PUBLICLY AVAILABLE SPECIFICATION

ISO/PAS 19363

First edition
2017-01

Electrically propelled road vehicles — Magnetic field wireless power transfer — Safety and interoperability requirements

Véhicules routiers électriques — Transmission d'énergie sans fil par champ magnétique — Exigences de sécurité et d'interopérabilité

Reference number
ISO/PAS 19363:2017(E)

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Foreword

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

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ISO PAS 19363:2017 was prepared by Technical Committee ISO/TC 22, *Road vehicles,* SC 37, *Electrically propelled vehicles*, in collaboration with IEC/TC 69 *Electric road vehicles and electric industrial trucks,* in accordance with ISO/IEC mode of cooperation 4.

Introduction

This document is an intermediate specification, published prior to the development of a full International Standard. This document prescribes the usage of the wireless power transfer technology to charge electrically propelled road vehicles. Even if the technology itself is well known, the implementation in a vehicle is new and demands to meet the very specific requirements of the automotive industry. The main purpose of this document is to respond to the upcoming market needs starting with determination of basic safety requirements and documentation for the first findings for vehicle usage.

This document will be transformed into an International Standard as soon as consolidated technical experiences are available. When transferring this document into an IS, technical changes are possible to adopt the document to the latest level of knowledge.

Electrically propelled road vehicles — Magnetic field wireless power transfer — Safety and interoperability requirements

1 Scope

This document defines the requirements and operation of the on-board vehicle equipment that enables magnetic field wireless power transfer (MF-WPT) for traction battery charging of electric vehicles. It is intended to be used for passenger cars and light duty vehicles.

This document addresses the following aspects for an EV device:

— transferred power;

— ground clearance;

— interoperability requirements among differently classified EV devices and associated off-vehicle systems;

— performance requirements under various conditions, including among different manufacturers and classifications;

— safety requirements;

— test procedures.

EV devices according to this document are intended to operate with off-board systems currently under development in the IEC 61980 series.

NOTE 1 This edition covers stationary applications.

NOTE 2 Bidirectional power transfer is not considered in this edition.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 14117, *Active implantable medical devices — Electromagnetic compatibility — EMC test protocols for implantable cardiac pacemakers, implantable cardioverter defibrillators and cardiac resynchronization devices*

ISO 15118-8, *Road vehicles — Vehicle to grid communication interface — Part 8: Physical layer and data link layer requirements for wireless communication*

ISO 16750-3, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 3: Mechanical loads*

ISO 16750-4, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 4: Climatic loads*

ISO 16750-5, *Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 5: Chemical loads*

IEC 61786-1, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings - Part 1: Requirements for measuring instruments*

ICNIRP 2010, *Guidelines for limiting exposure to time varying electric and magnetic fields (1 HZ – 100 kHZ)*

ICNIRP 1998, *Guidelines for limiting exposure to time varying electric and magnetic fields (up to 300 kHZ)*

3 Terms and definitions

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

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

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

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
alignment
relative position of primary to *secondary device* (3.27)

3.2
alignment check
confirmation that the primary and *secondary devices* (3.27) are properly positioned relative to each other

Note 1 to entry: Proper positioning is done to assure sufficient system functionality [e.g. *system efficiency* (3.35), EMF/EMC limits, safety requirements, etc.].

3.3
basic insulation
insulation of hazardous-live-parts which provides basic protection

3.4
battery system
(battery) energy storage device that includes cells or cell assemblies or battery pack(s), as well as electrical circuits and electronics

EXAMPLE BCU, contactors.

3.5
double insulation
insulation comprising both *basic insulation* (3.3) and *supplementary insulation* (3.30)

3.6
electric shock
physiological effect resulting from an electric current through a human body

3.7
electric vehicle/electric road vehicle
EV
any vehicle propelled by an electric motor drawing current from a *battery system* (3.4) intended primarily for use on public roads

3.8
EV communication controller
EVCC
embedded system, within the vehicle, that implements the communication between the vehicle and the SECC in order to support specific functions

Note 1 to entry: Such specific functions could be, for example, controlling input and output channels, encryption, or data transfer between vehicle and SECC.

3.9
EV device
on-board component assembly, comprising the *secondary device* (3.27), the *EV power electronics* (3.12) and the *EV communication controller* (3.8), as well as the mechanical connections between the components necessary for wireless power transfer

3.10
EV power circuit
EVPC
electrical component assembly that includes the *secondary device* (3.27) and *EV power electronics* (3.12), as well as the mechanical connections between the components

Note 1 to entry: EVPC is here defined specifically for *MF-WPT systems* (3.19).

3.11
EVPC power class
power class of an EVPC defined according to the *MF-WPT input power class* (3.18) of the supply device it is designed to operate

Note 1 to entry: The power delivered to the *EV device* (3.9) will be less than that maximum MF-WPT input power to the *MF-WPT system* (3.19) due to losses, for example, in the *supply power electronics* (3.34) and eddy currents in the MF-WPT shield or the vehicle underbody.

3.12
EV power electronics
on-board electronics, including all housings and covers, that convert the AC power from the *secondary device* (3.27) to DC power having suitable voltages and currents provided to the *battery system* (3.4) or the traction-battery

EXAMPLE Impedance matching network (IMN), filter, rectifier, impedance converter.

3.13
fine positioning
relative movement of the *secondary device* (3.27) in relation to the *primary device* (3.23) with the goal of reaching *optimal alignment* (3.20)

3.14
foreign object
object that is not an attached part of the vehicle or the *MF-WPT system* (3.19)

3.15
grid
electric power source that is not part of the vehicle for supplying electric energy to an EV using a *supply power circuit* (3.33)

3.16
Magnetic Field Wireless Power Transfer
MF-WPT
wireless transfer of energy from a power source to an electrical load via a magnetic field

3.17
message
data in a specified format

EXAMPLE A message contains data in a specified format that describes for example, a request or a reply.

Note 1 to entry: A message contains zero or more parameters.

3.18
MF-WPT input power class
power class of a supply device of *MF-WPT systems* (3.19) defined from the perspective of the maximum power drawn from the *grid* (3.15) in order to drive the supply device

Note 1 to entry: IEC 61980-3 will specify the MF-WPT input power classes, current status of discussions: for MF-WPT1 the maximum input power is ≤3,7 kW, for MF-WPT2 the maximum input power is >3,7 kW and ≤7,7 kW, for MF-WPT3 the maximum input power is >7,7 kW and ≤11 kW, for MF-WPT4 the maximum input power is >11 kW and ≤22 kW, for MF-WPT5 the maximum input power is >22 kW. For this document, MF-WPT1 to MF-WPT4 are under consideration.

3.19
MF-WPT system
system consisting of *primary device* (3.23), *supply power electronics* (3.34), *supply equipment communication controller* (3.32), (the supply device), *secondary device* (3.27), *EV power electronics* (3.12) and electric vehicle communication controller [the *EV device* (3.9)], including wiring, housing and covers used to transfer energy using magnetic fields

Note 1 to entry: See also Figure 1.

3.20
optimal alignment
alignment (3.1) with the most efficient power transfer

3.21
pairing
process by which an EV is correlated with the unique dedicated *primary device* (3.23) at which it is located and from which power will be transferred

3.22
power saver mode
mode in which the EV either turns *EV device* (3.9) components off or into a mode with reduced power consumption

3.23
primary device
device external to the EV that is the source of the MF-WPT, including all housings and covers

Note 1 to entry: When the EV is receiving power, the primary device acts as the source of the power to be transferred.

3.24
protection area
volume in and around the vehicle that has homogeneous protection target requirements

3.25
reference level
levels of field strength or power density derived from the basic restrictions using worst case assumptions about exposure

Note 1 to entry: If the reference levels are met, then the basic restrictions will be complied with, but if the reference levels are exceeded, that does not necessarily mean that the basic restriction will not be met.

3.26
reinforced insulation
insulation of hazardous live parts which provides a degree of protection against *electric shock* (3.6) equivalent to *double insulation* (3.5)

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as *basic insulation* (3.3) or *supplementary insulation* (3.30).

3.27
secondary device
device mounted on the EV, including all housings and covers, that captures the magnetic field sourced by the *primary device* (3.23)

Note 1 to entry: When the EV is receiving power, the *secondary device* (3.28) transfers the power from the primary to the EV.

3.28
secondary device ground clearance
vertical distance between the ground surface and the lowest point of the *secondary device* (3.28)

Note 1 to entry: The lower surface may not be planar and may not be parallel to the ground surface.

3.29
steady state
state of a system at which all state and output variables remain constant in time while all input variables are constant

3.30
supplementary insulation
independent insulation applied in addition to *basic insulation* (3.3) for fault protection

3.31
supply device
off-board component assembly comprising the *primary device* (3.23), the *supply power electronics* (3.34) and the supply device communication controller, as well as the mechanical connections between the components necessary for wireless power transfer

3.32
supply equipment communication controller
SECC
entity which implements the communication to one or multiple *EVCCs* (3.8)

Note 1 to entry: Functions of an SECC control input and output channels, data encryption, or data transfer between vehicle and SECC.

3.33
supply power circuit
off-board component assembly comprising the *supply power electronics* (3.34) and *primary device* (3.23), as well as the mechanical connections between the components

3.34
supply power electronics
off-board electronics, including all housings and covers, that supply the electric power to the *primary device* (3.23)

EXAMPLE PFC converter, DC-AC inverter, filter, impedance matching network.

3.35
system efficiency
efficiency from AC or DC power supply (input of the supply device) to the output of the *EV device* (3.9)

Note 1 to entry: It is of no importance whether the output is connected to a device or directly to a battery.

3.36
voltage class B
classification of an electric component or circuit with a maximum working voltage of >30 V and ≤1,000 V AC (rms) or >60 V DC and ≤1,500 V DC, respectively

4 Environmental conditions

Potential environmental stresses and related tests and requirements for electronic systems/components mounted in specific locations on/in the vehicle are described in ISO 16750.

The environmental requirements applicable to a particular EV device shall be identified and agreed between the customer and supplier and the compliance testing for these requirements shall be performed in accordance with the following ISO standards:

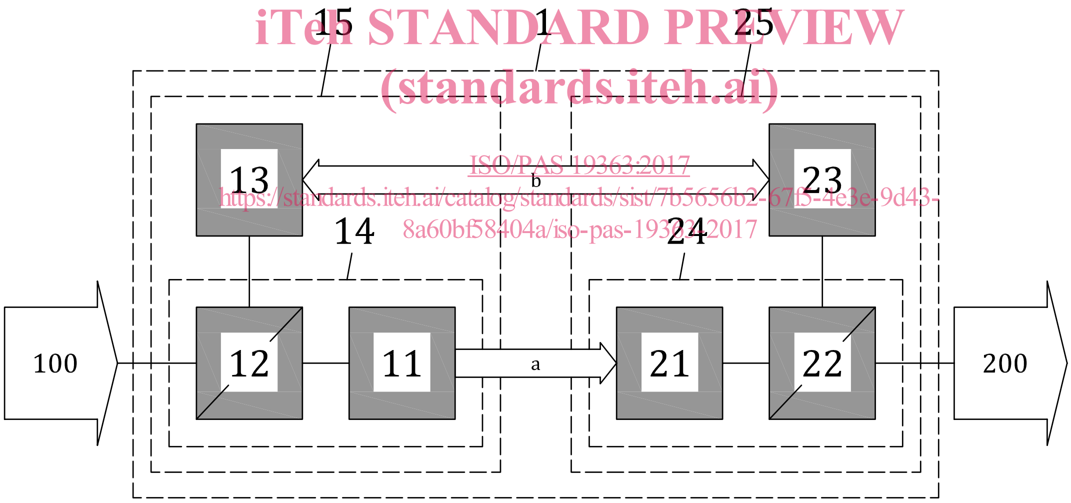
— mechanical loads according to ISO 16750-3, test procedure type VI, vehicle body;

— climate loads according to ISO 16750-4;

— chemical loads according to ISO 16750-5.

5 System description

Figure 1 shows an example for the structure of an MF-WPT system.



Key

1 MF-WPT system
11 primary device
12 supply power electronics
13 supply equipment communication controller (SECC)
14 supply power circuit
15 supply device
100 grid
21 secondary device
22 EV power electronics
23 EV communication controller (EVCC)
24 EV power circuit (EVPC)
25 EV device
200 battery
a Wireless power flow.
b Communication.

NOTE The numbering convention adopted is based on system blocks being assigned a number with the supply device blocks having numbers of the form “1X” and the EV device blocks of the form “2X”. The second digit identifies equivalent functionality in the supply and EV sub-systems.

Figure 1 — MF-WPT system

6 MF-WPT interoperability

6.1 General

Interoperability refers to the capability of the supply device and the EV device being able to transfer power wirelessly in a safe and efficient manner, based on compliance with the requirements in this document.

In order to determine interoperability, an EV device shall be tested according to 6.6 with the reference supply devices for which it is designed to operate.

NOTE 1 IEC 61980-3 will specify the reference supply devices. A supply device is designed so that it is operable with the relevant reference EV devices, specified in this document. In order to determine interoperability, a supply device is tested with the relevant reference EV devices specified in this document. This allows EV devices and supply devices to be sourced independently.

NOTE 2 The interoperability of the functions and communication is specified in Clause 7 and Clause 8.

6.2 Classification of EV power circuits

6.2.1 General

The reference EV devices are classified by MF-WPT class and Z class.

NOTE For this document, it is assumed that supply devices are designed to serve all Z classes.

6.2.2 MF-WPT classes

An EVPC shall be classified for one or more MF-WPT classes.

The maximum power of an EVPC shall be specified.

A reference EV device is classified for one MF-WPT class.

Reference EV devices are verified to meet the performance requirements (see 6.3) up to the maximum power of the MF-WPT class it is assigned to.

MF-WPT class interoperability requirements between the supply device and an EVPC are shown in Table 1.

Table 1 — MF-WPT Class Interoperability Requirements

		Supply device MF-WPT input power class			
		MF-WPT1	**MF-WPT2**	**MF-WPT3**	**MF-WPT4**
EVPC MF-WPT class	MF-WPT1	Required	Required[a]	[a]	[a]
	MF-WPT2	Required[a]	Required	[a]	[a]
	MF-WPT3	[a]	[a]	Required	[a]
	MF-WPT4	[a]	[a]	[a]	Required

[a] Under consideration.

MF-WPT class interoperability implies that the EV device shall be able to request adaptation of output power of the supply device.

6.2.3 Z classes

The Z classes as specified in Table 2 are based on the secondary device ground clearance.

Table 2 — Z classes

Z class	Secondary device ground clearance mm
Z1	100 to 150
Z2	140 to 210
Z3	170 to 250
NOTE Alternative for Z3 as 200 mm to 250 mm is under discussion.	

A reference EV device is verified to meet the performance requirements (see 6.3) within the entire Z class for which it is specified.

The secondary device ground clearance range for which an EVPC is designed shall be specified.

An EVPC shall meet the performance requirements (see 6.3) within the secondary device ground clearance range for which it is specified when tested with the reference supply device(s).

6.3 Performance requirements

6.3.1 General

An EVPC shall meet the performance requirements within the secondary device ground clearance range and within the power range as specified by the manufacturer when tested with the corresponding reference supply device.

6.3.2 Alignment tolerance requirements

The reference EV device are verified to meet the power transfer requirements as in 6.3.3 and the system efficiency requirements as in 6.3.4 over its entire Z class and the alignment tolerances in x and y direction (see Table 4).

An EVPC shall meet the requirements as in 6.3.3 and 6.3.4 over its entire secondary device ground clearance range and the alignment tolerances in x and y direction (see Table 3).

NOTE 1 Compliance is verified by including the maximum misalignment point within the test plan. The test conditions are defined in the test procedure.

NOTE 2 The alignment tolerances are defined with respect to the optimal alignment.

Table 3 — x and y alignment tolerance requirements

Axis	Alignment tolerance (mm)
x	±75
y	±100

The EV may have the capability to assist the driver in aligning the vehicle for proper coupling between the primary and secondary device. This functionality may require some support from the supply power circuit and standardization of this mechanism may be desired. The definition of such a mechanism does not preclude the use of alternate mechanisms by the EV.

6.3.3 Power transfer requirements

A reference EV device shall deliver the requested power under steady-state condition up to maximum power of the MF-WPT class for which it is specified.

An EVPC shall deliver the requested power under steady-state condition up to the power for which it is specified by the vehicle manufacturer.

A requested change in power delivery shall not cause a DC output voltage overshoot of an EVPC by more than ±250 V/ms with the peak voltage not higher than 10 % of the nominal DC output voltage. The DC output voltage ripple amplitude of an EVPC shall not exceed ±8 V.

6.3.4 System efficiency requirements

The minimum system efficiency shall be according to Table 4.

Table 4 — Minimum efficiency

Alignment	Minimum system efficiency
Optimal alignment	85 %
Within alignment tolerance	80 %

If auxiliary loads (e.g. thermal management or foreign object detection) are mandatory for a system specific application (e.g. higher power classes or higher flux), their power consumption shall also be included in the system efficiency calculation.

If auxiliary loads are not mandatory and partial load is not applicable for a system specific application, this shall be confirmed in a clear statement as part of the measurement procedure and type certification documents.

6.4 Frequency

To ensure interoperability, the power transfer shall be operated within the system frequency range respectively at the nominal frequency, according to Table 5.

Table 5 — Frequency

Description	Frequency (kHz)
System frequency range	81,38 to 90,00
Nominal frequency	85 ± 0,1

A fixed-frequency system shall transfer the power at the nominal frequency.

For frequency-tuneable systems, the nominal frequency is typically observed under optimal alignment and while the system is in a steady-state. Frequency-tuneable systems may transfer power at any frequency within the system frequency range.

NOTE To optimize the system efficiency, the MF-WPT system (or the supply power circuit) can tune the frequency within the system frequency range.

6.5 Reference EV devices

Reference EV devices for MF-WPT1 and MF-WPT2 are described in Annex A to Annex D.

NOTE Annex A to Annex D reflect the state-of-the-art proposals for reference EV devices that are under discussion. Technical investigations are ongoing to specify the reference EV devices and interoperability requirements.

6.6 Test procedure

Power transfer and system efficiency requirements shall be tested with the following setup:

— the EV device is connected to a battery or a simulated DC load.

Power transfer and system efficiency requirements shall be tested under the following conditions:

— ambient temperature of 25 °C ± 5 °C;