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Road vehicles — Connections for on-board electrical wiring harnesses —

Part 2: Terminology, test methods and general performance requirements

Véhicules routiers — Connexions pour faisceaux de câblage électrique embarqués —

Partie 2: Terminologie, méthodes d'essai et exigences de performances générales

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

This fifth edition cancels and replaces the fourth edition (ISO 8092-2:2005), which has been technically revised.

The main changes are as follows:

— adoption of the content according to new technical requirements,

— adoption of the content according to the new version of the ISO guidelines,

— alignment of the content regarding to the referred standards,

— subclause 4.24 "Flowing gas corrosion test" has been removed due to its technical irrelevance,

— former Annex A is adopted as an informative part under 4.1.2,

— Annex B has been removed due to its technical irrelevance.

A list of all parts in the ISO 8092 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Road vehicles — Connections for on-board electrical wiring harnesses —

Part 2: Terminology, test methods and general performance requirements

1 Scope

This document provides terminology and specifies test methods for general performance requirements of voltage class A connectors used in electrical wiring harnesses on road vehicles.

This document applies to connectors which, after mounting in the vehicle, are designed to only be disconnected in connection with repair and maintenance.

This document does not apply to internal connections for electronic devices.

This document does not apply to signal communication quality or data integrity.

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.

ISO 8092-5:2021, *Road vehicles — Connections for on-board electrical wiring harnesses — Part 5: Test methods and general performance requirements for wiring harness connector operation*

ISO 16750-3:2023, *Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 3: Mechanical loads*

ISO 16750-4:2023, *Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 4: Climatic loads*

ISO 16750-5:2023, *Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 5: Chemical loads*

ISO 20653:2023, *Road vehicles — Degrees of protection (IP-code) — Protection against foreign objects, water and access –Electrical equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
voltage class A
classification of an electric component or circuit with a maximum working voltage of ≤ 30 V a.c. (rms) or ≤ 60 V d.c., respectively

[SOURCE: ISO 21498-1:2021, 3.12]

3.2
housing
non-conducting feature for inserting the terminal and providing insulation between terminals

3.3
cable attachment
permanent junction of cable to terminal

Note 1 to entry: Crimp and weld are typical methods.

Note 2 to entry: For terms related to cables, see ISO 19642-1.

3.4
connector
assembly of terminal, *housing* (3.2) and related parts that terminate cable for the purpose of providing connection and disconnection to a suitable mating connector

3.5
connector coding
mechanical feature to provide differentiation, preventing mating of *connectors* (3.4) not intended to be mated

3.6
connector polarization
method or design feature, which prevents *connectors* (3.4) that are intended to mate from mating in an unintended orientation, rotation, or angular position, whilst allowing mating in the intended manner

3.7
CPA
connector position assurance
device that prevents accidental release of the *connector* (3.4) lock and serves as an indicator of full connector mating

3.8
TPA
terminal position assurance
feature installed or seated after the terminals are inserted into their *housing* (3.2) to assure that the terminals are properly positioned, and which reinforces the primary terminal locking mechanism or provides a separate, redundant terminal lock

3.9
socket terminal
terminal, including means for *cable attachment* (3.3), designed for electrical engagement on its inner surface, and to accept entry of a *pin terminal* (3.11), thus forming an electrical connection

Note 1 to entry: See Figure 1 for an example.

Note 2 to entry: Socket terminals are sometimes referred to as female terminals.

a) socket b) receptacle

Figure 1 — Example of a socket and a receptacle terminal

3.10
receptacle terminal
terminal, including means for *cable attachment* (3.3), designed for electrical engagement on its inner surface, and to accept entry of a *tab terminal* (3.12), thus forming an electrical connection

Note 1 to entry: See Figure 1 for an example.

Note 2 to entry: Receptacle terminals are sometimes referred to as female terminals.

3.11
pin terminal
terminal, including means for *cable attachment* (3.3), designed for electrical engagement on its outer surface and to enter a *socket terminal* (3.9), thus forming an electrical connection

Note 1 to entry: Pin terminals are sometimes referred to as male terminals.

Note 2 to entry: See Figure 2 for an example.

a) pin b) tab

Figure 2 — Example of a pin and a tab terminal

3.12
tab terminal
terminal, including means for *cable attachment* (3.3), designed for electrical engagement on its outer surface and to enter a *receptacle terminal* (3.10), thus forming an electrical connection

Note 1 to entry: Tab terminals are sometimes referred to as male terminals.

Note 2 to entry: Tab terminals are sometimes referred to as blade terminals.

Note 3 to entry: See Figure 2 for an example.

3.13
multipole connector
two mated *connectors* (3.4) halves with more than one terminal pair [e.g. one receptacle and one *tab terminal* (3.12)]

4 Test conditions and requirements

4.1 General

4.1.1 Preconditioning for environmental and mechanical durability test

All test samples shall be preconditioned at a standard ambient temperature of (23 ± 5) °C, and (25–75) % relative humidity for 24 h before the start of any test sequence.

4.1.2 Test conditions

All tests shall be carried out at a standard ambient temperature of (23 ± 5) °C and (25–75) % relative humidity unless otherwise stated in the test procedure. This is referred to as room temperature (RT).

A cable in compliance with applicable part of the ISO 19642 series is recommended. The cable or cables used shall be specified in the test report.

The cross-sectional area of the wire mentioned in this specification refers to wires with a copper conductor.

When the wire conductor is of a material other than copper, the cross–sectional area of the wire shall be specified by agreement between customer and supplier.

Cable attachment shall be performed in accordance with the terminal manufacturer's specifications, or as agreed between customer and supplier.

Care shall be taken so that test samples do not influence each other (e.g. in a heat chamber).

Each connector shall have the full complement of terminals fitted unless otherwise specified.

The terminals and connectors used in the test shall be fully assembled unless otherwise specified.

Connectors shall be tested in mated condition unless otherwise stated. In the case of a connector connecting directly to a device, a mating dummy may be used to carry out tests. This dummy shall represent the intended device's interface and electrical properties.

For connector mechanical tests, unless otherwise specified, fix the pin or tab housing of the unmated or mated connector in the appropriate fixture on the tension or force tester. Secure the other side in the appropriate fixture and insert or pull the socket or receptacle housing straight in/out. Straight-in or straight-out engagement is critical to avoid side loads and binding which can affect force measurements.

For terminal mechanical tests, unless otherwise specified, fix the pin or tab terminal of the unmated or mated terminal in the appropriate fixture on the tension or force tester. Secure the other side in the appropriate fixture and insert/pull the socket receptacle terminal straight in/out. Straight-in or straight-out engagement is critical to avoid side loads and binding which can affect force measurements.

Measurements shall be taken on all terminals regardless of the number of poles per connector, unless otherwise specified in the test methods or by agreement between customer and supplier.

Lubrication or other means of attaining better test results shall not be added to any surface unless representative of assembly conditions. Production-related remains of lubricants on the terminals are permitted.

Unless otherwise specified, all forces shall be applied at a constant speed of (50 ± 10) mm/min.

Unless otherwise specified, when a temperature of T_{max} is specified in a test, the applicable “highest value” temperature as per Table 1 shall be used. When a temperature of T_{min} is specified in a test, the applicable “lowest value” temperature as per Table 1 shall be used.

Table 1 — Environmental and test temperatures

Class	Typical application	Environmental temperature range °C		Test temperature Short term thermal ageing °C ±2 °C
		Lowest value Use for T_{min} of chamber ±2 °C	Highest value Use for T_{max} of chamber ±2 °C	
T1 (G)	interior	-40	85	100
T2 (J)	passenger compartment		100	125
T3 (O)	engine compartment		125	150
T4 (R)	engine applications used near hot components		150	175
T5 (N/A)	for use as needed		175	200 [a]

( ) value aligned with ISO 16750-4:2023, Table 1.

[a] or agreed between customer and supplier.

NOTE T_{min} and T_{max} apply to all environmental chamber temperatures where T_{min} and T_{max} are specified as using the applicable environmental temperature range except 7.2.2.1.

4.1.3 Test sequences and sample quantities

Table 2, Table 3, Table 4 and Table 5 list the test sequences. The test groups in the tables apply to sealed and unsealed connectors as noted. New samples shall be used for each test group. The test sequence for each test group shall be performed in accordance with the sequence number defined in the table's rows for each sequence. For each test group, the complete test sequence for the group on each sample shall be performed.

Table 2 — Mechanical test sequences groups A through H

Test group identification		A	B	C	D	E	F	G	H
u=apply test if samples are un- sealed		u	u	u	u	u	u	u	u
s=apply test if samples are sealed		s	s	s	s	s	s	s	s
Minimum test quantity of terminals/connectors		10	10	10	10	10	10	10	10
Sample cable length (mm)		-	-	-	-	-	-	-	-
Sample cable size	Maximum	-	-	-	-	-	-	-	-
	Minimum	-	-	-	-	-	-	-	-
4.2 Visual examination		1, 3	1, 3	1,3	1, 3	1, 3	1, 3	1,3	1,4
5.1 Connection and disconnection		2[a]							
5.2 Mating force – measurement and classification			2						
5.3 Unlocking force – measurement and classification				2					
5.4 Unmating force – measurement and classification					2				
5.5 Locking device strength						2			
5.6 Unintentional lever release force							2		
5.7 Locking force for CPA function								2	2
5.8 Disengage force for CPA function									3

[a] Perform force measurement for first mate and first unmate with part held in force tester.

Remaining mate and unmate cycles can be either hand mated or using the mechanized force test machine.

\- Cells containing "-" are to be defined between supplier and customer. Selection typically does not matter to test result.

Table 3 — Mechanical test sequences groups I through P

Test group identification		I	J	K	L	M	N	O	P
u=apply test if samples are unsealed		u	u	u	u	u	u	u	u
s=apply test if samples are sealed		s	s	s	s	s	s	s	s
Minimum test quantity of terminals/connectors		10[a]	10[a]	10	10	20[a]	10[a]	10[a]	10[b]
Sample cable length (mm)		-	-	-	-	-	-	-	>50
Sample cable size	Maximum	-	-	-	-	10	10	10	[c]
	Minimum	-	-	-	-	10	-	-	[c]
4.2 Visual examination		1, 3	1, 4	1, 3	1, 3	1, 4	1, 3	1, 3	1, 3
5.9 Locking force for TPA		2	2						
5.10 Disengage force for TPA			3						
5.11 Effectiveness of connector coding and polarization				2					
5.12 Connector engagement sound					2				
5.13 Terminal insertion force (TPA disengaged)						2			
5.14 Terminal insertion force (TPA engaged)							2		
5.15 Terminal insertion force with incorrect orientation								2	
5.16 Terminal extraction force						3			
5.17 Tensile strength of connection between terminal and wire									2

a Use unmated wire harness connector; the mating (header) connector is not used in the test.

b Sample is made from terminal and cable only.

c Test quantity is per terminal/cable combination; each combination shall be validated with a 10-piece sample, minimum.

\- Cells containing "-" are to be defined between supplier and customer. Selection typically does not matter to test result.

Table 4 — Environmental and electrical test sequence groups Q through W

Test group identification		Q	R	S	T	U	V	W
u=apply test if samples are unsealed		u	u	u	u	u	u	
s=apply test if samples are sealed		s	s	s	s[g]	s	s	s[g]
Minimum test quantity of connectors		5[c]	10	5[c]	5	5	5	5
Sample cable length (mm)		500	-	min. 500	min. 150	-	1 250	min. 150
Sample cable size	Maximum	[f]	all	all		all		
	Minimum				all		all	all
4.2 Visual examination		1	1, 6	1, 8, 10	1, 10, 14	1, 8	1, 3	1, 7
5.1 Connection and disconnection		2	2	2	2	2		
5.3 Unlocking force – measurement and classification					12[a]			
5.6 Unintentional lever release force					12[a]			
5.8 Disengage force for CPA function					11			
5.16 Terminal extraction force				9				
6.1 Connection resistance (voltage drop)			3, 5	3, 6	3, 7, 13	3, 5, 7		2, 5
6.2 Temperature rise		3[d]		(4), 7				
6.4 Insulation resistance					4, 8			
6.5 Withstand voltage					5, 9			3, 6
7.1 Thermal shock			4					
7.2 Thermal aging				5				
7.3 Temperature / humidity					6[e]			
7.4 Vibration with thermal cycling						6[b]		
7.5 Mechanical shock						4[b]		
7.6 Drop							2	
7.10 Salt spray								4

a Perform either 5.3 or 5.6 as applicable.

b It is allowed to apply each shock/vibration direction directly before the vibration test for this direction. Take intermediate resistance measurements between testing for each axis.

c Samples require thermocouples to measure or monitor temperature rise.

d This test is to estimate initial current in test part.

e Perform insulation resistance during condensation phase.

f Test all cable sizes that are applicable.

g Seal cable on far end.

( ) It is possible to omit this step by agreement between customer and supplier.

\- Cells containing "-" are to be defined between supplier and customer. Selection typically does not matter.

Table 5 — Environmental and electrical test sequence groups X through AF

Test group identification		X	Y	Z	AA	AB	AC	AD	AE	AF
u=apply test if samples are unsealed		u				u	u	u	u	u
s=apply test if samples are sealed		s	s[d]	s	s	s	s	s[d]	s	s
Minimum test quantity of connectors		5[e]	5	5	5	5	5	-	5	5
Sample cable length (mm)		500	max. 1 000	max. 1 000	min. 150	-	-	-	-	-
Sample cable size	Maximum	all		all	-		-		-	-
	Minimum		all		-	all	-	all	-	-
4.2 Visual examination		1, 7	1, 9	1, 6	1, 7	1, 10, 12	1, 6	1, 10, 14	1, 3	1, 3
5.1 Connection and disconnection		2	2	2				2		
5.5 Locking device strength						11				
5.16 Terminal extraction force		6								
6.1 Connection resistance (voltage drop)		3, 5	3, 6		2, 5		2, 4	13		
6.3 Current cycling at ambient temperature		4[c]		4			3			
6.4 Insulation resistance			8		3, 6	2, 5, 8		3, 7, 11		
6.5 Withstand voltage						3, 6, 9		4, 8, 12		
7.2 Thermal aging			5			4				
7.7 Water tightness [a]			4 [f], 7 [f]	3, 5				5[b], 9[b]		
7.8 Water tightness, dynamic					4					
7.9 High-pressure/steam-jet cleaning						7[b]				
7.11 Dust resistance							5			
7.12 Oil and liquid resistance								6		
7.13 Fretting corrosion									2	
7.14 Friction corrosion										2

[a] Aside from test sequence, test to failure can be performed using additional samples (*n*=5) for test 7.7 until the upper limit pressure is reached.

[b] Sealed connectors only.

[c] Monitor temperature rise during step.

[d] Seal cable on far end.

[e] Samples require thermocouples to measure or monitor temperature rise.

[f] Use the test configuration that stresses cable most representative of application (see Figure 16 and Figure 17).

\- Cells containing "-" are to be defined between supplier and customer. Selection typically does not matter.

4.2 Visual examination

4.2.1 Purpose

The purpose of this test is to document the physical appearance of the test samples. A comparison is made after testing between new and tested samples.

Examinations shall be performed by a person with normal or corrected vision, and normal colour sensitivity.

4.2.2 Test

Carry out a visual examination with the naked eye, at normal strength of vision, with normal colour perception, at the most favourable distance and with suitable illumination.

Visually inspect each test sample prior to testing and/or conditioning. Any manufacturing or material defects such as cracks, tarnishing, flash, etc. shall be documented. Special attention shall be paid to contact points and locking mechanisms.

In the event an aspect of the test sample is questionable, use appropriate diagnostic equipment to evaluate it.

Record in detail the condition of the test samples before and after the test procedures and document any differences that may occur.

If an aspect of the test sample is questionable and additional review is requested, inspect for plating wear as a final inspection and use a method agreed upon between customer and supplier to assess the type and amount of damage to the surface coating.

4.2.3 Requirements

Identification, appearance, workmanship and the finish of each test sample shall be as specified. There shall be no wear-through, cracks, corrosion, rough surface, damage, deformation or discoloration which may affect the connector's performance.

Customer and supplier shall agree on the criteria for plating wear.

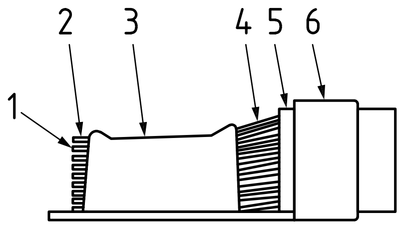
For sealed connector systems, there shall be no ingress of a solution or substance.

Colour conformance and fading shall be agreed between customer and supplier.

An identical match is not required but each colour shall be clearly identifiable as the intended colour.

For crimped wire attachments, both conductor and insulation shall be visible between the conductor crimp and the insulation support on the terminals. See example in Figure 3.

Wire strands shall protrude from the conductor crimp but shall not interfere with the mating part. In case of damaged wire strands, the functional performance shall be confirmed. For other types of wire attachment, no visible damage is allowed.



Key

1 conductor end
2 wire strands
3 conductor connection
4 conductor
5 insulation
6 insulation support

Figure 3 — Terminal crimp section

5 Mechanical tests

5.1 Connection and disconnection

5.1.1 Purpose

The purpose of this test is to precondition the connector for further tests and verify the mating and unmating forces required to manually mate and unmate the complete connector assembly.

Unmating forces are important criteria when determining that serviceability of design and for ensuring that the connection will remain mated during the service life of the vehicle.

5.1.2 Test

Perform 10 connections and disconnections, or as agreed between customer and supplier, as specified by the connector manufacturer.

5.1.3 Requirements

Each connector shall fulfil the requirements of the subsequently performed tests specified in Table 2, Table 3, Table 4 or Table 5.

5.2 Mating force – measurement and classification

5.2.1 Purpose

The purpose of this test is to document and classify the connector-mating properties.

5.2.2 Test

The test shall be performed according to ISO 8092-5:2021, 4.2.

5.2.3 Requirement

Record and classify the connector in accordance with ISO 8092-5:2021, Tables 1, 2 and 3.

5.3 Unlocking force – measurement and classification

5.3.1 Purpose

The purpose of this test is to determine the force required to release the connector lock feature.

Document and classify the force required to unlock the locking mechanism.

5.3.2 Test

The test shall be performed according to ISO 8092-5:2021, 4.4.

5.3.3 Requirement

a) Record and classify the connector force required to unlock the mechanism in accordance with ISO 8092-5:2021, Table 4.

b) The force required to deflect the release button so that the lock mechanism is disengaged shall be a minimum of 6 N.

5.4 Unmating force – measurement and classification

5.4.1 Purpose

The purpose of this test is to document and classify the force required to unmate a connector pair.

5.4.2 Test

The test shall be performed according to ISO 8092-5:2021, 4.5.

5.4.3 Requirement

Record and classify the connector in accordance with ISO 8092-5:2021, Table 5.

5.5 Locking device strength

5.5.1 Purpose

The purpose of this test is to determine the strength of the locking device of a fully mated connector pair without terminals. The test determines the retention forces which ensure that the connector will remain mated for the service life of the vehicle.

5.5.2 Test

Using completely mated connector, with CPA disengaged, fix one half of the connector in the force tester and pull the other half of the connector by gradually applying a force of up to 100 N in a straight direction at a speed that does not exceed 60 mm/min.

Dwell at 100 N for 10 s.

The connector shall be completely fixed in the force tester during the test and no side of the connector shall be distorted during the test.

If a test to failure force is required and agreed between customer and supplier, apply a gradually increasing force and record the force at which the connectors unmate.

5.5.3 Requirements

The connectors shall not break or unmate when a force of 100 N is applied.

5.6 Unintentional lever release force

5.6.1 Purpose

The purpose of this test is to determine the lever release force in order to ensure that the lever cannot move unintentionally from its locked position.

5.6.2 Test

Ensure the connector is completely locked, but with CPA disengaged. Gradually apply a force up to 200 N in the direction required to release the lever at a speed that does not exceed 60 mm/min.

If the mechanical lever leaves the locked position, record the force applied when this happens.

Remove and inspect the sample. Mate and unmate it to determine whether the lock mechanism still functions properly. Reassemble the connector to the fully-locked position. Reattach it in the force-testing fixture. Gradually apply force (same force direction and speed as before) until the lock releases.

Measure the applied force at the moment the mechanical lever leaves the locked position.

5.6.3 Requirements

a) The force applied when the mechanical lever leaves its locked position shall exceed 100 N.

b) After the initial release, the connector lock shall still function properly and the inspection shall not show any damage to the connector system.

c) The lever release force when applied a 2nd time shall be a minimum of 100 N.

5.7 Locking force for CPA function

5.7.1 Purpose

The purpose of this test is to determine whether a secondary connector lock is sufficiently locked in its shipping position and will remain in its intended position (not unintentionally activated). It is also used to assess the ergonomic capability to easily actuate the lock.

5.7.2 Test

Note that this test is performed with the connectors mated in one test sequence and with the connectors unmated in another test sequence. See Table 2, Table 3, Table 4 and Table 5 for the applicable configuration. The test is conducted by measuring the load as the CPA is moved from its shipping position to its fully-seated position by pushing it at a speed that does not exceed 60 mm/min.

5.7.3 Requirements

a) The locking force for the CPA with the connector mated correctly shall be between 5 N and 30 N.

b) The force required to seat the CPA with the connector in the unmated position shall meet or exceed the greater of 80 N or 1,5 times the maximum force measured in 5.2.

5.8 Disengage force for CPA function

5.8.1 Purpose

The purpose of this test is to determine the required disengage force for a CPA in order to assess its ergonomic capability and to assure the CPA will not unlock in service.

5.8.2 Test

With the connector mated and the CPA fully engaged, measure the load required to release the CPA by applying a force at a speed that does not exceed 60 mm/min.

Apply the force in the direction required to disengage the CPA. Record the force at which the CPA is disengaged, then continue the motion and record the force at which the CPA is fully removed.

5.8.3 Requirements

a) The CPA release force shall be between 5 N and 30 N.

b) The force required to fully remove the CPA from a connector shall be a minimum of 80 N.

5.9 Locking force for TPA

5.9.1 Purpose

The purpose of this test is to determine the mating force that is required to move the TPA device to its assembled position in order to assess its ability to resist unintentional activation and its ability to detect when a terminal is incorrectly positioned.

The justification for requiring a maximum locking force is to prevent the assembly of connectors with incorrectly seated TPAs in serial production.

5.9.2 Test

Move the TPA to its final position and measure the load required to move the TPA. Move the TPA at a speed that does not exceed 60 mm/min. Perform this test for the following two conditions:

a) TPA insertion and extraction force when the terminal is correctly seated (connector with terminals correctly placed in all positions);

b) TPA insertion and extraction force when the terminal is incorrectly seated (connector with terminals correctly placed in all positions except one location in which the terminal is partially inserted and not locked in position).

5.9.3 Requirements

a) The force required to move the TPA to its final position with the terminals in their correct positions shall be between 15 N and 60 N.

b) The force required to move the TPA to its final position with one incorrectly positioned terminal shall be greater than measured insertion force measured in 5.9.2 a) + 50 N.

5.10 Disengage force for TPA

5.10.1 Purpose

This test shall be conducted on connectors equipped with a TPA function.

The purpose of this test is to determine the force required to remove the TPA in order to assess its ability to resist unintentional unlocking.

5.10.2 Test

With the connector fully equipped with terminals and the TPA engaged, gradually apply force at a speed that does not exceed 60 mm/min in the direction required to disengage the TPA. For connectors with a pre-positioned TPA, measure the force required to fully remove the TPA from the connector. Record:

a) the force required to disengage the TPA, and

b) the force required to fully remove the TPA from the connector, if fitted with a pre-positioned TPA.

5.10.3 Requirements

a) The disengage force for the TPA shall be between 10 N and 50 N.

b) The removal force for the pre-positioned TPA from a connector shall be a minimum of 50 N.

5.11 Effectiveness of connector coding and polarization

5.11.1 Purpose

The purpose of this test is to ensure that connectors with different codings and polarizations cannot mate.

5.11.2 Test

Using a force test machine, apply force, in the applicable direction based on the design, for all possible incorrect coding combinations. Also test correct coding combination but 180° out of correct orientation. Apply force as specified below.

a) Hand-plug designs: apply the larger of 150 N or three times the first mating force measured in 5.2.

b) Lever designs: apply 150 N, with the force applied directly to the connector body.

5.11.3 Requirements

a) It shall not be possible to partially or fully mate connectors with incompatible codings or polarizations. Electrical contact is not permissible.

b) If the connector has a lever, the lever shall not start to engage a connector with an incompatible coding.

5.12 Connector engagement sound

5.12.1 Purpose

The purpose of this test is to determine the intensity of the sound that is emitted when a connector is fully mated. This test measures the sound level generated when two connectors are mated.

This test is only applicable for connectors that are designed to produce a sound upon correctly completed connection.

5.12.2 Test

The application of this test shall be agreed between customer and supplier.

The test shall be performed according to ISO 8092-5:2021, 4.3.

5.12.3 Requirements

The requirements shall be in accordance with ISO 8092-5:2021, 4.3.

5.13 Terminal insertion force (TPA disengaged)

5.13.1 Purpose

The purpose of this test is to measure the force required to insert a terminal into its connector cavity in order to assess its ergonomic capability and ensure wire buckling will not occur during terminal insertion.

5.13.2 Test

Insert the terminal into the connector housing with the TPA disengaged at a constant speed as per 4.1.2. Measure the insertion force. The use of an insertion tool in this lab test is permitted but shall be noted.

If the terminal structure requires a waterproofing seal, the test shall be performed with the waterproofing seal present and assembled.

5.13.3 Requirements

The insertion force of the terminal into the housing shall meet the applicable criterion in Table 6.

Table 6 — Terminal insertion force (TPA disengaged)

Terminal size [mm]	Terminal insertion force [N]
≤ 1,2	≤ 15
> 1,2 and ≤ 2,8	≤ 20
> 2,8	≤ 30

In case of sealed connectors, the force imposed by the seal shall be included.

NOTE Shielded connectors are separately listed in applicable parts of the ISO 8092 series.

5.14 Terminal insertion force (TPA engaged)

5.14.1 Purpose

The purpose of this test is to ensure that the design of the cavity and the TPA will prevent insertion of the terminal with the TPA engaged.

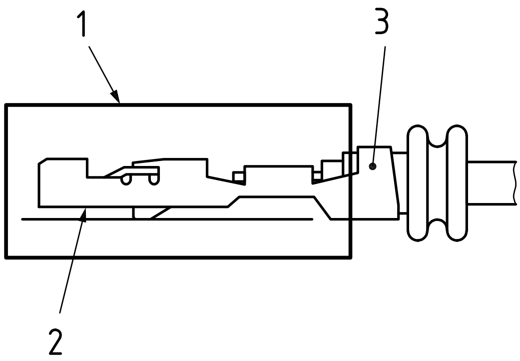
5.14.2 Test

Insert the terminal at constant speed as per 4.1.2 with a force 1,5 times the measured maximum insertion force per 5.13 or 30 N, whichever is greater, into the connector housing with the TPA engaged. The use of an insertion tool in this lab test is permitted but shall be noted.

If the terminal structure requires a waterproofing seal, the test shall be performed with the waterproofing seal present and assembled.

5.14.3 Requirements

The terminal shall not fit into or lock with a connector cavity beyond the insulation support when the force is applied. Refer to Figure 4.



Key

1 housing

2 erroneously plugged terminal

3 insulation support or seal shall be visible

Figure 4 — Illustration of terminal with incorrect position

5.15 Terminal insertion force with incorrect orientation

5.15.1 Purpose

The purpose of this test is to ensure that the design of the cavity and terminal polarization features will prevent insertion of a terminal with an incorrect orientation.

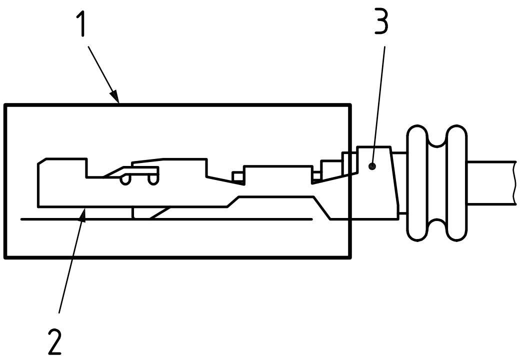
5.15.2 Test

This procedure is not required for multidirectional (round) terminals or other designs where the terminal is meant to plug and lock in any (360°) orientation.

Fix the cable with the terminal in incorrect orientations specified by agreement of customer and supplier. Apply a force to insert the terminal into the housing until 1,5 times the measured maximum insertion force as per 5.13 or 30 N, whichever is greater, is achieved.

5.15.3 Requirements

The terminal shall not fit or lock into a connector cavity beyond the insulation support with force applied. Refer to Figure 5 for additional visual criteria.



Key

1 housing

2 erroneously plugged terminal

3 insulation support or seal shall be visible

Figure 5 — Illustration of terminal with incorrect orientation

5.16 Terminal extraction force

5.16.1 Purpose

The purpose of extraction testing is to ensure that the terminal will remain in its housing with sufficient strength to withstand the rigors of the wiring harness and vehicle assembly processes.

5.16.2 Test

The test shall be conducted with the maximum wire cross section which may be assembled, and the terminal shall be completely assembled on the housing (TPA closed). All locking functions on the terminal shall be activated.

Fix the cable and housing in the force tester. Apply a gradually increasing force at a constant speed that does not exceed 60 mm/min in the direction required to disengage the terminal. Record the force at which the terminal is released from the housing.

Moisture conditioning using the following schedule:

— before performing the terminal extraction force test (primary and TPA after moisture conditioning), connectors shall be conditioned for 6 h at 40 °C and a relative humidity of (95–98) %. Readings for extraction force shall be taken within 1 h;

— complete the test within 8 h.

5.16.3 Requirements

Terminal extraction force shall be higher than the value specified in Table 7.

Table 7 — Terminal extraction force

Maximum nominal tab width [mm]	Primary lock retention [N]	Primary and TPA after moisture conditioning [N]
0,50	20	40
0,64	30	60

Table 7 *(continued)*

Maximum nominal tab width [mm]	Primary lock retention [N]	Primary and TPA after moisture conditioning [N]
1,2	40	70
1,5	45	70
2,8	60	100
6,3	80	130
9,5	100	150

NOTE Shielded connectors are separately listed in applicable parts of the ISO 8092 series.

5.17 Tensile strength of connection between terminal and wire

5.17.1 Purpose

The purpose of testing the tensile strength of connections is to determine their mechanical robustness.

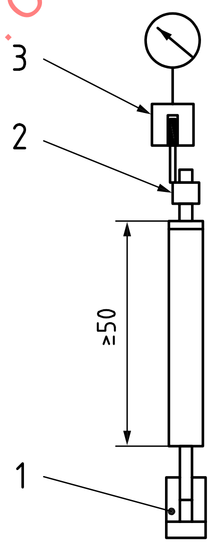
5.17.2 Test

Fix the terminal in the force tester as per Figure 6 and a minimum of 50 mm from the wire attachment area. Gradually apply force at an increasing speed that does not exceed 60 mm/min. When applicable, the insulation support shall be disabled, uncrimped, prior to performance of this test. Measure the maximum load until the wire or terminal breaks or the wire is extracted from the conductor crimp.

Record whether the failure mode was a wire break, a terminal break or wire extraction.

NOTE Shielded connectors are separately listed in applicable parts of the ISO 8092 series.

Dimensions in millimetres



Key

1 conductor fixation

2 terminal crimp

3 terminal fixation

Figure 6 — Tensile strength testing setup for terminal and cable

5.17.3 Requirements

The tensile strength between terminal and cable shall be higher than the value specified in Table 8. Criteria for non-ISO cables can be interpolated.

Table 8 — Minimum tensile strength of connection between terminal and cable conductor

Nominal cross-sectional area of cable (per ISO 19642 series) [mm^2]	**Minimum tensile strength** [N]
0,13	50
0,18	50
0,22	30
0,35	50
0,5	60
0,75	90
1	100
1,5	150
2	175
2,5	200
3	250
4	310
5	355
6	360
10	380

6 Electrical tests

6.1 Connection resistance (voltage drop)

6.1.1 Purpose

The purpose of this test is to determine the voltage drop associated with the electrical resistance of the conductor crimps and contact interface areas under specific current conditions. This voltage drop is then used to calculate the total connection resistance.

6.1.2 Test

6.1.2.1 Test setup

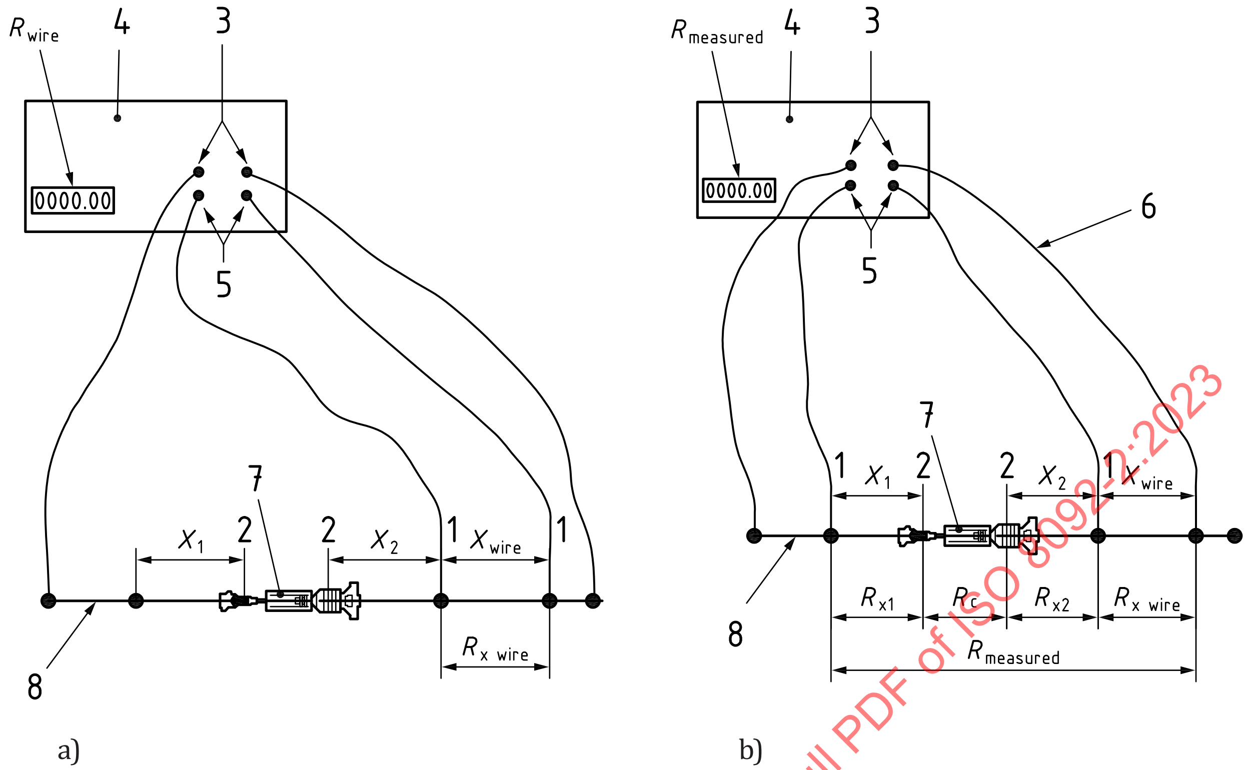
Determine the conductor resistance(s) of the wires(s) or device used by measuring the resistance, $R_{\text{x wire}}$, between the two sense measuring points shown in Figure 7 a).

Measure the resistance, R_{measured}, between the two sense measuring points shown in Figure 7 b) and Figure 8. The connection resistance, R_c, is determined by subtracting the value(s) R_{X1} and R_{X2} or R_{device}. and $R_{X3.}$

Distance $X_1 + X_2$ = Distance X_{wire}

Care shall be taken during measurement to avoid exerting abnormal pressure on the terminals under test and to avoid movement of the test wires.

The different points are shown in Figure 7 and Figure 8.



Key

1 measuring point

2 reference point, only

3 source

4 ohmmeter

5 sense

6 measuring line (4x)

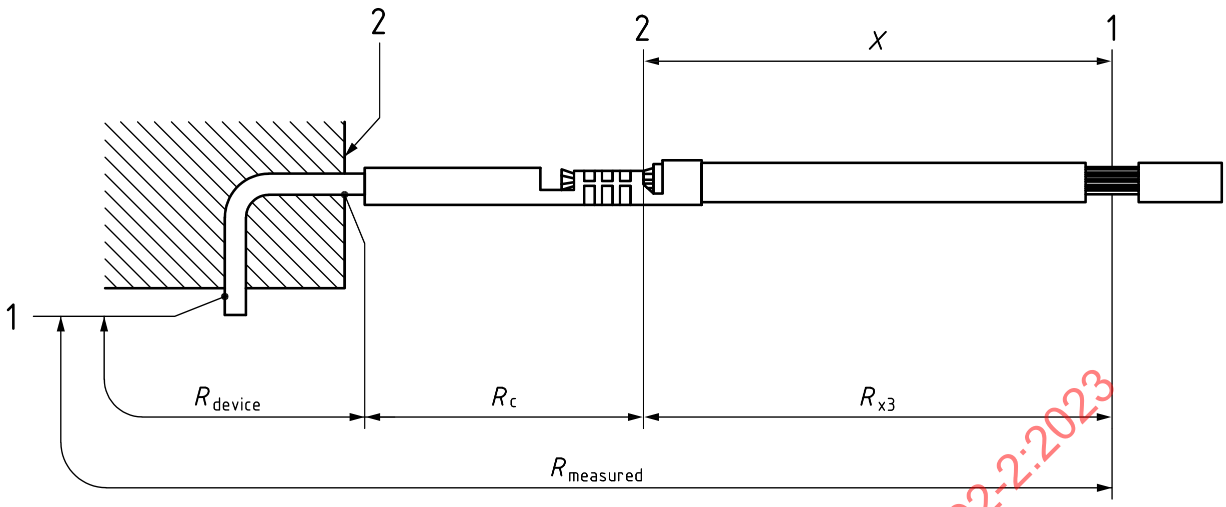
7 terminal system

8 wire

R_c connection resistance, resistance of conductor attachment included

Distance X = 25 mm to 100 mm is recommended.

Figure 7 — Measurement to determine the connection resistance in a wire-to-wire connection



Key

1 measuring point

2 reference points

Figure 8 — Connection resistance - connection on device

6.1.2.2 Measurement at millivolt level (dry circuit)

Determine the connection resistance using the test arrangements shown in Figure 7 and Figure 8.

To prevent the breakdown of possible insulating films on the contact interfaces when performing resistance measurement at the millivolt level, the test voltage shall not exceed 20 mV d.c. or peak voltage a.c. in an open circuit. Also, the test current shall not exceed 100 mA.

6.1.2.3 Measurement with specified test current (working condition)

Carry out the measurements after thermal equilibrium is reached at a current density of 5 A/mm^2 nominal cross-sectional area of the attached wire(s), unless otherwise stated. If the measuring wires are soldered to the measuring points, this shall not influence the connections.

6.1.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

The connection resistance, R_c, measured in 6.1.2.2 and 6.1.2.3, shall conform to the requirements specified in Table 9 or the customer requirements.

Table 9 — Maximum permitted connection resistance

Nominal pin or tab terminal size [mm]	Connection resistance		
	Initial	After endurance	
		Requirement 1 [a]	Requirement 2 [a] % of initial measured value
	max. [mΩ]	max. [mΩ]	max.
0,5	8,3	25	200
0,64	6,7	20	200
1,2	5	15	200
1,5	3,3	10	200
2,8	2,5	5	150
6,3	0,9	1,8 [b]	150
9,5	0,5	1	150

[a] Requirement 1 and/or requirement 2 are selected by supplier and user.

[b] High-performance 6,35 mm terminals may require a lower resistance. It is the connector manufacturer's responsibility to identify high-performance parts and alternate criteria.

6.2 Temperature rise

6.2.1 Purpose

The purpose of this test is to ensure that the temperature rise in the connector terminal is below a certain limit before and after the connector durability evaluation.

6.2.2 Test

The sample consists of the fully assembled connector with cable as specified in the applicable test sequence in Table 2, Table 3, Table 4 or Table 5. Take care to protect the test samples from draughts and artificial cooling (e.g. caused by a thermocouple). Place a thermocouple as close as possible to the hottest spot on the terminal, as determined by testing. The test shall be conducted on a connector with completely assembled terminals. Apply the current and measure the temperature of the terminals and ambient temperature after thermal equilibrium has been established. Subtract the ambient temperature from the measured temperature and calculate the temperature rise in the cable attachment. The permitted temperature rise, ΔT_0 (°C), is defined using the following formula:

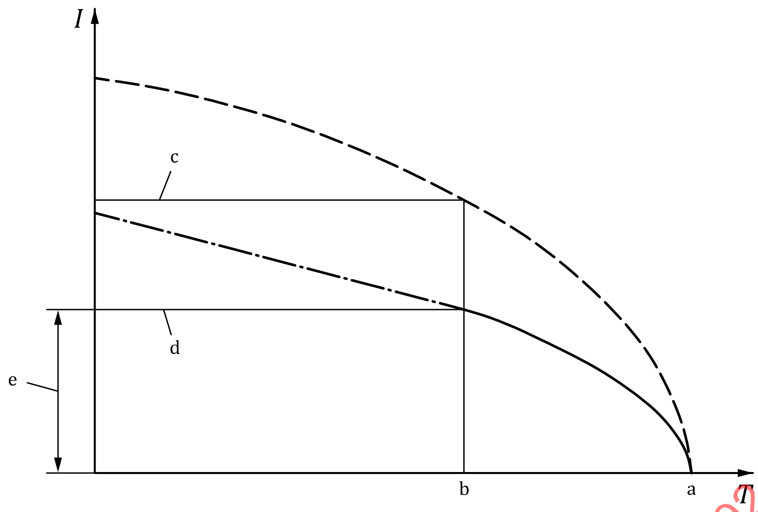
$$\Delta T_0 = T_p - T_a$$

where

T_p is the permitted temperature due to material limits, as defined in the agreement between customer and supplier, expressed in °C;

T_a is the ambient temperature, as defined in Table 1 expressed in °C.

The relationship between current, temperature rise, and ambient temperature is represented by a curve, as shown in Figure 9. T_p is plotted on the horizontal line. It is impossible to energize a current in this condition. If T_p and T_a are determined, it is possible to energize a current for ΔT. This is defined as I_n (initial current).



Key

T	temperature [°C]
I	current [A]
a	T_p, permitted temperature due to material limitations.
b	T_{max}, defined in Table 1.
c	I_n, initial current, defined as the current at which the terminal temperature becomes T_P at T_{max}.
d	Initial current at T_{max} times 0,8.
e	Permissible operating range.
— — — —	base curve
—·——·—	corrected curve
————	defined current limit curve

Figure 9 — Current limit and permitted temperature rise

6.2.3 Requirements

ΔT (°C) shall be equal to or less than T_p–T_a at 0,8 × I_n.

6.3 Current cycling at ambient temperature

6.3.1 Purpose

The purpose of this test is to simulate the deterioration of terminals due to the heat generated by current over the expected life of the vehicle.

6.3.2 Test

Perform the test with mated connectors using the full complement of terminals fitted. Place the test sample in a thermally controlled test chamber at T_{max} defined in Table 1. Apply 500 test cycles, each with 45 min current on, 15 min current off, using the current determined in Figure 9, key d. Take care to protect the test samples from drafts and artificial cooling.

NOTE The cable size can be changed according to agreement between customer and supplier to reflect actual use case(s).

6.3.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

All test samples shall fulfil the requirements described in 6.2.3 while being tested.

6.4 Insulation resistance

6.4.1 Purpose

The purpose of this test is to verify that the electrical resistance between any two cavities in a connector system will be sufficient to prevent detrimental electrical conductivity (current leakage) between the circuits passing through that connector. This test is typically conducted after other environmental stress tests to ensure that any material degradation or contaminants are not sufficient to create an unintended electrical path.

6.4.2 Test

Before measuring the insulation resistance following temperature/humidity cycling, unsealed connectors and splash-proof connectors shall be conditioned for 3 h at an ambient temperature of (23 ± 5) °C and a relative humidity of (25–75) %. Readings for sealed connectors shall be taken within 1 h.

Measure the insulation resistance at a relative humidity of (25–75) % by applying 500 V d.c. for 60 s between all terminals connected together and a metal foil surrounding the housing. For safety reasons, the metal foil shall be grounded. In addition, apply the voltage with a different test sample to every two adjacent terminals.

Record the insulation resistance when a stable reading is obtained.

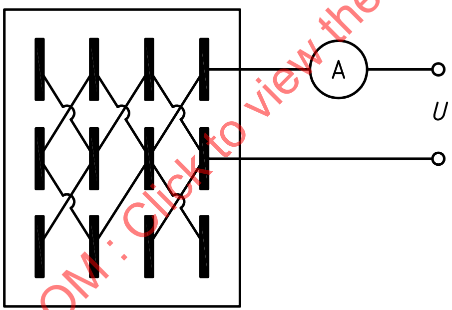


Figure 10 — Example of leakage current measurements between adjacent terminals

6.4.3 Requirements

The insulation resistance shall be at least 100 MΩ.

6.5 Withstand voltage

6.5.1 Purpose

The purpose of the dielectric withstand voltage test is to verify that the connection is able to withstand momentary over-potentials. This test is used to determine whether the insulating materials and spacing within the connector are adequate.

6.5.2 Test

Apply an AC voltage of 1 000 V rms (50 or 60 Hz) or a DC voltage of 1 600 V at a relative humidity of (25 –75) % for 1 min across all terminals connected together and a metal foil surrounding the housing. For safety reasons, the metal foil shall be grounded. In addition, apply the voltage on a different test sample to every two adjacent terminals.

For a multipole connector, use Figure 10.

6.5.3 Requirements

No dielectric breakdown or flashover is permitted.

7 Environmental tests

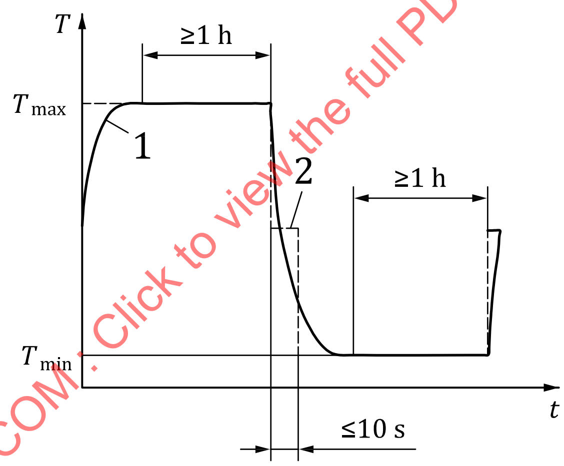
7.1 Thermal shock

7.1.1 Purpose

The purpose of this test is to simulate actual operating conditions using temperature variations as an aging mechanism in order to evaluate a connector system's electrical durability.

7.1.2 Test

Subject the mated samples to 100 thermal shock cycles as defined in Figure 11. Test duration of T_{max} and T_{min} shall be a minimum of 1 h. The transition time of ambient temperature shall be a maximum of 10 s.



Key

t	time [h]
T	temperature [°C]
T_{max}	highest value in the environmental temperature range as per Table 1
T_{min}	lowest value in the environmental temperature range as per Table 1 (-40 °C)
1	terminal temperature (—)
2	chamber temperature (---)

Figure 11 — Thermal shock temperature profile

7.1.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

7.2 Thermal aging

7.2.1 Purpose

The purpose of this test is to subject the connector assembly to temperature cycles that simulate a lifetime of heat exposure. This test is intended to produce accelerated stress relaxation and oxidation in systems affected by elevated temperatures.

7.2.2 Test

7.2.2.1 Short term

Subject the mated connector samples for 120 h, as defined in IEC 60068-2-2. Determine the maximum temperature to apply using the “test temperature” column in Table 1.

Short-term ageing shall be agreed between customer and supplier.

7.2.2.2 Long term

Subject the mated connector samples for 1 008 h, as defined in IEC 60068-2-2. Determine the maximum temperature to apply using the “environmental temperature” column in Table 1.

7.2.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

7.3 Temperature and humidity cycle

7.3.1 Purpose

The purpose of this test is to simulate actual operating conditions using temperature and humidity variations as ageing mechanisms in order to evaluate a connector system's electrical durability. High humidity and temperature can promote galvanic and electrolytic corrosion of the terminals, which may cause electrical and mechanical degradation. Temperature cycling promotes relative movement.

7.3.2 Test

Carry out the temperature and humidity cycling test using mated connectors in a housing with the full complement of terminals. If requested by the customer, carry out this test with the connectors connected to a device. Test the connectors, with cables assembled, using both the minimum and maximum conductor cross-sectional areas that the terminal system allows.

Subject the test samples (mated connectors), in a suitable test chamber, to 10 cycles of 24 h in the following test sequence (see Figure 12 for a diagram representation of the test cycles). The applicable test temperature range shall be taken from Table 1 as a function of environmental conditions.

Test cycle:

a) hold the chamber temperature at T_c = (23 ± 5) °C and 45 % to 75 % RH (relative humidity) for 4 h;

b) raise T_c to (55 ± 2) °C at 95 % to 99 % RH within 0,5 h;

c) hold T_c at (55 ± 2) °C at 95 % to 99 % RH for 10 h;

d) lower T_c to (- 40 ± 2) °C within 2,5 h.

e) hold T_c at (- 40 ± 2) °C for 2 h;

f) raise T_c to the applicable T_{max} as per Table 1 ±2 °C from (- 40 ± 2) °C within 1,5 h;

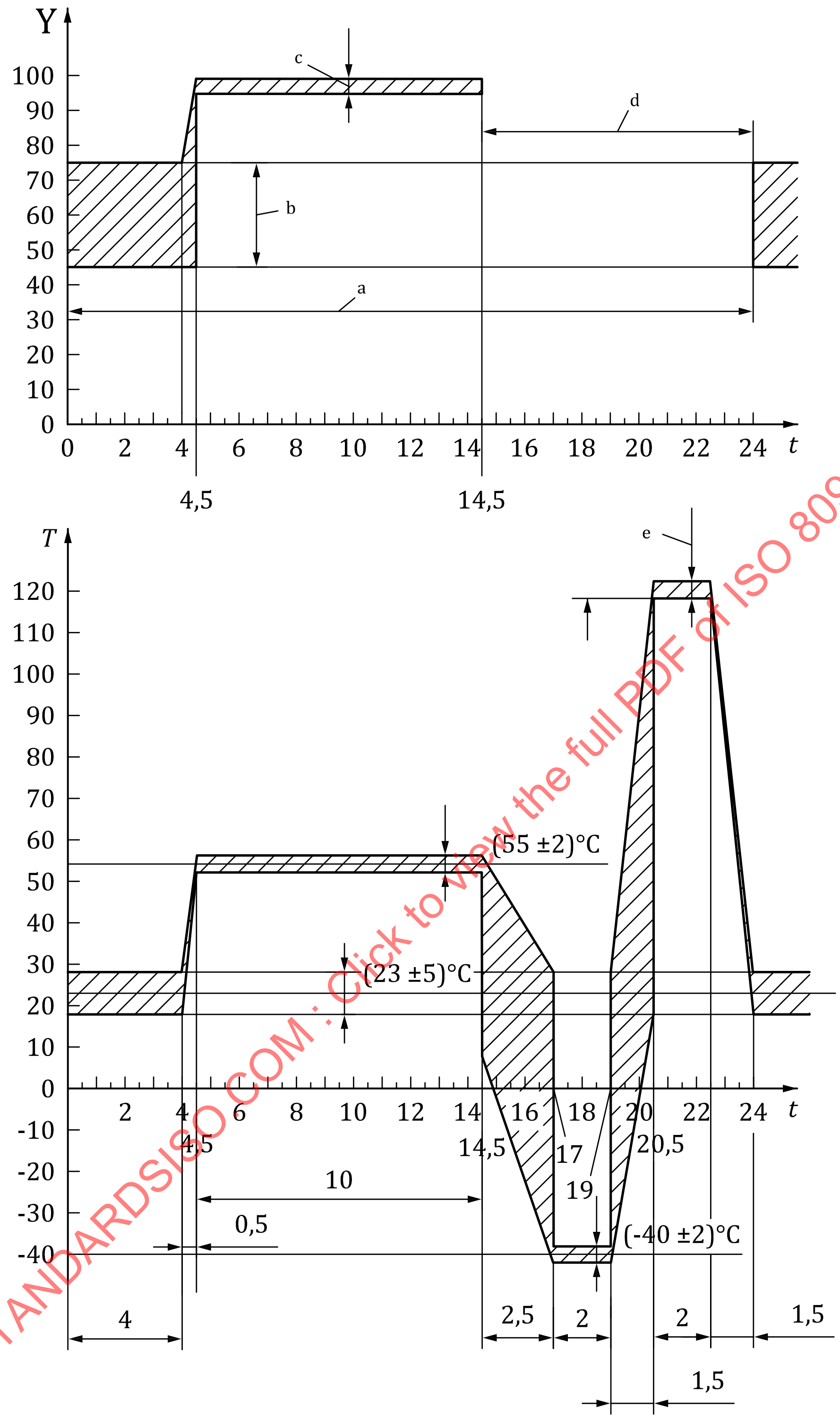
g) hold T_c at the applicable T_{max} as per Table 1, ±2 °C for 2 h;

h) lower T_c to room temperature (23 ± 5) °C within 1,5 h.

The test may be interrupted at the end of a cycle. During the interruption, test samples shall remain in the ambient conditions defined in a) in this subclause. Note the interruption duration in the test report.

NOTE 1 During the periods specified in d), e), f), g) and h), the relative humidity is uncontrolled.

NOTE 2 If the chamber needs more than 1,5 h to reach the class test temperature, the duration of period f) can be extended and period a) reduced accordingly.



Key

a	One cycle.	e	T_{max} (see Table 1).
b	(45 to 75) %.	*t*	time in hours
c	(95 to 99) %.	*T*	temperature in °C
d	Uncontrolled humidity.	Y	relative humidity

NOTE 1 Hatched areas indicate allowed temperature/humidity tolerance.

NOTE 2 Extended transition times can be used as long as the dwell times at temperature are maintained.

Figure 12 — Temperature/humidity cycling

7.3.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

7.4 Vibration with thermal cycling

7.4.1 Purpose

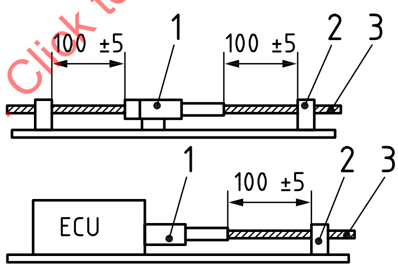
The purpose of this test is to evaluate the ability of the connector to sustain mechanical loads. The test exposes a connector system to vibration in order to simulate accelerated exposure to actual vehicle conditions. Vibration can cause wear of the terminal interfaces, increase the voltage drop, as well as cause intermittent electrical contact and failure of mechanical components of the connector system due to fatigue.

7.4.2 Test

Carry out the vibration with mated connectors suitably mounted on a vibration table as shown in Figure 13. Note the mounting method or methods (1, 2) used in the test report. Connect all of the terminal pairs in a series and connect them to a DC source that can provide a 100 mA current to allow monitoring of the connection resistance during the entire test (see Figure 14).

A reduced number of connected terminals can be agreed between customer and supplier. Decision should be based on analysis of which cavities that are most susceptible for relative movement.

Dimensions in millimetres



Key

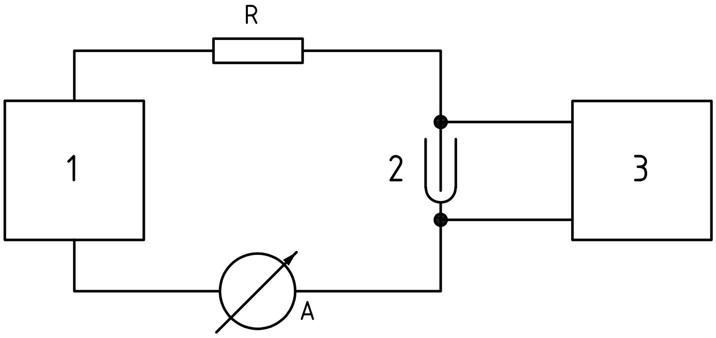
1 connector

2 fixture

3 cable

Preferably there should be no tension in the wires between the fixture and terminal. Slack can be achieved by adding a sag of 10 mm ±5 mm.

Figure 13 — Vibration test setup



Key

R variable resistor

1 power supply

2 connection under test

3 monitoring unit

Figure 14 — Connection resistance monitoring at combined temperature/vibration test

Subject the connector under test to the appropriate vibration class schedule as per 7.4.2.1.

When identified in 7.4.2.1, perform thermal cycling during the vibration schedules with temperatures using the following schedule:

— temperature range is T_{min} to T_{max} in accordance with Table 1;

— dwell time for T_{min} equals 2 h;

— dwell time for T_{max} equals 2 h;

— temperature transition rate range shall be (3 – 5) °C/min;

— one thermal cycle is approximately 360 min.

7.4.2.1 Vibration class

Vibration classes and profiles are in accordance with ISO 16750-3.

The following vibration profiles are recommended to be performed:

— Test Ia - passenger car, combustion engine, small and lightweight DUTs;

— Test IV - passenger car, sprung masses (vehicle body), small and lightweight DUT;

— Test V - passenger car, unsprung mass (wheel, wheel suspension), small and lightweight DUT.

Additional vibration profiles shall be agreed between customer and supplier.

7.4.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

Interruptions greater than 7 Ω shall not last longer than 1 µs.

The resonance frequency vibration responses of the housing shall also be recorded and documented in a diagram together with the excitation profile in the test report.

7.5 Mechanical shock

7.5.1 Purpose

The purpose of this test is to evaluate a connector system's ability to withstand to mechanical shock. This is done by simulating exposure to extreme component (or vehicle) conditions such as sudden impacts from potholes, road hazards, unpaved surfaces, speed bumps, hard braking, flat tire, etc. Mechanical shock can cause wear of the terminal interfaces, intermittent electrical contact and failure of mechanical components in the connector system.

7.5.2 Test

Perform the test in accordance with ISO 16750-3:2023, 4.2.1. Test the connector in all six spatial directions with 10 shocks per spatial direction. Include instrumentation for detection of interruptions greater than 7 Ω for longer than 1 µs with a current of 100 mA.

Use the following test parameters:

— pulse shape: half-sinusoidal;

— acceleration: 500 m/s^2;

— duration: 6 ms;

— number of shocks: 10 per test direction.

7.5.3 Requirements

a) All test samples shall fulfil subsequent requirements in the test group.

b) Interruptions greater than 7 Ω shall not last longer than 1 µs.

7.6 Drop

7.6.1 Purpose

The purpose of this test is to evaluate connector robustness when dropped on a hard surface, as may occur during wire- harness-assembly and vehicle-assembly processes.

7.6.2 Test

Assemble an unmated connector to match its production application. The length of the cable(s) and the test arrangement are shown in Figure 15. Attach the cable(s) to a fixed point that allows the test sample to swing freely (a simple attachment on a hook is sufficient). Hold the test sample horizontally and let it swing down to hit a steel plate of dimensions (300 × 500 × 25) mm. Perform one drop in each of the four connector orientations with all of the test samples, as shown in the Figure 15. Repeat three times for each orientation of the testing samples, or as agreed between customer and supplier.

The test samples shall be visually examined after each series of four drop orientations.

Dimensions in millimetres

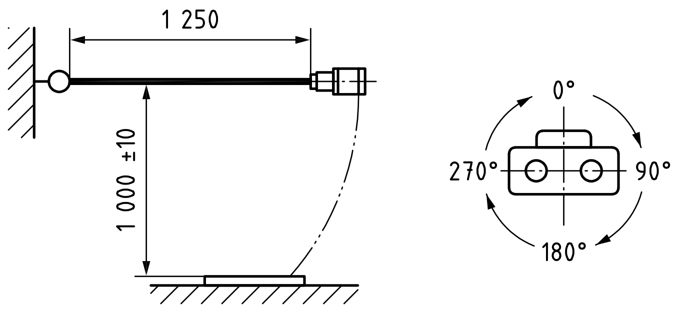


Figure 15 — Drop test arrangement and four orientations to test

7.6.3 Requirements

All test samples shall fulfil subsequent requirements in the test group.

Obvious breakage or damage is permitted after this test, as agreed between customer and supplier. The TPA shall still be in its fully assembled position after the drop test.

7.7 Water tightness

7.7.1 Purpose

The purpose of this test is to determine the sealing capability of connectors by creating a pressure differential between the inside and outside of the sealed area. The test includes a simulation of the effect of cable position at an unfavourable angle relative to the connector and the seal.

7.7.2 Test

Put the test sample in a water tank at (23 ± 5) °C. Fix as shown in Figure 16 unless the sequence Table 5 prescribes cable stress as per footnote f. If the test parameter in footnote f is prescribed, fix the sample so that the cable is deflected at a 30° angle, as shown in Figure 17.

1) Slowly increase the air pressure of the regulated pressure source supplying the tube (wire) in each sample until the monitored pressure within the connector under test reads 48 kPa. When the connector under test reach specified pressure, observe samples for a minimum of 30 s and verify that there are no air bubbles.

2) Switch the regulated source from pressure to vacuum. Decrease the air pressure until the monitored pressure within the connector under test reads -48 kPa and hold for a minimum of 30 s.

3) Remove the samples from the water, shake off excess fluid and then carefully dry all exterior surfaces of the sample. Immediately perform Insulation resistance test in accordance with 6.4.

Place the samples in a temperature chamber stabilized at the maximum ambient temperature for the temperature class selected from Table 1 for the connector under test. Heat soak all samples for 70 h. After the heat soak, remove the samples from the chamber and allow the samples to cool to room temperature.

Repeat steps 1 to 3 in this subclause except limit pressure in step 1 to 28 kPa and the vacuum in step 2 to -28 kPa.