

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Solderless connections –
Part 2: Crimped connections – General requirements, test methods and practical
guidance**

**Connexions sans soudure –
Partie 2: Connexions serties – Exigences générales, méthodes d'essai et guide
pratique**



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SOLDERLESS CONNECTIONS –**Part 2: Crimped connections –
General requirements, test methods and practical guidance**

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This third edition cancels and replaces the second edition published in 2006 and Amendment 1:2013. This edition constitutes a technical revision.

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

- a) the former Clauses 6 through 15 have been moved into a new informative Annex A titled "Practical guidance";

- b) several definitions have been added (conductor, wire, cable, crimping, crimped connection, crimp contact, terminal, terminal end, pre-insulated terminal end, termination, connecting device, splice, insulation support, insulation grip, pre-insulated crimped connection, crimping tool, locator, positioner, full cycle crimp mechanism, crimp anvil, crimp nest, crimp indenter, crimp height, crimp inspection hole, crimp barrel wire range, nominal cross-sectional area, geometric (actual) cross-sectional area, stranded conductor, crimp funnel, crimp depth, manufacturer, user, process indicator (PID));
- c) a three-level classification by end-product class has been introduced in Clause 4 Workmanship, based on the expected level of reliability of the end-use application for which the crimped connections under subject are suitable, similar to what was done in 4.3 of IEC 61191-1:2018 for soldered electrical and electronic assemblies;
- d) for better clarification, former subclause 4.5 Crimped connections, now renumbered and renamed 5.5 Prerequisites for crimped connections, has been split in several third level subclauses with assigned title;
- e) allowable strand damage has been introduced with reference to the classification in three levels by end-use application, for the production of test specimens;
- f) based on industry experience, in 5.3.1 the minimum copper content of a copper alloy suitable for making crimp barrels has been lowered to 57 % from original 60 %;
- g) the elongation at break of annealed copper suitable for conductors to be crimped has been increased to 15 % from original 10 %;
- h) the cross-sectional area of conductors for testing purposes is allowed to be the nominal (commercial) one, instead of the geometric (actual) one for wires with nominal cross-sectional area larger than 2,5 mm² (see 5.4.3), the geometric (actual) one being the reference in case of dispute on test results;
- i) consideration about wire insulation concentricity has been added in 5.4.5;
- j) former subclause 5.2.1 General examination is now renumbered and renamed as 7.1 General examination of crimp barrels and wires (examination of parts as called later) and a new subclause 7.2 Examination of crimp dimensions has been added, to cover examination of dimensions after crimping, with several new third-level subclauses: 7.2.1 Crimp height C_h , crimp width C_w and measurable crimp width C_{wm} , 7.2.2 Contact deformation after crimping, 7.2.3 Visual examination of insulation distance and conductor overhang, 7.2.4 Visual examination of splice crimped connections, 7.2.5 Visual examination of crimped connections on closed (machined) crimp barrels, 7.2.6 Visual examination of crimped connections on B-crimp open crimp barrels, 7.2.7 Visual examination of crimped connections with open crimp barrel with insulation grip;
- k) the pull-out force (tensile strength) requirements covering safety requirements of crimped connections in IEC 60352-2:2006, Table 1 have been kept, here renumbered Table 5; interpolated values for most used cross-sectional areas 0,34 mm² and 0,37 mm² have been added. Reference to IEC 61210 as source for these safety values has been removed, as partially inaccurate. Optional specification of higher pull-out force requirements, based on classification by end-use product as specified in 5.1, and more representative of what can be achieved based on the type of crimp barrel, the form of the crimping, the material and plating of barrel and wire, has been introduced in A.7.3;
- l) a microsection test (optional) has been added in 7.3.2;
- m) a vibration test (optional) has been added in 7.3.7;
- n) a current-carrying capacity test (optional) has been added in 7.4.3;
- o) an alternative current loading, cyclic test method has been added in 7.5.5;
- p) a flowing mixed gas corrosion test (optional) has been added in 7.6.2;
- q) crimping at low temperature (former subclause 5.4.2.5) has been completed in 7.5.6 by re-entering the test method already present in IEC 60352-2:1990, 11.4.5;
- r) types of test specimens have been expanded: a new type A specimen is added, type B is former type A, type C is former type B, type D is former type C, type E is former type D modified with addition of reference wires, type F is former type E, and new specimen types G and H were added to perform tests on splices;

s) normative references, as well as Bibliography, have been updated and expanded as required;

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

Draft	Report on voting
48B/3110/FDIS	48B/3128/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/publications.

A list of all parts in the IEC 60352 series, published under the general title *Solderless connections*, 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, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

INTRODUCTION

This document includes requirements and relevant tests as well as practical guidance in Annex A for crimped connections.

Two test schedules are provided:

- the basic test schedule which applies to solderless crimped connections which conform to all of the prerequisites of Clause 5. It is derived from experience with successful applications of such connections;
- the full test schedule which applies to solderless crimped connections which do not fully conform to all prerequisites of Clause 5, for example which are made with solid wires, using materials or finishes not included in Clause 4.

This philosophy permits cost- and time-effective performance verification using a limited basic test schedule for established crimped connections and an expanded full test schedule for connections requiring more extensive performance validation.

A detail product specification or the manufacturer's specification for crimped connections or associated cable assemblies or both, as well as for crimp contacts, terminal ends or splices, can include additional tests to verify enhanced performance or conformance with specified product classes or both. It can also reference this document with test severities and acceptance criteria other than those provided by either one of the two test schedules, as well as foresee an intermediate test schedule. The requirements of the detail product specification or the manufacturer's specification prevail.

The suitability of the crimped connection implies that the specified requirements and tests apply to all factors involved in producing a suitable crimped connection, namely:

- the crimp barrel, which can be part of a splice, a terminal end or a crimp contact, the contact deemed to be used in a single-pole or multipole connector;
- the wire (or range of wires) for which the termination is suitable;
- the tools required to produce that type of solderless connection.

The practical guidance in Annex A serves as a guideline for the required workmanship. Attention is drawn to the fact that some industries (e.g. automotive, aerospace, nuclear, military) can have specific workmanship standards or quality requirements, or both, which are outside the scope of this document.

IEC Guide 109 advocates the need to minimize the impact of a product on the natural environment throughout the product life cycle.

It is understood that some of the materials permitted in this document can have a negative environmental impact.

As technological advances lead to acceptable alternatives for these materials, they will be eliminated from future editions of this document.

SOLDERLESS CONNECTIONS –

Part 2: Crimped connections – General requirements, test methods and practical guidance

1 Scope

This part of IEC 60352 is applicable to solderless crimped connections made with:

- appropriately designed uninsulated or pre-insulated crimp barrels as parts of crimp contacts, terminal ends or splices, and
- stranded wires of 0,05 mm² to 10 mm² cross-section or
- solid wires of 0,25 mm to 3,6 mm diameter;

for use in electrical and electronic equipment.

Information on the materials and data from industrial experience is included in addition to the test procedures to provide electrically stable connections under prescribed environmental conditions.

This part of IEC 60352 is not applicable to crimping of coaxial cables.

This part of IEC 60352 determines the suitability of solderless crimped connections as described above, under specified mechanical, electrical and atmospheric conditions and provides a means of comparing test results when the tools used to make the connections are of different designs or manufacture.

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 60050-581, *International Electrotechnical Vocabulary (IEV) – Part 581: Electromechanical components for electronic equipment*

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

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-60, *Environmental testing – Part 2-60: Tests – Test Ke: Flowing mixed gas corrosion test*

IEC 60228, *Conductors of insulated cables*

IEC 60512-1, *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 60512-1-2, *Connectors for electronic equipment – Tests and measurements – Part 1-2: General examination – Test 1b: Examination of dimension and mass*

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 60512-2-5, *Connectors for electronic equipment – Tests and measurements – Part 2-5: Electrical continuity and contact resistance tests – Test 2e: Contact disturbance*

IEC 60512-4-3, *Connectors for electronic equipment – Tests and measurements – Part 4-3: Voltage stress tests – Test 4c: Voltage proof of pre-insulated crimp barrels*

IEC 60512-5-2, *Connectors for electronic equipment – Tests and measurements – Part 5-2: Current-carrying capacity tests – Test 5b: Current-temperature derating*

IEC 60512-6-4, *Connectors for electronic equipment – Tests and measurements – Part 6-4: Dynamic stress tests – Test 6d: Vibration (sinusoidal)*

IEC 60512-9-5, *Connectors for electrical and electronic equipment – Tests and measurements – Part 9-5: Endurance tests – Test 9e: Current loading, cyclic*

IEC 60512-11-1, *Connectors for electrical and electronic equipment – Tests and measurements – Part 11-1: Climatic tests – Test 11a – Climatic sequence*

IEC 60512-11-4, *Connectors for electronic equipment – Tests and measurements – Part 11-4: Climatic tests – Test 11d: Rapid change of temperature*

IEC 60512-11-7, *Connectors for electronic equipment – Tests and measurements – Part 11-7: Climatic tests – Test 11g: Flowing mixed gas corrosion test*

IEC 60512-11-9, *Connectors for electronic equipment – Tests and measurements – Part 11-9: Climatic tests – Test 11i: Dry heat*

IEC 60512-11-10, *Connectors for electronic equipment – Tests and measurements – Part 11-10: Climatic tests – Test 11j: Cold*

IEC 60512-11-12, *Connectors for electronic equipment – Tests and measurements – Part 11-12: Climatic tests – Test 11m: Damp heat, cyclic*

IEC 60512-16-4, *Connectors for electronic equipment – Tests and measurements – Part 16-4: Mechanical tests on contacts and terminations – Test 16d: Tensile strength (crimped connections)*

IEC 60512-16-7, *Connectors for electronic equipment – Tests and measurements – Part 16-7: Mechanical tests on contacts and terminations – Test 16g: Measurement of contact deformation after crimping*

IEC 60512-16-8, *Connectors for electronic equipment – Tests and measurements – Part 16-8: Mechanical tests on connections and terminations – Test 16h: Insulating grip effectiveness (crimped connections)*

IEC 60512-19-1, *Connectors for electronic equipment – Tests and measurements – Part 19-1: Chemical resistance tests – Test 19a: Fluid resistance of pre-insulated crimp barrels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-581, IEC 60512-1 and the following apply.

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

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

3.1

conductor

part of the cable or wire intended to carry electric current

Note 1 to entry: The conductor may be

- a) solid – made of a single strand of circular cross-section;
- b) stranded – made of several strands of circular cross-section assembled either by laying up concentrically or by bunching, and without insulation between them.

[SOURCE: IEC 60189-1:2018, 3.1]

3.2

wire

insulated conductor or assembly of several insulated conductors, laid up together and which may be provided with a screen

Note 1 to entry: The wire may be

- a) single – consists of a single insulated conductor;
- b) multiple – consists of several insulated conductors.

[SOURCE: IEC 60189-1:2018, 3.2, modified – In the term, "low frequency" has been deleted. Note 2 to entry has been deleted.]

3.3

cable

assembly of one or more conductors, with a protective covering and possibly filling, insulating and protective material

[SOURCE: IEC 60050-151:2001, 151-12-38, modified – In the definition, "and/or optical fibres" has been deleted.]

3.4

crimping

method of permanently attaching a termination to a conductor by pressure deformation or by reshaping a crimp barrel around the conductor to establish good electrical and mechanical connection

[SOURCE: IEC 60050-581:2008, 581-23-10, modified – In the definition, "the barrel" has been replaced with "a crimp barrel".]