary particle having a mass of approximately 1/1 840 atomic mass units, and a negative charge of  $1,602 \times 10^{-19}$  C

### 3.16 electronic components management plan ECMP

equipment manufacturer's document that defines the processes and practices for applying **electronic** components to an equipment or range of equipment

Note 1 to entry: Generally, it addresses all relevant aspects of the controlling components during system design, development, production, and post-production support.

### 3.17 electronic component

electrical or electronic device that is not subject to disassembly without destruction or impairment of design use