IEC 61980-1

Edition 1.0 2015-07

INTERNATIONAL STANDARD

colour inside

Electric vehicle wireless power transfer (WPT) systems – Part 1: General requirements

IEC 61980-1:2015-07(en)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 43.120

ISBN 978-2-8322-2814-2

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CONTENTS

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ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 1: General requirements

FOREWORD

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International Standard IEC 61980-1 has been prepared by Technical Committee 69: Electric road vehicles and electric industrial trucks.

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

FDIS	Report on voting
69/370/FDIS	69/380/RVD

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

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

This part is to be used in conjunction with the appropriate part of IEC 61980 series.

NOTE The following print types are used:

– requirements: in roman type;

– test specifications: in italic type;

– notes: in small roman type.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The IEC 61980 series is published in separate parts according to the following structure:

Part 1 covers general requirements for electric road vehicle (EV) wireless power transfer (WPT) systems including general background and definitions (e.g. efficiency, electrical safety, EMC, EMF).

Future Part 2 will cover specific requirements for communication between electric road vehicle (EV) and wireless power transfer (WPT) systems including general background and definitions.

Future Part 3 will cover specific requirements for electric road vehicle (EV) magnetic field wireless power transfer (MF-WPT) systems including general background and definitions (e.g. efficiency, electrical safety, EMC, EMF).

The requirements described in Part 1 are general. The technical requirements for the various wireless power transfer (WPT) technologies are very different, they will be treated in technology specific parts of the 61980 series. A list of possible WPT technologies can be seen in 6.2. The requirements for magnetic field-wireless power transfer systems (MF-WPT) will be described in future Part 3. Further parts of this series will describe other technologies such as power transfer via electric field wireless power transfer systems (EF-WPT) or electromagnetic field-WPT systems also named microwave-WPT systems (MW-WPT).

Reference to "technology specific parts" always refer to the technology specific future Part 3 and further technology specific parts of this series. The structure of the "technology specific parts" will follow the structure of Part 1.

Electric road vehicle (EV) will be covered by ISO 19363[1].

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1 Under consideration.

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 1: General requirements

1 Scope

This part of IEC 61980 applies to the equipment for the wireless transfer of electric power from the supply network to electric road vehicles for purposes of supplying electric energy to the RESS (Rechargeable energy storage system) and/or other on-board electrical systems in an operational state when connected to the supply network, at standard supply voltages ratings per IEC 60038 up to 1 000 V a.c. and up to 1 500 V d.c.

This standard also applies to Wireless Power Transfer (WPT) equipment supplied from on-site storage systems (e.g. buffer batteries, etc.).

The aspects covered in this standard include:

– the characteristics and operating conditions;
– the specification for required level of electrical safety;
– requirements for basic communication for safety and process matters if required by a WPT system;
– requirements for basic positioning, efficiency and process matters if required by a WPT system;
– requirements for two- and three-wheel vehicles (under consideration);
– requirements for WPT system while driving (under consideration);
– requirements for bidirectional power transfer (under consideration);
– specific EMC requirements for WPT systems.

This standard does not apply to:

– safety aspects related to maintenance;
– trolley buses, rail vehicles and vehicles designed primarily for use off-road;
– WPT vehicle power supply circuit, which is covered by ISO 6469 series, ISO 19363[2];
– EMC requirements for on-board equipment while connected, which are covered in IEC 61851-21-1[3];
– high level communication which are covered in ISO/IEC 15118 series.

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.

IEC 60038, *IEC standard voltages*

_____

2 Under consideration.

3 Under consideration.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-5, *Environmental testing – Part 2-5: Tests – Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing*

IEC 60068-2-11, *Environmental testing – Part 2-11: Tests – Test Ka: Salt mist*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60216 (all parts), *Electrical insulating materials – Thermal endurance properties*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-4-42, *Low-voltage electrical installations – Part 4-42: Protection for safety – Protection against thermal effects*

IEC 60364-4-43, *Low-voltage electrical installations – Part 4-43: Protection for safety – Protection against overcurrent*

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

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60364-7-722[4], *Low-voltage electrical installations – Part 7-722: Requirements for special installations or locations – Supply of electric vehicles*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60898-1, *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

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4 To be published.

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*
Amendment 1:2009
Amendment 2:2013

IEC 60990:1999, *Methods of measurement of touch current and protective conductor current*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection*

IEC 61000-3-11, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection*

IEC 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤ 75 A per phase*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

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

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

61000-4-34, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – General rules*

IEC 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – General rules*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61180-1, *High-voltage test techniques for low-voltage equipment – Part 1: definitions, test and procedure requirements*

IEC 61439-1:2011, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-5:2014, *Low-voltage switchgear and controlgear assemblies – Part 5: Assemblies for power distribution in public networks*

IEC 61810-1, *Electromechanical elementary relays – Part 1: General and safety requirements*

IEC 61851-1, *Electric vehicle conductive charging system – Part 1: General requirements*

IEC 61851-21-1[5], *Electric vehicle conductive charging system – Part 21-1: Electric vehicle onboard charger EMC requirements for conductive connection to a.c./d.c. supply*

IEC 61851-21-2[6], *Electric vehicle conductive charging system – Part 21-2: EMC requirements for OFF board electric vehicle charging systems*

IEC 61980-2[7], *Electric vehicle wireless power transfer (WPT) systems – Part 2 specific requirements for communication between electric road vehicle (EV) and infrastructure with respect to wireless power transfer (WPT) systems*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

IEC 62423, *Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

IEC Guide 117:2010, *Electrotechnical equipment – Temperatures of touchable hot surfaces*

CISPR 11:2009, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 12:2007, *Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of off-board receivers*

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5 Under consideration.

6 Under consideration.

7 Under consideration.

CISPR 32:2012, *Electromagnetic compatibility of multimedia equipment – Emission requirements*

ISO 4628-3, *Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting*

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

ISO 11451-2, *Road vehicles – Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy – Part 2: Off-vehicle radiation sources*

ISO/IEC 15118-1:2013, *Road vehicles – Vehicle to grid communication interface – Part 1: General information and use-case definition*

ISO 19363[8], *Electric propelled road vehicles – Magnetic field wireless power transfer*

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 terms and definitions given in IEC 61851-1 and the following apply.

3.1
primary device
device (external to the EV) which provides the contactless coupling to the secondary device

Note 1 to entry: When the EV is receiving power the primary device acts as the source of the power to be transferred. The device includes the housing and all covers.

3.2
secondary device
device mounted on the EV which provides the contactless coupling to the primary device

Note 1 to entry: When the EV is receiving power the secondary device transfers the power from the primary to the EV. The device includes the housing and all covers.

3.3
off-board power components
off-board electronics that supply the electric power through the primary and secondary device to the EV including all housings and covers

3.4
on-board power components
on-board electronics which convert the received power to DC which is provided to the RESS or the traction-battery of the EV including all housings and covers

8 Under consideration.

3.5
electric vehicle
EV
electric road vehicle
any vehicle propelled by an electric motor drawing current from a rechargeable storage battery or from other portable energy storage devices (rechargeable, using energy from a source off the vehicle such as a residential or public electric service), which is manufactured primarily for use on public streets, roads or highways

3.6
protection targets
protection targets define the various conditions needed to protect against adverse effects of electromagnetic fields as defined by laws, rules, norms, standards and recommendations

3.7
protection target 1
protection against the adverse effects of electromagnetic fields or waves

3.8
protection target 2
protection against indirect effects of electromagnetic fields or waves, particularly with regard to heating and risk of burns upon direct contact, ignition and fire

3.9
protection areas
protection areas defined to describe areas in and around the vehicle that have homogeneous protection target requirements

SEE: Figure 8

Note 1 to entry: Areas in this context is used in a conventional sense and is three dimensional in space.

3.10
Wireless Power Transfer
WPT
WPT means the transfer of electrical energy from a power source to an electrical load via electric and or magnetic fields or waves between a primary and a secondary device

3.11
WPT System
the primary device, the off-board power components, supply equipment communication controller, the secondary device, the on-board power components and the electric vehicle communication controller

SEE: Figure 2

3.12
mechanical air gap, <of a WPT system>
shortest distance between the surface of the primary device and the surface of the secondary device

SEE: Figure 6 and Figure 7

3.13
operational air gap, <of a WPT system>
distance between the field face of the primary device and the field face of the secondary device in a double sided field system

SEE: Figure 6 and Figure 7

3.14
Alignment, <of a WPT system>
process of finding the relative position of primary to secondary device for the efficient power transfer that is specified

3.15
WPT vehicle power supply circuit
electrical sub circuit including dedicated components for WPT such as secondary device and on-board power components

3.16
standby mode
mode for EMC testing in which the wireless power transfer system is ready to be used by primary and secondary device

EXAMPLE presence detection active.

3.17
active mode
mode for EMC testing in which the WPT system is transferring energy between primary and secondary device

3.18
foreign objects
in the context of this specification, a foreign object is any object that is not an attached part of the vehicle or the WPT system

3.19
arm's reach
either the distance measured from the floor to the fingertips of a person fully extended in the vertical direction or, for any other direction, one-third of that distance

3.20
pairing
process by which a vehicle is correlated with the unique dedicated primary device, at which it is located and from which the power will be transferred

3.21
exposed conductive part
conductive part which can readily be touched and which is not normally alive, but which may become alive under fault conditions

Note 1 to entry: Typical exposed conductive parts are walls of enclosures, operating handles, etc.

[SOURCE: IEC 60050-441:1984, 441-11-10]

4 Abbreviations

Abbreviation	Explanation	Source
a.c.	alternating current	[SOURCE: IEC 60050-131:2002, 131 11 24]
d.c.	direct current	[SOURCE: IEC 60050-131:2002, 131 11 22]
RCBO	residual current operated circuit-breaker with integral overcurrent protection	[SOURCE: IEC 60050-442:1998, 442 05 04]
RCD	residual current device	[SOURCE: IEC 60050-442:1998, 442 05 02]
CB	circuit-breaker	[SOURCE: IEC 60050-442:1998, 442 05 01]

5 General

The supply voltage ratings are as defined in the scope. The off-board supply equipment (see Figure 2) shall be rated for one or a range of standard nominal voltages as given in IEC 60038. For a.c. the preferred frequencies which are taken into account in this standard are 50 Hz and 60 Hz. The use of other frequencies for special purposes is not excluded.

The WPT vehicle power supply circuit shall be coupled to the WPT off-board supply equipment of the WPT system so that the wireless power transfer function operates safely.

In general, this principle is achieved by fulfilling the relevant requirements specified in this standard and compliance is checked by carrying out all relevant tests.

The WPT off-board supply equipment shall be so designed and constructed that in normal use their performance is reliable and minimizes the risk of danger to the user or surroundings.

Compliance is checked by meeting all of the relevant requirements of IEC 61980 series.

Unless otherwise mentioned, all tests indicated in this standard are type tests.

Unless otherwise stated, tests may be conducted on separate samples, at the discretion of the manufacturer.

The EV supply equipment manufacturer shall provide the interface characteristics specified in IEC 61439-1 to the testing laboratory where applicable.

6 Classification

6.1 General

WPT systems are classified according to:

– transfer technologies;
– transfer power classes;
– environmental conditions.

6.2 Transfer technologies

The transfer technologies for WPT systems are shown in Table 1.

Table 1 – Transfer technologies

Transfer technology	Definition	Abbreviation
Inductive power transfer	Energy transfer through magnetic field	MF-WPT
Capacitive power transfer	Energy transfer through electric field	EF-WPT
Microwave power transfer	Energy transfer through electromagnetic waves 1 GHz – 300 GHz	MW-WPT
Infrared power transfer	Energy transfer through electromagnetic waves 300 GHz – 400 THz	IR-WPT

NOTE Inductive power transfer includes technologies utilizing magnetic resonance.

Additional technologies can be added in the future.

6.3 Transfer power classes

Transfer power classes are technology specific and will be specified in the technology specific parts of IEC 61980 series.

6.4 Environmental conditions

Environmental conditions shall be defined for WPT systems electric vehicle and infrastructure components according to existing specification based on IEC 61851-1 and ISO 19363 (under consideration).

The EV supply equipment is classified according to the environmental conditions and use:

– indoor use;
– industrial area exposed to pollution and /or severe conditions;
– outdoor use.

NOTE 1 Required pollution degrees are given in 13.3.

NOTE 2 EV supply equipment classified for outdoor use can be used for indoor use, provided ventilation requirements are satisfied.

NOTE 3 In some countries, national regulations require ventilation for indoor use: US, Canada.

6.5 Installation

According to the installation of secondary device on the EV (see Figure 1):

- ground mounted;
  – in-ground mounted;
  – on-ground mounted;
  – over stand;
- vertical surface mounted;
- on-roof mounted.

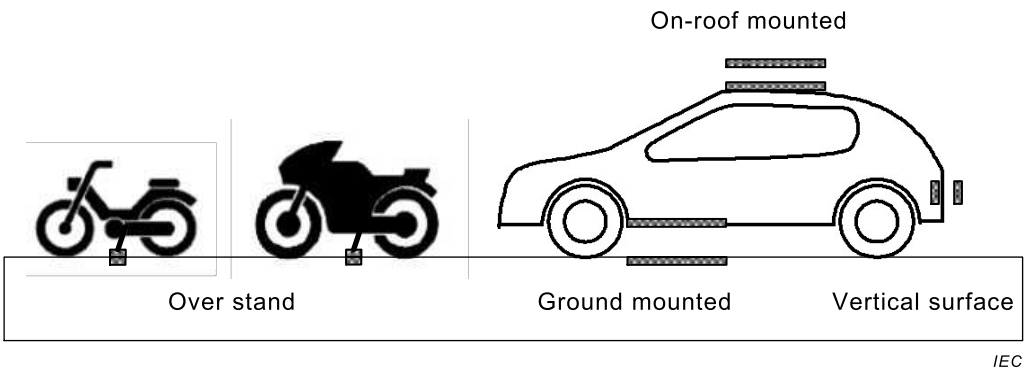


Figure 1 – Installation

7 Interoperability

Interoperability describes the state of the primary and the secondary device (as described in Figure 2) enabling wireless power transfer in a safe and efficient manner based on compliance with the relevant specification.

Interoperability can only be achieved by a WPT system, when the primary and secondary devices are of the same type of transfer technology.

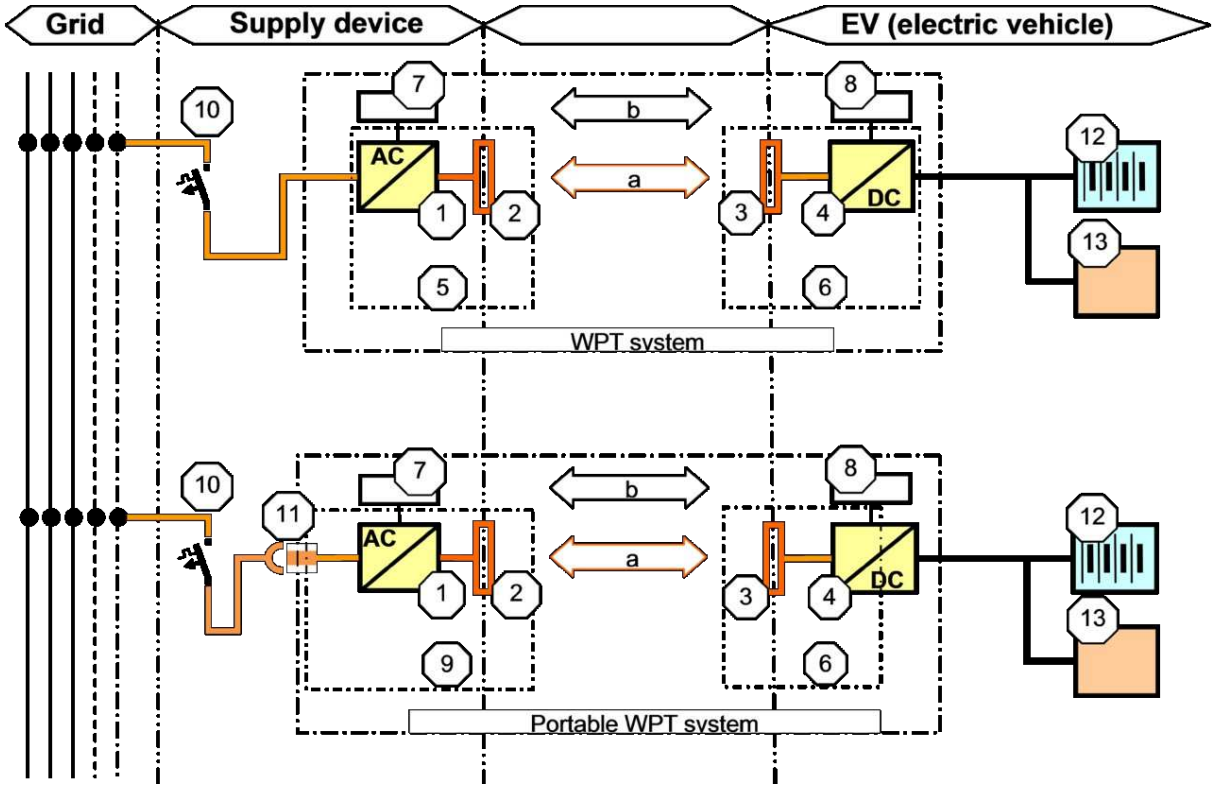
Interoperability of WPT systems between different transfer power classes within the same type of transfer technology is desired but not required.

Transfer technology specific interoperability will be described in the technology specific part of IEC 61980 series.

8 General system requirements

8.1 General

WPT is the transfer of electrical energy from a power source to an electrical load via electric and/or magnetic fields or waves between a primary and a secondary device without current flow over a galvanic connection. An example for WPT system (fixed installation and pluggable device) is provided in Figure 2. Some of the functional elements may be integrated into one enclosure.



Key	Name	Abbreviation
1	Off-board power components	
2	Primary device	
3	Secondary device	
4	On-board power components	
5	EV supply equipment	
6	WPT vehicle power supply circuit	
7	Supply equipment communication controller	SECC/PDCC
8	Electric vehicle communication controller	EVCC/SDCC
9	Portable EV supply equipment	
10	CB and RCD or RCBO	
11	Plug and socket-outlet	
12	RESS or traction battery	
13	Electrical load	
a	Wireless power transfer	
b	Communication according to future IEC 61980-2	

Figure 2 – Wireless Power Transfer system

8.2 Efficiency

System efficiency is defined from a.c. or d.c. power supply (input-supply-terminals of all off-board power and control electronics) to the connecting point of the electrical load on the vehicle side. It is of no importance whether this output is connected to a device or directly to a battery.

The efficiency will be specified in the technology specific parts of IEC 61980 series.

8.3 Measurement convention

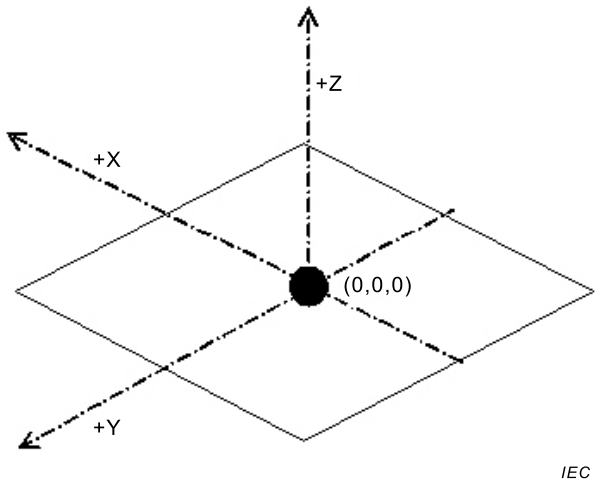
8.3.1 General

All dimensions below will be specified in the technology specific parts of IEC 61980 series.

8.3.2 Orientation

The three axes for the position of the primary and secondary device are defined as follows:

Dimensional data are based on the following orientation (see Figure 3).

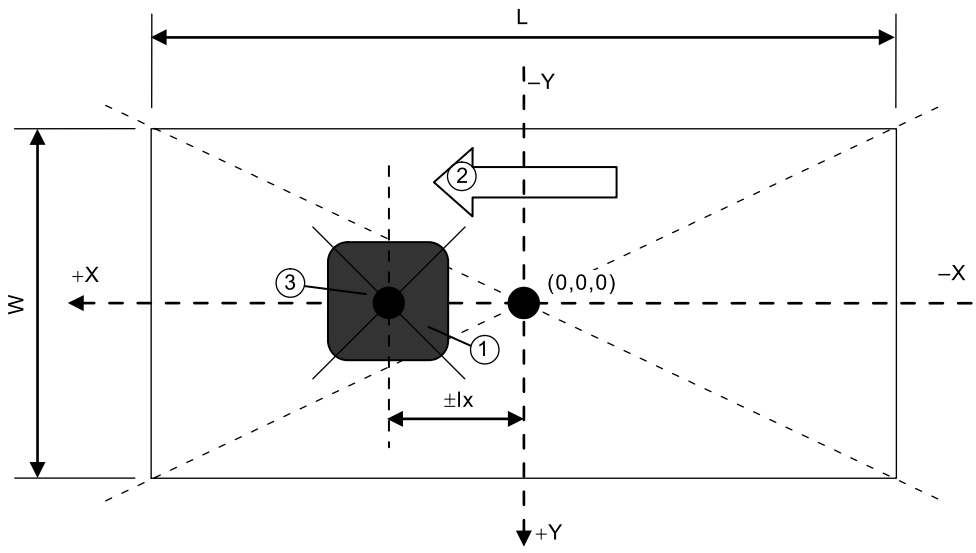


Key	Direction
+X	in the direction of travel (forward)
+Y	transverse to the direction of travel (leftward)
+Z	height (upward)
0,0,0	reference point

Figure 3 – Position of axes relative to orientation

8.3.3 Measurement convention of the parking space

The nominal position is defined for the purposes of unification of general measuring methods, comparability and subsequent compatibility testing. It is characterized by the shape of the parking space and the direction of travel. For ground mounted system, see Figure 4 gives an explanation about the measuring and the location of the primary device, As the measurements are recorded, see Table 2.



Key	Direction
1	primary device
2	0rientation: direction of travel
3	zero point (point of optimal power transfer)
0,0,0	reference point (zentre of the parking lot) (x=0, y=0, z=0)
L	length of the parking lot
W	width of the parking lot
+X	in the direction of travel (forward)
+Y	transverse to the direction of travel (leftward)
±lx	distance from the reference point to the zero point

Figure 4 – Position of the primary device

Table 2 – Position of primary device

direction	mm	axis
zero point in the direction of travel:	± xxx	X
transverse to the direction of travel:	± yyy	Y
in the height	± zzz	Z

NOTE The zero point is the point on the primary device for optimum alignment for power transfer.

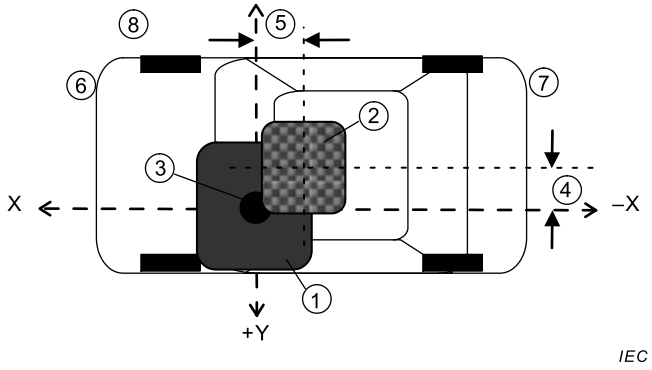
Some examples for possible parking positions are:

- parking lot in parallel to the drive direction;
- park forward, perpendicular to driving direction;
- park backwards, perpendicular to driving direction;
- parking at a diagonal angle to the driving direction.

8.3.4 Measurement convention of offset

The offset measurement conventions in direction of X axis and Y axis are defined as follows, see Figure 5. As the measurements are recorded, see Table 3.

Offset is the position in X and Y of the secondary device relative to zero point of the primary device.



key	name
1	primary device
2	secondary device
3	zero point
4	X offset
5	Y offset
6	front
7	rear
8	right side

Figure 5 – X and Y maximum offset

Table 3 – Offset

direction	mm	axis
in the direction of travel:	± xxx	X
transverse to the direction of travel:	± yyy	Y

8.3.5 Measurement convention of the primary device

Dimensions for the primary device are defined as shown in Table 4:

Table 4 – Primary device

direction	mm	axis
in the direction of travel:	xxx	X
transverse to the direction of travel:	yyy	Y
in the height	zzz	Z

8.3.6 Distance between the primary and secondary device (mechanical air gap)

For the design and electrical dimensioning of the wireless power transfer system, the distance between the primary and secondary device (mechanical air gap) depending on the transfer technologies is important. See Table 5.

NOTE The air-gap specified here is appropriate for technologies and mounting configurations where the primary and secondary devices are separated vertically. Other configurations are under consideration.

Table 5 – Mechanical air gap

direction	mm	axis
in the height	zzz	Z

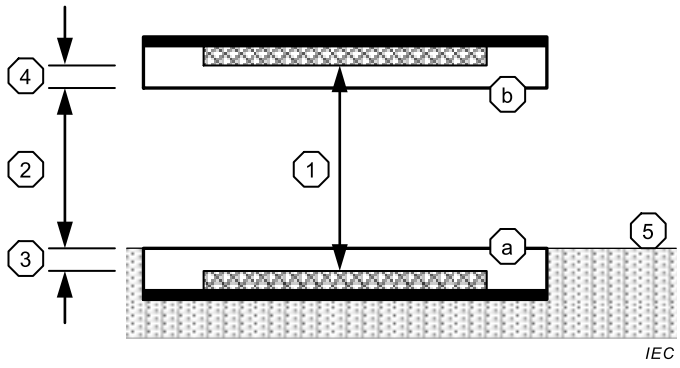
8.3.7 Primary device mounting

For the primary device, different mounting types are possible:

- in-ground-mounting (at or below surface);
- on-ground-mounting;
- other mounting position are under consideration (see 6.5).

8.3.8 In-ground-mounting

The primary device is completely embedded in the ground and mounted flush with the road surface. The surface of the primary device is located as shown in Figure 6 (Z = 0,0).



Key	Name
a	primary device
b	secondary device
1	operating air gap
2	mechanical air gap
3	covering primary device
4	covering secondary device
5	top of road surface

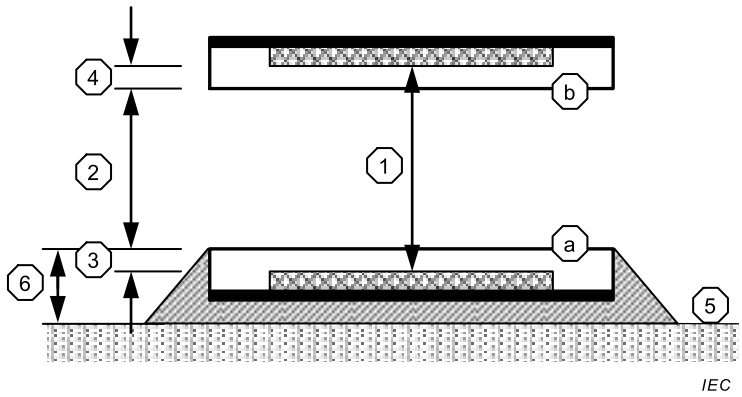
Figure 6 – In-ground-mounting

NOTE The distance between the primary and secondary device is equal to or greater than the ground clearance of the vehicle underneath the secondary device.

8.3.9 On-ground-mounting

The primary device is mounted in such a manner that it protrudes above ground up to certain mounting height as shown in Figure 7. The mounting height above road surface defined by installation guide of the corresponding vendor shall be equal to or less than the maximum value specified in the technology specific future parts of IEC 61980 series.

NOTE Defining a maximum mounting height is also reasonable in view of, for example, national specifications such as road construction regulations.



Key	Name
a	primary device
b	secondary device
1	operating air gap
2	mechanical air gap
3	covering primary device
4	covering secondary device
5	top of road surface
6	mounting height

Figure 7 – On-ground-mounting

Maximum mounting height may be a subject to local regulations defined regarding national specifications such as road construction regulations.

8.4 Primary and secondary device construction

The system specific dimensions and requirements on construction of the primary device will be defined in the technology specific future part of IEC 61980 series.

NOTE Relevant requirement for the secondary device will be defined in ISO19363 (under consideration).

Surface characteristics of primary device may be a subject to local regulations.

9 Communication

9.1 Command and control communication

The command and control communication between the EV supply equipment and the EV exchanges information necessary to start, control and terminate the process of WPT. This command and control communication shall be in accordance with future IEC 61980-2 (under consideration).

9.2 High level communication

High level communication information is any information exceeding the information covered by the command and control communication.

High level communication is optional and is covered in ISO/IEC 15118.

It may be possible to design WPT systems that do not require high level communication.

10 Protection against electric shock

10.1 General requirements

For EV supply equipment intended for fixed installation, the requirements are specified in IEC 60364-7-722.

Hazardous live parts shall not be accessible.

Protection measures against electric shock under single faults conditions shall be implemented.

It is recommended to use independent protection means (overcurrent and fault current) for each "connecting point" (see IEC 60364-7-722) to the vehicles that can be used simultaneously in order to ensure a better availability of power.

NOTE 1 For systems or equipment on board the vehicle, the requirements are specified in ISO 6469 series and ISO 19363 (under consideration).

NOTE 2 In the following countries, national regulations require shutters or equivalent protection methods with equivalent safety levels. For example: installation heights, blocking objects against touch ability, interlocking, locking cover etc.: FR, SE, IT.

NOTE 3 In the following countries, alternative installation rules are applicable: JP.

10.2 Protection against direct contact

10.2.1 Degrees of protection against access to hazardous parts

- IP ratings for enclosures shall be at least IPXXC

10.2.2 IP degrees for the enclosures

The minimum IP degrees for the enclosures of the off-board power components shall be for:

- indoor use: IP21;
- outdoor use: IP44.

The environments of use shall be indicated in the manual.

Compliance is checked by test in accordance with IEC 60529.

10.2.3 IP degrees for primary device

The IP degrees for the primary device for in-ground and on-ground mounted devices shall be as follows:

- the minimum IP degrees shall be: IP 65;
- the minimum IP degrees in public road installation: IP 69K (ISO 20653) as installed.

For other installations the IP ratings are under consideration.

Compliance is checked by test in accordance with IEC 60529.

NOTE In the following countries, the UL articulated finger probe is used according to national regulations: US, CA.

10.3 Stored energy – discharge of capacitors

One second after disconnecting the plug from the socket-outlet, the voltage between accessible conductive parts or any accessible conductive part and protective conductor shall be less than or equal to 60 V d.c. or the stored energy available shall be less than 0,2 J.

These requirements also apply to other user accessible pluggable parts of WPT off board systems.

10.4 Fault protection

Fault protection shall consist of one or more recognized provision(s).

According to IEC 60364-4-41:2005 the following protective measures are generally permitted:

- automatic disconnection of supply (Clause 411),
- double or reinforced insulation (Clause 412),
- electrical separation for the supply of one item of current-using equipment (Clause 413),
- extra-low-voltage (SELV and PELV) (Clause 414).

Complementary requirements for the supply for (or of) the electric vehicle located in special installations or locations are given in IEC 60364-7-722.

Compliance is checked by inspection.

10.5 Protective conductor dimensions

A protective conductor shall be provided to establish an equipotential connection between the earthing terminal of the mains supply and the exposed conductive parts of the EV supply equipment.

This protective conductor shall be of sufficient rating to satisfy the requirements of IEC 60364-5-54.

NOTE 1 In the following country, the size and rating of the protective conductor is determined by national codes and regulations: US.

Control signals on the protective conductor shall not enter the fixed electric installation, equipment shall be selected accordingly. Such signals, and the related devices, shall not impair the correct functioning of the devices installed to ensure the protective measure by the automatic disconnection of supply (e.g. RCD). The requirements of IEC 61140 shall apply.

NOTE 2 This requirement could be achieved by using a galvanic separation of the control electronics.

10.6 Supplementary measures

10.6.1 Additional protection

To avoid electric shock in case of failure of the basic and/or fault protection or carelessness by users, additional protection shall be required.

Except for circuits using the protective measure of electrical separation, each a.c. connecting point shall be protected by its own RCD complying with IEC 60947-2, IEC 61009-1, IEC 61008-1 or IEC 62423. RCD shall be at least of type A and its rated residual operating current shall not exceed 30 mA.

In case of multi-phase supply, if the characteristics of the load regarding possible DC fault currents > 6 mA are not known, protective measures against DC fault currents shall be taken, e.g. RCD type B or RCD type A in conjunction with an equipment detecting DC fault current to ensure proper functionality of the RCD type A.

RCD shall be used in conjunction with an over-current protection device.

NOTE 1 In the following countries: RCDs of type AC may be used: JP.

NOTE 2 In the following countries, a device which measures leakage current over a range of frequencies and trips at pre-defined levels of leakage current, based upon the frequency is required: US, CA.

NOTE 3 In the following countries, other systems of personnel protection are required: US.

10.6.2 Manual/automatic reset

Circuit breakers, RCDs, and other devices providing personnel protection against electric shock shall not automatically reset.

10.7 Telecommunication network

Tests on any telecommunication network or telecommunication port on the WPT-system, if present, shall comply with the requirements for connection to telecommunication networks, Clause 6 of IEC 60950-1:2005.

11 Specific requirements for WPT systems

11.1 General

Unless otherwise noted, during the following tests, the WPT system shall function at its nominal voltage while delivering maximum output power and current. If the equipment is designed to be used over a range of nominal voltages, the maximum nominal voltage of this range shall be used.

After each test, the original requirements shall still be met.

11.2 Leakage – touch current

This clause applies only to cord and plug connected equipment.

The touch current shall be measured within 1 h after the damp heat continuous test of IEC 60068-2-30, test Ca, at 40 °C ± 2 °C and 93 % relative humidity for four days, with the electric vehicle equipment (off board electronics) connected to AC supply network (mains) in accordance with Clause 6 of IEC 60990:1999.

The supply voltage shall be 1,1 times the nominal rated voltage for this measurement.

The touch current between any AC supply network pole and accessible metal parts connected with each other and with a metal foil covering insulated external parts and measured in accordance with IEC 60950-1, and shall not exceed the values indicated in Table 6.

Table 6 – Touch currents

	Class I	Class II
Between any (live) network poles and the accessible metal parts connected with each other and a metal foil covering insulated external parts.	3,5 mA	0,25 mA
Between any (live) network poles and the inaccessible metal (dead) parts normally non activated (in the case of double insulation).	not applicable	3,5 mA
Between inaccessible and accessible dead metal parts connected with each other and a metal foil covering insulated external parts (additional insulation).	not applicable	0,5 mA

The equipment is supplied from an isolating transformer or installed in such a manner that it is isolated from the earth.

NOTE Circuitry which is connected through a fixed resistance or referenced to earth has to be disconnected before this test.

11.3 Insulation resistance

The insulation resistance with a 500 V DC voltage applied between all inputs/outputs connected together (power source included) and the accessible parts shall be:

For a class I equipment	R ≥ 1 MΩ
For a class II equipment	R ≥ 7 MΩ

The measurement of insulation resistance shall be carried out after applying the test voltage for 1 minute and immediately after the damp heat continuous test of IEC 60068-2-30, test Ca, at 40 °C ± 2 °C and 93 % relative humidity for four days.

11.4 Dielectric withstand characteristic

11.4.1 Dielectric withstand voltage

11.4.1.1 General

The dielectric withstand voltage at power frequency (50 Hz or 60 Hz) shall be applied for 1 min as indicated in 11.4.1.2 or 11.4.1.3 as applicable.

11.4.1.2 For class I components and equipment

U_n + 1 200 V r.m.s. in common mode (all circuits in relation to the exposed conductive parts) and differential mode (between each electrically independent circuit and all other exposed conductive parts or circuits) as specified in 5.3.3.2.3 of IEC 60664-1:2007.

NOTE U_n is the nominal line to neutral voltage of the neutral-earthed supply system.

11.4.1.3 For class II components and equipment

2 × (U_n +1 200 V) r.m.s. in common mode (all circuits in relation to the exposed conductive parts) and differential mode (between each electrically independent circuit and all other exposed conductive parts or circuits) as specified in 5.3.3.2.3 of IEC 60664-1:2007.

For both class I and class II a.c. supply equipment, if the insulation between the mains and the extra low voltage circuit is double or reinforced insulation, 2 × (U_n + 1 200 V) r.m.s. shall be applied to the insulation.

Equivalent values of the DC voltage can be used instead of the AC peak values.

For this test, all the electrical equipment shall be connected, except those items of apparatus which, according to the relevant specifications, are designed for a lower test voltage; current-consuming apparatus (e.g. windings, measuring instruments, voltage surge suppression devices) in which the application of the test voltage would cause the flow of a current, 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.

For test voltage tolerances and the selection of test equipment, see IEC 61180-1.

11.4.2 Impulse dielectric withstand (1,2/50 μs)

The dielectric withstand of the power circuits at impulse shall be checked as follows:

- 6 000 V: in common mode (according to IEC 60664-1 installation category);

- 4 000 V: in differential mode (according to IEC 60664-1 installation category).

11.5 Overload protection and short circuit withstand

11.5.1 General

The test shall be carried out in accordance with the requirements of IEC 61180-1.

The protection measures against overcurrent and overvoltage shall comply with the requirements of IEC 60364-4-43, IEC 60364-4-44 and IEC 60364-7-722 (to be published).

NOTE 1 In the following countries, the methods of protection against overcurrent and overvoltage are in accordance with national codes: US, JP.

NOTE 2 In the following countries, the branch circuit overcurrent protection is based upon 125 % of the equipment rating: US, CA.

Protection devices against overcurrent or short circuits in the EV supply equipment shall be coordinated with those of the a.c. supply network.

The short circuit protection and withstand shall be in accordance with the requirements of IEC 61439-1 .

11.5.2 Earthing electrode and continuity test

Compliance is checked by the test in accordance with IEC 61439-1.

NOTE The test criteria may vary as specified by national regulations.

11.5.3 Earthing path test

The equipment earthing path (protective circuit) shall comply with the test requirement of IEC 61439-1.

NOTE In the following countries, the equipment earthing path complies with the test requirement in national standard: JP.

11.5.4 Short circuit withstand strength

Requirements for short circuit withstand strength shall be in accordance with IEC 61439-1.

NOTE 1 IEC 61439-1 specifies the current levels above which testing is required and the testing levels.

NOTE 2 Requirements for short circuit withstand strength may vary according to national regulations.

11.6 Temperature rise and protection against thermal incidents

11.6.1 General

The requirements in 11.6 are intended to prevent:

Accessible parts of the WPT system from exceeding certain temperatures to prevent skin burns when touched accidentally or intentionally, see 11.6.2.

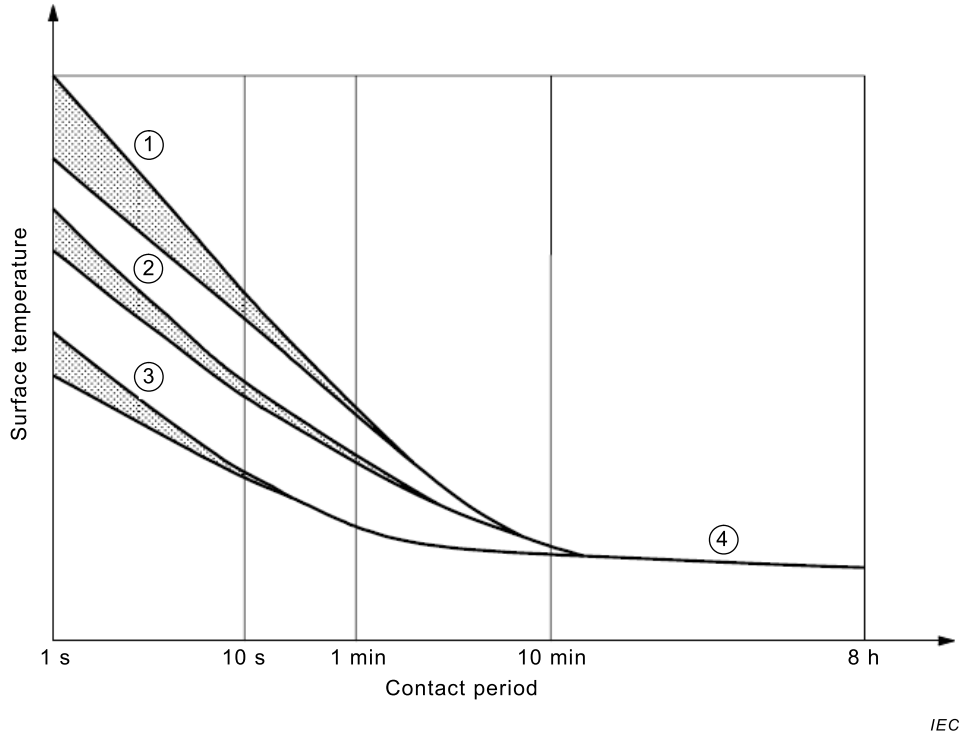
Components, parts, insulation and plastic materials of the WPT system from exceeding certain temperatures which may degrade the electrical, mechanical, or other properties of the WPT system during normal use over the expected life of the equipment, see 11.6.3.

Foreign objects in the air space between primary and secondary device from exceeding temperatures which could become a touch hazard , see 11.6.4.

11.6.2 Permissible surface temperature of accessible parts of the WPT system

Accessible parts of equipment within arm's reach shall not attain a temperature likely to cause burns to persons, and shall comply with the appropriate limits stated in IEC Guide 117:2010. Figure 8 (provided for information purpose only) shows a qualitative example of material temperature and contact period according to IEC Guide 117.

NOTE 1 For WPT systems transferring power from under the vehicle, to cover the unusual condition that a person intentionally reaches under the vehicle (e.g. to pick up an object which fell down), the space within arm's reach underneath the vehicle is considered accessible.



Key	Name
1	plastics
2	ceramics
3	metals
4	brun threshold

Figure 8 – Qualitative example of material temperature

For the application of this standard and the interpretation of the relevant figures within IEC Guide 117, a typical contact period of 1 s for the limits of "no burns" (Area 1 in the relevant figures within IEC Guide 117) shall be chosen.

Surfaces that may become subject to contact under unusual conditions (including e.g. for maintenance) that do not comply with the corresponding temperature touch limits shall be clearly marked with an appropriate warning label according to ISO 7010. Furthermore, the instructions accompanying the unit shall contain appropriate warnings.

NOTE 2 The limits given in IEC Guide 117 are based on protecting against burns by coming in contact with the surface of a hot object. These values are not based on fire hazard considerations.

11.6.3 Temperature limits for materials

The temperature rise of an element or part of the WPT system is the difference between the temperature of this element or part measured in accordance with IEC 61439-1: 2011, 10.10.2.3.3 and the ambient air temperature outside the equipment.

Any temperature rise shall not cause damage to current-carrying parts or adjacent parts of the equipment. In particular, for insulating materials, the original manufacturer shall demonstrate compliance either by reference to the insulation temperature index (determined for example by the methods of IEC 60216) or by compliance with IEC 60085.

Compliance is checked by testing the equipment in accordance with 10.10 of IEC 61439-1:2011.

The test shall be continued until thermal stabilisation is reached.

NOTE Thermal stabilisation is considered to have occurred when three successive readings, taken at intervals of not less than 10 min, indicate no increase greater than 2 K.

During the test (conducted at an ambient temperature of 35 °C), the temperature limits shall not exceed the values shown in Table 7. In those cases where the rated ambient temperature of the equipment during normal operation is not 35 °C, rated ambient temperature, this difference shall be taken into account when applying the limits in Table 7.

Table 7 – Values of temperature rise in normal use

Parts[a]	Temperature rise at ambient air temperature of 35 °C (IEC 61439-1)
Windings, if the insulation system (i.e., bobbins and any other insulating materials that are in contact with the windings) is:	
– of class A [b]	65
– of class E [b]	80
– of class B [b]	85
– of class F [b]	105
– of class H [b]	130
– of other classes [c]	–
Terminals for external conductors and terminals of switches	35
Insulation of internal and external wiring [e]:	
– of rubber	30
– of polyvinyl chloride	35
Parts the deterioration of which could affect safety [e]:	
– of rubber (other than insulation of wiring)	40
– of phenol formaldehyde	70
– of urea formaldehyde	50
– of impregnated paper and fabric	50
– of impregnated wood	50
– of polyvinyl chloride (other than insulation of wiring), polystyrene and similar thermo-plastic material	30
– of varnished cambric	40
Supports	
Printed circuit boards [e]:	
– bonded with phenol-formaldehyde, melamine-formaldehyde, phenol-furfural or polyester	70
– bonded with epoxy	105

[a] If other materials are used, they shall not be exposed to temperatures in excess of those which have been proved permissible for these materials.

[b] The classification is in accordance with IEC 60085 and IEC 60216; however, the values have been adjusted to take into account the fact that, in these tests, the temperatures are mean and not hot-spot values.

[c] If other insulating materials than those covered by IEC 60085 and IEC 60216 are used, the insulation system shall withstand the test of 10.3.

[d] If any component is part of the external surface of the equipment, the temperature of that component shall not exceed the value specified for the appropriate external part, as specified in 10.6.2.

[e] The grades of rubber and polyvinyl chloride insulation are those covered by IEC 60245 and IEC 60227, respectively.

11.6.4 Protection against burns from heating of foreign objects

The thermal danger posed by foreign objects to human beings due to heating caused by the operation of a WPT system is technology specific. The requirements in this subclause 11.6.4 are default requirements that apply for static WPT.

Depending on the WPT technology, a set of daily life test objects that may be exposed to the energy of the WPT system, is defined in the technology specific parts of IEC 61980 series.

For the defined test objects the following maximum temperature limits, based on IEC 60364-4-42 and IEC Guide 117, shall not be exceeded when accessible:

- metal parts with bare metallic surface: 80 °C;
- parts with non-metallic surface: 90 °C.

These values are default values and are based on thermal capacity assumptions about the heated object, specific test object types may have different limits defined depending on the specific technology and test-object definition (e.g. objects with small thermal capacity, such as foil coated papers).

These values are absolute limits, to mitigate the danger of burns to anyone attempting to touch the foreign object.

The above requirement may be met by any method that ensures that none of the test objects can reach a temperature that exceeds the above limits. Such methods include, but are not limited to, ensuring that the power density is low enough to not cause the test object to exceed that level; or suspending system operation until the foreign object has been removed.

11.7 Heat, fire and tracking

Under consideration.

11.8 Protection against mechanical incident

11.8.1 Incidents induced by sharp edge

The WPT system, when installed, shall not have any exposed sharp edges.

Construction may be subject to local regulations such as road construction regulations.

11.8.2 Incidents induced by steps from flat ground

Under consideration.

Construction may be subject to local regulations such as road construction regulations.

11.9 Areas of protection

The following four protection areas are defined as follows (see for example Figure 9):

- Area 1: Area of operation. The space formed by the outline of the primary and the secondary device. The area reserved for operation of the device and unexposed to the user under normal operating conditions;
- Area 2: Transition area. The section between the Area 1 (area of operation) and the Area 3;
- Area 3: Area surrounding the vehicle . Public area to the side, front, rear and top of the vehicle. Area around the chassis silhouette of the vehicle;
- Area 4: Vehicle interior (vehicle cabin).

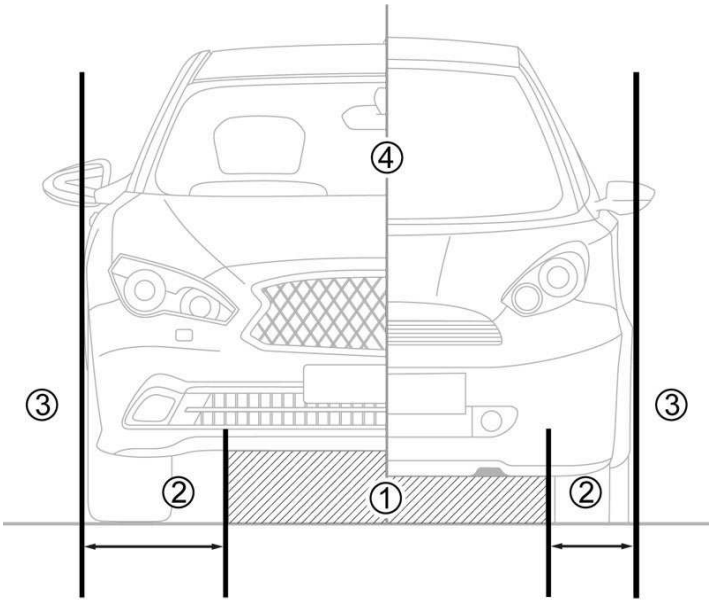


Figure 9 – Example for areas of protection, for ground mounted systems

11.10 Protection from electro-magnetic field

See Annex C.

11.11 Operational safety

Operational safety will be treated in future IEC 61980-2 and in the technology specific future part of IEC 61980 series.

11.12 Emergency service disconnect (optional)

If required by national rules an emergency disconnection device shall be installed to isolate the a.c. supply network (mains) from the a.c. EV supply equipment in case of risk of electric shock, fire or explosion. The disconnection device shall be provided with a means to prevent accidental operation.

Such a device, if required, may be placed in a location defined by the security service.

In some countries an emergency disconnecting means shall be provided in an accessible location for some equipment rated more than 60 A or more than 150 V to ground according to national rules: US, CA.

12 Power cable assembly requirements

Cable assembly requirements will be treated in the technology specific future part of IEC 61980 series.

The use of extension cords is not allowed for portable WPT systems.

13 Constructional requirements

13.1 General

The EV supply equipment excluding the primary device shall comply with the relevant part IEC 61439-1 if they are not installed in the same compartment.

13.2 Breaking capacity of switching devices

13.2.1 General

Switching devices shall have the characteristics described in the following 13.2.2 to 13.2.5.

13.2.2 Switch and switch-disconnector

Switches and switch-disconnectors shall comply with IEC 60947-3 and:

- for a.c. application shall have a rated current, at a utilization category of at least AC-22A, not less than the rated current;
- for d.c. application shall have a rated current, at a utilization category of at least DC-21A, not less than the rated current.

Compliance is checked by inspection, by measurement and by tests.

13.2.3 Contactor

Contactors shall comply with IEC 60947-4-1 and:

- for a.c. application shall have a rated current, at a utilization category of at least AC-2, not less than the rated current;
- for d.c. application shall have a rated current, at a utilization category of at least DC-3, not less than the rated current.

Compliance is checked by inspection, by measurement and by tests.

13.2.4 Circuit-breaker

Circuit-breaker shall comply with IEC 60898-1.

Compliance is checked by inspection, by measurement and by tests. The characteristic shall be at most C.

The characteristic curve may be defined by regulations.

13.2.5 Relays

Relays used to switch the main current path, if any, shall comply with IEC 61810-1 and:

- for AC application shall have a rated current not less than the declared rated current by the manufacturer;
- for DC application shall have a rated current not less than the declared rated current by the manufacturer.

13.3 Clearance and creepage distances

Equipment intended for indoor use only shall be designed to operate in an environment with a minimum pollution degree 2 and overvoltage category II.

Equipment intended for outdoor use shall be designed to operate in an environment with a minimum pollution degree 3 and overvoltage category III.

Lower overvoltage category can apply to the components if appropriate overvoltage reduction specified in IEC 60664-1 is provided.

The micro environment may be reduced to pollution degree 2 if the degree of protection of the enclosure is at least IP5X and care is taken to avoid condensation.

The equipment shall be evaluated when mounted in its enclosure, as intended by the manufacturer.

The clearance and creepage distances shall be in accordance with the requirements specified in IEC 60664-1.

NOTE The macro environment for indoor use only is assumed to be a pollution degree of at least 2 for mild conditions.

Micro environment for digital boards may require specific protection.

13.4 Protection measures

Under consideration.

14 Strength of materials and parts

14.1 General

WPT off board supply equipment shall be constructed of materials capable of withstanding the mechanical, electrical, thermal and environmental stresses that are likely to be encountered in specified service conditions.

After each of the following tests, the WPT system shall function at its nominal voltage with maximum output power.

Compliance is checked by verification after the test that:

a) the IP degree is not affected;
b) the operation of doors and locking points is not impaired;
c) the electrical clearances have remained satisfactory for the duration of the test, and;
d) for WPT equipment having a metallic enclosure, that no contact between live parts and the enclosure has occurred, caused by permanent or temporary distortion;
e) no degradation of performance is permitted.

For WPT equipment having an enclosure of insulating material, if the conditions above are satisfied, then damage such as small dents, small degrees of surface cracking or flaking are disregarded, provided that there are no associated cracks detrimental to the serviceability of the WPT equipment.

14.2 Stability/Mechanical impact

14.2.1 Locations with restricted access

The minimum degree of protection against mechanical impact provided by the enclosure shall be IK07 according to IEC 62262.

Compliance is checked by inspection, by measurement and by tests.

14.2.2 Locations with non-restricted access

The mechanical properties of an enclosure intended to be in non-restricted access areas shall comply with IEC 61439-5:2014, 10.2.101.

For wall mounted equipment, the minimum degree of protection against mechanical impact shall be IK08.

For ground mounted equipment, the minimum degree of protection against mechanical impact shall be IK10

Compliance is checked by inspection, by measurement and by test according to IEC 61439-5:2014, 10.2.101.

14.2.3 Vehicle drive-over

The primary device and its wiring of In-ground mounted or on-ground mounted shall withstand the drive-over of the vehicle under the conditions of its installation.

In general drive-over load pressure is equivalent to that of one tire. Detail requirements will be shown in the technology specific future part of IEC 61980 series.

Construction may be subject to local regulations such as road construction regulations.

The drive over load capability has to be stated by the manufacturer in the operation manual.

14.2.4 Lateral force by thrust power

Under consideration.

14.3 Mechanical load

14.3.1 General

The following subclauses apply to equipment placed in situations of general pedestrian traffic, work places and curb-side installations.

Specific requirements for domestic equipment are under consideration.

Equipment, when installed, in locations, may be protected by barriers providing equivalent mechanical protection that are not part of the equipment.

The wall or ground WPT equipment shall be fixed as intended by the manufacturer's installation instructions. A force of 500 N shall be applied for 5 min in the horizontal direction to the top of the WPT equipment in each of the four directions or in the worst possible horizontal direction. There shall be neither deterioration of WPT equipment nor deformation at its summit greater than:

- 50 mm during the load application;
- 10 mm after the load application.

14.3.2 Static load

Ground mounted equipment shall comply with IEC 61439-5:2014, 10.2.101.

Compliance is checked by inspection, by measurement and by tests IEC 61439-5:2014, 10.2.101.

This test is not required for wall-mounted equipment.

14.3.3 Shock load

Ground mounted equipment shall comply with IEC 61439-5:2014, 10.2.101.

Compliance is checked by inspection, by measurement and by tests IEC 61439-5:2014, 10.2.101.

This test is not required for wall-mounted equipment.

14.3.4 Torsional stress

Ground mounted equipment shall comply with IEC 61439-5:2014, 10.2.101.

Compliance is checked by inspection, by measurement and by tests IEC 61439-5:2014, 10.2.101.

This test is not required for wall-mounted equipment.

14.3.5 Strength of doors

Ground mounted equipment shall comply with IEC 61439-5:2014, 10.2.101.

Compliance is checked by inspection, by measurement and by tests IEC 61439-5:2014, 10.2.101.

14.3.6 Mechanical shock impacts induced by sharp edged objects

Ground mounted equipment intended for outdoor installation shall comply with IEC 61439-5:2014, 10.2.101.5.

Compliance is checked by inspection, by measurement and by tests IEC 61439-5:2014, 10.2.101.

14.4 Strength of materials and parts

14.4.1 Protection against corrosion

Protection against corrosion shall be ensured by the use of suitable materials or by protective coatings to the exposed surface, taking account of the normal service conditions.

The test specimens shall be new and in a clean condition in accordance with the test procedure of IEC 61439-1, 10.2.2.1 and shall be subjected to:

- severity test A for equipment classified for indoor use as detailed in IEC 61439-1:2011, 10.2.2.2. or;
- severity test B for equipment classified for indoor use as detailed in IEC 61439-1:2011, 10.2.2.3.

Compliance is checked by the test of IEC 61439-1:2011, 10.2.2.1, 10.2.2.4 and either 10.2.2.2 (indoor) or 10.2.2.3 (outdoor).

14.4.2 Test criteria

After the test of 14.4.1, the enclosure or samples shall be washed in running tap water for 5 min, rinsed in distilled or demineralised water then shaken or subjected to air blast to remove

water droplets. The specimen under test shall then be stored under normal service conditions for 2 h.

Compliance is checked by visual inspection to determine that:

– *there is no evidence of iron oxide, cracking or other deterioration more than that allowed by ISO 4628-3 for a degree of rusting Ri1. However surface deterioration of the protective coating is allowed. In case of doubt associated with paints and varnishes, reference shall be made to ISO 4628-3 to verify that the samples conform to the specimen Ri1;*

– *the mechanical integrity is not impaired;*

– *seals are not damaged,*

– *doors, hinges, locks, and fastenings work without abnormal effort.*

14.5 Environmental conditions

The WPT system shall be designed to resist the effect of normal automotive solvents and fluids, vibration and shock, material flammability standards and other conditions appropriate to the application.

14.6 Properties of insulating materials

14.6.1 Verification of thermal stability of enclosures

The thermal stability of enclosures manufactured from insulating material shall comply with the dry heat test specified in IEC 61439-1.

Compliance is checked by inspection and by tests of IEC 61439-1:2011, 10.2.3.1.

14.6.2 Resistance to fire (Glow wire)

Resistance to fire shall comply with IEC 60695-2-11.

14.6.3 Ball pressure test

For parts of insulating material which are subjected to ball pressure test, it shall be performed according to IEC 60695-10-2.

The test is made in a heated cabinet at a temperature of:

– 125 ± 5 °C for parts supporting live parts;

– 80 ± 5 °C for other parts.

For materials which show deformation, the diameter shall not exceed 2 mm. The test is not made on parts of ceramic material.

14.6.4 Resistance to tracking

Insulating parts supporting live parts shall be of material resistant to tracking.

For materials other than ceramic, compliance is checked by the test according to IEC 60112 with the following parameters:

– PTI test;

– solution a;

– applied voltage 175 V.

No flashover or breakdown between electrodes shall occur before a total of 50 drops have fallen.

14.6.5 Resistance to ultra-violet radiation

This test applies only to enclosures and external parts of equipment intended to be installed outdoor and which are constructed of synthetic materials or metals that are entirely coated with synthetic material.

Representative samples of such parts shall be subjected to tests in accordance with IEC 61439-1:2011, 10.2.4.

NOTE In the following countries, this requirement is optional: SE.

14.7 Static strength and stability

Lateral force by thrust power.

14.8 Vibration

Permanently mounted supply equipment shall not be subjected to this test.

Portable WPT system equipment shown in Figure 2, shall withstand vibration stress. Detail requirements will be shown in the technology specific future part of IEC 61980 series.

15 Service and test conditions

15.1 General

During the following tests, the WPT supply equipment shall function at its nominal voltage with maximum output power and current. No degradation of safety shall be permitted. If there are conditions under which noticeable performance degradation may occur, these shall be specified by the manufacturer.

WPT supply equipment is intended for use under the normal service conditions, and shall be in accordance with the requirements stated in 15.2.1 to 15.2.4 and 15.2.6, except where other special conditions are identified as part of an agreement between the user and the manufacturer. See 15.2.

NOTE 1 If components, for example relays, electronic equipment, are used which are not designed for these conditions, appropriate steps are taken to ensure proper operation.

NOTE 2 The performance check required by specific installation environment is performed according to the agreement between the user and the manufacturer.

15.2 Environmental test

15.2.1 Ambient air temperature

The equipment shall be tested at the specified ambient temperature, the maximum temperature and minimum temperatures at the transfer power classes guaranteed by the manufacturer under those conditions.

The equipment shall go through a functional test in all relevant modes at lowest temperature according to IEC 60068-2-1 (test Ab) and at the highest temperature according to IEC 60068-2-2 (test Bb).

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

National codes and regulations may require different operating temperature ranges.

Ambient air temperature for indoor installations:

– The ambient air temperature does not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C.
– The lower limit of the ambient air temperature is –5 °C.

NOTE 1 In the following countries, the cold test for equipment classified for indoor use uses the values specified for outdoor use: US, CA.

Ambient air temperature for outdoor installations are as follows:

– The ambient air temperature does not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C.
– The lower limit of the ambient air temperature is –25 °C.

NOTE 2 In the following countries, the lowest outdoor temperature is –35 °C: SE

15.2.2 Ambient humidity

The WPT systems shall be designed to operate within a relative humidity rate between 5 % and 95 %. One of the two tests below shall be conducted:

a) Humidity conditions for indoor installations:

The relative humidity of the air does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidity may be permitted at lower temperatures, for example 90 % at +20 °C. Moderate condensation should be borne in mind which may occasionally occur due to variations in temperature.

Compliance shall be determined by test under the following conditions:

– *6 cycles of 24 h each to damp heat cycling test according to IEC 60068-2-30 (Test Db) at (40 ± 3) °C and relative humidity of 95 %, and*
– *2 cycles of 24 h each to salt mist test according to IEC 60068-2-11; (Test Ka: Salt mist), at a temperature of (35 ± 2) °C.*

b) Humidity conditions for outdoor installations:

The relative humidity may temporarily be as high as 100 % at a maximum temperature of +25 °C.

Compliance shall be determined by test under the following conditions:

The test comprises two identical 12 day periods.

Each 12 day period comprises:

– *5 cycles of 24 h each to damp heat cycling test according to IEC 60068-2-30 (Test Db) at (40 ± 3) °C and relative humidity of 95 %, and*
– *7 cycles of 24 h each to salt mist test according to IEC 60068-2-11; (Test Ka: Salt mist), at a temperature of (35 ± 2) °C.*

15.2.3 Ambient air pressure

The WPT system shall be designed to operate at an atmospheric pressure between 860 hPa and 1 060 hPa.

15.2.4 Altitude

This standard applies to equipment designed to be installed at an altitude of up to 2 000 m.

Clearances and creepage distances for altitudes of more than 2 000 m shall be in accordance with the requirements specified in IEC 60664-1.

For equipment to be used at higher altitudes, it is necessary to take into account the reduction of the dielectric strength, the switching capability of the devices and of the cooling effect of the air.

15.2.5 Pollution degree

The pollution degree in 13.3 refers to the environmental conditions for which the equipment is intended, see: IP ratings in 10.2.2.

15.2.6 Dry heat

The dry heat test shall be in accordance with the requirements of IEC 61439-1.

Compliance is checked by inspection and by tests of 10.2.3.1 of IEC 61439-1:2011.

The dry heat test may be combined with the test for the verification of thermal stability of enclosures, see 14.7.

NOTE In the following countries, this requirement is optional: SE.

15.2.7 Cold test

The cold test shall be in accordance with IEC 60068-2-1, test Ab:

– at –25 °C ± 3 °C for 16 h, for equipment classified for outdoor use;

– at –5 °C ± 3 °C for 16 h, for equipment classified for indoor use.

15.3 Special service conditions

Where any special service conditions exist, the applicable particular requirements shall be complied with or special agreements shall be made between the equipment manufacturer and the user. The user shall inform the equipment manufacturer if such exceptional service conditions exist.

Special service conditions include, for example:

a) values of temperature, relative humidity and/or altitude differing from those specified in 15.2.1;

b) applications where variations in temperature and/or air pressure take place at such a speed that exceptional condensation is liable to occur inside the equipment;

c) heavy pollution of the air by dust, smoke, corrosive or radioactive particles, vapours or salt;

d) exposure to strong electric or magnetic fields;

e) exposure to extreme climatic conditions;

f) attack by fungus or small creatures;

g) installation in locations where fire or explosion hazards exist;

h) exposure to heavy vibration, shocks, seismic occurrences;

i) installation in such a manner that the current-carrying capacity or breaking capacity is affected, for example equipment built into machines or recessed into walls;

j) exposure to conducted and radiated disturbances other than electromagnetic, and electromagnetic disturbances in environments other than those described in this standard or IEC 61851-21-1 and IEC 61851-21-2;

k) exceptional overvoltage conditions or voltage fluctuations;

l) excessive harmonics in the supply voltage or load current.

15.4 Conditions during transport, storage and installation

A special agreement shall be made between the equipment manufacturer and the user if the conditions during transport, storage and installation, for example temperature and humidity conditions, differ from those defined in 15.1.

15.5 Outdoor exposure

15.5.1 Cold test for extreme cold climates

When the equipment is used in environments colder than those specified in 15.2.6, the cold test for extreme cold climates, if needed, shall be carried out in accordance with IEC 60068-2-1, test Ab, at the rated lowest temperature defined by the equipment manufacturer for 16 h, for equipment classified for indoor or outdoor use.

15.5.2 Heat test under solar radiation

The test shall be carried out in accordance with IEC 60068-2-5, test Sa, procedure B.

The heat test under solar radiation can be tested with higher air temperature.

15.6 Damp and salt mist test for marine and coastal environments

Damp and salt mist test are tested according to protection against corrosion tests, 14.4.1.

Hot damp test for tropical climates.

Method and values are under consideration.

15.7 Condensation within the assembly

Enclosed equipment and assemblies, for outdoor and indoor installation, intended for use in locations with high humidity and temperatures varying within wide limits, shall be provided with suitable arrangements to prevent harmful condensations within the equipment. Means such as ventilation and/or internal heating, drain holes, etc. may be used.

The specified degree of protection in 10.2.3 shall at the same time be maintained.

15.8 Vibration and shock

Under consideration.

15.9 Safety specifications

Under consideration.

16 Electromagnetic Compatibility (EMC)

16.1 Immunity requirements

A functional description and a definition of performance criteria during, or as a consequence of, the EMC testing shall be provided by the manufacturer and noted in the test report based on the following criteria (see Tables 8 and 9).

Performance criteria are described in IEC 61000-6-1 and IEC 61000-6-2.

Table 8 – WPT equipment immunity requirement – Environment other than residential

Port	Test applicability	Phenomenon	Basic standard	Test value	Performance criteria
WPT system	Standby and Active mode	Electrostatic Discharge (ESD)	IEC 61000-4-2	8 kV/4kV Air/Contact [e]	B
	Standby and Active mode	Radiated RF Fields (80 MHz-1 000 MHz)	IEC 61000-4-3	10 V/m[d]	A
	Standby and Active mode	Radiated RF Fields (1,4 GHz-2 GHz)	IEC 61000-4-3	3 V/m [d]	A
	Standby and Active mode	Radiated RF Fields (2 GHz-2,7 GHz)	IEC 61000-4-3	3 V/m [d]	A
		Magnetic Fields	IEC 61000-4-8	100 A/m [c]	A
AC Power input port (and I/O signal/control connected directly to mains supply)	Standby and Active mode	Electrical Fast Transients/Bursts	IEC 61000-4-4	2 kV (5/50 ns, 100 kHz)	B
	Active mode	Voltage Surges	IEC 61000-4-5	2 kV [a], 4 Kv [b] [f]	B
	Standby and Active mode	Conducted RF Fields (0,15 MHz-80 MHz)	IEC 61000-4-6	10 V (r.m.s.)	A
	Standby and Active mode	Voltage dips and interruptions	IEC 61000-4-11	30 % reduction for 25 cycles	C
			(<16 A)	60 % reduction for 10 cycles	C
			IEC 61000-4-34	>95 % reduction for 1 cycle	B
			(>16 A)	100 % reduction for 250 cycles	C

[a] Line to line.

[b] Line to earth (ground).

[c] Applicable only to apparatus containing devices susceptible to magnetic fields.

[d] The test level specified is the r.m.s. value of the unmodulated carrier.

[e] For ESD tests lower test levels are not needed to be tested.

[f] For surge tests lower test levels are not needed to be tested.

Table 9 – WPT equipment immunity requirement – residential environment

Port	Test applicability	Phenomenon	Basic standard	Test value	Performance criteria
WPT system	Standby and Active mode	Electrostatic Discharge (ESD)	IEC 61000-4-2	8 kV/4 kV Air/Contact [e]	B
	Standby and Active mode	Radiated RF Fields (80 MHz-1 000 MHz)	IEC 61000-4-3	3 V/m[d]	A
	Standby and Active mode	Radiated RF Fields (1,4 GHz-2 GHz)	IEC 61000-4-3	3 V/m [d]	A
	Standby and Active mode	Radiated RF Fields (2 GHz-2,7 GHz)	IEC 61000-4-3	3 V/m [d]	A
		Magnetic Fields	IEC 61000-4-8	30 A/m [c]	A
AC Power input port (and I/O signal/control connected directly to mains supply)	Standby and Active mode	Electrical Fast Transients/Bursts	IEC 61000-4-4	1 kV (5/50 ns, 100 kHz)	B
	Active mode	Voltage Surges	IEC 61000-4-5	2 kV[a], 1 kV[b] [f]	B
	Standby and Active mode	Conducted RF Fields (0,15 MHz-80 MHz)	IEC 61000-4-6	3V (r.m.s.)	A
	Standby and Active mode	Voltage dips and interruptions	IEC 61000-4-11	30 % reduction for 25 cycles	C
			(<16 A)	60 % reduction for 10 cycles	C
			IEC 61000-4-34	>95 % reduction for 1 cycle	B
			(>16 A)	100 % reduction for 250 cycles	C

[a] Line to line.

[b] Line to earth (ground).

[c] Applicable only to apparatus containing devices susceptible to magnetic fields.

[d] The test level specified is the r.m.s value of the unmodulated carrier.

[e] For ESD tests lower test levels are not needed to be tested.

[f] For surge tests lower test levels are not needed to be tested.

16.2 Disturbance requirement

16.2.1 Load and operating conditions

16.2.1.1 Load conditions

The following conditions have been defined for the purposes of testing. It is noted that this is not always representative of real use since the power will be reduced as the batteries become more charged.

The test load shall enable the WPT system to operate between 20 % and 80 % of the rated power. All other ports shall be connected to representative loads.

The manufacturer shall define the conditions during testing in a test plan according to the requirements of IEC 61000-3-2 or IEC 61000-3-12 for harmonic emission tests and IEC 61000-3-3 or IEC 61000-3-11 for flicker test.

16.2.1.2 Operating conditions

Tests need only be performed in the modes defined in this standard. The tests shall be made with load conditions defined in 16.2.1.1.

The configuration and mode of operation shall be specified in the test plan and the actual conditions, during the tests, shall be precisely noted in the test report.

The following modes of operation shall be assessed:

– standby mode;
– active mode for emission pre-test between 20 % and 80 %, for final measurement at the power that has been identified to produce worst-case emission during pre-test;
– active mode for immunity testing at minimum 50 % of the rated power.

If the WPT system has a large number of similar ports or ports with many similar connections, then a sufficient number shall be selected to simulate actual operating conditions and to ensure that all the different types of termination are covered (e.g. 20 % of the ports or at least four ports).

The tests shall be carried out within the specified operating range for the charging equipment and at its rated supply voltage, unless otherwise indicated in the relevant basic standard.

The EMC measurements can be done without the EV. The secondary device of the WPT shall be arranged during the test according to the (WPT) manufacturer’s specification.

16.2.2 Disturbance limits

16.2.2.1 General

The disturbance tests and limits for apparatus covered by this standard are given on a port by port basis.

Measurements shall be performed in well-defined and reproducible conditions for each type of disturbance.

The description of the test, the test methods and the test set-up are given in basic standards which are referred to in Table 10 and Table 11. The contents of these basic standards are not repeated here, however modifications or additional information needed for the practical application of the tests are given in this standard.

NOTE The reference to “basic standard“ is intended to be limited to those clauses of the relevant standard that give the description of the test, the test methods and the test set-up.

16.2.2.2 Limits and test conditions for disturbances in the low frequency (LF) range

16.2.2.2.1 Overview

Table 10 – Low frequency disturbances

Port	Phenomenon	Basic standard	Reference subclause in the present standard
AC power	Harmonics	IEC 61000-3-2 (rated current ≤16 A/phase) IEC 61000-3-12 (rated current ≤75 A/phase)	16.2.2.3
AC power	Voltage fluctuations and flicker	IEC 61000-3-3 IEC 61000-3-11	16.2.2.4

16.2.2.2.2 Harmonics

Requirements for harmonics are only specified if the WPT system is intended to be connected to a public mains network which is within the scope of the IEC 61000-3-2 or IEC 61000-3-12 respectively.

Other distribution systems are excluded from the scope of the base standards and hence do not apply.

A WPT system that has an input of less than or equal 16 A per phase and that is connected to a public low-voltage a.c. distribution system shall comply with IEC 61000-3-2. All WPT systems have been categorized as Class A apparatus according to the definitions of IEC 61000-3-2.

A WPT system that has an input of exceeding 16 A and up to and including 75 A per phase and that is connected to a public low-voltage a.c. distribution system shall comply with IEC 61000-3-12.

16.2.2.2.3 Voltage fluctuation and flicker

The disturbance caused by voltage fluctuation and flicker produced by a WPT system that has an input current from 16 A up to and including 75 A per phase, and that is connected to a public low-voltage a.c. distribution system shall comply with IEC 61000-3-11.

For systems less than 16 A/phase voltage fluctuations and flicker shall be tested according to IEC 61000-3-3.

The WPT system shall be operated during the appropriate observation time as follows:

a) Measurement started.

b) Start of a power transfer cycle.

c) Charging at a minimum of 50 % energy transfer during the rest of the observation period.

16.2.2.3 Limits and test conditions for disturbances in the radio frequency (RF) range

16.2.2.3.1 Overview

Table 11 – Radio frequency (RF) disturbances

Port	Phenomenon	Basic standard	Reference subclause in the present standard
AC power	Conducted disturbances (150 kHz-30 MHz)	CISPR 11	16.2.2.2.1
Telecommunication lines	Conducted disturbances (150 kHz-30 MHz)	CISPR 32	16.2.2.2.2
WPT system	Radiated disturbances (150 kHz-30 MHz)	CISPR 11	16.2.2.2.3
WPT system	Radiated disturbances (30 MHz-1 GHz)	CISPR 11	16.2.2.2.4
NOTE 1 Definition for Class A or B environment and the limits associated with are given within the relevant basic standard. NOTE 2 WPT is considered to be a group 2 equipment according to CISPR 11.			

WPT is considered to be group 2 equipment according to CISPR 11. For the purposes of this standard, apparatus is grouped according to its environmental classification. These definitions are detailed in CISPR 11:2009, Clause 5 and are summarised as follows:

– Class A equipment is equipment suitable for use in all locations other than residential those directly connected to a low voltage power supply network which supplies buildings used for residential purposes.

  Class A equipment shall meet class A limits.

  For class A equipment, the instructions for use accompanying the product shall contain the following warning:

  Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio communication services in such environments

– Class B equipment is equipment suitable for use in domestic establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

  Class B equipment shall meet class B limits.

16.2.2.3.2 Power input port (conducted disturbances in the range 150 kHz to 30 MHz)

Measurements shall be made in accordance with CISPR 11 using test equipment referenced in CISPR 11 as appropriate.

In CISPR 11:2009, Table 6 (Class A) or Table 7 (Class B) applies to WPT systems. Operating modes and parameters shall be used according to Table 9.

16.2.2.3.3 Wired network port (conducted disturbances in the range 150 kHz to 30 MHz)

The measurements shall be made in accordance with CISPR 32 using test equipment referenced in CISPR 32 as appropriate.

For class B WPT equipment the limits defined in CISPR 32:2012, Table A.11 apply and for class A WPT equipment the limits defined in CISPR 32:2012, Table A.10 apply.

16.2.2.3.4 WPT system port and enclosure port (radiated disturbances in the range 150 kHz to 30 MHz)

Measurement shall be made in accordance with CISPR 11 using test equipment referenced in CISPR 11 as appropriate.

Measurement is of the magnetic component of the radiated disturbance field strength.

For radiated disturbances in the range from 150 kHz up to 30 MHz, the limits of Table 12 applies to all kind of WPT systems for supply of EVs, independent of the classification as class A or B (see 16.2.2.3.1). If all other disturbance requirements of class B, except the magnetic field below 30 MHz, are fulfilled by the WPT system, then the warning (or caution) note in the documentation according to 16.2.2.3.1 is not required.

Table 12 – Limits of the magnetic field strength for WPT system

Frequency range MHz	**Magnetic field** **Quasi-peak** **Measurement distance D = 3 m** dB(μA/m)	**Magnetic field** **Quasi-peak** **Measurement distance D = 10 m** dB(μA/m)
0,15 – 0,49	82	57,5
0,49 – 1,705	72	47,5
1,705 – 2,194	77	52,5
2,194 – 3,95	68	43,5
3,95 – 11	43,5 decreasing linearly with logarithm of frequency to 28,5	18,5
11 – 20	28,5	18,5
20 – 30	18,5	8,5
Only small equipment (equipment, either positioned on a table top or standing on the floor which, including its cables fits in a cylindrical test volume of 1,2 m in diameter and 1,5 m above the ground plane) shall be measured in D = 3 m distance. All other equipment shall be measured in D = 10 m distance. At the transition frequencies, the more stringent limit shall apply.		

16.2.2.3.5 WPT system port and enclosure port (radiated disturbances in the range 30 MHz to 1 000 MHz)

Measurements shall be made in accordance with CISPR 11 using test equipment referenced in CISPR 11 as appropriate. In the range 30 MHz to 1 000 MHz, the limits of CISPR 11:2009, Table 9 or Table 11 apply to class A or class B WPT systems respectively. Measurement is of the electric component of the radiated disturbance field strength.

17 Marking and instructions

17.1 General

The marking and instructions shall be in accordance with 17.2 and 17.4.

The equipment shall be marked with ratings or other information to denote severe or unusual environmental conditions of use, see Clause 15.

17.2 Marking of EV supply equipment

The equipment shall bear the following markings in a clear manner:

– name, initials, trademark or distinctive marking to identify the manufacturer;
– equipment reference;
– serial number or catalogue number;
– date of manufacture;
– rated voltage in V;
– rated frequency in Hz;
– rated current in A;
– number of phases;
– IP degrees (degree of protection);
– "Indoor use only", or the equivalent, if intended for indoor use only;
– for a Class II station, the symbol shall clearly appear in the markings;
– all necessary information relating to the other declared classifications, characteristics and diversity factor(s);
– minimal contact information (phone number, address of contractor, installer or manufacturer);
– drive over capability.

Compliance is checked by inspection and test of Clause 14.

17.3 Legibility

Marking made by moulding, pressing, engraving or similar, including labels with a laminated plastic covering, shall not be submitted to the following test.

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

Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit.

NOTE The petroleum spirit is defined as a solvent hexane with a content of aromatics of maximum 0,1 % in volume, a kauributanol value of 29, an initial boiling point of 65 °C, a final boiling point of 69 °C and a density of approximately 0,68 g/cm^3.

After the test, the marking shall be legible to normal or corrected vision without additional magnification. It shall not be easily possible to remove marking plates and they shall show no curling.

17.4 Connection instructions

Instructions to the connection of the WPT system to the grid shall be provided with the WPT system user’s manual.

Annex A
(informative)

Use cases

A.1 General

Use cases are described by taking into account the following premises:

– These UCs apply to power transfer while EV is parked or driving.
– Communication distinguishes between data exchange required for the function control of power transfer and data exchange needed for value-added functions, such as payment or certification purposes.
– Communication inside the EV is not considered in this standard.

The EV is representing the system master; supply equipment is client according to the communication in conductive systems. An overview of the use cases is given in Figure A.1.

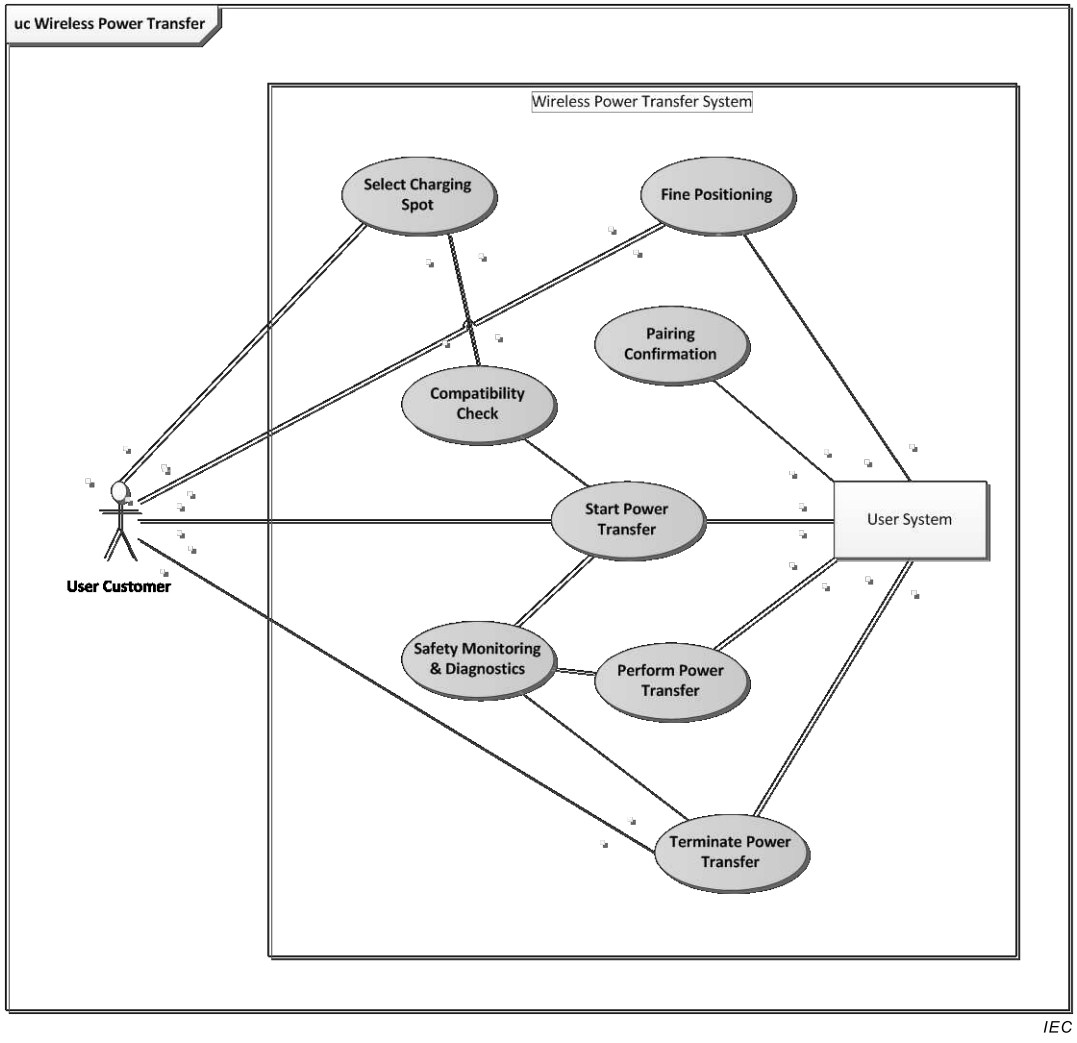


Figure A.1 – Use cases particularly for wireless power transfer

Besides the use cases specifically describing WPT systems aspects, additional use cases describing common power transfer topics can be applied. These uses cases are taken from

ISO/IEC 15118-1 and are not described here. Refer to ISO/IEC 15118-1 for details. See Figure A.2.

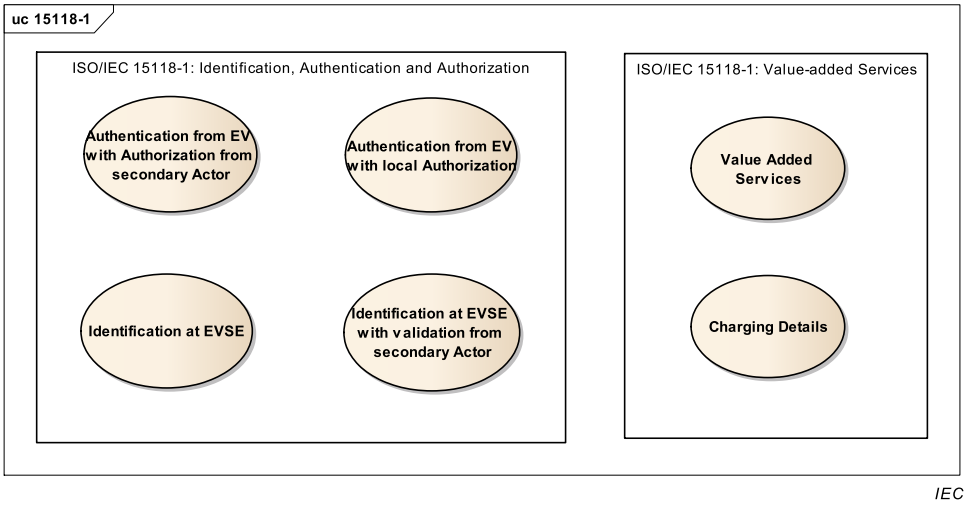


Figure A.2 – Use cases from ISO/IEC 15118-1 reusable for WPT systems

The use cases describe system behaviour from user point of view, they do not contain any technical system description.

A.2 Use case descriptions

A.2.1 UC Select "charging spot"

Activity diagram for UC Select Charging Spot, see Table A.1 and Figure A.3.

Table A.1 – UC Select "charging spot"

Actor	Customer
General	Customer is selecting a "charging spot", while being within the area of the WPT supply equipment and within the range of the communication system.
Preconditions	
Post conditions	
Basic scenario	Selection of "charging spot" with supply equipment support: The customer is moving the EV within an area up to X (adequate) metres around a WPT system. The EV is starting communication with the supply equipment. Use case "compatibility check" may be applied. Available "charging spot" may be indicated to the customer by the supply equipment or the EV information system.
Alternative	Selection of "charging spot" without system communication: – selection of a compatible "charging spot" has been done prior to entering parking region by backend internet service or any other system; – indication / identification if the "charging spot" is done by any means (e.g. signs); – compatibility has to be confirmed as part of the negotiation process.
Exceptions	communication failure

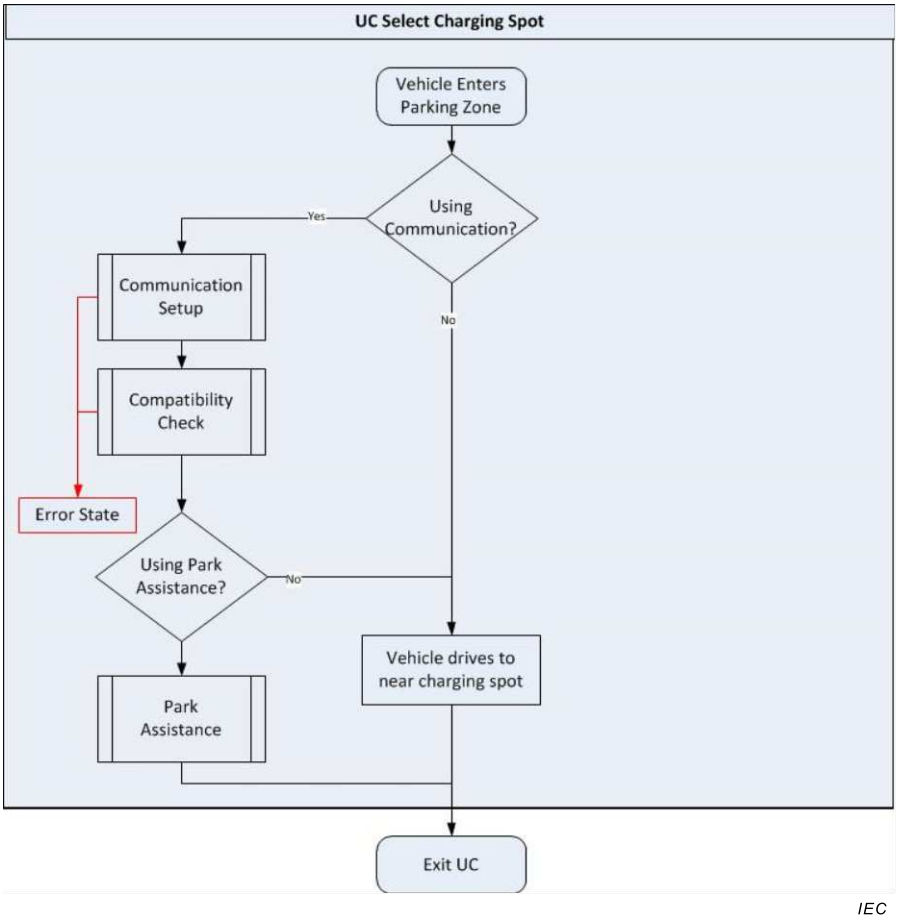


Figure A.3 – Activity diagram for UC Select "Charging Spot"

A.2.2 UC Compatibility Check

Activity diagram for UC Compatibility Check, see Table A.2 and Figure A.4.

Table A.2 – UC Compatibility Check

Actor	Customer
General	EV and supply equipment evaluating compatibility.
Preconditions	Communication is established:
Post conditions	Compatibility is confirmed
Basic scenario	The data being exchanged via the communication link need to contain the following information: – technical parameters for energy transfer (mandatory); – identifier (authentification, identification, authorization); – business model data (payment options, delivery profiles) (optional or only default values). Having confirmed system compatibility, the result is indicated to the customer. Since the result is available on EV side as well as on supply equipment side, both parts may be able to indicate readiness.
Alternative	Pre-negotiated compatibility: In case of well known environment (e.g. personal garage) compatibility is given by default, so that no further exchange of parameters is necessary. Compatibility is determined by identifiers (e.g. previous use of equipment).
Exceptions	Communication failure: – communication link is broken or other communication failure occurred; – no compatibility confirmed; – supply equipment or EV cannot confirm compatibility.

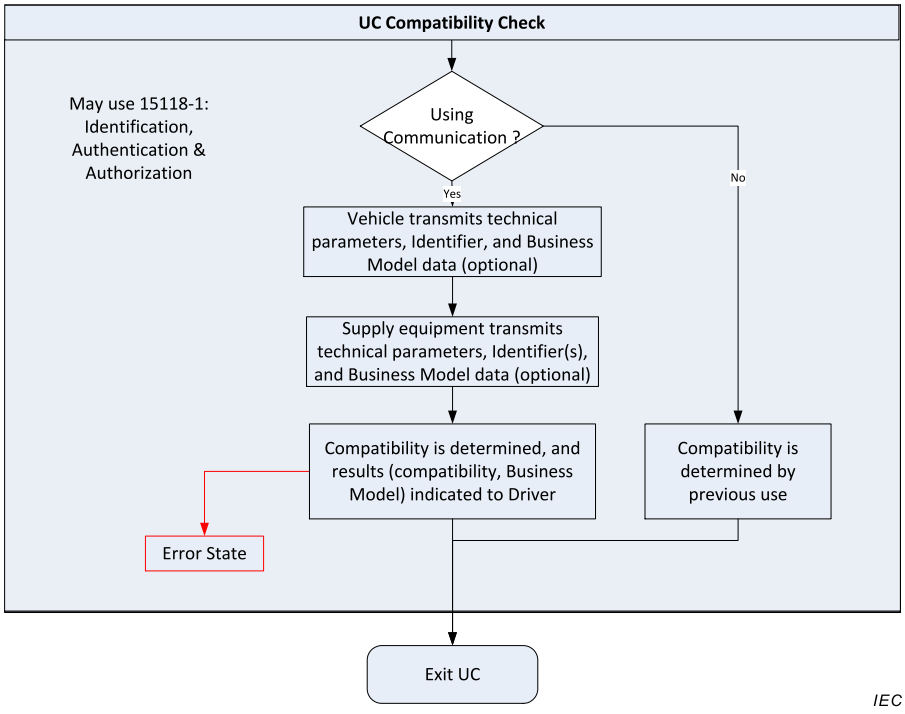


Figure A.4 – Activity diagram for UC Compatibility Check

A.2.3 UC Fine Positioning

Activity diagram for UC Fine Positioning, see Table A.3 and Figure A.5.

Table A.3 – UC Fine Positioning

Actor	Customer user system
General	Primary and secondary devices are being well positioned so that sufficient system functionality (e.g. primary/secondary device centring, primary/secondary device selection, safety issues, etc.) is reached. The positioning status is indicated to the EV as well as to the supply equipment system, especially the result (success or failure). The customer may be informed about the fine positioning result either by supply equipment or EV. The user might choose an optimal positioning to achieve best possible energy efficiency. No power transfer in excess of safety criteria is performed during fine positioning except for fine positioning use with low power output
Preconditions	EV and supply equipment are able to exchange information necessary for the alignment process
Post conditions	EV and supply equipment are sufficiently aligned. Alignment confirmed to relevant actors
Basic scenario	The primary or the secondary device is moved into a sufficient position with respect to the other device.
Alternative	As well, in case of a mobile primary device, the primary device may be well positioned manually. Depending on the implementation, there might exist a system, which achieve sufficient alignment without support from the WPT system.
Exceptions	– fine positioning failed; – sufficient position cannot be reached; – communication failure.
NOTE Sufficient means: The primary and secondary devices are being positioned so that they are located within the tolerance area over which performance is specified.	

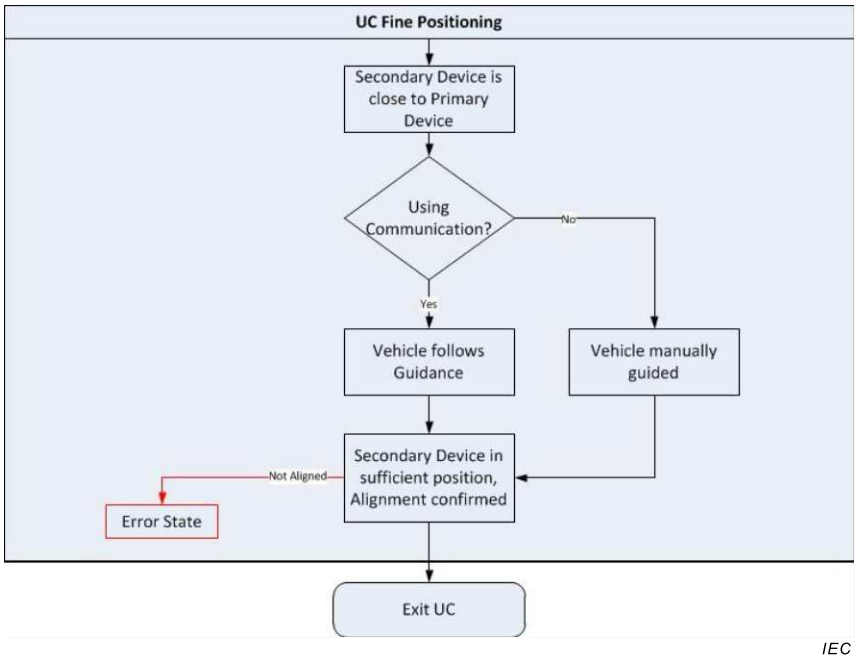


Figure A.5 – Activity diagram for UC Fine Positioning

A.2.4 UC Pairing Confirmation

Activity diagram for UC Pairing Confirmation, see Table A.4 and Figure A.6.

Table A.4 – UC Pairing Confirmation

Actor	User system
General	The process of pairing an EV to an unique dedicated primary device. The pairing process ensures that a power request signal send by the EV is only accepted by the primary device of the EV is located.
Preconditions	
Post conditions	The unique assignment of an EV to a dedicated primary device is accomplished and confirmed.
Basic scenario	The supply equipment and EV exchange information that allows a unique correlation between the serving primary device and the EV.
Alternative	In those cases where there is no ambiguity as to the serving primary device pairing is obvious and process need not to be done.
Exceptions	– pairing signal unavailable; – pairing cannot be confirmed.

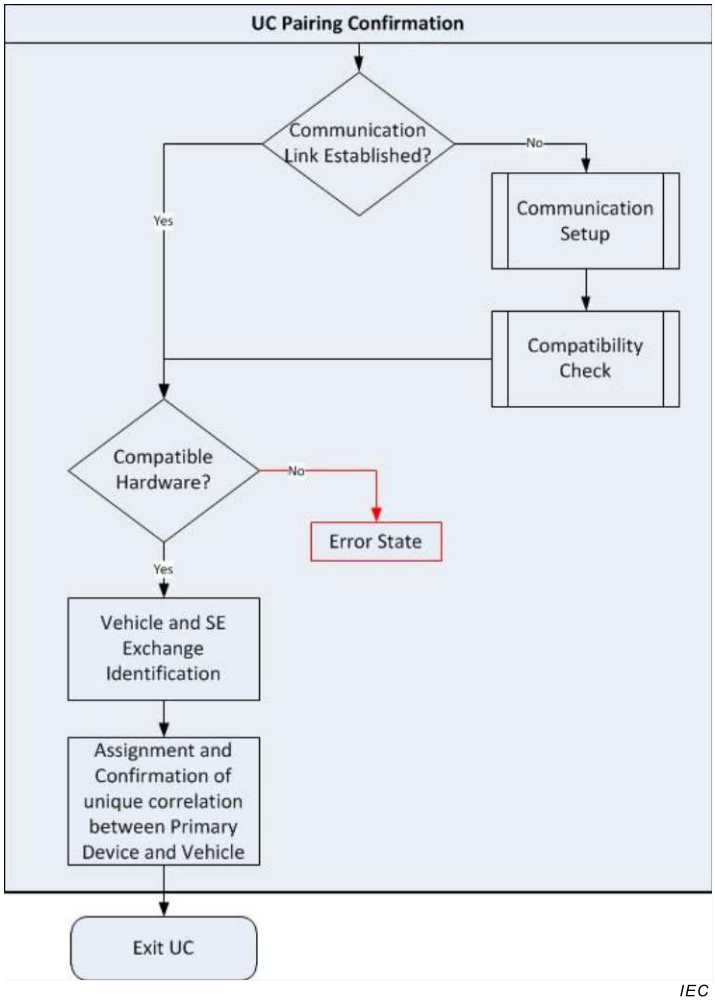


Figure A.6 – Activity diagram fur UC Pairing Confirmation

A.2.5 UC Start Power Transfer

Activity diagram for UC Start Power Transfer, see Table A.5 and Figure A.7.

Table A.5 – UC Start Power Transfer

Actor	User system
General	An indication to the system is done that triggers the system to prepare for power transfer. All actions to prepare the WPT system for power transfer are executed in this UC.
Preconditions	– alignment has been done successfully; – communication is established; – pairing has been done successfully.
Post conditions	EV and supply equipment are able to exchange information necessary for the power transfer process. System is ready to perform power transfer. Safety monitoring systems are activated.
Basic scenario	An indication to the system is done that power transfer may be started. This may happen by any means either on supply equipment or EV side. If not already done compatibility check shall be applied here. Exchange of parameters (if necessary). The indication triggers a preparation phase, in which supply equipment and EV get ready to perform power transfer. Additionally information of value added services may be exchanged and acted upon (if needed).
Alternative	Starting indication of this process may be given by the following methods: – button press on supply equipment; – button press or other user activity on EV side; – automatic indication by EV; – remote indication by additional user system (e.g. wifi, cell phone, time schedule, etc.).
Exceptions	– communication failure; – compatibility check failure; – safety monitoring failure (e.g. object detection positive, misalignment, etc.).

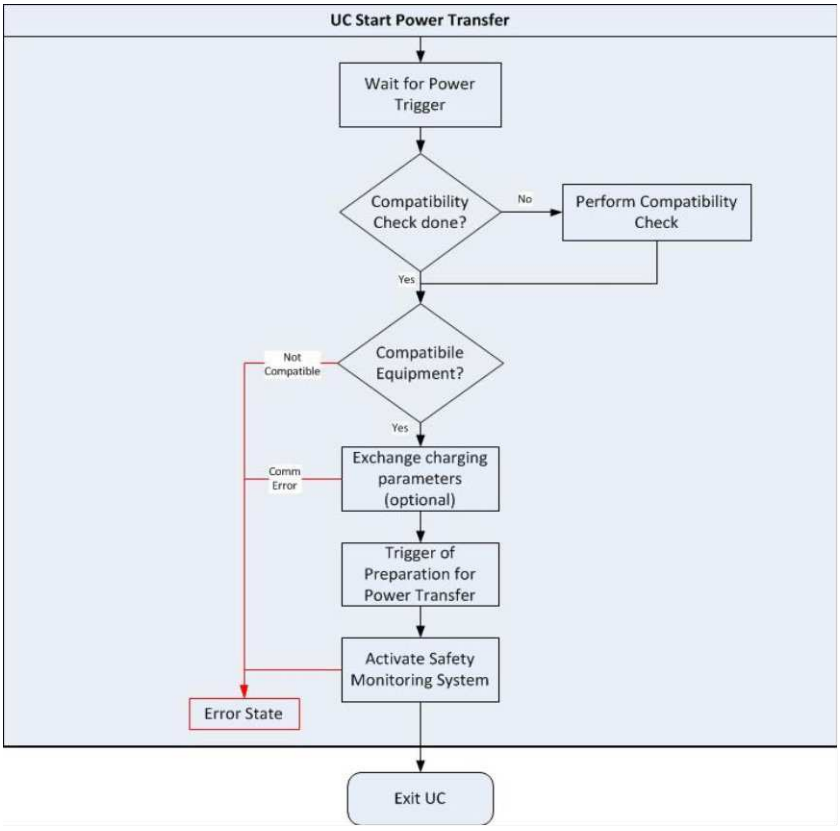


Figure A.7 – Activity diagram for UC Start Power Transfer

A.2.6 UC Perform Power Transfer

Activity diagram for UC Start Power Transfer, see Table A.6 and Figure A.8.

Table A.6 – UC Perform Power Transfer

Actor	User system
General	The supply equipment is transferring power wirelessly to the EV.
Preconditions	– communication (command and control) is established; – compatibility is approved; – alignment was successful; – pairing of EV and primary device was successful; – Safety monitoring system (see future 61980-2) is established on supply equipment side as well as on EV side; – successful exit of UC “Start power transfer”.
Post conditions	Power Transfer process is ongoing until one of the termination indicators apply.
Basic scenario	The supply equipment is transferring power through the device combination to the EV after requested by the EV by command and control communication. NOTE Zero power is defined as power transfer, too. The power transfer remains active as long as a valid request is present. Adjustment of power during the transfer process is done by command and control communication. Use Case “Safety Monitoring and Diagnostics” is applied.
Alternative	Additional trigger application: Power transfer process may be started by one of the following additional triggers: – customer button press on supply equipment; – customer button press or other user activity on EV side; – remote indication by additional user system. The trigger is applied in additionally. Power transfer is controlled by command and control communication.
Exceptions	– safety hazard detected communication failure; – EV move d out of alignment.

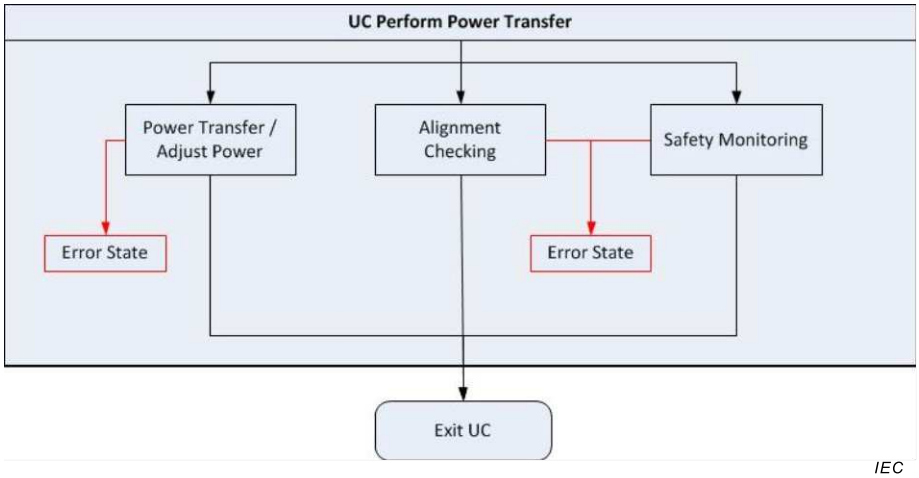


Figure A.8 – Activity diagram for UC Perform Power Transfer

A.2.7 UC Safety Monitoring and Diagnostics (see Table A.7)

Table A.7 – UC Safety Monitoring and Diagnostics

Actor	User system
General	This use case is applied by all use cases treating safety relevant actions. A monitoring system is supervising the wireless power transfer. In case of a safety hazard condition or a functional failure, the system ensures power transfer to be prevented.
Preconditions	EV and primary device are in aligned position
Post conditions	
Basic scenario	The system is activated prior to energy transfer. The monitoring system consists of an EV and a supply equipment. The system is checking safety conditions and is indicating the safety status to the supply equipment. If the safety conditions are fine, the system is allowed to transfer power. If safety conditions are detected to be hazardous, the system prohibits power transfer. The system is in operation continuously as long as power transfer is active. After terminating power transfer, the system is shut down.
Alternative	
Exceptions	Self-check of system fails (not able to operate properly)

A.2.8 UC Stop Power transfer

Activity Diagram for UC Stop Power transfer, see Table A.8 and Figure A.9.

Table A.8 – UC Stop Power transfer

Actor	Customer User system
General	The termination sequence for power transfer is initiated and applied.
Preconditions	Power transfer has terminated.
Post conditions	EV is ready to depart.
Basic scenario	After a trigger situation has occurred the supply equipment side is stopping power transfer to the EV. Supply equipment and EV are exchanging information about the energy transfer status as well as other features (e.g. metering information) in order to safely decouple supply equipment and EV. The trigger situation could be one of the following: – SOC of battery has been reached / no more power is needed; – stop button pressed or other customer action (HMI) on EV side; – stop button pressed by customer on supply equipment side; – indication of power transfer stop remote by external system; – detection of EV misalignment; – failure condition or safety hazard recognition. Monitoring systems are deactivated (UC “Safety Monitoring and Diagnostics”).
Alternative	
Exceptions	– communication failure; – primary device active after removing EV.

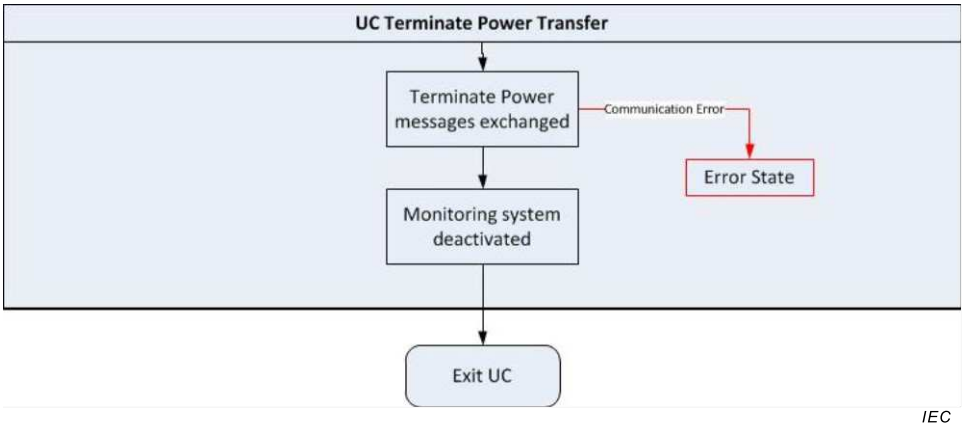


Figure A.9 – Activity diagram for UC Stop Power Transfer

Annex B
(informative)

EMC tables, EV connected to an WPT system

B.1 General

Table B.1 refers to Table 10, Clause 16 and is listed here for information.

Table B.2 refers to Table 11, Clause 16 and is listed here for information.

Table B.3 refers to Table 12, Clause 16 and is listed here for information.

B.2 WPT equipment immunity requirement (informative)

B.2.1.1 Environment other than residential environment with EV

Table B.1 – Environment other than residential environment with EV

Port	Test applicability	Phenomenon	Basic standard	Test value	Performance criteria
WPT with EV	Standby and active mode	Radiated RF Field (20 MHz– 2 000 MHz)	ISO 11451-2	30 V/m	A

B.2.1.2 Residential environment with EV

Table B.2 – Residential environment with EV

Port	Test applicability	Phenomenon	Basic standard	Test value	Performance criteria
WPT with EV	Standby and active mode	Radiated RF Field (20 MHz–2 000 MHz)	ISO 11451-2	30 V/m	A

B.3 Radio frequency (RF) disturbances

Table B.3 – Radio frequency (RF) disturbances – WPT system with EV

Port	Phenomenon	Basic standard	Reference subclause in the present standard
WPT system with EV	Radiated disturbances (30 MHz-1 GHz)	CISPR 12	
NOTE 1 Definition for Class A or B environment and the limits associated with are given within the relevant basic standard. NOTE 2 WPT is considered to be a group 2 equipment according to CISPR 11.			

B.4 WPT system with EV included (radiated disturbances in the range 30 MHz to 1 000 MHz)

Measurements shall be made in accordance with CISPR 12 using a representative sample EV as an alternative measurement for use of an auxiliary apparatus (i.e. of a WPT vehicle power supply circuit with a resistive load or vehicle traction battery) according to 15.2.1. Measurand is the electric component of the radiated disturbance field strength.

The limit of Clause 4 of CISPR 12:2007 applies to all WPT systems assessed together with a EV.

It shall be verified that the limits are met in standby mode and in active mode of operation. The limits shall be met irrespective of a possible supplementary basic data transfer via the WPT air gap interface at the operation frequency (or within the narrow frequency band) used for WPT.

Figure B.1 is an example for measurement of EMC with the EV model for the radiated emission measurement (top view).

Dimensions in millimetres

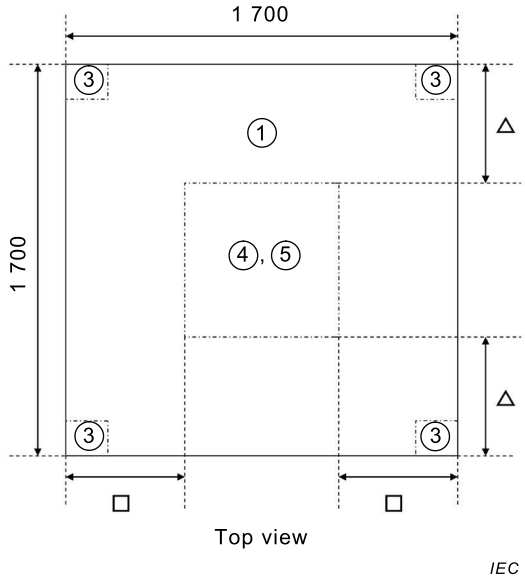
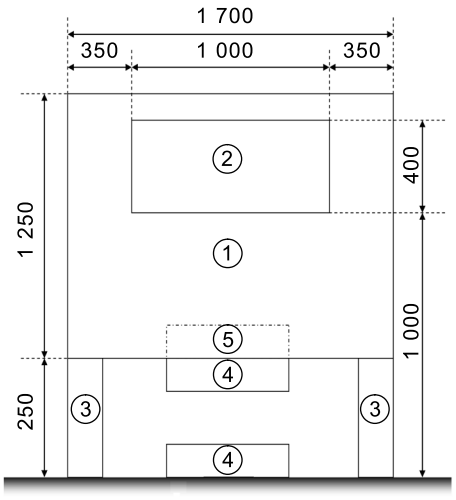


Figure B.1 – EV model for the radiated emission measurement (top view)

Figure B.2 is an example for measurement of EMC with the EV model for the radiated emission measurement (side view).

Dimensions in millimetres



Key	
1	Steel metal box L 1 700 mm × W1 700 mm × H1 250 mm as a vehicle body. Several vehicle sizes could be defined.
2	windows (light, left side of metal box) W 1 000 mm × H 250 mm
3	insulating support
4	coils, primary and secondary
5	onboard peripheral
NOTE 1 250 mm gap between 1 and ground is a typical distance. This distance should be defined in the test plan.	

Figure B.2 – EV model for radiated emission measurements (side view)

Annex C
(informative)

EMF, protection from electromagnetic field

C.1 Protection from electromagnetic field

Only applicable for in-ground mounted or on-ground mounted systems.

Requirements for other systems are under consideration.

C.2 Assessment of electronic and electrical equipment

WPT system shall be assessed regarding human exposure restriction for EMF.

The method as described below or any other applicable IEC standard (e.g. IEC 62311) or guidelines (ICNIRP) can be used to show compliance.

C.3 EMF measurement procedure

The WPT shall operate during the test with current level required to operate within 50 % and 100 % of the rated power.

To make the measurement of the field independent from the actual transmitted power a correction of all measured field values shall be done by using formula (C.1). The current shall be measured at the same time as the field is measured.

$$H_{Corr} = H_{Meas} \cdot \frac{I_r}{I_{Meas}} \quad (C.1)$$

where:

H_{Corr} is the corrected value of the measured magnetic field or flux density;

H_{Meas} is the measured value of the measured magnetic field or flux density;

I_{Meas} is the current flowing in the coil during the measurement of the field;

I_r is the rated current flowing at rated transmitted power as specified by the manufacturer.

NOTE 1 The magnetic field strength depends on the value of the current flowing in the coils. Typically the correlation between the field strength and the current in the coil is linear.

For determining the position of the worst case for testing the following procedure shall be applied.

– 1st Step:

Scan with the field-probe according to IEC 62233 (100 cm^2 coil area) over the complete surface of an imaginary vertical plane which is located in 20 cm distance (centre) and parallel to each of the four sides of the vehicle, see Figures C.1 and C.2. The 20 cm shall be measured from the most outstanding point of the vehicle surface, excluding the rear mirrors. The plane shall be limited by the size of the vehicle (sides, top) and the ground floor. The centre of the probe shall be in the imaginary surface. At least one point shall be measured and recorded in the test report for each of the four sides of the vehicle.

The centre of the measurement probe shall be kept at least in the middle of the distance between ground floor and the vehicle under body during this scan measurement. From a height of 50 cm above the height of the vehicle no measurement is necessary.

– 2nd Step:

At the positions where there is the maximum reading (worst case point) during the first step, a final measurement for a period of minimum 10 s shall be done. The reading at this point shall be recorded together with the exact position (x and y) in the test report and shall meet the applicable limits.

- Area 1: No measurement.
- Area 2: No measurement.
- Area 3: measurements shall be done in nominal position and offset conditions which are defined by system specifications.
- Area 4: measurements shall be done in optimum operating position, see also Figures C.3 and C.4.

The measurement values obtained are used to determine whether the fields comply with exposure limits by comparing them with the field limits for general public exposure such as the reference levels or basic restrictions from the ICNIRP, MPE (maximum permissible exposure) from the IEEE or in national regulations.

In absence of national or local regulations the WPT system shall comply with ICNIRP Guidelines 1998 or 2010.

If measured values are higher than reference levels, it does not necessarily follow that the basic restrictions have been exceeded, but a more detailed analysis is necessary to assess compliance with the basic restrictions.

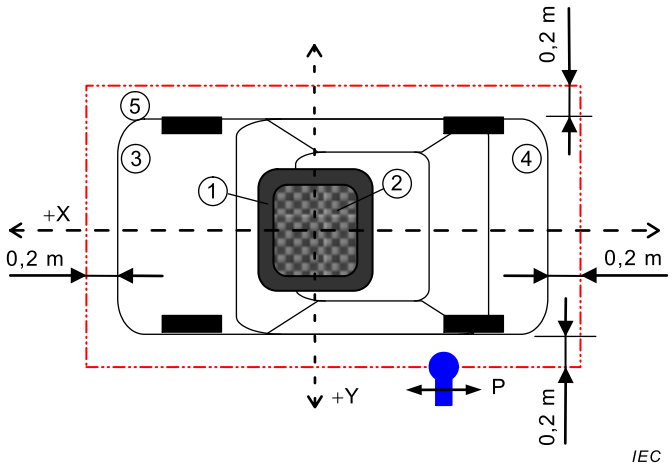
NOTE 2 IEC 62233:2005, Annex B (informative) Exposure limits are only for information and they do not make up an exhaustive list.

- IEC 62233:2005, Clause B.1, ICNIRP Guidelines ICNIRP 1998, ICNIRP 2010.
- IEC 62233:2005, Clause B.1, IEEE standard, e.g. IEEE Std C95.6-2002, etc.

NOTE 3 In the following country, acceptable dynamic magnetic field exposure levels are lower than stated: CA.

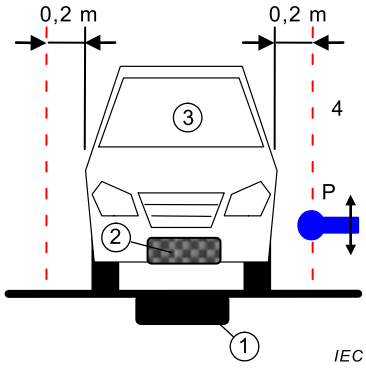
C.4 Measurement points

C.4.1 Area 3 measurement points of nominal position



Key	
1	Primary device
2	Secondary device
3	Front
4	Rear
5	Right
P	Probe

Figure C.1 – Top view



Key	
1	Primary device
2	Secondary device
3	EV
4	Virtual area for scanning the worst case position
P	Probe

Figure C.2 – Front view

In optimum operating position measurement, the secondary device(s) shall be centred on the primary device(s).

Manufacturers can use other methods to prove compliance with the limits.

NOTE The specified positions have been selected since they have been detected as worst case points after various simulations with field calculation software. (See also Bibliography: Phys Med Biol. 2013 Nov 7; 58(21): 7583–93.

C.4.2 Area 3 measurement points of offset positions

In offset conditions, measurements shall be carried out under the maximum offset conditions of X axis and Y axis according to the manufacturer's manual.

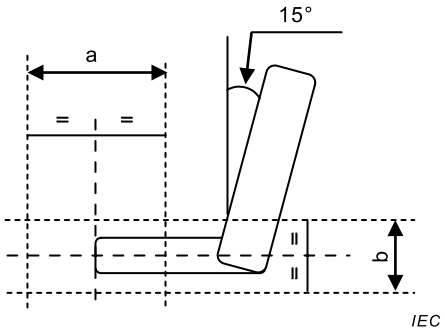
C.4.3 Area 4 measurement points

Before measurement all seats should be centre positioned if seats had the travel range. (See Figures C.3 and C.4 for the correct positioning.)

At the locations (a, b and c) indicated in Figure C.4, the whole surface of the seating and headrest shall be scanned with the probe described in IEC 62233 (100 cm^2 probe). The centre of the measurement probe shall be 10 cm above the surface of the seating and headrest.

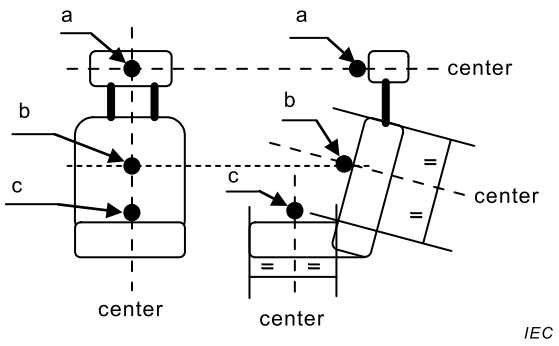
The worst case positions around the positions a, b and c shall be measured and recorded.

As regards buses or minibuses, measurements shall be carried out in driver’s seats and the closest seats to secondary device.



Key	
a	travel range forward/backward, centre position
b	travel range in height, centre position

Figure C.3 – Seats position



Key	
a	centre position of headrest
b	centre position of backrest
c	centre position of seat

Figure C.4 – Measurement points of seats

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10 Under consideration.

11 Under consideration.

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