भारतीय मानक

Indian Standard

IS 18925 (Part 2) : 2024
IEC 62561-2 : 2023

विद्युत संरक्षण प्रणाली कम्पोनेंट्स (एलपीएससी)

भाग 2 चालकों और अर्थ इलेक्ट्रोड के लिए अपेक्षाएँ

Lightning Protection System Components (LPSC)

Part 2 Requirements for Conductors and Earth Electrodes

ICS 29.020; 91.120.40

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September 2024 **Price Group 12**

Electrical Installation Sectional Committee, ETD 20

NATIONAL FOREWORD

This Indian Standard (Part 2) which is identical to IEC 62561-2 : 2023 'Lightning protection system components (LPSC) — Part 2: Requirements for conductors and earth electrodes' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Electrical Installation Sectional Committee and approval of the Electrotechnical Division Council.

This Standard is published in several parts. The other parts in this series are:

Part 1	Requirements for connection components
Part 3	Requirements for isolating spark gaps (ISGs)
Part 4	Requirements for conductor fasteners
Part 5	Requirements for earth electrode inspection housings and earth electrode seals
Part 6	Requirements for lightning strike counters (LSCs)
Part 7	Requirements for earthing enhancing compounds
Part 8	Requirements for components for isolated LPS

The text of the IEC standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appears referring to this standard, they should be read as 'Indian Standard'; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 6957 : 1988 Copper alloys — Ammonia test for stress corrosion resistance	IS 16872 : 2019 Copper alloys — Ammonia test for stress corrosion resistance	Identical
ISO 6892-1 Metallic materials — Tensile testing — Part 1: Method of test at room temperature	IS 1608 (Part 1) : 2022 Metallic materials — Tensile testing: Part 1 Method of test at room temperature	Identical
IEC 62305-3 Protection against lightning — Part 3: Physical damage to structures and life hazard	IS/IEC 62305-3 : 2010 Protection against lightning: Part 3 Physical damage to structures and life hazard	Identical
IEC 62305-4 Protection against lightning — Part 4: Electrical and electronic systems within structures	IS/IEC 62305-4 : 2010 Protection against lightning: Part 4 Electrical and electronic systems within structures	Identical

(*Continued on third cover*)

CONTENTS

INTRODUCTION

This part of IEC 62561 deals with the requirements and tests for lightning protection system components (LPSC), specifically conductors and earth electrodes, used for the installation of a lightning protection system (LPS) designed and implemented according to IEC 62305 (all parts).

Indian Standard

LIGHTNING PROTECTION SYSTEM COMPONENTS (LPSC)

PART 2 REQUIREMENTS FOR CONDUCTORS AND EARTH ELECTRODES

1 Scope

Part 2 of IEC 62561 specifies the requirements and tests for:

– metallic conductors (other than "natural" conductors) that form part of the air-termination and down-conductor systems,

– metallic earth electrodes that form part of the earth-termination system.

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.

IEC 60068-2-52:1996, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium, chloride solution*)

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62305-4, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

IEC 62561-1:2012, *Lightning protection system components (LPSC) – Part 1, Requirements for connection components*

ISO 2178, *Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method*

ISO 6892-1, *Metallic materials – Tensile testing – Part 1: Method of test at room temperature*

ISO 6957:1988, *Copper alloys – Ammonia test for stress corrosion resistance*

ISO 6988:1985, *Metallic and other non-organic coatings – Sulphur dioxide test with general condensation of moisture*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 http://www.iso.org/obp

3.1
air-termination system
part of an external LPS using metallic elements such as rods, mesh conductors or catenary wires intended to intercept lightning flashes

3.2
air-termination rod
part of the air-termination system consisting of a metal rod for intercepting and conducting flashes to the down-conductor and earthing system components of the LPS

3.3
air-termination conductor
part of the air-termination system consisting of a conductor for intercepting and conducting flashes to the down-conductor and earthing system components of the LPS

3.4
down-conductor
part of an external lightning protection system, which is intended to conduct lightning current from the air-termination system to the earth-termination system

3.5
earth-termination system
part of an external lightning protection system, which is intended to conduct and disperse lightning current to the earth

3.6
earth electrode
part or group of parts of the earth-termination system, which provides direct electrical contact with and disperses the lightning current to the earth

EXAMPLES: Earth rod, earth conductor and earth plate.

3.7
earth rod
earth electrode consisting of a metal rod driven into the ground

3.8
earth conductor
earth electrode consisting of a conductor buried in the ground

3.9
earth plate
earth electrode consisting of a metal plate buried in the ground

3.10
earth rod coupler
part of the earth-termination system that facilitates the coupling of one section of an earth rod to another for the purpose of deep driving

3.11
driving head
tool used in those applications where it is necessary to drive the earth rod

3.12
earth lead-in rod
rod installed between the down-conductor/test joint and the earth electrode

4 Requirements

4.1 General

Conductors and earth electrodes shall be designed in such a manner that, when they are installed in accordance with the manufacturer's instructions, their performance shall be reliable, stable and safe to persons and surrounding equipment.

The choice of a material depends on its ability to match the particular application requirements such as life cycle of the material, effects from galvanic corrosion and compatibility with other interconnected materials or services.

Summaries of the requirements are given in Annex C and Annex D and their corresponding tests are given in Annex A, Annex B and the sequence of tests in Annex E (Figure E.1), Annex F (Figure F.1) and Annex G (Figure G.1).

4.2 Documentation

The manufacturer or supplier of the conductors and earth electrodes shall provide adequate information in their literature to ensure that the installer of the conductors and earth electrodes can select and install the materials in a suitable and safe manner, in accordance with IEC 62305-3 and IEC 62305-4.

Compliance is checked by inspection.

4.3 Air-termination conductors, air-termination rods, earth lead-in rods and down-conductors

The material, configuration and cross-sectional area of the conductors and rods, shall be in accordance with Table 1. Their mechanical and electrical characteristics shall be in accordance with Table 2.

Other materials may be used if they possess equivalent mechanical and electrical characteristics and corrosion resistance properties for the intended application.

Other configurations may be used if the relevant dimensions are met.

Coated conductors and rods shall be corrosion resistant and the coating shall exhibit good adherence to the base material.

Compliance is checked by the tests of 5.2.2, 5.2.3, 5.2.4, 5.2.5 and 5.2.6.

NOTE A summary of requirements for the cross-sectional area, mechanical and electrical characteristics as well as tests is given in Annex C.

Table 1 – Material, configuration and cross-sectional area of air-termination conductors, air-termination rods, earth lead-in rods[g] and down-conductors

Material	Configuration	Cross-sectional area [a] mm^2	Recommended dimensions
Copper, Tin plated copper [b]	Solid tape	≥ 50	2 mm thickness
	Solid round [d]	≥ 50	8 mm diameter
	Stranded [f]	≥ 50	1,14 mm up to 1,7 mm strand diameter
	Rod solid round [h]	≥ 176	15 mm diameter
Aluminium	Solid tape	≥ 70	3 mm thickness
	Solid round	≥ 50	8 mm diameter
	Stranded [f]	≥ 50	1,63 mm strand diameter
Copper coated aluminium alloy [e]	Solid round	≥ 50	8 mm diameter
Aluminium alloy	Solid tape	≥ 50	2,5 mm thickness
	Solid round	≥ 50	8 mm diameter
	Stranded [f]	≥ 50	1,7 mm strand diameter
	Rod solid round [h]	≥ 176	15 mm diameter
Hot dipped galvanized steel	Solid tape	≥ 50	2,5 mm thickness
	Solid round	≥ 50	8 mm diameter
	Stranded [f]	≥ 50	1,7 mm strand diameter
	Rod solid round [h]	≥ 176	15 mm diameter
Copper coated steel [e]	Solid round	≥ 50	8 mm diameter
	Solid tape	≥ 50	2,5 mm thickness
Stainless steel [c]	Solid tape [i]	≥ 50	2 mm thickness
	Solid round [i]	≥ 50	8 mm diameter
	Stranded [f]	≥ 70	1,7 mm strand diameter
	Rod Solid round [h]	≥ 176	15 mm diameter

NOTE For the application of the conductors, see IEC 62305-3.

[a] Manufacturing tolerance: −3 %.

[b] Hot dipped or electroplated; minimum thickness coating of 1 µm. There is no requirement to measure the tin plated copper because it is for aesthetic reasons only.

[c] Chromium ≥ 16 %; nickel ≥ 8 %; carbon ≤ 0,08 %.

[d] 50 mm^2 (8 mm in diameter) may be reduced to 28 mm^2 (6 mm in diameter) in certain applications where mechanical strength is not an essential requirement. Consideration should, in this case, be given to reducing the spacing between the fasteners.

[e] Minimum 70 µm radial copper coating of 99,9 % copper content.

[f] The cross-sectional area of stranded conductors is determined by the resistance of the conductor according to IEC 60228.

[g] If the earth lead-in rod is partially installed in soil it has to fulfil the requirements of Table 2 and Table 3.

[h] Applicable for air-termination rods and earth lead-in rods. For air-termination rods where mechanical stress such as wind loading is not critical, a 9,5-mm diameter, 1-m long rod may be used.

[i] If thermal and mechanical considerations are important then these values should be increased to 75 mm^2.

4.4 Earth electrodes

4.4.1 General

The cross-sectional area of earth electrodes, its material and its configuration shall be in accordance with Table 3. Moreover, its mechanical and electrical characteristics shall be in accordance with Table 2.

Other materials may be used if they possess equivalent mechanical and electrical characteristics and corrosion resistance properties for the intended application.

Other configurations may be used if the relevant dimensions are met.

NOTE A summary of the requirements for dimensions, mechanical and electrical characteristics as well as tests is given in Annex D.

Table 2 – Mechanical and electrical characteristics of air-termination conductors, air-termination rods, earth lead-in rods, down-conductors and earth electrodes

Material	Maximum electrical resistivity μΩm	Tensile strength N/mm^2
Copper	0,018	200 to 450
Aluminium	0,03	≤ 150
Copper coated aluminium	0,03	≤ 150 [b]
Aluminium alloy	0,036	120 to 280
Steel	0,25	290 to 510
Steel (earth rods)	0,25	350 to 770
Copper coated steel	0,25	290 to 510 [b]
Copper coated steel (earth rods) [a]	0,25	350 to 770 [b]
Stainless steel	0,80	350 to 770
[a] Yield/tensile ratio 0,80 to 0,95 [b] Based on dimensions/tests of only core material of coated conductors.		

4.4.2 Earth rods

Earth rods shall be mechanically robust to ensure correct installation. The material of choice shall be sufficiently malleable to ensure that no cracking of the rod takes place during installation.

The threads on the rods, if any, shall be smooth and fully formed. For coated rods, the coating shall extend over the threads. A lead-in chamfer or point is recommended to facilitate driving.

For electroplated rods such as copper coated rods, it is desirable to thread roll the thread profile to ensure no copper is removed from the steel.

Compliance is checked by inspection and by the tests according to 5.3.

4.4.3 Couplers for earth rods

Earth rods can be extended allowing them to be driven deeper into the ground. This can be achieved by means of a joint/coupling device.

The choice of material shall be compatible with that of the earth rod being joined.

It shall be sufficiently mechanically robust to withstand the driving forces generated during installation.

It shall also exhibit good corrosion resistance.

Threaded external couplers shall be of a sufficient length to ensure no threads on the earth rod are exposed when installed.

Threaded internal couplers shall ensure that the mating faces of the earth rods come in contact after assembly.

Compliance is checked by the tests of 5.4.2, 5.4.3, 5.4.4 and 5.4.5.

4.4.4 Earth conductors and earth plates

Earth electrode conductors and earth plates shall be corrosion resistant and any coating shall exhibit good adherence to the base material.

Compliance is checked by the test of 5.2.2, 5.2.3, 5.2.4, 5.2.5 and 5.2.6.

4.5 Marking

All products complying with this document shall be marked at least with the manufacturer's or responsible vendor's name or trade mark or identifying symbol.

Where this proves to be impractical, the marking in accordance with the identifying symbol may be given on the smallest packing unit.

NOTE Marking can be applied for example by moulding, pressing, engraving, printing adhesive labels or water slide transfers.

Compliance is checked in accordance with 5.5.

Table 3 – Material, configuration and cross-sectional area of earth electrodes

Material	Configuration	Cross-sectional area [a]			Recommended dimensions
		Earth rod mm^2	Earth conductor mm^2	Earth plate cm^2	
Copper, Tin plated copper [f]	Stranded		≥ 50 [i]		1,7 mm strand diameter
	Solid round		≥ 50		8 mm diameter
	Solid tape		≥ 50		2 mm thick
	Solid round	≥ 176			15 mm diameter
	Pipe	≥ 110			20 mm diameter with 2 mm wall thickness
	Solid plate			≥ 2 500	500 mm × 500 mm and 1,5 mm thick[g]
	Lattice plate [g]			≥ 3 600	600 mm × 600 mm consisted of 25 mm × 2 mm section for tape or 8 mm diameter for round conductor
Hot dipped galvanized steel	Solid round		≥ 78		10 mm diameter
	Solid round	≥ 150 [b]			14 mm diameter
	Pipe	≥ 140 [b]			25 mm diameter with 2 mm wall thickness
	Solid tape		≥ 90		3 mm thick
	Solid plate			≥ 2 500	500 mm × 500 mm and 3 mm thick
	Lattice plate [d]			≥ 3 600	600 mm × 600 mm consisted of 30 mm × 3 mm section for tape or 10 mm diameter for round conductor
	Profile	[e]			3 mm thick
Bare steel [k]	Stranded		≥ 70		1,7 mm strand diameter
	Solid round		≥ 78		10 mm diameter
	Solid tape		≥ 75		3 mm thick
Copper coated steel [c]	Solid round	≥ 150 h			14 mm diameter if 250 µm minimum radial copper coating with 99,9 % copper content
	Solid round		≥ 50		8 mm diameter, if 250 µm minimum radial copper coating of 99,9 % copper content
	Solid round [l]		≥ 78		10 mm diameter, if 250 µm minimum radial copper coating of 99,9 % copper content
	Solid tape [l]		≥ 90		3 mm thick, if 250 µm minimum copper coating of 99,9 % copper content
Stainless steel [j]	Solid round		≥ 78		10 mm diameter
	Solid round	≥ 176 h			15 mm diameter
	Solid tape		≥ 100		2 mm thick
NOTE For the application of the earth electrodes, see IEC 62305-3.					

[a]	Manufacturing tolerance: −3 %.
[b]	Threads, where utilized, shall be machined prior to galvanizing.
[c]	The copper shall be intrinsically bonded to the steel. The coating can be measured using an electronic coating measuring thickness instrument.
[d]	Lattice plate constructed with a minimum total conductor length of 4,8 m.
[e]	Different profiles are permitted with a cross section of 290 mm^2 and a minimum thickness of 3 mm, e.g. cross profile.
[f]	Hot dipped or electroplated; minimum thickness coating of 1 µm. There is no requirement to measure the tin plated copper because it is for aesthetic reasons only.
[g]	In some countries, the cross-sectional area may be reduced to ≥ 1 800 cm^2 and the thickness to ≥ 0,8 mm.
[h]	In some countries, the cross-sectional area may be reduced to 125 mm^2.
[i]	The cross-sectional area of stranded conductors is determined by the resistance of the conductor according to IEC 60228.
[j]	Chromium ≥ 16 %, nickel ≥ 5 %, molybdenum ≥ 2 %, carbon ≤ 0,08 %.
[k]	Shall be embedded in concrete for a minimum depth of 50 mm.
[l]	Due to higher corrosion rate for solid tape earth conductors, it is recommended to use copper-coated steel with a coating of 250 µm.

5 Tests

5.1 General conditions for tests

Tests according to this document are type tests. These tests are of such a nature that, after they have been performed, they need not be repeated unless changes are made to the materials, design or type of manufacturing process, which might change the performance characteristics of the product.

– Unless otherwise specified, all tests are carried out on new specimens.
– Unless otherwise specified, three specimens are subjected to the tests and the requirements are satisfied if all the tests are met.
– If only one of the specimens does not satisfy a test, due to an assembly or a manufacturing fault, that test and any preceding one which may have influenced the results of the test shall be repeated and also the tests that follow shall be carried out in the required sequence on another full set of specimens, all of which shall comply with the requirements.

The applicant, when submitting a set of specimens, may also submit an additional set of specimens, which may be necessary should one specimen fail. The testing laboratory will then, without further request, test the additional set of specimens and will reject it only if a further failure occurs. If the additional set of specimens is not submitted at the same time, the failure of one specimen will entail rejection.

5.2 Air termination conductors, air-termination rods, earth lead-in rods, earth conductors and earth plates

5.2.1 General

Air-termination conductors, air-termination rods, earth lead-in rods, down-conductors and earth conductors and earth plates shall be subjected to the following tests to confirm their suitability for the intended application.

Earth electrodes shall be subjected to the tests according to Annex D.

Air-termination conductors, air-termination rods, earth lead-in rods, earth conductors and earth plates shall be subjected to the tests according to Annex E.

5.2.2 Test for thickness of coating

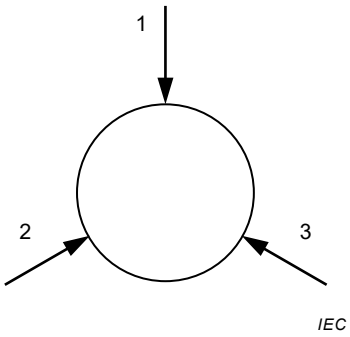
5.2.2.1 General conditions for tests

Specimens each approximately 500 mm long shall be subjected to a test for copper or zinc coating thickness.

The copper or the zinc coating on a steel core specimen shall be measured using a magnetic method instrument complying with ISO 2178. Zinc coating can also be measured in accordance with ISO 1460 or ISO 1461. When this test method is used, the length of specimens can be reduced.

For round specimens, measurements should be taken at three positions along the length of the specimen: one 50 mm from the top, one 50 mm from the bottom and one at the midpoint.

At each position detailed above, two additional measurements should be taken around the circumference of the specimen at approximately 120° separation (see keys 1, 2, 3 in Figure 1).



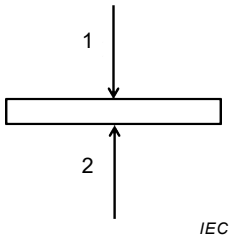
Key

1, 2, 3 position of measurements

Figure 1 – Coating measurements around the circumference of a round conductor

For flat specimens, measurements should be taken from both sides at three positions along the length of the material. All three measurements shall be taken in the middle of the width of the material in the following locations:

50 mm from the top, 50 mm from the bottom and at the mid-point (see keys 1, 2 in Figure 2).



Key

1, 2 position of measurements

Figure 2 – Coating measurements of a plate conductor

There is no requirement to measure the thickness of the tin plating on copper because it is applied for aesthetic reasons only.

5.2.2.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 1 for air-termination conductors, air-termination rods, earth lead-in rods, down-conductors and Table 3 for earth conductors and earth plates. Additionally, the zinc galvanizing coating shall be smooth, continuous and free from flux stains with a minimum weight of 350 g/m^2 for solid round specimens and 500 g/m^2 for solid tape specimens.

5.2.3 Bend and adhesion test for coated conductors

5.2.3.1 General conditions for tests

Coated conductors each approximately 500 mm long shall be bent to an angle of $(90\ ^{+5}_{0})°$:

- for a round conductor, the bending radius shall be equal to 5 times (± 1 mm) its diameter;
- for a tape conductor, the bending radius shall be equal to 5 times (± 1 mm) its thickness.

5.2.3.2 Acceptance criteria

After the test, the specimens shall show no sharp edges, cracks or peeling when inspected with normal or corrected vision without magnification.

5.2.4 Environmental test for coated materials

5.2.4.1 General conditions for tests

The electrical resistance over a length of 100 mm shall be measured prior to the environmental test on all specimens used in and complying with 5.2.3, air-termination rods, earth lead-in rods, down-conductors and earth electrodes.

Upon completion of the above measurements all specimens shall be subjected to an environmental test as specified in Clause A.2, followed by a humid sulphurous atmosphere treatment as specified in Clause A.3.

5.2.4.2 Acceptance criteria

After the test, the specimens shall satisfy the following criteria:

a) The electrical resistance over a 100 mm length measured after the tests shall not exceed the resistance value measured before the tests by more than 50 %.
b) The base metal shall not exhibit any visual corrosive deterioration when inspected with normal or corrected vision without magnification.

5.2.5 Electrical resistivity test

5.2.5.1 General conditions for tests

A sample length, approximately 1,2 m long, should be used for the test. The resistance measurement should be taken over a 1 m (± 1 mm) distance, using a micro-ohmmeter, and the reading corrected to a temperature of 20 °C using appropriate correction factors.

The resistivity of the sample length can then be found by the formula:

$$\rho = \frac{R \times a}{\ell} \ (\Omega m)$$

where:

R is the resistance in Ω over a 1 m length;

a is the cross-sectional area (m^2);

ℓ is the unit length (m).

The dimensions of the sample shall be measured at three equally distributed points along a 1 m length and its cross-sectional area should be within a ±5 % tolerance.

5.2.5.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 2.

5.2.6 Tensile test

5.2.6.1 General conditions for tests

For the methodology of carrying out tensile strength (R_m), see ISO 6892-1. For the testing of air-termination conductors, air-termination rods, earth lead-in rods, down conductors, earth conductors and earth plates, the test specimen shall be tested according to ISO 6892-1.

5.2.6.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 2.

5.3 Earth rods

5.3.1 General

Earth rods shall be subjected to the tests according to Annex F.

5.3.2 Test for thickness of coating on earth rods

5.3.2.1 General conditions for tests

Test conditions are described in 5.2.2.1.

5.3.2.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 3.

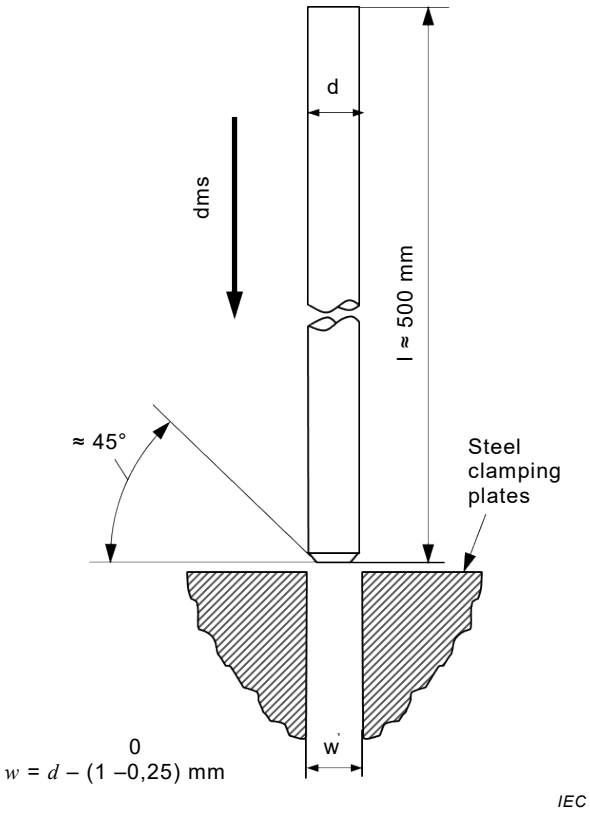
Additionally, for the zinc coated earth rods, the coating shall be smooth, continuous and free from flux stains with a minimum weight of 350 g/m^2.

5.3.3 Adhesion test

5.3.3.1 General conditions for tests

The copper-coated steel earth rod specimens, used in, and complying with, 5.3.2, with one end cut to an angle of approximately 45° shall be subjected to the following test.

The specimens are driven through two steel clamping plates or the jaws of a vice set ($1\ ^{0,00}_{-0,25}$) mm less than the diameter of the specimens, so as to shear off sufficient metal to expose the bond between the coating and the parent metal. A test arrangement for the adhesion test is shown in Figure 3.



Key

dms direction of mechanical stress

Figure 3 – Typical test arrangement for adhesion test

5.3.3.2 Acceptance criteria

After the test, the coating of the specimens shall show adherence to the parent metal. Separation of the copper from the steel is not acceptable.

5.3.4 Bend test

5.3.4.1 General conditions for tests

The copper coated steel earth rod specimens used in and complying with 5.3.3 shall be bent through a radius equal to 5 times (±1 mm) of their diameter to an angle of (90 ± 5)°.

5.3.4.2 Acceptance criteria

After the test, the specimens shall satisfy the following criteria:

a) the specimens shall not show sharp edges, cracks or peeling around the bending area when inspected with normal or corrected vision without magnification;

b) the base metal shall not exhibit any visual corrosive deterioration when inspected with normal or corrected vision without magnification.

5.3.5 Environmental test for coated earth rods

5.3.5.1 General conditions for tests

The copper coated steel earth rods specimens used in and complying with 5.3.4 and the zinc coated earth rods specimens used and complying with 5.3.2 shall be subjected to an environmental test as specified in Clause A.2 followed by a humid sulphurous atmosphere treatment as specified in Clause A.3.

5.3.5.2 Acceptance criteria

After the test, the specimens shall satisfy the following criteria.

a) The specimens shall be of good visual appearance and have no rough edges or burrs throughout their length.

b) The base metal of the specimens shall not exhibit any visual corrosive deterioration when inspected with normal or corrected vision without magnification. 100 mm from both ends of the specimens are excluded from inspection.

c) The electrical resistance over a 100 mm length measured after the tests shall not exceed the resistance value measured before the tests by more than 50 %.

White rust is not considered as corrosive deterioration.

5.3.6 Electrical resistivity test

5.3.6.1 General conditions for tests

A sample length of earth rod, approximately 1,2 m long should be used for the test. The resistance measurement should be taken over a 1 m (±1 mm) distance, using a micro-ohmmeter, and the reading corrected to a temperature of 20 °C, using appropriate correction factors.

The resistivity of the sample length of the earth rod can then be calculated using the formula:

$$\rho = \frac{R \times a}{\ell} \text{ (μΩm)}$$

where

R is the resistance in micro-ohms (μΩ) over a 1 m length;

a is the cross-sectional area (m^2);

ℓ is the unit length (m),

The dimensions of the earth rod should be measured at three equally distributed points along a 1 m length and its cross-sectional area should be within a ±5 % tolerance.

5.3.6.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 2.

5.3.7 Tensile strength test

5.3.7.1 General conditions for tests

For the methodology of carrying out tensile strength (R_m), see ISO 6892-1.

5.3.7.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 2.

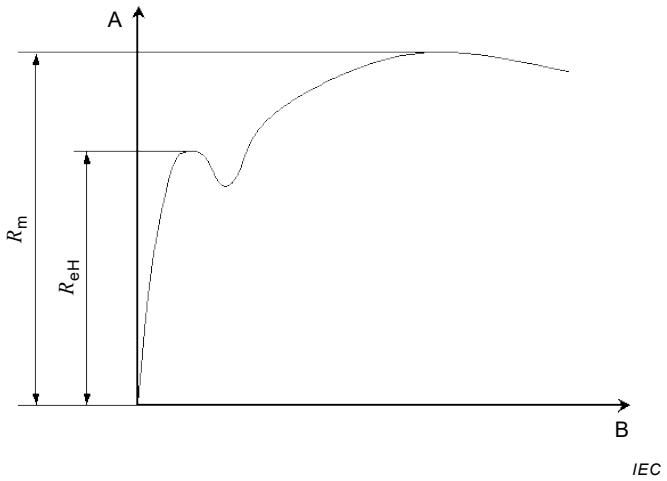
5.3.8 Test for yield/tensile ratio

5.3.8.1 General conditions for tests

The yield/tensile ratio is determined by ascertaining the upper yield strength (R_{eH}) and dividing the result by the tensile strength (R_m), (see Figure 4).

5.3.8.2 Acceptance criteria

The specimens are deemed to have passed the tests if they comply with the requirements of Table 2.



Key

A tensile strength

B elongation

Figure 4 – Definitions of upper yield strength R_{eH} and tensile strength R_m

5.4 Couplers for earth rods

5.4.1 General

Couplers for earth rods shall be subjected to the following tests to confirm their suitability for the intended application.

5.4.2 Compression test by mechanical means

5.4.2.1 General conditions for tests

Each specimen shall be assembled from two sections of earth rod, each 500 mm long. The tests shall be performed with suitable driving heads and driving tools following the manufacturer's or supplier's instructions.

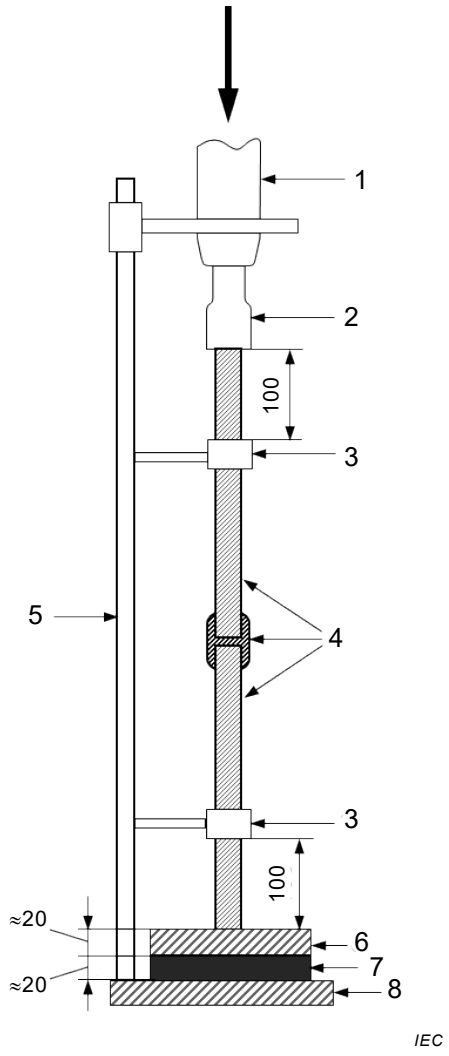
The top of the specimens shall be impacted with a vibration hammer defined with the following parameters for a duration of 1 min:

– percussion rate (2 000 ± 1 000) min^{-1};

– single stroke impact energy (50 ± 10) Nm.

A typical test arrangement is shown in Figure 5.

Dimensions in mm



Key

1 vibration hammer
2 driving head
3 bearing
4 specimen
5 test holder
6 metal plate approx. 200 mm × 200 mm × 20 mm
7 rubber mat approx. 200 mm × 200 mm × 20 mm, hardness 80 – 85 shore
8 metal base

Figure 5 – Typical test arrangement for the compression test by mechanical means

5.4.2.2 Acceptance criteria

The specimens are deemed to have passed the tests if their couplers are not broken or do not show any crack to normal or corrected vision without magnification.

5.4.3 Environmental test

5.4.3.1 General conditions for tests

Specimen assemblies used in and complying with 5.4.2 shall be subjected to an environmental test as specified in Annex A.

The manufacturer or supplier shall provide proof of the copper content of any part of the assembly made from an alloy copper.

5.4.3.2 Acceptance criteria

The specimens are deemed to have passed the tests if:

a) the specimen assembly remains intact;
b) the base metal of the specimens shall not exhibit any visual corrosive deterioration when inspected with normal or corrected vision without magnification. 100 mm from both ends of the specimens are excluded from inspection.

White rust is not considered as corrosive deterioration.

5.4.4 Electrical test

Specimen assemblies used in and complying with 5.4.3 shall be subjected, without cleaning, to an electrical test according to Clause B.1.

5.4.5 Tensile strength test

5.4.5.1 General conditions for tests

Specimen assemblies, used in and complying with 5.4.4, shall be subjected to a mechanical tensile force of 1 000 N (±10 N).

5.4.5.2 Acceptance criteria

After the tests as per 5.4.4 and 5.4.5, the specimens shall satisfy the criteria according to Clause B.2.

5.5 Marking test

5.5.1 General conditions for tests

The marking is checked by inspection and by rubbing it by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with white spirit/mineral spirit.

Marking made by moulding, pressing or engraving is not subjected to this test.

5.5.2 Acceptance criteria

The specimen is deemed to have passed the test if the marking remains legible.

6 Electromagnetic compatibility (EMC)

Products covered by this document are, in normal use, passive in respect of electromagnetic influences (emission and immunity).

7 Structure and content of the test report

7.1 General

The purpose of Clause 7 is to provide general requirements for laboratory test reports and to promote clear, complete reporting procedures for laboratories submitting test reports.

The results of each test carried out by the laboratory shall be reported accurately, clearly, unambiguously and objectively, in accordance with any instructions in the test methods. The results shall be given in a test report and shall include all the information necessary for the interpretation of the test results and all information required by the method used.

Particular care and attention shall be paid to the arrangement of the report, especially with regard to presentation of the test data and ease of assimilation by the reader. The format shall be carefully and specifically designed for each type of test carried out, but the headings shall be standardized as indicated below.

The structure of each report shall include at least information according to 7.2 to 7.10.

7.2 Report identification

The following information shall be included:

a) a title or subject of the report;

b) name, address, e-mail and telephone number of the test laboratory;

c) name, address, e-mail and telephone number of the sub test laboratory where the test was carried out if different from the company which has been assigned to perform the test;

d) unique identification number (or serial number) of the test report;

e) name and address of the vendor;

f) report shall be paginated and the total number of pages indicated;

g) date of issue of the report;

h) date(s) of performance of the test(s);

i) signature and title, or an equivalent identification of the person(s) authorized to sign for the testing laboratory for the content of the report;

j) signature and title of person(s) conducting the tests;

k) "This type test report may not be reproduced other than in full, except with the prior written approval of the issuing testing laboratory. This type test report only covers the samples submitted for test and does not produce evidence of the quality for series production."

7.3 Specimen description

a) Sample description.

b) Detailed description and unambiguous identification of the test sample and/or test assembly.

c) Characterization and condition of the test sample and/or test assembly.

d) Sampling procedure, where relevant.

e) Date of receipt of the test items.

f) Photographs, drawings or any other visual documentation, if available.

7.4 Conductor

a) Conductor material.

b) Cross-sectional area, dimensions and shape. It is recommended that the actual cross-sectional area also be given.

7.5 Standards and references

a) Identification of the test standard used and the date of issue of the standard.

b) Other relevant documentation with the documentation date.

7.6 Test procedure

a) Description of the test procedure.

b) Justification for any deviations from, additions to or exclusions from the referenced standard.

c) Any other information relevant to a specific test, such as environmental conditions.

d) Configuration of testing assembly.

e) Location of the arrangement in the testing area and measuring techniques.

7.7 Testing equipment, description

Description of equipment used for every test conducted, e.g. generator, conditioning/ageing device.

7.8 Measuring instruments description

Characteristics and calibration date of all instruments used for measuring the values specified in the standard, e.g. radius gauge shunts, tensile testing machine, extensometer, ohmmeter, torque meter, thickness caliper gauge, etc.

7.9 Results and parameters recorded

a) Required passing criteria for each test, defined by the standard.

b) Relevant observed or derived results of the tests.

All results shall be presented by means of tables, graphs, drawings, photographs or other documentation of visual observations as appropriate.

7.10 Statement of pass/fail

Statement that the specimen passed or failed the tests shall be reported. If the specimen has failed, a description of the failure is necessary.

Annex A
(normative)

Environmental test for conductors, air-termination rods and earth lead-in rods

A.1 General

The conditioning/ageing test consists of a salt mist treatment as specified in Clause A.2 followed by a humid sulphurous atmosphere treatment as specified in Clause A.3 and an additional ammonia atmosphere treatment as specified in Clause A.4 for specimens where any component part is made of copper alloy with a copper content less than 80 %.

The manufacturer or supplier shall provide proof of the copper content of any part of the assembly made from an alloy of copper.

A.2 Salt mist treatment

The salt mist treatment shall be in accordance with IEC 60068-2-52:1996, except for Clauses 7, 10 and 11 which are not applicable. The test is carried out using severity (2).

If the salt mist chamber can maintain the temperature conditions as specified in 9.3 of IEC 60068-2-52:1996, and a relative humidity of not less than 90 %, then the specimen may remain in chamber for the humidity storage period.

A.3 Humid sulphurous atmosphere treatment

The humid sulphurous atmosphere treatment shall be in accordance with ISO 6988:1985 with seven cycles with a concentration in volume of sulphur dioxide of $667 \times 10^{-6} \pm 25 \times 10^{-6}$, except for Clauses 9 and 10 which are not applicable.

Each cycle which has duration of 24 h is composed of a heating period of 8 h at a temperature of 40 °C ± 3 °C in the humid saturated atmosphere which is followed by a rest period of 16 h. After that, the humid sulphurous atmosphere is replaced.

If the test chamber maintains the temperature conditions as specified in 6.5.2 of ISO 6988:1985, then the specimen may remain in the chamber for the storage period.

A.4 Ammonia atmosphere treatment

The ammonia atmosphere treatment shall be in accordance with ISO 6957:1988 for a moderate atmosphere with the pH value 10, except for Clauses 8.4 and 9, which are not applicable.

Annex B
(normative)

Electrical test

B.1 General

Each specimen shall be stressed three times by a test current as given in Table B.1. The time interval between individual shots shall allow the arrangement of the specimen to cool down to approximately ambient temperature.

The impulse discharge current passing through the device under test is defined by the peak value I_{imp}, and the specific energy W/R. The impulse current shall show no reversal and reach I_{imp} within 50 µs. The transfer of the specific energy W/R shall be dissipated within 5 ms.

Table B.1 – Lightning impulse current (I_{imp}) parameters

I_{imp} kA −10/+10%	W/R kJ/Ω −10/+45 %
100	2 500
NOTE The parameters specified above can typically be achieved by an exponential decaying current in the range of 350 µs according to IEC 62305-1.	

B.2 Acceptance criteria

The specimens are deemed to have passed the tests if:

a) the couplers are not broken or do not show any crack to normal or corrected vision without magnification;

b) the contact resistance measured with a source of at least 10 A, as close as possible to the coupler, is equal to or less than 1 mΩ. In the case where the earth rod joint or the earth rods are of stainless steel, a value of equal to or less than 3 mΩ is allowed;

c) the specimen assembly still remains intact.

Annex C
(normative)

Requirements and tests for conductors

Table C.1 is a summary of requirements for cross-sectional area, mechanical and electrical characteristics as well as tests to be applied for air-termination conductors, air-termination rods, earth lead-in rods and down-conductors according to Table 1 and Table 2.

Table C.1 – Summary of requirements for various elements tested according to Table 1 and Table 2

Material	Configuration	Cross-sectional area, mechanical and electrical characteristics, tests to be applied
Copper Tin plated copper	Solid tape Solid round Stranded	Table 1 / Table 2 Tests: Footnotes of Table 1, 5.2.5 / 5.2.6 / 5.5
Aluminium	Solid tape Solid round Stranded	Table 1 / Table 2 Tests: Footnotes of Table 1, 5.2.5 / 5.2.6 /5.5
Copper coated aluminium alloy	Solid round	Table 1 / Table 2 Tests: Footnotes of Table 1 and Table 2, 5.2.2 / 5.2.3 / 5.2.4 / 5.2.5 / 5.2.6 / 5.5
Aluminium alloy	Solid tape Solid round Stranded	Table 1 / Table 2 Tests: Footnotes of Table 1, 5.2.5 / 5.2.6 / 5.5
Hot dipped galvanized steel	Solid tape Solid round Stranded	Table 1 / Table 2 Tests: Footnotes of Table 1, 5.2.2 / 5.2.3 / 5.2.4 / 5.2.5 / 5.2.6 / 5.5
Copper coated steel	Solid round Solid tape	Table 1 / Table 2 Tests: Footnotes of Table 1 and Table 2, 5.2.2 / 5.2.3 / 5.2.4 / 5.2.5 / 5.2.6 / 5.5
Stainless steel	Solid tape Solid round Stranded	Table 1 / Table 2 Tests: Footnotes of Table 1, 5.2.5 / 5.2.6 / 5.5

Annex D
(normative)

Requirements and tests for earth electrodes

Table D.1 is a summary of requirements for dimensions, mechanical and electrical characteristics as well as tests to be applied for earth electrodes according to Table 2 and Table 3.

Table D.1 – Summary of requirements for various elements tested according to Table 2 and Table 3

Material	Configuration	Application	Dimensions, mechanical electrical characteristics, tests to be applied
Copper	Solid round Solid round Solid tape Pipe Solid plate Lattice plate Stranded	Earth conductor Earth rod Earth conductor Earth rod Earth plate Earth plate Earth conductor	Table 2 / Table 3 Tests: Footnotes of Table 3, 5.2.5 / 5.2.6 / 5.3.6 / 5.3.7 / 5.5
Galvanized steel	Solid round Solid tape Solid plate Lattice plate Stranded	Earth conductor Earth conductor Earth plate Earth plate Earth conductor	Table 2 / Table 3 Tests: Footnotes of Table 3, 5.2.2 / 5.2.3 / 5.2.4 / 5.2.5 / 5.2.6 / 5.5
Galvanized steel	Solid round Pipe Profile	Earth rod Earth rod Earth rod	Table 2 / Table 3 Tests: Footnotes of Table 3, 5.3.2 / 5.3.5 / 5.3.6 / 5.3.7 /5.5
Bare steel	Solid round Solid tape	Earth conductor Earth conductor	Table 2 / Table 3 Tests: Footnotes of Table 3, 5.2.5 / 5.2.6 / 5.5
Copper coated steel	Solid round	Earth rod	Table 2 / Table 3 Tests: Footnotes of Table 2 and Table 3, 5.3.2 / 5.3.3 / 5.3.4 / 5.3.5 / 5.3.6 / 5.3.7 / 5.3.8 / 5.5
Copper coated steel	Solid round Solid tape	Earth conductor Earth conductor	Table 2 / Table 3 Tests: Footnotes of Table 2 and Table 3, 5.2.2 / 5.2.3 / 5.2.4 / 5.2.5 / 5.2.6 / 5.5
Stainless steel	Solid round Solid round Solid tape	Earth conductor Earth rod Earth conductor	Table 2 / Table 3 Tests: Footnotes of Table 3, 5.2.5 / 5.2.6 / 5.3.6 / 5.3.7 / 5.5
Couplers for earth rods	_____	_____	Tests: Footnotes of Table 3, 5.4.2 / 5.4.3 / 5.4.4 / 5.4.5 / 5.5. In addition tests according to IEC 62561-1:2017, 6.3

Annex E
(normative)

Flow chart of tests for air-termination conductors, air-termination rods, earth lead-in rods, down-conductors, earth conductors and earth plates, see Figure E.1

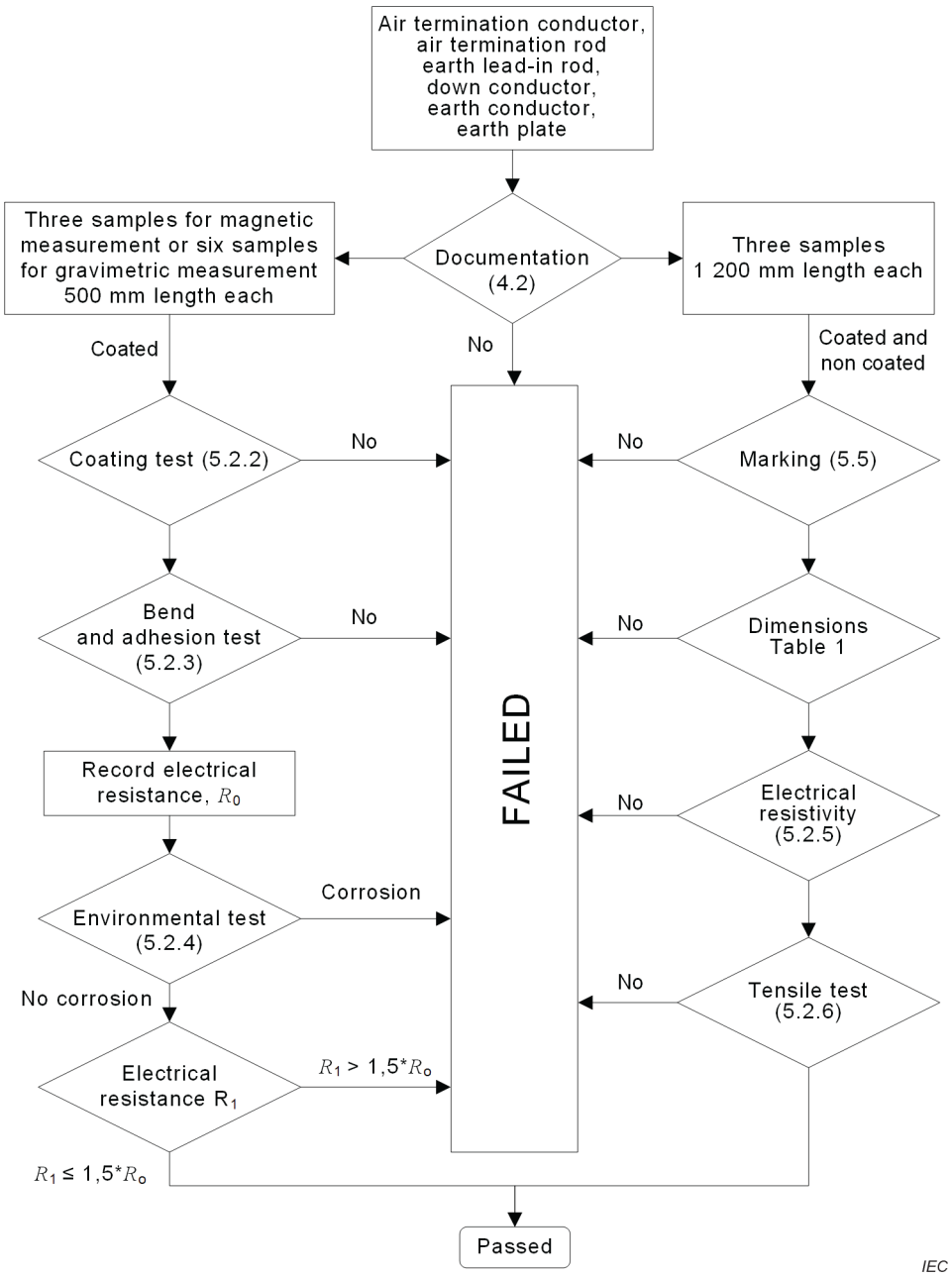


Figure E.1 – Flow chart of tests for air-termination conductors, air-termination rods, earth lead-in rods, down-conductors, earth conductors and earth plates

Annex F
(normative)

Flow chart of tests for earth rods

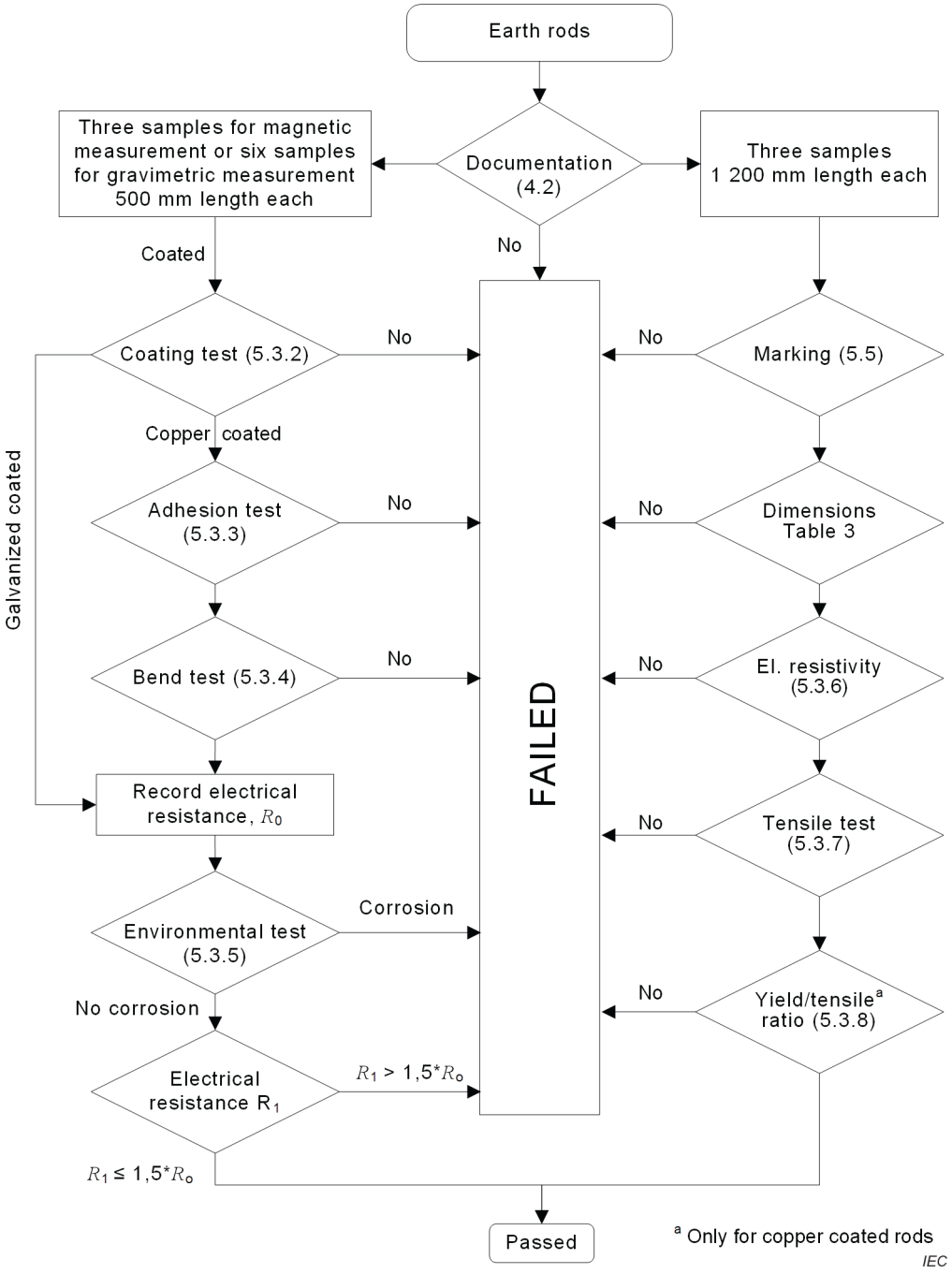


Figure F.1 – Flow chart of tests for earth rods

Annex G
(normative)

Flow chart of tests of couplers for earth rods

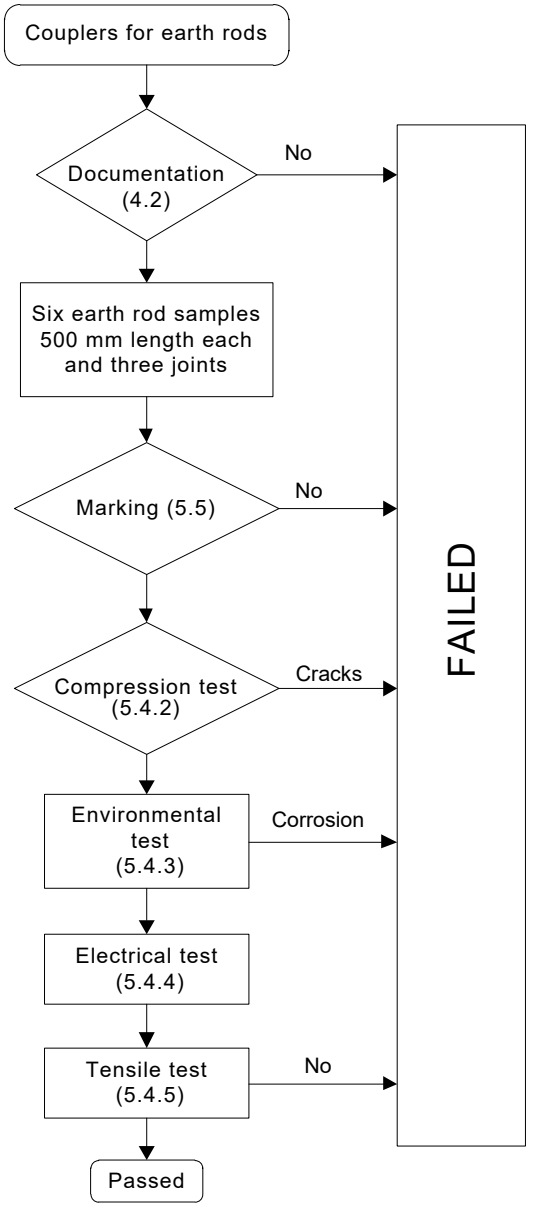


Figure G.1 – Flow chart of tests of couplers for earth rods

Bibliography

IEC 60050-614, *International Electrotechnical Vocabulary – Part 604: Generation, transmission and distribution of electricity – Operation*

IEC 60468:1974, *Method of measurement of resistivity of metallic materials*

IEC 62305-1, *Protection against lightning – Part 1: General principles*

ISO 1460, *Metallic coatings – Hot dip galvanized coatings on ferrous materials – Gravimetric determination of the mass per unit area*

ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

EN 50164-2*, Lightning Protection Components (LPC) – Part 2: Requirements for conductors and earth electrodes*

NATIONAL ANNEX A

(*National Foreword*)

A-1 BIS CERTIFICATION MARKING

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product(s) may be marked with the Standard Mark.

A-2 Clause **5.2.4.2**, **5.3.5.2** and **5.4.3.2**, add the following note:

NOTE — White rust, patina and surface oxidation are not considered to be corrosive deterioration.

A-3 Replace Table 3 with the following:

Table 3 Material, Configuration and Minimum Size of Commonly Used Earth Electrodes, Embedded in Soil or Concrete Used to Prevent Corrosion and Provide Mechanical Strength

Sl No.	Material and Surface	Shape	Diameter	Cross Sectional Area	Thickness	Weight of Coating	Thickness of Coating/ Sheating
			mm	mm^2	mm	g/m^2	μm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Steel embedded in concrete (bare, hot galvanized, electro-deposited copper or stainless)	Round wire	10				
		Solid tape or strip		75	3		
ii)	Steel hot-dip galvanized [c]	Strip[b] or shaped strip/plate – solid plate – Lattice plate		90	3	500	63
		Round rod installed vertically	16			350	45
		Round wire installed horizontally	10			350	45
		Pipe	25		2	350	45
		Stranded (embedded in concrete)		70			
		Cross profile installed vertically		290	3		

Sl No.	Material and Surface	Shape	Diameter	Cross Sectional Area	Thickness	Weight of Coating	Thickness of Coating/ Sheating
			mm	mm^2	mm	g/m^2	μm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
iii)	Steel with electro-deposited copper coating	Round rod installed vertically	14				250[e]
		Round wire installed horizontally	10				70
		Strip installed horizontally		90	3		70
iv)	Stainless steel [a]	Strip[b] or shaped strip/plate		90	3		
		Round rod/ wire installed vertically	16				
		Round wire installed horizontally	10				
		Pipe	25		2		
		Equipotential earth grid (600 mm × 600 mm)			4		
v)	Copper[f]/Tin plated copper [g]	Strip		50	2		
		Round wire installed horizontally		50			
		Round rod installed vertically	15				
		Stranded wire	1.7 for individual strands of wire	50			
		Pipe[e]	20		2		
		Solid plate (500 mm × 500 mm)			2		
		Lattice plate (600 mm × 600 mm)[h]			2		

Sl No.	Material and Surface	Shape	Diameter	Cross Sectional Area	Thickness	Weight of Coating	Thickness of Coating/ Sheating
			mm	mm^2	mm	g/m^2	μm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Equipotential earth grid (600 mm × 600 mm)			4		

[a] Chromium > / =16 %, Nickel > / = 5 %, Molybdenum > / = 2 %, carbon < / = 0.08 %

[b] As rolled strip or slit strip with round edges.

[c] The coating must be smooth, continuous and free from flux stains.

[d] Where experience shows that the risk of corrosion and mechanical damage is extremely low, 16 mm^2 can be used

[e] This thickness is provided to withstand mechanical damage of copper coating during the installation process. It may be reduced to not less than 100 μm where special precautions to avoid mechanical damage of copper during the installation process (for example, drilling holes or special protective tips) are taken according to the manufacturers instruction.

[f] An earth electrode of copper material buried in the soil shall not be used in contact with the steel members, steel pipes and steel piles related to the building structures because of corrosion considerations.

[g] Hot dipped or electroplated; minimum thickness coating of 1 μm. There is no requirement to measure the tin plated copper because it is for aesthetic reasons only.

[h] 25 mm × 2 mm section for tape or 8 mm diameter for round conductor.

(*Continued from second cover*)

The Committee has reviewed the provisions of the following international standards referred in this adopted standard and decided that they are acceptable for use in conjunction with this standard.

International Standard	*Title*
ISO 2178	Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method
ISO 6988 : 1985	Metallic and other non organic coatings — Sulphur dioxide test with general condensation of moisture
IEC 60068-2-52 : 1996	Environmental testing — Part 2-52: Tests — Test Kb: Salt mist, cyclic (sodium, chloride solution)
IEC 62561-1 : 2012	Lightning protection system components (LPSC) — Part 1: Requirements for connection components

Only the English language text has been retained while adopting it in this Indian Standard, and as such, the page number given here are not the same as in the IEC publication.

India specific changes have been made to the adopted IEC 62561-2 as outlined in National Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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Review of Indian Standards

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This Indian Standard has been developed from Doc No.: ETD 20 (24499).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi