

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Lightning protection system components (LPSC) -
Part 2: Requirements for conductors and earth electrodes**

**Composants des systèmes de protection contre la foudre (CSPF) -
Partie 2: Exigences pour les conducteurs et les électrodes de terre**



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**Lightning protection system components (LPSC) -
Part 2: Requirements for conductors and earth electrodes**

FOREWORD

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IEC 62561-2 has been prepared by IEC technical committee 81: Lightning protection. It is an International Standard.

This third edition cancels and replaces the second edition published in 2018. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) definitions of new conductor types mentioned in this document have been added;
- b) the document has been updated in line with IEC 60068-2-52:2017 on salt mist treatment;
- c) the document has been updated in line with ISO 22479:2019 on humid sulphurous atmosphere treatment;
- d) a new normative Annex H for material, configuration and cross-sectional area test has been introduced;

- e) a new normative Annex I for applicability of previous tests has been introduced.
- f) equipotential earth grid has been introduced.

The text of this International Standard is based on the following documents:

Draft	Report on voting
81/794/FDIS	81/800/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62561 series, published under the general title *Lightning protection system components (LPSC)*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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 the IEC 62305 series.

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1 Scope

This part 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, and
- metallic earth electrodes that form part of the earth-termination system.

NOTE 1 Additional requirements can be necessary for conductors and earth electrodes intended for use in hazardous environments.

NOTE 2 In CENELEC member countries, testing requirements of components for explosive atmospheres are specified in CLC/TS 50703-2.

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 60068-2-52:2017, *Environmental testing – Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60228, *Conductors of insulated cables*

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

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

ISO 1461:2022, *Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods*

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 22479:2019, *Corrosion of metals and alloys – Sulphur dioxide test in a humid atmosphere (fixed gas method)*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1**air-termination system**

part of an external lightning protection system (LPS) intended to intercept lightning flashes

EXAMPLE Air-termination rods, air-termination conductors and catenary wires.

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 of the lightning protection system (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 of the lightning protection system (LPS)

3.4**catenary wire**

part of the air-termination system consisting of an overhead wire for intercepting and conducting flashes to the down-conductor and earthing system of the lightning protection system (LPS)

3.5**copper coated steel**

steel that is manufactured through a continuous electro-plating process of copper over steel core, resulting in a permanent molecular bond between the two materials

3.6**down-conductor system**

part of an external LPS intended to conduct lightning current between the air-termination system and the earth-termination system

3.7**down-conductor**

part of the down-conductor system intended to conduct lightning current from the air-termination system to the earth-termination system of the LPS

3.8**earth lead-in conductor**

conductor installed between the down-conductor or test joint and the earth electrode intended to provide connection of the earth electrode with the test joint and can be partially buried in soil or partially embedded in concrete and partially placed in air

Note 1 to entry: An earth lead-in conductor can also provide mechanical protection against accidental stresses to the down conductor system.

3.9**earth-termination system**

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

3.10**earth electrode****ground electrode, USA**

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

EXAMPLE Tape, wire, earth plate, lattice earth plate, meshed earth plate, solid earth rod, tubular earth rod.

3.11

earth conductor

ground conductor, USA

earth electrode consisting of a conductor buried in the ground

3.12

earth plate

metallic earth electrode consisting of a solid plate buried in the ground or a lattice plate buried in the ground

3.13

earth rod

earth electrode consisting of a solid or tubular metal rod driven into the ground

3.14

earth-rod-driving-head

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

3.15

couplers for earth rods

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

Note 1 to entry: Male and female or plug and socket connections of earth rods are also defined as couplers.

3.16

hot dipped galvanized steel

steel coated by a process which alloys with the surface of the base metal when immersing the metal in a bath of molten zinc at a temperature of around 450 °C (842 °F)

3.17

type test

test required to be made before supplying a type of material covered by IEC 62561-2 on a general commercial basis, in order to demonstrate satisfactory performance characteristics to meet the intended application

3.18

stranded conductor

conductor consisting of a number of individual wires or strands all or some of which generally have a helical form

Note 1 to entry: The cross-section of a stranded conductor can be circular or otherwise shaped.

Note 2 to entry: The term "strand" is also used to designate a single wire.

[SOURCE: IEC 60050-461:2008, 461-01-07]

3.19

rope lay conductor

conductor composed of a central core surrounded by one or more layers of helically laid groups of wires

3.20

smooth weave stranded conductor

conductor constructed of multi-strand soft drawn wire, interwoven in a basket weave configuration so as to avoid fraying in application

3.21

equipotential earth grid

mat consisting of an array of conductor intended for potential equalization

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 for tests are given in Annex C and Annex D and the sequence of tests in Annex E, Annex F and Annex G.

4.2 Documentation and installation instructions

The manufacturer or supplier of the conductors and rods shall provide adequate information in their documentation or installation instructions, for example by drawings or photographs, to ensure that the installer of the conductors and rods can select and install the materials in accordance with IEC 62305-3 and IEC 62305-4.

To facilitate the installer, where it is necessary, the manufacturer or supplier may recommend the proper tools for their installation and instruments in order to perform specified measurements by IEC 62305 (all parts). In addition, where it is necessary to recommend a training for the safe selection and use of LPS components.

Documentation and installation instructions content shall not be in contradiction with the content of the relative testing report of each component.

Instructions are checked as per their completeness in accordance with 5.6.

4.3 Air-termination conductors, air-termination rods, catenary wires 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 cross-sections are met.

If dimensions, materials or configurations other than those shown in Table 1 and Table 2 are applied, it is possible to use such after a successful electrical test with lightning current as per Table B.1, class H, as well as all the tests required by Clause 5.

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

Compliance is checked by inspection and by the tests as follows:

- a) for coated specimens, according to 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.2.7, 5.2.8 and 5.5;
- b) for uncoated specimens, according to 5.2.6, 5.2.7, 5.2.8 and 5.5.

A summary of requirements for the cross-sectional area, mechanical and electrical characteristics as well as tests is given in Annex C. The corresponding flow chart is shown in Annex E.

Table 1 – Material, configuration and cross-sectional area of air-termination conductors, air-termination rods, catenary wires 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 k}	≥ 50	1,14 mm up to 1,7 mm strand diameter
	Rod solid round ^g	≥ 176	15 mm diameter
	Tubular rod	≥ 100	2 mm wall thickness
	Rope lay conductor and smooth weave stranded conductor	≥ 50 ⁱ	1,04 mm strand diameter
Aluminium	Solid tape	≥ 70	3 mm thickness
	Solid round	≥ 50	8 mm diameter
	Stranded ^{f k}	≥ 50	1,63 mm strand diameter
	Rope lay conductor and smooth weave stranded conductor	≥ 50 ^j	2,08 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 k}	≥ 50	1,7 mm strand diameter
	Rod solid round ^g	≥ 176	15 mm diameter
	Tubular rod	≥ 100	2 mm wall thickness
Hot dipped galvanized steel	Solid tape	≥ 50	2,5 mm thickness
	Solid round	≥ 50	8 mm diameter
	Stranded	≥ 50	1,7 mm strand diameter
	Rod solid round ^g	≥ 176	15 mm diameter
	Tubular rod	≥ 100	2 mm wall thickness
	Solid round	≥ 50	8 mm diameter

Material	Configuration	Cross-sectional area ^a mm ²	Recommended dimensions
Copper coated steel ^e	Solid tape	≥ 50	2,5 mm thickness
Stainless steel ^c	Solid tape ^h	≥ 50	2 mm thickness
	Solid round ^h	≥ 50	8 mm diameter
	Stranded	≥ 70	1,7 mm strand diameter
	Rod Solid round ^g	≥ 176	15 mm diameter
	Tubular rod	≥ 100	2 mm wall thickness

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 plating on copper.

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

^d 50 mm² (8 mm in diameter) may be reduced to 28 mm² (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.

^f The cross-sectional area of stranded conductors is determined by the resistance of the conductor according to IEC 60228 (bare stranded wire should be calculated based upon its diameter by measurements taken with calipers or a micrometer).

^g Applicable for air-termination 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.

^h If thermal and mechanical considerations are important, then these values should be increased to 75 mm².

ⁱ In some countries (e.g. United States), the minimum cross area is increased to not less than 58 mm² for structures over 23 m in height, with a minimum strand diameter 1,04 mm.

^j In some countries (e.g. United States), the minimum cross area is increased to not less than 97 mm² for structures over 23 m in height, with a minimum strand diameter 2,08 mm.

^k In Japan, a strand diameter of 2 mm is used.

Table 2 – Material properties

Material	Maximum electrical resistivity µΩm	Tensile strength N/mm ² ^b
Copper	0,019	60 to 510
Aluminium	0,031	
Copper coated aluminium alloy	0,031	
Copper coated steel	0,258	
Aluminium alloy	0,041	
Hot dipped galvanized steel	0,258	
Aluminium coated steel stranded wire	0,075	
Copper coated steel stranded wire	0,064	
Hot dipped galvanized steel (earth rods)	0,258	350 to 770
Copper coated steel (earth rods) ^a	0,258	
Stainless steel	0,824	

^a Yield/tensile ratio 0,80 to 0,95.

^b Based on dimensions/tests of only core material of coated conductors.

4.4 Earth electrodes

4.4.1 General

The cross-sectional area of earth electrodes (earth conductors, earth plates, earth rods) and earth lead-in conductors partially in soil, their material and their configuration shall be in accordance with Table 3. Moreover, their mechanical and electrical characteristics shall be in accordance with Table 2.

Other configurations may be used if the relevant cross-sectional area is met.

If materials or configurations other than those shown in Table 2 and Table 3 are applied, it is possible to use such after a successful electrical test with lightning current as per Table B.1, class H, as well as all the tests required by Clause 5.

Coated earth electrodes shall be corrosion-resistant and the coating shall exhibit good adherence to the base material.

Table 3 – Material, configuration and cross-sectional area of earth lead-in conductors, earth electrodes and equipotential earth grids

Material	Configuration ^l	Cross-sectional area ^a		Surface area	Recommended dimensions
		Earth rod mm ²	Earth electrode/ earth lead in conductor mm ²	Earth plate ^p cm ²	
Copper, Tin plated copper ^f	Stranded		≥ 50 ⁱ		1,7 mm strand diameter ^q
	Solid round		≥ 50		8 mm diameter
	Solid tape		≥ 50		2 mm thick
	Solid round	≥ 176			15 mm diameter
	Tubular rod	≥ 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
	Equipotential earth grid ^o				Mesh size 250 mm to 500 mm, conductor 4 mm diameter
Hot dipped galvanized steel	Solid round		≥ 78		10 mm diameter
	Solid round	≥ 150 ^b			14 mm diameter
	Tubular rod	≥ 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
	Equipotential earth grid ^o				Mesh size 250-500 mm, conductor 4 mm diameter
	Profile	e			3 mm thick
	Stranded		≥ 70		1,7 mm strand diameter ^q