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Road vehicles — Data cables — Test methods and requirements

Véhicules routiers — Câbles de données — Méthodes d'essai et exigences

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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.org
Web www.iso.org

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Foreword

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ISO/TS 16553 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

Road vehicles — Data cables — Test methods and requirements

1 Scope

This Technical Specification specifies test methods, requirements for screened and unscreened, and sheathed and unsheathed twisted pair data cables, and coaxial cables intended for use in road vehicle applications. For sheathed cables, the cables are in accordance with ISO/DIS 14572. See ISO/DIS 6722 for temperature class ratings.

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/DIS 6722:2002, *Road vehicles — 60 V and 600 V single-core cables — Dimensions, test methods and requirements*

ISO/DIS 14572:2006, *Road vehicles — Round, screened and unscreened 60 V and 600 V multi-core sheathed cables — Test methods and requirements for basic and high performance cables*

ASTM D 4566, *Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable*

3 Terms and definitions

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

3.1
capacitance
property of a system of conductors and dielectrics which permits the storage of electrically separated charges, when potential differences exist between the conductors

3.2
characteristic impedance
total opposition that a circuit presents to the flow of an alternating current, specifically the complex quotient of voltage divided by current

3.3
screen (screened, electromagnetic screen)
screen of conductive material intended to reduce the penetration and/or radiation of a varying electromagnetic field into an assigned region

3.4
core
assembly comprising a conductor with its own insulation (and screens if any)

3.5
coaxial pair (Cable)
uniform transmission line consisting of two cylindrical conductors with the same axis

4 General requirements

4.1 Tests

The cables shall be submitted to the tests as specified in Table 1.

4.2 General test conditions

These shall be according to 4.4 of ISO/DIS 6722.

4.3 Ovens

These shall be according to 4.5 of ISO/DIS 6722.

4.4 Visual appearance

This shall be according to 4.6 of ISO/DIS 14572.

5 Dimensions

5.1 Outside cable diameter

This shall be according to 5.2 of ISO/DIS 14572.

5.2 Ovality of sheath

The usage of this test according to 5.3 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

5.3 Thickness of sheath

This shall be according to 5.4 of ISO/DIS 14572.

5.4 Length of lay of a twisted pair

5.4.1 General

This test shall only be used for an unscreened twisted pair. The usage of this test shall be established by agreement between customer and supplier.

5.4.2 Test sample

The sheath (if any) shall be removed from a 1 m cable without allowing the ends to untwist. Other lengths may be used depending on the cable construction.

5.4.3 Apparatus

A measuring device with an accuracy of ± 1,0 mm shall be used.

Table 1 — Tests

Clause	Test description	According to ISO/DIS	Sheathed twisted pairs		Unsheathed twisted pairs		Coaxial
			Screened	Unscreened	Screened	Unscreened	
4	**General**	—	—	—	—	—	—
4.4	Visual appearance	—	A[a]B[b]	AB	——	—	AB
5	**Dimensions**	—	—	—	—	—	—
5.1	Outside cable diameter	14572	AB	AB	—	—	AB
5.2	Ovality	14572	C[c]D[d]	CD	—	—	—
5.3	Thickness of sheath	14572	AB	AB	—	—	AB
5.4	Length of lay of a twisted pair	—	—	CD	—	CD	—
6	**Electrical characteristics**	—	—	—	—	—	—
6.1	Continuity	14572	ABE[e]	ABE	ABE	ABE	ABE
6.2	Withstand voltage	14572	ABE	ABE	ABE	ABE	ABE
6.3	Characteristic impedance	—	CD	CD	CD	CD	CD
6.4	Capacitance	—	AB	AB	AB	AB	AB
6.5	Specific line delay	—	CD	CD	CD	CD	CD
6.6	Screening effectiveness	14572	CD	—	CD	—	CD
7	**Mechanical characteristics**	—	—	—	—	—	—
7.1	Pressure test at high temperature	14572	CD	CD	—	—	CD
7.2	Adhesion of sheath	14572	CD	CD	—	—	CD
7.3	Strip force of the dielectric	6722	—	—	—	—	AB
7.4	Cyclic bending	14572	C	C	—	—	C
8	**Low temperature characteristics**	—	—	—	—	—	—
8.1	Winding	14572	AB	AB	—	—	AB
8.2	Impact	14572	CD	CD	—	—	CD
9	Resistance to abrasion	14572	CD	CD	—	—	CD
10	**Heat ageing**	—	—	—	—	—	—
10.1	Long term ageing, 3000 h	14572	A	A	—	—	A
10.2	Short term ageing, 240h	14572	AB	AB	—	—	AB
10.3	Shrinkage by heat of sheath	14572	CD	CD	--	--	CD
11	**Resistance to chemicals**	—	—			—	-
11.1	Fluid compatibility of sheath	14572	AC	AC	—	—	AC
11.2	Durability of sheath marking	14572	CD	CD	—	—	CD
11.3	Resistance to ozone of sheath	14572	C	C	—	—	C
11.4	Temperature and humidity cycling	14572	C	C	—	—	C
12	**Resistance to flame prop.**	14572	AB	AB	—	—	AB
13	**Artificial weathering**	14572	C	C	—	—	C

[a] A - Initial certification

[b] B - Periodic certification: The frequency of periodic testing will be established by agreement between customer and supplier.

[c] C - Initial certification if required: The usage of "If required" tests will be established by agreement between customer and supplier.

[d] D - Periodic certification if required: The frequency of periodic testing and usage of "If required" tests will be established by agreement between customer and supplier.

[e] E - In process: A test made on all cable during or after manufacture.

NOTE Fluid compatibility of sheath - Some fluids are for "Certification" and others are "If required". See 11.1 for details.

5.4.4 Procedure

The test sample shall be fastened to prevent untwisting. The length of five lays shall be measured, where one lay is the axial length of one complete turn of the helix of a core in the twisted pair. The measured value shall be divided by five to determine the average length of lay.

5.4.5 Requirement

The average length of lay shall be within the values established by agreement between customer and supplier.

6 Electrical characteristics

6.1 Continuity

This shall be according to 6.1 of ISO/DIS 14572.

6.2 Withstand voltage

This shall be according to 6.2 of ISO/DIS 14572.

6.3 Characteristic impedance

6.3.1 General

The usage of this test will be established by agreement between customer and supplier.

6.3.2 Test sample

50 mm of sheath shall be removed from each end of a 3 m completed cable and 12 mm from each end of the cores.

6.3.3 Apparatus

An impedance analyzer with an impedance matching balanced/unbalanced transformer (BALUN) shall be used to convert the 50 Ω unbalance input to Z_N balanced output and a Z_N resistor

where

Z_N is the required nominal impedance of the cable in Ω.

A BALUN should be used if an unbalanced test method is used to evaluate a balanced cable.

6.3.4 Procedure

Calibration (refer to equipment manufacturer's recommended calibration procedure):

Connect the unbalanced input of the BALUN to the impedance analyzer. Set the impedance analyzer frequency to 1 MHz. Measure the resistance of the calibrated resistor R_R (should be approximately Z_N). Connect the calibration resistor to the balanced terminals of the BALUN and record the impedance reading Z_R (should be approximately 50 Ω).

Measurement:

Connect the test sample to the balanced terminals of the BALUN (connect screen, if any, to analyser ground). Measure the impedance with the signal cores open circuited and record as Z_O. Short the signal cores together and record as Z_S. Calculate the cable's characteristic impedance using the following formula.

$$Z = \frac{R_R}{Z_R}\sqrt{Z_O \times Z_S}$$

where

Z is calculated characteristic impedance of the cable in Ω;

R_R is measured resistance of the calibration resistor in Ω;

Z_R is measured impedance of the calibrated resistor in Ω;

Z_O is measured impedance of the test sample with the cores open circuited in Ω;

Z_S is measured impedance of the test sample with the cores short circuited in Ω.

6.3.5 Requirement

The characteristic impedance of the cable shall be established by agreement between customer and supplier.

6.4 Capacitance

6.4.1 Test sample

Remove 50 mm of sheath and screen (if any) and 25 mm of outer conductor (for coaxial cables) from one end of a 3 m cable. Remove 12 mm of insulation from each of the cores.

6.4.2 Apparatus

The test shall be performed with an impedance analyzer or equivalent set at 1 kHz.

6.4.3 Procedure

This procedure eliminates the effects of stray capacitance. Measure the test sample length (L_1).

Twisted pair — Measure the capacitance (C_1) between the two cores.

Twisted, screened pair — Measure the capacitance (C_1) between the two cores, the capacitance (C_{A1}) between one of the cores and the screen, and the capacitance (C_{B1}) between the other core and the screen.

Coaxial cable — Measure the capacitance (C_1) between the inner and outer conductors.

Trim the test sample to 1 m and repeat the procedure. Measure the new test sample length (L_2), the capacitance (C_2), and the capacitances to screen (C_{A2}) and (C_{B2}) where applicable. Calculate the specific capacitance using the following formulae:

$$C = \frac{C_1 - C_2}{L_1 - L_2};\ C_A = \frac{C_{A1} - C_{A2}}{L_1 - L_2};\ C_B = \frac{C_{B1} - C_{B2}}{L_1 - L_2}$$

where

C is specific capacitance in pF/m;

C_A is specific capacitance between core “A” and screen in pF/m;

C_B is specific capacitance between core “B” and screen in pF/m;

C_1 is capacitance between cores or conductors for length L_1 in pF;

C_2 is capacitance between cores or conductors for length L_2 in pF;

C_{A1} is capacitance between core “A” and screen for length L_1 in pF;

C_{A2} is capacitance between core “A” and screen for length L_2 in pF;

C_{B1} is capacitance between core “B” and screen for length L_1 in pF;

C_{B2} is capacitance between core “B” and screen for length L_2 in pF;

L_1 is initial test sample length in m;

L_2 is second test sample length in m.

6.4.4 Requirement

The values for C, C_A, and C_B shall be by agreement between customer and supplier.

6.5 Specific line delay

The usage of this test shall be established by agreement between customer and supplier.

6.5.1 Test sample

Remove 50 mm of sheath from one end of a 3 m completed cable and 12 mm from each end of the cores.

6.5.2 Apparatus

The test shall be performed with a network analyzer.

6.5.3 Procedure

This shall be according to ASTM D 4566. Measure phase constant with a network analyser at 1 MHz. Calculate specific line delay using the following formula:

$$t_p = \frac{10^9 \times \beta}{\omega \times L}$$

where

ω is the radian frequency in rad/s;

β is the phase constant in rads;

t_p is specific line delay in ns/m;

L is sample length in m.

6.5.4 Requirement

The calculated value shall be within the values established by agreement between customer and supplier.

6.6 Screening effectiveness

The usage of this test according to ISO/DIS 14572 shall be established by agreement between customer and supplier.

7 Mechanical characteristics

7.1 Pressure test at high temperature

The usage of this test according to ISO/DIS 14572 shall be established by agreement between customer and supplier.

7.2 Adhesion of sheath

The usage of this test according to ISO/DIS 14572 shall be established by agreement between customer and supplier.

7.3 Strip force of the dielectric, coaxial cable only

The usage of this test according to ISO/DIS 14572 shall be established by agreement between customer and supplier. Remove the sheath and outer conductor without disturbing the dielectric.

7.4 Cyclic bending

The usage of this test according to ISO/DIS 14572 shall be established by agreement between customer and supplier.

8 Low temperature characteristics

8.1 Winding

This shall be done according to 8.1 of ISO/DIS 14572.

8.2 Impact

The usage of this test according to ISO/DIS 14572 shall be established by agreement between customer and supplier.

9 Resistance to abrasion

This shall be done according to Clause 9 of ISO/DIS 14572.

10 Heat ageing

10.1 Long term ageing, 3000 h

This test is intended to confirm the “Temperature class rating” according to 10.1 of ISO/DIS 14572.

10.2 Short term ageing, 240 h

This test is intended to simulate thermal excursions according to 10.2 of ISO/DIS 14572.

10.3 Shrinkage by heat of sheath

The usage of this test according to 10.4 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

11 Resistance to chemicals

11.1 Fluid compatibility of sheath

The usage of this test according to 11.1 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

11.2 Durability of sheath marking

The usage of this test according to 11.2 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

11.3 Resistance to ozone of sheath

The usage of this test according to 11.3 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

11.4 Temperature and humidity cycling

The usage of this test according to 11.4 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

12 Resistance to flame propagation

This shall be according to Clause 12 of ISO/DIS 14572.

13 Artificial weathering

The usage of this test according to Clause 13 of ISO/DIS 14572 shall be established by agreement between customer and supplier.

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