INTERNATIONAL STANDARD

ISO 15170-2

First edition
2001-12-01

Road vehicles — Four-pole electrical connectors with pins and twist lock —

Part 2: Tests and requirements

Véhicules routiers — Connecteurs électriques à quatre contacts avec broches et verrouillage direct —

Partie 2: Essais et exigences

Reference number
ISO 15170-2:2001(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

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 3.

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 part of ISO 15170 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15170-2 was prepared by Technical Committee ISO/TC 22, *Motor vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 15170 consists of the following parts, under the general title *Road vehicles — Four-pole electrical connectors with pins and twist lock*:

— *Part 1: Dimensions and classes of application*

— *Part 2: Tests and requirements*

Road vehicles — Four-pole electrical connectors with pins and twist lock —

Part 2: Tests and requirements

1 Scope

This part of ISO 15170 specifies tests and requirements for electrical connectors and connections with up to four poles and twist lock coupling.

This type of connection is intended for electrical connections in truck, bus and trailer applications (e.g. for components directly mounted on the engine).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15170. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15170 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1817:1999, *Rubber, vulcanized — Determination of the effect of liquid*

ISO 4925:1978, *Road vehicles — Non-petroleum base brake fluid*

ISO 6988:1985, *Metallic and other non organic coatings — Sulphur dioxide test with general condensation of moisture*

ISO 7309:1985, *Road vehicles — Hydraulic braking systems — ISO reference petroleum base fluid*

ISO 8092-2:2000[1)], *Road vehicles — Connections for on-board electrical wiring harnesses — Part 2: Definitions, test methods and general performance requirements*

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 15170-1:2001, *Road vehicles — Four-pole electrical connectors with pins and twist lock — Part 1: Dimensions and classes of application*

IEC 60068-2-68:1994, *Environmental testing — Part 2: Tests — Test L: Dust and sand*

IEC 60068-2-75:1997, *Environmental testing — Part 2: Tests — Test Eh: Hammer tests*

1) Corrected and reprinted: 2001.

SAE J311, *Fluid for passenger car type automatic transmissions*

ASTM D975, *Standard specification for diesel fuel oils*

3 General

3.1 Application

The tests and requirements are applicable to

— fixed or free connectors of the device,

— free coupler connectors,

— connectors at the device coupled with the compatible free coupler connector,

— connections fitted with cables as specified or, for fixed connectors, after mounting.

3.2 General requirements

Unless specific requirements allow it, the test samples shall show no changes that could unduly influence their functioning. Cracks shall not be permitted.

3.3 Test conditions and preconditioning

Precondition all test samples for 24 h at (23 ± 5) °C and 45 % to 75 % relative humidity (RH) before starting any test sequence.

All tests shall be carried out at an ambient temperature of (23 ± 5) °C, unless otherwise stated.

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

Each test sequence (see Table 1) shall be started with unused, clean and dry test samples manufactured to conform to the dimensions specified in ISO 15170-1.

During the entire test sequence, no lubrication or other additional means on the contact surface shall be used to obtain better test results. Production-related remains of lubricants on the contacts may be ignored.

3.4 Classes of application

With regard to practical working conditions, the classes of application specified in Table 1 of ISO 15170-1:2001 shall be applied.

3.5 Test samples and test sequences

The tests shall be carried out with the sample groups as given in Table 1, in a top-to-bottom sequence, starting with unused samples and with certain tests carried out one after the other without pause (see footnote to Table 1).

The minimum number of test samples in a group shall be

— 10 samples where two contacts are fitted,

— 7 samples where three contacts are fitted, and

— 5 samples where four contacts are fitted.

Table 1 — Test sample groups and test sequences

Tests and requirements according to subclause	Test designation	Test sample group										
		A	B	C	D	E	F	G	H	J	K	L
4.1	Visual examination	X	X	X	X	X	X	X	X	X	X	X
5.2	Connection resistance			X							X	
4.2	Contact retention in housing	X										
4.3	Tensile strength of the conductor attachments to the contacts		X									
4.4	Operating torque for the twist lock			X								X
4.5	Static load resistance of the coupled connection											X
4.6	Static load resistance of the free connector				X							
6.7	Dust		X	X								
6.8	Protection against ingress of water		X	X								
5.3	Withstand voltage			X				X	X	X	X	X
5.4	Insulation resistance			X				X	X	X	X	X
6.5	Temperature cycling			X							X	
4.7	Vibrations			X								
4.8	Resistance to impact					X						
5.1	Temperature rise						X					
6.3	Industrial climate								X [a]			
6.4	Temperature/humidity cycling									X [a]	X	
6.2	Salt spray							X [a]			X	
6.5	Temperature cycling										X [a]	
6.6	Resistance to liquids											X
6.8	Resistance to ingress of water											X
5.2	Connection resistance		X								X [a]	
5.3	Withstand voltage	X		X				X [a]	X [a]	X [a]	X [a]	X
5.4	Insulation resistance	X		X				X [a]	X [a]	X [a]	X [a]	X
4.4	Operating torque of the twist lock			X								X
4.5	Static load resistance of the coupled connection											X
4.1	Visual examination	X	X	X	X	X	X	X	X	X	X	X

[a] The subsequent test shall be performed immediately following this test, without pause (see also 3.5).

4 Mechanical performance

4.1 Visual examination

Perform the visual examination in accordance with ISO 8092-2.

4.2 Contact retention in the housing

4.2.1 Test

Perform the contact retention test in accordance with the test given in ISO 8092-2.

4.2.2 Requirement

The contact tested according to 4.2.1 shall withstand the following forces:

— 100 N in the mating direction;

— 60 N in the opposite direction.

4.3 Tensile strength of the conductor attachment to the contact

4.3.1 Test

Perform the test of tensile strength of the conductor attachment to the contact in accordance with the test given in ISO 8092-2.

4.3.2 Requirement

The tensile strength of the conductor crimp, tested according to 4.3.1, shall withstand the minimum values specified in Table 2. For test sequences, see Table 1.

Table 2 — Minimum tensile strength of conductor crimps

Nominal cross-sectional area of crimped cable mm^2	Minimum tensile strength N
0,5	70
0,75	90
1	115
1,5	155
2	195
2,5	235
The minimum tensile strength of conductor crimp for cables with non-specified nominal cross-sectional area shall be determined by interpolation.	

4.4 Operating torque for the twist lock

4.4.1 Test

Mate and unmate the connectors by operating the twist lock using a suitable tool, without jerking and with a rotational speed of 1 rad/s max. Take care to avoid additional axial and radial forces.

4.4.2 Requirement

The operating torque values of the twist lock measured at the first and last operation shall be in accordance with the values given in Table 3.

Table 3 — Operating torque values of twist lock

Class	No. of operations	Torque		
		Locking	Unlocking	
		Nm max.	Nm min.	Nm max.
K1	10	1,2	0,5	1,2
K2	10			
K3	20			

4.5 Static load resistance of the coupled connection

4.5.1 Test

Apply a force, F, of (250^{+5}_{0}) N, without jerking, to the housing of the free coupler connector in an axial direction, by pulling in the withdrawal direction, as shown in Figure 1, and hold it for (10^{+2}_{0}) s.

Apply a torque of $(75^{+0,5}_{0})$ Nm to the free coupler connector, as shown in Figure 1, and hold it for (10^{+2}_{0}) s.

4.5.2 Requirements

The connection shall withstand the test conditions specified in 4.5.1.

After performance of the test according to 4.5.1, the general requirements of 3.2 shall be met.

4.6 Static load resistance of the free connector

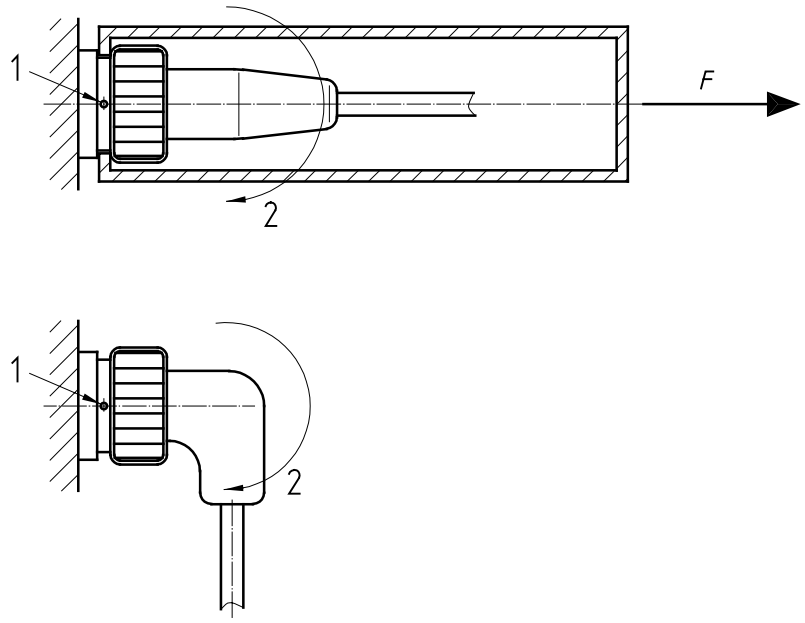
4.6.1 Test

Perform the test on free connectors, uncoupled and without cable attached.

Insert the connector between two plane, parallel plates which completely cover the connector. Apply a force of (350^{+5}_{0}) N vertically to the plates, without jerking, for a duration of (10^{+2}_{0}) s.

4.6.2 Requirements

The connector shall withstand, lying in all possible stable positions, the test according to 4.6.1, and shall fulfil the general requirements of 3.2.



Key

1 Pivot

2 Torque

Figure 1 — Application of force and torque

4.7 Vibrations

4.7.1 Test

Use mated connectors with cables attached according to the specification of the user.

Fix these connectors on the vibration table as shown in Figure 2 and Figure 3, accordingly. Connect the power supply to the cable ends or the contacts so that the vibration load is influenced only to the minimum.

Perform the test in all three perpendicular directions, starting with the main axis of the test arrangement, then laterally and finally in vertical directions parallel to gravity, with the following parameters:

— amplitudes and accelerations according to Table 4 (Figure 4 illustrates the relation of acceleration versus frequency);

— a frequency variation of 1 octave/min;

— test durations and test temperatures for each direction of 100 h [50 h at (23 ± 5) °C and 50 h at (120 ± 5) °C].

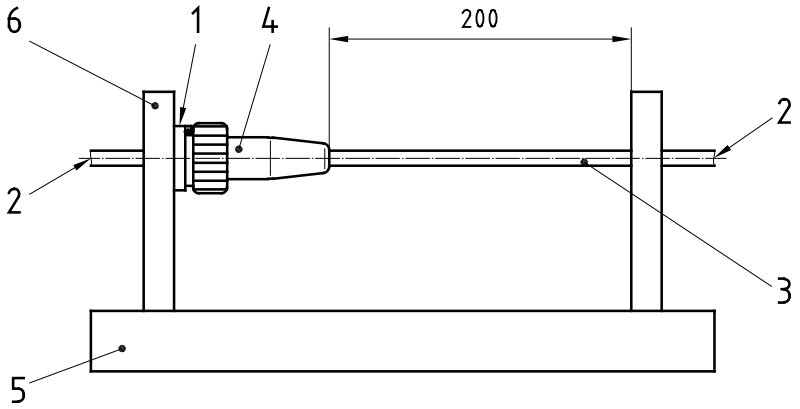
Monitor the contact resistance of each connection (mated contact pair) during the entire duration of the vibration test by applying a current of (100 ± 2) mA to the contacts.

4.7.2 Requirements

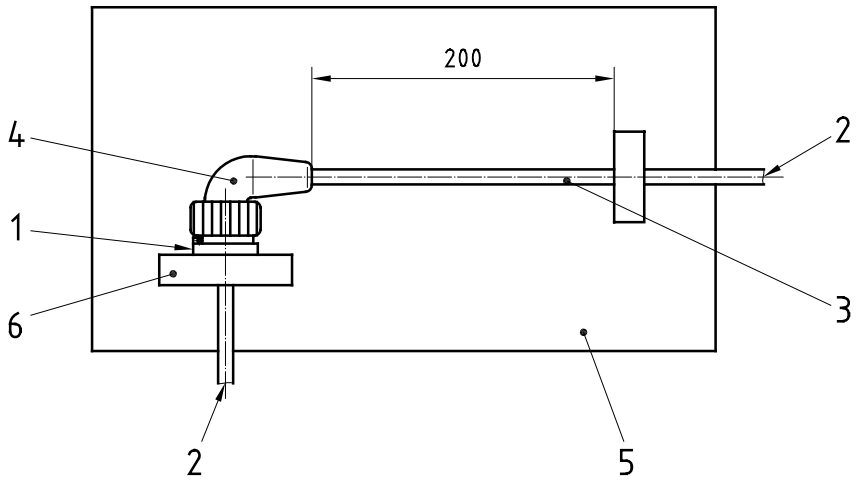
During the vibration test, the connection resistance monitored shall not exceed 7 Ω for periods of more than 1 µs during the entire test duration of 300 h (see Figure 5 and Figure 6).

After the vibration test, the test samples shall fulfil the requirements of the subsequent tests listed in Table 1.

Dimensions in millimetres



a) Fixed connector and free coupler connector with straight cable outlet



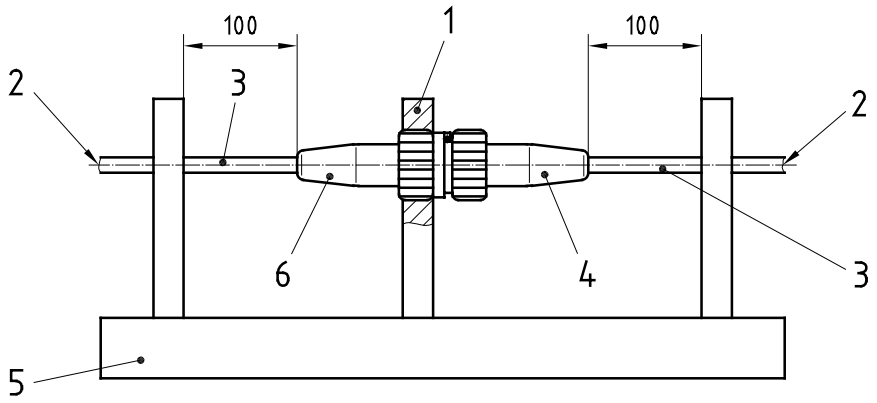
b) Fixed connector and free coupler connector with angular cable outlet

Key

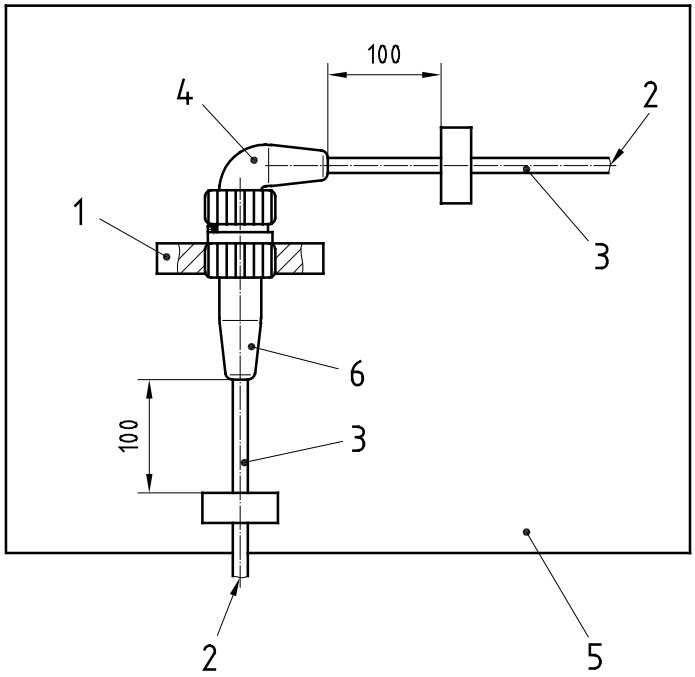
1 Fixed connector
2 To power supply
3 Two- to four-core cable (depending on number of contacts fitted)
4 Free coupler connector
5 Vibration table
6 Dummy enclosure of a test sample

Figure 2 — Test arrangement for vibration test with fixed connector

Dimensions in millimetres



a) Free connectors with straight cable outlet



b) Free connectors with one angular cable outlet

Key

1 Dummy support or similar device
2 To power supply
3 Two- to four-core cable (depending on number of contacts fitted)
4 Free coupler connector
5 Vibration table
6 Free connector

Figure 3 — Test arrangement for vibration test with free connectors

Table 4 — Vibration characteristics

Frequency Hz	Amplitude mm		Acceleration m/s^2	
	Class		Class	
	K1	K2, K3	K1	K2, K3
70 to 147	0,23	0,35	—	—
> 147 to 500	—	—	200	300
> 500 to 2 000	—	—	180	200

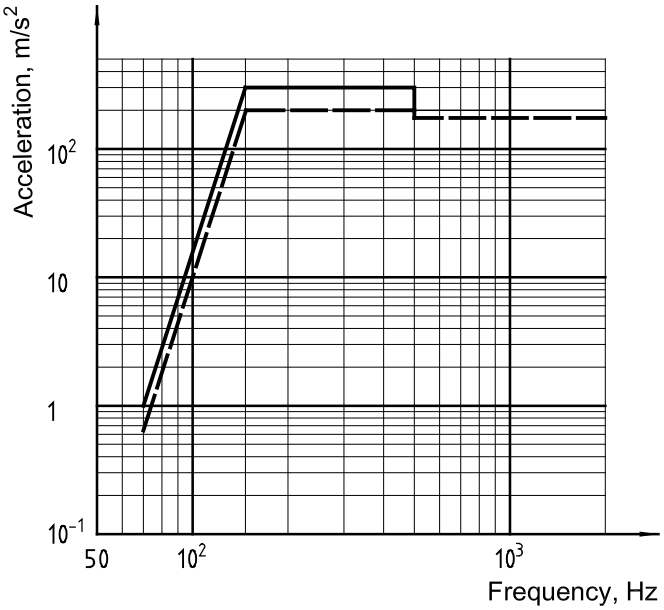
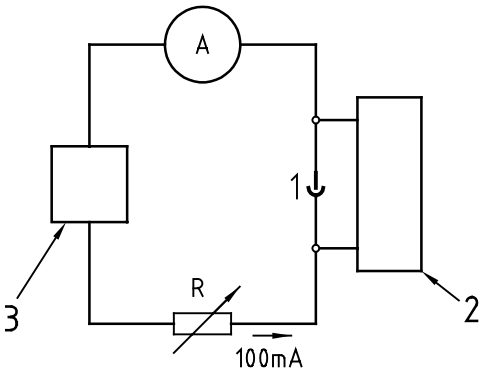


Figure 4 — Acceleration versus vibration frequency



Key

1 Connection
2 Test equipment
3 Power supply

Figure 5 — Test set-up

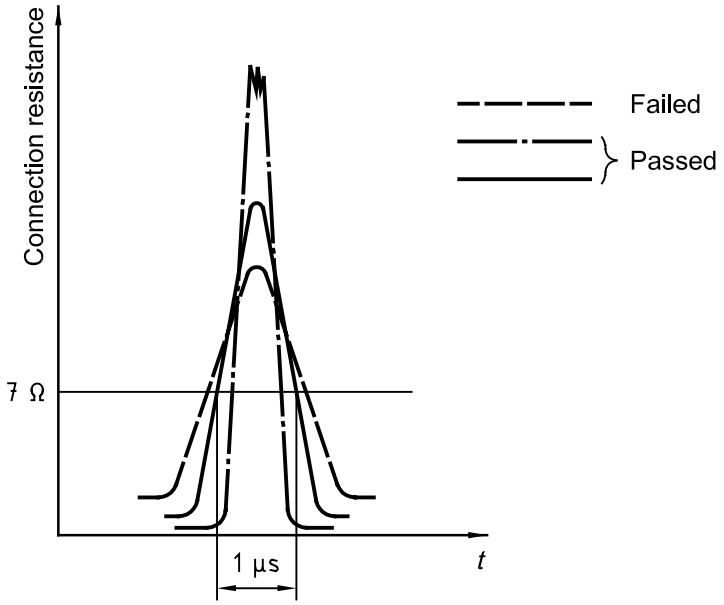


Figure 6 — Connection resistance at vibration

4.8 Resistance to impact

4.8.1 Test

This test is applicable only to fixed connectors likely to be damaged by an impact caused by dropping or toppling of the component on which they are mounted.

Perform the test with a pendulum hammer according to the test given in IEC 60068-2-75, with the following parameters:

— the impact in a direction 45° to the axis of the connector to the connector front;

— using a steel impact hammer, with a contour formed as a plane perpendicular to the direction of the impact;

— with an impact energy of 0,5 J.

4.8.2 Requirement

After performance of the impact test according to 4.8.1, the general requirements of 3.2 shall be met.

5 Electrical performance

5.1 Temperature rise

Perform the temperature rise test in accordance with ISO 8092-2.

5.2 Connection resistance (voltage drop)

5.2.1 Test

Carry out the connection resistance measurements at millivolt level according to the test given in ISO 8092-2.

5.2.2 Requirements

The connection resistance shall not exceed 5 mΩ at initial measurement as in 5.2.1. After a test with thermal or chemical stress, the connection resistance shall not exceed 10 mΩ. For test sequences, see Table 1.

5.3 Withstand voltage

Perform the withstand voltage test in accordance with ISO 8092-2.

5.4 Insulation resistance

Perform the insulation resistance test in accordance with ISO 8092-2.

6 Resistance to environmental influences

6.1 General

Perform the following tests with coupled connectors according to the requirements of the user. The cable ends shall be sealed.

6.2 Salt spray

6.2.1 Test

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

— 96 h for test sample group G, and

— 24 h for test sample group K.

6.2.2 Requirements

The connection tested according to 6.2.1 shall fulfil the requirements of the subsequent tests listed in Table 1.

After performance of the test according to 6.2.1, no signs of corrosion shall be visible.

6.3 Industrial climate

6.3.1 Test

Apply three cycles of the test in accordance with ISO 6988, but with a volume of 2,0 dm^3 of SO_2, instead of 0,2 dm^3, given into the test chamber (which means a theoretical concentration of 0,67 % at the start of a cycle), to mated connectors with the full complement of contacts and cables fitted. Each cycle shall consist of

— 8 h storage in the test chamber, followed by

— 16 h storage at room atmosphere.

6.3.2 Requirements

The connection tested according to 6.3.1 shall fulfil the requirements of the subsequent tests listed in Table 1.

After performance of the test according to 6.3.1, no signs of corrosion shall be visible.

6.4 Temperature/humidity cycling

6.4.1 Test

Carry out the temperature/humidity cycling test using free connectors (see Figure 3) with a housing possessing the full complement of contacts. Also carry out this test with a fixed connector (see Figure 2), if requested by the user. Test the connector with assembled cables 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 the following test sequence. Apply

— 21 cycles of 24 h on sample group J, and

— 7 cycles of 24 h on sample group K.

Use the upper value of the contact temperature range according to Table 1 of ISO 15170-1:2001 as the test temperature (see Table 5).

Table 5 — Test temperatures for temperature/humidity cycling

Class	Test temperature °C ± 2
K1, K2	120
K3	140 [a]
[a] Higher temperatures are to be agreed between manufacturer and user.	

Test cycle:

a) Hold the chamber temperature at t_c = (23 ± 5) °C and at 45 % to 75 % RH 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 from (– 40 ± 2) °C to the applicable test temperature in Table 5 within 1,5 h.

g) Hold t_c at the applicable test temperature in Table 5 for 2 h.

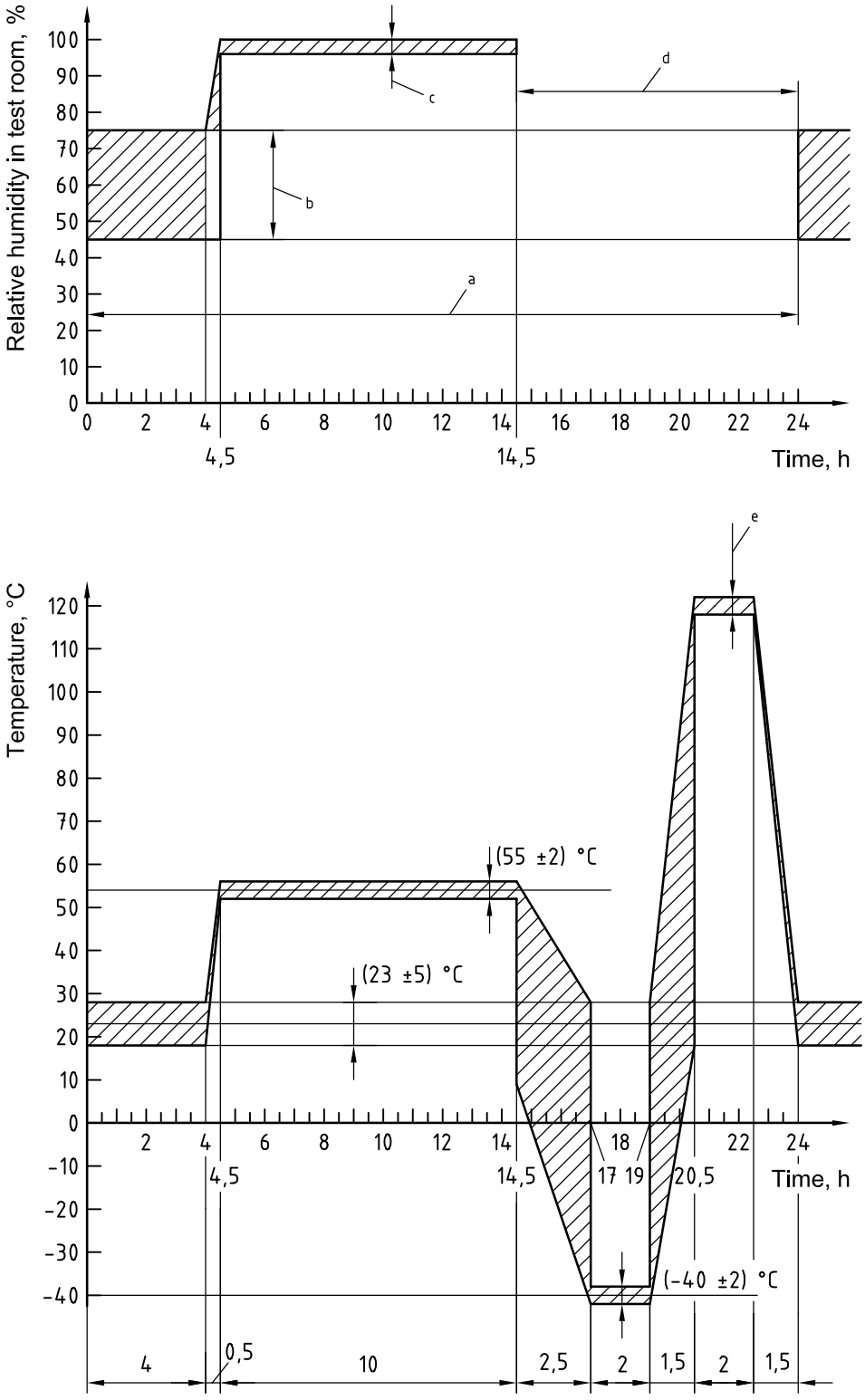
h) Allow to return to room temperature (23 ± 5) °C within 1,5 h.

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). Interruption time shall be noted in the test report.

NOTE 1 During periods 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 test temperature, the duration of period f) can be extended and period a) reduced accordingly.

NOTE 3 See Figure 7 for graphic representation of test cycles.



NOTE Hatched areas indicate allowed temperature/humidity tolerance.

a One cycle.
b (45 to 75) %.
c (95 to 99) %.
d Uncontrolled humidity.
e Test temperature (see Table 5).

Figure 7 — Temperature/humidity cycling

6.4.2 Requirement

The sample tested according to 6.4.1 shall fulfil the requirements of the subsequent tests listed in Table 1.

6.5 Temperature cycling

6.5.1 Test

Apply the following temperature cycles according to Figure 8:

— 50 cycles for test sample group C;

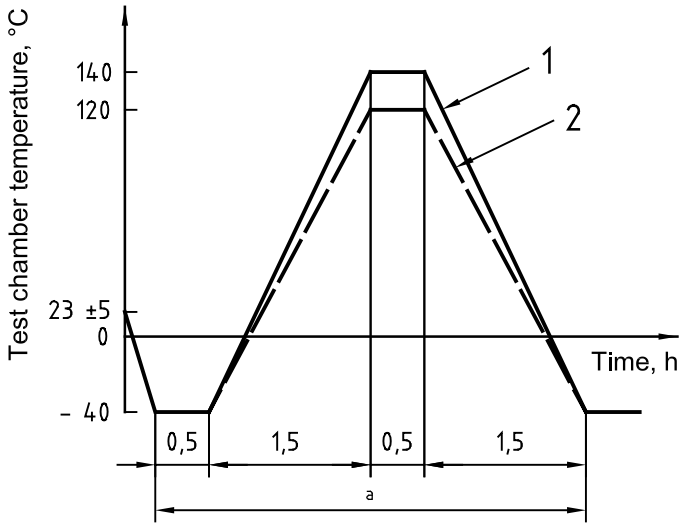
— 25 cycles for test sample group K.

6.5.2 Requirements

The connection tested according to 6.5.1 shall fulfil the requirements of the subsequent tests listed in Table 1.

After performance of the test according to 6.5.1, no signs of corrosion shall be visible. Slight colour changes may be disregarded.

The insulation resistance measured according to the test sequence given in Table 1 may decrease by not more than 1/10 of the initial measured value.



Key

1 Class K3

2 Class K1/K2

[a] 1 cycle = 4 h.

Figure 8 — Temperature cycle

6.6 Resistance to liquids

6.6.1 Test

Subject the samples (mated connectors) to the liquids specified in Table 6. In each case, one unused test sample shall be sprayed with the applicable liquid for a duration of 5 s and then stored at (80 ± 2) °C for 24 h.

Table 6 — Chemical fluids

Chemical fluid		Test liquid
Lubrication oil		Oil No. 1 in accordance with ISO 1817 [a]
Automatic transmission fluid		In accordance with SAE J311
Mineral hydraulic oil		In accordance with ISO 7309
Brake fluid		In accordance with ISO 4925
Battery acid		H_2SO_4 and H_2O: 1,28 g/cm^3
Antifreeze fluid		Not yet specified
Window washer fluid		Ethyl alcohol: 27 ml Isopropylen: 10 ml Ethylen glycol: 3 ml Water: 60 ml
Fuel	Gasoline	Fluid B according ISO 1817
	Diesel	ASTM D 975
Degreasing fluid		Solvent white spirit with approx. 17 % aromatic content

[a] Conforms to ASTM oil No. 1.

6.6.2 Requirement

After performance of the test according to 6.6.1, the test sample shall fulfil the requirements of the subsequent tests listed in Table 1.

6.7 Dust

6.7.1 Test

Perform the dust test specified in ISO 8092-2 to mated connectors with cables attached.

6.7.2 Requirement

After performance of the test according to 6.7.1, the samples shall fulfil the requirements of the subsequent tests listed in Table 1.

6.8 Resistance to ingress of water

6.8.1 Test

Perform the water tightness and high pressure water jet tests according to ISO 8092-2.

6.8.2 Requirement

After performance of the tests according to 6.8.1, the samples shall fulfil the requirements of the subsequent tests listed in Table 1.

ICS 43.040.10

Price based on 15 pages