IEC 60068-2-21

Edition 7.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices

Essais d'environnement –
Partie 2-21: Essais – Essai U: Robustesse des sorties et des dispositifs de montage incorporés

IEC 60068-2-21:2021-07(en-fr)

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

Tel.: +41 22 919 02 11
info@iec.ch
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 corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
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 It also gives information on projects, replaced and withdrawn publications.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
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - 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: sales@iec.ch.

IEC online collection - oc.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC online collection - oc.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 60068-2-21

Edition 7.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices

Essais d'environnement –
Partie 2-21: Essais – Essai U: Robustesse des sorties et des dispositifs de montage incorporés

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 19.040; 31.190

ISBN 978-2-8322-9999-9

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices

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.

International Standard IEC 60068-2-21 has been prepared by IEC technical committee 91: Electronics assembly technology.

This seventh edition cancels and replaces the sixth edition, published in 2006, and IEC 60068-2-77:1999. This edition constitutes a technical revision.

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

a) integration of parts of IEC 60068-2-77 (see Annex X); IEC 60068-2-77 is withdrawn with the publication of this document;
b) Annex X is added to show the correlation of the clauses and subclauses in this edition of IEC 60068-2-21 with the clauses in IEC 60068-2-21:2006 and IEC 60068-2-77:1999.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
91/1732/FDIS	91/1742/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A complete list of all parts comprising the IEC 60068 series, under the general title *Environmental testing*, can be found on the IEC website.

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

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

ENVIRONMENTAL TESTING –

Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices

1 Scope

This part of IEC 60068 is applicable to all electrical and electronic components whose terminations or integral mounting devices are liable to be submitted to stresses during normal assembly or handling operations and is also applicable to surface mount devices (SMDs).

The recommended test methods suitable for specific terminations/lead of devices are shown in Table 1.

Table 1 – Selection of test methods suitable for specific terminations/leads

Test method		Component	Mounted/not mounted	See Clause
Test	Type			
Ua_1	Tensile	Leaded devices	Not mounted	Clause 4
Ua_2	Thrust	Leaded devices	Not mounted	Clause 4
Ub	Bending	Leaded devices	Not mounted	Clause 5
Uc	Torsion	Leaded devices	Not mounted	Clause 6
Ud	Torque	Threaded stud, screw or other terminations	Not mounted	Clause 7
Ue_1	Substrate bending	Surface mount devices	Mounted	Clause 8
Ue_2	Pull/push	Surface mount devices	Mounted	Clause 8
Ue_3	Shear	Surface mount devices	Mounted	Clause 8
Uf_1	Body strength	Surface mount devices	Not mounted	Clause 9
Uf_2	Impact shock	Surface mount devices	Not mounted	Clause 9

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-58:2015, *Environmental testing – Part 2-58: Tests – Test Td – Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60194-2, *Printed board design, manufacture and assembly – Vocabulary – Part 2: Common usage in electronic technologies as well as printed board and electronic assembly technologies*

IEC 61191-2, *Printed board assemblies – Part 2: Sectional specification – Requirements for surface mount soldered assemblies*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
integral mounting device
auxiliary means to make a mechanical connection of a terminal or other mounting element to the inside of the component and its case

Note 1 to entry: Such means can be a stud, a nut, a bolt, or similar mechanical parts for fixing.

4 Tests Ua: Robustness of terminals against axial stresses

4.1 Object

The purpose of these tests is to verify that the terminations and their attachments to the body of the component will withstand such axial stresses as are likely to be applied during normal assembly or handling operations.

4.2 Application

The relevant specification shall state whether this test is applicable. It shall be carried out on all the terminations, except where a component has more than three terminations, in which case the specification shall state the number of terminations per component to be tested. The test shall be carried out in such a manner that all the terminations of the component have an equal probability of being subjected to the test.

4.3 General description

With the terminal in its normal position and the component held by its body, a force is applied to the terminal as described in the test procedure.

4.4 Preconditioning

The method of preconditioning shall be as prescribed in the relevant specification.

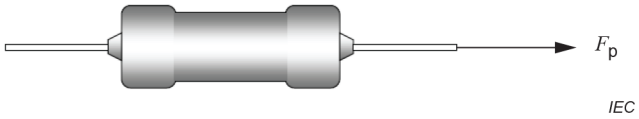
4.5 Initial measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

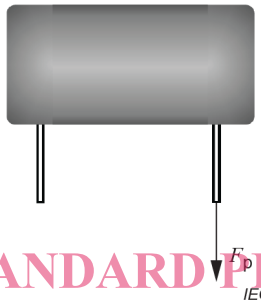
4.6 Test procedures

4.6.1 Test Ua_1: Tensile

With the termination in its normal position and the component held by its body, a force with a value as stated in Table 2 shall be applied to the termination in the direction of its axis and acting in a direction away from the body of the component. The force shall be applied gradually at a constant rate. The maximum force shall be reached within 5 s and maintained constant for (10 ± 1) s and the force shall be applied along an axis within 5° to the normal. Refer to Figure 1.



a) Pull force F_p applied to an axial leaded specimen



b) Pull force F_p applied to a radial leaded specimen

Figure 1 – Direction of the applied pull force F_p in test Ua_1

The value of the applied force is as follows:

a) Wire terminations (circular section or strip) or pins:

The value of the force applied shall be that indicated in Table 2.

Insulated wires shall be stripped of the insulation at the point at which the load is applied.

Stranded wires shall be united mechanically at the point of application of the load (such as by soldering or knotting), prior to the application of the load. Where the technical features of insulated or stranded wires can give rise to difficulties during the stripping, joining or knotting operations and be liable to cause dispute for the test results, such operations shall be in accordance with the relevant specification or, where necessary, with the instructions of the component manufacturer.

Table 2 – Value of applied pull force for test Ua_1

Nominal cross-sectional area (s)[a] mm^2	Corresponding diameter (d) for circular-section wires mm	Pull force F_p N
$s \leq 0{,}05$	$d \leq 0{,}25$	1
$0{,}05 < s \leq 0{,}10$	$0{,}25 < d \leq 0{,}35$	2,5
$0{,}10 < s \leq 0{,}20$	$0{,}35 < d \leq 0{,}50$	5
$0{,}20 < s \leq 0{,}50$	$0{,}50 < d \leq 0{,}80$	10
$0{,}50 < s \leq 1{,}20$	$0{,}80 < d \leq 1{,}25$	20
$s > 1{,}20$	$d > 1{,}25$	40

A relative tolerance of ±10 % shall apply to the prescribed pull force F_p.

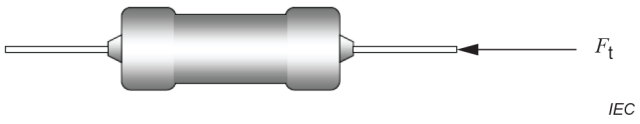
[a] For circular-section wires, strips or pins, the nominal cross-sectional area is equal to the value calculated from the nominal dimension(s) given in the relevant specification. For stranded wires, the nominal cross-sectional area is obtained by taking the sum of the cross-sectional areas of the individual strands of the conductor specified in the relevant specification.

b) Other terminations (tag terminations, threaded studs, screws, terminals, etc.):

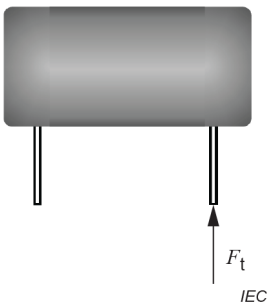
The value of the force to be applied shall be given in the relevant specification.

4.6.2 Test Ua_2: Thrust

With the termination in its normal position and the component held by its body, thrust shall be applied to the termination as close as possible to the body of the component, but leaving a clear 2 mm of wire between the body of the component and the nearest point of the device applying the force. The force shall be applied gradually at a constant rate. The maximum force shall be reached within 5 s and maintained constant for (10 ±1) s and the force shall be applied along an axis within 5° to the normal. Refer to Figure 2.



a) Thrust F_t applied to an axial leaded specimen



b) Thrust F_t applied to a radial leaded specimen

Figure 2 – Direction of the applied thrust F_t in test Ua_2

The value of the applied force is as follows:

a) Wire terminations (circular-section or strip) or pins

The value of the thrust applied shall be as given in Table 3.

Table 3 – Value of applied thrust for test Ua_2

Nominal cross-sectional area (s)[a] mm^2	Corresponding diameter (d) for circular-section wire mm	Thrust F_t N
$s \leq 0{,}05$	$d \leq 0{,}25$	0,25
$0{,}05 < s \leq 0{,}10$	$0{,}25 < d \leq 0{,}35$	0,5
$0{,}10 < s \leq 0{,}20$	$0{,}35 < d \leq 0{,}50$	1
$0{,}20 < s \leq 0{,}50$	$0{,}50 < d \leq 0{,}80$	2
$0{,}50 < s \leq 1{,}20$	$0{,}80 < d \leq 1{,}25$	4
$s > 1{,}20$	$d > 1{,}25$	8

A relative tolerance of ±10 % shall apply to the prescribed thrust F_t.

[a] For circular-section wires, strips or pins, the nominal cross-sectional area is equal to the value calculated from the nominal dimension(s) given in the relevant specification.

Insulated wires shall be stripped of the insulation at the point at which the load is applied.

Where the technical features of insulated wires can give rise to difficulties during the stripping, liable to cause dispute for the test results, such operations shall be in accordance with the relevant specification or, where necessary, with the instructions of the component manufacturer.

b) Other terminations (tag terminations, threaded studs, screws, terminals, etc.):

The value of the force to be applied shall be given in the relevant specification.

4.7 Final measurements

The specimen shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

4.8 Information to be given in the relevant specification

		Subclause
a)	Method of preconditioning	4.4
b)	Initial measurements	4.5
c)	Number of terminations to be tested, if more than three	4.2
d)	Force	4.6
e)	Details of stripping, joining or knotting operations, if necessary	4.6
f)	Final measurements	4.7

5 Tests Ub: Robustness of terminals against bending stresses

5.1 Object

The purpose of this test is to verify that pliable and rigid terminations and attachment of such terminations to the body of the component shall withstand such bending loads as are likely to be applied during normal assembly or handling operations.

5.2 Application

5.2.1 General

The relevant specification shall state the applicable test and the method to be used. If applicable, the test shall be carried out on all the terminations, except where a component has more than three terminations, in which case the specification shall state the number of terminations per component to be tested. The test shall be carried out in such a manner that all the terminations of the component have an equal probability of being subjected to testing. This limitation in the number of terminations tested does not apply to simultaneous bending (see 5.6.3), which is generally applicable to certain types of microelectronic packages with several terminations in line on one or more sides.

5.2.2 Pliable terminations

Terminations able to bend at least 30° with respect to its initial position (see Figure 3) under the applied force in accordance with Table 4:

Test Ub_1 (see 5.6.1) or Ub_3 (see 5.6.3) is applicable.

Key:

α_b displacement angle

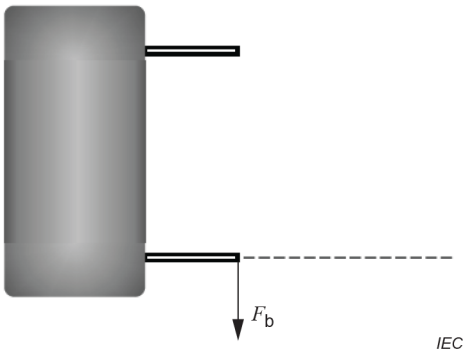
F_b bending force

Figure 3 – Displacement of pliable lead wires in test Ub

5.2.3 Rigid and all other terminations

For terminations other than described in 5.2.2, test Ub_2 (see 5.6.2) is applicable, except for rigid terminations.

For rigid terminations (e.g. pin type terminations), test Ub_1 (see 5.6.1.2) is applicable. Unless otherwise specified in the relevant specification, a constant force F_b, according to the type of termination given in Table 4 shall be applied to the termination as shown in Figure 4, causing a displacement of less than 30°.



Key:

F_b bending force

Figure 4 – Bending force applied to a specimen with non-pliable terminations

5.3 General description

As described in 5.2, in principle two procedures are applicable: bending with a constant force (see 5.2.3) or bending through a certain angle (see 5.2.2).

For each test procedure, three methods are applicable: one bend followed by a second bend in the opposite direction (Method 1; see 5.6.1.2), or two bends in the same direction (Method 2; see 5.6.1.3), or as specified (Method 3; see 5.6.1.4).

The value of the force to be applied is given in Table 4.

Table 4 – Value of applied force for test Ub

Section modulus (Z_x) mm^3	**Diameter(d) of corresponding round leads** mm	**Force F_b** N
$Z_x \leq 1{,}5 \times 10^{-3}$	$d \leq 0{,}25$	0,5
$1{,}5 \times 10^{-3} < Z_x \leq 4{,}2 \times 10^{-3}$	$0{,}25 < d \leq 0{,}35$	1,25
$4{,}2 \times 10^{-3} < Z_x \leq 1{,}2 \times 10^{-2}$	$0{,}35 < d \leq 0{,}50$	2,5
$1{,}2 \times 10^{-2} < Z_x \leq 0{,}5 \times 10^{-1}$	$0{,}50 < d \leq 0{,}80$	5
$0{,}5 \times 10^{-1} < Z_x \leq 1{,}9 \times 10^{-1}$	$0{,}80 < d \leq 1{,}25$	10
$1{,}9 \times 10^{-1} < Z_x$	$1{,}25 < d$	20
A relative tolerance of ±10 % shall apply to the prescribed force F_b.		

For round terminations, the section modulus Z_x is given by the following formula:

$$Z_x = \frac{\pi d^3}{32} \quad (1)$$

where

d is the lead wire diameter.