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ISO/PAS 5474-6

**Electrically propelled road
vehicles — Functional and safety
requirements for power transfer
between vehicle and external
electric circuit —**

Part 6:
**Safety and interoperability
requirements for heavy-duty
vehicles in magnetic field wireless
power transfer**

*Véhicules routiers à propulsion électrique — Exigences
fonctionnelles et exigences de sécurité pour le transfert de
puissance entre le véhicule et le circuit électrique externe —*

*Partie 6: Exigences de sécurité et d'interopérabilité pour les
véhicules utilitaires lourds dans le cadre du transfert d'énergie
sans fil par champ magnétique*

**First edition
2025-01**

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Published in Switzerland

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Foreword

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

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 document 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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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, SC 37, *Electrically propelled vehicles*.

A list of all parts in the ISO 5474 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document specifies requirements for on-board components of a wireless power transfer systems in heavy-duty vehicles. It gives guidance in terms of safety and performance and additionally addresses interoperability to off-board components from different manufacturers to, for example, support the development of public wireless charging infrastructure. 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. This document is based on limited experience with series development and production. Current and future product developments will continuously prove (and disprove) the applicability of this document to further improve the contents, especially regarding the interoperability between systems from different manufacturers.

The systems specified in this document are intended to work with off-board systems that are compliant with the requirements of the relevant portions of the IEC 61980 series. Some of those relevant documents are currently in development.

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Electrically propelled road vehicles — Functional and safety requirements for power transfer between vehicle and external electric circuit —

Part 6:

Safety and interoperability requirements for heavy-duty vehicles in magnetic field wireless power transfer

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 specifies requirements for static (vehicle not in motion) and dynamic (vehicle in motion) applications. It is intended to be used for heavy duty vehicles. This does not exclude the application of systems in passenger cars or light commercial vehicles

This document addresses the following aspects for an EV device:

- safety requirements;
- transferred power and power transfer efficiency;
- ground clearance of the EV device;
- functionality with associated off-board systems under various conditions and independent of manufacturer (interoperability);
- test procedures.

EV devices that fulfil the requirements in this document are intended to operate with supply devices that fulfil the MF-WPT related requirements in the IEC 61980 series.

In this edition, multiple secondary devices (modular approach for higher power classes) are not covered.

NOTE The dynamic application is shown in [Annex C](#).

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 5474-1, *Electrically propelled road vehicles — Functional and safety requirements for power transfer between vehicle and external electric circuit — Part 1: General requirements for conductive power transfer*

ISO 6469-3:2021, *Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety*

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

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

IEC 61980-1:2020, *Electric vehicle wireless power transfer (WPT) Systems — Part 1: General requirements*

IEC 61980-2, *Electric vehicle wireless power transfer (WPT) Systems — Part 2: Specific requirements for MF-WPT system communication and activities*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5474-1 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

alignment

relative position in x- and y-direction of the *secondary device* (3.16) to the *primary device* (3.10) for a given *secondary device ground clearance* (3.17)

3.2

alignment tolerance area

intended *wireless power transfer (WPT)* (3.23) operating area in x- and y-direction for a given *secondary device ground clearance* (3.17)

3.3

embedded mounting

mounting of a *primary device* (3.10) in such a manner that the top covering of the primary device is buried (embedded) under the pavement

3.4

centre alignment point

geometrical centre of the *alignment tolerance area* (3.2)

3.5

electrically propelled vehicle

vehicle with one or more electric drive(s) for vehicle propulsion

3.6

EV device

on-board component assembly of *wireless power transfer (WPT) system* (3.24)

3.7

EV power circuit

EVPC

on-board component assembly, comprising the *secondary device* (3.16) and *EV power electronics* (3.8), as well as the electrical and mechanical connections

3.8

EV power electronics

on-board component that converts the power and frequency from the *secondary device* (3.16) to the DC power output of the *EV power circuit (EVPC)* (3.7)

3.9

magnetic field WPT system

MF-WPT system

system using wireless transfer of energy from a power source to an electrical load via a magnetic field

3.10

primary device

off-board component that generates and shapes the magnetic field for *wireless power transfer (WPT)* (3.23)

3.11

protection area

volume in and around the vehicle that has uniform requirements with regard to effects of exposure to electromagnetic fields

3.12

rated output power

maximum power the *EV power circuit (EVPC)* (3.7) is designed to deliver consistently during a charging cycle

3.13

rechargeable energy storage system

RESS

rechargeable system that stores energy for delivery of electric energy for the electric drive

3.14

reference EVPC

EV power circuit (EVPC) (3.7) that serves for testing purposes

3.15

reference supply power circuit

reference SPC

supply power circuit that serves for testing purposes

3.16

secondary device

on-board component that captures the magnetic field

3.17

secondary device ground clearance

vertical distance between the ground surface and the lowest point of the *secondary device* (3.16) including the housing

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3.18

steady state

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

3.19

supply device

off-board component assembly of *wireless power transfer (WPT) system* (3.24)

3.20

supply power circuit

SPC

off-board component assembly, comprising the *primary device* (3.10) and supply power electronics (3.21), as well as the electrical and mechanical connections

3.21

supply power electronics

off-board component that converts the power and frequency from the supply network to the power and frequency needed by the *primary device* (3.10)

3.22

voltage class B

classification of an electric component or circuit with a maximum working voltage of (>30 and ≤1 000) V a.c. (rms) or (>60 and ≤1 500) V d.c., respectively

3.23

wireless power transfer

WPT

transfer of electrical energy from a power source to an electrical load without galvanic connection

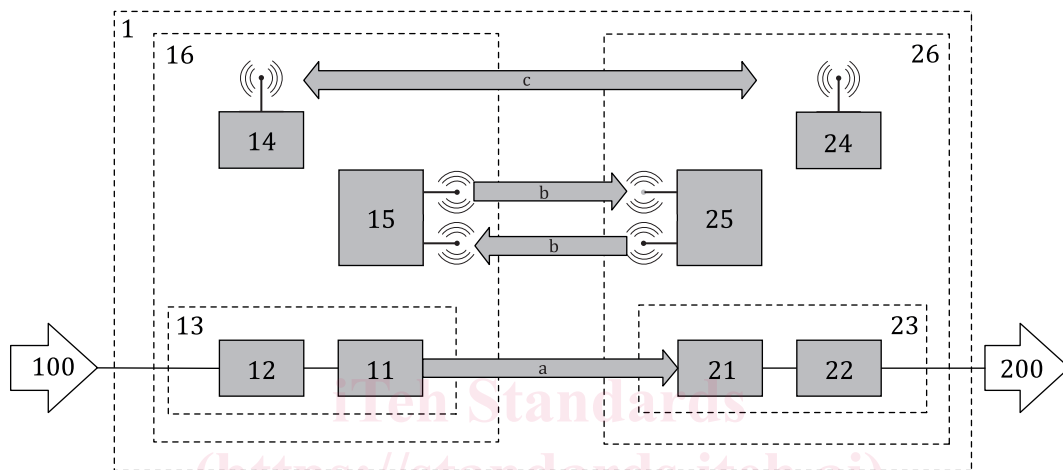
3.24

WPT system

system comprising all necessary components for *wireless power transfer (WPT)* (3.23) and control

4 System structure

The MF-WPT system is structured into functional entities. [Figure 1](#) shows this structure of functional entities in an exemplary static wireless power transfer system.



Key

- | | | | |
|-----|--|-----|------------------------------------|
| 1 | MF-WPT system | 21 | secondary device |
| 11 | primary device | 22 | EV power electronics |
| 12 | supply power electronics | 23 | EV power circuit |
| 13 | supply power circuit | 24 | EV communication controller (EVCC) |
| 14 | supply equipment communication controller (SECC) | 25 | EV device P2PS controller |
| 15 | supply device P2PS controller | 26 | EV device |
| 16 | supply device | 200 | RESS |
| 100 | supply network | | |
| a | Wireless power flow. | | |
| b | Wireless P2PS interface. | | |
| c | Wireless communication interface. | | |

Figure 1 — Example of system structure for static wireless power transfer

5 Requirements regarding environmental conditions

The requirements given in this document shall be met across the range of environmental conditions as specified by the vehicle manufacturer.

The environmental requirements applicable to a component depend on its mounting position. The component shall withstand and retain its degree of protection under the typical loads and stresses it is subjected to in its intended mounting position.

Components of the EV device installed at the underbody of the EV shall have IP degree IP6K7 and IP6K9K according to ISO 20653.

NOTE See ISO 16750 series, ISO 21498 series and ISO 19453 series for guidance.

6 Classification

This document specifies requirements that address the following aspects of MF-WPT systems:

- system safety,
- system performance, and
- interoperability.

Requirements regarding system safety and system performance are relevant and applicable to any MF-WPT system (including dedicated single-supplier solutions).

The interoperability requirements supplement the safety and performance requirements in order to allow for interoperability of a supply device and an EV device provided by independent suppliers. Cross-supplier interoperability is tested with the reference SPCs (under consideration) as specified in this document.

Two compatibility classes have been specified to accommodate these design considerations:

- Compatibility class A: EV devices of this class are intended for interoperable application and are required to meet a set of safety and performance requirements.
- Compatibility class B: EV devices of this class are not intended for interoperable application but still are required to meet the set of safety requirements. Performance requirements may be different than those of compatibility class A. EV devices of this class are tested with supplier-specified supply power circuits.

7 MF-WPT power transfer requirements

7.1 General

The supplier shall specify the rated conditions of an EVPC according to [Table 1](#).

Table 1 — EVPC rated conditions

Specifications of EVPC		Compatibility class A	Compatibility class B
Frequency range		Operation within (79 - 90) kHz	Operation within (79 - 90) kHz, (19-21) kHz (TBD)
Secondary device ground clearance		EVPC specific within 100 mm - 250 mm	EVPC specific
Centre alignment point(s)		EVPC specific	
Alignment tolerance area	x-direction	±100 mm	EVPC specific
	y-direction	±100 mm	EVPC specific
Output voltage range		EVPC specific within voltage classes A and B according to ISO 6469-3.	
Rated output power		EVPC specific up to 22 kW (MF-WPT4) EVPC specific up to 50 kW (MF-WPT5)	EVPC specific

7.2 Frequency

MF-WPT for EVs with compatibility class A is allowed to operate in the frequency range of (79 - 90) kHz. The operating frequency during power transfer is set by the supply device based on negotiations with the EV device.