INTERNATIONAL STANDARD

ISO 6722

Second edition
2006-08-01

Road vehicles — 60 V and 600 V single-core cables — Dimensions, test methods and requirements

Véhicules routiers — Câbles monoconducteurs de 60 V et 600 V — Dimensions, méthodes d'essai et exigences

Reference number
ISO 6722:2006(E)

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Published in Switzerland

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

This second edition cancels and replaces the first edition (ISO 6722:2002) which has been technically revised.

Road vehicles — 60 V and 600 V single-core cables — Dimensions, test methods and requirements

1 Scope

This International Standard specifies the dimensions, test methods, and requirements for single-core 60 V cables intended for use in road vehicle applications where the nominal system voltage is ⩽ (60 V d.c. or 25 V a.c.). It also specifies additional test methods and/or requirements for 600 V cables intended for use in road vehicle applications where the nominal system voltage is > (60 V d.c. or 25 V a.c.) to ⩽ (600 V d.c. or 600 V a.c.). It also applies to individual cores in multi-core cables.

Eight temperature classes are defined in Table 1.

Table 1 — Temperature class rating

Class	Temperature
A	– 40 °C to 85 °C
B	– 40 °C to 100 °C
C	– 40 °C to 125 °C
D	– 40 °C to 150 °C
E	– 40 °C to 175 °C
F	– 40 °C to 200 °C
G	– 40 °C to 225 °C
H	– 40 °C to 250 °C

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 6931-1, *Stainless steels for springs — Part 1: Wire*

IEC 60757, *Code for designation of colours*

IEC 60811-2-1, *Common test methods for insulating and sheathing materials of electrical and optical cables — Part 2-1: Methods specific to elastomeric compounds — Ozone resistance, hot set and mineral oil immersion tests*

ASTM B1, *Standard Specification for Hard-Drawn Copper Wire*

ASTM B3, *Standard Specification for Soft or Annealed Copper Wire*

ASTM B33, *Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes*

ASTM B298, *Standard Specification for Silver-Coated Soft or Annealed Copper Wire*

ASTM B355, *Standard Specification for Nickel-Coated Soft or Annealed Copper Wire*

3 Terms and definitions

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

3.1
60 Volt (V) cable
cable intended for use in road vehicle applications where the nominal system voltage is equal to or less than 60 V d.c. or 25 V a.c.

3.2
600 Volt (V) cable
cable intended for use in road vehicle applications where the nominal system voltage is greater than (60 V d.c. or 25 V a.c.) and less than (600 V d.c. or 600 V a.c.)

NOTE a.c. tests are performed at 50 Hz or 60 Hz. Applications at higher frequencies may require additional testing.

3.3
cable family
group with multiple conductor sizes having the same conductor strand coating, insulation formulation and wall-thickness type

3.4
nominal (value)
suitable approximate value used to designate or identify a component

4 General

4.1 Caution

Special care shall be taken with cables used with voltages above (60 V d.c. or 25 V a.c.) to protect them from mechanical stress in order to avoid shock hazard. Regardless of wall thickness, 600 V cables shall meet the “resistance to abrasion” requirements for thick wall cable.

4.2 Conductors

The conductors shall consist of plain or coated copper strands as shown in Table 2. Conductor sizes $\geqslant$ 0,5 mm^2 shall consist of soft annealed copper or annealed compressed/compacted wires. Conductor sizes $<$ 0,5 mm^2 shall consist of soft annealed copper, soft annealed compressed/compacted copper, hard unannealed copper or a copper alloy. The specifications for the conductors shall be completed by material specifications. Elongation requirements shall be established by agreement between customer and supplier. The finished cable shall meet the resistance requirements of 6.1 for all conductors except alloys. When an alloy is used, the resistance requirement shall be established by agreement between customer and supplier.

NOTE Examples of strandings are shown in Table A.1. These strandings highlight examples of conceptual configurations and are not intended to reflect any preferred constructions. Other strandings' configurations may be used provided they meet the requirements shown above and are agreed upon between customer and supplier.

Table 2 — Conductor specifications

ASTM B1	Hard-drawn copper wire
ASTM B3	Soft or annealed copper wire
ASTM B33	Tinned soft or annealed copper wire
ASTM B298	Silver-coated soft or annealed copper wire
ASTM B355	Nickel-coated soft or annealed copper wire
NOTE Silver- and nickel-coated conductors are intended for use with high “temperature class ratings”.	

4.3 Tests

The cables shall be submitted to the tests as specified in Table 3.

4.4 General test conditions

Test samples for all tests except those in Clause 5 and in 6.1 and 6.3 shall be preconditioned for at least 16 h at a room temperature of (23 ± 5) °C. Unless otherwise specified, all tests other than “in-process” tests shall be conducted at this same temperature. Where no tolerance is specified, all values shall be considered to be approximate.

4.5 Ovens

Unless otherwise specified, when an oven is required, it shall be a hot air oven. The air contained in the oven shall be completely changed at least eight (8) times but not more than twenty (20) times per hour at the specified temperature.

4.6 Representative conductor sizes for testing

When a test is required, all combinations of conductor size, wall thickness and insulation formulation shall meet the appropriate requirements. However, if representative conductor sizes for testing are permitted, compliance for a cable family may be demonstrated by testing examples of large and small conductor sizes only. Permission to show compliance for a cable family by testing “representative conductor sizes” shall be established by agreement between customer and supplier.

4.7 Recommended colours

A list of recommended colours is shown in Table B.1

Table 3 — Tests

Clause	Test description	In-process tests [a]	Certification		If required [c]	
			Initial	Periodic [b]	Initial	Periodic [b]
5	**Dimensions**					
5.1	Outside cable diameter	—	×	×	—	—
5.2	Insulation thickness	—	×	×	—	—
5.3	Conductor diameter	—	—	—	×	×
6	**Electrical characteristics**					
6.1	Conductor resistance	—	×	×	—	—
6.2	Withstand voltage	—	[d]	[d]	—	—
6.3	Insulation faults	[d]	—	—	—	—
6.4	Insulation volume resistivity	—	—	—	×	×
7	**Mechanical characteristics**					
7.1	Pressure test at high temperature	—	×	×	—	—
7.2	Strip force	—	—	—	×	×
8	**Low-temperature characteristics**					
8.1	Winding	—	×	×	—	—
8.2	Impact	—	—	—	×	×
9	**Resistance to abrasion**	—	[e]	[e]	—	—
9.2	Sandpaper abrasion	—	—	—	—	—
9.3	Scrape abrasion	—	—	—	—	—
10	**Heat ageing**					
10.1	Long-term ageing, 3 000 h	—	×	—	—	—
10.2	Short-term ageing, 240 h	—	×	×	—	—
10.3	Thermal overload	—	—	—	×	×
10.4	Shrinkage by heat	—	×	×	—	—
11	**Resistance to chemicals**					
11.2	Fluid compatibility	—	[f, g]	—	[f, g]	—
11.3	Durability of cable marking	—	—	—	[g]	[g]
11.4	Resistance to ozone	—	—	—	[g]	—
11.5	Resistance to hot water	—	—	—	[g]	—
11.6	Temperature and humidity cycling	—	—	—	[g]	—
12	**Resistance to flame propagation**	—	×	×	—	—

"X" To be applied.

"—" Not applicable.

[a] A test made on all cables during or after manufacture.

[b] The frequency of periodic testing shall be established by agreement between customer and supplier.

[c] The usage of "if required" tests shall be established by agreement between customer and supplier.

[d] Some cables are rated at 60 V and others at 600 V. See 6.2 and 6.3 for details.

[e] See Clause 9.

[f] Some fluids are for "certification" and others are "if required". See 11.2 for details.

[g] Compliance for a cable family may be demonstrated by testing examples of large and small conductor sizes only. See 4.6 for details.

5 Dimensions

5.1 Outside cable diameter

5.1.1 Test Sample

Prepare a test sample 3 m in length.

5.1.2 Apparatus

Use a measuring device with an accuracy of ± 0,01 mm. The device shall not cause deformation.

5.1.3 Procedure

Take three sets of measurements at positions separated by 1 m and record the highest and lowest outside cable diameter at each position.

5.1.4 Requirement

All measurements shall be within the limits of the appropriate maximum and minimum “outside cable diameter” specified in Table 4 and Table C.1. The values in Table 4 are normative. Since the values in Table C.1 are informative, they are not required; however, they may be applied by agreement between customer and supplier.

5.2 Insulation thickness

5.2.1 Test samples

Prepare three test samples from a cable sample 3 m in length. Take the test samples at 1 m intervals. Strip the insulation from the cable. A test sample consists of a thin cross section of insulation. Take care not to deform the test sample during the preparation process. If cable marking causes indentation of the insulation, take the first test sample through this indentation.

5.2.2 Apparatus

Use a measuring device with an accuracy of ± 0,01 mm. The device shall not cause deformation.

5.2.3 Procedure

Place the test sample under the measuring equipment with the plane of the cut perpendicular to the optical axis. Determine the minimum “insulation thickness”.

5.2.4 Requirement

No single value shall be less than the appropriate minimum insulation thickness specified in Table 4.

Table 4 — Dimensions

ISO conductor		Thick wall			Thin wall			Ultra-thin wall		
Size	Diameter	Insulation thickness		Outside cable diameter	Insulation thickness		Outside cable diameter	Insulation thickness		Outside cable diameter
mm^2	mm	mm		mm	mm		mm	mm		mm
	max.	nominal	min.	max.	nominal	min.	max.	nominal	min.	max.
0,13	0,55	—	—	—	0,25	0,20	1,05	0,20	0,16	0,95
0,22	0,70	—	—	—	0,25	0,20	1,20	0,20	0,16	1,05
0,35	0,90	—	—	—	0,25	0,20	1,40 [a]	0,20	0,16	1,20
0,50	1,10	0,60	0,48	2,30	0,28	0,22	1,60	0,20	0,16	1,40
0,75	1,30	0,60	0,48	2,50	0,30	0,24	1,90	0,20	0,16	1,60
1	1,50	0,60	0,48	2,70	0,30	0,24	2,10	0,20	0,16	1,75
1,5	1,80	0,60	0,48	3,00	0,30	0,24	2,40	0,20	0,16	2,10
2	2,00	0,60	0,48	3,30	0,35	0,28	2,80	0,25	0,20	2,40
2,5	2,20	0,70	0,56	3,60	0,35	0,28	3,00	0,25	0,20	2,70
3	2,40	0,70	0,56	4,10	0,40	0,32	3,40	—	—	—
4	2,80	0,80	0,64	4,40	0,40	0,32	3,70	—	—	—
5	3,10	0,80	0,64	4,90	0,40	0,32	4,20	—	—	—
6	3,40	0,80	0,64	5,00	0,40	0,32	4,30	—	—	—
10	4,50	1,00	0,80	6,50	0,60	0,48	6,00	—	—	—
16	6,30	1,00	0,80	8,30	0,65	0,52	7,90	—	—	—
25	7,80	1,30	1,04	10,40	0,65	0,52	9,40	—	—	—
35	9,00	1,30	1,04	11,60	—	—	—	—	—	—
50	10,50	1,50	1,20	13,50	—	—	—	—	—	—
70	12,50	1,50	1,20	15,50	—	—	—	—	—	—
95	14,80	1,60	1,28	18,00	—	—	—	—	—	—
120	16,50	1,60	1,28	19,70	—	—	—	—	—	—

NOTE Outside cable diameter minimum values for high-volume cable constructions are shown in Table C.1. Since the values in Table C.1 are informative, they are not required; however, they may be applied by agreement between customer and supplier.

[a] The outside cable diameter for conductor size 0,35 mm^2 with 7 strands shall be a maximum of 1,30 mm.

5.3 Conductor diameter

5.3.1 Test samples

The usage of this test shall be established by agreement between customer and supplier. In case of disputed results, a refereeing method is provided.

Referee test samples: in case of a dispute, prepare three test samples from a cable sample 3 m in length. Take the test samples at 1 m intervals. A test sample consists of a 20 mm length of cable. Take care not to deform the test sample. Immerse the test samples in a casting resin. After hardening, take a section perpendicular to the axis of the test sample.

5.3.2 Apparatus

Carry out this test on the same apparatus used for the measurement of the insulation thickness (see 5.2).

Referee apparatus: in case of a dispute, the measuring device shall be capable of at least 10 × linear magnification.

5.3.3 Procedure

Check the conductor diameter by measuring the inside diameter of the samples used in 5.2 and recording the maximum inside diameter for each test sample.

Referee procedure: in case of a dispute, measure the conductor diameter using the "referee test samples" and the "referee apparatus". Record the maximum conductor diameter for each test sample.

5.3.4 Requirement

The measured value shall not exceed the maximum value, specified in Table 4. This measured value is also required in 6.4.

6 Electrical characteristics

6.1 Conductor resistance

6.1.1 Test samples

Prepare a test sample 1 m in length plus the length necessary for connections. Other lengths may be used providing that the resistance reading is adjusted using the method shown in 6.1.3. The ends of the test sample may be soldered.

6.1.2 Apparatus

Use a resistance-measuring device with an accuracy of ± 0,5 % of the measured value and a thermometer with an accuracy of ± 0,5 °C.

6.1.3 Procedure

Measure the temperature of the test sample and the unsoldered length. Take care to ensure that connections are secure. Measure the resistance of the test sample. Correct the measured value using the following equation:

$$R_{20} = \frac{R_t}{L\left[1 + 0{,}003\ 93\left(t - 20\right)\right]}$$

where

R_{20} is the corrected conductor resistance at the reference temperature of 20 °C, expressed in milliohms per metre;

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

L is the unsoldered conductor length, expressed in metres;

t is the conductor temperature at the time of measuring, expressed in degrees centigrade.