IEC 60068-2-21

Edition 6.0 2006-06

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 60068-2-21:2006

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: 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.

- Catalogue of IEC publications: www.iec.ch/searchpub

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

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

- Electropedia: www.electropedia.org

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

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC 60068-2-21

Edition 6.0 2006-06

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

PRICE CODE
CODE PRIX U

ICS 19.040; 31.190

ISBN 978-2-88912-734-4

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
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 sixth edition cancels and replaces the fifth edition, published in 1999, and constitutes a technical revision.

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

– Addition of torque severity for nominal thread diameter of 8 mm in Test Ud: torque in accordance with IEC 60252-2 (see table 5)

– Modification of substrate specification and mounting method describing lead-free solder in Test Ue (see Figure 5 and 8.3.3 et al.)

– Modification of test jig and test condition in Test Ue_1: substrate bending test (see Figure 7 et al.)
– Change of pushing force from 10 N to 5 N in Test Ue_3: shear test (see 8.5.3.2)

This bilingual version corresponds to the monolingual English version, published in 2006-06.

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

FDIS	Report on voting
91/582/FDIS	91/607/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.

The French version of this standard has not been voted upon.

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

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 publication will remain unchanged until the maintenance result date indicated on the IEC web site 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.

The contents of the corrigendum of January 2012 have been included in this copy.

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.

Table 1 provides details of the applicable tests.

Table 1 – Application

Test	Type	Component	Mounted/not mounted
Ua_1	Tensile	Leaded devices	Not mounted
Ua_2	Thrust	Leaded devices	Not mounted
Ub	Bending	Leaded devices	Not mounted
Uc	Torsion	Leaded devices	Not mounted
Ud	Torque	Threaded stud or screw termination	Not mounted
Ue_1	Bending	Surface mounted devices	Mounted
Ue_2	Pull/push	Surface mounted devices	Mounted
Ue_3	Shear	Surface mounted devices	Mounted

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.

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

IEC 60068-2-20:1979, *Environmental testing – Part 2: Tests – Test T: Soldering*
Amendment 2 (1987)

IEC 60068-2-58:2004, *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 60068-2-61:1991, *Environmental testing – Part 2: Tests – Test Z/ABDM: Climatic sequence*

IEC 61249-2-7:2002, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

IEC 61188-5 (all parts), *Printed boards and printed board assemblies – Design and use*

IEC 61190-1-2:2002, *Attachment materials for electronic assembly – Part 1-2: Requirements for soldering pastes for high quality interconnections in electronics assembly*

IEC 61191-2:1998, *Printed board assemblies – Part 2: Sectional specification – Requirements for surface mount soldered assemblies*

ISO 272:1982, *Fasteners – Hexagon products – Widths across flats*

ISO 9453:1990, *Soft solder alloys – Chemical compositions and forms*

3 Test Ua_1: tensile

This test is applicable to all types of terminations.

3.1 Object

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

3.2 General description

With the termination in its normal position and the component held by its body, a force is 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 progressively (without any shock) and then maintained for a period of 10 s ± 1 s.

3.3 Preconditioning

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

3.4 Initial measurements

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

3.5 Test method

Unless otherwise specified in the relevant specification, the test method shall be as follows:

Refer to Figure 2a.

3.5.1 Application

This test applies to all types of terminations. 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 test.

3.5.2 Procedure

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 progressively (without any shock) and then maintained for a period of 10 s ± 1 s.

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 may 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 force for test Ua_1

Nominal cross-sectional area (S)[a] mm^2	**Corresponding diameter (d) for circular-section wires** mm	**Force with tolerance of ±10 %** 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] 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.

3.6 Final measurements

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

3.7 Information to be given in the relevant specification

	Subclause
a) Method of preconditioning	3.3
b) Initial measurements	3.4
c) Number of terminations to be tested, if more than three	3.5.1
d) Force (for oversized and other terminations)	3.5.2
e) Details of stripping, joining or knotting operations, if necessary	3.5.2
f) Final measurements	3.6

4 Test Ua_2: thrust

4.1 Object

The purpose of this test is to verify that the terminations and attachment of the terminations to the body of the component will withstand such thrusts as are likely to be applied during normal assembly or handling operations. This test applies only to specimens of small dimensions and of low mass, to the exclusion of equipment and assemblies.

NOTE This test does not apply to flexible terminations. The tests for flexible terminations are given in a) and b) of 5.1.

4.2 General description

With the termination in its normal position and the component held by its body, thrust is 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 progressively (without any shock) and then maintained for a period of 10 s ± 1 s.

4.3 Preconditioning

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

4.4 Initial measurements

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

4.5 Test method

Refer to Figure 2b.

4.5.1 Application

The relevant specification shall state whether this test is applicable. When 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 test. The relevant specification shall define the direction of applied force.

4.5.2 Procedure

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 progressively (without any shock) and then maintained for a period of 10 s ± 1 s.

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 as given in Table 3.

Table 3 – Value of applied force for test Ua_2

Nominal cross-sectional area (S)[a] mm^2	Corresponding diameter (d) for circular-section wire mm	Force with tolerance of ±10 % 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] 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 may give rise to difficulties during the stripping, 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.

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 Final measurements

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

4.7 Information to be given in the relevant specification

	Subclause
a) Method of preconditioning	4.3
b) Initial measurements	4.4
c) Indication as to whether the test is applicable	4.5.1
d) Number of terminations to be tested, if more than three	4.5.1
e) Direction of applied force	4.5.1
f) Details of stripping, if necessary	4.5.2
g) Force, for other than wire terminations or pins	4.5.2
h) Final measurements	4.6

5 Test Ub: bending

This test is applicable to pliable terminations only.

5.1 Object

The purpose of this test is to verify that pliable 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. In order for the terminations to be considered pliable, the following conditions shall apply:

a) Test prescribed in 5.5.2.1 and 5.5.2.3

The termination shall assume, during the course of the test, a displacement of at least 30° with respect to its initial position (see Figure 3c).

b) Test prescribed in 5.5.2.2:

The termination shall be capable of being bent with the fingers.

5.2 General description

a) Bending (wire or strip terminations)

With the termination in its normal position and the component held by its body in such a manner that the axis of the termination is vertical, a mass is suspended from the end of termination. The body of the component is then inclined through an angle of approximately 90° in the vertical plane and then returned to its original position; this operation constitutes one bend.

Method 1: two or more bends in opposite directions.

Method 2: two or more bends in the same direction.

b) Bending (tag terminations)

Tag terminations, capable of being bent with the fingers, shall be bent through 45° and then returned to their initial position; this operation constitutes one bend.

Method 1: two bends in opposite directions.

Method 2: two bends in the same direction.

c) Simultaneous bending

All the terminations on one side of the component shall be held in a clamp at a point 3 mm from the seal between the termination and the body of the component. A mass shall be attached to the clamp with the terminations pointing downwards. The body of the component is then inclined through an angle of 45° and returned to its original position. This test shall be performed in two opposite directions.

5.3 Preconditioning

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

5.4 Initial measurements

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

5.5 Test method

Unless otherwise specified in the relevant specification, the test method shall be as follows:

5.5.1 Application

The relevant specification shall state whether this test is applicable. When 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 test. This limitation in the number of terminations tested does not apply to simultaneous bending (5.5.2.3), which is generally applicable to certain types of microelectronic packages with several terminations in line on one or more sides.

5.5.2 Procedure

Refer to Figure 3.

5.5.2.1 Bending (wire or strip terminations)

With the termination in its normal position and the component held by its body in such a manner that the axis of the termination is vertical, a mass applying a force of a value given in Table 4 is then suspended from the end of the termination. The body of the component is then inclined, over a period of 2 s to 3 s, through an angle of approximately 90° in the vertical plane and then returned to its original position over the same period of time; this operation constitutes one bend. The test shall be performed according to the relevant specification, stipulating one or other of the following procedures.

a) Method 1 (see Figure 3a)

One bend immediately followed by a second bend in the opposite direction, or a larger number of alternate bends where prescribed in the relevant specification.

b) Method 2 (see Figure 3b)

Two bends in the same direction without interruption, or a larger number of alternate bends where prescribed in the relevant specification. No device capable of imposing a radius of curvature shall be placed between the body of the component and the point of application of the force. Strip terminations shall be bent perpendicularly to the widest surface of the strip.

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 with tolerance of ±10 % 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

NOTE 1 For round terminations, the section modulus is given by the following formula:

$$Z_x = \frac{\pi d^3}{32}$$

where d is the lead diameter.

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

$$Z_x = \frac{ba^2}{6}$$

where

a is the thickness of the rectangular strip perpendicular to the bending axis;

b is the other dimension of the rectangular strip;

Z_x is the section modulus.

NOTE 2 The section modulus is defined in ISO 31-3, item 3-21, and the derivation of the above formula can be found in standard textbooks on mechanical engineering.

5.5.2.2 Bending (tag terminations)

Tag terminations, capable of being bent with the fingers, shall be bent through 45° and then returned to their initial position; this operation shall constitute one bend (see Figure 3). The test shall be performed according to the relevant specification, stipulating one or other of the following procedures:

a) Method 1

One bend immediately followed by a second bend in the opposite direction.

b) Method 2

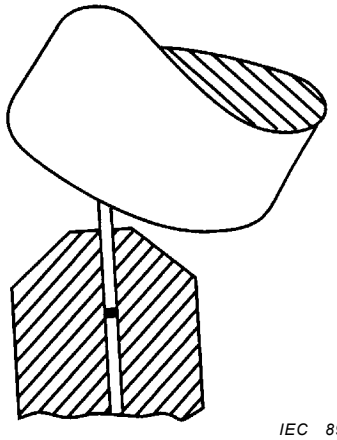
Two bends in the same direction, without interruption. The relevant specification may stipulate other details (such as use of pliers, place of bending, etc.).

5.5.2.3 Simultaneous bending

All terminations on one side of the component shall be clamped at the seating plane or, where it is not given, at a point approximately 3 mm from the seal between the termination and the body of the component, in a clamp with a radius of 0,1 mm at the edge where bending will occur. A mass shall be attached to the clamp with the terminations pointing downwards. This mass, which shall include the mass of the clamp, shall apply a force equal to that given in Table 4, multiplied by the number of leads clamped.

The body of the component is then inclined through an angle of 45°, taking 2 s to 3 s for the operation, and returned to its initial position over the same period of time. The test shall be performed once in one direction, and returned to the normal position, and once in the opposite direction, and again returned to the normal position (see Figure 3).

NOTE For the testing of short terminations, the clamp should be so designed that its upper surface will not touch the body of the component during the bending (which would cause a tensile stress on the terminations). See Figure 1 below:



IEC 894/01

Figure 1 – Clamp for the testing of short terminations

5.6 Final measurements

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