INTERNATIONAL STANDARD

ISO 18246

First edition
2015-12-01

Electrically propelled mopeds and motorcycles — Safety requirements for conductive connection to an external electric power supply

Cyclomoteurs et motocycles à propulsion électrique — Exigences de sécurité relatives au couplage conductif à une station extérieure d'alimentation d'énergie

Reference number
ISO 18246:2015(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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.

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).

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).

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 38, *Motorcycles and mopeds*.

If there is any lack of requirements especially for safety issues in this International Standard, the requirement in other relevant standards, such as ISO 17409, is adopted.

Introduction

This International Standard prescribes basic safety requirements for electrically propelled mopeds and motorcycles, which are called electric vehicles, for simplicity, in this International Standard, while connected to an external electric power supply. The safety requirements for off-board chargers are described in IEC 60335-2-29 and will be described in the IEC 61851-3 series (under consideration).

This International Standard does not consider discharging from vehicle to grid.

This International standard does not standardize specific charging method.

Moped and motorcycle are defined in ISO 3833:1977, 3.4 and 3.5.

Electrically propelled mopeds and motorcycles — Safety requirements for conductive connection to an external electric power supply

1 Scope

This International Standard specifies safety requirements for conductive connection to an external electric power supply of electrically propelled mopeds and motorcycles.

It is not applicable to vehicles not in normal conditions, such as damaged vehicles and vehicles which have mechanical and/or electrical failure.

It applies only to on-board charging systems between the plug or vehicle couplers and RESS circuits.

The safety requirements for vehicles not connected to external power supply are specified in ISO 13063.

NOTE This International Standard does not contain requirements for bidirectional power flow.

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

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

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

IEC 60664-1 Ed. 2.0:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests*

IEC 60950-1 Ed. 2.0:2005, *Information technology equipment — Safety — Part 1: General requirements*

3 Terms and definitions

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

3.1
basic insulation
insulation of hazardous-live-parts which provides basic protection

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

[SOURCE: IEV 195-06-06]

3.2
basic protection
protection against electric shock under fault-free conditions

Note 1 to entry: For low-voltage installations, systems and equipment, basic protection generally corresponds to protection against direct contact as used in IEC 60364-4-41.

[SOURCE: IEC 61140:2009, 3.1.1]

3.3
charger
power converter that performs the necessary functions for charging a battery

3.3.1
charger assembly
power converter that performs the necessary functions for charging a battery, including cables

3.4
degree of protection
protection provided by an enclosure against access, foreign objects and/or water and verified by standardized test methods

[SOURCE: ISO 20653:2013, 3.2]

3.5
double insulation
insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEV 195-06-08]

3.6
electric vehicle
moped or motorcycle with one or more electric drive(s) for propulsion (refer to Introduction)

[SOURCE: ISO 13063:2012, 3.19, modified — Terminological entry is changed from electrically propelled vehicle, and moped or motorcycle is changed from vehicle.]

3.7
equipotential bonding
provision of electric connections between conductive parts, intended to achieve equipotentiality

[SOURCE: IEV 195-01-10]

3.7.1
equipotential bonding terminal
terminal provided on equipment or on a device and intended for the electric connection with the equipotential bonding system

[SOURCE: IEV 195-02-32]

3.8
exposed conductive part
conductive part of the electric equipment which can be touched by a test finger according to IPXXB (refer to ISO 20653) after removing barriers/enclosures that can be removed without using tools but which may become live under failure conditions

[SOURCE: ISO 6469-3:2011, 3.17, modified]

3.9
external electric power supply
electric power source which is outboard of the vehicle for supplying electric energy to electric vehicle for electric propulsion

Note 1 to entry: The external electric power supplies include a.c. supply network (mains), grids and/or stationary external power sources.

[SOURCE: ISO 17409:2015, 3.23, modified]

3.10
hazardous-live-part
live part which, under certain conditions, can give a harmful electric shock

[SOURCE: IEV 826–12–13]

3.11
indoor use
equipment designed to be exclusively used in weather protected locations

[SOURCE: IEC 61851-1:2010, 3.28]

3.12
live part
conductor or conductive part intended to be electrically energized in normal use

Note 1 to entry: "Electrically energized" means that such a conductor or conductive part can have an electric potential.

[SOURCE: ISO 6469-1:2009, 3.14, modified]

3.13
maximum working voltage
highest value of a.c. voltage (r.m.s.) or of d.c. voltage that can occur in an electric system under any normal operating conditions according to the manufacturers' specifications, disregarding transients

[SOURCE: ISO 13063:2012, 3.26]

3.14
outdoor use
equipment designed to be allowed to be used in non weather protected locations

[SOURCE: IEC 61851-1:2010, 3.29]

3.15
plug
accessory having pins designed to engage with the contacts of a socket-outlet

Note 1 to entry: It also incorporate means for the electrical connection and mechanical retention of flexible cables or codes.

[SOURCE: IEV 442-03-02, modified]

3.16
primary circuit
circuit in the charger intended to be galvanically connected to a supply network (mains)

3.17
protection degree
protection provided by a barrier/enclosure related to the contact with live parts by a test probe, such as a test finger (IPXXB), a test rod (IPXXC), or a test wire (IPXXD), in accordance with ISO 20653

[SOURCE: ISO 6469-3:2011, 3.25]

3.18
protective conductor
PE
conductor provided for the purposes of safety

EXAMPLE Protection against electric shock.

Note 1 to entry: In an electrical installation, the conductor identified PE is normally also considered as protective earthing conductor.

[SOURCE: IEV 826-13-22, modified]

3.19
reinforced insulation
insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

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

[SOURCE: IEV 195-06-09]

3.20
residual current device
RCD
mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions

Note 1 to entry: A residual current device can be a combination of various separate elements designed to detect and evaluate the residual current and to make and break current.

[SOURCE: IEV 442-05-02]

3.21
rechargeable energy storage system
RESS
system that stores energy for delivery of electric energy and which is rechargeable

EXAMPLE Batteries, capacitors.

[SOURCE: ISO 13063:2012, 3.29]

3.22
RESS circuit
electric circuit which includes all live parts that are galvanically connected to the secondary circuits of the charger and charging circuits of RESS, excluding propulsion circuits

3.23
RESS coupler
means enabling the connection and disconnection of RESS to a flexible cable, an electric vehicle or a charger assembly

Note 1 to entry: It consists of two parts: a RESS connector and a RESS inlet.

3.23.1
RESS connector
part of a RESS coupler integral with, or intended to be attached to, a flexible cable, an electric vehicle or a charger assembly

3.23.2
RESS inlet
part of a RESS coupler incorporated in, or fixed to, RESS

3.24
secondary circuit
circuit in the charger intended to be galvanically connected to the RESS

3.25
socket-outlet
accessory having socket-contacts designed to engage with the pins of a plug and having terminals for the connection of cables or codes

[SOURCE: IEV 442-03-02]

3.26
supplementary insulation
independent insulation applied in addition to basic insulation, for failure protection

[SOURCE: IEV 195-06-07, modified — "fault" has been replaced with "failure".]

3.27
terminal
conductive part provided for the connection of a conductor to an accessory

[SOURCE: IEC 62196-1:2014, 3.14]

3.28
vehicle coupler
means enabling the connection and disconnection at will, of a flexible cable to an electric vehicle.

Note 1 to entry: It consists of two parts: a vehicle connector and a vehicle inlet.

[SOURCE: IEC 62196-1:2014, 3.3, modified — "and disconnection" has been added.]

3.28.1
vehicle connector
part of a vehicle coupler integral with, or intended to be attached to, one flexible cable

[SOURCE: IEC 62196-1:2014, 3.3.1]

3.28.2
vehicle inlet
part of a vehicle coupler incorporated in, or fixed to, the electric vehicle

[SOURCE: IEC 62196-1:2014, 3.3.2]

3.29
voltage class A
classification of an electric component or circuit as belonging to voltage class A, if its maximum working voltage is ≤30 V a.c. or ≤60 V d.c., respectively

Note 1 to entry: The values 60 V d.c. and 30 V a.c. are selected taking into account humid weather conditions.

[SOURCE: ISO 13063:2012, 3.33, modified — Note 1 to entry is added from ISO 13063:2012, Table 1.]

3.30
voltage class B
classification of an electric component or circuit as belonging to voltage class B, if its maximum working voltage is >30 and ≤1 000 V a.c. or >60 and ≤1 500 V d.c., respectively

Note 1 to entry: The values 60 V d.c. and 30 V a.c. are selected taking into account humid weather conditions.

[SOURCE: ISO 13063:2012, 3.34, modified — Note 1 to entry is added from ISO 13063:2012, Table 1.]

4 Environmental and operational conditions

The requirements given in this International Standard shall be met across the range of environmental and operational conditions for which the electric vehicles are designed to be charged, as specified by the vehicle manufacturer.

5 General requirements

The on-board charging system shall be operated safely and properly in normal use.

The on-board charging system shall comprise safety means, such as protection against electric shock of rider and/or surroundings even under single failure condition.

The fail-safe design shall be considered for the on-board charging system.

The on-board charging assembly shall be designed so that, if it could lead to malfunction in a hazardous manner, it shall cut off power to the RESS or the traction battery for safety.

The information necessary for installation, operation, and maintenance of the charger and any components shall be supplied in appropriate forms such as drawings, diagrams, charts, tables, and instructions.

Compliance is checked with the relevant requirements and tests specified in this International Standard.

6 Connection between the plug or vehicle couplers and RESS of the vehicle

6.1 General connection

6.1.1 Connections among charger, RESS, and vehicle

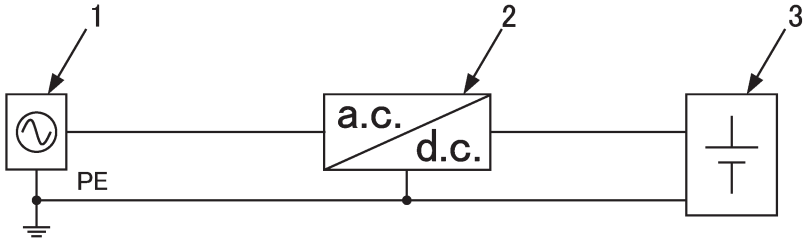
There are four ways in conductive charging systems regarding the connection to the earth. They are as follows.

a) Connection to the earth: It consists of the charger assembly and the vehicle/RESS, both of them connected to the earth for protection. The requirements are specified in 6.1.3.2.

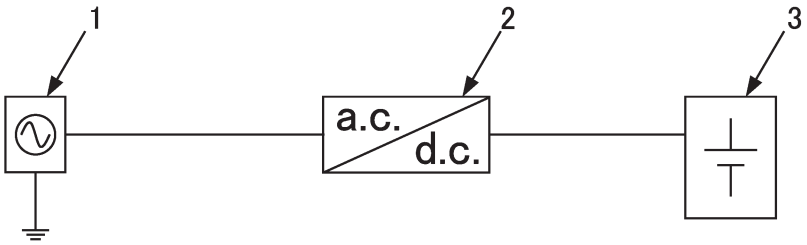
b) No connection to the earth: It consists of the charger assembly and the vehicle/RESS, neither of them connected to the earth for protection. The requirements are specified in 6.1.3.3.

c) Separate connection to the earth: It consists of the charger assembly unconnected to the earth for protection and the vehicle/RESS connected to the earth for protection. The requirements are specified in 6.1.3.4.

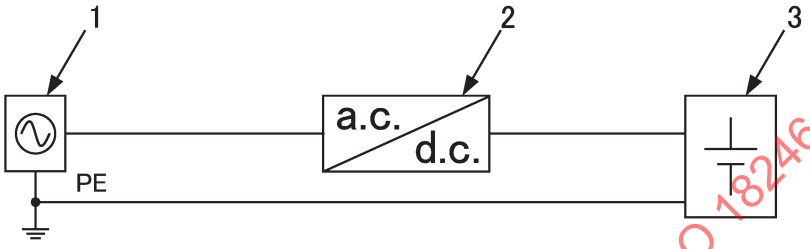
d) Partial connection to the earth: It consists of the charger assembly connected to the earth for protection and the vehicle/RESS unconnected to the earth for protection. The requirements are specified in 6.1.3.5.



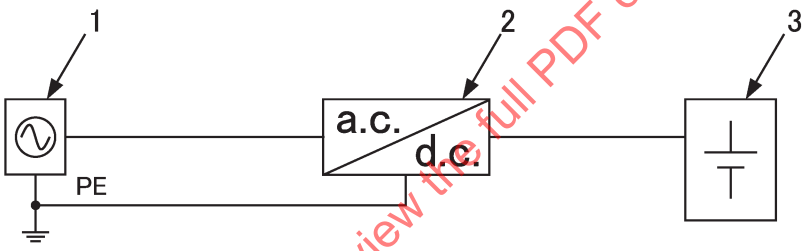
a) Connection to the earth



b) No connection to the earth



c) Separate connection to the earth



d) Partial connection to the earth

Key

1 a.c. supply network (mains)
2 charger
3 vehicle or detachable RESS

Figure 1 — Construction of the connection to the earth

Figure 1 shows TN power supply systems. Other configurations including TT power supply systems also exist.

6.1.2 General requirements for connection

6.1.2.1 Connection and disconnection

It shall not be possible to engage couplers/plug with different voltage rating or current rating.

Vehicle couplers and RESS couplers as the parts of the on-board charging system shall not be compatible. In case of charging type B or C described in Annex A, vehicle connectors and RESS connectors may be compatible in accordance with vehicle manufacturer's guidance or relevant standards for connection.

When the vehicle connector is connected to charge the vehicle and/or disconnected, the means preventing access to the live parts from any usual direction shall be provided.

Connection or disconnection of the vehicle coupler shall not cause the overturn of the vehicle in the normal operating conditions.

6.1.2.2 Protection against environmental pollution

Coupler shall be designed to be used under the micro ambient pollution degree 3 specified in Table 5. Prohibition of coupler/plug disconnection under the macro ambient pollution degree 4 specified in Table 5 shall be indicated in user's manual, marking or other method.

6.1.2.3 Wiring

Any connections integral to the on-board charging system shall not cause overheating of the pins and/or wires or impose undue strain on couplers/plugs.

Wire ways shall be smooth and free from sharp edges. Separate parts which can move during charging relative to each other shall not cause undue stress to electrical connections and internal conductors, including those providing equipotential bonding.

Even if the movable part of the on-board equipment is moved backwards and forwards and the conductor is flexed through the largest angle permitted by its construction, no damage shall occur to the wiring.

If an open coil spring or cord guards are used, it shall be correctly installed and insulated. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them.

Inlet openings and/or charging cable assemblies entries shall allow the introduction of the conduit or the sheath of the wires and/or cable so as to afford complete mechanical protection.

Conduit entries, charging cable assemblies entries and knockouts shall be constructed or located so that the introduction of the conduit or cable does not reduce creepage distances or clearances with the values specified in 8.5 and 8.6.

Conduit entries, charging cable assemblies entries and knockouts shall be constructed or located so that the introduction of the conduit or cable does not reduce the protection measures adopted by the manufacturer.

Compliance is checked by inspection.

6.1.3 Requirements for connection or no connection to the earth

6.1.3.1 Requirements for combination

The on-board charging system shall be one of the combinations specified in Table 1 or Table 2.

NOTE Refer to A.2 for the parts included in charging system.

The insulation requirements described in Table 1 and Table 2 show the minimum requirements for each combination.

The vehicle inlet shall not be compatible with connectors which are not intended to accommodate.

Table 1 — Allowable combination of charger and vehicle (the case of charging type A)

On-board chargers (fixed on vehicle)			Vehicles			The construction of the connection to the earth[d]
Grade of insulation between the enclosure and primary circuits[c]	Earthing of exposed conductive parts of primary circuits	Separation between the primary circuits and secondary circuits	Voltage class of RESS circuits	Grade of insulation between the accessible parts and RESS circuits	Earthing of exposed conductive parts	
Basic[a, b]	X	Not galvanically separated	A/B	Basic[a, b]	X	Refer to a
			A/B	Double or reinforced[a]	—	Refer to d
		Galvanically separated equivalent to basic insulation	A/B	Basic[b]	X	Refer to a
			A/B	Double or reinforced	—	Refer to d
		Galvanically separated equivalent to double or reinforced insulation	A	—	—	Refer to d
			A/B	Basic[b]	—	Refer to d
			A/B	Double or reinforced	—	Refer to d
Double or reinforced	—	Not galvanically separated	A/B	Basic[a, b]	X	Refer to c
			A/B	Double or reinforced[a]	—	Refer to b
		Galvanically separated equivalent to basic insulation	A/B	Basic[b]	X	Refer to c
			A/B	Double or reinforced	—	Refer to b
		Galvanically separated equivalent to double or reinforced insulation	A	—	—	Refer to b
			A/B	Basic[b]	—	Refer to b
			A/B	Double or reinforced	—	Refer to b

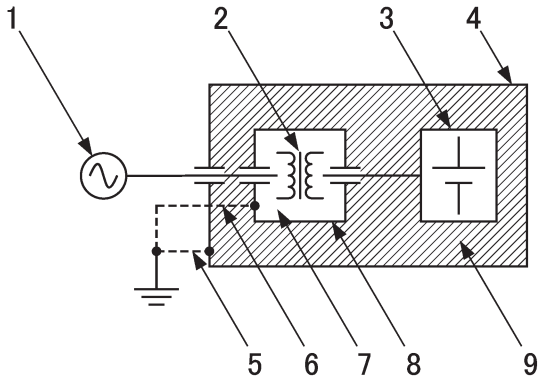
NOTE Potential equalization is required for the exposed conductive parts of voltage class B circuits of the vehicle in ISO 13063:2012, 8.12.

[a] ISO 13063 does not prohibit users from accessing to the voltage class A live parts of the vehicle.

[b] According to ISO 13063, an additional protection shall be required for the vehicle with the voltage class B component with basic insulation as a protective measure against electrical shock, in case that enough insulation is not ensured under single failure condition.

[c] The enclosure of chargers can be constructed of the exterior portion (e.g. enclosure) of the vehicle and also a part of the enclosure of a charger may be exposed.

[d] Refer to 6.1.1.



Key

1 a.c. supply network (mains)
2 separation between the primary circuit and secondary circuit of on-board chargers
3 on-board RESS
4 accessible parts of the vehicle
5 earth for protection of the vehicle
6 earth for protection of on-board chargers
7 insulation between the enclosure and primary circuits of on-board chargers
8 enclosure of on-board chargers (fixed)
9 insulation between the accessible parts and RESS circuits of the vehicle

Figure 2 — Sample of circuit diagram (the case of charging type A)

Table 2 — Allowable combination of charger and vehicle (the case of charging type B) or detachable RESS (the case of charging type C)

Off-board d.c. charger[c]	Vehicle or detachable RESS			The construction of the connection to the earth[d]
Separation between a.c. supply network (mains) and the vehicle or detachable RESS[c]	Voltage class of RESS circuits	Grade of insulation between the accessible parts and RESS circuits	Earthing of exposed conductive parts	
Galvanically separated equivalent to basic insulation	A/B	Basic[b]	X	Refer to a or c
	A/B	Double or reinforced	—	Refer to b or d
Galvanically separated equivalent to double or reinforced insulation	A	—	—	Refer to b or d
	A/B	Basic[b]	—	Refer to b or d
	A/B	Double or reinforced	—	Refer to b or d

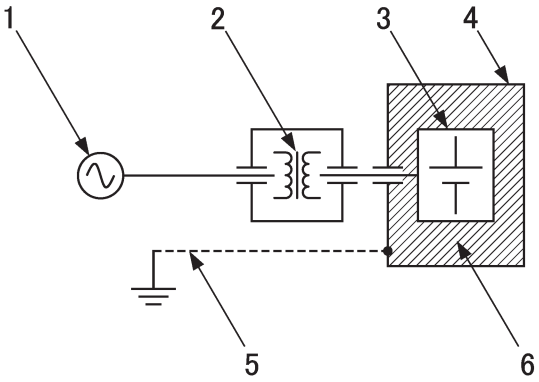
NOTE Potential equalization is required for the exposed conductive parts of voltage class B circuits of the vehicle in ISO 13063:2012, 8.12.

[a] ISO 13063 does not prohibit users from accessing to the voltage class A live parts of the vehicle.

[b] According to ISO 13063, an additional protection shall be required for the vehicle with the voltage class B component with basic insulation as a protective measure against electrical shock, in case that enough insulation is not ensured under single failure condition.

[c] The grades showed in these columns are conditions of off-board chargers, which are necessary to provide requirements for a vehicle.

[d] Refer to 6.1.1.



Key

1 a.c. supply network (mains)
2 separation between the a.c. supply network (mains) and the vehicle
3 on-board RESS
4 accessible parts of the vehicle
5 earth for protection of the vehicle
6 insulation between the accessible parts and RESS circuit of the vehicle

Figure 3 — Sample of circuit diagram (the case of charging type B)

6.1.3.2 Requirements of the "connection to the earth"

The construction of the connection to the earth is specified in 6.1.1.

In the case of charging type A, the following conditions shall be satisfied in order to make up this connection:

— not galvanically separated or galvanically separated equivalent to basic insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as basic insulation;

— the insulation of vehicle between the accessible parts and RESS circuits being categorized as basic insulation;

— earthing of enclosure of on-board chargers;

— earthing of exposed conductive parts of vehicle.

In the case of charging type B or C, the following conditions shall be satisfied in order to make up this connection:

— galvanically separated equivalent to basic insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— the insulation of vehicle and/or detachable RESS between the accessible parts and RESS circuits being categorized as basic insulation;

— earthing of exposed conductive parts of vehicle and/or detachable RESS.

The protection measures shall meet the requirements as described in 7.2 and 7.3 and compliance shall be tested according to Clause 8.

6.1.3.3 Requirements of "no connection to the earth"

The construction of the connection is specified in 6.1.1.

In the case of charging type A, the following conditions shall be satisfied in order to make up this connection:

— not galvanically separated or galvanically separated equivalent to basic insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as double or reinforced insulation;

— the insulation of vehicle between the accessible parts and RESS circuits being categorized as double or reinforced insulation;

or

— galvanically separated equivalent to double or reinforced insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as double or reinforced insulation;

— the insulation of vehicle between the accessible parts and RESS circuits being categorized as at least basic insulation;

or

— galvanically separated equivalent to double or reinforced insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as double or reinforced insulation;

— voltage class of RESS circuits being A.

In the case of charging type B or C, the following conditions shall be satisfied in order to make up this connection:

— galvanically separated equivalent to basic insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— the insulation of vehicle and/or detachable RESS between the accessible parts and RESS circuits being categorized as double or reinforced insulation;

or

— galvanically separated equivalent to double or reinforced insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— the insulation of vehicle and/or detachable RESS between the accessible parts and RESS circuits being categorized as at least basic insulation;

or

— galvanically separated equivalent to double or reinforced insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— voltage class of RESS circuits being A.

The protection measures shall meet the requirements as described in 7.2 and 7.3 and compliance shall be tested according to Clause 8.

6.1.3.4 Requirements of a "separate connection to the earth"

The construction of the connection to the earth is specified in 6.1.1.

In the case of charging type A, the following conditions shall be satisfied in order to make up this connection:

— not galvanically separated or galvanically separated equivalent to basic insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as double or reinforced insulation;

— the insulation of vehicle between the accessible parts and RESS circuits being categorized as basic insulation;

— earthing of exposed conductive parts of vehicle.

In the case of charging type B or C, the following conditions shall be satisfied in order to make up this connection:

— galvanically separated equivalent to basic insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— the insulation of vehicle and/or detachable RESS between the accessible parts and RESS circuits being categorized as basic insulation;

— earthing of exposed conductive parts of vehicle and/or detachable RESS.

NOTE The requirements described in "connection to the earth" are applicable if off-board charger is equipped with earthing.

When the equipotential bonding terminal of RESS/vehicle isolated with basic insulation is connected to the protective conductor, the protective earthing connection between the a.c. supply network (mains) and RESS and/or vehicle may be bypassed through the off-board charger assembly.

The protection measures shall meet the requirements as described in 7.2 and 7.3 and compliance shall be tested according to Clause 8.

6.1.3.5 Requirements of "partial connection to the earth"

The construction of the connection to the earth is specified in 6.1.1.

In the case of charging type A, the following conditions shall be satisfied in order to make up this connection:

— not galvanically separated or galvanically separated equivalent to basic insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as basic insulation;

— the insulation of vehicle between the accessible parts and RESS circuits being categorized as double or reinforced insulation;

— earthing for enclosure of on-board chargers;

or

— galvanically separated equivalent to double or reinforced insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as basic insulation;

— the insulation of vehicle between the accessible parts and RESS circuits being categorized as at least basic insulation;

— earthing for enclosure of on-board chargers;

or

— galvanically separated equivalent to double or reinforced insulation between the primary circuits and secondary circuits;

— the insulation of on-board chargers between the enclosure and primary circuits being categorized as basic insulation;

— voltage class of RESS circuits being A;

— earthing for enclosure of on-board chargers.

In the case of charging type B or C, the following conditions shall be satisfied in order to make up this connection:

— galvanically separated equivalent to basic insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— the insulation of vehicle and/or detachable RESS between the accessible parts and RESS circuits being categorized as double or reinforced insulation;

or

— galvanically separated equivalent to double or reinforced insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— the insulation of vehicle and/or detachable RESS between the accessible parts and RESS circuits being categorized as at least basic insulation;

or

— galvanically separated equivalent to double or reinforced insulation between a.c. supply network (mains) and vehicle and/or detachable RESS;

— voltage class of RESS circuits being A.

NOTE 1 The requirements described in “no connection to the earth” are applicable if off-board charger is not equipped with earthing.

The protection measures shall meet the requirements as described in 7.2 and 7.3 and compliance shall be tested according to Clause 8.

NOTE 2 When the off-board charger assembly is connected to the earth, the RCD or monitoring system to detect leaking current to the earth can be installed onto the connection between the a.c. supply network (mains) and RESS of the vehicle.

6.1.4 Service life of the vehicle inlet

The requirements of the vehicle inlet or RESS inlet are specified by the vehicle manufacturer.

6.1.5 Vehicle behaviour during charging

If the plug is connected to the external electric power supply, vehicle movement by its own propulsion system shall be impossible.

For a vehicle with a permanently attached charging cable, this requirement is not applicable if using the cable to charge the vehicle prevents the use of the vehicle (e.g. seat cannot be closed, the cable position does not allow the rider to sit in or step into the vehicle).

In case that the device equipped on the vehicle provides the vehicle with maintaining standstill, the propulsion motor may activate even if the plug is connected to the external electric power supply.

If the vehicle is disconnected from the external electric power supply, unintentional vehicle movement by its own propulsion system shall not be induced.

6.2 A.C. connection

6.2.1 Requirements for the connection to a.c. supply network (mains)

There shall be only one means of connecting the charger to an external power supply.

Compliance is checked by inspection.

In the case of charging type A described in Annex A, the connecting parts of charging cable assembly that comply with IEC 60884 shall not exceed the following ranges either indoors or outdoors:

— alternate rated working voltage 440 V;

— alternate rated current 32 A.

If pre-soldered flexible conductors are used for an a.c. connection with screw-type terminals, care shall be taken that the pre-soldered area shall be outside of the clamp area when connected as for normal use.

6.2.2 Requirements of connection and/or disconnection process in a.c. contacts

6.2.2.1 Contact sequence

Earth contact, if any, shall close before line and neutral contacts.

The sequence of other contacts, if any, shall be specified by the vehicle manufacturer.

6.2.2.2 Removal sequence

Earth contact, if any, shall open after line and neutral contacts.

The sequence of other contacts, if any, shall be specified by the vehicle manufacturer.

6.2.3 Protection from unintended voltage for a.c. connection

The plug or vehicle inlet shall comply with at least one of the following requirements:

— the energy shall be below 0,2 J within 1 s after cut off of the external power supply;

— the voltage shall be below 60 V d.c. and 30 V a.c. (r.m.s.) within 1 s after cut off of the external power supply.

NOTE Cut off of external power supply means loss of supply voltage, including disconnection and voltage outage on the supply.

6.3 D.C. connection

6.3.1 Requirements of connection and/or disconnection process in d.c. contacts

For safety reasons, requirements of the connecting and disconnecting sequence shall be specified by the vehicle manufacturer.

6.3.2 Protection from unintended voltage for d.c. connection

The vehicle inlet shall comply with at least one of the following requirements:

— the energy of the total capacitance between any energized voltage class B live part and the electric chassis and/or exposed conductive parts shall be lower than 0,2 J at its maximum working voltage. Total capacitance should be calculated based on designed values of related parts and components;

— the voltage shall be below 60 V d.c. within 1 s after disconnection of the vehicle coupler.

These requirements shall be fulfilled in unmated portions of the vehicle inlet if other parts do not cover poles.

6.3.3 Specific requirements

Contacts shall be so designed as to ensure adequate contact pressure when completely engaged with the corresponding connection between the charger device and vehicle couplers or RESS of the vehicle. Contacts of RESS coupler and/or vehicle coupler shall be self-adjusting to ensure adequate contact pressure.

7 Protection of persons against electric shock

7.1 General requirements

Protection against electric shock shall be comprised of the following:

— basic protection measures against direct contact with hazardous-live-parts;

— measures for protection under single failure conditions.

The basic protection measures against direct contact shall be provided by basic insulation of the hazardous-live-parts or any hazardous-live-parts while charged shall not be accessible in normal use. If basic protection is provided by barriers/enclosures, hazardous-live-parts shall be placed inside enclosures or behind barriers, preventing access to the hazardous-live-parts from any usual direction of access.

Any exposed conductive parts shall not become hazardous-live-parts under normal conditions (operation as intended use and in the absence of a failure) and under single failure conditions.

NOTE When one or more live parts isolated from primary circuit and from earth become accessible by failure, those parts are not considered hazardous-live-parts if they are at the same potential.

7.2 Requirements and measures for voltage class A on-board components

In the case of no galvanic separation or galvanic separation equivalent to basic insulation between the a.c. supply network (mains) and voltage class A circuits, the voltage class A circuit shall have the equivalent insulation as described in 7.3.4 and the equivalent potential equalization as described in 7.3.5.

NOTE If the insulations between the a.c. supply network (mains) and voltage class A circuits are only basic, the class A circuits can be hazardous-live-parts under single failure condition.

7.3 Requirements and measures for the voltage class B on-board charging system

7.3.1 Requirements for the on-board charging system

Protection against electric shock shall be comprised of the following:

a) basic protection measures against direct contact with hazardous-live-parts (basic protection);

b) measures for protection under single failure conditions.

The protection measures shall meet the requirements as described in 7.3.2.

7.3.2 Protection under single failure conditions

The voltage class B on-board equipment shall have sufficient isolation resistance according to 8.4.

If the minimum isolation resistance requirement cannot be maintained under all operational conditions and over the entire service life, one of the following measures shall be applied:

a) monitoring of the isolation resistance periodically or continuously. An appropriate warning shall be provided if loss of isolation resistance is detected. The voltage class B on-board charging system may be deactivated depending on the operational state of the vehicle or the ability to activate the voltage class B on-board charging system may be limited;

b) double insulation or reinforced insulation;

c) an additional layer of barriers/enclosures over the basic protection.

Exposed conductive parts of voltage class B electric on-board equipment including exposed conductive barriers/enclosures shall be bonded to the electric chassis and/or exposed conductive parts for potential equalization.

7.3.3 Requirements of barrier/enclosures

If protection is provided by barriers/enclosures, hazardous-live-parts shall be placed inside enclosures or behind barriers, preventing access to the hazardous-live-parts from any usual direction of access.

The barriers/enclosures shall provide sufficient mechanical resistance under normal operating conditions, as specified by the manufacturer.

If barriers/enclosures are accessible directly, they shall be opened or removed only by use of tools or maintenance keys or they shall have means to deactivate hazardous-live-parts with class B voltage of the on-board charging system.

NOTE 1 Refer to 9.1 for marking on barriers/enclosures of voltage class B electric parts of the on-board charging system.

NOTE 2 Refer to 7.4.2 for the minimum protection degree for person against electrical shock on barrier/enclosures.

7.3.4 Requirements of insulation

If protection is provided by insulation, the hazardous-live-parts of the on-board charging system shall be totally encapsulated by insulation, which can be removed only by destruction or tools.

The insulating material shall be suitable to the maximum working voltage and operating/storage temperature ratings of the vehicle and its charging system.

Insulating varnish, dope, enamel, and other similar materials are not acceptable as basic insulation of the voltage class B components.

The insulation of the voltage class B components shall fulfill the withstand voltage capability according to the withstand voltage test in the 8.3.

7.3.5 Requirements of potential equalization

All voltage class B on-board components forming the potential equalization current path (conductors and/or connections) shall withstand the maximum single failure current in a maximum failure clearance time.

The resistance of the potential equalization path between any two exposed conductive parts of the voltage class B on-board charging system which can be touched simultaneously by a person shall not exceed 0,1 Ω.

7.4 Protection degrees

7.4.1 General

The on-board charging components shall comply with the protection degree IPXXB at minimum.

The on-board charging components shall meet their minimum protection degree for person against electrical shock shown in Table 3.

If vehicle coupler parts and/or cable parts can be disconnected without tools, they shall comply with IPXXB at minimum in unmated condition for the contacts that can have class B voltage.

Table 3 — Protection degree

Part	Minimum protection degree
For charging assembly	IPXXD or IPXXB
For vehicle couplers mated	IPXXD
For plugs mated	IPXXD
For vehicle couplers not mated	IPXXD or IPXXB
For plugs not mated	Conform to regulation of each country

7.4.2 Requirements of the protection degree of barrier/enclosures against electric shock

Barriers/enclosures shall comply with the protection degree IPXXB at minimum.

In case the barriers/enclosures can be intentionally or unintentionally accessed under normal conditions of use and without any tool by the rider, barrier/enclosures shall comply with the protection degree IPXXD at minimum.

8 Other requirements for the on-board charging system

8.1 General test requirements of on-board equipment

The tests to verify the protection measures shall in principle be performed on each electrical circuit on the on-board equipment.

If the safety aspects in relation to on-board equipment are not affected, the tests may be performed outside the vehicle.

The tests shall be carried out with the on-board equipment, or any movable part of it, placed in the most unfavourable position which may occur in normal use. Unless otherwise specified, the tests shall be carried out in a draught-free location and at an ambient temperature of 23 °C ± 5 °C.

8.2 Degree of protection of on-board equipment

The on-board equipment shall meet their minimum degree of protection shown in Table 4.

In case of using the standard type plug, the degree of protection shall be subject to their manufacturers' specifications. Tests shall be made on each standard type plug to ensure the plug complies with requirements specified in Table 4.

The on-board electrical equipment installed at the place of the pollution degree 3 described in Table 5 shall be adequately protected against the ingress of solids, liquids, and/or contaminants such as dust, acids, corrosive gases, and salts that can be present in the physical environment.

The degree of protection of solid foreign objects and of liquids shall give no influences under normal use against dust, coolants, and swarf.

The on-board equipment shall be designed when dismantling to avoid displacing any water within the on-board equipment. The on-board equipment shall then withstand the dielectric strength specified in 8.3 and, after carefully wiping the vehicle couplers/plugs to remove any surplus water, an inspection shall show that there is no trace of water on insulation which could result in a reduction of creepage distances or clearances below the values specified in 8.5 and 8.6.

Compliance is checked by inspection or tests specified in ISO 20653.

Table 4 — Degree of protection of the on-board equipment

Part	Degree of protection	
	Indoor use	Outdoor use
Vehicle coupler/charger coupler mated	IP21	IP44
Vehicle coupler not mated	IP21	IP44
Charger coupler not mated	IP21	IP24
Plug not mated	Conform to regulation of each country	Conform to regulation of each country

Table 5 — Pollution degree of the on-board equipment

Pollution degree	Environmental conditions
1	No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
2	Only non-conductive pollution occurs except that occasionally, a temporary conductivity caused by condensation is to be expected.
3	Conductive pollution occurs or dry, non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.
4	Continuous conductivity occurs due to conductive dust, rain or other wet conditions.
NOTE This table is extracted from IEC 60664–1, 4.6.2. The related information also can be found in IEC 60664–1 .	

8.3 Dielectric withstand characteristics of on-board equipment

8.3.1 Test voltage not conductively connected to the parts

The test voltage, a.c. or d.c., shall be more than the highest voltage that is actually applied to the parts. The test voltage shall be derived from the relevant over-voltages of the electric circuit to which the parts are connected. Transient over-voltages that can be expected, including influences from other connections to external electric power sources, if any, shall be considered. The test voltage and its duration shall be specified, considering applicable parts and sections of IEC 60664 by the vehicle manufacturer.

The following a.c. test voltage of a frequency between 50 Hz and 60 Hz shall be applied for 1 min:

a) (2*U* + 1 000) V a.c. (r.m.s.) if basic insulation applies;

b) (2*U* + 2 400) V a.c. (r.m.s.) if double insulation and/or reinforced insulation applies between a.c. or d.c. parts of class B voltage and d.c. parts of class A voltage;

NOTE In case of double insulation and/or reinforced insulation applying in between the a.c. or d.c. parts of class B voltage and d.c. parts of class A voltage, the dielectric withstand voltage between d.c. parts of class A voltage and exposed conductive parts is specified in 8.3.2.

c) (2*U* + 3 250) V a.c. (r.m.s.) if double insulation and reinforced insulation applies

where *U*, expressed in volts, is the maximum working voltage of the electric circuit to which the parts are connected.

The equivalent d.c. test voltage is 1,41 times the a.c. (r.m.s.) value.

The following test procedure shall be applied:

— all voltage class B live parts of the on-board equipment shall be connected to each other;

— for components with conductive housing, all live parts of the voltage class A electric circuit of the on-board equipment and all exposed conductive parts of the on-board equipment shall be connected to each other;

— for components with non-conductive housing, all live parts of the voltage class A electric circuit of the on-board equipment and electrode wrapped around the housing shall be connected to each other;

— components designed for a lower test voltage and current consuming apparatus (e.g. windings, measuring instruments and voltage surge suppression devices) shall be disconnected. Such apparatus shall be disconnected at one of their terminals unless they are not designed to withstand the full test voltage, in which case all terminals may be disconnected.

8.3.2 Dielectric withstand voltage of voltage class A direct current part

In case of double insulation and/or reinforced insulation applying in between the a.c. or d.c. parts of class B voltage and d.c. parts of class A voltage, the dielectric withstand voltage expressed in V shall be equal to (2 *Ur* + 500) V a.c. (r.m.s.) for 2 min and applied between live parts and other exposed metal parts only, where *Ur*, expressed in volts, is the rated voltage of the electric circuit of voltage class A.

8.4 Isolation resistance requirements of on-board equipment

8.4.1 General

The minimum isolation resistance of the on-board equipment shall be at least 100 Ω/V for d.c. circuits and at least 500 Ω/V for a.c. circuits. The reference shall be the maximum working voltage with each electric component or circuit while charged.

NOTE Hazard of electric shock occurs when electric currents depending on value and duration pass through the human body. Harmful effects can be avoided if the current is within zone DC-2 for d.c. or zone AC-2 for a.c. as shown in IEC/TS 60479–1: 2005, Figure 20 and Figure 22, respectively. The relation of harmful body currents and other wave forms and frequencies is described in IEC/TS 60479–2. The isolation resistance requirements of 100 Ω/V for d.c. or 500 Ω/V for a.c. allow body currents of 10 mA and 2 mA, respectively.

To meet the above requirement for the entire circuit of the on-board equipment, it is necessary to have a higher isolation resistance for each part, depending on the number of the parts and the structure of the circuit which they belong.

If d.c. and a.c. circuits are conductively connected, one of the following two options shall be fulfilled:

a) option 1: meet at least the 500 Ω/V requirement for the combined circuit;

b) option 2: meet at least the 100 Ω/V requirement for the entire conductively connected circuit, if at least one of the additional protection measures as defined in 8.4.2 is applied to the a.c. circuit.

8.4.2 Additional protection measures for the a.c. circuit connected to the d.c. circuit of the on-board equipment

One or a combination of the following measures in addition to or instead of the basic protection measures as described in 7.3 may be applied to provide protection against single failure(s) to address the failure(s), for which it is intended:

a) one or more layers of insulation, barriers, and/or enclosures in addition to the basic protection;

b) double or reinforced insulation instead of basic insulation;

c) rigid barriers/enclosures with sufficient mechanical robustness and durability, over the vehicle service life.

NOTE The rigid barriers/enclosures include (but are not limited to) power control enclosures, motor housings, connector casings and housings, etc. They can be used as single measure instead of basic barriers/enclosures to meet both basic and single failure(s) protection requirements.

8.5 Creepage distance of on-board equipment

The creepage distance of the on-board charging system shall be designed according to IEC 60664-1. In this case, the pollution degree shall be suitable for the range of application specified in IEC 60664-1.

If electrolyte leakage of RESS can occur under normal operating conditions, it is recommended that the creepage distance be as follows (refer to Figure 4).

a) In the case of a creepage distance between two connection terminals of the electric circuit for the charging system:

$$d \geq 0{,}25U + 5 \quad (1)$$

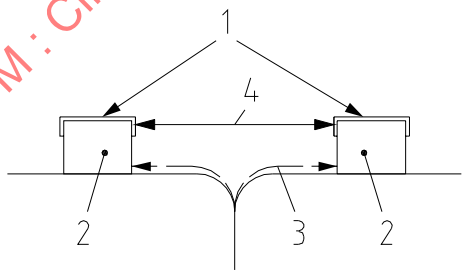
b) In the case of a creepage distance between live parts and the electric chassis:

$$d \geq 0{,}125U + 5 \quad (2)$$

where

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

U is the maximum working voltage between the two connection terminals of each electric component or circuit while charged, in volts (V).



Key

1 conductive surface
2 connector terminal
3 creepage distance
4 clearance

Figure 4 — Creepage distance and clearance

8.6 Clearance of on-board equipment

The clearance of the on-board charging system shall be designed according to IEC 60664-1. In this case, the pollution degree shall be suitable for the range of application specified in IEC 60664-1.

If electrolyte leakage of RESS can occur under normal operating conditions, the construction around the voltage class B electrical circuits shall be designed to fulfill the clearance shown in Table 6.

NOTE This requirement can be applied to clearance around vented lead-acid batteries.

Table 6 — Minimum clearance of the on-board equipment

Maximum working voltage of each electric component or circuit while charged *U*		Minimum clearance *d*[a] mm			
		Current ≤ 63 A		Current > 63 A	
d.c. V	a.c. V (r.m.s.)	L-L[b]	L-A[c]	L-L[b]	L-A[c]
60 < *U* ≤ 125	30 < *U* ≤ 125	3	5	5	6
125 < *U* ≤ 250		3	5	5	6
250 < *U* ≤ 380		4	6	6	8
380 < *U* ≤ 500		6	8	8	10
500 < *U* ≤ 660		6	8	8	10
660 < *U* ≤ 800	660 < *U* ≤ 750	10	14	10	14
800 < *U* ≤ 1 500	750 < *U* ≤ 1 000	14	20	14	20

NOTE This classification of working voltage is prepared for clearance requirement only.

[a] Refer to Figure 4.

[b] Distance between two of connection terminals of the on-board equipment.

[c] Distance between the live part and the PE of the on-board equipment.

8.7 Touch current

When the vehicle is connected to a.c. supply network (mains), the touch current of the vehicle shall not exceed the following values according to the test procedure specified below:

— for the vehicle with earthing connection 3,5 mA peak;

— for the vehicle without earthing connection 0,35 mA peak.

The touch current shall be measured when the vehicle is connected to a.c. supply network (mains) and the vehicle system is operating at highest rated power, highest rated frequency and 110 % of the highest rated voltage with disconnection of the protective conductor (switch "e" in IEC 60950-1 open) in accordance with IEC 60950-1, 5.1.3. The touch current shall be then measured in accordance with IEC 60950-1, 5.1.4, using the measurement network of IEC 60950-1, D.1 and considering the r.m.s. value. Terminal A of measuring network shall be connected to an enclosure of equipment under test (EUT) via measurement switch "s" such as shown in IEC 60990, Figure 6 or 11.

The above measurement shall be repeated with reversed polarity of the current carrying conductors, if applicable (switch "p1" in IEC 60950-1).

The circuitry connected through a fixed resistance or referenced to earth (e.g. electric vehicle connection check) should be disconnected before this test.

8.8 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 around the vehicle.

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 single failure situations.

8.9 Environmental tests

8.9.1 General

During the following tests, the on-board equipment shall function at its nominal voltage with maximum output power and current of each electric component or circuit while charged. After each test, the on-board equipment shall meet its performance requirements.

8.9.2 Ambient air temperature

The ambient air temperature of the on-board equipment while preserved and/or charged shall not exceed +40 °C and its average over a period of 24 h shall not exceed +35 °C. The ambient air temperature of the on-board equipment while preserved and/or charged shall not descend lower than –5 °C. If needed, the other ambient air temperature can be specified.

The on-board equipment shall be tested at the specified ambient temperature, the maximum temperature and minimum temperatures at the power levels guaranteed by the manufacturer under those conditions.

The on-board equipment shall go through a start and stop cycle at each temperature.

NOTE National standards or regulations may require different operating temperature ranges.

8.9.3 Ambient humidity

The on-board equipment shall be designed with a relative humidity rate between 5 % and 95 % for charging and preserving.

8.9.4 Ambient air pressure

The on-board equipment shall be designed to operate at an atmospheric pressure between 860 hPa and 1 060 hPa for charging and preserving.

8.10 Permissible surface temperature

The maximum permissible surface temperature of the on-board equipment that is touched but not grasped, at the maximum rated current and at ambient temperature of 40 °C, shall be

— 70 °C for metal parts, and

— 85 °C for non-metallic parts.

8.11 Environmental conditions

The on-board equipment shall be designed to

— resist the effect of normal electric vehicle solvents and fluids,

— resist the effect of vibration and shock,

— resist the effect of other conditions appropriate to the application, and

— comply with material flammability standards.

8.12 Unintentional charging system behaviour

Unintentional behaviour of the on-board equipment caused by single-point man-made, hardware or software failure(s) (single failure(s)) during operation in the system and components specific to electric vehicles and on-board equipment shall be minimized.

8.13 Electromagnetic compatibility

8.13.1 Susceptibility

Care shall be taken to minimize electromagnetic susceptibility of the on-board equipment, taking into account national standards or regulations and International Standards.

8.13.2 Emissions

Care shall be taken to minimize electromagnetic emission from the on-board equipment, taking into account national standards or regulations and International Standards.

8.14 Service

The on-board equipment shall be designed so that vehicle manufacturers' certified technicians may remove, service and replace it if necessary.

9 Marking, instructions, and indications

9.1 Marking

The vehicle shall be marked in accordance with applicable national standards or regulations and International Standards.

The symbol shown in Figure 5 shall appear on (preferably) or near voltage class B parts of the on-board equipment. The same symbol shall be visible on barriers and enclosures, which, when removed, expose live parts of voltage class B circuits. Accessibility and removability of barriers/enclosures should be considered for the necessity of the symbol. The symbol background shall be yellow, the bordering and the arrow shall be black in accordance with ISO 3864-1.

Figure 5 — Symbol of voltage class B parts of the on-board equipment

9.2 Legibility

The markings required by this International Standard shall be legible with corrected vision, durable and visible during use.

The marking shall have a good contrast with their background. If the indication may be placed on a vehicle, parts of a vehicle or the on-board equipment, the indication may be viewed by the rider from one's normal seated position.

9.3 Connection instructions

Instructions for the connection of the vehicle to an external electric power supply shall be provided with place of manufacturer indicating and/or the user's manual.

9.4 Indication

The on-board equipment may be able to indicate that the vehicle is properly connected to an external electric power supply. The indication may be easily recognizable by the person who carries on the charging.

The on-board equipment may be able to indicate that the vehicle is ready for energy to be supplied from the external electric power supply. The indication may be easily recognizable by the person who carries on the charging.

The indication shall have a good contrast with their background. If the indication may be placed on a vehicle, parts of a vehicle or the on-board equipment, the indication may be viewed by the rider from rider's normal seated position.

Annex A
(informative)

Charging types

A.1 Classification of charging type

In the most fundamental sense of charging, there are three functional portions. The first is the supply network (mains). The second is the charger assembly that consists of charger and cable assembly. The third is the RESS, which may be incorporated onto the vehicle.

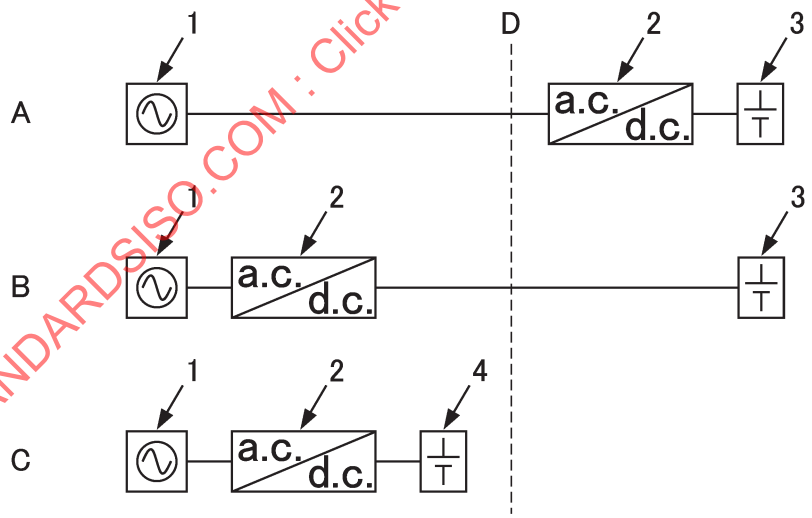
The classification has been defined based upon acceptance of the connection and/or disconnecting between those three portions for operational safety:

For charging type A, the charger and the RESS are not able to be removed from the vehicle and they are electrically not able to be disconnected from the vehicle.

For charging type B, the RESS is not able to be removed and the charger is able to be removed from the vehicle. The RESS is electrically not able to be disconnected from the vehicle and the charger is electrically able to be disconnected from the vehicle.

For charging type C, the charger and the RESS are able to be removed from the vehicle and they are electrically able to be disconnected from the vehicle.

Any connections belong to conductive charging systems are able to be classified into the charging types of Figure A.1.



Key

1	a.c. supply network (mains)	A	charging type A
2	charger	B	charging type B
3	RESS	C	charging type C
4	detachable RESS	D	electrical detachable line from the vehicle

Figure A.1 — Classification of charging type in the conductive charging