INTERNATIONAL STANDARD

ISO 8092-2

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

Part 2: Definitions, test methods and general performance requirements

Véhicules routiers — Connexions pour faisceaux de câblage électriques embarqués —

Partie 2: Définitions, 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8092-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This fourth edition cancels and replaces the third edition (ISO 8092-2:2000), which has been technically revised.

ISO 8092 consists of the following parts, under the general title *Road vehicles — Connections for on-board electrical wiring harnesses*:

— *Part 1: Tabs for single-pole connections — Dimensions and specific requirements*

— *Part 2: Definitions, test methods and general performance requirements*

— *Part 3: Tabs for multi-pole connections — Dimensions and specific requirements*

— *Part 4: Pins for single- and multi-pole connections — Dimensions and specific requirements*

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

Part 2: Definitions, test methods and general performance requirements

1 Scope

This part of ISO 8092 defines terms, and specifies test methods and general performance requirements for single-pole and multi-pole connections used with on-board electrical wiring harnesses of road vehicles.

This part of ISO 8092 is applicable to connectors designed to be disconnected after mounting in the vehicle for repair and maintenance only. It does not cover one-part connections, i.e. where one part of the connection has direct contact to the pattern of the printed circuit board.

This part of ISO 8092 is not applicable to internal connections of electronic devices.

2 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.

ISO 1817; *Rubber, vulcanized — Determination of the effect of liquids*

ISO 3170; *Petroleum liquids — Manual sampling*

ISO 6722, *Road vehicles — 60 V and 600 V single core cables — Dimensions, test methods and requirements*

ISO 7309, *Road vehicles — Hydraulic braking systems — ISO reference petroleum base fluid*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

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

IEC 60050-581, *International Electrotechnical Vocabulary — Electromechanical components for electronic equipment*

IEC 60068-2-27, *Environmental testing. Part 2: Tests. Test Ea and guidance: Shock*

IEC 60512-11-7, *Connectors for electronic equipment — Tests and measurements — Part 11-7: Climatic tests — Test 11 g: Flowing mixed gas corrosion test*

IEC 60512-11-14, *Connectors for electronic equipment — Tests and measurements — Part 11-14: Test 11p — Flowing single gas corrosion test*

SAE J311b, *Fluid for passenger car type automatic transmission*

3 Terms and definitions

For the purpose of this part of ISO 8092, the definitions given in IEC 60050-581 and the following apply.

3.1
connection
two mated connectors or contacts

EXAMPLE See Figure 1.

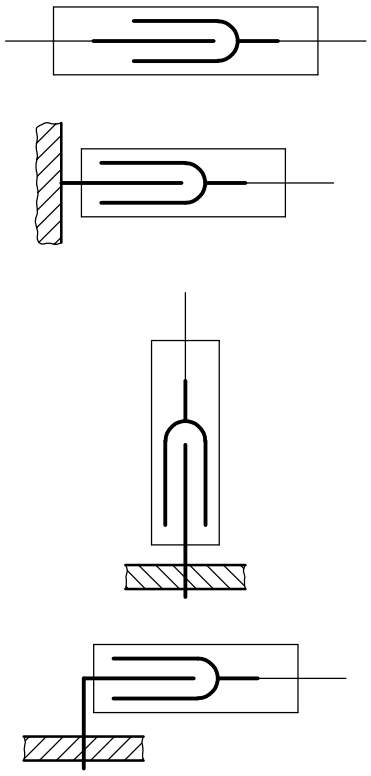


Figure 1 — Typical examples of connections

3.2
connector
assembly of contact and housing that terminates conductors for the purpose of providing connection and disconnection to a suitable mating connector

3.3
contact
conductive element in a connector (including means for cable attachment) that mates with a corresponding element to provide an electrical path

3.4
contact area
area in contact between two mated contacts that provides an electrical path

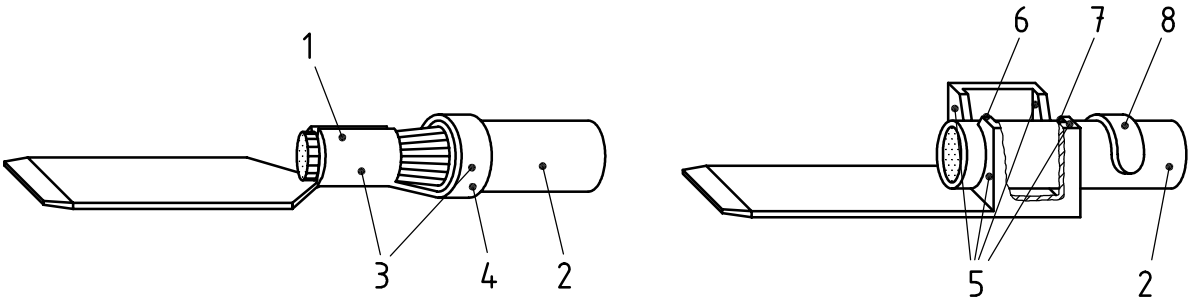
3.5
male contact
contact (including means for cable attachment) designed for electrical engagement on its outer surface and to enter a female contact, thus forming an electrical connection

EXAMPLE See Figure 2 (tab, pin, blade).

3.6
female contact
contact (including means for cable attachment) designed for electrical engagement on its inner surface, and to accept entry of a male contact, thus forming an electrical connection

EXAMPLE See Figure 3 (receptacle, sleeve).

Dimensions in millimetres

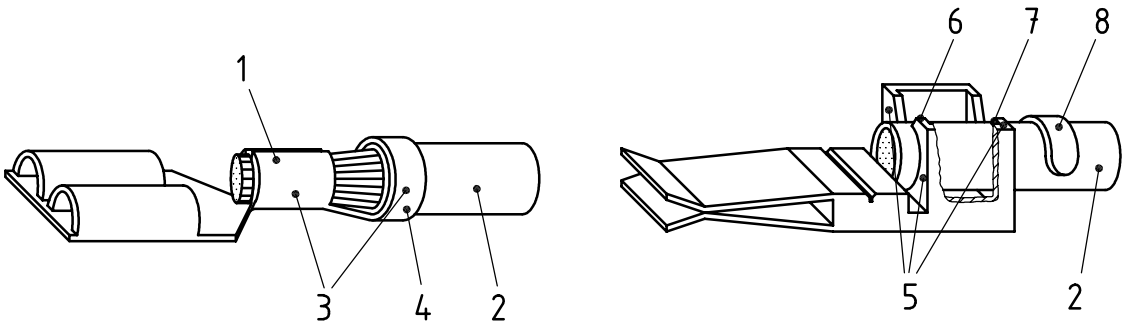


Key

1	conductor crimp	5	cable attachment by insulation displacement
2	cable	6	connection slot
3	cable attachment	7	connection slot/insulation support, if 8 is not available
4	insulation support/sealing grip	8	insulation support

Figure 2 — Male contact

Dimensions in millimetres



Key

1	conductor crimp	5	cable attachment by insulation displacement
2	cable	6	connection slot
3	cable attachment	7	connection slot/insulation support, if 8 is not available
4	insulation support/sealing grip	8	insulation support

Figure 3 — Female contact

3.7
positive-locking female contact
female contact with automatic positive-locking and manual unlocking device engaging a hole or dimple in the male contact

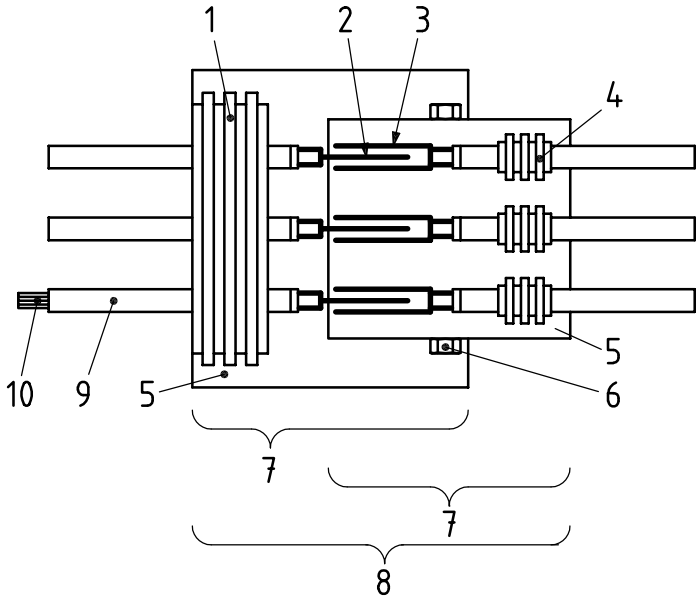
3.8
cable attachment
any permanent joining of cable to contact

EXAMPLES Include crimp, insulation, displacement, welding and screwing.

3.9
detent
raised portion of the female contact that engages a hole or dimple in the male contact thus providing a latch for the mated parts

3.10
multi-pole connection
two mated connectors with more than one contact pair

EXAMPLE See Figure 4.



Key

1	multiple cable seal	6	housing seal
2	male contact	7	connector
3	female contact	8	connection
4	single cable seal	9	cable
5	housing	10	conductor

Figure 4 — Multi-pole connectors/connection

3.11
connector coding
device, either for visual, mechanical or sensitive, or combinations of these preventing connection of connectors from the same family and having the same number of contacts but with different coding

4 Tests and requirements

4.1 General

4.1.1 Preconditioning

All test samples shall be preconditioned at (23 ± 5) °C and 45 % to 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 an ambient temperature of (23 ± 5) °C, unless otherwise stated in the test plan.

Each test sequence (see Table 1) shall be started with unused test samples manufactured to conform to the dimensions specified in the applicable part of ISO 8092.

Contacts with a locking device shall be tested with adequate counterparts to permit locking.

Cables shall be in conformance with ISO 6722, and the cable or cables used shall be noted in the test report. Additional dimensions of the cable or cables used shall be according to Annex A.

Cable attachment shall be performed in accordance with the contact manufacturer's recommendations.

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 contacts fitted, unless otherwise specified in the test method. Measurements shall be taken on a minimum of four contacts per connector, unless otherwise specified in the test methods. For 1-, 2-, and 3-pole connectors, all contacts shall be measured.

During the entire test sequence, lubrication or other means of attaining better test results shall not be added to the test surface. However, production-related remains of lubricants on the contacts are permitted.

4.1.3 Multiple-position connections

Connectors or contacts that allow connections for multiple positions shall meet the requirements of this International Standard in all intended positions.

4.1.4 Test sequences

The test sequence for each sample group shall be in accordance with Table 1 (sequences are indicated by Xs, ordered from top to bottom). Also given in the same table is the applicability of test sequences to sealed or unsealed connectors. A new test sample group shall be used for each test sequence.

4.1.5 Number of test samples

Each test sample group shall contain a minimum of:

— 20 test samples in the case of single-pole connectors,

— 10 test samples in the case of 2-pole connectors,

— 7 test samples in the case of 3-pole connectors,

— 5 test samples in the case of 4-pole connectors.

Moreover, not less than 20 contacts of each type shall be tested.

Unless otherwise specified, all test samples shall be used for all tests in a test sample group.

4.2 Visual examination

4.2.1 Test

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

Table 1 — Test sequences and requirements

Test		Test sample group [a] / sequence													Requirement
		A	B	C	D	E	F	G	H	I	K	L	M	N	
Unsealed connectors	Sub-clause	X	X	X	X	X	X	X	X	X	X	X			Sub-clause
Sealed connectors		X	X	X	X	X	X	X	X	X			X	X	
Visual examination	4.2.1	X	X	X	X	X	X	X	X	X	X	X	X	X	4.2.2
Contact insertion force	4.6.1	X													4.6.2
Contact retention in housing	4.7.1	X													4.7.2
Tensile strength for crimped connections	4.4.1							X							4.4.2
Connector coding and polarization	4.15.1		X												4.15.2
Connection and disconnection	4.3.1		X												4.3.2
Connection resistance (voltage drop)	4.8.1		X	X	X	X			X	X	X				4.8.2
First connection to 10th disconnection	4.3.1		X												4.3.2
Current cycling	4.17.1			X											4.17.2
Insulation resistance	4.12.1				X								X		4.12.2
Withstand voltage	4.13.1				X						X				4.13.2
Temperature/humidity cycling	4.10.1				X										4.10.2
Combined temperature vibration	4.11.2					X									4.11.3
Thermal ageing	4.18.1												X		4.18.2
Chemical fluids	4.23.1											X		X	4.23.2
Temperature rise	4.14.1						X								4.14.2
Mechanical shock	4.19.2								X						4.19.3
Connection resistance (voltage drop)	4.8.1		X	X		X									4.8.2
Locking device strength	4.5.2		X									X		X	4.5.3
Contact retention in housing	4.7.1											X			4.7.2
Water tightness	4.9.1.1												X[b]		4.9.2.1
Insulation resistance	4.12.1				X								X[b]	X	4.12.2
High pressure water jet	4.9.1.2										X		X[b]		4.9.2.2
Insulation resistance	4.12.1												X		4.12.2
Withstand voltage	4.13.1				X						X	X			4.13.2
Rapid change of temperature	4.22.1		X												4.22.2
Salt spray	4.16.1										X				4.16.2
Flowing gas corrosion	4.24.1									X					4.24.2
Connection resistance (voltage drop)	4.8.1		X		X				X	X	X				4.8.2
Drop	4.20.1											X		X	4.20.2
Dust	4.21.1			X											4.21.2
Visual examination	4.2.1	X	X	X	X	X	X	X	X	X	X	X	X	X	4.2.2

[a] See 4.1.4 and 4.1.5.

[b] The subsequent test shall be performed within 1 hour of the test indicated.

4.2.2 Requirement

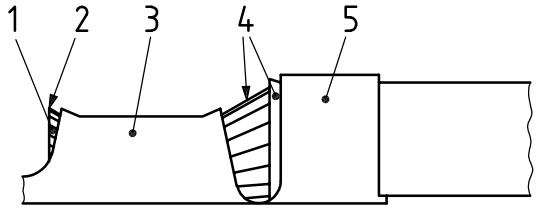
Identification, appearance, workmanship and the finish of each item shall be as specified.

Visual examination as detailed in 4.2.1 shall allow identification, appearance, workmanship and finish of the item to be checked against the relevant specification.

For crimped cable attachments, both insulation and the conductor shall be visible between the conductor crimp and the insulation support on the male and female contacts, as shown in Figure 5. Conductors shall protrude from the conductor crimp but shall not interfere with the mating part. All wire strands shall be enclosed by the conductor crimp. There shall be no damaged wire strands.

For other types of cable attachment, no visible damage is allowed.

During visual examination of the connectors, for all test sample groups, special care shall be taken to ensure, as a minimum requirement, that no cracking, discoloration, deformation or — where applicable — ingress of water is in evidence.



Key

1 conductor end (conductor end shall be visible)
2 wire strand
3 conductor crimp
4 conductor and insulation (conductor and insulation shall be visible)
5 insulation support

Figure 5 — Conductor crimp and insulation support

4.3 Connection and disconnection

4.3.1 Test

Perform connection and disconnection as specified by the connector manufacturer at a constant speed between 25 mm/min and 100 mm/min. Note the speed applied in the test report.

Subject the connector to 10 connections and disconnection. Measure the force necessary at

— first connection;

— first disconnection;

— 10th disconnection.

For positive-locking female connectors perform an eleventh cycle with the locking device engaged for the locking device strength test as in 4.5.2.2.

4.3.2 Requirements

The contacts, tested according to 4.3.1, shall conform to the requirements specified in the applicable part of ISO 8092. In the case of multi-pole connections, the connection and disconnection forces, determined in 4.3.1, shall be as in the particular specification.

4.4 Tensile strength for crimped connections

4.4.1 Test

Test the tensile strength of the conductor-to-contact attachment using suitable test apparatus operated at a constant speed within the range 25 mm/min to 100 mm/min. Note the speed applied in the test report.

Attach each test sample to the corresponding cable or cables as specified by the connector manufacturer.

The cable insulation support shall be rendered mechanically ineffective. Perform the test with contacts alone. When more than one cable is attached, apply the force according to Table 2 to each cable by using separate samples.

In the case of cable attachment by insulation displacement, the test may be performed with the contacts located in the housing (see Annex B).

NOTE Other types of cable attachment are under consideration [for insulation displacement connections (IDC), see Annex B].

4.4.2 Requirements

The tensile strength of the conductor crimp, tested according to 4.4.1, shall withstand the minimum values specified in Table 2.

Table 2 — Minimum tensile strength of conductor crimps

Nominal cross-sectional area of cable (mm^2)	Minimum tensile strength (N)
0,22	30
0,35	50
0,5	60
0,75	90
1	100
1,5	150
2	175
2,5	200
3	260
4	310
5	355
6	360
10	380
The minimum tensile strength of conductor crimp for cables with non-specified nominal cross-sectional area shall be determined by interpolation.	

NOTE For further information for crimped connection see IEC 60352-2.

4.5 Locking device strength

4.5.1 Purpose

The purpose of this test is to check the ability of locked connectors to withstand a specific static load.

Subject connectors for single- and multi-pole connections to the tests in 4.5.2.1 or 4.5.2.2 as appropriate.

4.5.2 Test

4.5.2.1 For single-pole and multi-pole connectors with integral-housing locking devices and without a positive locking female contact, carry out the following test procedure.

With empty connector housings, and with the full complement of contacts fitted, make a fixture or fixtures that can be secured to the connectors being tested, and whose securing shall not distort either connector during the testing. Mount the housing on the fixture or fixtures with the locking device engaged. Apply a test force of (100^{+2}_{0}) N to the fixture in the disconnection direction and hold it constant for (10^{+2}_{0}) s.

4.5.2.2 For positive-locking female contacts and single-pole and multi-pole connectors with positive-locking female contacts, after the 11th connection as specified in 4.3.1, apply a test force of (100^{+2}_{0}) N to the test sample with the locking device engaged in the disconnection direction and hold constant for (10^{+2}_{0}) s.

4.5.3 Requirements

The locking device of connectors for multi-pole connections, tested according to 4.5.2, shall withstand the test force.

4.6 Contact insertion force

4.6.1 Test

Test the insertion force of the contact into the cavity by using the minimum- and maximum-sized cable that can be attached, placing it in the insertion direction via a test fixture, and positioning it as close as possible to the cable attachment. Take care that the contact under test is locked as intended.

Use a constant speed between 25 mm/min and 100 mm/min for insertion. The applied speed shall be noted in the test report.

4.6.2 Requirements

The contact insertion force, tested according to 4.6.1, shall be a maximum of 15 N for contacts with cables attached that have a nominal cross-sectional area $\leqslant$ 1 mm^2.

NOTE It is intended to change these values for the next revision of this part of ISO 8092.

For contacts with cables of larger nominal cross-sectional areas, the force shall be a maximum of 30 N.

In the case of sealed connectors or splash-proof connectors, the force imposed by the seal shall be included.

4.7 Contact retention in housing

4.7.1 Test

Carry out the test for contact retention forces using a suitable test apparatus. The contacts shall have all locking devices effective. Apply a constant force to the front and/or back of the contact in an axial direction and hold it for (10^{+2}_{0}) s. The constant force applied shall be noted in the test report.

4.7.2 Requirements

The contacts, tested according to 4.7.1, shall withstand 60 N. Higher forces may be required according to connection or disconnection forces, material and design.

4.8 Connection resistance (voltage drop)

4.8.1 Test

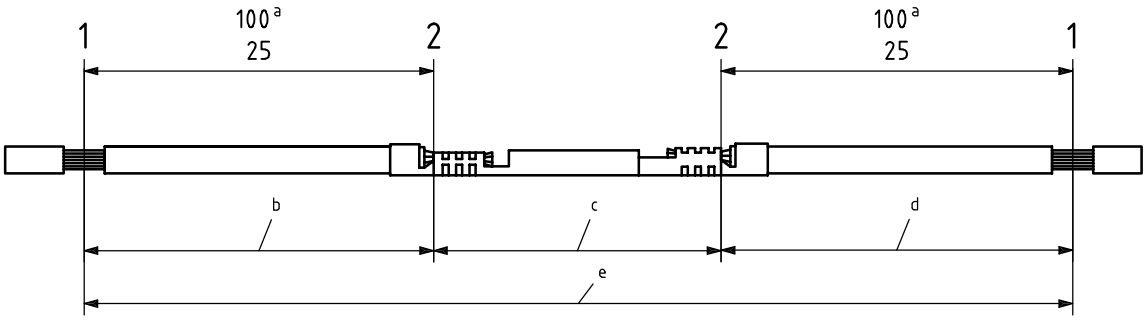
4.8.1.1 General

Determine the conductor resistance(s) of cable(s) or device used. Measure the resistance, $R_{measured}$, between the two measuring points 1 shown in Figures 6 and 7. The connection resistance R_c is determined by subtracting the value(s) $R_{cable\ 1}$ and $R_{cable\ 2}$ or R_{device}.

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

The different points are shown in Figure 6.

Dimensions in millimetres



Key

1 measuring point

2 reference point, only

a Distance recommended.

b Resistance $R_{cable\ 1}$.

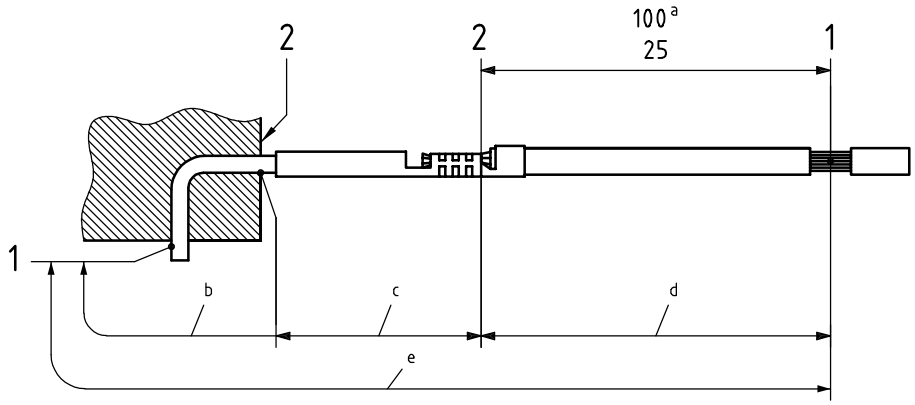
c R_c Connection resistance, resistance of conductor attachment included.

d Resistance $R_{cable\ 2}$.

e Resistance $R_{measured}$.

Figure 6 — Measurement to determine the connection resistance for cable-to-cable connection

Dimensions in millimetres



Key

1 measuring point

2 reference points

a Distance recommended.

b Resistance R_{device}.

c R_c Connection resistance, resistance of conductor attachment included.

d Resistance R_{cable}.

e Resistance $R_{measured}$.

Figure 7 — Connection resistance — connection on device

4.8.1.2 Measurements at millivolt level

Determine the connection resistance using the test arrangements shown in Figures 6 and 7.

For the resistance measurement at millivolt level, in order to prevent the breakdown of possible insulating films on the contacts, the test voltage shall not exceed 20 mV dc or peak voltage ac in open circuit. The test current shall not exceed 100 mA.

4.8.1.3 Measurements at specified test current

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 cable(s), unless otherwise stated. If the measuring cables are soldered at the measuring points, they shall not influence the connections.

4.8.2 Requirements

The connection resistance; R_C, determined according to 4.8.1, shall conform to the requirements specified in the applicable part of ISO 8092.

4.9 Influence of water

4.9.1 Water tightness

4.9.1.1 Water tightness verification

4.9.1.1.1 General

Assemble the connectors with the full complement of contacts fitted. The cables attached shall be of the minimum and maximum overall diameter that the connector sealing system allows. The cable ends shall be sealed. Precondition the test sample (mated connectors) in a temperature chamber at the test temperature for the designated class according to Table 3, for a period of 4 h.

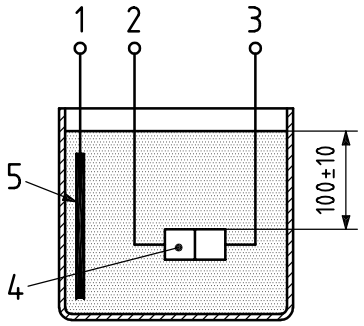
Table 3 — Environmental and test temperatures

Class	Environmental temperature range °C		Test temperature °C
	Lowest value	Highest value	± 2 °C
1	-40	70	85
2		85	100
3		100	125
4		125	155
5		155	175

4.9.1.1.2 Sealed connectors

Immediately following preconditioning, immerse the test sample (mated sealed connectors) in deionized water with 5 % NaCl (m/m), to which 0,1 g/litre wetting agent has been added. The liquid temperature shall be (23 ± 5) °C. Include a dye so that the ingress of liquid into the test sample can be visually checked after the electrical test. Immerse the test sample as shown in Figure 8 for a period of 1 h. Take leakage current measurements of the test sample immersed in the liquid. Take the measurement between each contact and the electrode. Using a different test sample, take the measurement between every two adjacent contacts. See the example shown in Figure 9.

Dimensions in millimetres



Key

1, 2, 3 measuring point
4 test sample
5 electrode

Figure 8 — Water tightness test

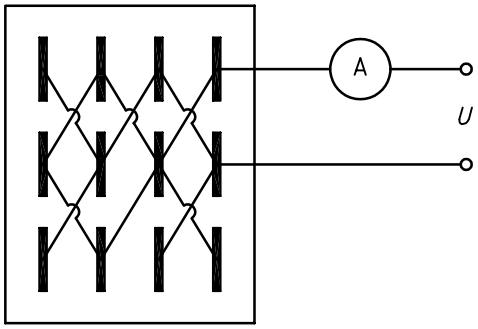


Figure 9 — Example of leakage current measurements between adjacent contacts

4.9.1.1.3 Splash-proof connectors

Immediately following preconditioning, submit the test sample (mated splash-proof connectors) to splash-proof test IPX4, as specified in ISO 20653. Apply the smallest tube arc. Other equipment may be used provided that its use leads to the same end results. In case of a dispute between user and supplier, the test according to ISO 20653 IPX4 shall be decisive. It is recommended that a dye be added to the water to distinguish between water ingress and condensation.

4.9.1.2 High-pressure water jet test

The high-pressure water jet test shall only be applied to on-board electrical connections, which are intended for use outside of the passenger compartment. Perform the test according to ISO 20653 IPX9K.

4.9.2 Requirements

4.9.2.1 Water tightness is verified by testing sealed and splash-proof connectors (4.9.1.1). For the test of sealed connectors, which shall be carried out according to 4.9.1.1.2, the leakage current shall not exceed 50 µA at 48 V applied voltage. The tested sealed connectors and the splash-proof connectors (tested according to 4.9.1.1.3) shall fulfil subsequently performed tests given in Table 1.

4.9.2.2 The requirement as described within ISO 20653 applies. The connectors shall be subsequently submitted to the tests according to Table 1.

4.10 Temperature / humidity cycling

4.10.1 Test

Carry out the temperature/humidity cycling test using cable-to-cable connections (see Figure 6) with a housing possessing the full complement of contacts. If requested by the user, carry out this test with connections on an apparatus (see Figure 7). Test the connectors, with cables assembled, of the minimum and maximum cross-sectional areas allowed by the contact system. Subject the test samples (mated connectors), in a suitable test chamber, to 10 cycles of 24 hours in the following test sequence (see Figure 10 for a graphic representation of the test cycles). The applicable test temperature shall be taken from Table 3 as a function of environmental conditions.

Test cycle:

a) Hold the chamber temperature at t_c = (23 ± 5) °C and at 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 test temperature in Table 3 ± 2 °C from (– 40 ± 2) °C within 1,5 h.

g) Hold t_c at the applicable test temperature in Table 3, ± 2 °C for 2 h.

h) Lower t_c to room temperature (23 ± 5) °C within 1,5 h

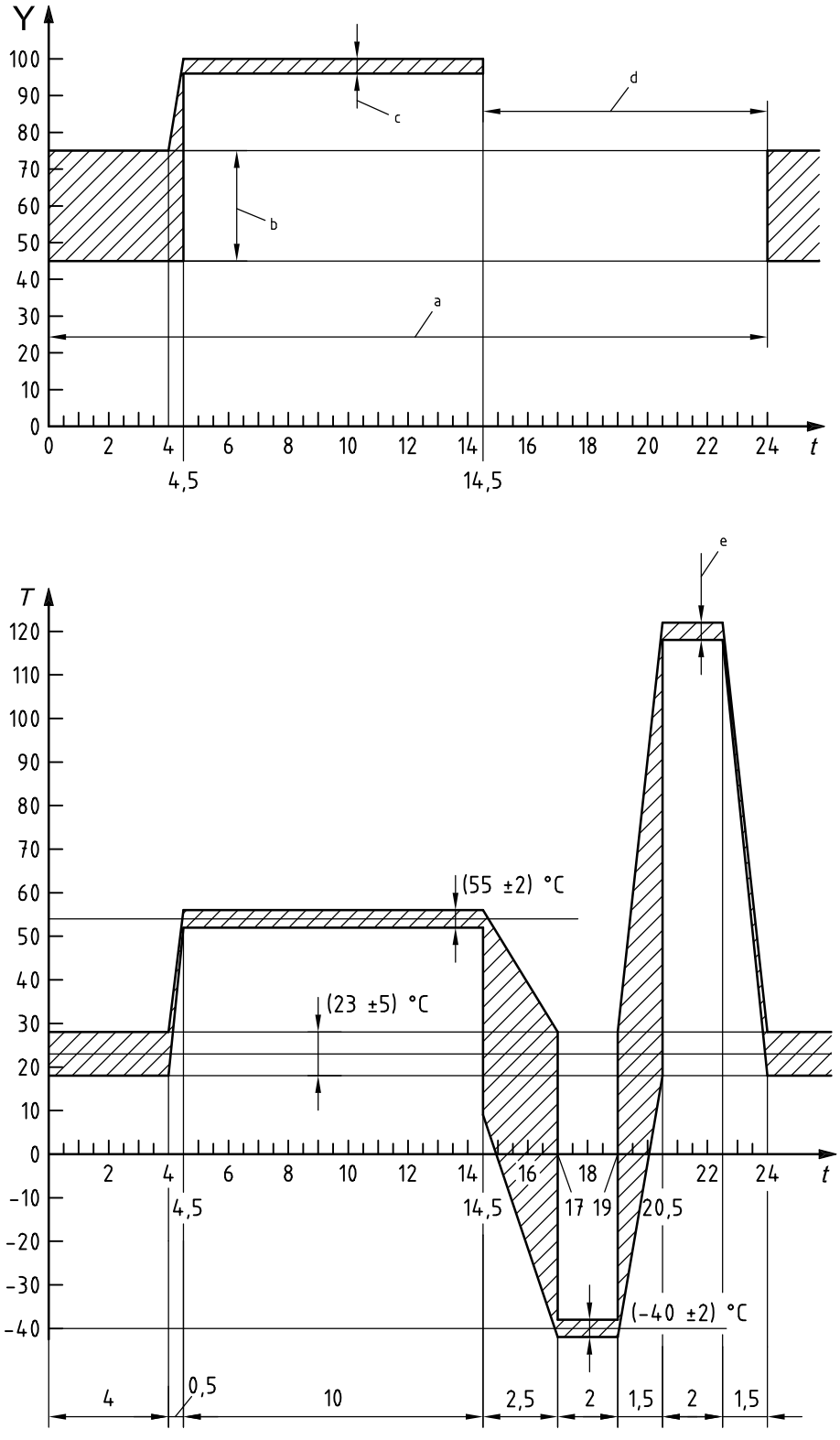
At the end of a cycle, the test may be interrupted. During the interruption, test samples shall remain at the ambient conditions as defined in a). Note the interruption time in the test report.

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 class test temperature, the duration of period f) may be extended and period a) reduced accordingly.

4.10.2 Requirements

The sample, tested according to 4.10.1, shall fulfil subsequently performed tests given in Table 1.



NOTE Hatched areas indicate allowed temperature/humidity tolerance.

Key

a	One cycle.	e	Test temperature (see Table 3).
b	(45 to 75) %.	t	time in hours
c	(95 to 99) %.	T	temperature in °C
d	Uncontrolled humidity.	Y	relative humidity in test room

Figure 10 — Temperature/humidity cycling

4.11 Combined temperature / vibration

4.11.1 Vibration severity

The vibration test methods specified consider various levels of vibration severities applicable to on-board electrical connections. It is recommended that vehicle manufacturer and supplier choose the test method, the environmental temperature and vibration parameters depending on the environment of the connections in the vehicle.

4.11.2 Test

Carry out the vibration with mated connectors suitably mounted on a vibration table as shown in Figure 11. Note the mounting method or methods (1, 2) used in the test report. Wire all contacts in series and connect them to a dc source allowing a current flow of 100 mA for monitoring the connection resistance during the entire test (see Figure 12). Subject the connection to a simple harmonic motion (Table 4) at the applicable test temperature, according to Table 3, having preconditioned the samples as follows.

Connect and disconnect the samples five times, in order to condition the interface sufficiently to reveal any surface degradation.

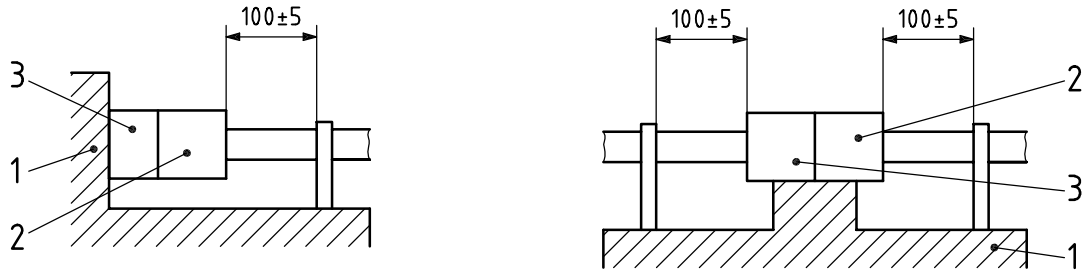
Subject the mated samples to 50 thermal shock cycles, each consisting of

— 30 min at a temperature of (– 40 ± 2) °C,

— 10 s maximum transition time,

— 30 min at the highest value of the applicable environmental temperature in Table 3, and

— 10 s maximum transition time.

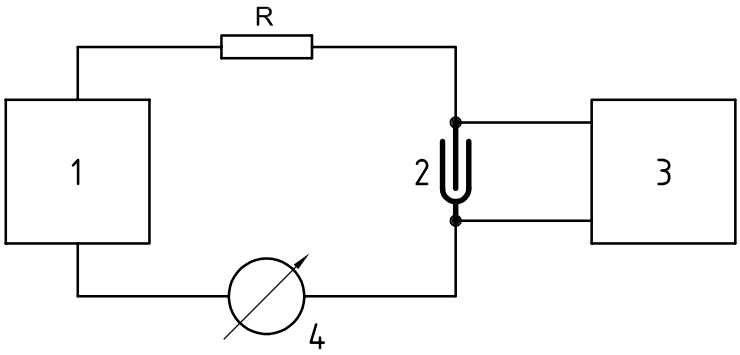


a) Method 1 **b) Method 2**

Key

1 test bench
2 test sample
3 fixed connector
4 ammeter

Figure 11 — Combined temperature/vibration test — Mounting methods



Key

R variable resistor

1 power supply
2 connection under test
3 monitoring unit
4 ammeter

Figure 12 — Connection resistance monitoring at combined temperature/vibration test

Table 4 — Combined temperature/vibration test parameters

Class	Low frequency/amplitude	High frequency/acceleration	
A	10 Hz to 58 Hz/ ± 0,75 mm	> 58 Hz to 500 Hz/ 10g[a]	not applicable
B	10 Hz to 81 Hz/ ± 0,75 mm	> 81 Hz to 500 Hz/ 20g	> 500 Hz to 2 000 Hz/18g
C	10 Hz to 100 Hz/ ± 0,75 mm	> 100 Hz to 500 Hz/ 30g	> 500 Hz to 2 000 Hz/20g

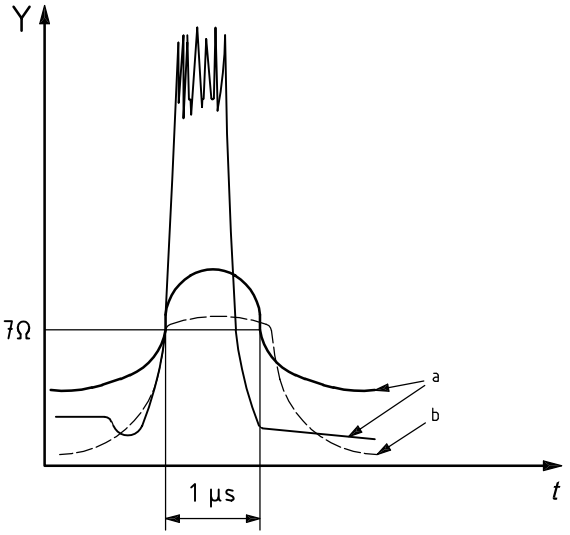
[a] g = 9,806 65 m/s^2.

Carry out the frequency variation by logarithmic sweeping of 1 octave per minute. The motion shall be applied for a period of 16 h in each of the three mutually perpendicular directions (total test time 48 h).

In addition, the test samples may be subjected to a measured vehicle vibration profile for the same duration.

4.11.3 Requirements

During the vibration test carried out according to 4.11.1, the connection resistance shall not exceed 7 Ω for a period of more than 1 µs (Figure 13). After completion of the test, the test samples shall fulfil subsequently performed tests given in Table 1.



Key

a OK.

b Not OK.

Y connection resistance

t time

Figure 13 — Connection resistance at vibration

4.12 Insulation resistance

4.12.1 Test

Measure the insulation resistance at a relative humidity of 45 % to 75 % by applying 500 V dc between all contacts connected together and a metal foil surrounding the housing. For safety reasons, connect the metal foil to earth. In addition, apply the voltage with a different test sample to every two adjacent contacts.

For particular applications, the test voltage may be reduced to 100 V dc if agreed between manufacturer and user. Note the voltage applied in the test report.

Record the insulation resistance when a stable reading is obtained.

4.12.2 Requirements

The insulation resistance, measured according to 4.12.1, shall be at least 100 MΩ. Before insulation-resistance measurements are taken following temperature/humidity cycling, unsealed connectors and splash-proof connectors shall remain for 3 h at an environmental temperature of (23 ± 5) °C and a relative humidity of 45 % to 75 %. Sealed connectors shall have readings taken within 1 h.

4.13 Withstand voltage

4.13.1 Test

Apply an ac voltage of 1 000 V rms (50 Hz or 60 Hz) or a dc voltage of 1 600 V at a relative humidity of from 45 % to 75 % for 1 min across all contacts connected together and a metal foil surrounding the housing. For safety reasons, connect the metal foil to earth. In addition, apply the voltage with a different test sample to every two adjacent contacts.

4.13.2 Requirements

During this test, according to 4.13.1, neither dielectric breakdown nor flash-over shall occur.

4.14 Temperature rise

4.14.1 Test

Carry out the test using mated cable-to-cable connectors and connectors on apparatus using simulated or actual part(s) with the maximum and minimum cable cross-sectional area allowed by the contact system.

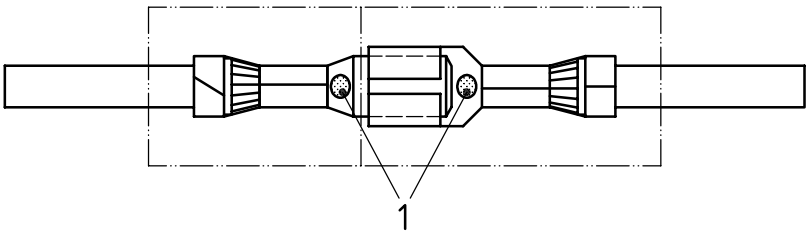
Attach the test samples to cables of (200 ± 5) mm in length in the case of nominal cross-sectional areas up to and including 2,5 mm^2, and (500 ± 5) mm in length for cables with larger nominal cross-sectional areas.

Take care to protect the test samples from draughts and artificial cooling (e.g. caused by a thermocouple).

The contact(s) to be measured shall be those that reach the highest stabilised temperature. Figure 14 shows the typical area of measurements.

Perform the test with the full complement of contacts fitted, each loaded with the test current as in Table 5, multiplied by the applicable reduction coefficient from Table 6.

Measure the temperature of the contacts and ambient temperature after thermal equilibrium has been established and record them.



Key

1 typical area of measurements

Figure 14 — Test sample for temperature rise test

Table 5 — Cable cross-sectional areas and test currents

Nominal cross-sectional area mm^2	Test current A ± 2 %
0,22	3,5
0,35	5
0,5	8
0,75	11
1	13,5
1,5	18
2	21
2,5	24
3	26,5
4	31
5	35
6	38,5
10	50
NOTE The test currents for cables with nominal cross-sectional area not indicated above shall be determined by interpolation.	

Table 6 — Reduction coefficients

Number of poles	Reduction coefficient
1	1
2 to 3	0,75
4 to 5	0,6
6 to 8	0,55
9 to 12	0,5
13 to 20	0,4
21 to 30	0,3
> 30	0,2

4.14.2 Requirements

The temperature rise of each contact, which shall be tested according to 4.14.1, shall not exceed 40 °C, where the temperature rise equals the measured contact temperature minus the test ambient temperature. Each contact shall fulfil subsequently performed tests given in Table 1.

The temperature rise shall not be used as a guide to the capability of the connector to operate at elevated ambient temperatures.

4.15 Connector coding and polarization

4.15.1 Test

Carry out the test by agreement between the supplier and user.

4.15.2 Requirements

It shall be impossible to mate partly or fully two connectors in any false position without permanent damage to one or both parts. Electrical connection shall be prevented before coding or polarization is engaged.

4.16 Salt spray

4.16.1 Test

Carry out the neutral salt spray (NSS) test specified in ISO 9227. Apply it to mated connectors fitted with the full complement of contacts and cables connected. The duration of the test shall be 48 h.

4.16.2 Requirements

The connection, tested according to 4.16.1, shall fulfil subsequently performed tests given in Table 1.

4.17 Current cycling

4.17.1 Test

Carry out the current cycling with test samples as given in 4.14.1, and with test current(s) as specified by the connector manufacturer for each contact used. The corresponding cable size shall be in accordance with Table 6.

Perform the test with the full complement of contacts fitted.

Place the test sample in a thermally controlled test chamber at the highest value of the applicable environmental temperature given in Table 3, and apply 500 test cycles, each 45 min current on, 15 min current off. Take care to protect the test samples from draughts and artificial cooling.

4.17.2 Requirements

The connectors, tested according to 4.17.1, shall fulfil subsequently performed tests given in Table 1.

4.18 Thermal ageing

4.18.1 Test

Place the test sample (two fully-equipped mated connectors) in a test chamber and leave them there at the temperature given in Table 3 for 100 h. Alternatively, the test time may be increased to 500 h at the highest value of the applicable environmental temperature in Table 3.

4.18.2 Requirements

The sample, tested according to 4.18.1, shall fulfil subsequently performed tests given in Table 1.

4.19 Mechanical shock

4.19.1 Purpose

The test shall be performed with connectors for use in high shock areas only. The purpose of this test is to reveal mechanical and electrical weaknesses in specified performance.

4.19.2 Test

Take a test sample (mated connectors) as used in the vehicle and including all additional equipment used to install and connect the sample to the vehicle wiring harness/system. Use appropriate test equipment. Ensure that the test fixture is free of resonance within the range of frequencies applied, and allow sufficient distribution of the instantaneous acceleration. Subject the test samples to half-sine shocks according to IEC 60068-2-27. Apply an acceleration of $100g$ (981 m/s^2) for a duration of 5 ms. Apply 1 000 shocks in both directions of the three mutually perpendicular axes (total number of shocks is $2 \times 3 \times 1\,000 = 6\,000$). Monitor the connection resistance during the shocks as in 4.11.1.

4.19.3 Requirements

The connection resistance shall not exceed 7 Ω for a period of more than 1 µs. The connectors, tested according to 4.19.2, shall fulfil subsequently performed tests given in Table 1.

4.20 Drop

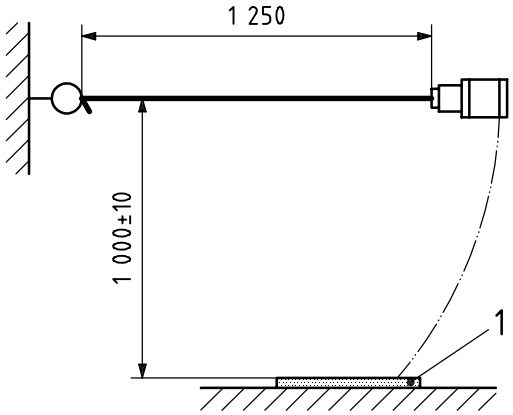
4.20.1 Test

Perform the test at a relative humidity of 45 % to 75 %.

Wire the sample (unmated connector) according to its application. The length of the cable(s) and the test arrangement shall be as given in Figure 15. Attach the cable(s) to a fixed point and allow a free swinging of the test sample (a simple attachment on a hook can, however, be sufficient).

Hold the test sample horizontally and let it swing down to hit a steel plate of dimensions 300 mm × 500 mm × 25 mm (thickness). Repeat as often as agreed between manufacturer and user.

Dimensions in millimetres



Key

1 typical area of measurements

Figure 15 — Drop test arrangement

4.20.2 Requirements

The sample, tested according to 4.20.1, shall fulfil subsequently performed tests given in Table 1.

4.21 Dust

4.21.1 Test

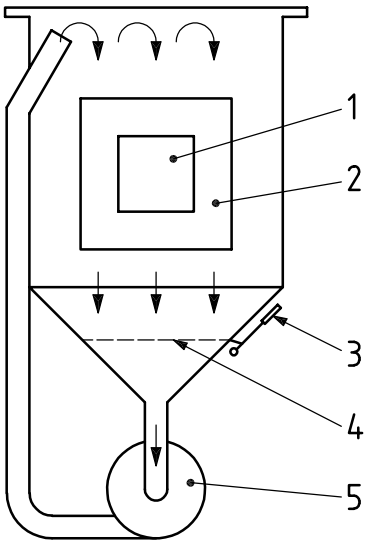
This test shall be performed, with mated connectors, cables attached, when a dust test is requested by the user. Use a test chamber incorporating the basic principles illustrated by Figure 16. Ensure the dust used (use undecomposed feldspar) is clean, free from carbonaceous material or other impurities and is used in a dry condition. The particle size shall be as follows:

- smaller than 150 µm — 100 % to 99 % by weight;
- smaller than 105 µm — 86 % to 76 % by weight;
- smaller than 75 µm — 70 % to 60 % by weight;
- smaller than 40 µm — 46 % to 35 % by weight;
- smaller than 20 µm — 30 % to 20 % by weight;
- smaller than 10 µm— 19 % to 11 % by weight;
- smaller than 5 µm — 11 % to 5 % by weight;
- smaller than 2 µm — 5 % to 1,5 % by weight.

Use a dust concentration of approximately 2 kg dust in suspension per 1 m^3 test chamber volume. Mount the test samples in an orientation similar to that in which they are mounted in the vehicle. Agitate the dust every 15 min for 6 s during a period of 5 h. Other periods may be agreed.

4.21.2 Requirements

The connectors, tested according to 4.21.1, shall fulfil subsequently performed tests given in Table 1. After disconnection, no visible damage is permitted.



Key

1 test sample
2 glass window
3 vibrator
4 guard screen
5 circulation pump or other means suitable for maintaining the dust in suspension

Figure 16 — Dust test

4.22 Rapid change of temperature (thermal shock)

4.22.1 Test

Subject the mated samples to 100 thermal shock cycles, each consisting of

- 30 min at a temperature of – 40 °C ± 2 °C,
- 10 s max. transition time,
- 30 min at the highest value of the applicable environmental temperature given in Table 3, and
- 10 s max. transition time.

4.22.2 Requirements

After being tested according to 4.22.2, the test sample shall fulfil subsequently performed tests given in Table 1. The connection resistance measured shall not exceed the value specified in the applicable part of ISO 8092.

4.23 Chemical fluids

4.23.1 Principle and application

The resistance to chemical fluids is only required for connectors likely to be exposed to such fluids. For this purpose, a list of chemicals and tests common to automotive use has been established (see Table 7). The vehicle manufacturer and supplier should choose the fluids and tests depending on the connector application.

Table 7 — Chemical fluids

Chemical fluid		Test liquid	Liquid temperature °C	Duration of immersion min
Lubrication oil		Oil No. 1 according ISO 1817 [a)]	85 ± 2	60
Automatic transmission fluid		According to SAE J311b		
Mineral hydraulic oil		According to ISO 7309		
Brake fluid		DOT 4 (SAE J 1709)		
Battery acid		37 % sulphuric acid	23 ± 5	1
Battery alkaline		KOH	23 ± 5	1
Antifreeze fluid		Not yet specified.	118 ± 5	60
Window washer fluid		Ethyl alcohol 27 ml Isopropylen 10 ml Ethylen glycol 3 ml Water 60 ml	50 ± 2	
Fuel	Gasoline	according ISO 3170	23 ± 5	
	Diesel	according ISO 3170		

[a] Conforms to ASTM oil No. 1.

4.23.2 Test

Apply the test liquids at the temperatures and for duration according to Table 7. For each test liquid a new specimen shall be used.

After a chemical fluid test it is permitted to rinse (with inert fluid) and dry the outside of the test sample before continuing the test sequences in Table 1.

4.23.3 Requirements

After being tested according to 4.23.2, the test sample shall fulfil subsequently performed tests given in Table 1.

4.24 Flowing gas corrosion test

4.24.1 Test

Apply test 11g Flowing mixed gas corrosion test, method 4 or, as an alternative, test method 1, as per IEC 60512-11-7, to mated unsealed connectors and to unmated sealed and unsealed connectors. This test may be performed as flowing single gas corrosion test, test 11p as per IEC 60512-11-14, severity 2. The duration of the test shall be 21 days.

4.24.2 Requirements

The connectors, tested according to 4.21.1, shall fulfil subsequently performed tests.

Annex A
(normative)

Additional cable dimensions

Additional cable dimensions shall be a shown in Table A.1.

Table A.1 — Additional dimensions of cables used

ISO conductor size	Conductor maximum diameter	Number of wires	Thick wall Outside cable diameter		Thin wall Outside cable diameter	
			minimum	maximum	minimum	maximum
mm^2	mm		mm	mm	mm	mm
0,13	0,55	7	—	—	0,95	1,05
0,22	0,70	7	—	—	1,10	1,20
0,35	0,90	7	—	—	1,20	1,30
0,35	0,90	12, 19	—	—	1,30	1,40
0,50	1,10	7, 16, 19	2,00	2,30	1,50	1,70
0,75	1,30	7, 19, 24, 37	2,20	2,50	1,70	1,90
1,00	1,50	7, 19, 26, 32, 37	2,40	2,70	1,90	2,10
1,50	1,80	7, 19, 30, 37, 41	2,70	3,00	2,20	2,40
2,00	2,00	19, 28, 37, 65	3,00	3,30	2,50	2,80
2,50	2,20	19, 37, 50	3,20	3,60	2,70	3,00
3,00	2,40	19, 37, 44, 65	3,70	4,10	3,10	3,40
4,00	2,80	19, 37, 56	3,90	4,40	3,50	3,80
5,00	3,10	19, 37, 65, 70	4,40	4,90	3,90	4,20
6,00	3,40	37, 84	4,50	5,00	4,00	4,30
10,00	4,50	63, 80	5,90	6,50	5,60	6,00
16,00	6,30	105, 126	7,70	8,30	7,50	7,90
25,00	7,80	154, 196	9,80	10,40	9,00	9,40
35,00	9,00	276, 551	11,00	11,60	—	—
50,00	10,50	396, 798	12,90	13,50	—	—
70,00	12,50	360, 1140	14,70	15,50	—	—
95,00	14,80	475, 836	17,00	18,00	—	—
120,00	16,50	608, 1064	18,70	19,70	—	—

Annex B
(informative)

Cable attachment by insulation-displacement connection (IDC) — Bending test

B.1 Bending test

The object of this test is to assess the ability of a insulation displacement connection (IDC) to withstand the mechanical stress caused by bending the attached cable.

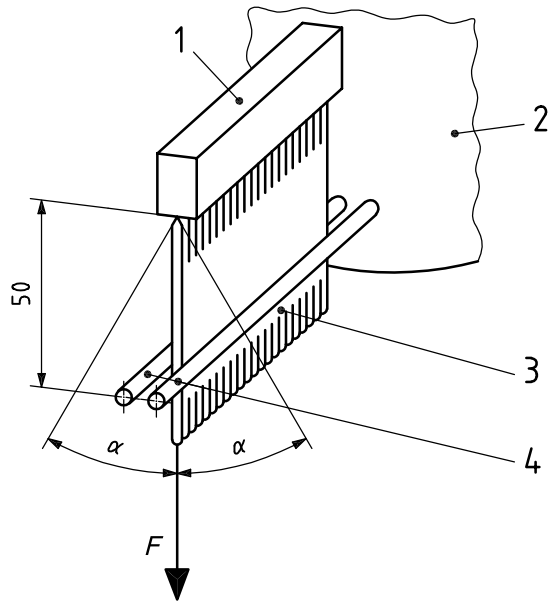
The test shall be performed with connectors fully equipped with their contacts and effective cable attachment. The test specimen shall be securely held in such a position that the cable(s) hang(s) along its (their) longitudinal axis in the connection slot(s). All connections shall be connected in series.

An axial force *F* shall be applied to the free end(s) of the cable(s) to keep it (them) straight.

The force shall be evenly distributed over the whole bundle, if multiple cables are attached. The force shall be agreed between supplier and vehicle manufacturer, depending on the number of cables bundled and attached, the cross-section of the cables, the type and material of the insulation. The recommended value of the applied force *F* is 10 N to 50 N.

The cable(s) shall then be bent in both directions from vertical which constitutes one cycle. The bending angle α shall be 30°, the number of cycles shall be 10, if not otherwise agreed between supplier and vehicle manufacturer. Bending the cable(s) shall be carried out using a suitable device, for example as indicated in Figure B.1.

Dimensions in millimetres



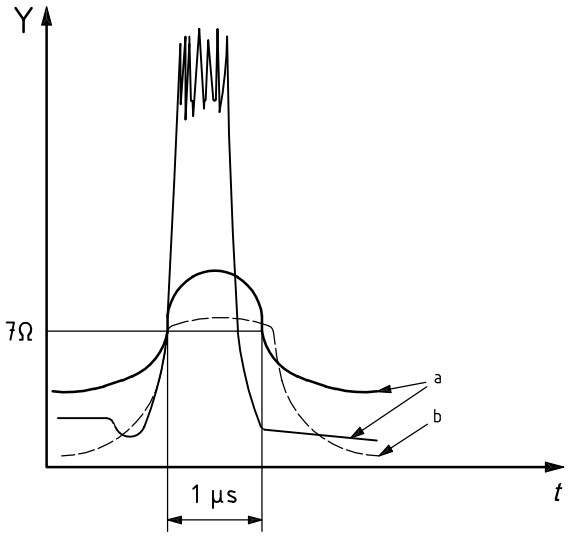
Key

1 connector
2 driving plate for the cable bending device
3 cable(s) attached
4 driving plate pins
F force
α bending angle

Figure B.1 — Test arrangement for bending test

B.2 Requirements

Contact resistance shall be monitored during the full duration of the bending test. The connection resistance shall not exceed 7 Ω for a period of more than 1 s (Figure B.2). After testing, IDC shall not be damaged and the cable shall not be broken.



Key

a OK.

b Not OK.

Y connection resistance

t time

Figure B.2 — Connection resistance at bending test

Bibliography

[1] ASTM D975-98b, *Standard specification for diesel fuel oils*

[2] IEC 60352-2, *Solderless connections. Part 2: Solderless crimped connections — General requirements, test methods and practical guidance*

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