

INTERNATIONAL STANDARD

Wind turbines –
Part 24: Lightning protection

IEC 61400-24:2010
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Part 24: Lightning protection

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WIND TURBINES –

Part 24: Lightning protection

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This first edition replaces IEC/TR 61400-24, published in 2002. It constitutes a technical revision. It is restructured with a main normative part, while informative information is placed in annexes.

The text of this standard is based on the following documents:

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88/366/FDIS	88/369/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61400 series, under the general title: *Wind turbines*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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A bilingual version of this publication may be issued at a later date.

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WIND TURBINES –

Part 24: Lightning protection

1 Scope

This International Standard applies to lightning protection of wind turbine generators and wind power systems.

Normative references are made to generic standards for lightning protection, low-voltage systems and high-voltage systems for machinery and installations and electromagnetic compatibility (EMC).

This standard defines the lightning environment for wind turbines and application of the environment for risk assessment for the wind turbine. It defines requirements for protection of blades, other structural components and electrical and control systems against both direct and indirect effects of lightning. Test methods to validate compliance are recommended.

Guidance on the use of applicable lightning protection, industrial electrical and EMC standards including earthing is provided.

Guidance regarding personal safety is provided.

Guidelines for damage statistics and reporting are provided.

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.

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068 (all parts), *Environmental testing*

IEC 60071 (all parts), *Insulation Co-ordination*

IEC 60071-2:1996, *Insulation Co-ordination – Part 2: Application guide*

IEC 60099-4, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*

IEC 60099-5, *Surge arresters – Part 5: Selection and application recommendations*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60204-11, *Safety of machinery – Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*

IEC 60243-1, *Electrical strength of insulating materials – Test methods – Part 1: Tests at power frequencies*

IEC 60243-3, *Electric strength of solid insulating materials – Test methods – Part 3: Additional requirements for 1,2/50 μ s impulse tests*

IEC 60364-4-44, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*

IEC 60364-5-53:2001, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*
Amendment 1(2002)¹⁾

IEC 60464-2, *Varnishes used for electrical insulation – Part 2: Methods of test*

IEC/TS 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC 60479-4, *Effects of current on human beings and livestock – Part 4: Effects of lightning strokes on human beings and livestock*

IEC 60587, *Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC/TR 61000-5-2, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling*

IEC/TS 61400-23, *Wind turbine generator systems – Part 23: Full-scale structural testing of rotor blades*

IEC 61643-1, *Low-voltage surge protective devices – Part 1: Surge protective devices connected to low-voltage power distribution systems – Requirements and tests*

IEC 61643-12, *Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles*

IEC 61643-21, *Low voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

IEC 61643-22, *Low-voltage surge protective devices – Part 22: Surge protective devices connected to telecommunications and signalling networks – Selection and application principles*

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

IEC 62305-1:2006, *Protection against lightning – Part 1: General principles*

¹⁾ There exists a consolidated edition 3.1 (2002) that comprises IEC 60364-5-53 (2001) and its Amendment 1 (2002).

IEC 62305-2:2006, *Protection against lightning – Part 2: Risk management*

IEC 62305-3:2006, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

IEC 62305-4:2006, *Protection against lightning – Part 4: Electrical and electronic systems within structures*

EN 50164-1, *Lightning Protection Components (LPC) – Part 1: Requirements for connection components*

CLC HD 637 S1, *Power installations exceeding 1kV A.C.*

ITU-T K.2, *Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*

ITU-T K.21, *Resistibility of telecommunications equipment installed in customer premises to overvoltages and overcurrents*

ITU-T K.46, *Protection of telecommunication lines using metallic symmetric conductors against lightning-induced surges*

3 Terms and definitions

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

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 average steepness of the front of short stroke current

average rate of change of current within a time interval $\Delta t = t_2 - t_1$

NOTE It is expressed by the difference $\Delta i = i(t_2) - i(t_1)$ of the values of the current at the start and at the end of this interval, divided by the time interval $\Delta t = t_2 - t_1$ (see Figure A.3).

3.3 bonding bar

bar on which metal installations, electric power lines, telecommunication lines and other cables can be bonded to an LPS

3.4 collection area

A_d
for a structure, area of ground surface which has the same annual frequency of direct lightning flashes as the structure

3.5 connecting leader

lightning leader developing from a structure as a response to an external electric field imposed either by a charged cloud overhead or by a downward leader approaching the structure

3.6**conventional earthing impedance**

ratio of the peak values of the earth-termination voltage and the earth-termination current which, in general, do not occur simultaneously

3.7**coordinated SPD protection**

set of SPD properly selected, coordinated and installed to reduce failures of electrical and electronic systems

NOTE Coordination of SPD protection must include the connecting circuits to provide insulation coordination of complete systems.

3.8**down-conductor system**

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

3.9**downward flash**

lightning flash initiated by a downward leader from cloud to earth

NOTE A downward flash consists of a first short stroke, which can be followed by subsequent short strokes and may include a long stroke.

3.10**earth electrode**

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

3.11**earth-termination system**

part of an external LPS which is intended to conduct and disperse lightning current into the earth

3.12**effective height**

H

for a wind turbine, the highest point the blades reach, i.e. hub height plus rotor radius

3.13**external lightning protection system**

part of the LPS consisting of an air-termination system, a down-conductor system and an earth-termination system

NOTE The down conductor is often placed inside wind turbine blades.

3.14**flash charge**

Q_{flash}

time integral of the lightning current for the entire lightning flash duration

3.15**foundation earth electrode**

reinforcement steel of foundation or additional conductor embedded in the concrete foundation of a structure and used as an earth electrode