IEC/PAS 61076-2-110

Edition 1.0 2010-03

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

Connectors for electronic equipment – Product requirements – Part 2-110: Circular connectors – Detail specification for circular connectors M 12 × 1 with screw-locking, for high speed Ethernet and high speed data communication with frequencies up to 500 MHz and 10 gigabits/s

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IEC/PAS 61076-2-110 has been prepared by subcommittee 48B: Connectors, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment.

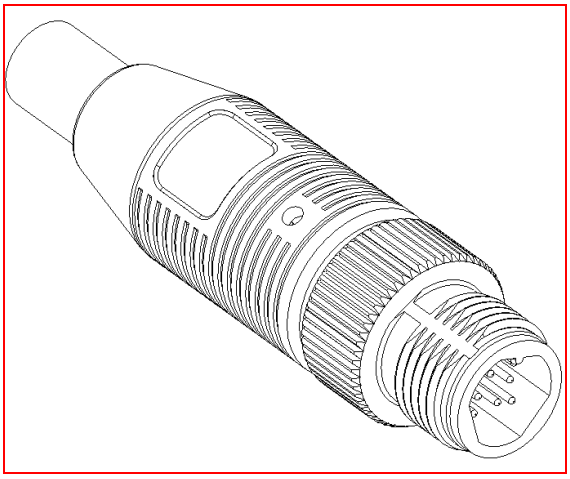
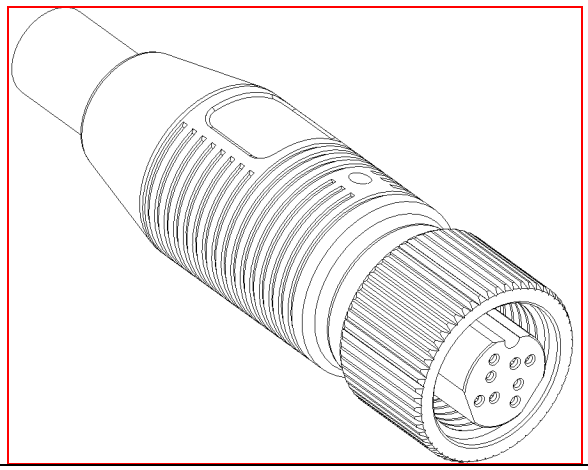
The text of this PAS is based on the following document:

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

Draft PAS	Report on voting
48B/2096/PAS	48B/2148/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single 3-year period, following which it shall be revised to become another type of normative document, or shall be withdrawn.

INTERNATIONAL ELECTROTECHNICAL COMMISSION	IEC 61076-2-110
ELECTRONIC COMPONENTS in accordance with IEC 61076-1	
 	Circular connectors M12 × 1 mm 8 poles, for data communication with frequencies up to 500 MHz Pin and socket connector Rewireable – Non-rewireable Free cable connectors Straight and right angle connectors Fixed connectors Flange mounting Rear mounting Single hole mounting

CONNECTORS FOR ELECTRONIC EQUIPMENT – PRODUCT REQUIREMENTS –

Part 2-110: Circular connectors – Detail specification for circular connectors M 12 × 1 with screw-locking, for high speed Ethernet and high speed data communication with frequencies up to 500 MHz and 10 gigabits/s

1 General information

Throughout this detail specification dimensions are in mm.

1.1 Scope

This Publicly Available Specification (PAS) describes M12 circular connectors for use in industrial environments for high speed Ethernet and high speed data transfer. Applications include, but are not limited to, vision systems and data acquisition. Screw locking M12 connectors consist of fixed and free connectors.

Male connectors have round contacts Ø 0,6mm.

1.2 Recommended method of termination

The contact terminations shall be of the following types: screw, crimp, insulation piercing, and insulation displacement.

1.2.1 Number of contacts or contact cavities

Connector type H	M12	2 to 8 contacts

1.3 Ratings and characteristics

Rated voltage: 48 V, see 4.2.1, Table 3

Current rating: 0,5 A, see 4.2.3

Insulation resistance: 10^8 Ω, see 4.2.5

Climatic category: –25 °C /+85 °C / 21 days see 4.1, Table 2

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 – 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, *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 this document are in mm. Drawings are shown in the first angle projection. The shapes 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 2.2.

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

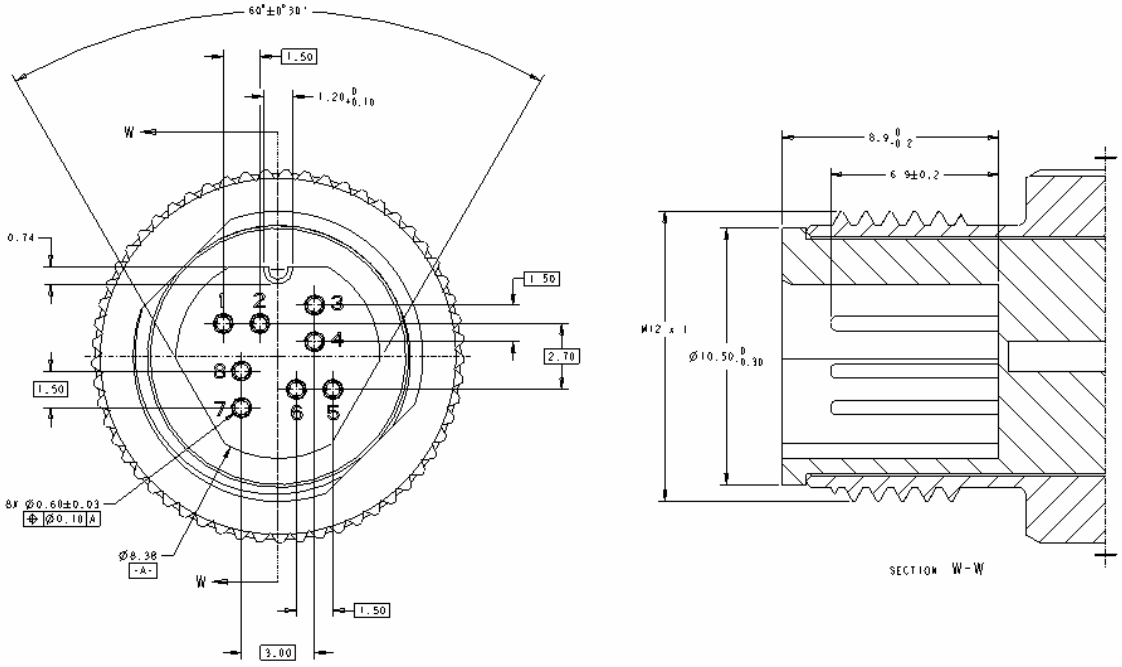


Figure 1 – Interface dimensions free connector

3.3 Gauges

3.3.1 Sizing gauges and retention force gauges

Material: tool steel, hardened

$\sqrt{\nabla}$ = Surface roughness according to ISO 1302: Ra = 0,25 µm max.
0,15 µm min.

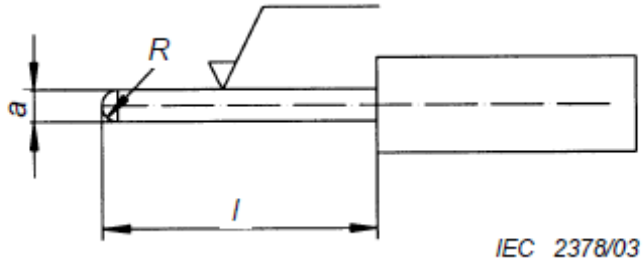


Figure 2 – Gauge dimensions

Table 1 – Gauges

Gauge	Mass g	Application	Ø a mm	L min mm
P31	-	Sizing	0,63	10
P32	20	Retention force	0,57	10

4 Characteristics

4.1 Climatic category

Conditions: IEC 60068-1

Table 2 – 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 3 – Rated voltage - Impulse voltage – Pollution degree

Contact arrangement according to Clause 3	Rated voltage V	Rated impulse voltage kV	IP 65/67 variants Pollution degree [b)]
8 poles	48	1,5	3

a) In mated condition.

b) The rated voltage and impulse voltage are based on pollution degree 2. This results from application of the rules of IEC 60664-1.

4.2.2 Voltage proof

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

Table 4 – Voltage proof connectors

Contact arrangement according to 3.2	Between contacts Impulse withstand voltage (kV)		Between contacts and metal housing Impulse withstand voltage (kV)	
	Fixed connectors	Free connectors	Fixed connectors	Free connectors
	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 (0,25mm^2 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 < 5mΩ

4.2.5 Insulation resistance

Conditions: IEC 60512, Test 3a, Method A
Standard atmospheric conditions
Insulation resistance ≥10^8 Ω

4.3 Mechanical

4.3.1 IP degree of protection

IP65 / 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 5 – 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 6 – Insertion and withdrawal forces

Total insertion force N	Total withdrawal force N
23 max	30 max

4.3.4 Contact retention in insert

Not applicable

4.3.5 Polarizing method

Conditions: IEC 60512, Test 13e
Insertion force 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 set 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 7 – Number of test specimens

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

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.

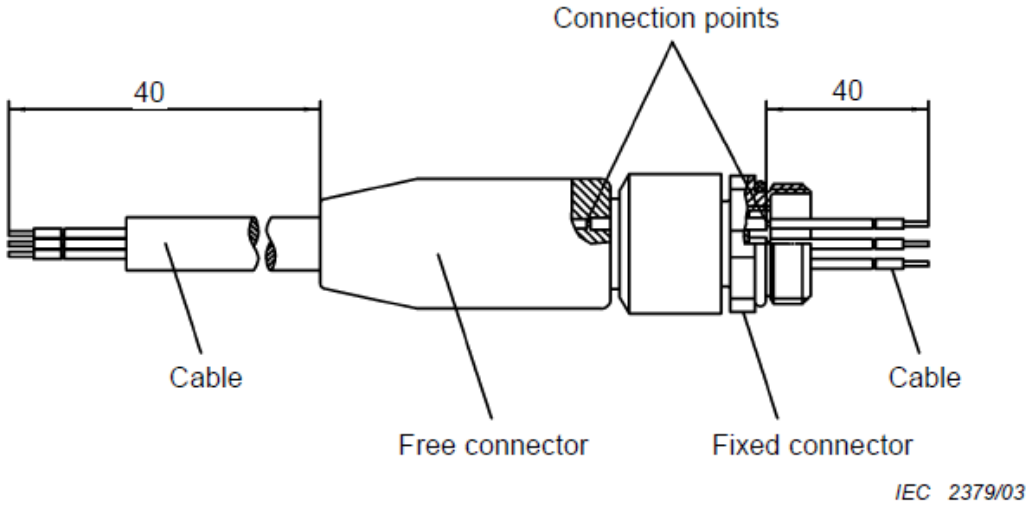
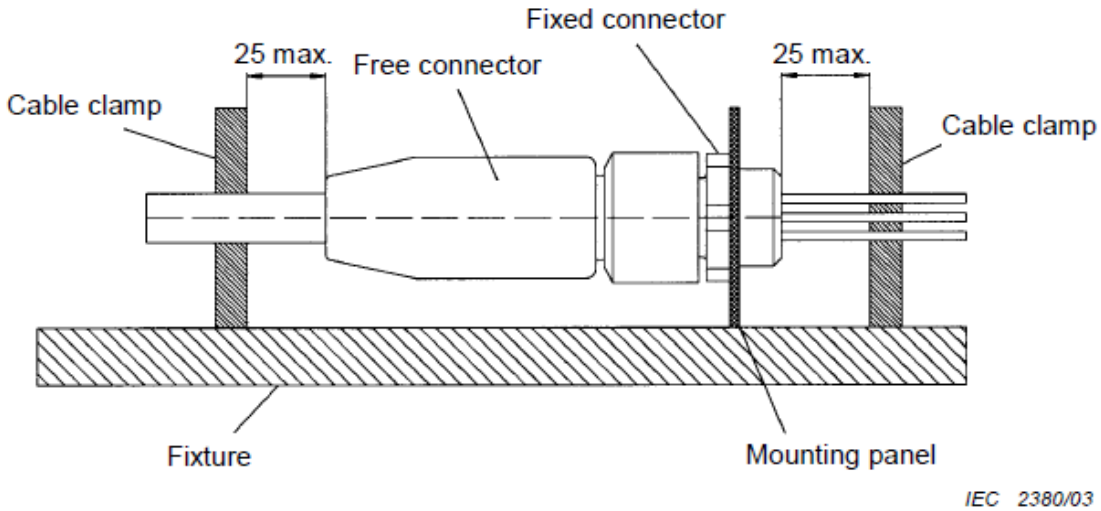


Figure 3 – Contact resistance arrangement

5.1.2 Arrangement for dynamic stress tests (vibration)

Conditions: see 4.3.6



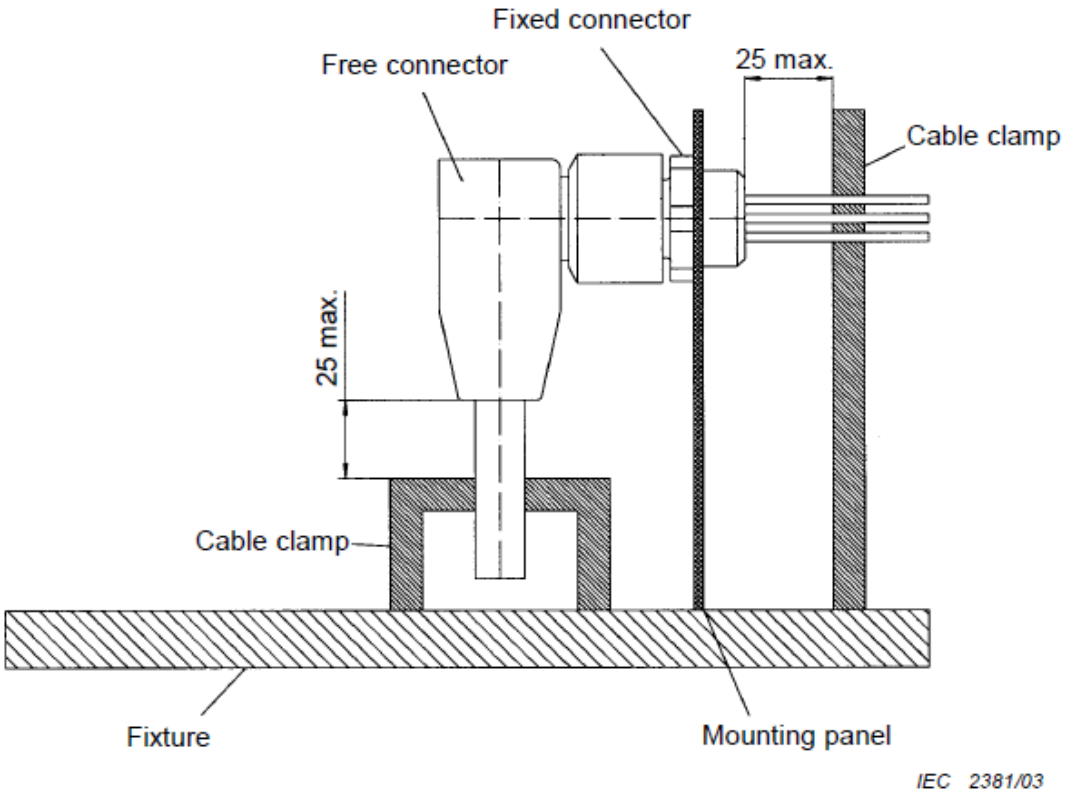


Figure 4 – Dynamic stress test arrangement

5.2 Test schedule

5.2.1 Test group P-Preliminary

All specimens shall be subjected to the following tests.

Table 8 – 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	1	Unmated Connectors	Visual examination	1a	There shall be no defect that would impair normal operation
P2			Connection points according to 5.1.1 all contacts per specimens	Contact resistance – Millivolt level method	2a	Initial value acc.4.2.4
P3			Test voltage 500 V ± 15 V d.c. Method A	Insulation Resistance	3a	Initial Value acc.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 9 – 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 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

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
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 tempera-ture	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 acc.4.2.5
				Voltage Proof	4a	According to 4.2.2
				Visual examination	1a	There shall be no defect that would impair normal operation
AP6	Climatic sequence	11a				
AP6.1	Dry heat	11i	Temperature: 85 °C Duration: 16 h	Insulation resistance at high temperature	3a	Initial Value acc.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 acc.4.2.5
				Voltage proof	4a	Acc. 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

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	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 acc.AP1

5.2.3 Test group BP – Mechanical endurance

Table 10 – 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)			
				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 IEC 60068-2-60	Contact resistance- Millivolt level method	2a	Rise in relation to initial values ≤10 mΩ
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 ≤10 mΩ
				Insulation resistance	3a	Initial value acc.4.2.5
				Voltage proof	4a	According 4.2.2
			Unmated connectors	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
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

5.2.4 Test group CP – Electrical load

Table 11 – 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	Rapid change of temperature	11d	−25 °C to 85 °C *r* = 1 h 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
CP2	Mechanical operation	9a	See BP2			
CP3	Electrical load and temperature	9b	Duration: 1000 h Amb.temp.: 40 °C Current load according to 4.2.3 Recovery time: 2 Temperature: sensor in center of specimen	Contact resistance – Millivolt level method		Rise in relation to initial values ≤10 mΩ
				Insulation Resistance	3a	Initial value acc.4.2.5
				Voltage Proof	4a	According to 4.2.2
CP4			Unmated connectors	Visual examination	1a	

5.2.5 Test group DP – Chemical resistivity

Table 12 – 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
DP1	Resistance to fluids	19c	Upon agreement between manufacturer and user			Upon agreement between manufacturer and user

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
DP2	Retreatment		Clearing of specimen by washing briefly in light petrol	Contact resistance – Millivolt level	2a	Rise in relation to initial values ≤15 mΩ
DP3				Voltage proof	4a	According to 4.2.2
DP4			Unmated connectors	Visual examination	1a	There shall be no defect that would impair normal operation

5.2.6 Test group EP – Connection method tests

Table 13 – 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
EP1	Crimp Terminations					
EP1.1	Tensile strength (crimped connection)	16d	According to IEC 60352-2			

5.2.7 Test group FP – Electrical transmission requirements

These tests are applicable for connector for symmetrical pair cabling. The measurements shall be performed according to the contact and pair designation in Table 18

Table 18 – Contact and pair designation for symmetrical cabling

Table 14 – Contact pair

Pair	Contact
1	1
	2
2	3
	4
3	5
	6
4	7
	8

Category 6A performance level, respective to transmission characteristics, is determined according to specific test methods described in test group FP, see Table 15 – Test group FP. Category 6A transmission performance interoperability shall be demonstrated by testing the fixed connectors with the full range of free connectors according to IEC 60512-27-100 and IEC 60512-25-9. Transmission performance and backward compatibility shall be

demonstrated by testing the fixed connectors with the full range of free connectors or “test plugs” described in IEC 60512-6-100.

All transmission performance requirements apply between the reference planes specified in IEC 60512-27-100.

Table 15 – Test group FP

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
FP1			All pairs	Insertion loss	In the style of 60512-27-100 Test 27a	Mated connectors All pairs: $\leq 0{,}02 \cdot \sqrt{f_f}$ dB from 1 MHz to 500 MHz. Whenever the formula results in a value less than 0,1 dB, the requirement shall revert to 0,1 dB.
FP2				NEXT loss	In the style of 60512-27-100 Test 27c	Mated connectors All pair combinations: ≥ 94-20log(*f*) dB from 1 MHz to 250 MHz All pair combinations: ≥ 46,04 - 30 log(*f/250*) dB from 250 MHz to 500 MHz. Whenever the formula results in a value greater than 80 dB, the requirement shall revert to 80 dB.
FP3			All pairs, both directions	Return loss	In the style of 60512-27-100 Test 27b	Mated connectors All pairs: ≥ 68-20log(*f*) dB from 1 MHz to 500 MHz. Whenever the formula results in a value greater than 30 dB, the requirement shall revert to 30 dB
FP4			All pairs, both directions (pair to pair)	FEXT loss	In the style of 60512-27-100 Test 27d	Mated connectors All pair combinations: ≥ 83.1-20log(f) dB from 1 MHz to 500 MHz Whenever the formula results in a value greater than 75 dB, the requirement shall revert to

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
						75 dB.
FP5			All pairs, both directions	TCL	In the style of 60512-27-100 Test 27f	Mated connectors All pairs: ≥ 68 - 20 log(f) dB from 1 MHz to 500 MHz. Whenever the formula results in a value greater than 50 dB, the requirement shall revert to 50 dB.
FP6			All pairs, both directions	TCTL	In the style of 60512-27-100 Test 27g	Mated connectors All pairs: ≥ 68- 20 log(f) dB from 1 MHz to 500 MHz. Whenever the formula results in a value greater than 50 dB, the requirement shall revert to 50 dB.
FP7	Input to Output resistance			Millivolt level method	2a	Per 6.4.5
FP8	Resistance unbalance			Millivolt level method	2a	Per 6.4.6
FP9			All pairs, both directions	PS ANEXT	In the style of 60512-25-9	Mated connectors All pairs: ≥ 110,5 – 20 log(f) dB from 1 MHz to 500 MHz.
FP10			All pairs, both directions	PS AFEXT	In the style of 60512-25-9	Mated connectors All pairs: ≥ 107 – 20log(*f*) dB from 1 MHz to 500 MHz Whenever the formula results in a value greater than 67 dB, the requirement shall revert to 67 dB.
All measurements to be performed on mated connectors. Although the mated free connector can be different according to the requirements of the test standards, the same fixed connectors shall be used for each of the tests						

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