INTERNATIONAL STANDARD

**ISO 14572**

Third edition
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# 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

*Véhicules routiers — Câbles monoconducteurs ou multiconducteurs ronds, sous gaine, blindés et non blindés de 60 V et 600 V — Méthodes d'essai et exigences pour les câbles à performances de base et à hautes performances*



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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 14572 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 14572:2006), which has been technically revised.

# 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

**WARNING — The use of this International Standard may involve hazardous materials, operations, and equipment. This International Standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety practices and determine the applicability of regulatory limitations prior to use.**



## 1 Scope

This International Standard specifies test methods and requirements for basic- and high-performance round, single- or multi-core sheathed 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.) and ≤ (600 V d.c. or 600 V a.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 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-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*

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

IEC 62153-4-3, *Metallic communication cable test methods — Part 4-3: Electromagnetic compatibility (EMC) — Surface transfer impedance — Triaxial method*

IEC 62153-4-5, *Metallic communication cable test methods — Part 4-5: Electromagnetic compatibility (EMC) — Coupling or screening attenuation — Absorbing clamp method*

IEC 62153-4-6, *Metallic communication cable test methods — Part 4-6: Electromagnetic compatibility (EMC) — Surface transfer impedance — Line injection method*

## 3 Terms and definitions

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

NOTE Whenever a.c. voltage is specified throughout this International Standard, a.c. rms value shall be used.

**3.1**
**basic-performance (cable)**
(cable) meeting basic requirements for general automotive applications

**3.2**
**core**
assembly comprising a conductor with its own insulation (and screens if any)

**3.3**
**high-performance (cable)**
(cable) meeting all basic requirements plus enhanced mechanical and/or environmental performance (as defined by the customer)

**3.4**
**screen**
conductive material intended to reduce the penetration and/or radiation of a varying electromagnetic field into an assigned region

**3.5**
**unscreened**
without a screen

**3.6**
**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.)

**3.7**
**600 volt (V) cable**
cable intended for use in road vehicle applications where the nominal system voltage greater than (60 V d.c. or 25 V a.c.) and less than or equal to (600 V d.c. or 600 V a.c.)

**3.8**
**nominal (value)**
suitable approximate value used to designate or identify a component

## 4 General requirements

### 4.1 Safety concerns

See “Warning” at the beginning of this International Standard.

### 4.2 Rating of cables

#### 4.2.1 Voltage rating

The voltage rating is established by the rating of the cores. 60 V and 600 V cores shall not be mixed in the same multi-core cable.

#### 4.2.2 Temperature class rating

The temperature class rating is established by the rating(s) of the cores and sheath. The rating of the cable shall be equal to the lowest rating of the individual cores and sheath. For details on temperature classes see ISO 6722-1.

### 4.3 600 volt cables

Special care shall be taken for cables used for voltages above 60 V d.c. to protect them from mechanical stress to avoid shock hazard.

The 600 V cable sheath shall be visually identified with permanent orange colour.

### 4.4 Tests

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

**Table 1 — Tests**

| Clause | Test description | In-progress tests[a] | Certification | | If required[c] | |
|---|---|---|---|---|---|---|
| | | | Initial | Periodic[b] | Initial | Periodic[b] |
| 4.7 | Visual appearance | — | X | X | — | — |
| 5.1 | Outside cable diameter | — | X | X | — | — |
| 5.2 | Ovality of sheath | — | — | — | X | X |
| 5.3 | Thickness of sheath | — | X | X | — | — |
| 5.4 | Electrical continuity | X | X | X | — | — |
| 5.5 | Withstand voltage | X | X | X | — | — |
| 5.6 | Screening effectiveness | — | — | — | X | X |
| 5.7 | Pressure test at high temperature | — | X | X | — | — |
| 5.8 | Adhesion of sheath | — | — | — | X | X |
| 5.9 | Cyclic bending | — | — | — | X | — |
| 5.10 | Winding at low temperature | — | X | X | — | — |
| 5.11 | Impact at low temperature | — | — | — | X | X |
| 5.12 | Resistance to abrasion | — | — | — | X | X |
| 5.13 | Long-term heat ageing, 3 000 h | — | X | — | — | — |
| 5.14 | Short-term heat ageing, 240 h | — | X | X | — | — |
| 5.15 | Thermal overload | — | — | — | X | X |
| 5.16 | Shrinkage by heat of sheath | — | X | X | — | — |
| 5.17 | Fluid compatibility | | Note | Note | | |
| 5.18 | Durability of sheath marking | — | — | — | X | X |
| 5.19 | Resistance to ozone | — | — | — | X | — |
| 5.20 | Temperature and humidity cycling | — | — | — | X | — |
| 5.21 | Resistance to flame propagation | — | X | X | — | — |
| 5.22 | Artificial weathering | — | — | — | X | — |

NOTE Some fluids are for “certification” and others are “if required” (see 5.17 for details).

[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.



## 4.5 General test conditions

If not otherwise specified, the device under test (DUT) shall be preconditioned for at least 16 h at a room temperature (RT) of (23 ± 5) °C and a relative humidity (RH) of 45 % to 75 %. Unless otherwise specified, all tests other than in-progress tests shall be conducted at these conditions.

Where no tolerance is specified, all values shall be considered to be approximate.

When a.c. tests are performed, they shall be at 50 Hz or 60 Hz. Applications at higher frequencies may require additional testing.

## 4.6 Ovens

The procedure should be followed according to ISO 6722-1.

## 4.7 Visual appearance

On visual examination, the sheath shall be smooth, even and free from surface imperfections such as lumps, voids, particles, or other imperfections.

# 5 Tests and requirements

## 5.1 Outside cable diameter

### 5.1.1 Purpose

This test is intended to verify that the cable outside diameter is within the required tolerances to fit seal and harness dimension requirements.

Due to the variety of constructions, the requirements for dimensions shall be established by agreement between customer and supplier.

### 5.1.2 Test

Perform the test according to ISO 6722-1.

### 5.1.3 Requirement

The outside cable diameter shall be within the limits established by agreement between customer and supplier.

## 5.2 Ovality of sheath

### 5.2.1 General test usage

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

Due to the variety of constructions, the requirements for dimensions shall be established by agreement between customer and supplier.

### 5.2.2 Purpose

This test is intended to verify that the cable ovality is within the required tolerances to fit seal and harness dimension requirements.

### 5.2.3 Test

Measure the maximum ($d_{max}$) and the minimum ($d_{min}$) outside cable diameters according to ISO 6722-1. Then calculate the ovality, $O$, in Equation (1) as follows:

$$O = \frac{(d_{max} - d_{min})}{0{,}5 \times (d_{max} + d_{min})} \times 100 \quad (1)$$

where

$O$ is the amount the sheath is “out of round” in %;

$d_{max}$ is the maximum outside cable diameter in mm;

$d_{min}$ is the minimum outside cable diameter in mm.

### 5.2.4 Requirement

Ovality shall be within the limits established by agreement between customer and supplier.

## 5.3 Thickness of sheath

### 5.3.1 Purpose

This test is intended to verify that the cable sheath thickness is within the required tolerances.

Due to the variety of constructions, the requirements for dimensions shall be established by agreement between customer and supplier.

### 5.3.2 Test

Perform the test according to “insulation thickness” as specified in ISO 6722-1.

### 5.3.3 Requirement

The thickness of sheath shall be within the limits established by agreement between customer and supplier.

## 5.4 Electrical continuity

### 5.4.1 Test sample

Remove 100 mm of sheath from each end of a complete cable and 25 mm of insulation from each end of the cores.

### 5.4.2 Test

Use an appropriate source connected in series with an indicator such as an ohmmeter, light, or buzzer.

Connect the apparatus to one of the cores. Repeat the procedure until all cores have been tested. If a screen is present, test the continuity using the same procedure for a core. As an alternative, all of the cores shall be tested at once by connecting them in series. Take care to select a current which shall not damage the individual conductors.

### 5.4.3 Requirement

The indicator shall show continuity.

## 5.5 Withstand voltage

### 5.5.1 General

Unscreened single-core cables shall be tested according to ISO 6722-1.

### 5.5.2 Purpose

This test is intended to find electrical defects of the final product in accordance with this International Standard.

### 5.5.3 Test sample

Remove 100 mm of sheath from one end of the cable and remove 25 mm of insulation from each core. For the test, connect the conductors of all the cores together at one end, except for the core being tested. If a screen is present, it shall be connected in the same manner as a core.

### 5.5.4 Test

Use a 50 Hz or 60 Hz voltage source capable of applying 2 kV a.c. for a minimum of 3 s.

Apply 2 kV a.c. between the core to be tested and the remaining core(s) for a minimum of 3 s. Repeat the procedure until all cores have been tested. If a screen is present, it shall be tested as one of the cores.

#### 5.5.5 Requirement

Breakdown shall not occur between core(s). If a screen is present, breakdown shall not occur between the core(s) and screen.

### 5.6 Screening effectiveness

#### 5.6.1 General

This test is only used for screened cables. The usage of this test shall be established by agreement between customer and supplier.

#### 5.6.2 d.c. Resistance of the screen

##### 5.6.2.1 Purpose

This test is intended for cables working at frequencies equal to or less than 1 MHz.

##### 5.6.2.2 Test sample

Prepare the test sample according to “Conductor resistance” as specified in ISO 6722-1. Remove 100 mm of sheath from each end of a complete cable.

##### 5.6.2.3 Test

Perform the test according to “Conductor resistance” as specified in ISO 6722-1.

##### 5.6.2.4 Requirement

The requirements for d.c. resistance of the screen shall be established by agreement between customer and supplier.

#### 5.6.3 Surface transfer impedance — Line injection method

##### 5.6.3.1 General

Allowable frequencies for testing should be according to “Surface transfer impedance, Line injection method” of IEC 62153-4-6.

##### 5.6.3.2 Test sample

Prepare the test sample according to “Surface transfer impedance, Line injection method” of IEC 62153-4-6.

##### 5.6.3.3 Test

Perform the test according to “Surface transfer impedance, Line injection method” as specified in IEC 62153-4-6.

##### 5.6.3.4 Requirement

The requirements for surface transfer impedance shall be established by agreements between customer and supplier.

#### 5.6.4 Surface transfer impedance — Tri-axial method

##### 5.6.4.1 General

Allowable frequencies for testing should be according to “Surface transfer impedance, Tri-axial method” of IEC 62153-4-3.

#### 5.6.4.2 Test sample

Prepare the test sample according to “Surface transfer impedance, Tri-axial method” as specified in IEC 62153-4-3.

#### 5.6.4.3 Test

Perform the test according to “Surface transfer impedance, Tri-axial method” as specified in IEC 62153-4-3.

#### 5.6.4.4 Requirement

The requirements for surface transfer impedance shall be established by agreements between customer and supplier.

### 5.6.5 Screening attenuation — Absorbing clamp method

#### 5.6.5.1 General

Allowable frequencies for testing should be according to “Screening attenuation, Absorbing clamp method” of IEC 62153-4-5.

#### 5.6.5.2 Test sample

Prepare the test sample according to “Screening attenuation, Absorbing clamp method” as specified in IEC 62153-4-5.

#### 5.6.5.3 Test

Perform the test according to “Screening attenuation, Absorbing clamp method” as specified in IEC 62153-4-5.

#### 5.6.5.4 Requirement

The requirements for screening attenuation shall be established by agreements between customer and supplier.

## 5.7 Pressure test at high temperature

### 5.7.1 Test samples

Prepare three test samples, each of 100 mm length.

### 5.7.2 Test

Perform the test in accordance with ISO 6722-1 and the following.

Apply force $F$ by the blade to the test sample as given by Equation (2):

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

where

$F$ is the total vertical force exerted on the test sample in N;

$D$ is the appropriate maximum outside cable diameter in mm as agreed between customer and supplier;

$i$ is the appropriate nominal value of the sheath thickness in mm as agreed between customer and supplier;

0,8 is a coefficient in N/mm.

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

Measure the thickness of the sheath immediately after cooling, at the point of indentation, and at points 10 mm to both sides of the impression, by means of a measuring device that does not cause deformation. Omit the withstand voltage test.

#### 5.7.3 Requirement

For basic-performance cables, the thickness within the area of the indentation shall not be less than 40 % of the mean of the other two values.

For high-performance cables, the thickness within the area of the indentation shall not be less than 60 % of the mean of the other two values.

### 5.8 Adhesion of sheath

#### 5.8.1 General

This test shall be agreed between customer and supplier.

#### 5.8.2 Test sample

Prepare the test sample according to ISO 6722-1 “Strip force”. Prepare three test samples of 150 mm from a cable sample 3 m in length. Take the test samples at 1 m intervals. The undisturbed length of sheath shall be 100 mm.

#### 5.8.3 Test

Perform the test according to ISO 6722-1. A metal plate is provided with a round hole equal to the approximate inside diameter of the sheath.

If the 100 mm section of sheath buckles when sliding, prepare new test samples with the undisturbed length of sheath equal to 50 mm and repeat the procedure.

#### 5.8.4 Requirement

The undisturbed section of sheath shall be able to be removed without damage to the interior cores. The strip force shall be within the limits as agreed between customer and supplier.

### 5.9 Cyclic bending

#### 5.9.1 General

This test shall be agreed between customer and supplier.

#### 5.9.2 Test samples

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

#### 5.9.3 Test

The apparatus shall be similar to the one shown in Figure 1. Any apparatus is acceptable as long as it meets the following conditions:

— Bend radius $r = 2{,}5 \times$ outside cable diameter;

— A force, $F$, which produces a tension of 5 N/mm$^2$ in the conductors;

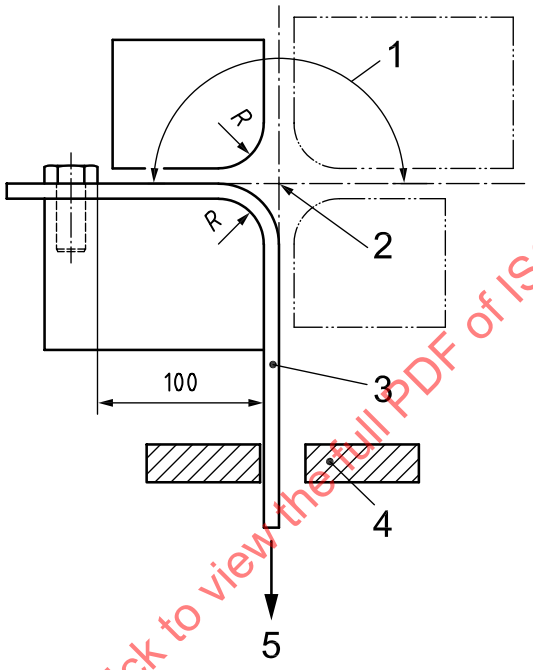
— A fixture that bends the test sample ±90° at a rate of 15 cycles/min;

— If a mass is used, a guide may be applied to stop the mass from swinging.

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 at a speed of 15 cycles/min for the number of cycles as agreed between customer and supplier. Repeat the procedure for the other test sample.

Interruption of electrical conduction shall be detected by an appropriated method, sampling rate ≤10 ms.

Dimensions in millimetres




**Key**

1 1 cycle (90° to each side)
2 pivot
3 cable
4 fixed guide (optional)
5 force, $F$

**Figure 1 — Apparatus for cyclic bending**



#### 5.9.4 Requirement

The requirement(s) for the cyclical bending shall be established by agreement between customer and supplier.

### 5.10 Winding at low temperature

#### 5.10.1 Test sample

Prepare the 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.

#### 5.10.2 Test

Perform the test according to ISO 6722-1. Use a freezing chamber at (−40 ± 2) °C.

(−25 ± 2) °C may be used when agreed between customer and supplier.

See Table 2 for mandrel diameter.

**Table 2 — Winding**

| Outside cable diameter<br>mm | Mandrel diameter<br>mm | Mass, if rotating mandrel is used<br>kg | Minimum number of turns |
|---|---|---|---|
| $D \leq 2{,}5$ | ≤ 5 times "Outside cable diameter" | 0,5 | 3 |
| $2{,}5 < D \leq 5$ | | 2,5 | 3 |
| $5 < D \leq 10$ | | 5 | 2 |
| $10 < D \leq 15$ | | 10 | 0,5 |
| $15 < D \leq 25$ | | 20 | 0,5 |
| $25 < D$ | | 30 | 0,5 |

Apply for this test a winding speed of 0,2 $s^{-1}$ for all cable sizes and a number of turns according to Table 2. After winding, the outer sheath shall be visually examined. If there is no sign of cracks in the sheath, perform the withstand voltage test according to 5.5.

If required by the customer, strip the sheath without damage to the inner cores, visually examine them, and if there is no sign of cracks, perform a 1 kV a.c. withstand voltage test with the separate cores as in ISO 6722-1.

#### 5.10.3 Requirements

The test samples shall show no signs of cracks. Breakdown shall not occur during the different withstand voltage tests.

### 5.11 Impact at low temperature

#### 5.11.1 General

This test shall be agreed between customer and supplier.

#### 5.11.2 Test samples

Prepare three samples of a minimum length of 150 mm. Unless otherwise specified, a sample shall contain the complete sheath including any existing multiple layers.

#### 5.11.3 Test

Perform the test according ISO 6722-1. The mass of the hammer is specified in Table 3.

**Table 3 — Impact**

| Cable outside diameter<br>mm | Mass of the hammer<br>g |
|---|---|
| $D \leq 15$ | 300 |
| $15 < D \leq 25$ | 400 |
| $25 < D \leq 35$ | 500 |
| $35 < D$ | 600 |

After impact, allow the test samples to return to RT, and make a visual examination of the sheath.

If a screen is present, perform the withstand voltage test between the screen and salt water bath; however, make the following changes to the procedure specified in ISO 6722-1:

— Immerse the test sample in the salt water bath for a minimum of 10 min prior to the application of the voltage.

— Apply the 1 kV a.c. voltage for 1 min.

— Do not “ramp up” the voltage after the application of the 1 kV a.c. voltage.

#### 5.11.4 Requirement

The test sample shall show no sign of cracks. If a screen is present during the withstand voltage test, breakdown shall not occur.

### 5.12 Resistance to abrasion

#### 5.12.1 General

This test shall be agreed between customer and supplier.

#### 5.12.2 Test sample

Prepare a sample of 1 m length. Remove 100 mm of sheath from each end of the cable and 25 mm of the insulation from each core. Twist stripped ends of the cores together. If a screen is present, it shall be twisted together with the cores.

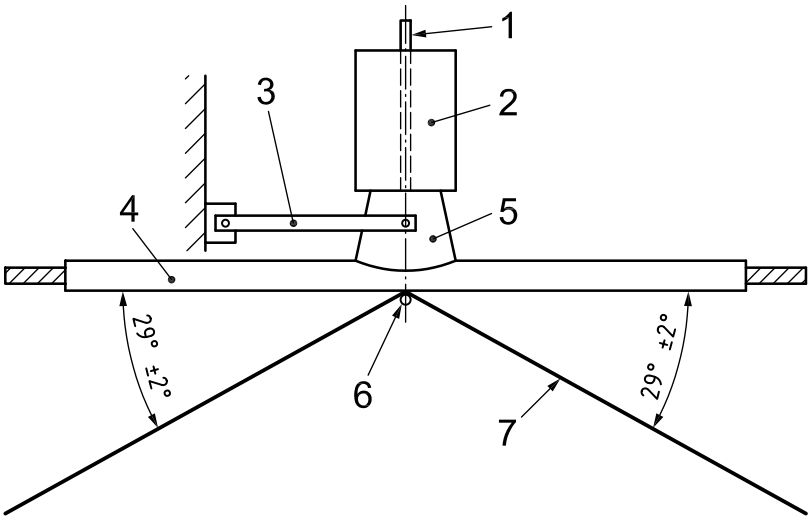
#### 5.12.3 Test

Measure the resistance to abrasion using 80J garnet sandpaper with 5 mm to 10 mm conductive strips perpendicular to the edge of the sandpaper, spaced a maximum of every 75 mm. Mount a suitable bracket to the pivoting arm (see Figure 2) to maintain the test sample position over an unused portion of the sandpaper. Exert a force of (0,63 ± 0,05) N on the test sample by the combination of the bracket, support rod, and pivoting arm. The total vertical force exerted on the test sample shall be the combination of the force exerted by the bracket, pivoting arm, support rod and additional mass. A 2 kg mass may substitute the 4 kg mass if found necessary.

Mount the cable in a horizontal position as shown in Figure 2. Use an area of the abrasion tape not previously used. Place the mass and bracket on top of the cable. Draw the sandpaper under the specimen at a rate of (1 500 ± 75) mm/min and record the length of sandpaper necessary to expose a conductor or screen. Move the test sample 20 mm and rotate the test sample clockwise 90°. Repeat the procedure for a total of 4 readings. The mean of the readings shall determine the resistance to abrasion.

#### 5.12.4 Requirement

The resistance to abrasion shall meet the requirements as agreed between customer and supplier.




**Key**

| | | | |
|---|---|---|---|
| 1 | support rod | 5 | bracket |
| 2 | 4 kg additional mass | 6 | tape supporting pin, diameter = 6,9 mm |
| 3 | pivoting arm | 7 | 80J, garnet sandpaper abrasion tape |
| 4 | test sample | | |

**Figure 2 — Apparatus for "Sandpaper abrasion"**

## 5.13 Long-term heat ageing, 3 000 h

### 5.13.1 Purpose

This test is intended to confirm the temperature class rating.

### 5.13.2 Test samples

Prepare the test samples according to ISO 6722-1. Remove 25 mm of sheath from each end of the cable.

### 5.13.3 Test

Perform the test according to ISO 6722-1. See Table 2 for mandrel diameter and mass.

After winding, visually examine the outer sheath. If there is no sign of cracks in the sheath, perform the withstand voltage test as in 5.5.

If required by the customer, strip the sheath without damage to the inner cores, visually examine them, and if there is no sign of cracks, perform a 1 kV a.c. withstand voltage test with the separate cores as specified in ISO 6722-1.

### 5.13.4 Requirements

According to ISO 6722-1. The test samples shall show no signs of cracks. Breakdown shall not occur during the different withstand voltage tests.

## 5.14 Short-term heat ageing, 240 h

### 5.14.1 Purpose

This test is intended to simulate thermal excursions.

#### 5.14.2 Test samples

Prepare the test samples according to ISO 6722-1. Remove 25 mm of sheath from each end of the cable.

#### 5.14.3 Test

Perform the test according to ISO 6722-1. See Table 2 for mandrel diameter and mass.

After winding, visually examine the outer sheath. If there is no sign of cracks in the sheath, perform the withstand voltage test as in 5.5.

If agreed between customer and supplier, strip the sheath without damage to the inner cores, visually examine them, and if there is no sign of cracks, perform a 1 kV a.c. withstand voltage test with the separate cores as specified in ISO 6722-1.

#### 5.14.4 Requirements

The test samples shall show no signs of cracks. Breakdown shall not occur during the different withstand voltage tests.

### 5.15 Thermal overload

#### 5.15.1 Purpose

This test is intended to simulate thermal overload conditions of the cable.

#### 5.15.2 Test samples

Prepare the test samples according to ISO 6722-1. Remove 25 mm of sheath from each end of the cable.

#### 5.15.3 Test

Perform the test according to ISO 6722-1. See Table 2 for mandrel diameter and mass.

After winding, visually examine the outer sheath. If there is no sign of cracks in the sheath, perform the withstand voltage test according to 5.5.

If agreed between customer and supplier, strip the sheath without damage to the inner cores, visually examine them, and if there is no sign of cracks, perform a 1 kV a.c. withstand voltage test with the separate cores as specified in ISO 6722-1.

#### 5.15.4 Requirements

The test samples shall show no signs of cracks. Breakdown shall not occur during the different withstand voltage tests.

### 5.16 Shrinkage by heat of sheath

#### 5.16.1 Test sample

Prepare three test samples of 200 mm in length.

#### 5.16.2 Test

Perform the test according to ISO 6722-1. Measure the shrinkage of the sheath.