



TECHNICAL SPECIFICATION



Electric vehicle wireless power transfer (WPT) systems – Part 3: Specific requirements for the magnetic field wireless power transfer systems

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 43.120

ISBN 978-2-8322-6675-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	9
4 Abbreviations	13
4 Symbols and abbreviated terms.....	13
5 General	13
6 Classification.....	13
7 Interoperability	15
7 System infrastructure requirements	15
8 General systems requirements	24
9 Communication.....	24
10 Protection against electric shock	24
11 Specific requirements for WPT systems.....	25
12 Power cable assembly requirements.....	26
13 Constructional requirements	27
14 Strength of materials and parts.....	27
15 Service and test conditions.....	28
16 Electromagnetic compatibility (EMC)	28
17 Marking and instructions.....	28
101 Test procedure	28
Annex AA (informative) DD reference EV power circuit (EVPC) for MF-WPT1, MF-WPT2 and MF-WPT3	37
Annex BB (informative) Circular reference EV power circuit (EVPC) for MF-WPT1, MF-WPT2 and MF-WPT3	54
Annex CC (informative) Heavy-duty magnetic field WPT	73
Annex DD (informative) Coil position in parking spot.....	79
Annex EE (informative) Description for system interoperability.....	80
Bibliography.....	107
Figure 101 – Flush mounted	11
Figure 102 – Surface mounted.....	12
Figure 103 – Components of an MF-WPT system	16
Figure 104 – Control loop of WPT system	21
Figure 105 – Illustration of test positions.....	30
Figure AA.1 – Mechanical dimensions of the MF-WPT1/Z1 DD reference secondary device.....	38
Figure AA.2 – Schematic of the EV power electronics for the MF-WPT1/Z1 DD reference EVPC.....	39
Figure AA.3 – Mechanical dimensions of the MF-WPT1/Z2 DD reference secondary device.....	40

Figure AA.4 – Schematic of the EV power electronics for the MF-WPT1/Z2 DD reference EVPC	41
Figure AA.5 – Mechanical dimensions of the MF-WPT2/Z1 DD reference secondary device	42
Figure AA.6 – Schematic of the EV power electronics for the MF-WPT2/Z1 DD reference EVPC	43
Figure AA.7 – Mechanical dimensions of the MF-WPT2/Z2 DD reference secondary device	44
Figure AA.8 – Schematic of the EV power electronics for the MF-WPT2/Z2 DD reference EVPC	45
Figure AA.9 – Mechanical dimensions of the MF-WPT2/Z3 DD reference secondary device	46
Figure AA.10 – Schematic of the EV power electronics for the MF-WPT2/Z3 DD reference EVPC	47
Figure AA.11 – Mechanical dimensions of the MF-WPT3/Z1 DD reference secondary device	48
Figure AA.12 – Schematic of the EV power electronics for the MF-WPT3/Z1 DD reference EVPC	49
Figure AA.13 – Mechanical dimensions of the MF-WPT3/Z2 DD reference secondary device	50
Figure AA.14 – Schematic of the EV power electronics for the MF-WPT3/Z2 DD reference EVPC	51
Figure AA.15 – Mechanical dimensions of the MF-WPT3/Z3 DD reference secondary device	52
Figure AA.16 – Schematic of the EV power electronics for the MF-WPT3/Z3 DD reference EVPC	53
Figure BB.1 – Mechanical dimensions of the MF-WPT1/Z1 circular reference secondary device	55
Figure BB.2 – Schematic of the EV power electronics for the MF-WPT1/Z1 circular reference EVPC	56
Figure BB.3 – Mechanical dimensions of the MF-WPT1/Z2 circular reference secondary device	57
Figure BB.4– Schematic of the EV power electronics for the MF-WPT1/Z2 circular reference EVPC	58
Figure BB.5 – Mechanical dimensions of the MF-WPT1/Z3 circular reference secondary device	59
Figure BB.6 – Schematic of the EV power electronics for the MF-WPT1/Z3 circular reference EVPC	59
Figure BB.7 – Mechanical dimensions of the MF-WPT2/Z1 circular reference secondary device	61
Figure BB.8 – Schematic of the EV power electronics for the MF-WPT2/Z1 circular reference EVPC	62
Figure BB.9 – Mechanical dimensions of the MF-WPT2/Z2 circular reference secondary device	63
Figure BB.10 – Schematic of the EV power electronics for the MF-WPT2/Z2 circular reference EVPC	64
Figure BB.11– Mechanical dimensions of the MF-WPT2/Z3 circular reference secondary device	65
Figure BB.12 – Schematic of the EV power electronics for the MF-WPT2/Z3 circular reference EVPC	66

Figure BB.13 – Mechanical dimensions of the MF-WPT3/Z1 circular reference secondary device	67
Figure BB.14 – Schematic of the EV power electronics for the MF-WPT3/Z1 circular reference EVPC	68
Figure BB.15 – Mechanical dimensions of the MF-WPT3/Z2 circular reference secondary device	69
Figure BB.16 – Schematic of the EV power electronics for the MF-WPT2/Z2 circular reference EVPC	70
Figure BB.17 – Mechanical dimensions of the MF-WPT3/Z3 circular reference secondary device	71
Figure BB.18– Schematic of the EV power electronics for the MF-WPT3/Z3 circular reference EVPC	72
Figure CC.1 – Mechanical dimensions of the MF-WPT5 heavy-duty WPT reference primary device	75
Figure CC.2 – Schematic of supply power electronics for the heavy-duty WPT reference primary device	76
Figure CC.3 – Mechanical dimensions of the MF-WPT5 heavy-duty WPT reference secondary device	77
Figure CC.4 – Schematic of the EV power electronics for the MF-WPT5 heavy-duty WPT secondary reference device	78
Figure DD.1 – Coil position in parking spot	79
Figure EE.1 – General schematic of the concept showing the coil system and the ports at which the parameters are defined	81
Figure EE.2 – Example of GA impedance zone with stimulationi results for different reference primary devices and secondary devices	89
Figure EE.3 – Schematic to explain impedance	91
Figure EE.4 – Behaviour of the reflected impedance	92
Figure EE.5 – Position of measurement points	95
Figure EE.6 – Coaxial gauge device	97
Figure EE.7 – Transversal gauge device	99
Figure EE.8 – Design of winding for the transversal gauge device	100
Figure EE.9 – Exemplary test bench setup for secondary interoperability tests	101
Figure EE.10 – Exemplary test bench setup for primary device interoperability tests	103
Figure EE.11 – Test set-up for electric interoperability design testing	105
Figure EE.12 –Test set-up for electric interoperability design testing	105

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 3: Specific requirements for the magnetic field wireless power transfer systems

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 61980-3, which is a Technical Specification, has been prepared by IEC technical committee 69: Electric road vehicles and electric industrial trucks.

The text of this Technical Specification is based on the following documents:

Draft TS	Report on voting
69/554A/DTS	69/616B/RVDTS

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

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

A list of all parts of the IEC 61980 series, published under the general title *Electric vehicle wireless power transfer (WPT) systems*, can be found on the IEC website.

This part is to be used in conjunction with IEC 61980-1:2015.

The clauses of the particular requirements in this document supplement or modify the corresponding clauses in IEC 61980-1:2015. Where the text indicates an "addition" to or a "replacement" of the relevant requirement, test specification or explanation of IEC 61980-1:2015, these changes are made to the relevant text of IEC 61980-1:2015, which then becomes part of the standard. Where no change is necessary, the words "Clause xx of IEC 61980-1:2015 is applicable" are used. Additional items to those of IEC 61980-1:2015 are numbered starting 101. Additional annexes are lettered from AA onwards.

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

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

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:

- IEC 61980-1 covers general requirements for electric road vehicle (EV) wireless power transfer (WPT) systems including general background and definitions. (e.g. efficiency, electrical safety, EMC);
- IEC TS 61980-2 covers specific requirements for communication between electric road vehicle (EV) and wireless power transfer (WPT) systems including general background and definitions.
- IEC TS 61980-3 covers 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).

The requirements described in IEC 61980-1 are general. The technical requirements for the various wireless power transfer (WPT) technologies are very different; they are specified in the technology specific parts of the IEC 61980 series. A list of possible WPT technologies is listed in IEC 61980-1. The requirements for magnetic field wireless power transfer systems (MF-WPT) are described in this document. Further parts of the IEC 61980 series will describe other technologies such as power transfer via electric field (EF-WPT) or via electromagnetic 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 refers to each parts of the IEC 61980 series. The structure of the "technology specific parts" follows the structure of IEC 61980-1.

WPT systems are still under development. For this reason, there is the future but not immediate possibility of an agreement to publish an International Standard. The committee has decided, by following the procedure set out in ISO/IEC Directives part 1:2018, 2.3, that the publication of a Technical Specification is appropriate. The reason for publishing the Technical Specification is a high market need for a first basic technical description.

IEC TS 61980-2, also published as a Technical Specification for the same reason as IEC TS 61980-3, deals with communication and for this reason has an independent structure. The numbering of the clauses does not follow the numbering of the other parts of the IEC 61980 series.

The electric road vehicles (EV) requirements of the MF-WPT system are covered by ISO PAS 19363.

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 3: Specific requirements for the magnetic field wireless power transfer systems

1 Scope

This part of IEC 61980, which is a Technical Specification, applies to the equipment for the magnetic field wireless power transfer (MF-WPT) 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. The MF-WPT system operates at standard supply voltages ratings per IEC 60038 up to 1 000 V AC and up to 1 500 V DC. The power transfer takes place while the electric vehicle (EV) is stationary.

This document also applies to MF-WPT equipment supplied from on-site storage systems (e.g. buffer batteries) at standard supply voltages ratings per IEC 60038 up to 1 000 V AC and up to 1 500 V DC.

The aspects covered in this document include

- the characteristics and operating conditions,
- the required level of electrical safety,
- requirements for basic communication for safety and process matters if required by a MF-WPT system,
- requirements for positioning to assure efficient and safe MF-WPT power transfer, and
- specific EMC requirements for MF-WPT systems.

The following aspects are under consideration for future documents:

- requirements for two- and three-wheel vehicles,
- requirements for MF-WPT systems supplying power to EVs in motion, and
- requirements for bidirectional power transfer.

This standard does not apply to

- safety aspects related to maintenance, and
- trolley buses, rail vehicles and vehicles designed primarily for use off-road.

NOTE The teRMS used in this document are specifically for MF-WPT.

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.

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

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

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

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

IEC TS 61980-2:2019, *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 62423, *Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

DIN 7405:1963, *Wire staple 24/6 for office-staplers*

EN 10130, *Cold rolled low carbon steel flat products for cold forming – Technical delivery conditions*

ICNIRP Guidelines 1998, *ICNIRP guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)*, International commission on non-ionizing radiation protection, published in: *Health Physics* 74(4):494-522; 1998

ICNIRP Guidelines 2010, *ICNIRP guidelines for limiting exposure to time-varying electric and magnetic fields (1 Hz – 100 kHz)*, International commission on non-ionizing radiation protection, published in: *Health Physics* 99(6):818-836; 2010

UL 2251, *Standard for plugs, receptacles, and couplers for electric vehicles*