IEC 61076-3-119

Edition 1.0 2017-12

INTERNATIONAL STANDARD

Connectors for electrical and electronic equipment – Product requirements – Part 3-119: Rectangular connectors – Detail specification for shielded and unshielded, free and fixed 10-way connectors with push-pull coupling for industrial environments for data transmission with frequencies up to 100 MHz

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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International Standard IEC 61076-3-119 has been prepared by subcommittee 48B: Electrical connectors, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment.

This first edition cancels and replaces IEC PAS 61076-3-119 published in 2013. This edition constitutes a technical revision.

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

FDIS	Report on voting
48B/2602/FDIS	48B/2617/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 61076 series, published under the general title *Connectors for electronic equipment – Product requirements*, 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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

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<tr><td colspan="2">IEC SC 48B – Connector specifications available from:
IEC General secretariat
or from the addresses shown on the inside cover.</td><td>IEC 61076-3-119 Ed. 1.0</td></tr>
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DETAIL SPECIFICATION in accordance with
IEC 61076-1</td><td></td></tr>
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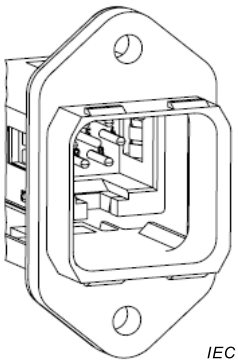
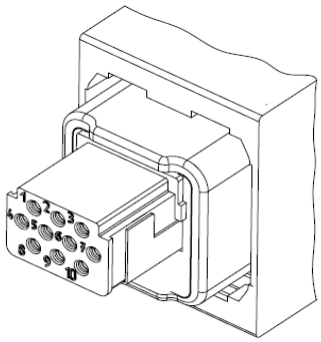
 
IEC</td><td> 
IEC</td><td>10-way rectangular connector
round contacts Ø 1 mm
screw or crimp terminations, solder or printed board connections upon agreement between manufacturer and user
shielded and unshielded, free and fixed
for data transmission with frequencies up to 100 MHz
with push-pull coupling</td></tr>
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CONNECTORS FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – PRODUCT REQUIREMENTS –

Part 3-119: Rectangular connectors – Detail specification for shielded and unshielded, free and fixed 10-way connectors with push-pull coupling for industrial environments for data transmission with frequencies up to 100 MHz

1 Scope

This part of IEC 61076-3 establishes specifications and test requirements for 10-way shielded and unshielded rectangular, free and fixed connectors, with push-pull coupling, for data transmission with frequencies up to 100 MHz and for use in industrial environments.

This document specifies free and fixed connectors with round contacts, suitable for screw or crimp terminations. Other terminations techniques, such as solder or printed board connections are upon agreement between manufacturer and user. The free and fixed connectors have a push-pull locking mechanism for IP65 and IP67 protection according to IEC 60529.

Connectors according this document are without breaking capacity COC according to 3.9 of IEC 61984:2008, therefore they are not intended to be engaged or disengaged in normal use when live or under load, if not otherwise specified by the manufacturer.

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 60050-581:2008, *International Electrotechnical Vocabulary – Part 581: Electromechanical components for electronic equipment*

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

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60352-2, *Solderless connections – Part 2: Crimped connections – General requirements, test methods and practical guidance*

IEC 60352-5, *Solderless connections – Part 5: Press-in connections – General requirements, test methods and practical guidance*

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 60512-3-1, *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*

IEC 60512-5-1, *Connectors for electronic equipment – Tests and measurements – Part 5-1: Current-carrying capacity tests – Test 5a: Temperature rise*

IEC 60512-6-3, *Connectors for electronic equipment – Tests and measurements – Part 6-3: Dynamic stress tests – Test 6c: Shock*

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

IEC 60512-9-1, *Connectors for electronic equipment – Tests and measurements – Part 9-1: Endurance tests – Test 9a: Mechanical operation*

IEC 60512-11-1, *Electromechanical components for electronic equipment – Basic testing procedures and measuring methods – Part 11: Climatic tests – Section 1: Test 11a – Climatic sequence*

IEC 60512-11-3, *Connectors for electronic equipment – Tests and measurements – Part 11-3: Climatic tests – Test 11c: Damp heat, steady state*

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 60512-13-2, *Connectors for electronic equipment – Tests and measurements – Part 13-2: Mechanical operation tests – Test 13b: Insertion and withdrawal forces*

IEC 60512-13-5, *Connectors for electronic equipment – Tests and measurements – Part 13-5: Mechanical operation tests – Test 13e: Polarizing and keying method*

IEC 60512-15-1, *Connectors for electronic equipment – Tests and measurements – Part 15-1: Connector tests (mechanical) – Test 15a: Contact retention in insert*

IEC 60512-15-6, *Connectors for electronic equipment – Tests and measurements – Part 15-6: Connector tests (mechanical) – Test 15f: Effectiveness of connector coupling devices*

IEC 60512-15-7, *Connectors for electronic equipment – Tests and measurements – Part 15-7: Connector tests (mechanical) – Test 15g: Robustness of protective cover attachment*

IEC 60512-16-5, *Connectors for electronic equipment – Tests and measurements – Part 16-5: Mechanical tests on contacts and terminations – Test 16e: Gauge retention force (resilient contacts)*

IEC 60512-26-100, *Connectors for electronic equipment – Tests and measurements – Part 26-100: Measurement setup, test and reference arrangements and measurements for connectors according to IEC 60603-7 – Tests 26a to 26g*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*
IEC 60529:1989/AMD1:1999
IEC 60529:1989/AMD2:2013

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm^2 up to 35 mm^2 (included)*

IEC 61076-1:2006, *Connectors for electronic equipment – Part 1: Generic specification*

IEC 61984:2008, *Connectors – Safety requirements and tests*

IEC 62197-1:2006, *Connectors for electronic equipment – Quality assessment requirements – Part 1: Generic specification*

IEC 62430:2009, *Environmentally conscious design for electrical and electronic products*

IEC Guide 109, *Environmental aspects – Inclusion in electrotechnical product standards*

ISO 128 (all parts), *Technical drawings – General principles of presentation*

ISO 1101:2017, *Geometrical product specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out*

ISO 1302:2002, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

ISO 11469:2016, *Plastics – Generic identification and marking of plastic products*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-581 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 Technical information

4.1 Ratings and characteristics

4.1.1 Rated current

The minimum value is 3 A at an ambient temperature of 40 °C for 0,5 mm^2 (AWG 20), all contacts. The upper limiting temperature (ULT) is 70 °C.

4.1.2 Rated voltage

50 V a.c. / 60 V d.c. for assembled connectors.

4.1.3 Insulation resistance

The minimum value is 100 MΩ.

4.1.4 Voltage proof

The minimum value is 1 500 V a.c. r.m.s., contact-to-contact and contact-to-shield, if applicable.

4.2 Performance levels

To be specified by the manufacturer.

4.3 Compatibility levels

Connectors according to this document shall be intermateable in accordance with IEC 61076-1:2006.

4.4 Climatic categories

Conditions: according to IEC 60068-1 and Table 1.

Table 1 – Climatic category

Climatic category	Lower temperature °C	Upper temperature °C	Damp heat steady state (days)
40/070/21	-40	70	21

4.5 Clearance and creepage distances

Clearance and creepage distances shall be measured according to IEC 60512-1-2 with the following additional requirement.

For these connectors clearance and creepage distances shall be measured only in mated position.

Minimum clearance: 0,8 mm.

Minimum creepage distance: 1,0 mm.

4.6 Marking

The marking of the connector and the package shall be in accordance with 2.7 of IEC 61076-1:2006. The position of the contacts shall be identified by a suitable marking according to Figures 2 and 3.

5 Dimensional information

5.1 General

Drawings shall comply with the relevant parts of ISO 128 and geometrical tolerances are given in accordance with ISO 1101. Dimensions are given in millimetres; drawings are shown in first angle projection. The shape of the connectors may deviate from those given in Figure 1 and in the following drawings as long as the specified dimensions are not influenced.

The following requirements shall apply to the complete connector consisting of both the free and fixed connectors.

For safety aspects IEC 61984 is applicable.

Missing dimensions shall be chosen according to the common characteristics and intended use. The interface dimensions of the female style shall be chosen according to the common characteristics of the male styles.

5.2 Isometric view and common features

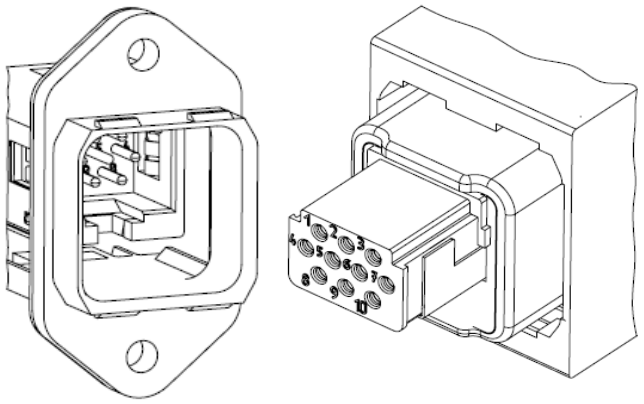


Figure 1 – Fixed (male) and free (female) connector

5.3 Engagement (mating) information – Contact levels and sequencing

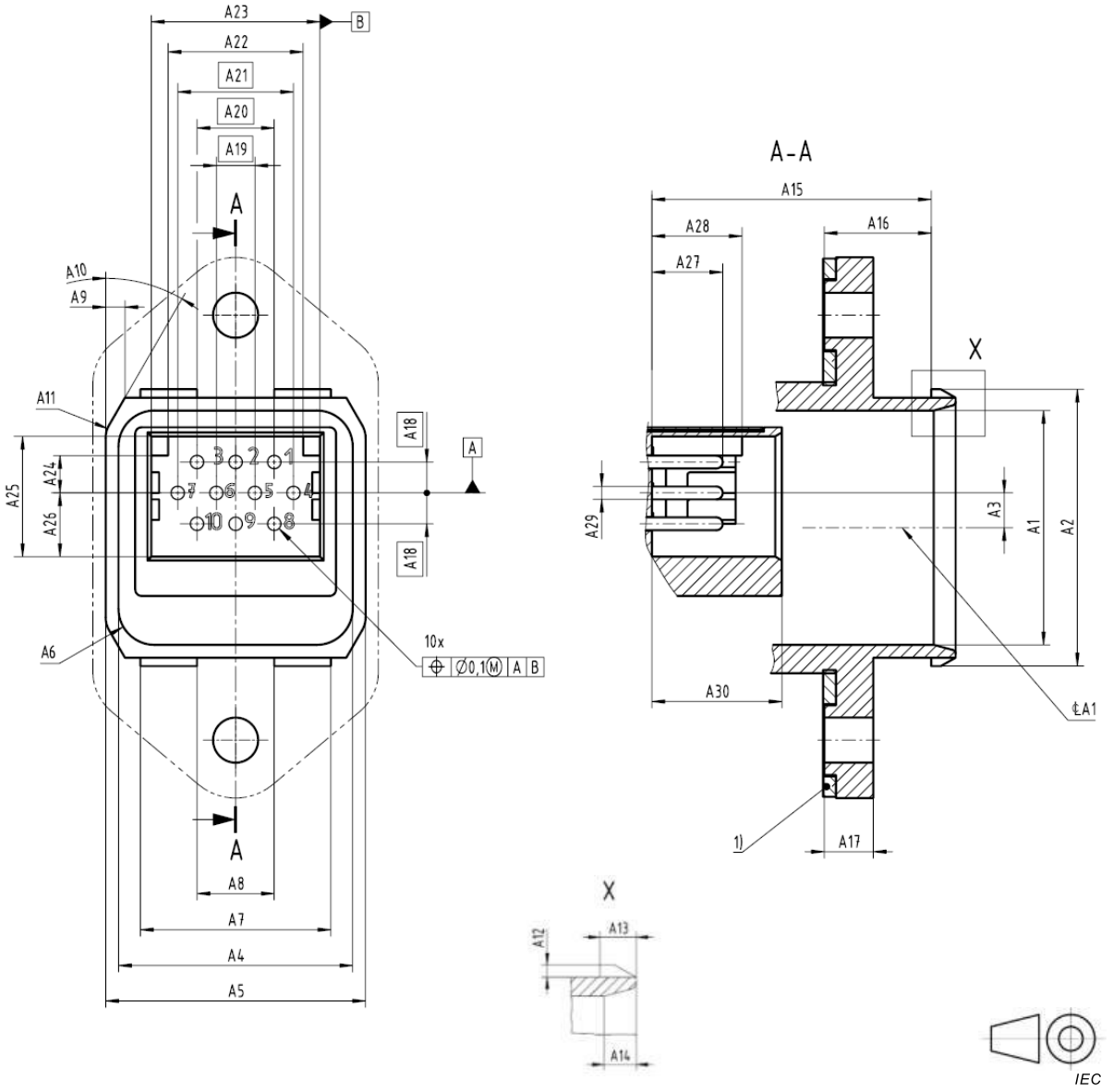
All contacts shall have the same contact level (no first-make last-break contact).

5.4 Fixed connectors

5.4.1 Dimensions

Figure 2 and Table 2 provide the dimensional requirements for the fixed connectors.

Dimensions in millimetres



1) Seal, to comply with test conditions as per IEC 60529 (IP65/IP67 protection), test schedule AP 14 to AP 16.

Figure 2 – Fixed connector

Table 2 – Dimensions of the fixed connector

Dimensions in millimetres

Letters	Minimum	Nominal	Maximum
A1	18,17	18,2	18,23
A2	21,45	21,5	21,55
A3	2,6	2,7	2,8
A4	18,17	18,2	18,23
A5	20,1	20,2	20,3
A6	2,77	2,8	2,83
A7	14,75	14,8	14,85
A8	5,95	6	6,05
A9	1,3	1,5	1,7
A10	29	30	31
A11	1,9	2	2,1
A12	0,6	0,65	0,7
A13	1,85	1,9	1,95
A14			2,1
A15	21,3	21,7	22,1
A16	8,25	8,3	8,35
A17	3,7	3,8	3,9
A18		2,4	
A19		3	
A20		6	
A21		9	
A22	10,4	10,5	10,6
A23	13,05	13,15	13,25
A24	2,8	2,9	3
A25	9,25	9,35	9,45
A26	4,85	4,95	5,05
A27	4,8	5,3	5,8
A28	6,9	7	7,1
A29	0,97	ø1	1,03
A30	10,05	10,15	10,25

5.4.2 Terminations

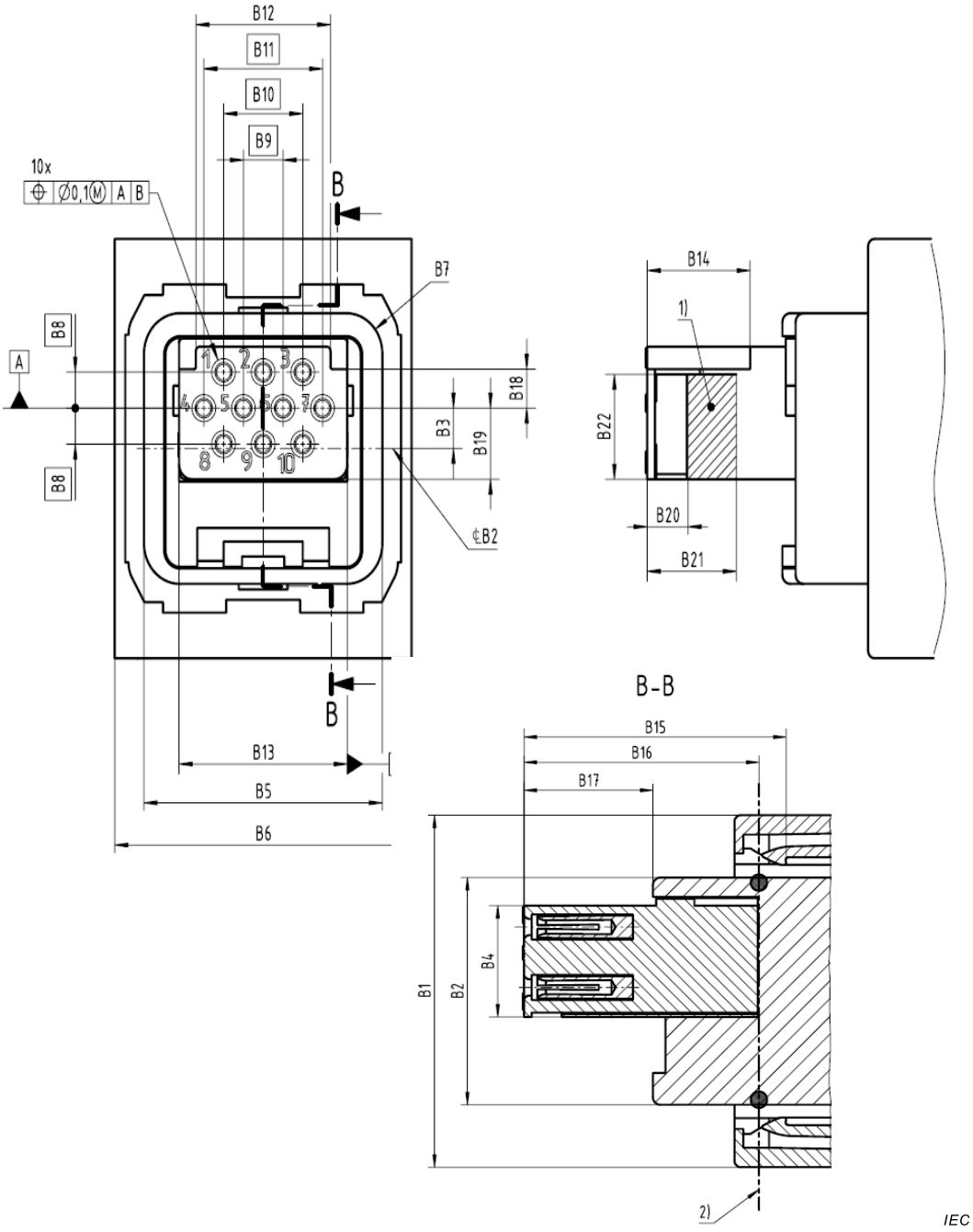
According to IEC 61984:2008, 6.6. Screw-type terminations according to IEC 60999-1 or crimp terminations according to IEC 60352-2. Other terminations techniques, such as solder or printed board connections e.g. per IEC 60352-5 are upon agreement between manufacturer and user.

5.5 Free connectors

5.5.1 Dimensions

Figure 3 and Table 3 provide the dimensional requirements for the free connectors.

Dimensions in millimetres



1) Area for shield-connection

2) Reference plane for IP65/IP67 sealing

Figure 3 – Free connector

Table 3 – Dimensions of the free connector

Dimensions in millimetres

Letters	Minimum	Nominal	Maximum
B1			29
B2	18,03	18,06	18,09
B3	2,6	2,7	2,8
B4	8,75	8,85	8,95
B5	18,03	18,06	18,09
B6			22,8
B7	2,67	2,7	2,73
B8		2,4	
B9		3	
B10		6	
B11		9	
B12	10,1	10,2	10,3
B13	12,7	12,75	12,8
B14	7,5		
B15	20,55	20,85	21,15
B16			20,5
B17	10,1		
B18	2,5	2,6	2,7
B19	4,7	4,75	4,8
B20			3,1
B21	7		
B22	6,5		

5.5.2 Terminations

According to IEC 61984:2008,6.6. Screw-type terminations according to IEC 60999-1 or crimp terminations according to IEC 60352-2. Other terminations techniques, such as solder or printed board connections e.g. per IEC 60352-5 are upon agreement between manufacturer and user.

5.5.3 Accessories

Not applicable.

5.6 Mounting information for connectors – Mounting on panels

Mounting information for the fixed connector shall be in accordance with Figure 4 and Table 4.

Dimensions in millimetres

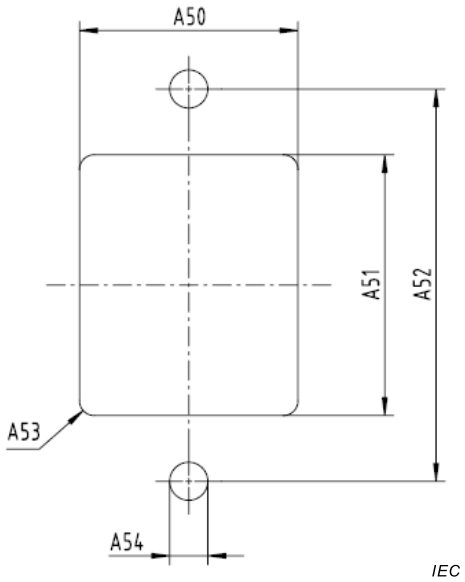


Figure 4 – Panel cut-out

Table 4 – Panel cut-out

Dimensions in millimetres

Letters	Minimum	Nominal	Maximum
A50	18,35		
A51	21,95		
A52	32,9	33	33,1
A53	-	-	R 1,25
A54	-	M3 or alternatively Ø 3,2	-

5.7 Gauges – Sizing gauges and retention force gauges

Figure 5 and Table 5 show the gauge dimensions. Material: tool steel, hardened.

=surface roughness according to ISO 1302: Ra_{max} = 0,25 µm, Ra_{min} = 0,15 µm min.

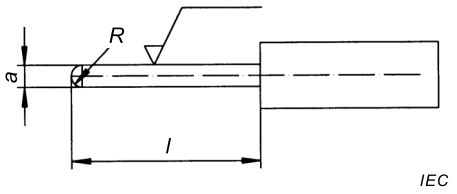


Figure 5 – Gauge

Table 5 – Gauge dimensions

Gauge	Mass g	Application	a mm	l mm	Nom pin Ø mm
P1		Sizing	$1{,}03\ ^{+0{,}01}_{0}$	10	1,00
P2	25	Retention force	$0{,}97\ ^{0}_{-0{,}01}$	10	

6 Characteristics

6.1 General

Connectors shall be tested under the conditions given in this document and meet the relevant requirements specified. The methods according to IEC 62197-1 should be applied for quality assessment upon agreement between manufacturer and user.

6.2 Pin assignment and other definitions

For pin assignment see Figures 2 and 3.

6.3 Classification into climatic categories

Conditions: according to IEC 60068-1 and Table 1.

6.4 Electrical characteristics

6.4.1 Creepage and clearance distances

See 4.5. Reductions in creepage or clearance distances may occur due to the printed board or wiring used, and shall duly be taken into account.

NOTE IEC 61984:2008, excerpt from 6.19.2 – Creepage distances: For a connector with a degree of protection IP54 or higher according to IEC 60529, the insulating parts inside the enclosure may be dimensioned for a lower pollution degree. This lower pollution degree also applies to mated connectors where the enclosure is ensured by the connector housing and which may only be disengaged for test and maintenance purposes.

6.4.2 Voltage proof

Condition: IEC 60512-4-1, test 4a at standard atmospheric conditions.

All variants: 1 500 V a.c. r.m.s., contact-to-contact and contact-to-shield, if applicable.

6.4.3 Current-carrying capacity

Conditions: IEC 60512-5-1, test 5a, temperature rise.

All contacts, see 4.1.1.

6.4.4 Contact resistance

Conditions: IEC 60512-2-1, test 2a.

All contacts: Initial value 10 mΩ max., rise in relation to initial value 15 mΩ maximum.

6.4.5 Shield to shield resistance

Conditions: IEC 60512-2-1, test 2a.

Connection points: cable termination to cable termination.

Shield (if any): 100 mΩ maximum.

6.4.6 Insulation resistance

Conditions: IEC 60512-3-1, test 3a.

Method B, mated connectors at standard atmospheric conditions.

Test voltage: 500 V d.c.

Each contact to all others: 100 MΩ min.

6.5 Transmission characteristics

6.5.1 General

Compliance to this document, in respect to transmission characteristics, is determined according to specific test methods described in test group HP, see Table 14 for symmetrical pair cables.

All transmission performance requirements shall apply between the reference planes specified in IEC 60512-26-100.

All transmission results shall report the worst case overall for the corresponding pair or pair combination after testing all the samples.

NOTE In the following subclauses, f is the frequency, expressed in MHz.

6.5.2 Insertion loss

Conditions: IEC 60512-26-100, test 26a, mated connectors.

All pairs: ≤ 0,04x$\sqrt{f}$ dB from 1 MHz to 100 MHz.

Whenever the formula results in a value less than 0,1 dB, the requirement shall revert to 0,1 dB.

6.5.3 Return loss

Conditions: IEC 60512-26-100, test 26b, mated connectors.

All pairs: ≥ 60-20log (f) dB from 1 MHz to 100 MHz.

Whenever the formula results in a value greater than 30 dB, the requirement shall revert to 30 dB.

6.5.4 NEXT

Conditions: IEC 60512-26-100, test 26c, mated connectors.

All pair combinations: ≥ 83-20log (f) dB from 1 MHz to 100 MHz.

Whenever the formula results in a value greater than 75 dB, the requirement shall revert to 75 dB.

6.5.5 FEXT

Conditions: IEC 60512-26-100, test 26d, mated connectors.

All pair combinations: ≥ 75,1-20log (f) dB from 1 MHz to 100 MHz .

Whenever the formula results in a value greater than 75 dB, the requirement shall revert to 75 dB.

6.5.6 Transverse conversion loss

Conditions: IEC 60512-26-100, test 26f, mated connectors.

All pairs: ≥ 66-20log (f)dB from 1 MHz to 100 MHz.

The TCL for frequencies that give calculated values greater than 50 dB can revert to the minimum requirement of 50 dB.

6.5.7 Transverse conversion transfer loss

Conditions: IEC 60512-26-100, test 26g, mated connectors.

All pairs: ≥ 66-20log (f) dB from 1 MHz to 100 MHz.

The TCTL for frequencies that give calculated values greater than 50 dB can revert to the minimum requirement of 50 dB.

6.5.8 Transfer Impedance

Conditions: IEC 60512-26-100, test 26e, mated connectors.

All pairs: ≤ 0,1 x $f^{0,3}$ Ω from 1 MHz to 10 MHz and
≤ 0,02 x f Ω from 10 MHz to 80 MHz.

6.6 Mechanical characteristics

6.6.1 Mechanical operation

Conditions: IEC 60512-9-1, test 9a.

Standard atmospheric conditions, Speed: 10 mm/s max.:

500 operations (matings and unmatings).

6.6.2 Effectiveness of connector coupling devices

Conditions: IEC 60512-15-7, test 15f.

A force of 50 N shall be applied at the end of the free housing to load the coupling device with the maximum torque for a time of 60 s, and a force rise of 44,5 N/s max.

6.6.3 Insertion and withdrawal forces

Conditions: IEC 60512-13-2, test 13b, speed: 50 mm/min maximum.

All types, insertion and withdrawal: F_{max} = 50 N.

6.6.4 Contact retention in insert

Conditions: IEC 60512-15-1, test 15a.

Force: F_{min} = 40 N.

6.6.5 Polarizing and coding method

Conditions: IEC 60512-13-5, test 13e and IEC 61984.

Force F for preventing unintended mating, F_{min} = 20 N or 1,5 times the insertion force, whichever is higher.

6.7 Other characteristics

6.7.1 Vibration (sine)

Conditions: IEC 60512-6-4, test 6d, frequency range 10 Hz to 500 Hz, displacement 0,35 mm peak-to-peak, acceleration 50 m/s^2 r.m.s., duration 2 h each axis, 3 axis.

6.7.2 Shock

Conditions: IEC 60512-6-3, test 6c, acceleration 500 m/s^2.

Duration: 11 ms, half-sine wave, 3 shocks in each axis and direction,3 axes.

6.7.3 Degree of protection provided by enclosures (IP-code)

Conditions: IEC 60529:1989, test 14.2.5 and test 14.2.7 (second numeral) and IEC 60529, test 6, Table 7 (first numeral).

IP65 and IP67 according to IEC 60529:1989, connectors shall be tested in mated and locked position.

6.7.4 Screen and shielding properties

Shields shall meet the relevant requirements of 6.4.5 and 6.5.8.

6.8 Environmental aspects

6.8.1 Marking of insulation material (plastics)

If applicable and reasonable, all plastic material shall be marked according to ISO 11469 to ease recycling.

6.8.2 Design/use of material

The design shall take into account the relevant IEC recommendations for designing products (IEC 62430) and the use of material (IEC Guide 109) with regard to the environment. Compliance is checked by inspection.

7 Test schedule

7.1 General

7.1.1 Introductory remarks

This test schedule shows the tests and the order in which they shall be carried out, as well as the requirements which shall be met.

Unless otherwise specified, mated sets of connectors shall be tested. Care shall be taken to keep a particular combination of connectors together during the complete test sequence; when, e.g. unmating, shall be necessary for a certain test, the same connectors shall be mated for the subsequent tests.

In the following, a mated set of connectors shall be called a specimen.

7.1.2 Climatic category

The climatic category shall meet the relevant requirements of 4.4.

7.1.3 Clearance and creepage distances

Creepage and clearance distances shall meet the relevant requirements of 4.5.

7.1.4 Arrangement for contact and shield resistance measurement

Conditions: IEC 60512-2-1, test 2a.

The measurement of contact resistance shall be carried out on the number of contacts specified. Any subsequent measurements of contact resistance shall be made on the same contacts.

The resistance of the wires between each measurement point as detailed in Figure 6 and the termination points between wire and contact on the free and fixed connectors should be measured or calculated.

The resistance of the wires shall be subtracted from the measured value to fulfil the specified contact or shield resistances.

Dimensions in millimetres

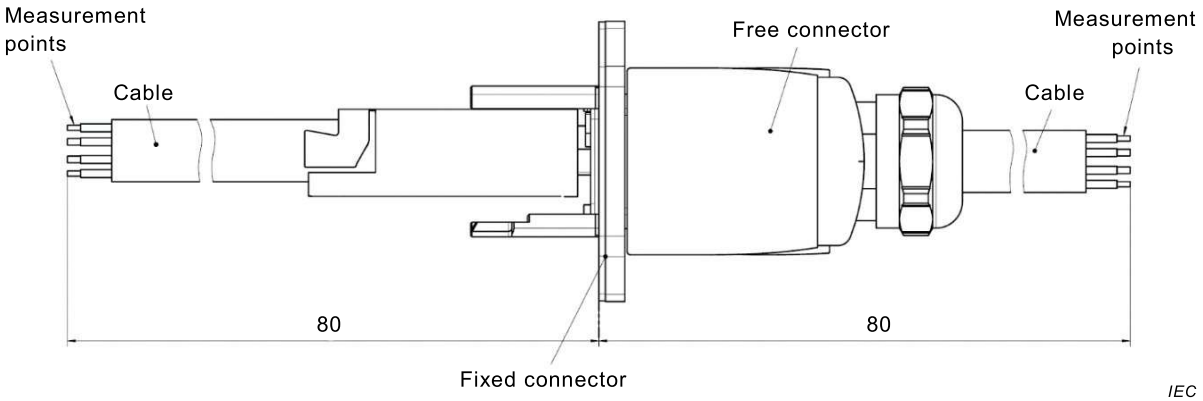


Figure 6 – Contact / shield resistance arrangement

7.1.5 Arrangement for dynamic stress tests

Conditions: IEC 60512-6-3 and IEC 60512-6-4, tests 6c and 6d respectively, test arrangement as per Figure 7.

Dimensions in millimetres

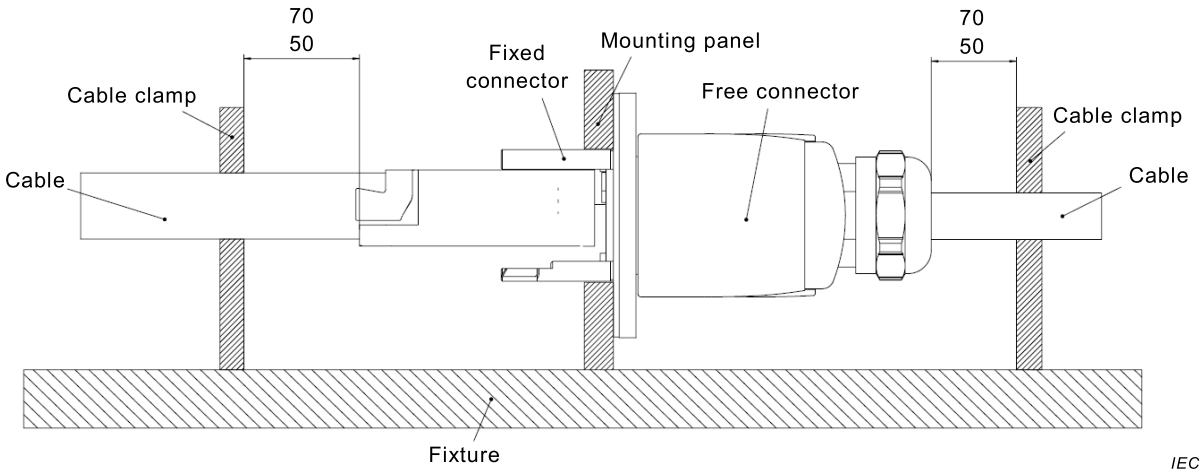


Figure 7 – Connector vibration and shock test arrangement

7.1.6 Arrangement for testing static load; axial

Not applicable.

7.1.7 Wiring of specimens

As specified by the manufacturer and user and representing relevant applications.

7.2 Test schedules

7.2.1 Basic (minimum) test schedule

Not applicable.

7.2.2 Full test schedule

7.2.2.1 General

The number of test specimens for each group and the number of contacts tested shall be as given in Table 6. A visual examination according to 60512-1-1 shall be performed on all test specimens.

Contact resistance measurements and contact disturbance measurements may be performed on different contacts. It is permissible to prepare separate connectors for each.

Dimensions shall be measured that affect clearance and creepage distances and other critical dimensions that affect intermateability.

The test parameters required shall not be less than those listed. The following tests specify the minimum characteristics to be checked and the minimum requirements to be fulfilled. The test results shall be written down in a test report.

Table 6 – Number of test specimens and contacts

Test group	AP	BP	CP	DP	EP	HP
Test specimens	3	3	3	3	3	2
Number of contacts	all	all	all	all	all	

7.2.2.2 Test group P – Preliminary

All specimens shall be subject to the following tests, see Tables 7 to 13.

Table 7 – Test group P

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
P1	General examination		Unmated connectors	Visual examination	1a	There shall be no defect that would impair normal operation.
				Examination of dimensions	1b	The dimensions shall comply with those specified in the relevant figure of Clause 5.
P2	Polarizing method	13e	Shall be as per 6.6.5. F_{min} = 20 N or 1,5 times of the insertion force			
P3				Contact resistance	2a	All contacts: 10 mΩ max initial value.
P4				Shield to shield resistance	2a	Shall be as per 6.4.5, 100 mΩ max.
P5				Insulation resistance	3a	Shall be as per 6.4.6 100 MΩ min.
P6				Voltage proof	4a	Shall be as per 6.4.2, No break down or flashover.

7.2.2.3 Test group AP – Dynamic/climatic

All specimens shall be subject to the following tests.

Table 8 – Test group AP

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
AP1				Insertion and withdrawal forces	13b	Shall be as per 6.6.3 F_{max} = 50 N
AP2	Rapid change of temperature	11d	-40 °C to +70 °C mated connectors 25 cycles t_1 = 30 min			
AP3				Insulation resistance	3a	Shall be as per 6.4.6 100 MΩ min
AP4				Contact resistance	2a	Shall be as per 6.4.4 All contacts, rise in relation to initial value: 15 mΩ max.
AP5				Shield to shield resistance	2a	Shall be as per 6.4.5 100 mΩ max.
AP6				Voltage proof	4a	Shall be as per 6.4.2. No break down or flashover
AP7				Visual examination	1a	There shall be no defect that would impair normal operation.
AP8	Climatic sequence	11a	Mated connectors			
AP8.1	Dry heat	11i	+70 °C, 16 h			There shall be no defect that would impair normal operation
AP8.2	Damp heat, cyclic	11m	40 °C to 25 °C heat 93 % humidity 1 cycle			There shall be no defect that would impair normal operation
AP 8.3	Cold	11j	-40 C° Duration: 2 h Recovery time: 2 h			
AP 8.4	Damp heat, cyclic	11m	40 °C to 25 °C heat 93 % humidity 5 cycles			
AP 8.5				Visual examination	1a	There shall be no defect that would impair normal operation

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
AP9				Insulation resistance	3a	Shall be as per 6.4.6 100 MΩ min
AP10				Voltage proof	4a	Shall be as per 6.4.2 no break down or flashover
AP11				Contact resistance	2a	Shall be as per 6.4.4 All contacts, rise in relation to initial value: 15 mΩ max.
AP12				Shield to shield resistance	2a	Shall be as per 6.4.5 100 mΩ max.
AP13	Effective-ness of connector coupling device	15f	Conditions shall be as per 6.6.2. Applied force 50 N and duration 60 s, force rise 44,5 N/s max.			There shall be no defect that would impair normal operation.
AP14	Protection IPX5		Water jets (IPX5) 6,3 mm nozzle Test conditions as per IEC 60529:1989, Table 8, 14.2.5			No leakage on contacts
AP15	Protection IPX7		1m, 30 min Test conditions as per IEC 60529:1989, Table 8, 14.2.7			No leakage on contacts
AP16	Protection IP6X		Dust chamber with under pressure Test conditions as per IEC 60529:1989, Table 7,13.4 and 13.6			No deposit of dust observable inside the enclose at the end of the test
AP 17				Insertion and withdrawal forces	13b	Shall be as per 6.6.3 F_{max}= 50 N
AP 18			Not applicable			
AP 19				Visual examination	1a	There shall be no defect that would impair normal operation.

7.2.2.4 Test group BP – Mechanical endurance

All specimens shall be subject to the following tests.

Table 9 – Test group BP

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
BP 1				Gauge retention force	16e	Conditions shall be as per 5.7.1. The gauge P2 shall be retained.
BP 2				Insertion and withdrawal forces	13b	Conditions shall be as per 6.6.3. F_{max} = 50 N.
BP 3	Mechani-cal operation (half of the specified number of cycles)	9a	250 operations, including push-pull locking system, see 6.6.1			There shall be no defect that would impair normal operation
BP 4				Contact resistance	2a	Conditions shall be as per 6.4.4. All contacts, rise in relation to initial value: 15 mΩ max.
BP 5				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.
BP6.1	Flowing mixed gas corrosion test	11g	Method 4, test-duration of 4 days The specimens shall be exposed to FMG in unmated condition			
BP6.2				Contact Resistance	2a	Conditions shall be as per 6.4.4. All contacts, rise in relation to initial value 15 mΩ max.
BP 6.3				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.
BP7	Mechani-cal operation (remaining number of operations)	9a	250 operations, including push-pull locking system, see 6.6.1	Visual examination	1a	There shall be no defect that would impair normal operation
BP8				Contact resistance	2a	Conditions shall be as per 6.4.4. All contacts, rise in relation to initial value 15 mΩ max.

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
BP 9				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.
BP10				Voltage proof	4a	Conditions shall be as per 6.4.2. No break down or flashover
BP11				Polarizing method	13e	Not applicable
BP12	Effective-ness of connector coupling device	15f	Conditions shall be as per 6.6.2. Applied force 50 N and duration 60 s, force rise 44,5 N/s max			
BP13				Visual examination	1a	There shall be no defect that would impair normal operation.

7.2.2.5 Test group CP – Moisture

All specimens shall be subject to the following tests.

Table 10 – Test group CP

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or Condition of test	Title	IEC 60512 Test No.	All connector styles
CP1				Insertion and withdrawal forces	13b	Conditions shall be as per 6.6.3. F_{max} = 50 N
CP2	Damp heat, steady state	11c	40 °C , 93 % rel. humidity 21 days, Polarization voltage 60 V DC			Polarization voltage 60 V DC, contact-to-contact and if applicable 60 V contact-to-shield
CP3				Insulation resistance	3a	Conditions shall be as per 6.4.6. 100 MΩ min
CP4				Voltage proof	4a	Conditions shall be as per 6.4.2. No break down or flashover
CP5				Contact resistance	2a	Conditions shall be as per 6.4.4. All contacts, rise in relation to initial value 15 mΩ max.
CP 6				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.
CP7				Insertion and withdrawal forces	13b	Conditions shall be as per 6.6.3. F_{max}= 50 N.
CP8	Contact retention in insert	15a	6 contacts / specimen			Conditions shall be as per 6.6.4. F_{min} = 40 N
CP9				Visual examination	1a	There shall be no defect that would impair normal operation.

7.2.2.6 Test group DP – Heat and electrical load

All specimens shall be subject to the following tests.

Table 11 – Test group DP

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
DP 1	Mechanical operations	9a	500 operations, including push-pull locking system, see 6.6.1			Conditions shall be as per 6.6.1.
DP 2	Electrical load and temperature	9b	Duration of test: 500 h, ambient temperature 40 °C, current 3 A, wire cross-section 0,5 mm^2, temperature measurement in the middle of specimen			Upper temperature limit 70 °C
DP 3				Contact resistance	2a	Conditions shall be as per 6.4.4. All contacts, rise in relation to initial value 15 mΩ max.
DP 4				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.
DP 5				Insulation resistance	3a	Conditions shall be as per 6.4.6. 100 MΩ min.
DP 6				Voltage proof	4a	Conditions shall be as per 6.4.2. No break down or flashover
DP 7				Visual examination	1a	There shall be no defect that would impair normal operation.

7.2.2.7 Test group EP – Dynamic stress

All specimens shall be subject to the following tests.

Table 12 – Test group EP

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
EP 1	Vibration – sine	6d	Frequency range 10 Hz to 500 Hz, 0,35 mm, acceleration 5 g, duration 2 h over 3 axis	Contact disturbance	2e	Conditions shall be as per 6.7.1, Duration of disturbance < 1 µs.
EP 2				Visual examination	1a	There shall be no defect that would impair normal operation.
EP 3				Contact resistance (optional)	2a	Not applicable
EP 3.1				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.
EP 4	Shock	6c	Acceleration 500 m/s^2, Duration 11 ms, 3 shocks in each axis and direction, half-sine wave	Contact disturbance	2e	Conditions shall be as per 6.7.2. Duration of disturbance < 1 µs.
EP 5				Visual examination	1a	There shall be no defect that would impair normal operation.
EP 6				Contact resistance	2a	Conditions shall be as per 6.4.4. All contacts, rise in relation to initial value: 15 mΩ max.
EP 7				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. 100 mΩ max.

7.2.2.8 Test group HP – Signal integrity and screening effectiveness tests

These tests are applicable for signal connector for symmetrical pair cabling. For example the measurements shall be performed with one pair connected to the contacts 1 and 8 and the other pair connected to the contacts 4 and 5. Table 13 shows test group HP.

All specimens shall be subject to the following tests.

Table 13 – Test group HP

Test phase	Test			Measurement to be performed		Requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.	All connector styles
HP 1			All pairs	Insertion loss, IL	26a	Conditions shall be as per 6.5.2 All pairs: ≤0,04 $\sqrt{(f)}$ dB
HP 2			All pairs, both directions	Return loss, RL	26b	Conditions shall be as per 6.5.3. ≥60 – 20log(f)
HP 3			All pairs, both directions (pair to pair)	Near end cross talk, NEXT	26c	Conditions shall be as per 6.5.4. ≥83 – 20log(f)
HP 4			All pairs, both directions (pair to pair)	Far end crosstalk, FEXT	26d	Conditions shall be as per 6.5.5. ≥75,1 – 20log(f) dB
HP 5			All pairs, both directions	Transverse conversion loss, TCL	26f	Conditions shall be as per 6.5.6. All pairs: ≥66 – 20log(f) dB
HP 6			All pairs, both directions	Transverse conversion transfer loss, TCTL	26g	Conditions shall be as per 6.5.7. All pairs: ≥66 – 20log(f) dB
HP 7				Transfer impedance	26e	Conditions shall be as per 6.5.8. ≤0,02 x f Ω from 10 MHz to 80 MHz.
HP 8				Shield to shield resistance	2a	Conditions shall be as per 6.4.5. Conditions shall be as per 6.4.5. Screen resistance 100 mΩ max.
HP 9				Resistance unbalance	2a	All signal contacts, measurement points as defined in 7.1.4. Unbalance resistance ≤50 mΩ max.

7.2.2.9 Test group JP – Connections

See the requirements of the relevant IEC standards: IEC 60352-2, IEC 60352-5, IEC 60999-1 or IEC 60068-2-20.

7.3 Test procedures and measuring methods

The test methods specified and given in the referred IEC standards shall be used, in case of any deviation to other test methods it shall be reported in technical documentation. In case of dispute, however, the method specified in this document shall be used.

Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in IEC 60068-1.

7.4 Pre-conditioning

Before the tests are performed, the connectors shall be preconditioned under conditions specified in IEC 60068-1 for a period of 24 h, unless otherwise specified by the detail product specification.

7.5 Wiring and mounting of specimens

7.5.1 Wiring

See 7.1.7.

7.5.2 Mounting

If connector mounting should be specified by a test, the connectors shall be rigidly mounted on a metal plate, a printed board or to specified accessories, whichever is applicable, using the normal mounting method, fixing devices and panel cut-out, as given in 5.6.

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch