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Second edition
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Electrically propelled road vehicles — Safety specifications —

Part 1: On-board rechargeable energy storage system (RESS)

Véhicules routiers électriques — Spécifications de sécurité — Partie 1: Système de stockage de l'énergie rechargeable à bord du véhicule (RESS)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 6469-1 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 21, *Electrically propelled road vehicles*.

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This second edition cancels and replaces the first edition (ISO 6469-1:2001), which has been technically revised.

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ISO 6469 consists of the following parts, under the general title *Electrically propelled road vehicles — Safety specifications*:

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— *Part 1: On-board rechargeable energy storage system (RESS)*

— *Part 2: Vehicle operational safety means and protection against failures*

— *Part 3: Protection of persons against electric shock*

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Electrically propelled road vehicles — Safety specifications —

Part 1: On-board rechargeable energy storage system (RESS)

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1 Scope

This part of ISO 6469 specifies requirements for the on-board rechargeable energy storage systems (RESS) of electrically propelled road vehicles, including battery-electric vehicles (BEVs), fuel-cell vehicles (FCVs) and hybrid electric vehicles (HEVs), for the protection of persons inside and outside the vehicle and the vehicle environment. Flywheels are not included in the scope of this part of ISO 6469.

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This part of ISO 6469 does not apply to RESS in motorcycles and vehicles not primarily intended as road vehicles, such as material handling trucks or fork-lift trucks.

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This part of ISO 6469 applies only to RESS in on-board voltage class B (see 3.18) electric circuits for vehicle propulsion.

This part of ISO 6469 does not provide comprehensive safety information for manufacturing, maintenance and repair personnel.

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.

ISO 6469-3, *Electric road vehicles — Safety specifications — Part 3: Protection of persons against electric shock*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Safety signs used in workplaces and public areas*

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

3 Terms and definitions

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

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3.1
auxiliary electric system
on-board vehicle system, other than the propulsion system, which operates on electric energy

3.2
battery electric vehicle
BEV
electric vehicle with only a **traction battery** (3.17) as the power source for vehicle propulsion

NOTE The abbreviation BEV is often shortened to EV.

3.3
conductive part
conductor
part capable of conducting electric current

3.4
creepage distance
shortest distance along a surface of a solid insulating material between two **conductive parts** (3.3)

3.5
direct contact
contact of persons with live parts

3.6
electric chassis
conductive parts of a vehicle, electrically connected, whose potential is taken as a reference

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3.7
electric drive
combination of a traction motor and associated power electronics for the conversion of electric to mechanical power and vice versa

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3.8
electric power system
electric circuit, containing electric power sources (e.g. fuel-cell stacks, **batteries**) (3.17)

3.9
electrically propelled vehicle
vehicle with one or more **electric drive(s)** (3.7) for vehicle propulsion

3.10
exposed conductive part
conductive part which can be touched by a test finger according to a degree of protection as specified in ISO 20653

3.11
fuel-cell vehicle
FCV
electric vehicle with a fuel-cell system as the power source for vehicle propulsion

NOTE A FCV may also have a RESS or another power source for vehicle propulsion.

3.12
hybrid electric vehicle
HEV
vehicle with at least one **RESS** (3.16) and one fuelled power source for vehicle propulsion

EXAMPLE ICE or fuel-cell systems are typically types of fuelled power sources.

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3.13
insulation-resistance monitoring system
system which periodically or continuously monitors the insulation resistance between **live parts** (3.14) and the **electric chassis** (3.6)

3.14
live part
conductor or **conductive part** (3.3) intended to be electrically energized in normal use

NOTE "Electrically energized" means that such a conductor or **conductive part** can have an electric potential against the **electric chassis** (3.6).

3.15
maximum working voltage
highest value of a.c. voltage root-mean-square (rms) or of d.c. voltage which may occur in an electric system under any normal operating conditions according to the manufacturer's specifications, disregarding transients

3.16
rechargeable energy storage system
RESS
system that stores energy for delivery of electric energy and which is rechargeable

EXAMPLE Batteries, capacitors.

3.17
traction battery
propulsion battery
battery
collection of all traction **battery packs** which are electrically connected, for the supply of electric power to the electric drive and possibly **auxiliary electric systems** (3.1)

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3.18
voltage class B
classification of an electric component or circuit as belonging to voltage class B, if its maximum working voltage is > 30 V a.c. and $\leqslant 1\,000$ V a.c., or > 60 V d.c. and $\leqslant 1\,500$ V d.c., respectively

NOTE For more details, see ISO 6469-3.

4 Environmental and operating conditions

The requirements given in this part of ISO 6469 shall be met across the environmental and operating conditions for which the electrically propelled vehicle is designed to operate, as specified by the vehicle manufacturer.

NOTE See ISO 16750 for guidance.

5 Marking

RESS that are part of voltage class B electric circuits shall be marked with the symbol shown in Figure 1. The symbol background shall be yellow, and the bordering and the arrow shall be black, in accordance with ISO 7010.

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This warning shall be visible when accessing the RESS.

Figure 1 — Marking of RESS

6 Requirements for RESS

6.1 Isolation resistance of the RESS

6.1.1 General

The measurement of the isolation resistance of the RESS shall include auxiliary components located inside the RESS housing, e.g. monitoring or temperature-conditioning devices and liquid fluids (if any).

Both terminals of the RESS generally have different isolation resistances (R_{i1} and R_{i2} in Figure 2) against the electric chassis. For safety reasons, the lower one is regarded as the relevant RESS isolation resistance, which can be calculated using voltages measured in a procedure taking the voltage of the charged RESS as the test voltage.

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6.1.2 Preconditioning and conditioning

For the measurement of the RESS isolation resistance within the vehicle, i.e. the RESS installed as for normal operation, both power terminals of the RESS shall be disconnected from the electric propulsion circuit and any other external circuit.

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Terminals of the internal auxiliary systems of the RESS that are operated by power sources outside the RESS (e.g. the auxiliary 12 V battery) shall be disconnected from the outside power source and connected to the electric chassis of the vehicle, except for terminals that are required to activate the RESS (e.g. by connecting the battery packs inside a traction battery to the power terminals).

For the measurement of the RESS isolation resistance outside the vehicle (the RESS as a stand-alone system) the electric chassis shall be simulated by an electric conductor, e.g. a metal plate, to which the RESS shall be attached with their standard mounting devices, for best representing the resistances between the RESS housing and the electric chassis of the vehicle.

Prior to the measurement, the RESS shall be subjected to a preconditioning period of at least 8 h at (5 ± 2) °C, followed by a conditioning period of 8 h at a temperature of (23 ± 5) °C, a humidity of $90\,^{+10}_{-5}$ %, and an atmospheric pressure between 86 kPa and 106 kPa, in order to reach the dew point.

Alternative preconditioning and conditioning parameters may be selected, provided transition across the dew point occurs shortly after the beginning of the conditioning period. The specific conditions of the RESS type and usage shall be considered.

If possible, the RESS should be charged to the maximum state of charge recommended by the vehicle/RESS manufacturer.

For measurements within the vehicle, if the RESS is rechargeable only from on-board energy sources, the RESS should be charged at any state of charge within the normal operation level that is appropriate for measurement, as defined by the vehicle manufacturer.

The voltmeter or the measuring device used in this test shall have an internal resistance above 10 MΩ.

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6.1.3 Procedure

The isolation resistance shall be measured during the conditioning period at a rate, from which the lowest resistance value can be determined.

If switches for the battery current are integrated in the RESS, they shall be closed during the measurement.

The procedure for each measurement is the following [see Figure 2 and Equations (1) and (2)]:

— Measure the voltages between each terminal of the RESS and the vehicle electric chassis, and name the higher one U_1, the lower one U'_1 and the two corresponding isolation resistances R_{i1} and $R_{i2} = R_i$.

NOTE 1 R_{i2} is the lower isolation resistance and is therefore the RESS isolation resistance R_i to be determined.

— Add a known measuring resistance R_0 parallel to R_{i1} and measure the voltages U_2 and U'_2.

During the measurements, the test voltage shall be stable.

NOTE 2 Theoretically, the value of R_0 has no influence on the calculated isolation resistance. However, R_0 should be selected so as to improve the accuracy of the measured voltages on the calculated isolation resistances as much as possible. A value in the range of (100 to 500) Ω/V RESS working voltage is appropriate. The value should be known with an uncertainty of maximum 2 %.

— Calculate the isolation resistance R_i, using R_0 and the three voltages U_1, U'_1, and U_2 with Equation (1):

$$R_i = R_0 \frac{U_1 - U_2}{U_2}\left(1 + \frac{U'_1}{U_1}\right) \quad (1)$$

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NOTE 3 In the first edition of this part of ISO 6469, Equation (1) was called an *alternative* and the standard equation there was only an approximation, which was removed in this edition. Equation (1) is also used in SAE J1766 and FMVSS 305, but partly with different indexes.

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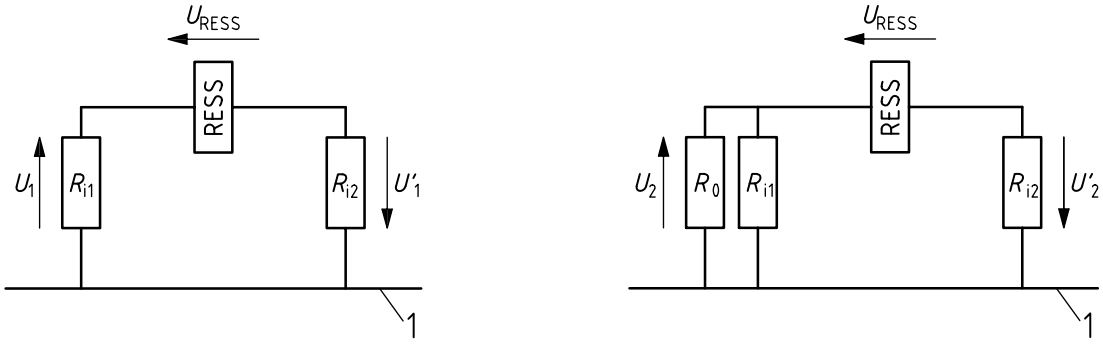
— R_i can also be calculated, using R_0 and all four voltages U_1, U'_1, U_2 and U'_2 by applying Equation (2):

$$R_i = R_0\left(\frac{U'_2}{U_2} - \frac{U'_1}{U_1}\right) \quad (2)$$



a) Measurement of U_1 and U'_1 **b) Addition of R_0 and measurement of U_2 and U'_2**

Key

1 electric chassis

NOTE 1 R_{i1} and R_{i2} represent the fictitious isolation resistances between the two terminals of the RESS and the chassis.

NOTE 2 R_0 is a measuring resistance.

Figure 2 — Measurement of isolation resistance

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