
**Road vehicles — Multi-core connecting
cables —**

**Part 1:
Test methods and requirements for
basic performance sheathed cables**

Véhicules routiers — Câbles de raccordement multiconducteurs —

*Partie 1: Méthodes d'essai et exigences pour les câbles gainés à
performance de base*



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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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.

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

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

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

This third edition cancels and replaces the second edition (ISO 4141-1:2005), which has been technically revised. The main changes compared to the previous edition are as follows:

— Temperature range of cable defined as Class A and Class B (see [10.1](#) and [10.2](#)).

A list of all parts in the ISO 4141-series can be found on the ISO website.

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

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Road vehicles — Multi-core connecting cables —

Part 1:

Test methods and requirements for basic performance sheathed cables

1 Scope

This document specifies the test methods and requirements of basic performance multi-core sheathed cables for the connection of towing and towed vehicles, suitable for a temperature range of class A and class B defined in ISO 6722-1:2011, Table 1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 4141-3, *Road vehicles — Multi-core connecting cables — Part 3: Construction, dimensions and marking of unscreened sheathed low-voltage cables*

ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 4892-4, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

ISO 6722-1, *Road vehicles — 60 V and 600 V single-core cables — Part 1: Dimensions, test methods and requirements for copper conductor cables*

ISO 7638-1, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — Part 1: Connectors for braking systems and running gear of vehicles with 24 V nominal supply voltage*

ISO 7638-2, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — Part 2: Connectors for braking systems and running gear of vehicles with 12 V nominal supply voltage*

ISO 12098, *Road vehicles — Electrical connections between towing vehicles and trailers — 15 pole connector for commercial vehicles equipped with 24V systems — Dimensional characteristics and contact allocation*

ISO 14572, *Road vehicles — Round, sheathed, 60 V and 600 V screened and unscreened single- or multi-core cables — Test methods and requirements for basic- and high-performance cables*

IEC 60811-1-1, *Common test methods for insulating and sheathing materials of electric cables — Part 1: Methods for general application — Section 1: Measurement of thickness and overall dimensions — Tests for determining the mechanical properties*

EN 14214, *Automotive fuels — Fatty acid methyl esters (FAME) for diesel engines — Requirements and test methods*

DIN V 70070, *Diesel engines — NO_x-reduction additives AUS 32 — Requirements and test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6722-1 and the following apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

cable basic performance

cable meeting basic requirements for general automotive applications

3.2

core

insulated conductor assembly comprising a conductor with its own insulation (and screens, if any)

3.3

screen

conductive material intended to reduce the penetration and/or radiation of a varying electromagnetic field into an assigned region

3.4

unscreened

absence of a screen

4 General

Single core identification shall conform to ISO 4141-3. The single components of multi-core sheathed cables shall comply with ISO 6722-1 for single cores.

The general test conditions and the ovens used shall be in accordance with ISO 6722-1.

If a visual examination is required, the sheath shall be smooth, even and free from surface imperfections e.g. lumps, voids and particles.

The test sequence for each sample group shall be in accordance with [Table 1](#) (sequences are indicated by Xs, ordered from top to bottom).

Table 1 — Test sequences and requirements

Test	Sub-clause	Test sample group / sequence																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Visual examination	Clause 4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Outside cable diameter	5.1	X																	
Ovality	5.2	X																	
Thickness of the sheath	5.3		X																
Lay length	5.4			X															
Continuity	6.1				X														
Withstand voltage	6.2					X				X			X	X					
Cyclic bending	7.3					X													
Winding	8.1									X									
Impact	8.2										X								
Long term ageing	10.1												X						
Short term ageing	10.2													X					

Table 1 (continued)

Test	Sub-clause	Test sample group / sequence																	
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Visual examination	Clause 4					X				X	X		X	X					
Withstand voltage	6.2					X				X			X	X					
Capacitance	6.3						X												
Pressure at high temperature	7.1							X											
Adhesion of the sheath	7.2								X										
Resistance to abrasion	Clause 9											X							
Fluid compatibility	11.1														X				
Durability of sheath marking	11.2															X			
Resistance to ozone	11.3																X		
Resistance to flame propagation	Clause 12																	X	
Artificial weathering	Clause 13																		X
Visual examination	Clause 4								X						X	X	X	X	X

5 Dimensions

5.1 Outside cable diameter

5.1.1 Test sample

Prepare a test sample of 600 mm length.

5.1.2 Apparatus

According to ISO 6722-1.

5.1.3 Procedure

Determine the maximum and minimum outside cable diameter by taking three sets of measurements separated by 200 mm and recording the highest ($d_{\max}$) and lowest ($d_{\min}$) values of the measurements at each of the three positions.

5.1.4 Requirement

Each diameter measured shall be between the limits agreed between customer and supplier for the cable under testing, which shall be within the limits specified in ISO 4141-3.

5.2 Ovality

5.2.1 Test sample and apparatus

Use the measurements of [5.1](#).

5.2.2 Procedure

Calculate the ovality for each set of measurements as follows:

$$\text{Ovality (\%)} = \frac{(d_{\max.} - d_{\min.})}{0,5(d_{\max.} + d_{\min.})} \times 100$$

5.2.3 Requirement

Each ovality calculated shall be within the limits as specified in ISO 4141-3.

5.3 Thickness of the sheath

5.3.1 Test samples, apparatus, procedure

According to ISO 6722-1, insulation thickness.

5.3.2 Requirement

Each value measured shall not be less than the minimum wall thickness as specified in ISO 4141-3.

5.4 Lay length

5.4.1 General

This test is intended for twisted pair cores only.

5.4.2 Test samples

Prepare a test sample of 1 000 mm length.

5.4.3 Apparatus

Use a measuring device with an accuracy of 1 mm.

5.4.4 Procedure

Remove (500 ± 25) mm of its sheath without allowing the ends to untwist. Fasten the test sample at its ends. Measure the length over five consecutive lays, where one lay is the axial length of one complete turn of the helix of a core in the twisted pair.

5.4.5 Requirement

The length measured shall not exceed 250 mm for five lays.

6 Electrical characteristics

6.1 Continuity

According to ISO 14572.

6.2 Withstand voltage

According to ISO 14572.

6.3 Capacitance

6.3.1 General

This test is intended for unscreened twisted pair cores used for data communication only.

6.3.2 Test samples

Prepare a test sample of 5 m length, remove 50 mm of sheath from one end and remove 12 mm of insulation from each of the cores.

6.3.3 Apparatus

Use a standard capacitance measuring device with alternating current and a frequency of 1 kHz.

6.3.4 Procedure

Cores a and b are cores for data transmission of the connecting cable, e.g. cores 6 and 7 of a cable in accordance with ISO 7638-1 or ISO 7638-2, or cores 14 and 15 of a cable in accordance with ISO 12098.

Subject cores a and b to the two different capacitance measurements A and B as described below (see also [Figure 1](#)).

— Measurement A:

Short circuit cores a and b. Set the short-circuit bridge at that cable end, where the measuring device is connected. Measure the capacitance C_A between these cores and all other cores connected in parallel.

The measured value is:

$$C_A = 2 C_i \quad (1a)$$

$$C_i = 1/2 C_A \quad (1b)$$

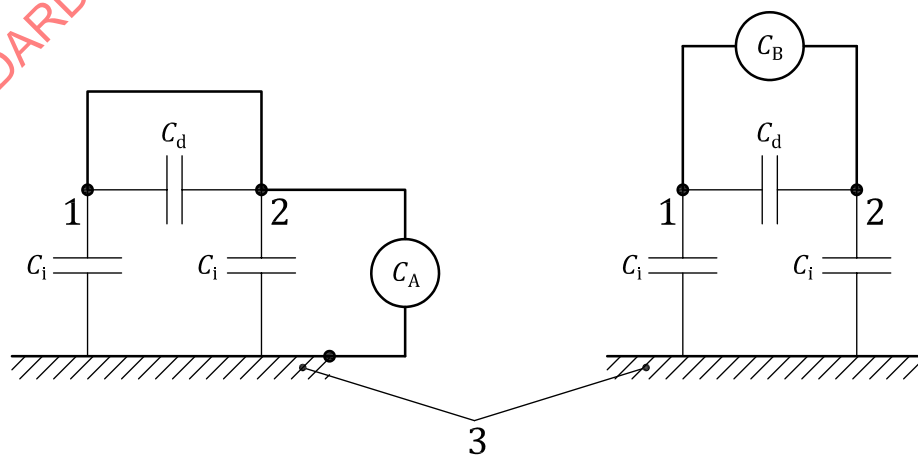
— Measurement B:

Remove the short circuit between core a and b. Measure the capacitance C_B between core a and b.

The measured value is:

$$C_B = C_d + 1/2 C_i \quad (2a)$$

$$C_d = C_B - 1/2 C_i \quad (2b)$$



a) Measurement A (C_A)

b) Measurement B (C_B)

Key

- 1 core a
- 2 core b
- 3 all other cores connected in parallel

Figure 1 — Capacitance measurement**6.3.5 Requirements**

The capacitance per length shall not exceed the values given in [Table 2](#) for:

- C_i : capacitance between each data core and all other cores connected in parallel;
- C_d : capacitance between the data cores;
- C_{bus} : bus capacitance, $C_{bus} = C_i + 2 C_d = 2 C_B$.

Table 2 — Maximum capacitance per length

Cable	C_i	C_d	C_{bus}
Uncoiled cable	100 pF/m	50 pF/m	160 pF/m
Coiled cable	170 pF/m	85 pF/m	270 pF/m

NOTE C_{bus} is the determinant value. For C_i and C_d separately, the maximum values given in the table are allowed. However, because $C_{bus} = C_i + 2 C_d$, the maximum value for C_{bus} restricts the allowed values for C_i and C_d .

7 Mechanical characteristics**7.1 Pressure test at high temperature**

According to ISO 14572 and apply the requirements for basic performance cables.

7.2 Adhesion of the sheath

According to ISO 14572.

7.3 Cyclic bending**7.3.1 General**

This test applies to uncoiled cables only.

7.3.2 Test samples

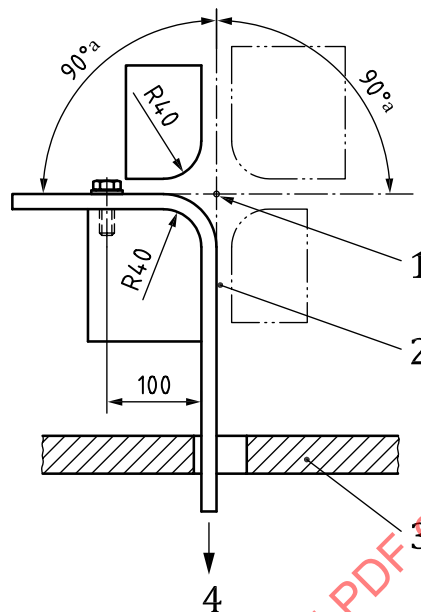
Take two test samples of 600 mm length from points separated by at least 1 m.

7.3.3 Apparatus

The apparatus shall be similar to the one shown in [Figure 2](#). Any apparatus is acceptable as long as it meets the following requirements:

- $R = 40$ mm
- A force $F = 50$ N
- A fixture that bends the test sample $\pm 90^\circ$ at a rate of 15 cycles/min.

- If a mass is used, a guide may be applied to stop the mass from swinging
- Conductor breakage shall be monitored by applying a current ($5 \pm 0,5$) A to all conductors during the entire test phase. If breakage occurs the test procedure shall stop automatically.



Key

- 1 pivot
- 2 cable
- 3 fixed guide (optional)
- 4 force F
- a Cycle (90° to each side).

Figure 2 — Apparatus for cyclic bending

7.3.4 Procedure

Mount the test sample with one end attached to the flexing member and the other end loaded by the force F . Flex the test sample for 5 000 cycles at a speed of 15 cycles/min.

7.3.5 Requirement

No conductor shall break during the test. The samples when inspected visually shall show no cracks. If the samples meet this requirement, perform the tests specified in 6.2.

8 Low temperature characteristics

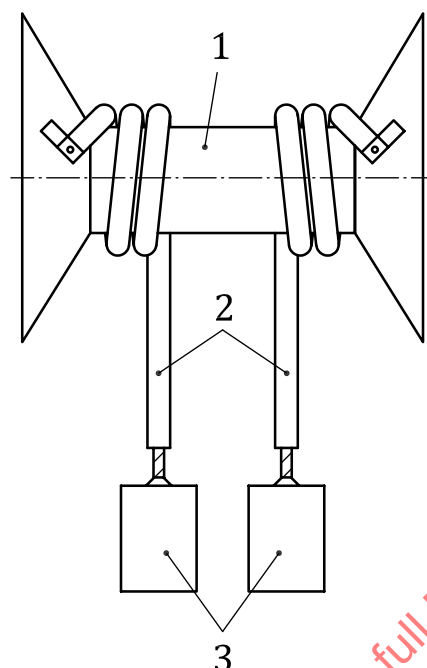
8.1 Winding

8.1.1 Test sample

According to ISO 6722-1. Remove 100 mm of sheath from one end of the cable and remove 25 mm of insulation from each core.

8.1.2 Apparatus

According to ISO 6722-1. A freezing chamber at $(-40 \pm 2) ^\circ\text{C}$ shall be used. The mandrel shall have a diameter of 80 mm and the mass shall be 20 kg.



Key

- 1 mandrel
- 2 test sample(s)
- 3 mass(es)

Figure 3 — Apparatus for winding

8.1.3 Procedure

According to ISO 6722-1.

After conditioning, bend the samples 180° around the mandrel. The bending shall take place within 5 s in the freezing chamber. After winding, allow the test samples to regain room temperature.

8.1.4 Requirements

The test samples, when visually examined, shall show no cracks. If the samples meet this requirement, perform the withstand voltage test as specified in [6.2](#).

8.2 Impact

8.2.1 Test samples

Prepare three samples of a minimum length of 150 mm.

8.2.2 Apparatus

According to ISO 6722-1. The mass of the hammer is 500 g.

8.2.3 Procedure

According to ISO 6722-1. After impact, allow the test samples to regain room temperature.

8.2.4 Requirement

The test samples, when visually examined, shall show no cracks.

9 Resistance to abrasion

According to ISO 14572. The usage of this test will be established by agreement between customer and supplier.

10 Heat ageing

10.1 Long term ageing, 3 000 h

According to ISO 14572. This test is intended to confirm the temperature of class A or class B. Apply the appropriate test temperature of class A or class B according to ISO 6722-1.

Temperature class shall be agreed between customer and supplier.

10.2 Short term ageing, 240 h

According to ISO 14572, but use a mandrel of 60 mm diameter. This test is intended to simulate thermal excursions for class A or class B cables. Apply the appropriate test temperature of class A or class B according to ISO 6722-1.

Temperature class shall be agreed between customer and supplier.

11 Resistance to chemicals

11.1 Fluid compatibility of the sheath

NOTE There is a separate standard in preparation about fluid testing. As long as this standard is not available, the tests described at this chapter are valid. It is intended to revise this document as soon as a comprehensive standard about fluid testing which is applicable also to cables and connectors will be available.

11.1.1 Test samples

According to ISO 6722-1.

11.1.2 Apparatus

Use an apparatus as shown in [Figure 3](#). The mandrel shall have a diameter of 80 mm and the mass shall be 20 kg. The minimum number of turns shall be 0,5.

Table 3 — Test liquids for fluid compatibility of the sheath

Test liquid	Liquid specification	Test Temperature [°C]	Test duration [h]
gasoline	ISO 1817, liquid B	23 ± 5	20
gasoline	ISO 1817, liquid C	23 ± 5	20
gasoline	ISO 1817, liquid D	23 ± 5	20
diesel	ISO 1817, liquid F	23° ± 5	20
Urea	DIN V 70070	23 ± 5	20
lubricating oil	ISO 1817, oil No. 1	50 ± 3	20
lubricating grease	ISO 1817, liquid 101	50 ± 3	20
hydraulic oil ^a	ISO 1817, liquid 102	23 ± 5	20
Engine coolant ^a	b	50 ± 3	20
brake fluid ^a	b	23 ± 5	20
Rape fuel Methyl Ester ^a	EN 14214	23 ± 5	20
^a If agreed between customer and supplier.			
^b As defined between customer and supplier.			

11.1.3 Procedure

Immerse each test sample into the test liquid using the temperature and duration as defined in [Table 3](#). Remove the test sample from the fluid and wipe the surface to remove any remaining liquid and allow it to dry at room temperature for 30 minutes. Within five minutes after the drying period, wind the cable using the apparatus described in [11.1.2](#). The minimum number of turns shall be 0,5.

11.1.4 Requirements

After winding (whilst the sample is still on the mandrel) the sample shall show no cracks. Other requirements shall be by agreement between customer and supplier.

11.2 Durability of sheath marking

11.2.1 General

This test only applies if marking is required.

11.2.2 Test Samples

Prepare a test sample of at least 300 mm length for each test fluid as specified in [Table 3](#).

11.2.3 Apparatus

According to ISO 6722-1, durability of cable marking.

11.2.4 Procedure

According to ISO 6722-1, but apply the test for all the test fluids as specified in [Table 3](#).

11.2.5 Requirements

According to ISO 6722-1. Only the outer sheath shall be examined.