INTERNATIONAL STANDARD

ISO 6722-1

Third edition
1996-03-01

Road vehicles — Unscreened low-tension cables —

Part 1: Test methods

Véhicules routiers — Câbles basse tension non blindés —

Partie 1: Méthodes d'essai

Reference number
ISO 6722-1:1996(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

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.

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.

International Standard ISO 6722-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

This third edition cancels and replaces the second edition (ISO 6722-1:1984), which has been extended to include new test methods.

ISO 6722 consists of the following parts, under the general title *Road vehicles — Unscreened low-tension cables*:

— *Part 1: Test methods*

— *Part 2: Requirements*

— *Part 3: Conductor sizes and dimensions for thick-wall insulated cables*

— *Part 4: Conductor sizes and dimensions for thin-wall insulated cables*

Annex A forms an integral part of this part of ISO 6722. Annex B is for information only.

Road vehicles — Unscreened low-tension cables —

Part 1:
Test methods

1 Scope

This part of ISO 6722 specifies the test methods for unscreened single-core low-tension cables [nominal system voltage of 50 V (r.m.s.) or less] used in road vehicle applications. It also applies to the individual cores in multi-core cables.

Depending on the environmental temperature, six cable classes are defined:

— class A: – 40 °C to + 85 °C;

— class B: – 40 °C to + 100 °C;

— class C: – 40 °C to + 125 °C;

— class D: – 40 °C to + 155 °C;

— class E: – 40 °C to + 175 °C;

— class F: – 40 °C to + 200 °C.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 6722. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 6722 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1817:1985, *Rubber, vulcanized — Determination of the effect of liquids.*

ISO 6722-2:1996, *Road vehicles — Unscreened low-tension cables — Part 2: Requirements.*

ISO 6722-3:1993, *Road vehicles — Unscreened low-tension cables — Part 3: Conductor sizes and dimensions for thick-wall insulated cables.*

ISO 6722-4:1993, *Road vehicles — Unscreened low-tension cables — Part 4: Conductor sizes and dimensions for thin-wall insulated cables.*

ISO 8458-2:1989, *Steel wire for mechanical springs — Part 2: Cold-drawn carbon steel wire.*

3 General test conditions

Test samples for all tests except that in 4.1 shall be preconditioned for at least 16 h at a temperature of (23 ± 5) °C and relative humidity of 45 % to 75 %.

Unless otherwise specified, all tests shall be conducted at this same temperature of (23 ± 5) °C and relative humidity of 45 % to 75 %.

4 Test for insulation faults

This test is not a qualification test but an in-process test carried out under production conditions.

All cables shall be sujected to the procedure in 4.2.

4.1 Apparatus

The power supply shall be a transformer delivering a sinusoidal voltage. A voltmeter, a fault indicator and a pulse counter shall be available. The test electrode may consist of a metal ball chains, metal brushes or any other type of suitable electrode.

4.2 Procedure

The test voltage shall be

3 kV (r.m.s.) for cables smaller than 0,5 mm^2;

5 kV (r.m.s.) for cables equal to or greater than 0,5 mm^2.

Check before applying the test voltage that the conductor of the cable under test has continuity throughout its full length. The electrode length and frequency shall be chosen considering the speed of the cable running through the field of the electrode so that each point of the cable shall be loaded by at least nine voltage cycles.

The cable shall meet the requirements specified in ISO 6722-2.

NOTE 1 Other test methods may be used provided that insulation faults are detected with the same certainty.

5 Dimensional check

5.1 Outside cable diameter

5.1.1 Test sample

The test sample length shall be approximately 1,5 m.

5.1.2 Procedure

Determine the maximum outside cable diameter by taking three sets of measurements at least 200 mm apart and recording the greatest overall diameter at each point. The accuracy of the measuring instrument shall be ± 0,01 mm.

The test sample shall meet the requirements specified in ISO 6722-2.

5.2 Measurement of insulation thickness

5.2.1 Measuring equipment

A measuring microscope or a profile projector of at least × 10 magnification may be used. Both types of equipment shall allow reading to three decimal places. In case of doubt, the measuring microscope shall be taken as the reference method.

5.2.2 Preparation of test samples

NOTE 2 Test samples may also be used for the test in 5.3.

Prepare three specimens as described in 7.2.1. Strip a test sample from each specimen. The test samples consist of a thin slice of insulation, cut with a suitable device (sharp knife, razor-blade, etc.) perpendicular to the conductor centreline, taking care not to deform the test sample. If cable marking has caused indentation in the insulation, the first test sample shall be taken through this indentation.

5.2.3 Measuring method

Place the test sample under the measuring equipment with the plane of the cut perpendicular to the optical axis.

Take measurements to determine the minimum insulation thickness of each test sample, in millimetres to two decimal places.

Each measured value shall meet the requirement specified in ISO 6722-2.

5.3 Measurement of conductor diameter

5.3.1 Test sample

This test may be carried out on the same test sample and with the same measuring equipment as used for insulation thickness (see 5.2).

5.3.2 Measuring procedure

Check the conductor diameter by measuring the inside diameter of the test samples used in 5.2.2 and recording the maximum inside diameter at each point.

The test sample shall meet the requirement specified in ISO 6722-2.

6 Electrical characteristics

6.1 Conductor resistance

The measuring device shall be accurate enough to measure the resistance of a conductor 1 m long. The measured value shall be corrected if the conductor temperature differs from the reference temperature of 20 °C.

Determine the conductor resistance, R_{20}, at the reference temperature of 20 °C, expressed in milliohms per metre, with the following equation, applicable to copper conductor resistance:

$$R_{20} = \frac{R_T}{L\,[1 + 0{,}003\ 9\ (T - 20)]}$$

where

R_T is the conductor resistance measured at the conductor temperature, expressed in milliohms;

L is the conductor length, expressed in metres;

T is the conductor temperature at the time of measuring, expressed in degrees Celsius.

The accuracy of the measuring device shall be ± 0,5 % of the measured value.

6.1.1 Test sample

The test sample length shall be 1 m plus the length necessary for connections.

6.1.2 Procedure

Use a Wheatstone bridge or equivalent instrument to determine the resistance of the test sample. Take care to ensure that connections are secure.

The test samples shall meet the requirements in ISO 6722-2.

6.2 Withstand voltage

6.2.1 Test sample

The test sample length shall be approximately 1,2 m.

6.2.2 Procedure

Immerse the test sample in a salt solution (mass fraction of NaCl = 3 %, and water) as shown in figure 1, for 4 h, at room temperature, ends emerging, and then apply 1 kV r.m.s. test voltage at a frequency of 50 Hz or 60 Hz for 30 min between the conductor and the solution.

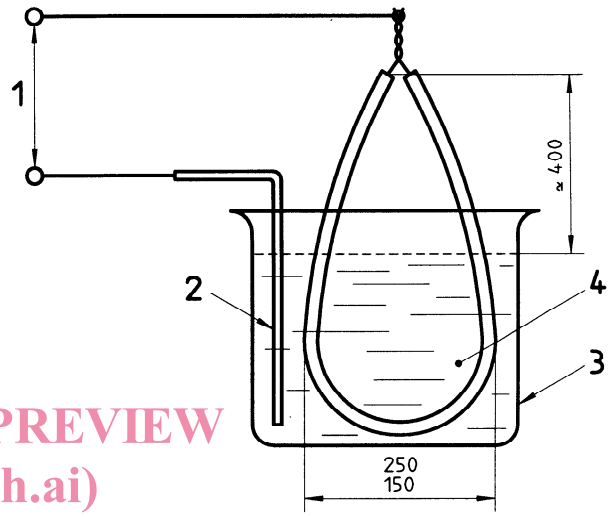
If the test sample fulfils the requirements of ISO 6722-2, then increase the voltage at a rate of 500 V/s until the following value is reached:

3 kV (r.m.s.) for cables smaller than 0,5 mm^2;

5 kV (r.m.s.) for cables equal to or greater than 0,5 mm^2.

Upon completion of this test, the test sample shall fulfil the requirements of ISO 6722-2.

Dimensions in millimetres



Key

1 Test voltage
2 Electrode
3 Glass jar
4 Salt solution

Figure 1 — Apparatus for withstand voltage test

6.3 Insulation resistance

6.3.1 Test sample

The test sample length shall be approximately 5 m.

6.3.2 Procedure

Immerse the test sample with each end emerging by approximately 250 mm in tap water at a temperature of (70 ± 2) °C for 2 h.

Apply a d.c. voltage of approximately 500 V between the conductor and the water. The insulation resistance shall be measured 1 min after application of the voltage; it shall not be less than the equivalent of a volume resistivity, ρ_0, expressed in ohms millimetres,

as specified in ISO 6722-2, calculated from the equation:

$$\rho_0 = 2{,}725 \frac{l \times R}{\lg\left(\frac{D}{d}\right)}$$

where

l is the immersed length of the test sample, expressed in millimetres;

R is the measured insulation resistance, expressed in ohms;

D is the outside cable diameter, in accordance with 5.1, expressed in millimetres;

d is the conductor diameter, in accordance with 5.3, expressed in millimetres.

NOTE 3 Voltages between 100 V and 500 V are allowed, if the measured results conform with the results obtained using 500 V.

7 Mechanical characteristics

7.1 Pressure test at high temperature

7.1.1 Test sample

Three test samples of approximately 1,2 m shall be taken from the cable to be tested.

7.1.2 Procedure

7.1.2.1 Test apparatus

Perform this test with the test apparatus shown in figure 2.

Attach the test sample to the support so that it does not bend under the pressure of the blade. The load and the blade of the apparatus shall be perpendicular to the cable axis.

The apparatus shall be free from vibrations.

7.1.2.2 Load for pressure test

Apply a force F, expressed in newtons, through the blade to the test sample, as given by the equation:

$$F = 0{,}8\sqrt{i(2D - i)}$$

where

D is the maximum value of the outside diameter, in ISO 6722-3 or ISO 6722-4, expressed in millimetres;

i is the nominal value of the insulation thickness, in ISO 6722-3 or ISO 6722-4, expressed in millimetres.

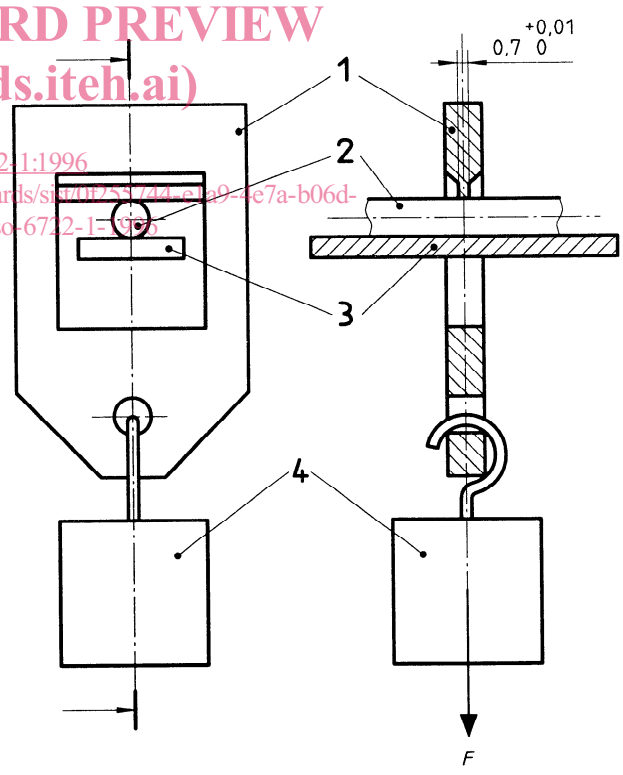
The coefficient 0,8 carries the unit newton per millimetre.

The calculated force may be rounded off to the lower digit, but not beyond 3 %.

7.1.2.3 Thermal treatment of test sample

Place the test sample under load, not preheated, in a hot air oven with natural draught at the temperature specified in table 1 for 4 h. Then cool the test sample within 10 s by immersing it in cold water.

Dimensions in millimetres



Key

1 Test frame
2 Test sample
3 Support
4 Mass

Figure 2 — Apparatus for pressure test at high temperature

Table 1

Class	Test temperature[1] °C
A	85 ± 2
B	100 ± 2
C	125 ± 3
D	155 ± 3
E	175 ± 3
F	200 ± 3

1) Temperature class rating.

7.1.3 Test voltage

After this test, apply a test voltage as specified in 6.2 to the test sample where the pressure was applied.

Upon completion of the test, the samples shall meet the requirements specified in ISO 6722-2.

7.2 Adhesion of insulating layer to conductor

This test applies to cables with a nominal cross-sectional area equal to or less than 6 mm^2.

7.2.1 Test sample

Three test samples of approximately 100 mm separated by at least 1 m shall be taken from the cable to be tested.

7.2.2 Procedure

Over a length AB (see figure 3) of about 25 mm from one end of the test sample, cleanly cut the insulation and carefully strip it from the conductor. Then cut the test sample to a length of 85 mm at D and remove the insulation to a point 75 mm from the previously stripped end, care being taken not to damage the remaining insulation.

Place the test sample at (23 ± 2) °C in the test fixture illustrated in figure 4. The metal plate is provided with a round hole equal to the maximum conductor diameter specified in ISO 6722-3 or ISO 6722-4. Measure the force F necessary to start the sliding of the insulation over the conductor. The speed of the tensile machine shall be 250 mm/min.

The measured force shall be within the values specified in ISO 6722-2.

7.3 Stripping of insulation

Where cables are required to be stripped, it shall be possible to remove the insulation over at least 20 mm cleanly and without difficulty.

Dimensions in millimetres

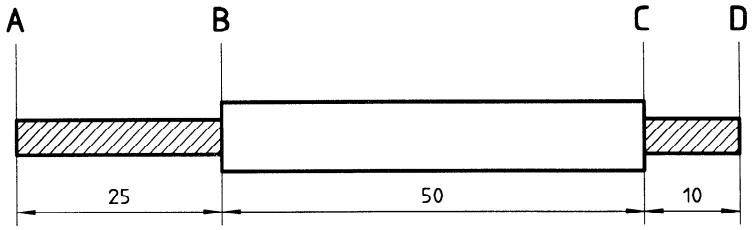


Figure 3 — Adhesion of insulating layer to conductor: test sample

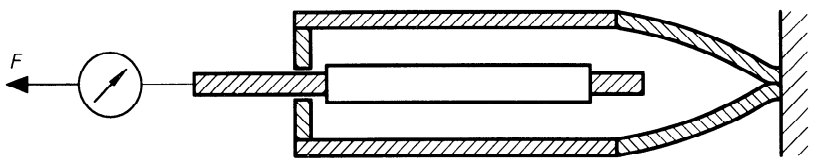


Figure 4 — Adhesion of insulating layer to conductor: test fixture

8 Winding tests at low temperature

These tests apply to cables with a nominal cross-sectional area equal to or less than 10 mm^2.

8.1 Test sample

Take four test samples of approximately 600 mm at least 1 m apart from the cable to be tested.

Two samples are used for the winding test without ageing (see 8.3) and two samples for the winding test after ageing (see 8.4).

8.2 Procedure

Fix the samples on a rotatable mandrel as shown in figure 5 with a diameter as specified in table 2. Load the free ends with a mass as specified in table 2. Install the mandrel with the samples hanging vertically in a freezing chamber at the temperature specified in 8.3 or 8.4.2 for 4 h. If the test device is pre-cooled, a freezing time of 2 h is sufficient if it is ensured that the samples have reached the temperature specified. Then wind at least three close-pitched turns around the mandrel within the freezing chamber at a winding speed as specified in table 2.

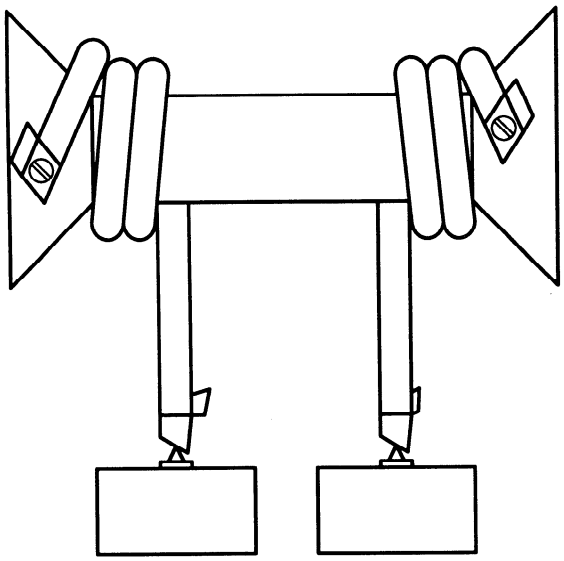


Figure 5 — Test mandrel

Table 2

Cross-sectional area S mm^2	Mandrel diameter mm	Mass kg	Winding speed s^{-1}
$S \leqslant 0{,}75$	6	0,5	1
$0{,}75 < S \leqslant 1{,}5$	10	2,5	
$1{,}5 < S \leqslant 2{,}5$	15	5	
$2{,}5 < S \leqslant 6$	20		
$6 < S \leqslant 10$	40	10	0,5

After this winding test, if the test sample fulfils the requirement specified in ISO 6722-2, carry out the following voltage test. Immerse the wound test sample without mandrel in a salt solution as in 6.2.2 at a temperature of (23 ± 5) °C with the ends emerging approximately 50 mm above the solution, and apply a 1 kV r.m.s. test voltage at a frequency of 50 Hz or 60 Hz between the conductor and the solution for 1 min.

Upon completion of the test, the samples shall meet the requirements specified in ISO 6722-2.

8.3 Winding test at low temperature without ageing

The test specified in 8.2 shall be carried out at the temperature specified in ISO 6722-2.

8.4 Winding test at low temperature after short-term ageing

8.4.1 Ageing procedure

Place the test samples, fixed as shown in figure 6, in a hot air oven with natural draught at the temperature specified in table 3 for 240 h. The air contained in the oven shall be completely changed at least eight times per hour but not more than 20 times per hour at the temperature specified.

The samples shall be fixed by the conductor to avoid any contact between the insulation and the supports and shall be separated by at least 20 mm from each other and from the inner surface of the oven. Cable insulation made of different materials shall not be tested at the same time.

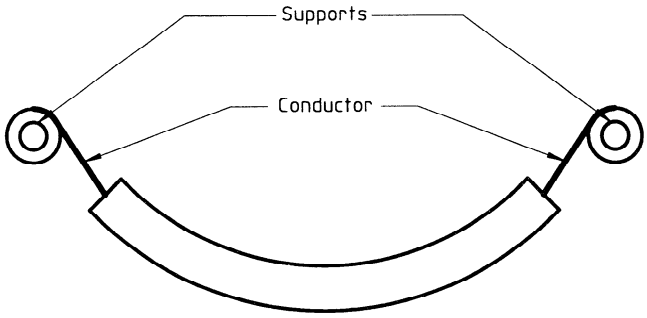


Figure 6 — Fixing of test samples

Table 3

Class	Short-term ageing temperature[1)] °C
A	110 ± 2
B	125 ± 3
C	150 ± 3
D	180 ± 3
E	200 ± 3
F	225 ± 4

1) Temperature class rating + 25 °C.

Immediately after ageing, withdraw the samples from the oven and maintain them at (23 ± 5) °C for at least 16 h without direct solar light.

8.4.2 Winding test

After ageing, carry out the winding test in 8.2 at the temperature specified in ISO 6722-2.

9 Impact test at low temperature

This test applies to cables with a nominal cross-sectional area greater than 10 mm^2.

9.1 Test sample

Three samples of approximately 1,2 m shall be taken from the cable to be tested.

9.2 Procedure

Perform the impact test in the middle of the test sample using the apparatus shown in figure 7. The mass of the hammer shall be

300 g for cables where: 10 $mm^2 < S < 50$ mm^2;

400 g for cables where: 50 $mm^2 \leqslant S$.

Place the apparatus, positioned on a sponge rubber pad of 40 mm thickness, together with the test samples in a freezing chamber at a temperature of (− 15 ± 2) °C for at least 16 h. If the apparatus is pre-cooled, a freezing time of 4 h is sufficient, provided that the test samples have reached the specified temperature. At the end of this period, place the test samples parallel to the steel base. Then allow the hammer to fall from a height of 100 mm on to them.

After the test, allow the test samples to attain a temperature of (23 ± 5) °C and examine them.

If the samples fulfil the requirements specified in ISO 6722-2, then perform the voltage test in 6.2, except that the voltage of 1 kV shall be applied for 1 min.

Upon completion of the test, the samples shall meet the requirements of ISO 6722-2.

10 Winding and impact tests after long-term ageing, for initial product acceptance

10.1 Test samples

Two samples of approximately 600 m separated by at least 1 m shall be taken from the cable to be tested.

10.2 Ageing procedure

Place the test samples, fixed as shown in figure 6, in a hot air oven with natural draught at the temperature specified in table 4 for 3 000 h. The air contained in the oven shall be changed at least eight times per hour but not more than 20 times per hour at the temperature specified.