

JIS

JAPANESE INDUSTRIAL STANDARD

Testing methods of electrical copper and aluminium wires

JIS C 3002—1992



Singapore Productivity and Standards Board
Information Resource Centre
No.1 Science Park Drive
Singapore 118221
Tel: 772 9643 Fax: 778 2774

Please check and report any damages (e.g. torn pages, missing pages, wrong pagination, scribbling and other marks, soiled pages, etc.) found to the library counter before borrowing out the standard.

A charge of S\$5.00 will be imposed on any one found damaging the standard. This includes removal of binding materials such as tapes and staples.

Thank you for your cooperation.

Translated and Published

by

Japanese Standards Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

JAPANESE INDUSTRIAL STANDARD

J I S

Testing methods of electrical copper and
aluminium wires

C 3002-1992

1. Scope

This Japanese Industrial Standard specifies testing methods of electrical copper wires and electrical aluminium wires (hereafter referred to as the "copper wires" and "aluminium wires") respectively.

Remarks 1. The following Standards are cited in this Standard:

JIS B 7502-Micrometer Callipers for External Measurement

JIS B 7507-Vernier Callipers

JIS B 7721-Tensile Testing Machines

JIS C 3001-Resistance of Copper Materials for Electrical
Purposes

JIS K 8085-Ammonia Solution

JIS K 8088-Sulfur

JIS K 8180-Hydrochloric Acid

JIS K 8252-Ammonium Peroxydisulfate

JIS K 8949-Sodium Sulfide Enneahydrate

JIS K 8984-Copper (II) Sulfate (Anhydrous)

2. The International Standards corresponding to this Standard are given below.

IEC 28 (1925)-International standard of resistance for copper

IEC 92-3 (1965)-Electrical installations in ships. Part 3: Cables
(construction, testing and installations)

IEC 468 (1974)-Method of measurement of resistivity of metallic
materials

3. The units and numerical values given in { } in this Standard are based on the traditional units and are appended for informative reference.

2. Classification of tests

The tests are classified as shown in Table 1.

Table 1. Classification of tests

Class	Applicable clause for testing method
Appearance	3.
Construction	4.
Tension	5.
Conductivity	6.
Edgewise bending	7.
Plating	8.

3. Appearance

In the appearance test, the wires shall be checked by visually or by the hand touch on the following items while the wires are wound in bundles, wound on drums or wound on bobbins.

Flatness·flaw·rust·fissure·dirt·connecting point·bird cage

The tinned copper wires shall further be checked on the surface plating whether that is performed uniformly or not.

4. Construction

The construction test shall be carried out on the test piece taken from one end of the sample, and the diameter for solid wire, the width, thickness and chamfering radius for flat type wire, and the diameter of component wire, number of component wire, direction of strand, pitch of lay and outside diameter for stranded wire, shall be measured as follows:

- (1) Solid wire For the measurement of diameter, the external micrometer specified in JIS B 7502 or at least the equivalent, shall be used. For the solid wire whose nominal diameter is in the order of 1/1000 mm, however, a measuring equipment having minimum graduation of 1/1000 mm shall be used.

The diameter shall be measured at not less than two locations on the same plane perpendicular to the wire axis spaced at a nearly equal angle, and expressed as the mean value.

- (2) Flat type wire The thickness and width shall be measured with the measuring equipment specified in (1) or the vernier callipers of 0.05 mm graduation specified in JIS B 7507 at not less than two locations along the longitudinal direction, and expressed the respective mean value.

The chamfering radius shall be measured with a radius gauge (R gauge) on the same plane perpendicular to the wire axis at each chamfered corner, and expressed the mean value.

(3) Stranded wire

- (a) The outside diameter shall be measured by using the micrometer specified in (1) or the vernier callipers specified in (2), in a similar way to that specified in (1) measurement of diameter.
- (b) As for the direction of strand, whether it is S strand (right-handed) or Z strand (left-handed) shall be checked.

Remarks: S strand means the direction shown in Fig. 1 (A), and is also called right-handed. To the contrary, Z strand means the direction shown in Fig. 1 (B), and is also called left-handed.

Fig. 1. Direction of strand



- (c) The measurement of the pitch of lay for the concentric strand shall be made as follows: count the number of strands n of that layer, fit the scale along the axial direction, measure the distance between the reference strand and $(n + 1)$ th strand and take the value so measured as the pitch of lay.

The pitch of lay may be measured with a scale on the copy of the component wire arrangement which is taken by applying a piece of paper along the axial direction.

When the pitch of lay is expressed as the multiple of the pitch circle diameter⁽¹⁾, the expression is as follows:

$$P_n = \frac{P}{D_1}$$

where, P_n : lay ratio
 P : pitch of lay (mm)
 D_1 : pitch circle diameter (mm)

Note (1) The pitch circle diameter means the diameter of circle connecting the centres of all component wires in a certain layer.

5. Tension

The tension test shall be carried out on the test piece taken from one end of the sample, and the tensile strength and elongation are measured in accordance with the following items. For the stranded wires, however, only the tensile strength is checked but not the elongation.

(1) Preparation of test piece

- (1.1) The test piece for solid wires and flat type wires shall have a length of about 400 mm, and be marked with the gauge marks 250 mm apart on its middle part. The test piece for stranded wires, shall be so prepared that the distance between clamps becomes 500 mm or more, and if necessary, the both ends of the test piece are loosened and solidified with suitable alloy or resin.

(1.2) Calculation of sectional area

- (a) The sectional area of the solid wire shall be calculated from the diameter obtained by the method specified in 4.(1).
- (b) The sectional area of the flat type wire shall be calculated from the thickness, width and chamfering radius obtained by the method specified in 4.(2).

(2) Procedure

- (2.1) Tension test conditions: The tension test shall be made under the following conditions:

- (a) Temperature The temperature shall be an ordinary temperature and if necessary, the test temperature shall be recorded.
- (b) Testing machine The testing machines shall be the ones specified in JIS B 7721, and the pulling speed shall be 100 mm/min or less for hard-drawn, half-hard-drawn copper wires (inclusive of plated ones) and aluminium wires, and 300 mm/min or less for annealed copper wires (inclusive of plated ones).

(2.2) Calculation of tensile strength and elongation

- (a) Tensile strength The tensile strength shall be converted into per unit area by the following formula:

$$\sigma_b = \frac{F}{A}$$

where,

σ_b : tensile strength (MPa) {kgf/mm²}

F : maximum tensile load (N) {kgf}

A : sectional area (mm²)

- (b) Elongation The distance between gauge marks when the broken parts of the test piece are jointed together is measured, and the elongation shall be obtained from the following formula, or by direct reading using a percent scale.

$$\epsilon = \frac{l_1 - l_0}{l_0} \times 100$$

where, ϵ : elongation (%)

l_1 : length between gauge marks when broken parts are jointed together (mm)

l_0 : gauge length (mm)

- (c) As for the following cases, the test shall be invalid.

- ① When the test piece for the solid wires and flat type wires is cut at a point within 25 mm from the gauge marks or outside the gauge marks, and does not comply with the requirements.
- ② When the test piece for the stranded wires is cut at the clamped portion, and does not comply with the requirements.

6. Conductivity

The conductivity test shall be carried out on the test piece taken from one end of the sample in accordance with the following items. However, it may be measured directly with a conductivity bridge.

(1) Measurement of electric resistance

- (a) In the measurement of the electric resistance, a double bridge or potentiometer shall be used. Measuring the length of the test piece shall, as a rule, be 1 m or 50 cm.
- (b) The temperature of the room or the oil bath for measuring the electric resistance shall be kept at a constant temperature within the range of 10°C to 30°C, and before measurement, the test piece shall be exposed in the measuring room (or in the measuring oil bath) until its temperature becomes the same as that of the measuring room (or the measuring oil bath).
- (c) In the measuring of the electric resistance, the measuring current shall not give any influence on the results of the measurement.

(2) Measurement of mass

- (a) The measurement of the mass shall be carried out accurately on the length on which the electric resistance is measured, with the cross sections at the both ends finished flat.
- (b) The balance used for the measurement of the mass shall be selected so that suitable sensitivity corresponding to the measuring mass can be obtained.

- (3) Calculating method of conductivity The calculation of the conductivity shall be made as follows:

$$\gamma = \frac{A}{\frac{R \cdot m}{l^2 G} + B(20 - t)} \times 100 \quad \text{or} \quad \frac{C}{\frac{R \cdot m}{l^2} + D(20 - t)} \times 100$$

where, γ : conductivity (%)
 R : electric resistance (Ω)
 m : mass (g)
 l : measuring length (m)
 t : temperature ($^{\circ}\text{C}$)
 G : density (g/cm^3)

A, B, C, D and G are the constants given in Table 2.

Table 2. Constants

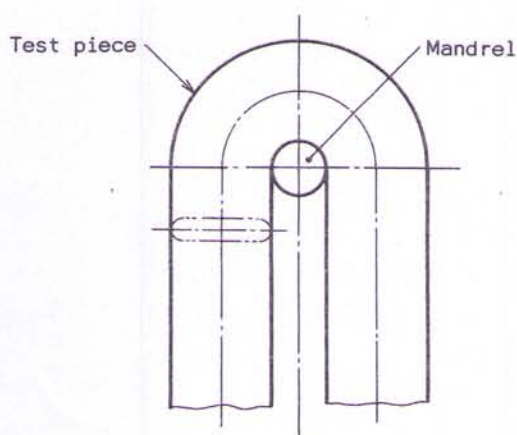
	Copper wire	Aluminium wire
A	0.017241	0.017241
B	0.000068	0.000113
C	0.153280	0.046552
D	0.00060	0.00031
G	8.89	2.70

Remarks: These constants are the values when the conductivity of standard annealed copper specified in JIS C 3001 at 20°C is set as 100 %.

7. Edgewise bending

In the edgewise bending test, the test piece taken from one end of the sample shall be, as shown in Fig. 2, bent through 180 degrees perfectly so that the opening of wire ends becomes the same as the diameter of mandrel while the test piece lies in a plane, and the existence of cracks shall be checked.

Fig. 2. Edgewise bending



8. Plating

The plating test shall be carried out in accordance with sodium polysulfide method or ammonium persulfate method.

(1) Sodium polysulfide method

- (a) Preparation of test piece The plated surface of the test piece of about 200 mm long taken from one end of the sample, shall be wiped carefully with a cloth dipped in alcohol, benzene, etc., and then washed in water sufficiently.
- (b) Test solution The hydrochloric acid solution to be used shall be prepared by diluting the hydrochloric acid specified in JIS K 8180 with distilled water so that the specific gravity at 15°C can be 1.088. The sodium polysulfide solution to be used shall be prepared as follows: dissolve 100 g of the sodium sulfide specified in JIS K 8949 in nearly equal amount of the distilled water to make the specific gravity of 1.170 at 15°C, add 45 g of the first grade sulfur specified in JIS K 8088 and dissolve it by heating as mildly warm as possible, cool and filter the solution, dilute it with the distilled water to make the specific gravity of 1.142 at 15°C. After preparation, the solution shall be stored in a container tightly plugged and placed in a cold and dark place. The solution shall not be used after seven days or more.
- (c) Testing method Each solution shall be kept at $15 \pm 2^\circ\text{C}$ being put in the glass vessels of the inner diameter about 50 mm, height 150 mm to 200 mm. The test piece shall be dipped in the hydrochloric acid solution for one minute, taken out and washed in water sufficiently, dipped in the sodium polysulfide solution for one minute, and then taken out and washed in water.

The test procedure shall be carried out specified times, while the above mentioned one cycle of operations being counted as one time, and whether black copper sulfide is generated on the surface or not shall be checked.

- (d) The length of the test piece to be dipped in the test solution shall be 100 mm to 200 mm, and the examination shall be carried out on the middle part of the test piece that is exclusive of the part lying about 20 mm up and down from the dipped boundaries. The test pieces to be dipped simultaneously should have the same diameters as far as possible, and the maximum number of the test pieces N is approximately obtained from the following formula.

$$N = \frac{20}{d}$$

where, N : maximum number of test pieces (piece)
 d : nominal diameter of test piece (mm)

The test solution can be used up to 10 times of dipping so long as the test is carried out successively.

(2) Ammonium persulfate method

- (a) Preparation of test piece The test piece shall be taken from one end of the sample so that the total length L (mm) shown by the following formula can be obtained.

$$L = \frac{300}{d}$$

where, L : total length of test piece (mm)
 d : nominal diameter of test piece (mm)

The plated surface of the test piece shall be washed in alcohol, benzene, petroleum ether, etc., wiped off with a clean soft cloth, dried and the both ends shall be sealed with wax or the like so that no copper can appear. The both ends coated with wax or the like shall, however, not be included in the length (L). If necessary, the test piece may be cut into suitable length so that perfect dipping in the test solution can be made.

- (b) Test solution The test solution shall be made as follows: dissolve 10 g of the ammonium persulfate specified in JIS K 8252 in the distilled water of about 500 ml, add 75 ml of the ammonia water (specific gravity 0.90) specified in JIS K 8085, and further dilute with the distilled water to 1 litre. The ammonium persulfate solution shall be prepared newly at each time, and shall be kept at a temperature of 35°C or lower.
- (c) Colorimetric standard solution The standard solution shall be made as follows: dissolve 0.200 g of the first grade anhydrous cupric sulfate specified in JIS K 8984 in the distilled water of about 500 ml, add 75 ml of the ammonia water (specific gravity 0.90) specified in JIS K 8085, and further dilute with the distilled water to 1 litre.

- (d) Testing method The test piece shall be dipped thoroughly into the test solution of 100 ml contained in a test tube. The test piece is allowed to stand in the test solution at $18 \pm 3^{\circ}\text{C}$ for 15 minutes and then taken out.

The colorimetric standard solution contained in the same kind test tube to the same depth, and the test solution shall be compared visually from the longitudinal direction of the test tubes, and whether the color of the test solution is not darker than that of the colorimetric standard solution or not shall be checked.

STANDARDS, PRODUCTIVITY AND INNOVATION BOARD

Information Resource Centre
2 Bukit Merah Central, 4th floor
Singapore 159835

This book / standard must be returned on or before
the date due stamped below.

A fine of 50¢ will be charged for each day the item is kept overdue.

10 SEP 2002

CANCEL

17 FEB 2006

CANCEL

28 MAR 2006

To renew, please call : 6279 3924

SISIR LIBRARY



0000600478762

AAF 3231

C 3002-1992
Edition 1

Japanese Text

Established by Minister of International Trade and Industry

Date of Establishment: 1950-07-15

Date of Revision: 1992-08-01

Date of Public Notice in Official Gazette: 1992-08-20

Investigated by: Japanese Industrial Standards Committee

Divisional Council on Electricity

Technical Committee on Electrical Copper Wires

This English translation is published by:
Japanese Standards Association
1-24, Akasaka 4, Minato-ku,
Tokyo 107 Japan
© JSA, 1993

Printed in Tokyo by
Hohbunsha Co., Ltd.