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**Telecommunication cables - Foamed polyolefin dielectric,
corrugated copper-tube outer conductor, 50 Ohm radio-
frequency coaxial cable for wireless communications**

通信电缆

无线通信用 50 Ω 泡沫聚烯烃绝缘皱纹铜管外导体射频同轴电缆

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Telecommunication cables - Foamed polyolefin dielectric, corrugated copper-tube outer conductor, 50 Ohm radio-frequency coaxial cable for wireless communications

1 Scope

This document specifies the product classification, requirements, test methods, inspection rules, and packaging, transportation and storage requirements for foamed polyolefin dielectric, corrugated copper-tube outer conductor, 50 Ohm radio-frequency coaxial cable for wireless communications.

This document applies to the manufacture, testing and use of foamed polyolefin dielectric, corrugated copper-tube outer conductor, 50 Ohm radio-frequency coaxial cable for wireless communications (hereinafter referred to as cable). The operating frequency range of the cable is 100~7125 MHz.

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.

GB/T 2951.11, *Common test methods for insulating and sheathing materials of electric and optical cables -- Part 11: Methods for general application -- Measurement of thickness and overall dimensions -- Tests for determining the mechanical properties* (GB/T 2951.11-2008, IEC 60811-1-1:2001, IDT)

GB/T 2951.13, *Common test methods for insulating and sheathing materials of electric and optical cables -- Part 13: Methods for general application -- Measurement for determining the density -- Water absorption tests -- Shrinkage test* (GB/T 2951.13-2008, IEC 60811-1-3:2001, IDT)

GB/T 3048.10, *Test methods for electrical properties of electric cables and wires -- Part 10: Spark test of extruded protective sheaths*

GB/T 4909.2, *Test methods for bare wires -- Part 2: Measurement of dimensions*

GB/T 6995.3, *Markings for electric wires and cables -- Part 3: Identifications of cables and wires*

GB/T 19849, *Seamless copper-tube for cable*

GB/T 21021.1, *Intermodulation level measurement for passive RF and microwave devices -- Part 1: General requirements and measuring methods* (GB/T 21021.1-2021, IEC 62037-1:2012, IDT)

GB/T 21021.4, *Intermodulation level measurement for passive RF and microwave devices -- Part 4: Measurement of passive intermodulation in coaxial cables* (GB/T 21021.4-2021, IEC 62037-4:2012, IDT)

GB/T 26125, *Electrical and electronic products -- Determination of six regulated substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers)* (GB/T 26125-2011, IEC 62321:2008, IDT)

GB/T 26303.1, *Measuring method for dimensions and shapes of wrought copper and copper alloy -- Part 1: Tube*

GB/T 26303.3, *Measuring methods for dimensions and shapes of wrought copper and copper alloys -- Part 3: Sheets and strips*

GB/T 29197, *Copper-clad aluminum wire*

GB/T 39560.8, *Determination of certain substances in electrical and electronic products -- Part 8: Phthalates in polymers by gas chromatography-mass spectrometry (GC-MS), gas chromatography-mass spectrometry using a pyrolyzer/thermal desorption accessory (Py/TD-GC-MS)* (GB/T 39560.8-2021, IEC 62321-8:2017, IDT)

YD/T 760, *Polyolefin insulation materials for communication cables*

YD/T 837.3, *Test method of copper-core, polyolefin insulated, composite aluminum-plastic sheathed cables for urban local communications. Part 3: Test method of mechanical and physical properties*

YD/T 837.4, *Test method of copper-core, polyolefin insulated, composite aluminum-plastic sheathed cables for urban local communications. Part 4: Test method of environmental performances*

YD/T 837.5, *Test method of copper-core, polyolefin insulated, composite aluminum-plastic sheathed cables for urban local communications. Part 5 Test method of cable structure*

YD/T 1113, *Low-smoke halogen-free compounds for telecommunication cable and optical fiber cable*

JB/T 8137, *Delivery drums for wires and cables*

- a) Double layer insulation - polyolefin bond layer/polyolefin closed cell foam layer.
- b) Triple layer insulation - polyolefin bonding layer/polyolefin closed cell foam layer/polyolefin outer skin layer.

In the above two insulation structures, the polyolefin bonding layer shall be bonded to both the inner conductor and the polyolefin closed-cell foam layer. In the three-layer insulation structure, the polyolefin outer skin layer shall be tightly bonded to the polyolefin closed-cell foam layer.

5.3.3 Insulation properties

Insulation shall meet the following requirements.

- a) Insulation adhesion: There shall be no gap between the insulation layer and the inner conductor. The insulation shall be tightly attached to the inner conductor without looseness. The insulation adhesion on the inner conductor of the copper-clad aluminum wire and the inner conductor of the smooth copper tube shall not be less than 98 N.
- b) Insulation heat shrinkage: total insulation shrinkage shall not exceed 6.4 mm.

5.4 Outer conductor

5.4.1 Outer conductor type and structural dimensions

The outer conductor is composed of an annular corrugated copper tube or a spiral corrugated copper tube. The thread direction of the spiral corrugated copper tube shall be right-handed.

The outer conductor type and structural dimensions are shown in Table 7.

5.5.3 Cable identification mark

The identification marks of finished cables shall comply with the requirements of GB/T 6995.3. The cable sheath shall be printed with the manufacturer's name or code, manufacturing year, cable model and length at intervals of 1m along its length. The mark shall be clearly identifiable and shall be in a color that has a large contrast with the sheath color. The length mark shall be in meters. The nominal spacing is 1000mm. The error range shall not exceed 0~0.5%.

5.6 Cable performance requirements

5.6.1 Mechanical and physical properties and environmental performance

5.6.1.1 Low temperature bending

The low temperature bending test of the cable shall be carried out in accordance with the provisions of 6.5.1. After the test, the sheath and outer conductor of the specimen shall be free of cracks, cracks and other damage. The voltage standing wave ratio measured at both ends of the cable shall still meet the requirements in Table 10.

5.6.1.2 Temperature shock

The temperature shock test of the cable shall be carried out in accordance with the provisions of 6.5.2. After the test, the axial dimension change of the conductor in the cable specimen shall not exceed 1.6 mm. The axial dimension change of the insulation shall not exceed 3.2 mm.

5.6.1.3 Repeated bending

The repeated bending test of the cable shall be carried out in accordance with the provisions of 6.5.3. After the test, the inner conductor, outer conductor and sheath of the specimen shall be free of breakage, cracks and other damage. The voltage standing wave ratio measured at both ends of the cable shall still meet the requirements in Table 10.

6.1.2.1 Structural dimensions and deviations

The test method for the structural dimensions and deviations of conductors in smooth copper tubes is as follows.

- a) Average outer diameter: use an outer diameter micrometer with a graduation of 0.01 mm to measure the outer diameter of the smooth copper tube according to the provisions of GB/T 26303.1. The average value of the maximum outer diameter and the minimum outer diameter measured is taken as the test result.
- b) Pipe wall thickness: measure with a wall thickness micrometer with a graduation of 0.01mm according to the provisions of GB/T 26303.1. The average value of the maximum and minimum thicknesses measured is taken as the test result.
- c) Roundness: when testing the outer diameter of a smooth copper tube, the difference between the maximum and minimum outer diameters measured is the roundness.

6.1.3 Spiral corrugated copper tube inner conductor

When preparing the specimen, cut a section of cable about 15 times the nominal corrugation pitch and straighten it. Remove the cable sheath, outer conductor, insulation and avoid damaging the inner conductor by appropriate means. Then measure the structural dimensions of the inner conductor of the spiral corrugated copper tube according to the measurement method for the spiral corrugated outer conductor specified in 6.3.

6.2 Insulation

6.2.1 Insulation adhesion

Visually (without a magnifying glass) check whether there are gaps and looseness between the insulation layer and the inner conductor. For cables with copper-clad aluminum wire inner conductors and smooth copper tube inner conductors, cut off the insulated core wire with a total length of not less than 300 mm. Keep (50 ± 2) mm long insulation layer. Test the adhesion of the inner conductor to the insulation according to the method specified in GB/T 17737.313. The test environment temperature shall be $(20 \pm 5)^{\circ}\text{C}$.

6.2.2 Insulation heat shrink

Carry out insulation heat shrinkage test according to GB/T 2951.13. Cut 200 mm long insulation core wire. Mark 150 mm long insulation in the middle. Remove the insulation outside the marked line. Put the prepared specimen into a circulating ventilation oven. Keep it at (115 ± 2) for 4 h. Then cool it to room temperature. The shrinkage caused by cutting the insulation specimen shall be included in the total shrinkage.

6.3 Outer conductor

To prepare the test specimen, cut a length of cable approximately 15 times the nominal corrugation pitch and straighten it. Remove the cable sheath in an appropriate manner and avoid damaging the outer conductor. Then measure the structural dimensions as specified below.

- a) Peak average outer diameter - Use a vernier caliper with a graduation of 0.02 mm to measure the peak of the outer conductor wrinkle. The average of the maximum and minimum values measured is taken as the test result.
- b) Average pitch of wrinkles - Measure at least 5 consecutive pitch lengths with a vernier caliper with a graduation of 0.02 mm. Calculate the average value.
- c) Average outer diameter of spiral corrugated outer conductor trough - Use a thin wire (diameter not greater than 0.25 mm) made of suitable material that is not easy to stretch, and wrap it along the trough of the outer conductor corrugation for at least 6 corrugation pitches. Tighten the thin wire appropriately. Make two marks on the thin wire by appropriate methods. The two-point marks shall be made at the intersection of a line parallel to the cable axis and the thin wire. The mark points shall contain at least 5 corrugation pitches. Measure the length between the two-mark points after the thin wire is straightened. Calculate the outer diameter of the trough according to formula (1).

$$\text{Outer diameter of trough} = \sqrt{(L/n)^2 - P^2/\pi} - \Delta \dots\dots\dots (1)$$

In formula (1):

L - the straight-line length between the marks, in millimeters (mm);

n - the number of pitches between the marks;

P - the average value of the measured wrinkle pitch, in millimeters (mm);

Δ - the diameter of the test wire, in millimeters (mm).

- d) Average outer diameter of the trough of the annular corrugated outer conductor - Measure at the trough of the corrugation of the outer conductor with a vernier caliper with a graduation of 0.02 mm. The average of the maximum and minimum values measured is taken as the test result.
- e) Pipe wall thickness before corrugation - Measure with a wall thickness micrometer with a graduation of 0.01 mm in accordance with the provisions of GB/T 26303.1. The thickness of the copper strip used for the conductor is allowed

E_E - elongation at break after aging;

E_U - elongation at break before aging.

6.5 Mechanical, physical and environmental properties of cables

6.5.1 Low temperature bending

Test the low temperature bending performance of the cable according to Method C in Chapter 6 of GB/T 17737.201-2015 and the provisions of this section. The core shaft diameter for the low temperature bending test shall comply with the provisions of Table 12. The length of the cable specimen with specification code 42 shall be enough to allow the specimen to be wound around the mandrel half a circle. The length of the cable specimen with other specifications shall be enough to allow the specimen to be wound around the mandrel once. Place the cable specimen in the low temperature test chamber. Cool the polyethylene sheathed cable to -55°C . Cool the halogen-free low-smoke flame-retardant polyolefin sheathed cable to -30°C . The insulation time is not less than 4 h. Then take out the specimen. Perform the bending test immediately. The cable with specification code 42 shall be wound around the mandrel half a circle at a uniform speed. The cables with other specifications shall be wound once. The winding operation time shall be controlled within 10~15 s.

After the test is completed, visually (without a magnifying glass) inspect the sheath and outer conductor of the specimen. Test the cable for voltage standing wave ratio. Allow the specimen to return to room temperature before visual inspection. See Table 12 for the mandrel diameter for the bend test.

6.5.2 Temperature shock

The temperature shock test is carried out according to the following steps.

- a) The end treatment of the temperature shock test specimen is shown in Figure 3. Take a section of cable about 300 mm long and prepare the specimen as shown in Figure 3. The inner conductor about 25 mm long and the insulation layer about 2 mm long are exposed at both ends of the specimen. The sheath, outer conductor and insulation layer of the cable shall be neatly cut perpendicular to the longitudinal axis of the cable specimen.

between the inner conductor and the outer conductor of the cable.

6.6.4 Sheath spark test

Carry out spark test on cable sheath according to the provisions of GB/T 3048.10.

6.6.5 Capacitance

Test the capacitance of the cable according to GB/T 17737.103.

6.6.6 Relative transmission speed

According to GB/T 17737.108, test the relative transmission speed of the cable.

6.6.7 Average characteristic impedance

According to GB/T 17737.108, the average characteristic impedance of the test cable is tested. The test frequency is 200 MHz or higher than 200 MHz.

6.6.8 Attenuation constant

Test the attenuation constant of the cable as specified in IEC 61196-1-113.

6.6.9 VSWR

According to GB/T 17737.112, test the impedance consistency of the cable. The test results are displayed and recorded as voltage standing wave ratio. Test the entire cable or 20 m in length. Both ends of the cable shall be tested. The test results shall meet the requirements.

6.6.10 Passive third-order intermodulation level (upon request)

According to the three methods specified in GB/T 21021.4, namely, the static test, the clamping cable loop dynamic test and the bending tool dynamic test, and the measurement method specified in GB/T 21021.1, the passive third-order intermodulation level of the cable at the working frequency is tested. It is recommended to use a 7-16 RF coaxial connector that complies with IEC 61169-4 to connect the two ends of the cable. The port input continuous wave power (P_{CW}) of the two signal sources is 43 dBm (20 W). The minimum bending radius (R , i.e., the minimum radius of a single bending of the cable) in the clamping cable loop dynamic test and the minimum radius of repeated bending (R_{min}) of the cable in the bending tool dynamic test shall comply with the provisions of Table 14.

The clamped cable ring dynamic test shall be carried out on two specimens. In the test procedure 5.2c) specified in GB/T 21021.4-2021, one of the cable specimens shall first be subjected to and pass the repeated bending test in accordance with the provisions of 6.5.3 of this document. Then the cable repeated bending minimum radius (R_{min} , see the provisions of Table 14) is used as the cable minimum bending radius (R) of the

specimen in this test.

In the dynamic test, the passive third-order intermodulation level measured by the cable under static conditions after the movement is completed is used as the final result of the test. The maximum value of the passive third-order intermodulation level generated under the moving state is recorded but not evaluated.

6.7 Flame-retardant test of flame-retardant cable

Flame-retardant cables shall be subjected to a single cable vertical flame spread test according to the method specified in GB/T 18380.12.

When flame-retardant cables are required to undergo a vertical flame spread test for bundled cables, the test shall be carried out in accordance with the method specified in GB/T 18380.35.

6.8 Restricted substances

According to GB/T 26125, test the content of restricted substances such as heavy metals and organic bromides.

According to GB/T 39560.8, test the content of restricted low molecular weight phthalates.

7 Inspection rules

7.1 Exit-factory requirements

Cables shall be inspected by the manufacturer's quality inspection department and can only leave the factory after passing the inspection. Cables leaving the factory shall be accompanied by a quality inspection certificate.

7.2 Product Inspection

Product inspection is divided into exit-factory inspection and type inspection.

8 Packaging, transportation and storage

8.1 Packaging

8.1.1 Overview

Finished cables shall be packaged in reels or coils. The length of each cable reel (coil) shall be the standard length of the manufacturer, or the length agreed upon by the manufacturer and the user. The minimum diameter of the cable winding when packaged in reels or coils shall not be less than the core shaft diameter for bending test in Table 12.

8.1.2 Packaging in reels

The finished cable shall be neatly wound on the cable drum. The cable drum shall comply with the provisions of JB/T 8137 or JB/T 12750. Both ends of the cable shall be sealed and fixed on the cable drum.

The cable packaging drum shall indicate the following: manufacturer's name, cable model, length, cable number and an arrow indicating the correct rolling direction of the cable drum.

8.1.3 Packaging in coils

Cables with smaller diameters, shorter lengths or as required by the contract can also be packaged in coils. Both ends of the cable shall be sealed and tied at least 3 times at evenly spaced locations to ensure that the cable does not become loose during transportation and storage.

Each cable coil shall be accompanied by a certificate of conformity, which shall indicate the manufacturer's name (or registered trademark), cable model, length, cable number and inspector number.

The coiled cables shall be delivered in cartons or other boxes with sufficient strength. The following information shall be marked on the packaging box: manufacturer name, cable model, length and cable number.

8.2 Transportation and storage

The following matters shall be noted during the transportation and storage of cables:

- a) Keep the ends sealed to prevent the cable from getting wet or soaked in water;
- b) Store in a ventilated and dry place;

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