

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

**Connectors for electronic equipment – Product requirements –
Part 2-109: Circular connectors – Detail specification for connectors M 12 × 1
with screw-locking, for data transmissions with frequencies up to 500 MHz**

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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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PRE-STANDARD

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INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CONNECTORS FOR ELECTRONIC EQUIPMENT –
PRODUCT REQUIREMENTS –**

**Part 2-109: Circular connectors –
Detail specification for connectors M 12 × 1 with screw-locking,
for data transmissions with frequencies up to 500 MHz**

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The text of this PAS is based on the following document:

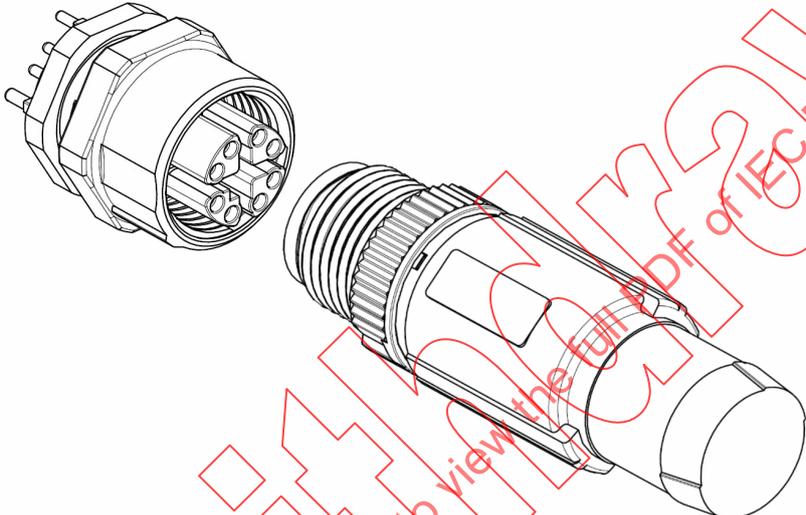
This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

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| <p>ELECTRONIC COMPONENTS in accordance with IEC 61076-1</p> | |
|  | <p>Circular connectors M12 × 1 mm 2 to 8 ways, for data transmissions with frequencies up to 500 MHz</p> <p>Connectors with round contact Rewireable</p> <p>Free cable connectors Straight and right angle connectors</p> <p>Fixed connectors</p> <p>Flange mounting Rear mounting</p> |

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CONNECTORS FOR ELECTRONIC EQUIPMENT – PRODUCT REQUIREMENTS –

Part 2-109: Circular connectors – Detail specification for connectors M 12 × 1 with screw-locking, for data transmissions with frequencies up to 500 MHz

1 General information

Throughout this detail specification dimensions are in mm.

1.1 Scope

This Publicly Available Specification (PAS) describes circular connectors with IP 65 and IP 67 protection degree and specified up to 500 MHz, typically used for data transmissions. These connectors consist of fixed and free connectors, either rewirable or non-rewirable, with M12 × 1 screw-locking.

Male connectors have round contacts \varnothing 0,6 mm.

1.2 Recommended method of termination

The contact terminations shall be of the following types: screw, crimp, insulation piercing, insulation displacement, press-in or solder.

1.2.1 Number of contacts or contact cavities

2 to 8 contacts and 8 cavities.

Table 1 – Contact termination

| Number of contacts | Typical. termination |
|-------------------------------|---|
| 2 to 8 | 0,14 mm ² to 0,25 mm ² 1) |
| NOTE 1 Equals to AWG 26 to 24 | |

1.3 Ratings and characteristics

Rated voltage: 48 V, see 4.2.1, Table 6

Current rating: 0,5 A, see 4.2.3

Insulation resistance: 10⁸ Ω, see 4.2.5

Climatic category: –25 °C / +85 °C / 21 days, see 4.1, Table 5

Contact spacing: see Clause 3

1.4 Normative references

The following referenced documents are indispensable for the application 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 – Part 581: Electromechanical components for electronic equipment*

IEC 60068-1:1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

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

IEC 60512 (all parts), *Connectors for electronic equipment – Tests and measurements*

IEC 60512-1-100, *Connectors for electronic equipment – Tests and measurements – Part 1-100: General – Applicable publications*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code)*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

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

IEC 61076-2:1998, *Connectors for use in d.c., low-frequency analogue and digital high speed data applications – Part 2: Circular connectors with assessed quality – Sectional specification*

IEC 61076-2-101:2008, *Connectors for electronic equipment – Product requirements – Part 2-101: Circular connectors – Detail specification for M12 connectors with screw-locking*

IEC 61984, *Connectors – Safety requirements and tests*

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

1.5 Marking

The marking of the connector and the package shall be in accordance with 2.6 of IEC 61076-2.

1.6 Safety aspects

For safety aspects IEC 61984 shall be considered unless otherwise specified.

2 Technical information

2.1 Definitions

For the purposes of this PAS, the terms and definitions given in IEC 60050-581 apply.

2.2 Survey of styles and variants

Subclause 2.2 of IEC 61076-2-101:2008 applies.

3 Dimensions

3.1 General

All dimensions in mm are original. Drawings are shown in the first angle projection. The shape of the connectors may deviate from those given in the following drawings as long as the specified dimensions are not influenced.

For connector dimensions, see 3.2 and 3.3.

Missing dimensions shall be chosen according to the common characteristics and intended use.

The missing interface dimensions of the female styles shall be chosen according to the common characteristics of the male styles.

3.2 Interface dimensions for connectors with female contacts

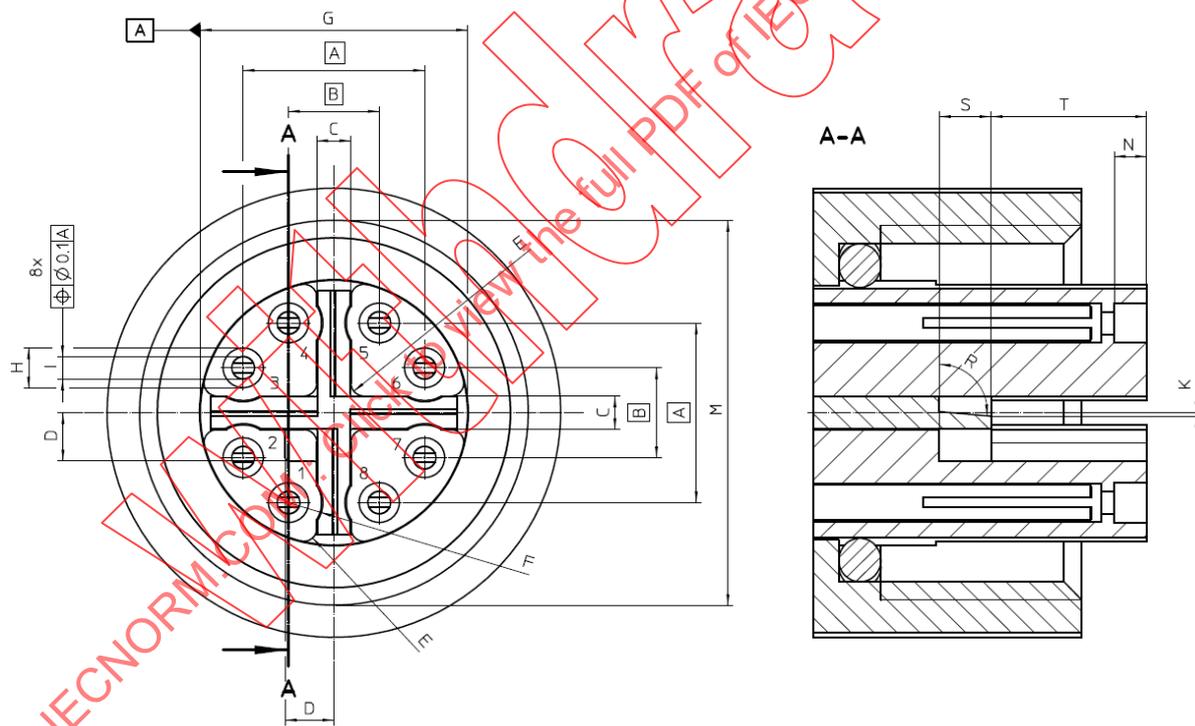


Figure 1 – Interface dimensions for connectors with female contacts

Table 2 – Interface dimensions fixed connector

| Reference | Minimum [mm] | Nominal [mm] | Maximum [mm] |
|-----------|--------------|--------------|--------------|
| A | 5,6 | 5,6 | 5,6 |
| B | 2,8 | | 2,8 |
| C | 1,05 | 1,05 | 1,1 |
| D | 1,5 | 1,5 | 1,6 |
| E | 0,4 | 0,4 | 0,5 |
| F | 0,96 | 1,02 | 1,02 |
| G | 8,15 | 8,25 | 8,25 |
| H | 1,24 | 1,24 | 1,34 |
| I | 0,7 | 0,7 | 0,75 |
| K | 0,1 | 0,1 | 0,15 |
| M | M12x1 | | |
| N | 1 | 1 | 1,1 |
| R | 94,5° | 95° | 95° |
| S | 1,6 | 1,6 | 1,7 |
| T | 4,7 | 4,8 | 4,9 |

NOTE All radii without dimensions are 0,1.

3.3 Interface dimensions for connectors with male contacts

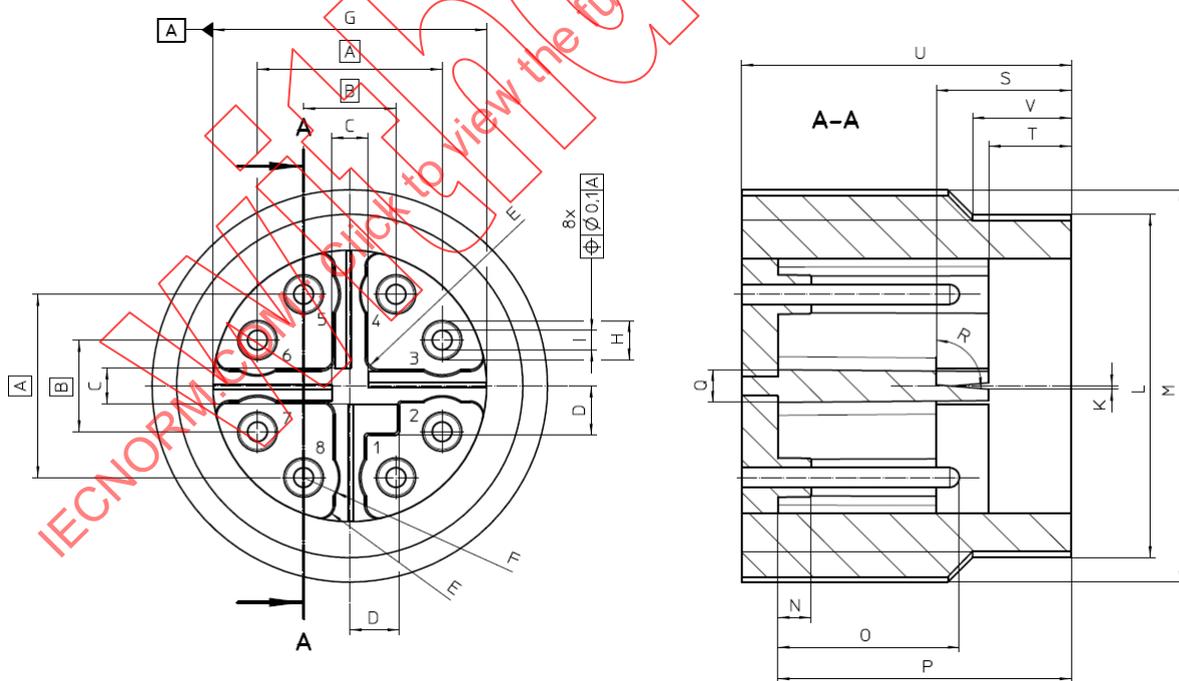


Figure 2 – Interface dimensions for connectors with male contacts

Table 3 – Interface dimensions free connector

| Reference | Minimum [mm] | Nominal [mm] | Maximum [mm] |
|-----------|--------------|--------------|--------------|
| A | 5,6 | 5,6 | 5,6 |
| B | 2,8 | 2,8 | 2,8 |
| C | 1,1 | 1,1 | 1,2 |
| D | 1,4 | 1,5 | 1,5 |
| E | 0,3 | 0,4 | 0,4 |
| F | 1,06 | 1,06 | 1,11 |
| G | 8,3 | 8,3 | 8,45 |
| H | 1,1 | 1,2 | 1,2 |
| I | 0,57 | 0,6 | 0,63 |
| K | 0,07 | 0,1 | 0,13 |
| L | 10,2 | 10,5 | 10,5 |
| M | M12×1 | | |
| N | 0,9 | 1 | 1 |
| O | 5,5 | 5,5 | 5,7 |
| P | 8,7 | 8,9 | 8,9 |
| Q | 0,9 | 1 | 1 |
| R | 94,5° | 95° | 95° |
| S | 4,1 | 4,1 | 4,2 |
| T | 2,5 | 2,5 | 2,6 |
| U | 10 | | |
| V | | | 3 |

NOTE All radii without dimensions are 0,1.

3.3.1 Pin front view of connectors and contact position

As described in 3.2.

The contact or cavity marking shall be on the termination side of the connector insert as long as the size of the components allows the placement there.

3.4 Gauges

3.4.1 Sizing gauges and retention force gauges

Material: tool steel, hardened

∇ = Surface roughness according to ISO 1302: Ra = 0,25 µm max.
0,15 µm min.

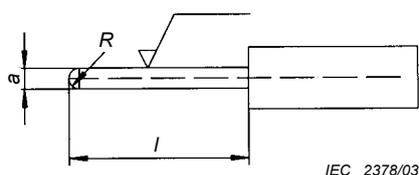


Figure 3 – Gauge dimensions

Table 4 – Gauges

| Gauge | Mass g | Application | Ø a mm | l min. mm |
|-------|-----------|--------------------|-----------|--------------|
| P31 | – | Sizing | 0,63 | 10 |
| P32 | 30 | Retention force | 0,57 | 10 |

4 Characteristics

4.1 Climatic category

Conditions: IEC 60068-1

Table 5 – Climatic category

| Climatic category | Category of temperature | | Damp heat steady-state | | Days |
|----------------------|-------------------------|-------------|------------------------|---------------------------|------|
| | Lower °C | Upper °C | Temperature °C | Relative humidity % | |
| 25/85/21 | -25 | +85 | 40 | 93 | 21 |

4.2 Electrical

4.2.1 Rated voltage – Rated impulse voltage – Pollution degree

Conditions: IEC 60664-1

The permissible rated voltage depends on the application or specified safety requirement. Reductions in creepage or clearance distances may occur due to the printed board or wiring used and shall be duly taken into account.

Table 6 – Rated voltage – Impulse voltage – Pollution degree

| Contact arrangement according to Clause 3 | Rated voltage V | Rated impulse voltage kV | IP 65 and IP 67 variants Pollution degree ^{b)} |
|---|-----------------------|-----------------------------------|---|
| 8 poles | 48 ^{b)} | 1,5 ^{b)} | 3 ^{a)} |
| a) In mated and locked condition. b) The rated voltage and impulse voltage are based on pollution degree 2. This results from application of the rules from IEC 60664-1. | | | |

4.2.2 Voltage proof

Conditions: IEC 60512-4-1, Test 4a
Standard atmospheric conditions
Mated connectors

Table 7 – Voltage proof connectors

Values in kilovolts (kV)

| | Impulse withstand voltage Between contacts | | Impulse withstand voltage Between contacts and metal housing | |
|--|---|-----------------|--|-----------------|
| | Fixed connectors | Free connectors | Fixed connectors | Free connectors |
| Contact arrangement according to Figure 1 | 0,5 | 0,5 | 0,5 | 0,5 |

4.2.3 Current-carrying capacity

Conditions: IEC 60512, Test 5a
All contacts
Values at 40 °C ambient temperature

8 pole (0,25mm² wire gauge) = 0,5 A (single contact 1 A)

4.2.4 Contact resistance

Conditions: IEC 60512, Test 2a
Standard atmospheric conditions
Connecting points see 5.1.1

Contact resistance < 5 mΩ

4.2.5 Insulation resistance

Conditions: IEC 60512, Test 3a, Method A
Standard atmospheric conditions
Insulation resistance ≥ 10⁸ Ω

4.3 Mechanical**4.3.1 IP degree of protection**

IP65 and IP67 according to IEC 60529 connectors in mated and locked position. IP68 as agreed between manufacturer and user.

4.3.2 Mechanical operation

Conditions: IEC 60512, Test 9a
Standard atmospheric conditions
Max. speed of operations = 10 mm/s
Rest: 30 s, unmated

Table 8 – Number of mechanical operations

| Contact finish | Mechanical operations |
|----------------|-----------------------|
| Gold | 100 |
| Other types | a) |

a) Other mating cycles are permissible when agreed between manufacturer and user.

4.3.3 Insertion and withdrawal forces

Conditions: IEC 60512, Test 13b
Standard atmospheric conditions
Max. speed = 10 mm/s

Table 9 – Insertion and withdrawal forces

| Total insertion force N | Total withdrawal force N |
|----------------------------|-----------------------------|
| 30 max | 30 max |

4.3.4 Contact retention in insert

Not applicable

4.3.5 Polarizing method

Conditions: IEC 60512, Test 13e
Engaging force: $1,5 \times$ total insertion force but 35 N min.

4.3.6 Vibration (sinusoidal)

Conditions: IEC 60512, Test 6d
Standard atmospheric conditions
Connectors in mated and locked position
The fixed and free connector shall be rigidly installed in a suitable fixture as specified in 5.1.2
Vibration Severity: 10 Hz to 500 Hz and 0,35 mm or 5 g

4.3.7 Shock

Conditions: IEC 60512 Test 6c
Connectors in mated and locked position
The fixed and free connector shall be rigidly installed in a suitable fixture as specified in 5.1.2
Half sine shock acceleration 490m/s^2 (50g)
Duration of impact: 11ms

5 Test schedule

5.1 General

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

Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in IEC 60068-1, as directed by the applicable part of IEC 60512.

Unless otherwise specified, mated and locked sets of connectors shall be tested. Care shall be taken to keep a particular combination of connectors together during the complete test sequence, i.e. when unmating is necessary for a certain test, the same connector styles as before shall be mated for the subsequent tests.

In the following, a mated and locked sets of connector styles is called a specimen.

When the initial tests have been completed, all the specimens are divided in the 4 test groups AP, BP, CP and DP. In addition 20 single contacts are used for EP and 20 additional specimens for FP.

Before testing commences, the connectors shall be stored for at least 24 h in the non-engaged state under standard atmospheric conditions as per IEC 60068-1.

The necessary specimens are stated in Table 1.

Table 10 – Number of test specimens

| | Test group | | | | | | |
|--------------------|------------|----|----|----|----|--------------------|----|
| | P | AP | BP | CP | DP | EP | FP |
| Number of specimen | 12 | 3 | 3 | 3 | 3 | 20 single contacts | 2 |

5.1.1 Arrangement for contact resistance measurements

Conditions: see 4.2.4

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.

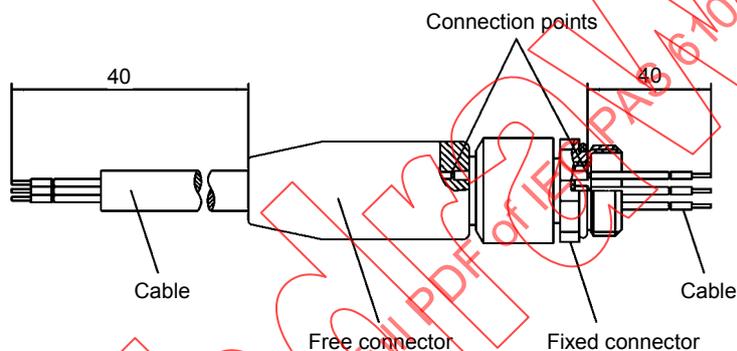
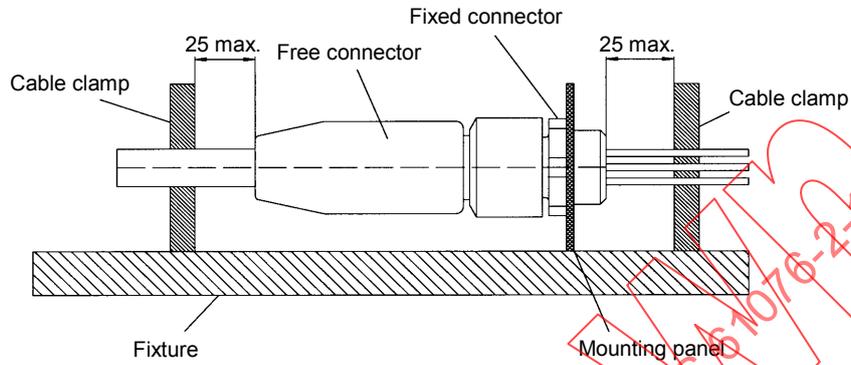


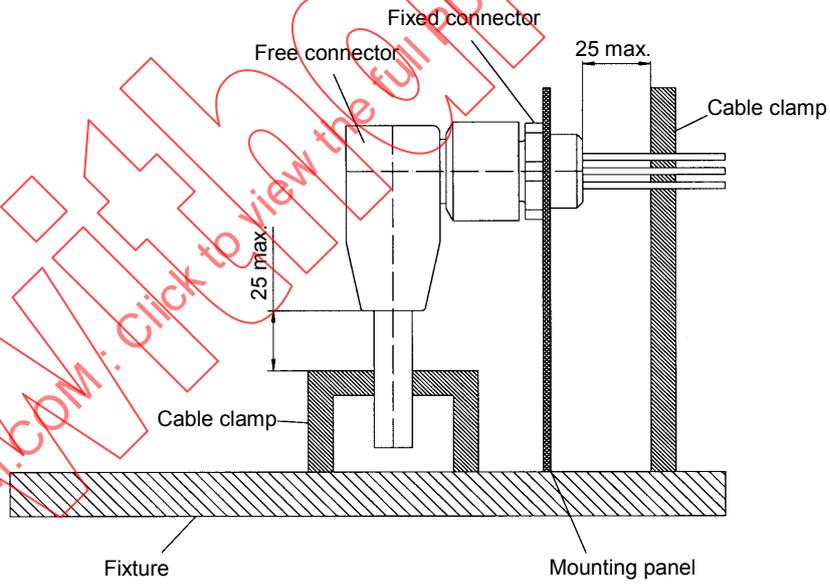
Figure 4 – Contact resistance arrangement

5.1.2 Arrangement for dynamic stress tests (vibration)

Conditions: see 4.3.6



IEC 2380/03



IEC 2381/03

Figure 5 – Dynamic stress test arrangement

5.2 Test schedule

5.2.1 Test group P-Preliminary

All specimens shall be subject to the following tests.

Table 11 – Test group P

| Test phase | Test | | | Measurement to be performed | | Requirements |
|------------|---------------------|---------------------|---|---|---------------------|---|
| | Title | IEC 605 12 Test No. | Severity or condition of test | Title | IEC 605 12 Test No. | All connector styles |
| P1 | General examination | 1 | Unmated connectors | Visual examination | 1a | There shall be no defect that would impair normal operation |
| | | | | Dimensional examination | 1b | The dimensions shall comply with those specified in 2.2 and 3 |
| P2 | | | Connection points according to 5.1.1 all contacts per specimens | Contact resistance – Millivolt level method | 2a | Initial value according to 4.2.4 |
| P3 | | | Test voltage 500 V ± 15 V d.c. Method A | Insulation resistance | 3a | Initial value according to 4.2.5 |
| P4 | | | Contact/contact same measuring points as for P3 | Voltage proof | 4a | According to 4.2.2 |

The specimen shall be divided into 4 groups. All connectors in each group shall undergo the tests specified for the relevant group.

5.2.2 Test group AP – Dynamic/ Climatic

Table 12 – 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 | | | See 4.3.3 | Insertion and withdrawal forces | 13b | Requirements see 4.3.3 |
| AP2 | Gauge retention force | | Female contacts only 3 contacts/ specimen sizing and retention force gauge see 3.3.1 | Engaging and separating forces | 16e | See 3.3.1 |
| AP3 | Vibration | 6d | Sweep cycles: 10 Full duration: 6 h See 4.3.6 | Contact disturbance | 2e | Duration of disturbance 1 µs max. |
| | | | | Contact resistance – Millivolt level method | 2a | Rise in relation to initial values ≤10 mΩ |
| | | | | Visual examination | 1a | There shall be no defect that would impair normal operation |
| AP4 | Shock | 6c | See 4.3.7 | Contact disturbance | 2e | Duration of disturbance 1 µs max. |
| | | | | Contact resistance – Millivolt level method | 2a | Rise in relation to initial values ≤10 mΩ |
| | | | | Visual examination | 1a | There shall be no defect that would impair normal operation |
| AP5 | Rapid change of temperature | 11d | -25 °C to 85 °C t = 30 min. 5 cycles | Contact resistance – Millivolt level method | 2a | Rise in relation to initial values ≤10 mΩ |
| | | | | Insulation resistance | 3a | Initial value according to 4.2.5 |
| | | | | Voltage proof | 4a | According to 4.2.2 |
| | | | | Visual examination | 1a | There shall be no defect that would impair normal operation |

Table 12 (continued)

| 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 |
| AP6 | Climatic sequence | 11a | | | | |
| AP6.1 | Dry heat | 11i | Temperature: 85 °C Duration: 16 h | Insulation resistance at high temperature | 3a | Initial value according to 4.2.5 |
| AP6.2 | Damp heat, cyclic, first cycle | 11m | Method dB Temperature: 40 °C Recovery time: 2 h | Visual examination | 1a | There shall be no defect that would impair normal operation |
| AP6.3 | Cold | 11j | Temperature: -25 °C Duration: 2 h Recovery time: 2 h | Visual examination | 1a | There shall be no defect that would impair normal operation |
| AP6.4 | Damp heat, cyclic, remaining cycles | 11m | Conditions according to AP6.2 5 cycles Recovery time: 2 h | Contact resistance – Millivolt level method | 2a | Rise in relation to initial values ≤15 mΩ |
| | | | | Insulation resistance | 3a | Initial value according to 4.2.5 |
| | | | | Voltage proof | 4a | According to 4.2.2 |
| | | | | Insertion and withdrawal forces | 13b | Requirements see 4.3.3 |
| | | | | Visual examination | 1a | There shall be no defect that would impair normal operation |
| AP7 | IP Protection degree | IEC 60529 | | Table 1 of IEC 60529 | | According to 4.3.1 |
| AP8 | | | | Visual examination | 1a | There shall be no defect that would impair normal operation |
| AP9 | Polarizing method | 13e | See 4.3.5 | | | It shall be possible to correctly align and mate the appropriate mating connectors. It shall not be possible to mate the connectors in any other than the correct manner. The insertion and withdrawal forces according to AP1 |

5.2.3 Test group BP – Mechanical endurance

Table 13 – 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 |
| BP1 | | | Female contacts only 3 contacts/specimen sizing and retention force gauge see 3.3.1 | Gauge retention force | 16e | See 3.3.1 |
| BP2 | Mechanical operation (half of the specified number of operations) | 9a | Speed 10 mm/s max. Rest 30 s (unmated) Operations see 4.3.2 Speed: 10 mm/s max. Rest time: 30 s (unmated) | | | |
| | | | | Contact resistance- Millivolt level method | 2a | Rise in relation to initial values $\leq 15 \text{ m}\Omega$ |
| | | | | Visual examination | 1a | There shall be no defect that would impair normal operation |
| BP3 | Climatic test | | | | | |
| BP3.1 | Corrosion industrial atmosphere | 11g | Flowing mixed gas corrosion - 4 days, test method 4 according to IEC 60068-2-60 | Contact resistance- Millivolt level method | 2a | Rise in relation to initial values $\leq 15 \text{ m}\Omega$ |
| BP4 | Mechanical operation (remaining half of specified number of operations) | 9a | See BP2 | Contact resistance – Millivolt level method | 2a | Rise in relation to initial values $\leq 10 \text{ m}\Omega$ |
| | | | | Insulation resistance | 3a | Initial value according to 4.2.5 |
| | | | | Voltage proof | 4a | According to 4.2.2 |
| | | | Unmated connectors | Visual examination | 1a | There shall be no defect that would impair normal operation |
| BP5 | | | | Insertion and withdrawal forces | 13b | For requirements, see 4.3.3 |
| BP6 | | | Female contacts only 3 contacts/specimen sizing and retention force gauge, see 3.3.1 | Gauge retention force | 16e | See 3.3.1 |