

# 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**



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# 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**

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## ENVIRONMENTAL TESTING –

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

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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- a) integration of parts of IEC 60068-2-77 (see Annex X); IEC 60068-2-77 is withdrawn with the publication of this document;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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/standardsdev/publications](http://www.iec.ch/standardsdev/publications).

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- amended.

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## 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 <sub>1</sub>	Tensile	Leaded devices	Not mounted	Clause 4
Ua <sub>2</sub>	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 <sub>1</sub>	Substrate bending	Surface mount devices	Mounted	Clause 8
Ue <sub>2</sub>	Pull/push	Surface mount devices	Mounted	Clause 8
Ue <sub>3</sub>	Shear	Surface mount devices	Mounted	Clause 8
Uf <sub>1</sub>	Body strength	Surface mount devices	Not mounted	Clause 9
Uf <sub>2</sub>	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.

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#### 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.

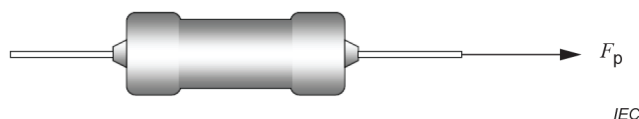
#### 4.5 Initial measurements

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

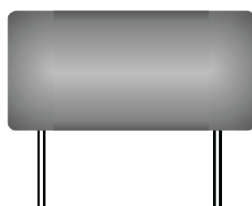
## 4.6 Test procedures

### 4.6.1 Test $U_{a1}$ : 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  $(10 \pm 1)$  s and the force shall be applied along an axis within  $5^\circ$  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  $U_{a1}$**

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<sub>1</sub>**

Nominal cross-sectional area (s) <sup>a</sup> mm <sup>2</sup>	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  $\pm 10$  % shall apply to the prescribed pull force  $F_p$ .

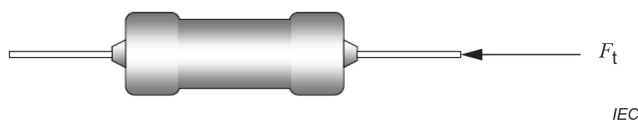
<sup>a</sup> For circular-section wires, strips or pins, the nominal cross-sectional area is equal to the value calculated from the nominal dimension(s) given in the relevant specification. For stranded wires, the nominal cross-sectional area is obtained by taking the sum of the cross-sectional areas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

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

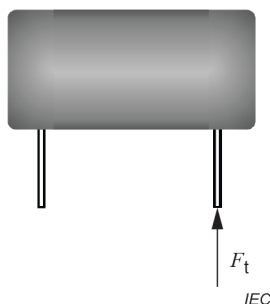
The value of the force to be applied shall be given in the relevant specification.

#### 4.6.2 Test Ua<sub>2</sub>: 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  $(10 \pm 1)$  s and the force shall be applied along an axis within  $5^\circ$  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<sub>2</sub>**

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<sub>2</sub>**

Nominal cross-sectional area (s) <sup>a</sup> mm <sup>2</sup>	Corresponding diameter (d) for circular-section wire mm	Thrust F <sub>t</sub> 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  $\pm 10$  % shall apply to the prescribed thrust F<sub>t</sub>.

<sup>a</sup> 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

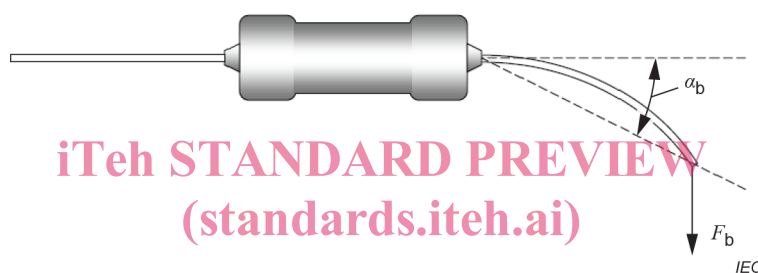
### 5.2.1 General

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  $30^\circ$  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:**

$\alpha_b$  displacement angle

$F_b$  bending force

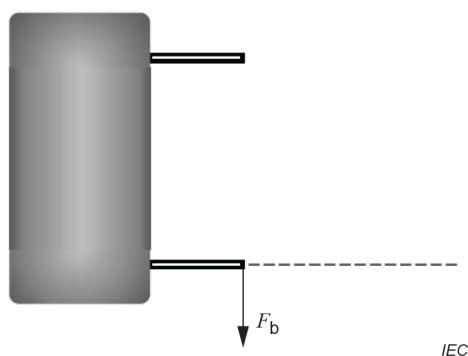
<https://standards.iteh.ai/catalog/standards/sist/5813bcc2-4562-4aca-a403-2a3d6a5bef6b/iec-60068-2-21-2021>  
 IEC 60068-2-21:2021

**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  $30^\circ$ .

**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 <sup>3</sup>	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  $\pm 10$  % 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.