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## Electrically propelled road vehicles — Safety specifications —

### Part 3: Electrical safety

*Véhicules routiers électriques — Spécifications de sécurité —  
Partie 3: Sécurité électrique*

ICS: 43.120

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## Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 22 Road vehicles, Subcommittee SC 37, Electrically propelled vehicles.

This fourth edition cancels and replaces the third edition (ISO 6469-3:2018), which has been technically revised. The main changes compared to the previous edition are as follows:

- Changes from ISO 6469-3:2018/Amd1:2020 AMD 1 implemented
- Requirements for equal potential bonding revised

A list of all parts in the ISO 6469-3 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

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# Electrically propelled road vehicles — Safety specifications —

## Part 3: Electrical safety

### 1 Scope

This document specifies electrical safety requirements for voltage class B electric circuits of electric propulsion systems and conductively connected auxiliary electric systems of electrically propelled road vehicles.

It specifies electrical safety requirements for protection of persons against electric shock and thermal incidents.

It does not provide comprehensive safety information for manufacturing, maintenance and repair personnel.

NOTE 1 Electrical safety requirements for post-crash are described in ISO 6469-4.

NOTE 2 Electrical safety requirements for conductive connections of electrically propelled road vehicles to an external electric power supply are described in ISO 17409.

NOTE 3 Specific electrical safety requirements for magnetic field wireless power transfer between an external electric power supply and an electrically propelled vehicle are described in ISO PAS 19363.

NOTE 4 Electrical safety requirements for motorcycles and mopeds are described in ISO 13063.

### 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.

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 17409, *Electrically propelled road vehicles — Conductive power transfer — Safety requirements*

ISO 20653, *Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access*

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*

### 3 Terms and definitions

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

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

**3.1  
auxiliary electric system**

vehicle system, other than the propulsion system, that operates on electric energy

**3.2  
balance of electric circuit**

remaining section of an electric circuit when all electric power sources that are energized (e.g. *RESS* (3.31) and *fuel cell stacks* (3.20)) are disconnected

**3.3  
basic insulation**

insulation of *hazardous live parts* (3.22) which provides *basic protection* (3.4)

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

Note 2 to entry: Where insulation is not provided by solid insulation only, it is complemented with protective barriers or protective enclosures to prevent access to live parts in order to achieve basic protection.

[SOURCE: IEC 60050-195:1998, 195-06-06, modified — “hazardous-live-parts” written as “hazardous live parts”, Note 2 to entry added]

**3.4  
basic protection**

protection against *electric shock* (3.14) under fault-free conditions

[SOURCE: IEC 60050-195:1998, 195-06-01]

**3.5  
clearance**

shortest distance in air between two *conductive parts* (3.6)

[SOURCE: IEC 60664-1:2020, 3.2]

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**3.6  
conductive part**

part which can carry electric current

[SOURCE: IEC 60050-195:1998, 195-01-06]

**3.7  
conductively connected circuit**

two electric circuits are considered conductively connected unless they are separated by at least basic insulation

**3.8  
creepage distance**

shortest distance along the surface of a solid insulating material between two *conductive parts* (3.6)

[SOURCE: IEC 60050-151:2001/AMD1:2013, 151-15-50]

**3.9  
degree of protection**

**IP**  
protection provided by an enclosure or barriers against access, foreign objects and/or water and verified by standardized test methods in accordance with ISO 20653

[SOURCE: ISO 20653:2013, 3.2, modified — The phrases “or barriers” and “in accordance with ISO 20653” were added]



**3.10****direct contact**

electric contact of persons or animals with *live parts* (3.25)

[SOURCE: IEC 60050-195:1998, 195-06-03]

**3.11****double insulation**

insulation comprising both *basic insulation* (3.3) and *supplementary insulation* (3.33)

[SOURCE: IEC 60050-195:1998, 195-06-08]

**3.12****electric chassis**

*conductive parts* (3.6) of a vehicle that are electrically connected and whose potential is taken as reference

**3.13****electric drive**

combination of traction motor, power electronics and their associated controls for the conversion of electric to mechanical power and vice versa

**3.14****electric shock**

physiological effect resulting from an electric current through a human body or animal body

[SOURCE: IEC 60050-195:1998, 195-01-04]

**3.15****electrically propelled vehicle**

vehicle with one or more *electric drive(s)* (3.13) for vehicle propulsion

**3.16****energized**

qualifies a conductive part having an electric potential difference with respect to a relevant reference

[SOURCE: IEC 60050-151:2001/AMD1:2013, 151-15-58, modified — Note deleted]

**3.17****equipotential bonding**

provision of electric connections between *conductive parts* (3.6), intended to achieve equipotentiality

[SOURCE: IEC 60050-195:1998, 195-01-10]

**3.18****exposed conductive part**

*conductive part* (3.6) of equipment which can be touched and which is not normally live, but which can become live when *basic insulation* (3.3) fails

Note 1 to entry: A conductive part of electrical equipment which can become live only through contact with an exposed conductive part which has become live, is not considered to be an exposed conductive part itself.

[SOURCE: IEC 61140:2016, 3.6, modified — “exposed conductive part” replaces “exposed-conductive-part” and Note 1 to entry deleted]

**3.19****fault protection**

protection against *electric shock* (3.14) under single-fault conditions

[SOURCE: IEC 60050-195:1998, 195-06-02]

### 3.20

#### **fuel cell stack**

assembly of two or more fuel cells that are electrically connected

### 3.21

#### **fuel cell system**

system, typically containing the following subsystems: *fuel cell stack* (3.20), air processing, fuel processing, thermal management, water management, and their control

### 3.22

#### **hazardous live part**

*live part* (3.25) which, under certain conditions, can give a harmful electric shock

Note 1 to entry: For guidance on harmful physiological effects see IEC 61140.

[SOURCE: IEC 60050-195:1995, 448-14-31, modified — term changed from “hazardous-live-part” to “hazardous live part” and Note 1 to entry added]

### 3.23

#### **isolation resistance**

#### **insulation resistance**

resistance between *live parts* (3.25) of an electric circuit and the *electric chassis* (3.12) as well as other electric circuits which are insulated from this electric circuit

### 3.24

#### **isolation resistance monitoring system**

system that periodically or continuously monitors the *isolation resistance* (3.23) between *live parts* (3.25) and the *electric chassis* (3.12)

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### 3.25

#### **live part**

conductor or *conductive part* (3.6) intended to be energized in normal use, but by convention not the *electric chassis* (3.12)

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[SOURCE: IEC 60050-195:1998, 195-02-19, modified — “including a neutral conductor” and Note 1 to entry deleted and “a PEN conductor or PEM conductor or PEL conductor” replaced by “the electric chassis”]

### 3.26

#### **maximum working voltage**

highest value of AC voltage (rms) or of DC voltage that can occur under any normal operating conditions according to the manufacturer's specifications, disregarding transients and ripple

### 3.27

#### **overload protection**

protection intended to operate in the event of overload on the protected section

[SOURCE: IEC 60050-448:1995, 448-14-31]

### 3.28

#### **overcurrent protection**

protection intended to operate when the current is in excess of a predetermined value

[SOURCE: IEC 60050-448:1995, 448-14-26]

### 3.29

#### **protective barrier**

part providing protection against *direct contact* (3.10) from any usual direction of access

[SOURCE: IEC 60050-195:1998, 195-06-15, modified — optional prefix “(electrically)” removed]

**3.30****protective enclosure**

electrical enclosure surrounding internal parts of equipment to prevent access to *hazardous live parts* (3.22) from any direction

[SOURCE: IEC 60050-195:1998, 195-06-14, modified — optional prefix “(electrically)” removed and “hazardous-live-parts” written as “hazardous live parts”]

**3.31****rechargeable energy storage system****RESS**

rechargeable system that stores energy for delivery of electric energy for the *electric drive* (3.13)

EXAMPLE Battery, capacitor, flywheel.

**3.32****reinforced insulation**

insulation of *hazardous live parts* (3.22) which provides protection against *electric shock* (3.14) equivalent to *double insulation* (3.11)

Note 1 to entry: Reinforced insulation may comprise several layers that cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 61140:2016, 3.10.4]

**3.33****supplementary insulation**

independent insulation applied in addition to *basic insulation* (3.3), for fault protection

[SOURCE: IEC 60050-195:1998, 195-06-07]

**3.34****touch current**

electric current passing through a human body or through livestock when it touches one or more accessible parts of cables or equipment

[SOURCE: ISO 17409:2020, 3.57, modified — “cables” replaces “an installation”]

**3.35****vehicle power supply circuit**

*voltage class* (3.36) B electric circuit which includes all parts that are conductively connected to the vehicle inlet (case B, case C) or the plug (case A) or part of an Autoconnect Charging Device that is mounted on the electrically propelled vehicle (case D, case E) and that is operational when connected to an external electric power supply

Note 1 to entry: Case A, case B, case C are defined in IEC 61851-1.

Note 2 to entry: Case D, case E and Autoconnect Charging Device are defined in IEC 61851-23-1 (under preparation).

[SOURCE: ISO 17409:2020, 3.61, modified — “Note 1 to entry replaced and Note 2 to entry added.”]

**3.36****voltage class**

classification of an electric component or circuit according to its *maximum working voltage* (3.26)

**3.37****electric power source**

system that provides electric energy

EXAMPLE RESS, fuel cell system, photovoltaic system.

## 4 Voltage classes

Depending on its maximum working voltage  $U$ , an electric circuit, a section of a circuit or an electric component belongs to the voltage classes specified in [Table 1](#).

**Table 1 — Voltage classes**

Voltage class	Maximum working voltage	
	DC in V	AC in V (rms value)
A	$0 < U \leq 60$	$0 < U \leq 30$
B	$60 < U \leq 1\,500$	$30 < U \leq 1\,000$
B1	$60 < U \leq 75$	$30 < U \leq 50$
B2	$75 < U \leq 1\,500$	$50 < U \leq 1\,000$

The voltage classes B1 and B2 are subclasses of voltage class B. Due to the different voltage levels, different requirements are specified for voltage class B1 and voltage class B2, whereas the requirements for voltage class B2 are more stringent. The requirements for voltage class B2 may be applied for the complete range of voltage class B, including the voltage range of voltage class B1. It is allowed to use voltage class B instead of voltage class B1 and voltage class B2.

In cases where voltage class B is referenced by another standard, the requirements for voltage class B2 apply.

NOTE 1 Dividing voltage class B into two voltage classes B1 and B2 allows chassis connected voltage class B1 drivetrain and connected electrical systems in electric vehicles according to the given scope. Otherwise, all circuits which contain AC sections with a maximum working voltage between 30 V AC and 50 V AC, and DC sections with a maximum working voltage up to 60 V DC, would have to be insulated from the chassis, only because the AC part of the circuit falls into voltage class B range, whereas the DC part could still fall under the regulations for a voltage class A circuit.

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NOTE 2 If the requirements of voltage class B1 are fulfilled, the maximum working voltage of an electric circuit, a section of a circuit or an electric component can be up to 75 V DC and up to 50 V AC.

NOTE 3 The requirements for voltage class B1 are based on IEC 61140, IEC 60479-1, IEC 60479-2, IEC 60479-5, and IEC 60364-4-41.

NOTE 4 The voltage limits of voltage class B1 are harmonized with the European Low Voltage Directive and IEC 61140 (the AC limit). Electric vehicles are not in the scope of the European Low Voltage Directive.

## 5 General requirements

### 5.1 Environmental and operational requirements

The requirements given in this document shall be met across the range of environmental and operational conditions for which the electrically propelled vehicle is designed to operate, as specified by the vehicle manufacturer.

NOTE See ISO 16750, ISO PAS 19295 and ISO 19453 for guidance.

### 5.2 Marking

#### 5.2.1 Marking of voltage class B electric components

The symbol W012 in accordance with ISO 7010 shown in [Figure 1](#) shall be visible on protective barriers and protective enclosures, which, when removed, expose hazardous live parts of voltage class B electric circuits. Accessibility and removability of protective barriers and protective enclosures should be considered when evaluating the requirement for the symbol.