IEC 60512-9-5

Edition 2.0 2020-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Connectors for electrical and electronic equipment – Tests and measurements – Part 9-5: Endurance tests – Test 9e: Current loading, cyclic

Connecteurs pour équipements électriques et électroniques – Essais et mesures – Partie 9-5: Essais d'endurance – Essai 9e: Charge en courant, essai cyclique

IEC 60512-9-5:2020-06(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 It also gives information on projects, replaced and withdrawn publications.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.

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 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 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.

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.

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.

Glossaire IEC - std.iec.ch/glossary
67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

IEC 60512-9-5

Edition 2.0 2020-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Connectors for electrical and electronic equipment – Tests and measurements – Part 9-5: Endurance tests – Test 9e: Current loading, cyclic

Connecteurs pour équipements électriques et électroniques – Essais et mesures – Partie 9-5: Essais d'endurance – Essai 9e: Charge en courant, essai cyclique

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 31.220.01

ISBN 978-2-8322-8414-8

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 9-5: Endurance tests – Test 9e: Current loading, cyclic

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 60512-9-5 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

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

- added method B and renamed the former test method as method A, to provide an alternative with more adjustable time "ON" and "OFF" for products with larger thermal mass;
- added introduction to provide background of this revision;

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

FDIS	Report on voting
48B/2803/FDIS	48B/2819/RVD

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

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

A list of all parts in the IEC 60512 series, published under the general title *Connectors for electrical and electronic equipment – Tests and measurements*, 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 "http://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.

INTRODUCTION

The object of this document is to detail a standard method for subjecting solderless connections to a thermal stress conditioning by cyclic current loading, in order to verify the right combination of conductor material, termination material and tool application – if any is required, in view of any possible creep phenomena that might lead to a reduction of performance of the solderless connection.

Although requiring electric power to apply the specified current loading, this test is an endurance test by thermal conditioning, whose aim is to submit specimens of connectors using solderless connections or of solderless connections to a repeated cycling between ambient temperature (normal laboratory conditions) and the upper limiting temperature (ULT) specified for the connector or solderless connection, either by the detail product specification or the manufacturer specification, or by the default values provided in the relevant part of IEC 60352 series.

The way the solderless connection under test acts is affected both by the solderless termination design and material and the attached conductor size and material, as well as by any tool applied to produce the connection, with all relevant settings and accessories as specified for the particular combination of termination and conductor.

Time “ON” represents the “heating” interval necessary to reach the ULT from ambient temperature, time “OFF” represents the “cooling” interval, necessary to cool down the specimen to ambient temperature. The sum of these intervals represents a cycle. Due to the various nature of a solderless connection in terms of size and thermal inertia of the termination and of the attached conductor, the traditional method with fixed duty cycle duration it is not always suitable.

For this reason, two methods are now provided to perform this test:

– method A is the traditional one, with time “ON” of 45 min and time “OFF” of 15 min, that has proven suitable for small-sized solderless connections, e.g. connections employing conductors with cross-sectional area less than or equal to 10 mm^2. However, even in such cases, depending on the thermal mass of the termination or the conductor (e.g. for a crimped connection), method B may be preferable;

– method B is with time “ON” or time “OFF” to be determined experimentally by the first test cycle. Moreover, heating time by current load may be even abbreviated by increasing and controlling the current load, whereas cooling may be accelerated too, by forced air cooling. Because the number of repeated cycles is the primary factor affecting the severity of this test, long duration times at ULT (highest temperature) and ambient temperature (lowest temperature) may not be necessary for the purpose of this test. This method is suitable for large-sized solderless connections, e.g. connections employing conductors with cross-sectional area larger than 10 mm^2.

CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – TESTS AND MEASUREMENTS –

Part 9-5: Endurance tests – Test 9e: Current loading, cyclic

1 Scope

This part of IEC 60512, when required by the detail product specification, is used for testing connectors or solderless connections within the scope of technical committee 48. It may also be used for similar devices when specified in a detail product specification.

The object of this document is to detail a standard method for subjecting solderless connections to thermal stress conditioning by cyclic current loading.

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 60352 (all parts), *Solderless connections*

IEC 60512-1:2018, *Connectors for electrical and electronic equipment – Tests and measurements – Part 1: Generic specification*

IEC 60512-1-1, *Connectors for electronic equipment – Tests and measurements – Part 1-1: General examination – Test 1a: Visual examination*

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60512-2-2, *Connectors for electronic equipment – Tests and measurements – Part 2-2: Electrical continuity and contact resistance tests – Test 2b: Contact resistance – Specified test current method*

IEC 60512-2-6, *Connectors for electronic equipment – Tests and measurements – Part 2-6: Electrical continuity and contact resistance tests – Test 2f: Housing (shell) electrical continuity*

IEC 60512-3-1, *Connectors for electronic equipment – Tests and measurements – Part 3-1: Insulation tests – Test 3a: Insulation resistance*

IEC 60512-4-1, *Connectors for electronic equipment – Tests and measurements – Part 4-1: Voltage stress tests – Test 4a: Voltage proof*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60512-1 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

4 Preparations

4.1 Test equipment

For the performance of this thermal conditioning, a suitable current source generator is required. Test may be performed either in AC or DC current. The output voltage of the power source shall be suitable to cover the voltage drop all along the test circuit, which may foresee daisy chained specimens (see 4.2 and 4.3).

Other instruments required are a voltmeter to measure voltage drop and a micro-ohm meter to measure resistance across the solderless connection under test.

Further test instruments are those specified in the relevant test methods called up in the following clauses.

4.2 Preparation of specimens

A specimen shall consist of a solderless connection made with the relevant termination and the appropriate conductor as specified in the detail product specification.

Type and number of specimens shall be specified in the detail product specification. In case of multiple specimens, these may be wired in series, provided that each specimen does not thermally influence the subsequent one. Therefore, the length of the connecting conductors shall be chosen long enough to avoid mutual influence (the temperature at the opposite end of a heated specimen should be ambient temperature).

4.3 Mounting of specimens

Mounting and electrical connections in the test circuit shall be as specified in the detail product specification, e.g. connection of several specimens in series.

For solderless connections used in connectors, in case of multiple specimens specified, the specimens shall be mounted inside one or more relevant connector mating pairs.

5 Test/measuring methods

5.1 Pre-conditioning

Before starting the initial measurements, the specimens shall be pre-conditioned under standard atmospheric conditions for testing as specified in IEC 60512-1 for a period of 24 h, unless otherwise specified in the detail product specification.

5.2 Initial measurements

Before test is started, initial measurements (e.g. initial contact resistance or initial voltage drop) as specified in the detail product specification shall be done in accordance with the relevant part of IEC 60512.

5.3 Test

5.3.1 General

Two methods are available:

– method A is the traditional one, fixing the time “ON” and time “OFF” of the cyclic current loading;
– method B is a variant of method A that identifies experimentally the time “ON” and “OFF” of the cyclic current loading during the first cycle of test, and allows forced heating and cooling, in order to reduce time, when a high number of cycles is specified, e.g. by increasing the applied current and then regulating it, and by using forced air cooling.

Method A is suitable for small-sized solderless connections, e.g. connections employing conductors with cross-sectional area lower than or equal to 10 mm^2. However, even in such cases, depending on the thermal mass of the termination (e.g. crimp contact), method B may be preferable.

Method B is suitable for large-sized solderless connections, e.g. connections employing conductors with cross-sectional area larger than 10 mm^2.

5.3.2 Method A

This method is particularly suitable for relatively small solderless connections. When the involved dimensions of both the solderless termination and the attached conductor, their mass, and the implied thermal mass are likely to determine longer heating and cooling periods, method B is preferable.

The test shall be carried out in still air.

The ambient temperature shall be recorded during the test. Care shall be taken to minimize radiant heat effects.

The specimen shall be loaded with current as specified in the detail product specification. The purpose of this current load is to increase the temperature of the specimens up to the ULT specified in the detail product specification or, in lack of it, the default ULT specified in the relevant part of IEC 60352.

Current loading shall be “ON” for 45 min and “OFF” for 15 min. This shall be considered to be one cycle. Preferred number of cycles are 20, 100 and 500, unless otherwise specified in the detail product specification.

Material combinations which have proven their reliable performance in many years of application in multiple application-specific working conditions, do not require a high number of cycles specified. Material combinations that are new or different from those referred to as preferred choice in the relevant part of IEC 60352 shall require a high number of cycles to gain validation.

5.3.3 Method B

This method is particularly suitable for large-sized solderless connections, i.e. employing cross-sectional area conductors larger than 10 mm^2. This method can however be used also for smaller sized solderless connections.

The heating period and cooling period are not of specified duration. Their duration shall be established experimentally at the first cycle.

The current to apply for heating shall be such that the solderless connection reaches at regime (steady-state) the upper limiting temperature (ULT) specified by the detail product

specification or by the relevant part of IEC 60352 (e.g. by default for crimped connection ULT = 125 °C).

The ambient temperature shall be recorded during the test.

When this test is applied on solderless connections to be used in connectors, this current is provided by the derating diagram of the connector, for the specified conductor cross-sectional area, where the solderless connection under test is used.

In such cases the specimens shall be arranged in the relevant connector mated pair(s) in a condition representative of their actual use.

All points of a derating curve represent combinations of current (derated by a factor 0,8 unless otherwise specified on the derating curve) and ambient temperature for which the connection's hot spot reaches the ULT.

It is allowed to shorten the heating and cooling periods of a cycle, in order to minimize overall test duration, e.g. by applying a current higher than that identified above and then regulating it during the heating period, and by using forced air cooling during the cooling period.

The regime (steady state) condition, both at the end of the heating and of the cooling periods, is reached when thermal stability is achieved. This is defined as when the temperature variation does not exceed 2 °C in 10 min (due to the amplitude of the temperature cycling, a more stringent accuracy in defining the steady state condition is not required).

The preferred numbers of cycles are 20, 100 and 500 unless otherwise specified in the detail product specification.

Material combinations that have proven their reliable performance in many years of application in multiple application-specific working conditions do not require a high number of cycles specified. Material combinations that are new or different from those referred to as preferred choice in the relevant part of the IEC 60352 series shall require a high number of cycles to gain validation.

5.4 Recovery

After this cyclic test and before carrying out any subsequent measurement, the specimen shall be allowed to recover at standard conditions for testing as specified in 6.1 of IEC 60512-1:2018 for a period of 1 h minimum.

5.5 Final measurements

a) Contact resistance (IEC 60512-2-1, test 2a). This test may be replaced by a voltage drop measurement (IEC 60512-2-2, test 2b), particularly suitable for large sized solderless connections. This is the first and most important failure criterion to fix in the detail product specification (or in the relevant part of IEC 60352).

b) Housing (shell) electrical continuity (IEC 60512-2-6, test 2f), where applicable.

c) Insulation resistance (IEC 60512-3-1, test 3a), if applicable (solderless connections that do not have pre-insulated cover and that are tested outside of the connector body, do not require this test).

d) Voltage proof (IEC 60512-4-1, test 4a), if applicable (solderless connections that do not have pre-insulated cover and that are tested outside of the connector body, do not require this test).

e) Visual examination (IEC 60512-1-1, test 1a).

f) Operational tests (if applicable, the detail product specification may e.g. require a sealing test from the IEC 60512-14 series, or an ingress protection test according IEC 60529).