

Solderless connections —

Part 2: Solderless crimped connections — General requirements, test methods and practical guidance

The European Standard EN 60352-2:1994, with the incorporation of amendments A1:1997 and A2:2002, has the status of a British Standard

ICS 29.120.20

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee EPL/48, Electromechanical components for electronic equipment, to Subcommittee EPL/48/2, Connectors for electronic equipment, upon which the following bodies were represented:

- Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
- British Telecommunications plc
- BSI Quality Assurance
- Federation of the Electronics Industry
- Ministry of Defence
- Premises Cabling Association

This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 April 1997

© BSI 16 August 2002

The following BSI references relate to the work on this standard:
Committee reference EPL/48/2
Announced in
BSI Update March 1997

ISBN 0 580 27354 7

Amendments issued since publication

Amd. No.	Date	Comments
13812	16 August 2002	See national foreword

Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Foreword	2
Text of EN 60352-2	3

National foreword

This Part of BS EN 60352 has been prepared by Subcommittee EPL/48/2, and is the English language version of EN 60352-2:1994, *Solderless connections — Part 2: Solderless crimped connections — General requirements, test methods and practical guidance*, including amendment A1:1997 and amendment A2:2002, published by the European Committee for Electrotechnical Standardization (CENELEC). It is identical with IEC 60352-2:1990, including amendment 1:1996 and amendment 2:2002, published by the International Electrotechnical Commission (IEC). It supersedes BS 6516-2:1990, which will be withdrawn 1997-09-01.

Amendment A1:1997 was incorporated within the text at the time of publication of this British Standard.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to IEC text carry the number of the IEC amendment. For example, text altered by IEC amendment 1 is indicated by **A1** **A1**.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 50, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Solderless connections — Part 2: Solderless crimped connections — General requirements, test methods and practical guidance

(includes amendments A1:1997 and A2:2002)
(IEC 60352-2:1990 + A1:1996 + A2:2002)

Connexions sans soudure —
Deuxième partie: Connexions serties sans
soudure —
Règles générales, méthodes d'essai et guide
pratique
(inclut les amendements A1:1997 et A2:2002)
(CEI 60352-2:1990 + A1:1996 + A2:2002)

Lötfreie elektrische Verbindungen —
Teil 2: Crimpverbindungen — Allgemeine
Anforderungen, Prüfverfahren und
Anwendungshinweise
(enthält Änderungen A1:1997 und A2:2002)
(IEC 60352-2:1990 + A1:1996 + A2:2002)

This European Standard was approved by CENELEC on 1994-05-15. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

At the request of the 77th Technical Board of CENELEC, HD 476.2 S1:1992 (IEC 352-2:1990) was submitted to the CENELEC voting procedure for conversion into a European Standard.

The test of the International Standard was approved by CENELEC as EN 60352-2 on 15 May 1994.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1995-07-15
- latest date of withdrawal of conflicting national standards (dow) —

Annexes designated normative are part of the body of the standard. In this standard, Annex ZA is normative.

Foreword to amendment A1

The text of document 48B/493/FDIS, future amendment 1 to IEC 352-2:1990, prepared by SC 48B, Connectors, of IEC TC 48, Electromechanical components and mechanical structures for electronic equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60352-2:1994 on 1996-12-09.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-09-01
- latest date by which the national standard conflicting with the amendment have to be withdrawn (dow) 1997-09-01

Annexes designated normative are part of the body of the standard. In this standard, Annex ZA is normative. Annex ZA has been added by CENELEC.

Foreword to amendment A2

The text of document 48B/1126/FDIS, future amendment 2 to IEC 60352-2:1990, prepared by SC 48B, Connectors, of IEC TC 48, Electromechanical components and mechanical structures for electronic equipment, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A2 to EN 60352-2:1994 on 2002-03-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2002-12-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2005-03-01

Annexes designated normative are part of the body of the standard. In this standard, Annex ZA is normative. Annex ZA has been added by CENELEC.

Contents

	Page
Foreword	2
Introduction	3
Section 1. General	
1 Scope	3
2 Object	3
3 Terminology	3
4 IEC type designation	5
Section 2. Requirements	
5 Workmanship	7
6 Tools	7
7 Crimp barrels	7
8 Wires	7
9 Crimped connections	8
Section 3. Tests	
10 Testing	9
11 Type tests	9
12 Test schedules	18
Section 4. Practical guidance	
13 General	27
14 Tool information	27
15 Crimp barrel information	28
16 Wire information	34
17 Connection information	37
18 Crimping process	41
19 Correct crimped connections (additional information)	43
20 Faults with crimped contacts having open barrels	43
21 General information about crimp type contacts as part of a multipole connector	48
22 Final remarks	49
Annex ZA (normative) Normative references to international publications with their corresponding European publications	

Section 1. General

Introduction

This standard includes requirements, tests and practical guidance information. Two test schedules are provided: a basic test schedule which applies to solderless crimped connections which conform to all of the requirements given in Section 2 and a full test schedule which applies to solderless crimped connections which do not fully conform to all of the requirements, e.g. which are made with solid wires, different materials, etc.

A2 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 standard may have a negative environmental impact.

As technological advances lead to acceptable alternatives for these materials, they will be eliminated from the standard. **A2**

1 Scope

This standard is applicable to solderless crimped connections made with stranded wires of 0,05 mm² to 10 mm² cross-section or solid wires of 0,25 mm to 3,6 mm diameter and appropriately designed uninsulated or pre-insulated crimp barrels for use in telecommunication equipment and in electronic devices employing similar techniques.

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

NOTE This standard is not intended to be applied to crimping of coaxial cables.

2 Object

To determine the suitability of solderless crimped connections under specified mechanical, electrical and atmospheric conditions.

To provide a means of comparing test results when the tools used to make the connections are of different designs or manufacture.

3 Terminology

The terms and definitions used in and applicable to this standard are included in IEC 60050: International Electrotechnical Vocabulary, Chapter 581.

IEC 60512 also contains some applicable terms and definitions.

For the purpose of this standard, the following additional terms and definitions shall apply:

3.1

crimp barrel

a conductor barrel designed to accommodate one or more conductors and to be crimped by means of a crimping tool

3.2

open crimp barrel

a crimp barrel with an open shape before crimping, e.g. U- or V-shape

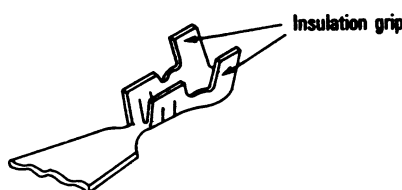
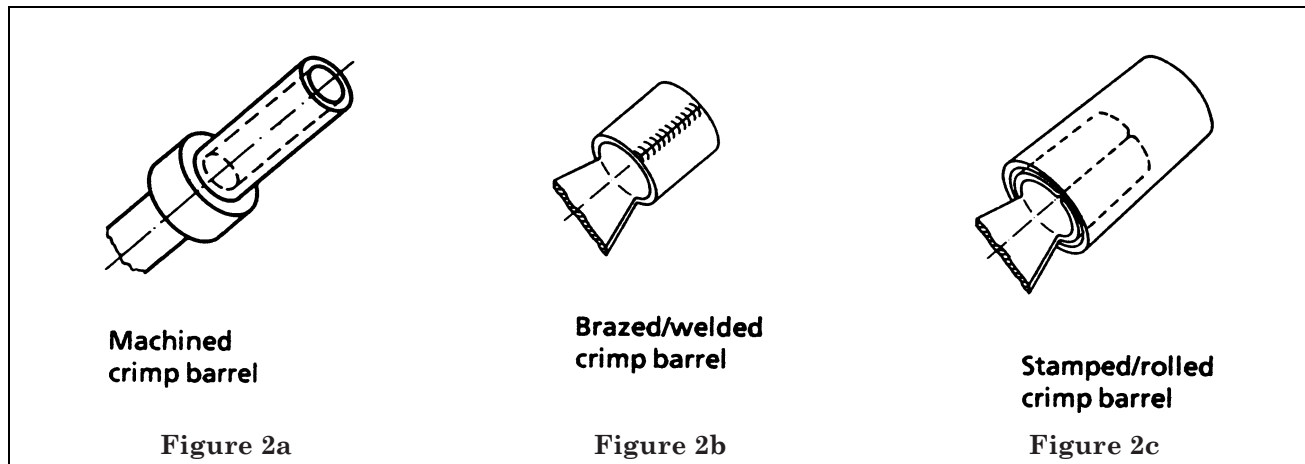


Figure 1

3.3

closed crimp barrel

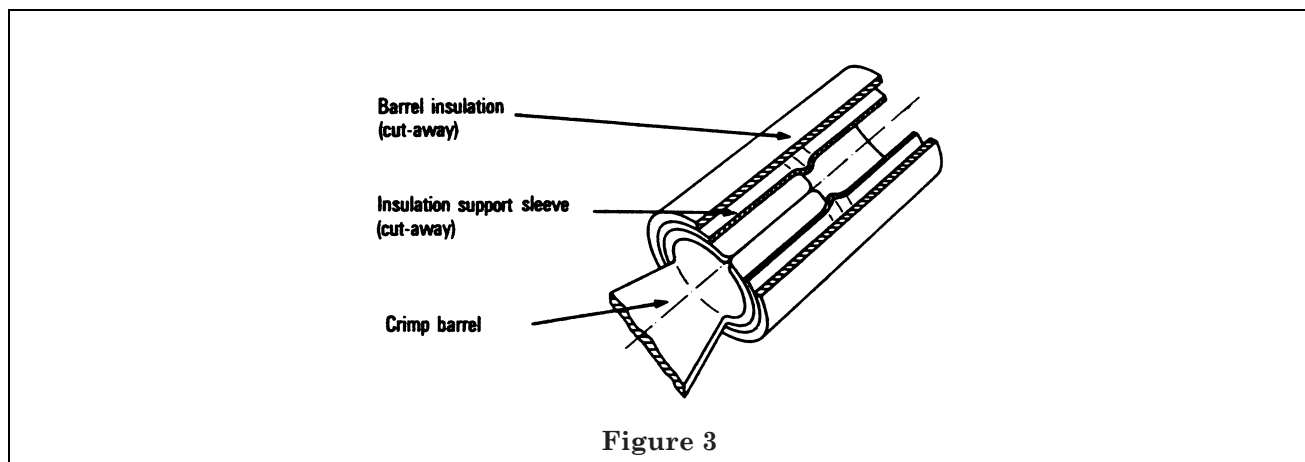
a crimp barrel with a closed shape before crimping



3.4

pre-insulated crimp barrel

a crimp barrel with a permanent layer of insulation through which the crimp is made

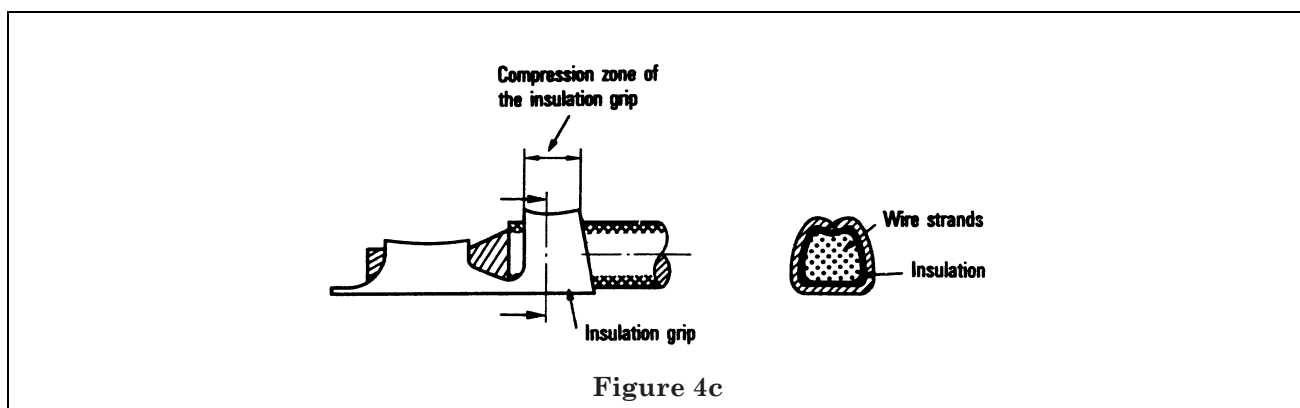
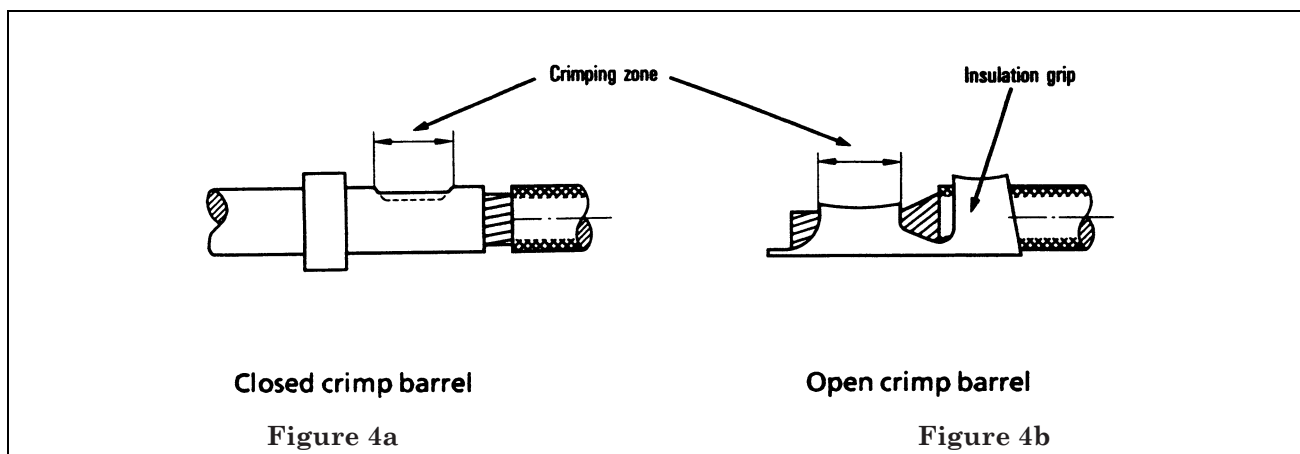


3.5

crimping zone

that portion of a crimp barrel where the crimped connection is achieved by pressure deformation or reshaping of the barrel around the conductor

where the crimp barrel is equipped with an insulation grip, this is also reshaped by compression by the crimping tool to secure the insulation of the wire



3.6

crimping die

that part of a crimping tool which forms the crimp(s) and usually incorporates the crimp anvil(s), the crimp indenter(s), and the positioner

NOTE Crimping dies may have separate or integral sections for compressing the insulation grip, if provided.

4 IEC type designation

Not applicable.

Section 2. Requirements

5 Workmanship

The connections shall be processed in a careful and workmanlike manner, in accordance with good current practice.

6 Tools

Crimping tools shall be used and inspected according to the instructions given by the tool manufacturer.

The crimping tool shall be able to make uniformly reliable connections during its useful life.

The crimping tool shall be equipped with the appropriate dies. Where the dies are adjustable, the correct setting for the barrel to be crimped shall be used.

Hand crimping tools shall be provided with a full cycle crimping mechanism.

Automatic crimping tools shall be provided with a full cycle crimping mechanism or equivalent safeguard. They shall be correctly set and the setting shall be maintained.

Tools are evaluated by testing crimped connections made with the tools to be evaluated.

7 Crimp barrels

7.1 Materials

Crimp barrels shall be made of copper or copper alloy with a copper content of 60 % minimum.

The Vickers hardness shall not exceed 220 HV 5 when tested in accordance with ISO 6507-1.

7.2 Dimensions

The dimensions shall be suitable for stranded wires as specified in clause 8.

NOTE For guidance on the relationship between the size of the crimp barrel and the cross-section of the conductor, see 15.4.

7.3 Surface finishes

The crimp barrel shall be unplated or plated with tin, tin-lead, silver, gold or palladium.

The surface shall be free of contamination and corrosion.

7.4 Design features

The crimp barrel shall be so designed that the crimped connection is achieved by pressure deformation or reshaping of the crimp barrel around the stripped conductor.

NOTE Techniques where the connection is achieved by parts of the barrel penetrating through the insulation of an insulated conductor are not covered by this standard.

The following barrel types shall be used:

- open crimp barrels, uninsulated;
- closed crimp barrels, either pre-insulated or uninsulated.

The crimp barrels shall be free of sharp edges likely to damage the conductors.

8 Wires

Stranded conductors shall be used.

8.1 Materials

Annealed copper having an elongation at break of not less than 10 % shall be used.

8.2 Dimensions

The cross-section of the stranded conductor shall be within the range 0,05 mm² to 10 mm².

NOTE For guidance on the relationship between the size of the crimp barrel and the cross-section of the conductor, see 15.4.

8.3 Surface finishes

Conductors unplated or finished with tin, tin-lead or silver shall be used.

The surface shall be free of contamination and corrosion.

8.4 Insulation

The insulation shall be capable of being readily stripped from the conductor without changing the physical characteristics of the conductor or strands, respectively.

9 Crimped connections

- a) The combination of the tool, barrel and wire shall be compatible.
- b) Where the crimp barrel is equipped with an insulation support or insulation grip, the overall diameter of the insulated wire shall be compatible with the dimensions of the support or grip.
- c) The wire shall be stripped to the correct length. The strands of the stripped part of the conductor shall not be damaged, e.g. partly or totally broken.

The stripped part of the conductor shall be clean and free from particles of insulation.

The lay of the strands shall be correct. If the lay has been disturbed, it may be restored by a light twist.

- d) The conductor shall be correctly located in the barrel, i.e. to the correct depth. This shall be verified as follows:

- in the case of open crimp barrels or closed crimp barrels with inspection provision, this shall be visually checked;
- in the case of closed crimp barrels without inspection provision, e.g. inspection hole, this shall be measured (indirectly by measuring the possible insertion depth of the barrel, the stripping length of the wire and the distance between the end of the barrel and the beginning of the wire insulation).

All strands of the wire shall be within the barrel. There shall be no damaged strands.

- e) Where the crimp barrel is equipped with an insulation support or insulation grip, the insulation shall be correctly located in the support or grip.

Section 3. Tests

10 Testing

10.1 General

As explained in the Introduction, there are two test schedules which shall be applied according to the following conditions:

- crimped connections which conform to all of the requirements of Section 2 shall be tested to and meet the requirements of the basic test schedule of **12.2**;
- crimped connections which do not fully conform to all of the requirements of Section 2, e.g. which are made with solid wires, different materials, etc., shall be tested to and meet the requirements of the full test schedule of **12.3**.

10.2 Standard conditions for testing

Unless otherwise specified, all tests shall be carried out under the standard conditions for testing as specified in IEC 60512-1.

The ambient temperature and the relative humidity at which the measurements are made shall be stated in the test report.

In case of dispute about test results, the test shall be repeated at one of the referee conditions of IEC 60068-1.

10.3 Preconditioning

Where specified, the connections shall be preconditioned under standard conditions for testing for a period of 24 h, in accordance with IEC 60512-1.

10.4 Mounting of the specimen

When mounting is required in a test, the specimens shall be mounted using the normal mounting method, unless otherwise specified.

11 Type tests

11.1 General examination

The tests shall be carried out in accordance with Test 1a: Visual examination, and Test 1b: Examination of dimension and mass, of IEC 60512-2. The visual examination test may be carried out with magnification up to approximately five times.

All crimped connections shall be examined to ensure that the applicable requirements of clauses **7**, **8** and **9** have been met.

11.2 Mechanical tests

E2 NOTE For crimped connections made with more than one wire, see **17.2**. **A2**

11.2.1 Tensile strength

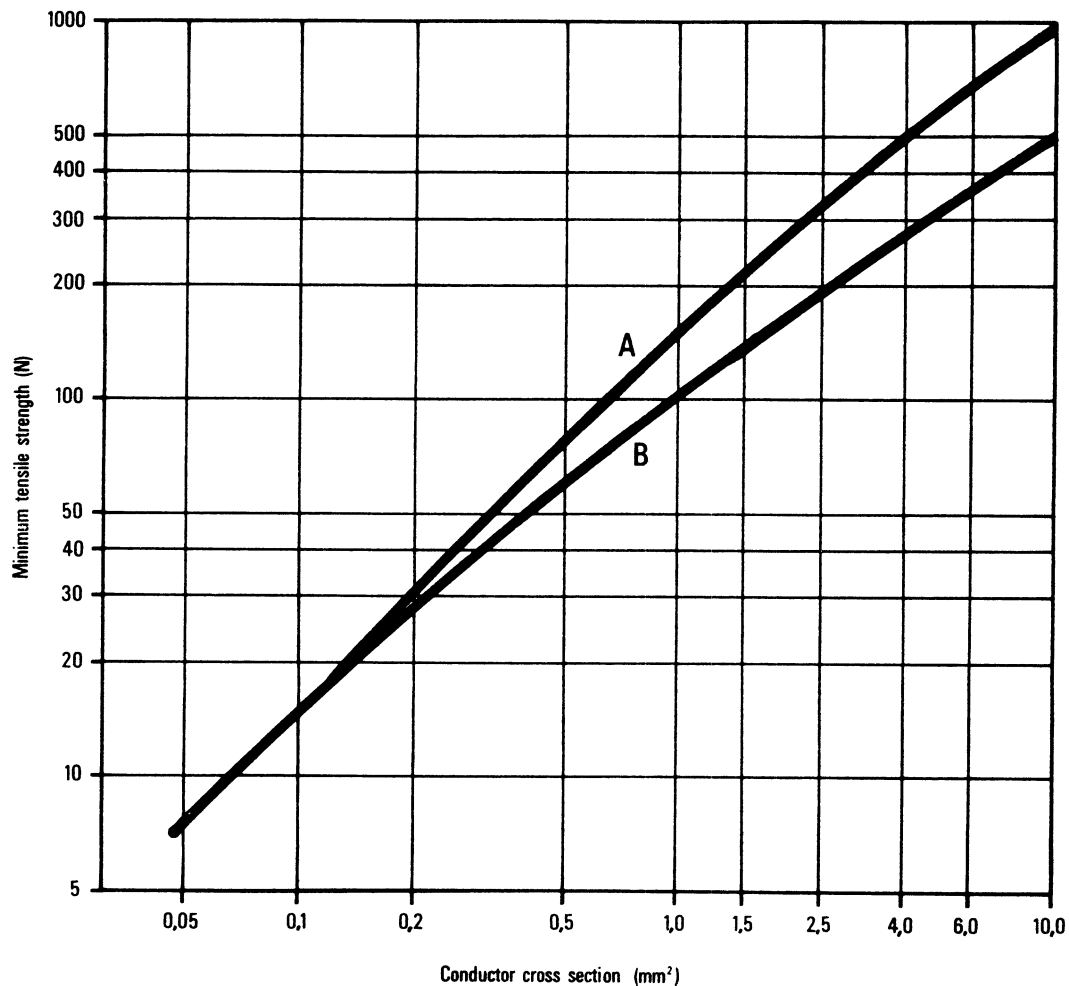
A2 The test shall be carried out in accordance with Test 16d of IEC 60512: Tensile strength (crimped connections).

Unless otherwise specified by the manufacturer of the crimp barrel (terminal), the minimum values of the tensile strength given in Table IV shall be applied.

Table IV — Tensile strength of crimped connections

Conductor cross-section		Tensile strength
mm ²	AWG ¹⁾	N
0,05	30	6
0,08	28	11
0,12	26	15
0,14	—	18
0,22	24	28
0,25	—	32
0,32	22	40
0,5	20	60
0,75	—	85
0,82	18	90
1,0	—	108
1,3	16	135
1,5	—	150
2,1	14	200
2,5	—	230
3,3	12	275
4,0	—	310
5,3	10	355
6,0	—	360
8,4	8	370
10,0	—	380
NOTE To test the crimped connection, the same values are included in IEC 60760, Clause 17 and IEC 61210, Table 9.		
¹⁾ For information only.		

A2



Curve A: Minimum values for closed crimp barrels

Curve B: Minimum values for open crimp barrels and for pre-insulated crimp barrels

Figure 5 — Tensile strength of crimped connections

11.2.2 Insulation grip effectiveness

The test shall be carried out in accordance with Test 16h: Insulation grip effectiveness (crimped connections), of IEC 60512-8.

Number of winding cycles: 2

Tension to be applied: Lowest tension necessary to bring the wire into contact with the mandrel.

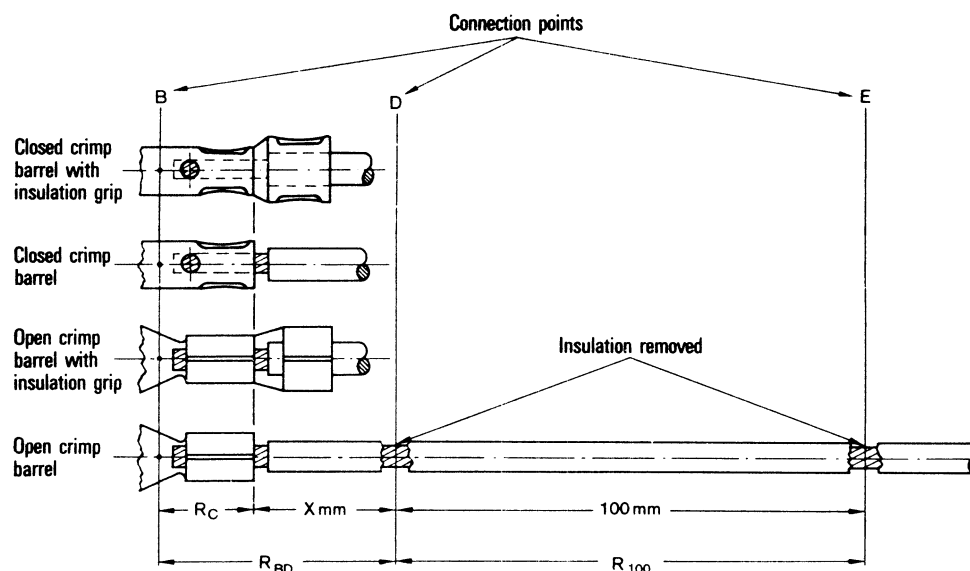
11.3 Electrical tests

NOTE For crimped connections made with more than one wire, see 17.2. **NOTE**

11.3.1 Contact resistance

The test shall be carried out in accordance with Test 2a: Contact resistance — Millivolt level method, or Test 2b: Contact resistance — Specified test current method, of IEC 60512-2, as specified in the relevant specification.

A suitable test arrangement is shown in Figure 6.



$$R_C = R_{BD} - \frac{X}{100} \times R_{100}$$

where

R_C = contact resistance of crimped connection

R_{BD} = measured resistance between connection points B and D

R_{100} = measured resistance over 100 mm wire length (D-E)

X = distance between crimp barrel end and connection point D in mm

NOTE Distance X: 25 mm to 100 mm is recommended

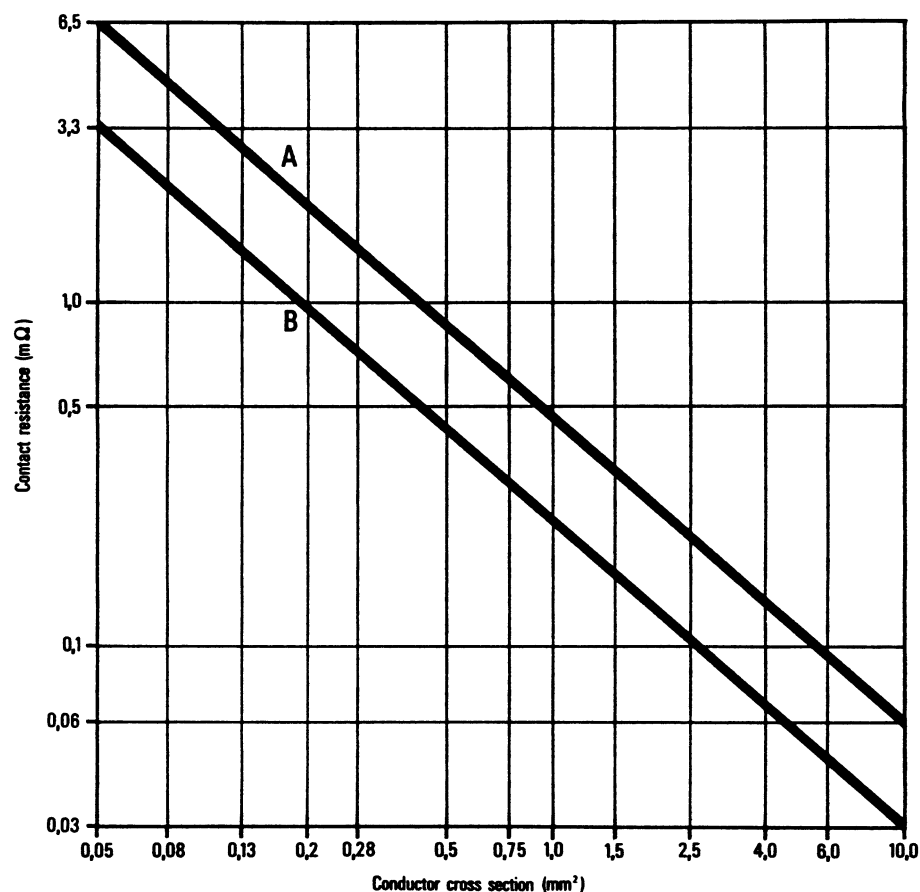
Figure 6

Contact point B shall be as close as possible to the end of the wire in the crimp barrel but, in the case of an open crimp barrel, not touching the end of the wire.

To achieve dependable and reproducible test results, good contact to all strands at the connection points is necessary. By locating the connection point D at a safe distance away from the crimped connection, any means to ensure the necessary good contact to all strands may be used.

A suitable test device shall be used to ensure good contact at all connection points. The test device shall ensure the connection points are located at predetermined fixed distances. Where test probes are used, they shall be sufficiently rounded to avoid damaging the conductor strands.

When Test 2b is applied, the test current shall be 1 A per mm² conductor cross-section. The duration of application of the test current shall be short enough to prevent heating of the specimens.



Curve A: Values for initial contact resistance, maximum

Curve B: Values for maximum change in resistance after electrical or climatic conditioning

Figure 7 — Contact resistance R_C of crimped connections with copper barrels and copper conductors ($K = 1$)

The cross-section to be used when applying Figure 7 is the cross-section calculated with the number of strands and the nominal diameter of one strand.

The values for maximum initial contact resistance (curve A) and the values for maximum change in resistance (curve B) as presented in Figure 7 apply only to crimped connections made with crimp barrels according to clause 7 and conductors according to clause 8 and where $K = 1$.

For barrel materials other than copper, the values of both curves A and B are to be multiplied by “K”, where

$$K = \frac{\text{resistivity of material used}}{\text{resistivity of copper}}$$