

PUBLICLY AVAILABLE SPECIFICATION PRE-STANDARD

**Connectors for electronic equipment – Product requirements –
Part 2-107: Circular connectors – Detail specification for circular hybrid
connectors M12 with electrical and fibre-optic contacts with screw-locking**

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connectors M12 with electrical and fibre-optic contacts with screw-locking**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

**Part 2-107: Circular connectors – Detail specification for circular
hybrid connectors M12 with electrical and fibre-optic contacts
with screw-locking**

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IEC PAS 61076-2-107 edition 1 has been prepared by subcommittee 48B: Connectors, of IEC technical committee 48: Electromechanical components and mechanical structures for electronic equipment, in cooperation with subcommittee 86B: Fibre optic interconnecting devices and passive components, of technical committee 86: Fibre optics.

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/1790B/NP	48B/1828/RVN

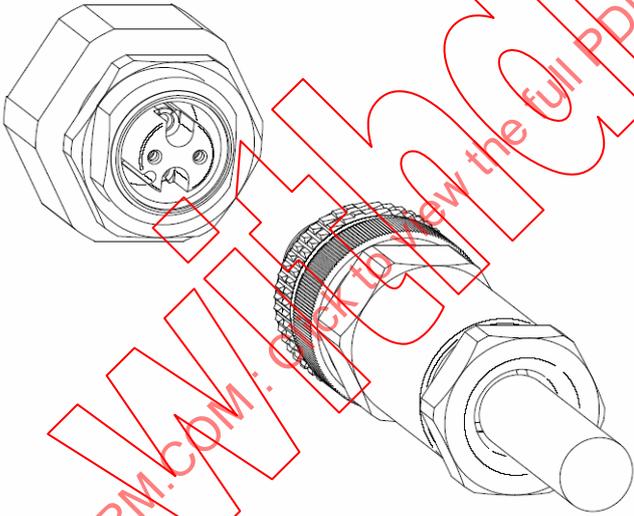
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**CONNECTORS FOR ELECTRONIC EQUIPMENT –
PRODUCT REQUIREMENTS –**

Part 2-107: Circular connectors – Detail specification for circular hybrid connectors M12 with electrical and fibre-optic contacts with screw-locking

<p>IEC SC 48B – Connectors</p> <p>Specification available from: IEC General secretariat or from the addresses shown on the inside cover.</p>	<p>IEC/PAS 61076-2-107</p>
<p>ELECTRONIC COMPONENTS</p> <p>DETAIL SPECIFICATION in accordance with IEC 61076-1</p>	
	<p>Circular hybrid connectors M12-4: with 2 way electrical connections with \varnothing 1,0 male contacts and with 2 way fibre optic connections with \varnothing 1,25 ceramic LC ferrule</p>
	<p>Free cable connectors Straight connectors</p> <p>Fixed connectors</p> <p>Flange mounting Single hole mounting</p> <p>Adapters</p> <p>Feed through</p>

1 General information

This Publicly Available Specification (PAS) has been prepared by SC 48B to support and to be referenced in IEC 61784-5-3:2007.

This PAS is subject to further development of a joint Project Team of SC 48B and SC 86B to publish an International Standard IS.

1.1 Scope

This PAS describes circular M12-connectors typically used for industrial process measurement and control. These connectors consist of fixed and free connectors with screw-locking as well as adaptors.

The connectors are suitable to connect two optic fibres and two electrical wires intended for power transmission to the optionally integrated transmitter and receiver, not specified in this PAS.

Male connectors have round electrical contacts \varnothing 1,0 mm and cylindrical ceramic optic contacts \varnothing 1,25 mm according to IEC 61754-20 Type LC for

- All-silica optic fibre cables
- Single-Mode fibre 9/125 μ m
- Multi-Mode fibre 50/125 μ m or 62,5/125 μ m

NOTE M12 is the dimension of the thread of the screw locking mechanism of these circular connectors.

1.2 Recommended method of termination

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

The optical contact terminations shall be defined between manufacturer and user. Preferred termination method for the international standard should be developed between SC 48B and SC 86B.

1.3 Ratings and characteristics

1.3.1 Electrical contacts

Rated voltage: 250 V d.c. or a.c.

Rated current: 4 A

Insulation resistance: minimum $10^8 \Omega$

Climatic category: see 4.1, Table 6

Contact spacing: see Clause 3

1.3.2 Optic contacts

Dimensions for ferrule and end face:

- for mono mode fibre, according to Grade 1 of IEC 61754-20
- for multi mode fibre, according to Grade 2 of IEC 61754-20

Insertion loss: Under development between SC 48B and SC 86B

Return loss: Under development between SC 48B and SC 86B

Climatic category : see 4.1, Table 6

Contact spacing : not applicable

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 (all parts), *Solderless connections*

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 60529:2001, *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 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*

IEC 60999-2, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units*

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

IEC 61754-20:2002, *Fibre optic connector interfaces – Part 20: Type LC connector family*

ISO 1302, *Geometrical Product Specification (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 61076-1:2006.

1.6 Safety aspects

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

2 Technical information

All dimensions in mm.

2.1 Terms and definitions

For the purpose of this Publicly Available Specification, the terms and definitions from IEC 60050 (581) apply.

2.1.1 Mounting orientation

Circular mounting position of the connector in relation to the polarization of the mating interface.

2.2 Survey of styles and variants

For all connector styles with cables, the length L of the cable shall be agreed upon between manufacturer and user.

For interface dimensions, see 3.2.

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

2.2.1 Fixed connectors

Table 1 – Styles of fixed connectors

Style	Description
AF	Fixed connector, electrical female contacts, single hole mounting thread M16 x 1,5, mounting orientation
BF	Fixed connector, electrical female contacts, for feed through, single hole mounting thread M16 x 1,5

2.2.1.1 Style AF

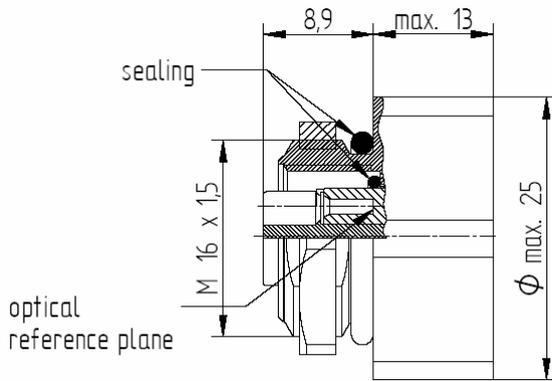


Figure 1 – Fixed connector, electrical female contacts, single hole mounting thread M16 × 1,5 mounting orientation

2.2.1.2 Style BF

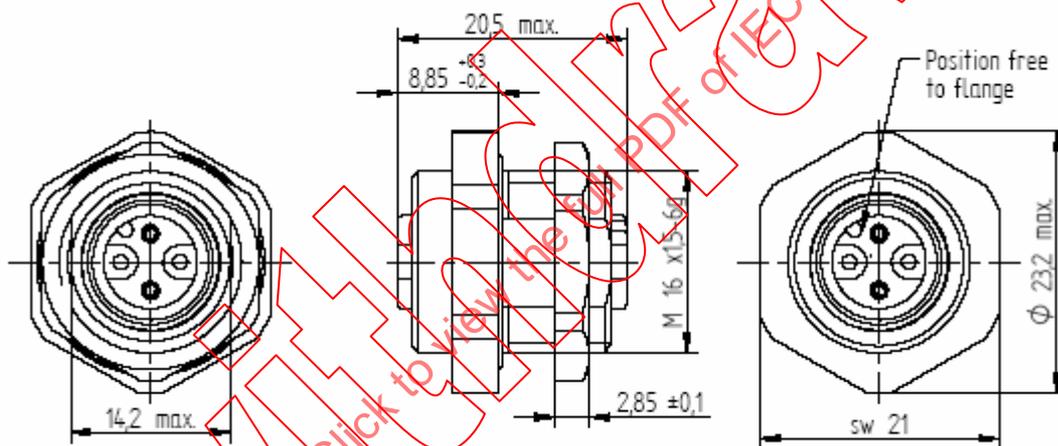


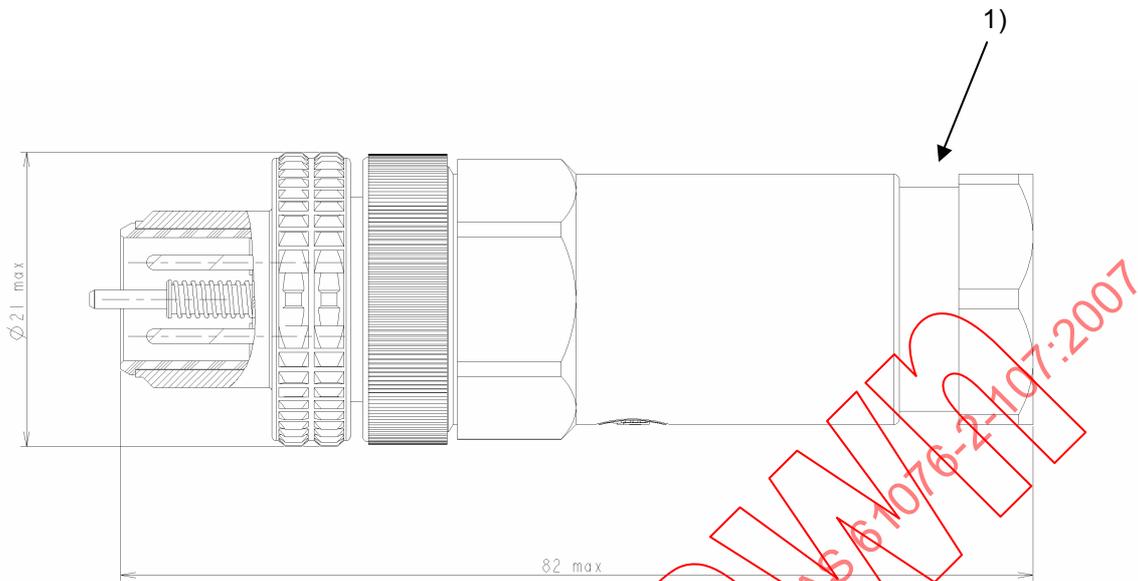
Figure 2 – Fixed connector, electrical female contacts, for feed through, single hole mounting thread M16 × 1,5

2.2.2 Free connectors

Table 2 – Styles of free connectors

Style	Description
CM	Free connector, straight version, with locking nut, male contacts

2.2.2.1 Style CM



Key

- 1) Cable outlet diameter upon agreement

Figure 3 – Free connector, straight version, with locking nut, male contacts

2.2.3 Adaptor

Table 3 – Styles of adaptors

Style	Description
DF	Adaptor, straight version, without locking nut

2.2.3.1 Style DF

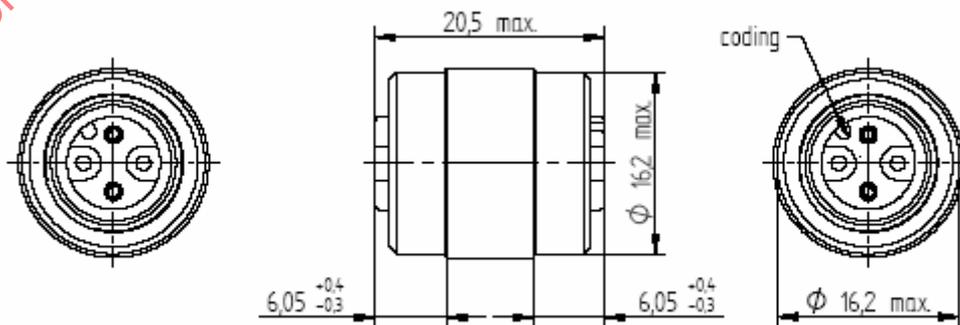


Figure 4 – Adaptor, straight version, without locking nut

3.3 Engagement (mating) information

Arrows in Figure 6 indicate mating direction.

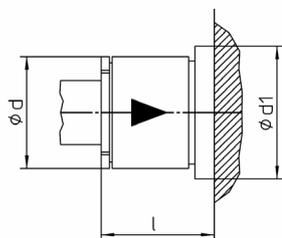


Figure 6a - Housing variant 1

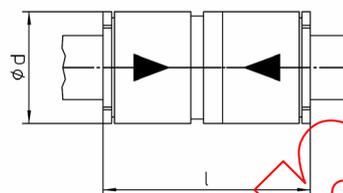


Figure 6b - Housing variant 2

Figure 6 – Engagement (mating) information

Table 4 – Dimensions of connectors Type D in mated position

Figure	Combination of styles	d maximum	d1	l ¹⁾ maximum
6a	AF-CM	Ø 21	Ø 26,2	65
6a	BF-CM	Ø 21	Ø 26,2	65
6b	CM-DF-CM	Ø 21	---	130

¹⁾ Dimensions in mated position, additional space for insertion: 15 mm.

3.4 Gauges for electric contacts

Sizing gauges and retention force gauges

Material: tool steel, hardened

▽ = Surface (clean and free of grease)
roughness according to ISO 1302: Ra = 0,25 µm maximum, 0,15 µm minimum

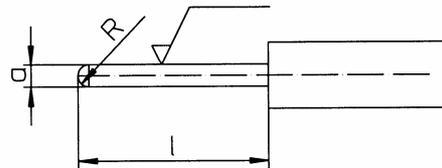


Figure 7 – Gauge dimensions

Table 5 - Gauges

Gauge	Mass g	Application	Ø a mm	l minimum mm	Nom pin Ø
P11	-	Sizing	1,03	10	1,0 ± 0,03
P12	20	Retention force	0,97	10	

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4 Characteristics

4.1 Climatic category

Conditions: IEC 60068-1

Table 6 – Climatic category

Climatic category	Category 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 characteristics (only electrical contacts)

4.2.1 Rated voltage – 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 7 – Rated voltage – Impulse voltage – Pollution degree

Rated voltage V	Rated impulse voltage kV	Pollution degree
250	2,5	3
NOTE Only in mated and locked condition. Due to the accessibility of the male contacts, the rated voltage shall be reduced to 50 V SELV/PELV.		

4.2.2 Voltage proof

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

Table 8 – Voltage proof

Between contacts r.m.s. withstand voltage		Between contacts and metal housing	
Fixed connectors kV	Free connectors kV	Fixed connectors kV	Free connectors kV
1,4	1,4	1,4	1,4

4.2.3 Current-carrying capacity

Conditions: IEC 60512, Test 5b
All contacts
Values at 40°C 4 A

4.2.4 Contact resistance

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

4.2.5 Insulation resistance

Conditions: IEC 60512, Test 3a, Method A
Standard atmospheric conditions
Test voltage 500 V ± 15 V d.c.

4.3 Optic characteristics (only optic contacts)

(Under development between SC 48B and SC 86B)

4.4 Mechanical

4.4.1 IP degree of protection

IP65 and IP67 according to IEC 60529, connectors in mated and locked position.

IP68 as agreed upon between manufacturer and user.

4.4.2 Mechanical operation

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

Table 9 – Number of mechanical operations

Contact finish	Mechanical operations
Gold	100
Silver	50
Tin	20
other types	a)

a) Other mating cycles are upon agreement between manufacturer and user.

4.4.3 Insertion and withdrawal forces

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

Table 10 – Insertion and withdrawal forces

Total insertion force N	Total withdrawal force N
25	30

4.4.4 Contact retention in insert

Not applicable

For removable crimp type contacts, the introduction of an appropriate requirement is under consideration.

4.4.5 Polarizing method

Conditions: IEC 60512, Test 13e
Insertion force: 35 N minimum.

4.4.6 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 to 500 Hz and 0,35 mm or 50 m/s²

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 up according to the test groups.

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 11.

Table 11 – Number of test specimens

	Test group					
	P	AP	BP	CP	DP	EP
No. of specimens	12	3	3	3	3	20 single contacts

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.

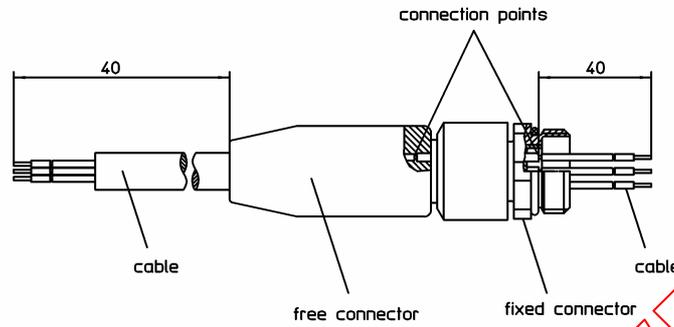


Figure 8 – Contact resistance arrangement

5.1.2 Arrangement for dynamic stress tests (vibration)

Conditions: see 4.4.6

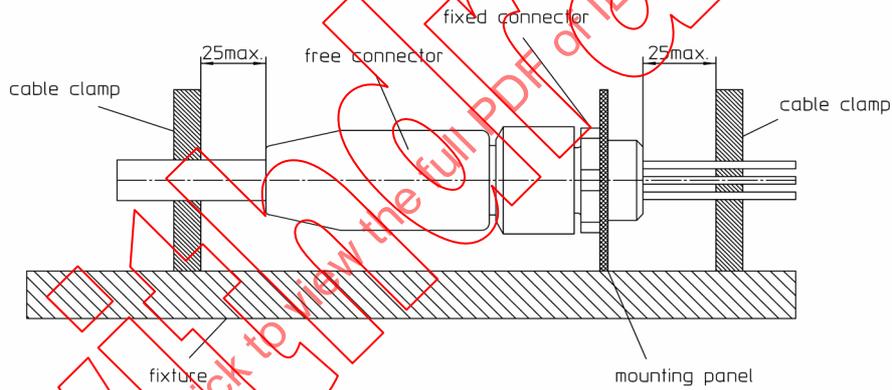


Figure 9 – Dynamic stress test arrangement A

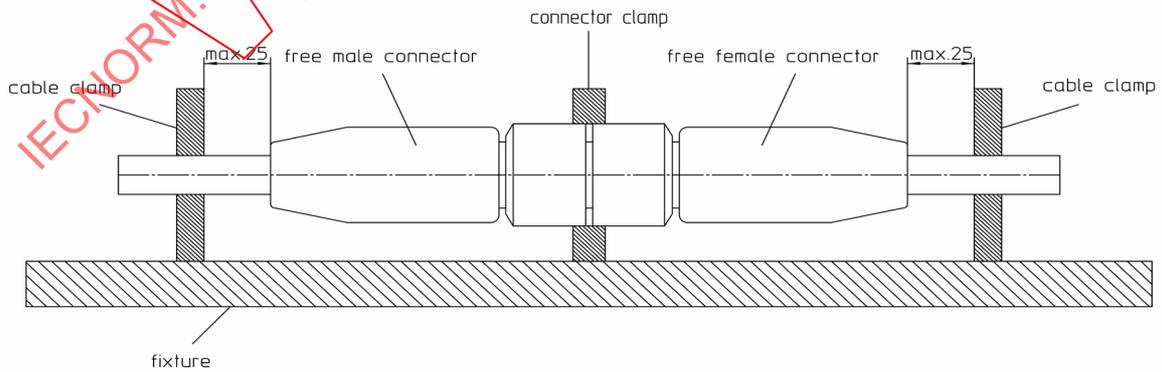


Figure 10 – Dynamic stress test arrangement B

5.2 Test schedule

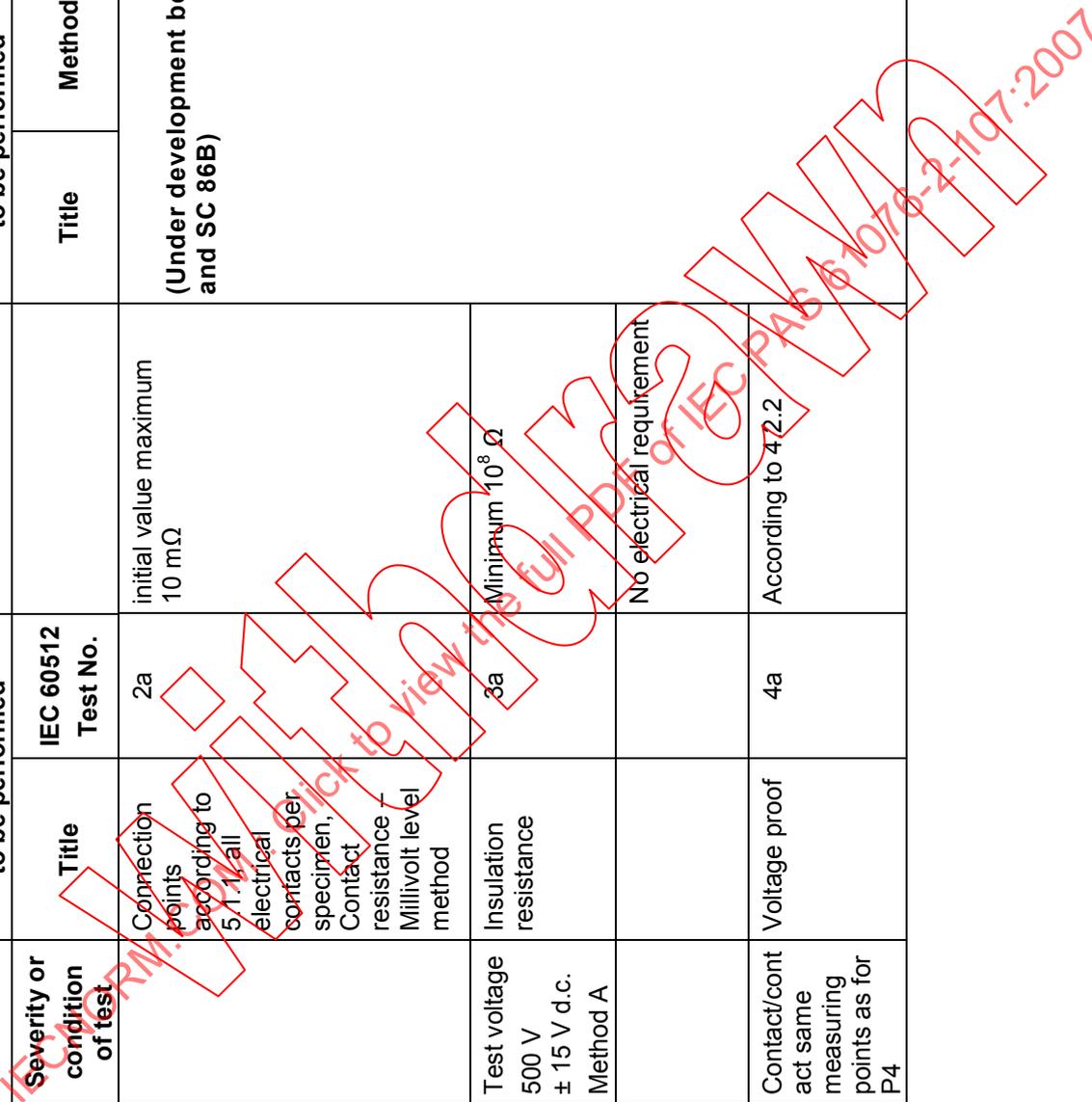
5.2.1 Test group P – Preliminary

All specimens shall be subject to the following tests.

Table 12 – Test group P

Test phase	Test		Electrical measurement to be performed	Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	IEC 60512 Test No.			Severity or condition of test	Title	
P1	General examination	1	Unmated connectors	Visual examination	There shall be no defect that would impair normal operation		
				Dimensional examination			
P2	Polarizing method	13e	see 4.4.5		It shall be possible to correctly align and mate the appropriate mating connectors		

Test phase	Test		Electrical measurement to be performed	Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	IEC 60512 Test No.			Severity or condition of test	Title	
P3	Connection quality (initial value)		Connection points according to 5.1.1 all electrical contacts per specimen, Contact resistance – Millivolt level method	2a	initial value maximum 10 mΩ		(Under development between SC 48B and SC 86B)
P4			Insulation resistance	3a	Minimum 10 ⁸ Ω		
P5	Return loss (random mated)		Test voltage 500 V ± 15 V d.c. Method A		No electrical requirement		
P6			Contact/contact same measuring points as for P4	4a	According to 4.2.2		



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

5.2.2 Test group AP – Dynamic Climatic

Table 13 – Test group AP

Test phase	Test		Electrical measurement to be performed	Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	IEC 60512 Test No.			Severity or condition of test	Title	
AP1	Insertion and withdrawal force	See 4.4.3	Insertion and withdrawal force	13b	Requirements see 4.4.3		
AP2	Gauge retention force	Female contacts only 2 contacts/ specimen sizing and retention force gauge see 3.3	Engaging and separating forces	16e	See 4.4.4		
AP3	Vibration	10 Hz - 500 Hz, 0,35 mm resp. 50 m/s ² Sweep cycles: 10 Full duration: 6 h	Contact disturbance	2e	Duration of disturbance maximum 1 µs	(Under development between SC 48B and SC 86B)	
			Contact resistance – Millivolt level method	2a	Rise in relation to initial values maximum 15 mΩ		
			Insertion loss	25b	Maximum 0,5 dB per connector		
			Visual examination	1a	There shall be no defect that would impair normal operation		

Test phase	Test		Electrical measurement to be performed	Electrical requirements	Optic measurement to be performed		Optic requirements
	IEC 60512 Test No.	Severity or condition of test			Title	Method	
AP4	Shock 6c	Arrangement according to 5.1.2 Half sine shock Acceleration 490 m/s ² (50 g) Duration of impact: 11 ms	Contact disturbance	2e	Duration of disturbance maximum 1 µs	(Under development between SC 48B and SC 86B)	
			Contact resistance – Millivolt level method	2a	Rise in relation to initial values maximum 15 mΩ		
			Visual examination	1a	There shall be no defect that would impair normal operation		
AP5	Rapid change of temperature 11d	-15 °C to 85 °C t = 30 min 5 cycles	Contact resistance – Millivolt level method	2a	Rise in relation to initial values maximum 15 mΩ		
			Insulation resistance	3a	Minimum 10 ⁸ Ω		
			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	Minimum 10 ⁸ Ω		
AP6.2	Damp heat, cyclic; first cycle 11m	Method Db Temp.: 40 °C Recovery time: 2 h	Visual examination	1a	There shall be no defect that would impair normal operation		

Test phase	Test			Electrical measurement to be performed		Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	IEC 60512 Test No.	Severity or condition of test	Title	IEC 60512 Test No.		Title	Method	
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			(Under development between SC 48B and SC 86B)
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 maximum 15 mΩ			
				Insulation resistance	3a	Minimum 10 ⁸ Ω			
				Voltage proof	4a	According to 4.2.2			
AP7	Impacting dust and water								
AP7.1	Second characteristic numeral		Spray-IPX5-IPX7 Test 5 and 7 Test 5: nozzle 6,3 mm Test 7: 1 m, 30 min	IEC 60529:2001 Test 14.2.5 and Test 14.2.7		No leakage on contacts			
AP7.2	First characteristic numeral		Dust IP6X Test 6, Table 7	IEC 60529:2001 Test 6 Table 7		IP6X no deposit of dust on contacts			

Test phase	Test		Electrical measurement to be performed		Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	IEC 60512 Test No.	Title	IEC 60512 Test No.		Title	Method	
AP7.3			Contact resistance – Millivolt level method	2a	Rise in relation to initial values maximum 15 mΩ			(Under development between SC 48B and SC 86B)
			Insulation resistance	3a	Minimum 10 ⁸ Ω			
			Voltage proof	4a	According to 4.2.2			
			Insertion and withdrawal force	13b	Requirements - see 4.4.3			
			Visual examination	1a	There shall be no defect that would impair normal operation			

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5.2.3 Test group BP – Mechanical endurance

Table 14 – Test group BP

Test phase	Test		Severity or condition of test	Electrical measurement to be performed		Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	IEC 60512 Test No.		Title	IEC 60512 Test No.		Title	Method	
BP1	Gauge retention force		Female contacts only 2 contacts/ specimen sizing and retention force gauge see 3.3	Engaging and separating forces	16e	See 4.4.4			(Under development between SC 48B and SC 86B)
BP2	Mechanical operation (half of the specified number of operations)	9a	Speed: 10 mm/s maximum Rest: 30 s (unmated) Operations see 4.4.2	Contact resistance – Millivolt level method	2a	Rise in relation to initial values maximum 15 mΩ			
BP3	Corrosion industrial atmosphere (salt spray)	11f	48 h	Visual examination	1a	There shall be no defect that would impair normal operation			
				Visual examination	1a	There shall be no defect that would impair normal operation			

Test phase	Test		Electrical measurement to be performed	Electrical requirements	Optic measurement to be performed		Optic requirements
	Title	Severity or condition of test			Title	Method	
BP4	Mechanical operation (remaining half of specified number of operations)	See BP2 9a	Contact resistance - Millivolt level method	2a	Rise in relation to initial values maximum 15 mΩ	(Under development between SC 48B and SC 86B)	
				3a	Minimum 10 ⁸ Ω		
				4a	According to 4.2.2		
				1a	There shall be no defect that would impair normal operation		
BP5	Gauge retention force	Female contacts only 2 contacts/ specimen sizing and retention force gauge see 3.3	Engaging and separating forces	16e	See 4.4.4		
				1a	There shall be no defect that would impair normal operation		
BP6	Fibre / cable retention		Visual examination	1a	There shall be no defect that would impair normal operation		
BP7	Mechanical impact		Visual examination	1a	There shall be no defect that would impair normal operation		
BP8	Torsion		Visual examination	1a	There shall be no defect that would impair normal operation		