BRITISH STANDARD

BS ISO 6469-1:2009

Electrically propelled road vehicles — Safety specifications

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

ICS 43.120

British Standards

National foreword

This British Standard is the UK implementation of ISO 6469-1:2009.

The UK participation in its preparation was entrusted to Technical Committee PEL/69, Electric vehicles.

A list of organizations represented on this committee can be obtained on request to its secretary.

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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)

Reference number
ISO 6469-1:2009(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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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*.

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

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

— *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*

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.

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.

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.

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

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

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.

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)

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.

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.

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.

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.

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 %.

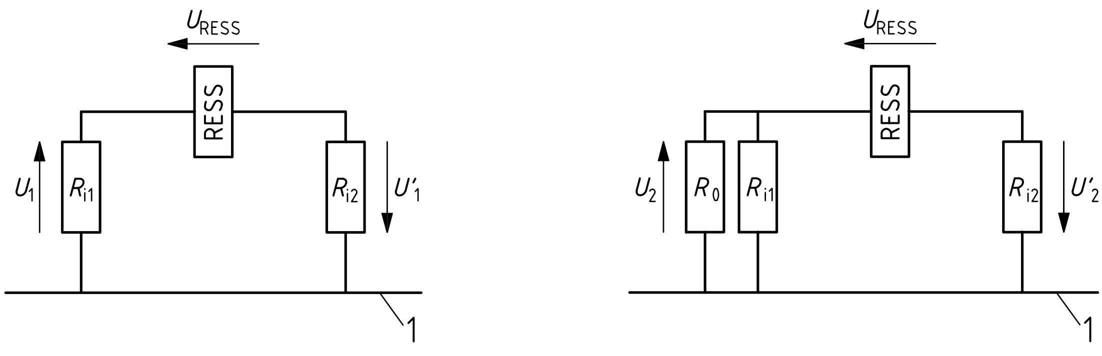
— Calculate the isolation resistance R_i, using R_0 and the three voltages U_1, U'_1, and U_2 with Equation (1):

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

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.

— 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):

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



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

Alternatively, the isolation resistance may be determined by adequate procedures and measurement equipment if the results will be equivalent to, or have a clear correlation with, the one measured as specified above, e.g. by using an internal RESS isolation-resistance monitoring system or an external isolation-resistance monitoring system.

6.1.4 Requirement

For a RESS not embedded in a whole circuit, the minimum requirement for the isolation resistance R_i divided by its maximum working voltage shall be 100 Ω/V, if not containing a.c., or 500 Ω/V, if containing a.c. without additional a.c. protection throughout the entire lifetime of the RESS. When the RESS is integrated in a whole electric circuit, a higher resistance value for the RESS may be necessary.

NOTE 1 For details on the integration of RESS and for additional a.c. protection, see ISO 6469-3.

NOTE 2 Resistances lower than the required minimum isolation resistances can occur due to the deterioration of certain battery types.

If the isolation resistance of the whole power circuit, measured with an on-board isolation-resistance monitoring system, meets the requirements in ISO 6469-3, the isolation-resistance measurement of the RESS as a single component in 6.1 is not required.

6.2 Clearance and creepage distance

This subclause deals with the additional leakage-current hazard between the connection terminals of a RESS, including any conductive fittings attached to them and any conductive parts, due to the risk of electrolyte or dielectric medium spillage from leakage under normal operating conditions.

This subclause does not apply to maximum working voltages lower than 60 V d.c.

If electrolytic leakage does not occur, the RESS should be designed according to IEC 60664-1. The pollution degree shall be suitable for the range of application. If electrolyte leakage can occur, it is recommended that the creepage distance be as follows (see Figure 3).

a) In the case of a creepage distance between two RESS connection terminals:

$$d \geqslant 0{,}25U + 5$$

where

d is the creepage distance measured on the tested RESS, in millimetres (mm);

U is the maximum working voltage between the two RESS connection terminals, in volts (V).

b) In the case of a creepage distance between live parts and the electric chassis:

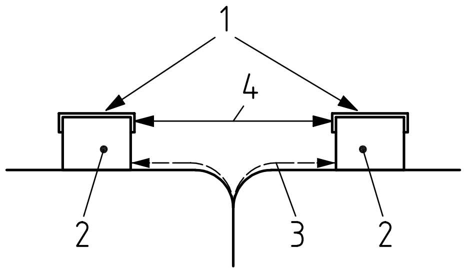
$$d \geqslant 0{,}125U + 5$$

where

d is the creepage distance between the live part and the electric chassis, in millimetres (mm);

U is the maximum working voltage between the two RESS connection terminals, in volts (V).

The clearance between conductive surfaces shall be 2,5 mm minimum.



Key

1 conductive surface
2 connector terminal (RESS pack or RESS)
3 creepage distance
4 clearance

Figure 3 — Creepage distance and clearance

6.3 Requirements for the emission of hazardous gases and other hazardous substances

To prevent explosion, fire or toxicity hazards, the following requirements apply when hazardous gases and other substances can be emitted by the RESS. These requirements shall consider normal operating and environmental conditions. No potentially dangerous concentration of hazardous gases and other hazardous substances shall be allowed anywhere in the driver, passenger and load compartments.

Refer to the latest version of applicable National/International Standards or regulations for the maximum allowed accumulated quantity of hazardous gases and other substances.

Appropriate countermeasures shall manage first-failure situations.

6.4 Heat generation from the RESS

Heat generation under any first-failure condition, which could form a hazard to persons, shall be prevented by appropriate measures, e.g. based on monitoring of current, voltage or temperature.

7 RESS over-current interruption

If a RESS system is not short-circuit proof in itself, a RESS over-current interruption device shall open the RESS circuit under conditions specified by the vehicle and/or RESS manufacturer, to prevent dangerous effects for persons, the vehicle and the environment.

8 Specific RESS crash-test requirements

8.1 Protection of occupants

The following requirements and those of 6.3 shall be met in a crash test, in accordance with the test requirements of applicable National and/or International Standards or regulations or standards:

NOTE If no national/international regulations are available, the manufacturer's test procedures may be applied.

a) If the RESS is located outside the passenger compartment, it shall not penetrate into the passenger compartment.

b) If the RESS is located inside the passenger compartment, movement of the RESS shall be limited to ensure the safety of the occupants.

c) No spilled electrolyte shall enter the passenger compartment during and after the test.

8.2 Protection of a third party

The RESS and its components shall not be ejected from the vehicle after a crash test, as specified in 8.1, unless otherwise required in these tests.

8.3 Protection against a short-circuit

In the case of a crash corresponding to the tests in 8.1, the electric power system shall be protected against the effects of a short-circuit.

NOTE RESS over-current interruption devices according to Clause 7 can be used to meet this requirement.

Bibliography

[1] ISO 8713:2005[1)], *Electric road vehicles — Vocabulary*

[2] ISO 16750 (all parts), *Road vehicles — Environmental conditions and testing for electrical and electronic equipment*

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

[4] ECE Regulation 100, *Uniform provisions concerning the approval of battery electric vehicles with regard to specific requirements for the construction and functional safety*

[5] FMVSS 305, *Electric powered vehicles: Electrolyte spillage and electrical shock protection*

[6] SAE J1766, *Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing*

1) Currently under revision.

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