



DPC: 23 / 30435555 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 31 October 2023

Origin: International

Latest date for receipt of comments: 20 December 2023

Project No. 2021/00789

Responsible committee: PEL/69 Electric vehicles

Interested committees:

Title: BS EN IEC 63381 Electric vehicle wireless power transfer (WPT) systems

Part 6: Specific requirements for magnetic field dynamic power transfer (MF-D-WPT) system communication and activities

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

**WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD.
THIS DRAFT IS NOT CURRENT BEYOND 20 December 2023**

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <http://standardsdevelopment.bsigroup.com>

Responsible Committee Secretary: **Ms Andreea Vieru (BSI)**
Direct tel: **0208 996 7432**
E-mail: **andreea.vieru@bsigroup.com**

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



69/920/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 63381 ED1

DATE OF CIRCULATION:

2023-10-27

CLOSING DATE FOR COMMENTS:

2024-01-19

SUPERSEDES DOCUMENTS:

69/742/NP, 69/752/RVN

IEC TC 69 : ELECTRICAL POWER/ENERGY TRANSFER SYSTEMS FOR ELECTRICALLY PROPELLED ROAD VEHICLES AND INDUSTRIAL TRUCKS

SECRETARIAT:

Belgium

SECRETARY:

Mr Peter Van den Bossche

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE AC/22/2007 OR NEW GUIDANCE DOC).

TITLE:

<p>ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS – Part 6: Specific requirements for magnetic field dynamic power transfer (MF-D-WPT) system communication and activities</p>

NOTE FROM TC/SC OFFICERS:

To become 61980-6

Copyright © 2023 International Electrotechnical Commission, IEC. All rights reserved. It is permitted to download this electronic file, to make a copy and to print out the content for the sole purpose of preparing National Committee positions. You may not copy or "mirror" the file or printed version of the document, or any part of it, for any other purpose without permission in writing from IEC.



Documents

Document Sharing Hub

Contents

1		
2	FOREWORD.....	7
3	INTRODUCTION.....	9
4	1 Scope.....	10
5	2 Normative references	10
6	3 Terms and definitions	10
7	3.13 inverter	12
8	4 Abbreviated terms	12
9	5 General system structure and interoperability concept.....	13
10	5.1 System structure.....	13
11	5.1.1 General architecture	13
12	5.1.2 Communication and signalling for power management.....	14
13	5.2 Interoperability concept.....	16
14	6 General communication requirements.....	17
15	7 Communication procedure during an MF-D-WPT session	17
16	7.1 General.....	17
17	7.2 Activities	18
18	7.2.1 Preparation (supply device)	18
19	7.2.2 Preparation (EV device).....	18
20	7.2.3 Communication setup / Request D-WPT service	19
21	7.2.4 Compatibility check / Service authentication	19
22	7.2.5 Paring.....	20
23	7.2.6 Alignment check (lateral direction).....	20
24	7.2.7 Magnetic coupling check (longitudinal direction)	20
25	7.2.8 Power Transfer	20
26	7.2.9 Control handover	22
27	7.2.10 Stand-by.....	22
28	7.2.11 Power transfer terminate	23
29	7.2.12 Terminate D-WPT service session	24
30	7.2.13 Parameters definition between EV device and supply device	24
31	7.2.14 Safety monitoring and diagnostics	25
32	7.2.15 Wake-up after power outage	25
33	7.3 Exception handling	26
34	7.3.1 General	26
35	7.3.2 Exception descriptions.....	26
36	7.3.3 Supply device exceptions	28
37	7.3.4 EV device exceptions	28
38	Annex A (informative) System Architecture	29
39	A.1 General.....	29
40	A.2 One supply power electronics drives multiple primary devices	29
41	A.2.1 Parallel connection of primary devices	29
42	A.2.2 P2PS with magnetic coupling check.....	30
43	A.3 DC (Direct Current) Power Distribution	31
44	A.4 Corresponding states to each step in passing D-WPT charging area	
45	(included sections and segments).....	32
46	Annex B (informative) P2PS sensors	33

47	B.1	General.....	33
48	B.2	Example of auxiliary signal transmitters/receivers arrangements.....	33
49	B.3	Example of auxiliary signal transmitters/receivers arrangements.....	33
50	Annex C (informative) Communication of dynamic wireless power transfer for electric		
51		vehicles	34
52	C.1	General over view	34
53	C.2	Message sequence in the communication for D-WPT	35
54	C.3	State transitions in the communication for D-WPT	36
55	C.3.1	State transition diagram at D-SECC (in supply device)	36
56	C.3.2	State transition diagram at D-EVCC (in EV device)	37
57	C.3.3	State transition table in D-SECC (Supply device).....	38
58	C.3.4	State transition table in D-EVCC (EV device).....	39
59	Annex D (informative) Communication of dynamic wireless power transfer for electric		
60		vehicles	41
61	D.1	General over view	41
62	D.2	Communication architecture.....	41
63	D.2.1	Overview	41
64	D.2.2	Infrastructure operation strategy	43
65	D.3	Detailed communication description	44
66	D.3.1	Bidirectional communication: Vehicle <-> Cloud	44
67	D.3.2	Bidirectional communication: Management Unit <-> Cloud	44
68	D.3.3	Unidirectional communication: Vehicle -> Management Unit.....	44
69	Annex E (informative) Segment Switching based on Vehicle Detection Using		
70		Bidirectional P2PS	45
71	E.1	General.....	45
72	E.2	Vehicle Detection.....	46
73	E.2.1	Coupling/Decoupling	47
74	E.2.2	Message	47
75	E.3	Segment Switching	47
76	E.3.1	General.....	47
77	E.3.2	Group Segment Switching.....	48
78	E.3.3	Group Segment Switching with Superposition	49
79	E.3.4	Calculating Speed of a Vehicle	49
80	Annex F (informative) Use cases		50
81	F.1	General.....	50
82	F.2	Use case descriptions	50
83	F.2.1	UC checking adjacent D-SECC	50
84	Annex G (normative) State diagrams of MF-D-WPT process		54
85	G.1	General.....	54
86	G.2	Supply device state definitions	54
87	G.2.1	Supply device state diagram	54
88	G.2.2	System On (DWPT_S_ON).....	55
89	G.2.3	Session initiated (DWPT_S_SI).....	55
90	G.2.4	Idle (DWPT_S_IDLE).....	55
91	G.2.5	Power transfer active (DWPT_S_PTA)	55
92	G.2.6	Power transfer (DWPT_S_PT)	55
93	G.2.7	Control Handover (DWPT_S_CH)	55
94	G.2.8	System off (DWPT_S_OFF).....	56

95	G.2.9 Service terminated occupied (DWPT_S_STO).....	56
96	G.2.10 StandBy (DWPT_S_STBY)	56
97	G.2.11 Sleep (DWPT_S_SLP).....	56
98	G.3 Supply device state transitions.....	56
99	G.3.1 TS_03 & TS_10.....	57
100	G.3.2 TS_04 & TS_05.....	58
101	G.3.3 TS_06 & TS_08 & TS_12	58
102	G.3.4 TS_07 & TS_13 and TS_15	59
103	G.3.5 TS_11.....	60
104	G.3.6 TS_08.....	61
105	G.3.7 TS_09.....	62
106	G.3.8 TS_16.....	63
107	G.3.9 TS_14.....	64
108	G.4 Vehicle device state definitions	65
109	G.4.1 Vehicle device state diagram	65
110	G.4.2 System Off (DWPT_V_OFF)	65
111	G.4.3 System On (DWPT_V_ON).....	65
112	G.4.4 System Initialized (DWPT_V_SI).....	65
113	G.4.5 Sleep (DWPT_V_SLEEP)	66
114	G.4.6 Power Transfer Active (DWPT_V_PTA).....	66
115	G.4.7 Power Transfer (DWPT_V_PT)	66
116	G.4.8 Standby (DWPT_V_STBY).....	66
117	G.4.9 System Off (DWPT_V_OFF)	67
118	G.4.10 System Off (DWPT_V_OFF)	67
119	G.5 Vehicle device state transitions.....	67
120	G.5.1 TV_03.....	69
121	G.5.2 TV_04 & TV_05.....	69
122	G.5.3 TV_07 & TV_15.....	70
123	G.5.4 TV_08 & TV_14 & TV_16.....	71
124	G.5.5 TV_09.....	72
125	G.5.6 TV_10.....	72
126	G.5.7 TV_11.....	73
127	G.5.8 TV_17.....	74
128	G.5.9 TV_18.....	74
129	G.5.10 TV_19.....	75
130		
131		
132		
133	Figure 1 - Example of an MF-D-WPT system	14
134	Figure 2 – Corresponding states to each steps in passing D-WPT charging area	18
135	Figure 3 – Communication system	21
136	Figure 4 – Example of controlled power transfer trajectory.....	22
137	Figure 5 – Classification of system events	26
138	Figure A.1 – Configuration of primary device parallel connection to supply power	
139	electronics	30
140	Figure A.2 – Configuration of P2PS with coupling check	31
141	Figure A.3 – Configuration of P2PS with coupling check	32
142	Figure A.4 – Corresponding states to each step in passing D-WPT charging area.....	

143	Figure B.1 – Example of auxiliary signal transmitters/receivers arrangements for the	
144	EV device (left) and the supply device (right)	33
145	Figure C.1 – Structure of communication in D-WPT	34
146	Figure C.2 – Message sequence in D-WPT during Control handover	36
147	Figure C.3 – State transition diagram in D-SECC	37
148	Figure C.4 – State transition diagram in D-EVCC	38
149	Figure D.1 – General overview.....	41
150	Figure D.2 – Components of the system	42
151	Figure D.3 – Control strategy of the infrastructure.....	43
152	Figure E.1 – Configuration of VD for Dynamic WPT	45
153	Figure E.2 – Example of Bidirectional P2PS Procedure	47
154	Figure E.3 – Example of Segment Switching	48
155	Figure E.4 – Example of Group Segment Switching	48
156	Figure E.5 – Example of Group Segment Switching with Superposition.....	49
157	Figure F.1 – Use cases particularly for dynamic wireless power transfer	50
158	Figure G.1 – Supply device state diagram	54
159	Figure G.2 – Transition TS_03 and TS_10	58
160	Figure G.3 – Transition TS_04 and TS_05	58
161	Figure G.4 – Transition TS_06 & TS_08 and TS_12.....	59
162	Figure G.5 – Transition TS_07, TS_13 and TS_15.....	60
163	Figure G.6 – Transition TS_11	61
164	Figure G.7 – Transition TS_08	62
165	Figure G.8 – Transition TS_09	63
166	Figure G.9 – Transition TS_16	63
167	Figure G.10 – Transition TS_14	64
168	Figure G.11 – vehicle device state diagram	65
169	Figure G.12 – Transition TV_03	69
170	Figure G.13 – Transition TV_04 & TV_05.....	70
171	Figure G.14 – Transition TV_07 & TV_15.....	71
172	Figure G.15 – Transition TV_08 & TV_14 & TV_16	72
173	Figure G.16 – Transition TV_09	72
174	Figure G.17 – Transition TV_10	73
175	Figure G.18 – Transition TV_11	73
176	Figure G.19 – Transition TV_17	74
177	Figure G.20 – Transition TV_18	74
178	Figure G.21 – Transition TV_19	75
179		
180	Table 1 – Requirement for the communication interface between one SECC and one	
181	EVCC	14
182	Table 2 – Requirement for P2PS system in unidirectional P2PS.....	15
183	Table 3 – Requirement for P2PS system for lateral alignment check purpose in	
184	unidirectional P2PS	15
185	Table 4 – Specification of P2PS system in unidirectional P2PS.....	15

186	Table 5 – Requirement for P2PS system in bidirectional P2PS	16
187	Table 6 – Requirement for P2PS system for lateral alignment check purpose in	
188	bidirectional P2PS	16
189	Table 7 – Specification of P2PS system in bidirectional P2PS.....	16
190	Table 8 – Communication information for Communication setup/ Request D-WPT	
191	service.....	19
192	Table 9 – Communication information for compatibility check.....	19
193	Table 10 – Communication information for power transfer.....	22
194	Table 11 – Communication information for power transfer stand-by	23
195	Table 12 – Communication information for power transfer terminated	23
196	Table 13 – Communication information for power transfer service session	24
197	Table 14 – Parameters sent from EV device to supply device	24
198	Table 15 – Parameters sent from supply device to EV device	25
199	Table 16 – Exception Handling	27
200	Table C.1 – State transition table in D-SECC	38
201	Table C.2 – State transition table in D-EVCC	39
202	Table D.1 – Legend to Figure D.2	42
203	Table E.1 – Communication information for Vehicle Detecting	47
204	Table F.1 – UC Checking adjacent D-SECC.....	51
205	Table F.2 – UC Perform Power transfer	51
206	Table F.3 – UC Checking vehicle on segment.....	51
207	Table F.4 – UC Perform Control handover	52
208	Table F.5 – UC Compatibility Check	52
209		
210		
211		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –**Part 6: Specific requirements for magnetic field dynamic power transfer (MF-D-WPT) system communication and activities**

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.

IEC CD 63381 has been prepared by IEC technical committee TC69: Electrical power/energy transfer systems for electrically propelled road vehicles and industrial trucks.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
69/XX/FDIS	69/XX/RVD

Full information on the voting for the approval of this International Standard 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.

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

- 262 • reconfirmed,
- 263 • withdrawn,
- 264 • replaced by a revised edition, or
- 265 • amended.

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, EMF);
- IEC 61980-2 specifically applies to magnetic field wireless power transfer (MF-WPT) for electric road vehicles (EV) and covers specific requirements for system activities and communication between the electric road vehicle side and the off-board side, including general background and definitions;
- IEC 61980-3 covers specific power transfer requirements for the off-board side of magnetic field wireless power transfer systems for electric road vehicles (e.g. efficiency, electrical safety, EMC, EMF);
- IEC 61980-4 covers specific power transfer requirements for the off-board side of magnetic field high power wireless power transfer (H-WPT) systems for electric vehicles electric road vehicles (e.g. efficiency, electrical safety, EMC, EMF);
- IEC 61980-5 covers specific power transfer requirements for the off-board side of magnetic field dynamic wireless power transfer (MF-D-WPT) systems for electric vehicles electric road vehicles (e.g. efficiency, electrical safety, EMC, EMF);
- IEC 61980-6 specifically applies to magnetic field dynamic wireless power transfer for electric road vehicles (EV) and covers specific requirements for system activities and communication between the electric road vehicle side and the off-board side, including general background and definitions.

Requirements for the on-board side of MF-WPT and MF-D-WPT for electric road vehicles are covered in ISO 5474-4 and ISO 5474-6

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 6: Specific requirements for magnetic field dynamic power transfer (MF-D-WPT) system communication and activities

1 Scope

This part of IEC 61980 addresses communication and activities of magnetic field dynamic wireless power transfer (MF-D-WPT) systems. The power transfer takes place while the electric vehicle (EV) is in motion.

Note “In motion” includes a temporally stop on the road.

The requirements in this document are intended to be applied for MF-D-WPT systems according to IEC 63243(61980-5), ISO 5474-4 and ISO 5474-6.

Supply device fulfilling the requirements in this document are intended to operate with EV devices fulfilling the requirements described in ISO 5474-4 and ISO 5474-6.

The aspects covered in this document include:

- operational and functional characteristics of the MF-D-WPT communication system and related activities
- operational and functional characteristics of the positioning system

The following aspects are under consideration for future documents:

- requirements for two- and three-wheel vehicles,
- requirements for bidirectional power transfer

Note: Any internal communication at supply device or EV device is not in the scope of this document

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.

Clause 2 of IEC 61980-1:2020, IEC 61980-2:2023 is applicable.

Addition

ISO PAS CD 5474-6:2023, Electrically propelled road vehicles — Functional requirements and safety requirements for power transfer — Part 6: Magnetic field wireless power transfer — Safety and interoperability requirements for heavy-duty vehicles

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61980-1:2020, IEC 61980-2:2023, IEC 61980-3:2022, IEC 63243(61980-5):2023 and the following terms and definitions apply.

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

- 331 • IEC Electropedia: available at <http://www.electropedia.org/>
- 332 • ISO Online browsing platform: available at <http://www.iso.org/obp>

333 Clause 3 of IEC 61980-1:2020 is applicable.

334 ***Additional terms and definitions:***

335 **3.1**
336 **magnetic field- dynamic wireless power transfer system**
337 **MF-D-WPT system**

338 system comprising the supply device(s) and the EV device(s) to perform MF-D-WPT

339 **3.2**
340 **segment switching**

341 turn on/off function of supply power electronics that supplies power to the primary coil(s) of the
342 segment

343 **3.3**
344 **D-WPT management unit**
345 **supply device**

346 off-board component assembly consisted of one or more supply device module

347 **3.4**
348 **supply device module**

349 off-board component assembly comprising the components necessary for D-WPT

350 **3.5**
351 **supply equipment**

352 off-board equipment comprising the SECC and one or multiple supply devices working under
353 the control of the same SECC

354 **3.6**
355 **D-WPT Session**

356 D-WPT activities starting with successful communication setup and ending with terminate
357 communication

358 **3.7**
359 **D-WPT charging site**

360 physical location of one or more D-WPT charging spots

361 **3.8**
362 **lateral alignment**

363 relative position in y-direction of the secondary device to the primary device for a given
364 secondary device ground clearance

365 **3.9**
366 **longitudinal alignment**

367 relative position in x-direction of the secondary device to the primary device for a given
368 secondary device ground clearance

3.10

D-EVCC

Dynamic WPT Electric Vehicle Communication Controller

embedded system, within the vehicle, that implements the communication between the vehicle and the SECC in order to support specific functions in Dynamic WPT

3.11

D-SECC

Dynamic WPT Supply Equipment Communication Controller

entity which implements the communication to one or multiple EVCCs in Dynamic WPT.

3.11

Control handover

the change of connection and control between D-EVCC and D-SECCs in inter-inverter segment switching.

3.12

DWMM

Dynamic WPT Mobility Manager

the entity that implements Control handover while tracking the mobility of EV device.

3.13 inverter

power electronic device or circuitry that changes direct current(DC) to alternating current(AC).

4 Abbreviated terms

D-WPT	Dynamic Wireless Power Transfer
EV	electric vehicle
EVCC	EV communication controller
D-EVCC	Dynamic WPT Electric Vehicle Communication Controller
FOD	foreign object detection
ID	Identification number
LPE	low power excitation
LOP	living object protection
P2PS	point to point signaling
SECC	Supply Equipment Communication Controller
D-SECC	Dynamic WPT Supply Equipment Communication Contreoller
DWMM	Dynamic WPT Mobility Manager

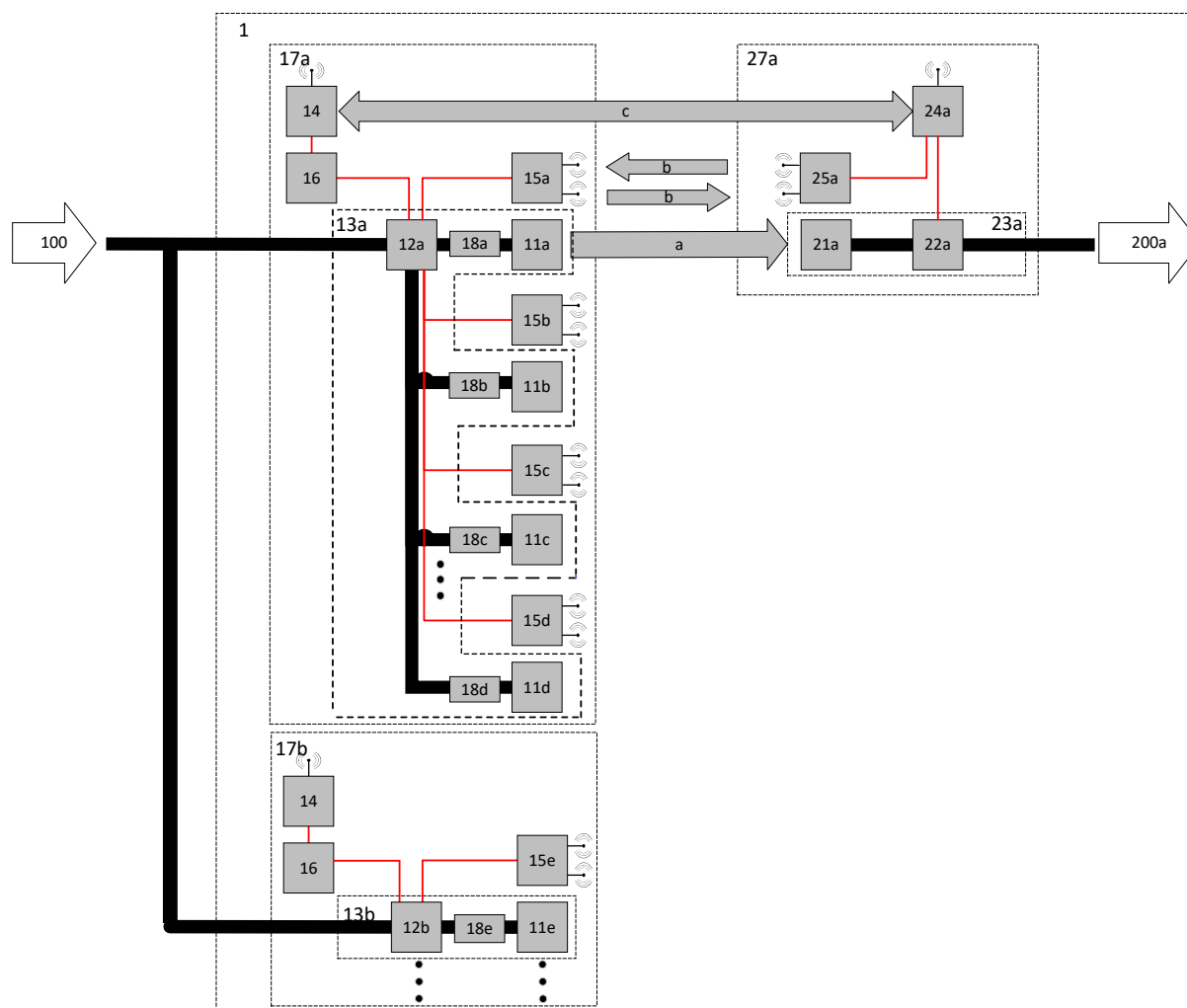
5 General system structure and interoperability concept

5.1 System structure

5.1.1 General architecture

Figure 1 shows a representation for the structure of the components referred to throughout this document. A communication system consists of two types of communication: wide area communication that can communicate a lot of information and narrow area communication that is mainly for pairing, which may be performed via P2PS.

Further configurations can be found in Annex A.



Key Name

- 1 MF-D-WPT system
- 11 primary device
- 12 supply power electronics
- 13 supply power circuit
- 14 Dynamic WPT SECC (D-SECC)
- 15 supply device P2PS controller
- 16 D-WPT management unit (DWMM)
- 17 supply device
- 18 switch
- 100 supply network

Key Name

- 21 secondary device
- 22 EV power electronics
- 23 EV power circuit (EVPC)
- 24 Dynamic WPT EVCC (D-EVCC)
- 25 EV device P2PS controller
- 27 EV device
- 200 RESS / motor
- b Uni/bi-directional wireless signaling

a wireless power flow

c Cellular/Cloud/Wi-Fi with mobility support

Figure 1 - Example of an MF-D-WPT system

Note 1: Communication between the D-SECC and D-EVCC can be direct communication or via cloud.

Note 2: More than one EV can be supplied power from one supply device or one primary device.

Note 3: An EV can have more than one secondary devices.

Note 4: D-SECC can be located either at a local facility or at comprehensive communication centre.

5.1.2 Communication and signalling for power management

5.1.2.1 General

Power Management consists of two layers.

- Wide area management, including the distribution network, is determined from the maximum amount of power from the grid.
- Local management is the distribution of power to each coil.

5.1.2.2 Bidirectional wireless communication

The communication between D-SECC and D-EVCC is performed by high speed wireless communication. Table 1 shows the requirements for the communication interface between one D-SECC and one D-EVCC.

Example DSRC, cellular network (5G or LTE) local 5G

Table 1 – Requirement for the communication interface between one SECC and one EVCC

Category	Detail
Communication speed	TBD (e.g. **bps)
Data size (bit width)	TBD
Communication latency	TBD
Communication area	TBD (e.g. 1km)

5.1.2.3 Unidirectional wireless signaling (P2PS)

The P2PS is used to inform the vehicle ID from the vehicle to the supply device in paring, alignment check, magnetic coupling check, terminate power transfer and power transfer terminate activities. Table 2 shows the requirements for the communication interface between one supply device P2PS controller and one EV device P2PS controller.

The P2PS may be used as lateral alignment check measures. Table 3 shows the requirements for such purpose.

The specifications of P2PS system are given in Table 4.

Two or more sensors might be used together to meet the requirements.

Table 2 – Requirement for P2PS system in unidirectional P2PS

Category	Detail
Data format	TBD (e.g. **bps)
Communication area	TBD (e.g. **mm)
Robustness	Communication should be established even if the antenna is buried under pavement, and with rain, snow, and snow melting agent.
Signaling speed	TBD (e.g. communication establishment less than 2ms, xx messages per xx ms)
Signal rump-up speed	TBD

Table 3 – Requirement for P2PS system for lateral alignment check purpose in unidirectional P2PS

Category	Detail
Vehicle position range to be detected (lateral)	TBD (e.g. 100mm)
Accuracy of vehicle position detection	TBD (e.g. ±10mm)
Installation position of off-board antenna	Under the ground (e.g. 0~150mm)
Position determination method	TBD (e.g. communication establishment itself or RSSI)

Note 1: The specific value depends on the level of EMC

Note 2: Area where magnetic connection is strong enough for power transfer. If supply device needs some preparation time to start D-WPT, the area should be wide to buy supply device that time. However, the area cannot be too wide or interference between signals from multiple cars may occur.

Table 4 – Specification of P2PS system in unidirectional P2PS

Category	Detail
Physical layer	TBD
Data link layer	TBD
Antenna type	TBD
Communication frequency	TBD
Communication confirmation method	TBD
Encoding scheme	TBD (e.g. Manchester coding)
Installation position of on-board antenna	Underfloor of vehicle

5.1.2.4 Bidirectional wireless signaling (P2PS)

The P2PS is used to exchange some information between the vehicle and the supply device in paring, alignment check, magnetic coupling check, terminate power transfer and power transfer terminate activities. The procedure consists of sending request signal from supply side and then sending reply signal from vehicle side. The detail flow is given in Annex E. Table 5 shows the requirements for the communication interface between one supply device P2PS controller and one EV device P2PS controller.

The P2PS may be used as lateral alignment check measures. Table 6 shows the requirements for such purpose.

The specifications of P2PS system are given in Table 7.

Two or more sensors might be used together to meet the requirements.

Table 5 – Requirement for P2PS system in bidirectional P2PS

Category	Detail
Data format	TBD (e.g. **bps)
Communication area	TBD (e.g. **mm)
Robustness	Communication should be established even if the antenna is buried under pavement, and with rain, snow, and snow melting agent.
Signaling speed	TBD (e.g. communication establishment less than 2ms, xx messages per xx ms)
Signal rump-up speed	TBD

Table 6 – Requirement for P2PS system for lateral alignment check purpose in bidirectional P2PS

Category	Detail
Vehicle position range to be detected (lateral)	TBD (e.g. 100mm)
Accuracy of vehicle position detection	TBD (e.g. ±10mm)
Installation position of off-board antenna	Under the ground (e.g. 0~150mm)
Position determination method	TBD (e.g. communication establishment itself or RSSI)

Note 1: The specific value depends on the level of EMC

Note 2: Area where magnetic connection is strong enough for power transfer. If supply device needs some preparation time to start D-WPT, the area should be wide to buy supply device that time. However, the area cannot be too wide or interference between signals from multiple cars may occur.

Table 7 – Specification of P2PS system in bidirectional P2PS

Category	Detail
Physical layer	TBD
Data link layer	TBD
Antenna type	TBD
Communication frequency	TBD
Communication confirmation method	TBD
Encoding scheme	TBD (e.g. Manchester coding)
Installation position of on-board antenna	Underfloor of vehicle

5.2 Interoperability concept

Interoperability of MF-D-WPT requires that both the power transfer mechanism and the communication can interoperate. The requirements for interoperability of the power transfer in D-WPT mechanism are given in IEC 61980-5.

6 General communication requirements

MF-D-WPT systems shall use communication between electric road vehicle (EV) and infrastructure for the MF-WPT power transfer process.

For MF-D-WPT systems the physical and data link layer (OSI layers 1 and 2) of the wireless communication interface (c in Figure 1) shall be in accordance with DSRC, IEEE 802.11 with mobility support, or cellular network (5G or LTE) and so on.

The communication of a MF-D-WPT system shall be implemented as per ISO 15118-xx. This includes the requirements for message exchange and communication security.

A robust operation of a MF-D-WPT system requires the implementation of different but interrelated timing requirements.

MF-D-WPT system shall conform to

- communication timing requirements according to ISO 15118-20

- timing requirements with respect to specific activities and actions described in clause 7, respectively.

MF-D-WPT system shall maintain inherently safe operation without relying solely on the wireless communications.

A MF-WPT system shall be tested in accordance with ISO 15118-20 and clause 7 of this standard.

7 Communication procedure during an MF-D-WPT session

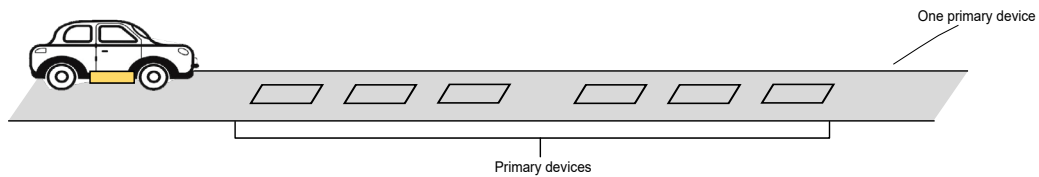
7.1 General

Clause 7 describes the power transfer process with respect to communication. The process is structured as a chain of individual activities, which can be derived from state diagrams and the corresponding transitions.

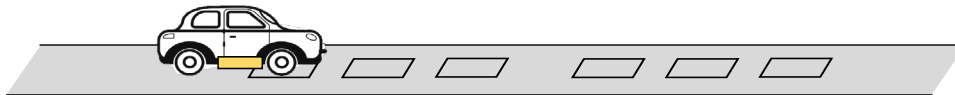
Basic activities or elements for the description of the D-WPT process are described in the state diagrams in Annex G.

Following the typical course in the state diagrams results in a general sequence of D-WPT illustrated in Figure 2.

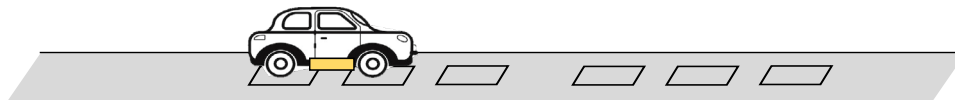
Step1 Preparation, Communication Setup/Request D-WPT services,
Compatibility Check/Service authentication



Step2 First Section Pairing, Alignment Check (Lateral direction)



Step3 First Segment Magnetic Coupling Check



Step4 Perform Power Transfer, Stand By,
Magnetic Coupling Check for Next Segment



Step5 Terminate communication



Figure 2 – Corresponding states to each steps in passing D-WPT charging area

7.2 Activities

7.2.1 Preparation (supply device)

In this state, supply device performs circuit activation and safety check without any communication with EV device. If safety could be confirmed, the state changes to “Waiting request from EV device”. If there is a problem, the supply device informs D-EVCC it has a problem and is not available for D-WPT.

7.2.2 Preparation (EV device)

In this state, EV device perform circuit activation and safety check without any communication with D-SECC. If safety could be confirmed, the state changes to “Communication setup /

Request D-WPT service". If there is a problem on EV device, it will not start wide area communication to give up following sequence for D-WPT.

7.2.3 Communication setup / Request D-WPT service

Communication setup and request DWPT service will be initiated by D-EVCC. D-EVCC communicates with D-SECC in D-WPT charging areas which EV has entered or may enter later. Target D-SECC is selected referring current position of EV obtained by wide area communication. GPS information may be used to detect the position of the vehicle. Various information of wide area communication and P2PS communication is linked by using Vehicle ID.

The information to be exchanged is given in Table 8.

Table 8 – Communication information for Communication setup/ Request D-WPT service

Direction	Information	Communication timing	with wide area	With P2PS
V to S	Vehicle ID	Initial / periodical refresh	✓	
V to S	User(billing) ID	Initial / periodical refresh	✓	
S to V	Answer to ID registration request	Initial / periodical refresh	✓	
Note: (✓) is optional.				

7.2.4 Compatibility check / Service authentication

After successful communication setup, the D-EVCC and D-SECC shall ensure that the primary device and secondary device are compatible. Compatibility check is performed on the supply device side from the information associated with the vehicle ID acquired by communication.

Preconditions: Communication setup and Request D-WPT service can be received.

Check item

- Secondary device ground clearance
- Secondary device geometry
- EV device circuit topology
- EV device self-resonance frequency
- Number of secondary coils

Post conditions: Trigger for pairing, alignment check, and fine positioning.

The information to be exchanged is given in Table 9.

In addition, D-EVCC can provide information for billing and other supports.

Table 9 – Communication information for compatibility check

Direction	Information	Communication timing	with wide area	With P2PS
V to S	Vehicle ID	Initial / periodical refresh	✓	
V to S	Maximum receivable power	Initial / periodical refresh	✓	
V to S	Secondary device grand clearance	Initial / periodical refresh	✓	
V to S	Secondary device geometry	Initial / periodical refresh	✓	

V to S	Secondary device D-WPT class	Initial / periodical refresh	✓	
V to S	EV device circuit topology	Initial / periodical refresh	✓	
V to S	EV device natural frequency	Initial / periodical refresh	✓	
V to S	Number of secondary devices	Initial / periodical refresh	✓	
S to V	Maximum transferable power	Initial / periodical refresh	✓	
S to V	Minimum transferable power	Initial / periodical refresh	✓	
S to V	Maximum primary device operation frequency	Initial / periodical refresh	✓	
S to V	Minimum primary device operation frequency	Initial / periodical refresh	✓	
S to V	Primary device geometry	Initial / periodical refresh	✓	
S to V	Primary device Circuit topology	Initial / periodical refresh	✓	
S to V	Supply device ID (optional)	Initial / periodical refresh	✓	
S to V	Primary device location (area level)	Initial / periodical refresh	✓	
	Vehicle position (area level)			
Note: (✓) is optional.				

544

545 7.2.5 Paring

546 Wireless P2PS interface shall ensure that the primary device and secondary device are uniquely
547 paired.

548

549 7.2.6 Alignment check (lateral direction)

550 This state aims to ensure that lateral distance between primary and secondary device is within
551 the tolerance. Alignment check is performed by P2PS. Alignment check is kept running based
552 on the P2PS exchange until vehicle leaves D-WPT charging site or the state changes to
553 'Terminate communication'. The result of the alignment check can be sent from SECC to EVCC
554 by the wide area communication.

555

556 7.2.7 Magnetic coupling check (longitudinal direction)

557 Supply device checks the_magnetic coupling condition and confirms that the secondary device
558 exists within the longitudinal tolerance area.

559 Magnetic coupling check shall be performed for each segment, while Pairing and Alignment
560 check can be performed for a set of segments.

561

562 7.2.8 Power Transfer

563 In this state, supply device performs power transfer to EVPC, and both of them should have the
564 ability to control transferred power for the sake of usefulness of MF-D-WPT and protection of
565 EVPC itself. Larger power transfer helps EV device to prolong its travel distance without static-
566 wireless nor conductive charging. However, capacity of RESS varies from passenger car to
567 commercial vehicle, and it sometimes experiences drastic fluctuation in power demand for
568 driving, like sharp regenerative braking, which requires EVPC to regulate transferred power to
569 secure RECC from overcharge.

570 EVPC basically accepts transferred power from supply device without any control, but it begins
571 control when transferred power has exceeded or is exceeding its limit, such as rated power of
572 RESS, which fluctuates according to state of charge and driving power demand for EV device.

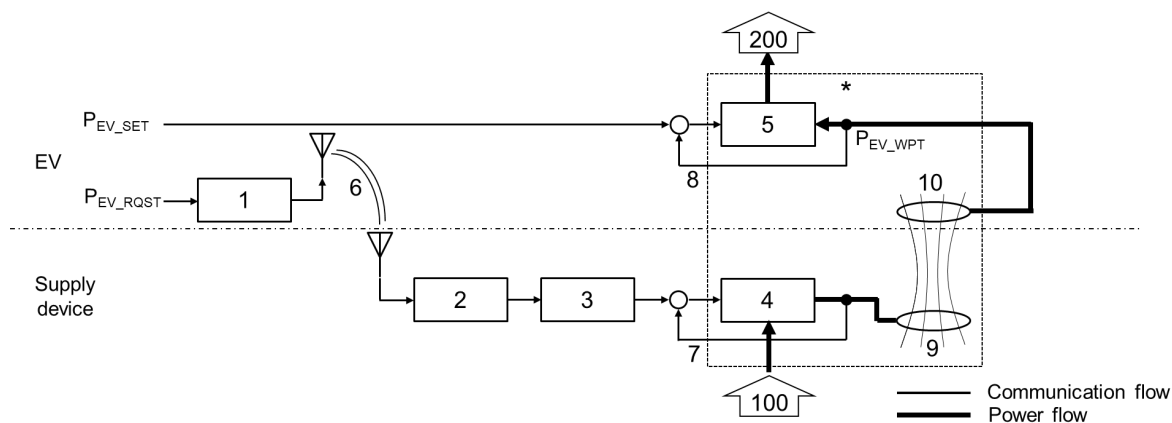
Power control in EVPC is also required to deal with malfunction in wide area communication, which can lead to contradiction between power control target in primary device and request from EVCC, and sudden break down in EVPC and RESS in the middle of power transfer.

Power control in supply device and EVPC may interfere each other, especially when supply device tries to achieve power request given from wide area communication which is larger than latest power limit in EVPC, especially in sharp regenerative braking with smaller RESS in EV device. If possible, supply device is recommended to be able to detect the mismatch in power control target and limit, then regulate power transfer to balance them.

State transits to 'Stand-by' when power transfer is interrupted for a short period while the secondary device is still above the primary device in cases, for example, foreign objects are detected above primary device, or the P2PS signal becomes low due to misalignment of secondary device.

State transits to 'Service terminated' when secondary device is passing above primary device and transferred power shrinks due to weaken P2PS signal between the two devices. Weaken magnetic coupling can be detected in supply device by monitoring transferred power, so basically supply device decides to state transition to 'Service terminated', then begins decreasing voltage to stop power transfer. Example of power transfer trajectory is shown in Figure 4.

During Power Transfer state when D-EVCC informs the location to current D-SECC, current D-SECC sends control handover request to DWMM and next D-SECC receives control handover request through DWMM. The detail of flow is given in Annex C



Key	Name
1	EV communication controller (EVCC)
2	Supply equipment communication controller (SECC)
3	D-WPT management unit
4	Supply power circuit
5	EV power circuit (EVPC)
100	Supply network
200	RESS

Key	Name
6	Bidirectional wireless communication
7	Supply device control loop (slower)
8	EV device control loop (faster)
9	Primary device
10	Secondary device

Symbol	Definition
P_{EV_SET}	Desired power for delivery to the EV's RESS
P_{EV_RWST}	EV device requested power level from supply device
P_{EV_WPT}	Actual power delivered to EV's RESS
*	Control Plant: A system in control theory that generates an output and is acted upon by a controller

Figure 3 – Communication system

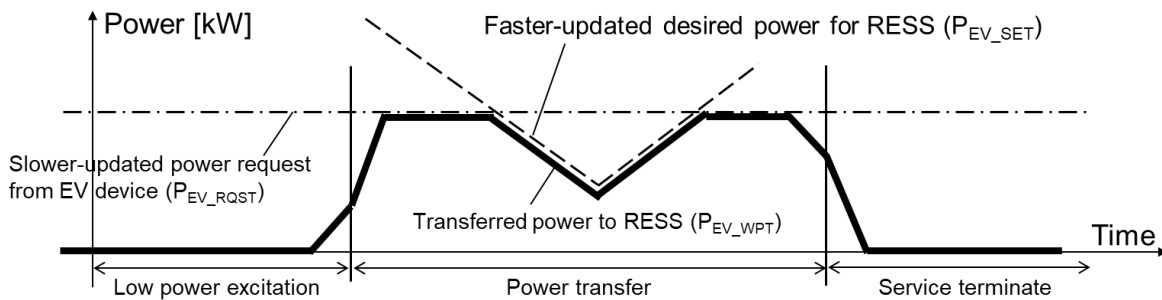


Figure 4 – Example of controlled power transfer trajectory

Preconditions: Magnetic coupling check can be completed

Actions:

- perform power transfer
- adjust output power

Post conditions: Trigger for power transfer terminate

The information to be exchanged is given in Table 10.

Table 10 – Communication information for power transfer

Direction	Information	Communication timing	with wide area	With P2PS
V to S	Vehicle ID	Continuous	✓	✓
V to S	Power request	Continuous	✓	(✓)
S to V	Supply device status	Continuous	✓	
Note: (✓) is optional.				

7.2.9 Control handover

In the Control handover state the supply device sends D-EVCC information to nearby D-SECC. Power transferring keeps in this state. The state is exited normally upon successful authorization or compatibility check response from nearby D-SECC.

Precondition: Power transfer

Action: inform D-EVCC of the information on next D-SECC

Postcondition: Power transfer

7.2.10 Stand-by

In this state, power transfer is interrupted for a short while for some reason, and once both EV device and supply device get ready for D-WPT, then state returns to 'power transfer'. Examples of the problems which may interrupt power transfer is shown in statement for state 'power transfer'.

Precondition: Trigger for stand-by can be received