IEC PAS 61980-5

Edition 1.0 2024-12

PUBLICLY AVAILABLE SPECIFICATION

colour inside

**Electric vehicle wireless power transfer (WPT) systems –
Part 5: Interoperability and safety of dynamic wireless power transfer (D-WPT) for electric vehicles**

IEC PAS 61980-5:2024-12(en)

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ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 5: Interoperability and safety of dynamic wireless power transfer (D-WPT) for electric vehicles

FOREWORD

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IEC PAS 61980-5 has been prepared by IEC technical committee 69: Electrical power/energy transfer systems for electrically propelled road vehicles and industrial trucks. It is a Publicly Available Specification.

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

Draft	Report on voting
69/975/DPAS	69/1011/RVDPAS

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

The language used for the development of this Publicly Available Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This document is to be read in conjunction with IEC 61980-1:2020.

The clauses of the particular requirements in this document supplement or modify the corresponding clauses in IEC 61980-1:2020. Where the text indicates an "addition" to or a "replacement" of the relevant requirement, test specification or explanation of IEC 61980-1:2020, these changes are made to the relevant text of IEC 61980-1:2020, which then becomes part of the standard. Where no change is necessary, the words "Clause/Subclause xx of IEC 61980-1:2020 is applicable" are used. Additional items to those of IEC 61980-1:2020 are numbered starting 101. Annexes are lettered from A onwards.

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

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

- reconfirmed,
- withdrawn, or
- revised.

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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 applies to magnetic field wireless power transfer (MF-WPT) for electric road vehicles 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 PAS 61980-4[1] covers specific power transfer requirements for the off-board side of magnetic field high power wireless power transfer (H-WPT) systems for 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 road vehicles (e.g. efficiency, electrical safety, EMC, EMF). This document is IEC 61980-5 and is under development as a PAS.
- IEC 61980-6[2] 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 PAS 5474-6[3].

This document is being published as a PAS for information about how dynamic charging systems can work, as evidenced by demonstration systems described in Annex A to Annex D.

1 Under preparation. Stage at the time of publication: IEC CD PAS 61980-4:2024.

2 Under development.

3 Under preparation. Stage at the time of publication: ISO CD PAS 5474-6:2023.

ELECTRIC VEHICLE WIRELESS POWER TRANSFER (WPT) SYSTEMS –

Part 5: Interoperability and safety of dynamic wireless power transfer (D-WPT) for electric vehicles

1 Scope

This part of IEC 61980 applies to the off-board supply equipment for dynamic wireless power transfer via magnetic field (MF-D-WPT) to electric road vehicles in motion for purposes of supplying electric energy to the RESS (rechargeable energy storage system) and/or other on-board electrical systems.

The system operates at standard supply voltage ratings per IEC 60038 up to 1 000 V AC and up to 1 500 V DC from the supply network. The power transfer takes place primarily while the electric vehicle (EV) is in motion, but can continue to take place under certain conditions while the vehicle is not in motion.

Off-board supply equipment fulfilling the requirements in this document are intended to operate with EV devices fulfilling the requirements of ISO 5474-4[4] and ISO 5474-6.

The aspects covered in this document includes

– the characteristics and operating conditions,
– specific power transfer requirements for the off-board side of magnetic field dynamic wireless power transfer systems for electric road vehicles, and
– the general requirement of electrical safety and EMC for MF-D-WPT.

Examples of D-WPT systems are described in the informative Annex A to Annex D.

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 60038, *IEC standard voltages*

IEC 61980-1, *Electric vehicle wireless power transfer (WPT) systems – Part 1: General requirements*

IEC 61980-3, *Electric vehicle wireless power transfer (WPT) systems – Part 3: Specific requirements for magnetic field wireless power transfer systems*

ITU-R Recommendation SM.2110.1:2019, *Guidance on frequency ranges for operation of non-beam wireless power transmission for electric vehicles*

4 Under preparation. Stage at the time of publication: ISO DIS 5474-4:2024.

3 Terms and definitions

For the purposes of this document, he terms and definitions given in IEC 61980-1, IEC 61980-3 and the following terms and definitions apply, except as follows.

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

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

Additional terms and definitions:

3.101
dynamic wireless power transfer
D-WPT
WPT while vehicle is in motion

3.102
embedded depth
z_{RS}
distance between the road surface and the top of housing in the primary device

3.103
embedded mounting
mounting of a primary device in such a manner that the top covering of the primary device is buried (embedded) in the pavement.

3.104
inverter
power electronic device or circuitry that changes direct current (DC) to alternating current (AC)

Note 1 to entry: Inverter is a part of a power electronics.

3.105
magnetic gap
vertical (z-direction) distance between the coil of the primary device and the coil of the secondary device

3.106
standby state
state where power transfer is stopped and power electronics is not ready to transfer power for a short period, but communication stays up

3.107
segment
unit of coil(s) and core(s) controlled independently in the primary device

Note 1 to entry: Depending on the system structure, a switch for energization, supply device P2PS controller and supply power electronics might be part of a segment. See Figure 2.

3.108
segment switching
turn on/off function that energizes the primary coil(s) of the segment

3.109
steady state
state of a system at which quasi-constant power is transferred

4 Abbreviated terms

IEC 61980-1:2020, Clause 4, does not apply.

5 General

IEC 61980-1:2020, Clause 5, applies, except as follows.

Replacement of the first paragraph :

The supply device (see Figure 2) shall be rated for one or a range of standard nominal voltages and frequencies as listed in IEC 60038.

6 Classification

Replacement:

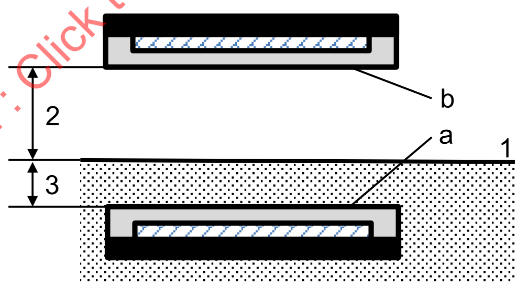
6.1 Compatibility class A and compatibility class B

The supply device is classified according to the compatibility class:

– compatibility class A supply device;
– compatibility class B supply device.

6.2 Installation

For dynamic wireless power transfer, the primary device shall be embedded per Figure 1. Z_{RS} gives the distance under road surface between the road surface and the top of the housing in the primary device as shown in Figure 1.



Key

a primary device

b secondary device

1 top of road surface

2 secondary device ground clearance (Z)

3 embedded depth (Z_{RS})

Figure 1 – Embedded mounting

The magnetic gap is the vertical (z-direction) distance between the coil of the primary device and the coil of the secondary device.

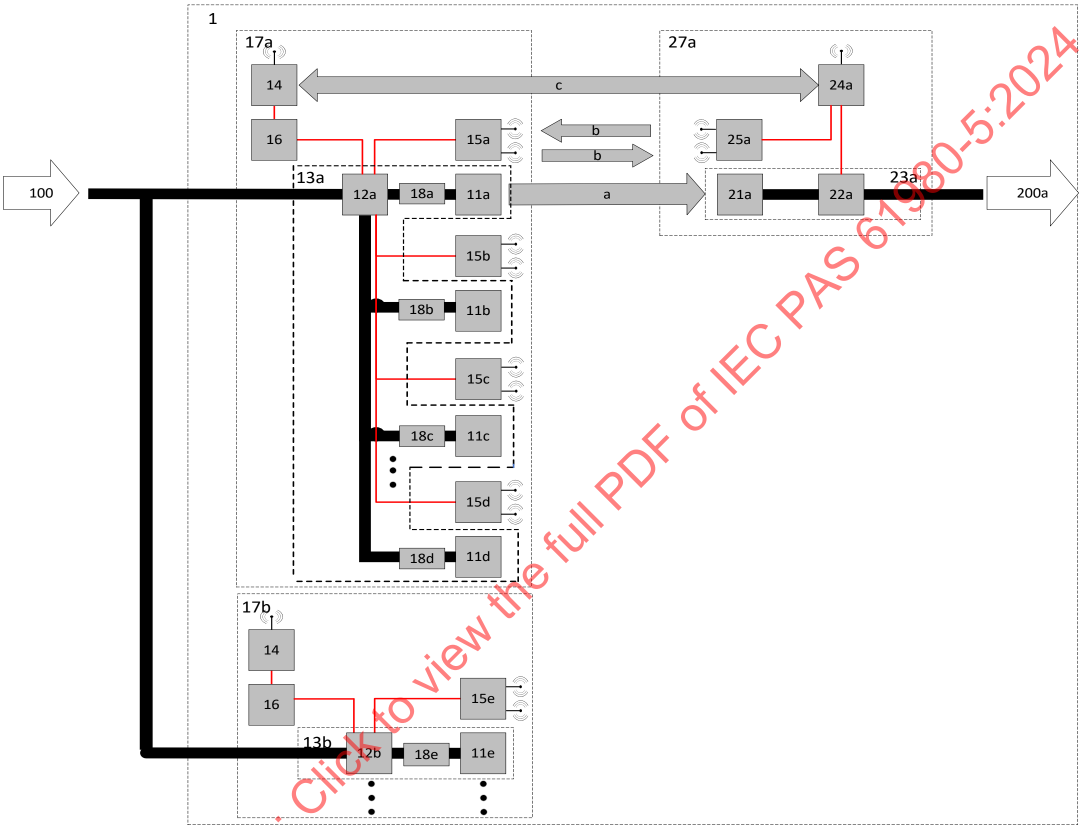
7 General supply device requirements

IEC 61980-1:2020, Clause 7, applies except as follows:

7.1 General architecture

Replacement:

Figure 2 shows an example for the structure of the components referred to in this document.



Key	Name	Key	Name
1	MF-D-WPT system		
11	primary device	21	secondary device
12	supply power electronics	22	EV power electronics
13	supply power circuit	23	EV power circuit (EVPC)
14	dynamic WPT SECC (D-SECC)	24	dynamic WPT EVCC (D-EVCC)
15	supply device P2PS controller	25	EV device P2PS controller
16	D-WPT management unit (DWMM)		
17	supply device	27	EV device
18	switch	200	RESS / motor
100	supply network	b	uni/bi-directional wireless signalling
a	wireless power flow	c	cellular/cloud/Wi-Fi with mobility support
18x+15x+11x	segment		

Figure 2 – Example of MF-D-WPT system

In dynamic wireless power transfer (D-WPT) system for electric vehicles, primary infrastructure is divided into several segments. Only small number of segments will be turned on at specific time for dynamic wireless power transfer while electric vehicle passes by those segments. In order to support this segment switching operation, wireless communication support with low latency and P2PS signalling can be used.

7.2 Power transfer requirements

Additional subclauses:

7.2.1 General

Unless otherwise stated in any of the subsequent clauses of this document, requirements apply to supply devices and their component parts.

7.2.2 Frequency requirements

For both compatibility class A supply devices and compatibility class B supply devices, the supply device shall utilize magnetic resonance to perform power transfer within the fundamental frequency range of 79 kHz to 90 kHz in accordance with ITU-R Recommendation SM.2110.1:2019, Table 1.

7.2.3 Input voltage and kVA levels

For both compatibility class A and compatibility class B supply devices, the manufacturer shall specify the input voltage range of operation and the rated input kVA.

7.2.4 Output voltage and power when stationary

7.2.4.1 Compatibility class A device

For a compatibility class A supply device, the reference EVPC shall provide an output which covers the reference EVPC output range at the rated output power when stationary.

7.2.4.2 Compatibility class B device

For a compatibility class B supply device, the specific class B EVPC specified by the manufacturer shall provide an output which covers the reference EVPC output range at the rated output power when stationary.

7.2.5 Speed of travel

7.2.5.1 Compatibility class A device

A compatibility class A supply device shall be able to transfer power to all reference EVPCs over the specified output voltage range, power and efficiency when mounted on a test vehicle traveling at a maximum speed up to 120 kph. The required parameters (voltage, power, efficiency) are part of the reference EVPC specification.

7.2.5.2 Compatibility class B device

A compatibility class B supply device shall be able to transfer power to the EVPCs specified by the manufacturer over the specified output voltage range, power and efficiency when mounted on a test vehicle traveling at a maximum speed specified by manufacturer. The required parameters (voltage, power, efficiency) are part of the EVPC specification.

7.2.6 Safety performance

In the event of an emergency shutdown condition, the supply device shall immediately reduce primary device coil current to zero and turn off all high voltages in order to make the system safe.

7.3 Efficiency

Additional subclauses:

7.3.1 General

The power transfer efficiency in case of D-WPT is the ratio of the sum of the output power (i.e. energy) in the EVPC divided by the sum of the input power (i.e. energy) in the SPC for each segment from the phase "inverter rise" to the phase "inverter fall".

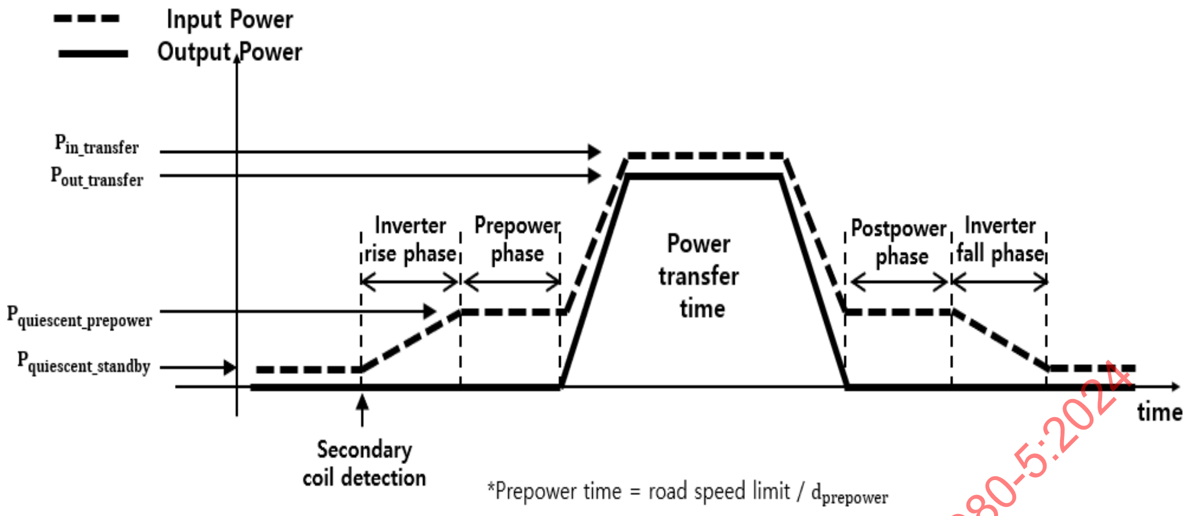
Measured efficiency values according to 7.3.3 are representative values for evaluating products, but they do not correspond to actual efficiency values.

NOTE 1 Measurement of the power transfer efficiency and determination of conformance with the eventual requirements in this document will be made by a test vehicle receiving energy while in motion over a test track with the candidate supply device(s) installed and reference EVPCs installed on the test vehicle. In order to develop confidence that the supply device being developed will meet the performance requirements, there are preliminary steps which can give theoretical results that can indicate likelihood of conformance. These are specified in 7.3.2 and 7.3.3.

NOTE 2 The static measurement on the efficiency of D-WPT with dynamic parameters includes speed information, which is an important difference between static and dynamic WPT. Although it is possible the D-WPT efficiency measurement does not exactly match reality, efficiency can be expressed in a normalized equation. The D-WPT efficiency measurement method includes factors such as segment length, vehicle speed, and waiting time to derive efficiency that is close to reality.

7.3.2 Dynamic power transfer phases

The phases described in 7.3.2 are relevant for the determination of the electrical efficiency of D-WPT systems. These phases apply while a vehicle is driving over a road D-WPT segment, having requested wireless power from that segment. The requirement for power transfer efficiency in under consideration.



Key

$P_{quiescent\_prepowe}$ quiescent power required to maintain the coil current required in a single primary coil segment in order to begin power transfer once the secondary coil becomes coupled with the primary coil segment

$P_{quiescent\_standby}$ quiescent power required to be ready for power ramp up in detecting the secondary coil at the DWPT system segment

Figure 3 – Definition of phases for each road segment in D-WPT

7.3.3 Brief description of the individual phases

7.3.3.1 Phase "inverter rise"

Phase required to ramp up the high frequency inverter that provides current to the primary coil to a ready state just prior to power transfer to a secondary coil

Inverter rise is the phase from $P_{quiescent\_standby}$ to $P_{quiescent\_prepower}$. At the light load condition, the rated current is supplied to the primary coil. The rated current is maintained before the inverter fall.

7.3.3.2 Phase "pre-power"

Phase "pre-power" is the period that the high frequency primary inverter remains in a ready state after the inverter rise time and before power transfer to a secondary coil begins.

7.3.3.3 Phase "power transfer ramp-up"

Phase "power transfer ramp-up" is the period required for the secondary to ramp up from zero power to its peak or steady-state received power level when coupling to a single segment.

7.3.3.4 Phase "power transfer ramp-down"

Phase "power transfer ramp-down" is the period required for the secondary to ramp down from its peak or steady-state power level to zero power when decoupling from a single segment.

7.3.3.5 Phase "inverter fall"

Phase required for the high frequency primary inverter to ramp down the current to the primary coil to be in a standby state. Inverter rise is the phase from $P_{quiescent\_standby}$ to $P_{quiescent\_prepower}$. At the light load condition, the rated current is supplied to the primary coil. The rated current is maintained before the inverter fall.

7.3.4 Methods of measuring power transfer efficiency in D-WPT

Measuring the efficiency of power transfer in D-WPT shall be performed as shown in the following procedure and Figure 4.

– Efficiency shall be measured in static condition with a secondary placed in 4 positions over the primary segment being energized.
– Perfect matching.
– Lowest Z level with max. side offset.
– Highest Z level with max. side offset.
– Medium Z level centered with worst case coupling.
– The average of the 4 values shall be stated as system efficiency.
– Power (out, in) measurement points:
  - at nominal, max., min. heights;
  - centred along X-axis at entry, centre, exit;
  - worst-case offset in X-axis at entry, centre, exit;
  - average static power:

$$P_{\text{in\_average}} = \left(\sum P_{\text{in@each point}}\right) / \text{ number of points}$$

$$P_{\text{out\_average}} = \left(\sum P_{\text{out@each point}}\right) / \text{ number of points}$$

  - measure $P_{\text{quiescent\_standby}}$, $P_{\text{quiescent\_prepower}}$, d_{prepower} and $t_{\text{postpower}}$;
  - calculate $t_{\text{prepower}} = d_{\text{prepower}} / v_{\text{speed\_limit}}$;
  - calculate $\eta_{\text{effective}}$

$$\eta_{\text{effective}} = \frac{P_{\text{out\_average}} \times \dfrac{L_{\text{segment}}}{v_{\text{speed}_{\text{limit}}}}}{P_{\text{in\_average}} \times \dfrac{L_{\text{segment}}}{v_{\text{speed}_{\text{limit}}}} + P_{\text{quiescent}_{\text{prepower}}} \times \left(t_{\text{prepower}} + t_{\text{postpower}}\right) + \left(\dfrac{P_{\text{quiescent}_{\text{prepower}}} + P_{\text{quiescent}_{\text{standby}}}}{2}\right) \times \left(t_{\text{inverter\_rise}} + t_{\text{inverter\_fall}}\right)}$$

Report $\eta_{\text{effective}}$

where

d_{prepower}	is the distance distance between vehicle entry sensor and segment;
$\eta_{\text{effective}}$	is the effective system efficiency calculated with dynamic parameters;
L_{segment}	is the length of segment;
$P_{\text{quiescent\_prepower}}$	is the quiescent power required to maintain the coil current required in a single primary coil segment in order to begin power transfer once the secondary coil becomes coupled with the primary coil segment;
$P_{\text{quiescent\_standby}}$	is the quiescent power required to be ready for power ramp up in detecting the secondary coil at the DWPT system segment;
$P_{\text{in\_average}}$	is the summation of power at each measuring points (primary side) divided by the number of measuring points;
$P_{\text{out\_average}}$	is the summation of power at each measuring points (secondary side) divided by the number of measuring points.

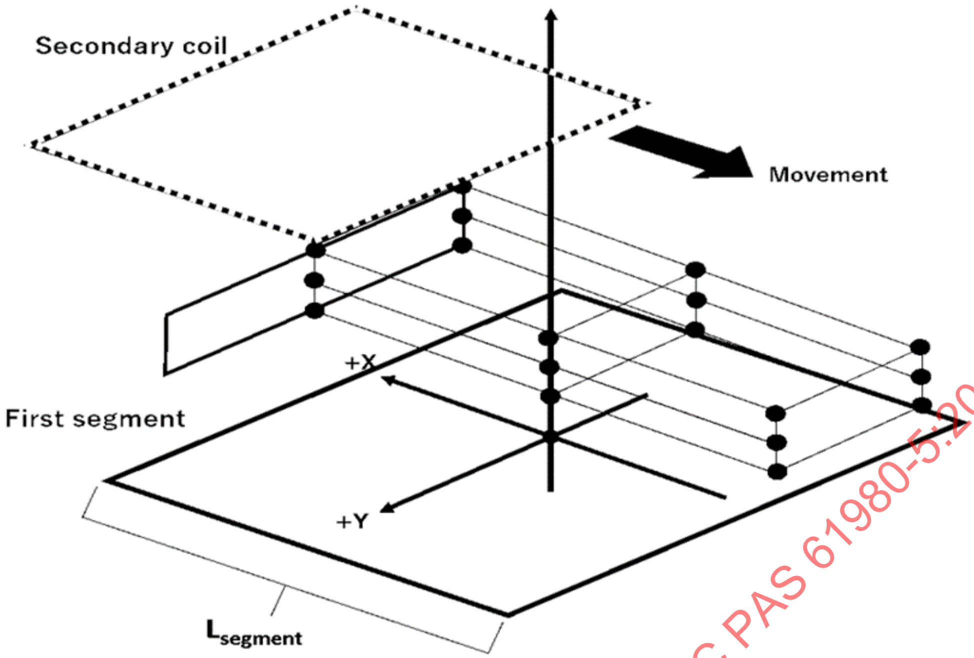


Figure 4 – Measuring the efficiency in D-WPT

7.4 Alignment

Replacement:

7.4 Alignment in D-WPT

The alignment tolerances in Y-axis relative to the centre alignment point for the primary device of a supply device shall be considered as ±200 mm.

NOTE The alignment tolerance with the support of autonomous driving can be ±50 mm.

8 Communication

IEC 61980-1:2020, Clause 8, applies except as follows:

Addition:

The communication and control concept for both compatibility class A supply devices and compatibility class B supply devices will be described in IEC 61980-6.

The communication and control requirements for compatibility class A supply devices will be described in IEC 61980-6.

The hardware to support the communication which will be described in IEC 61980-6 between the D-EVCC and D-SECC is not specified in this document. See future IEC 61980-6 for details.

9 Power transfer interoperability

IEC 61980-1:2020, Clause 9, applies except as follows.

Addition:

Interoperability refers to D-WPT between a supply device and an EV device that were not specifically designed with each other, for example, D-WPT between devices from different vendors or devices of different power classes.

For a compatibility class A supply device, interoperability shall be verified with the normative reference EVPCs (under consideration), meeting all the requirements for a compatibility class A supply device listed in Clause 7.

Interoperability of a compatibility class B supply device does not apply since the supply device is meant to work with specific EVPCs. It is verified with each of those EVPCs to meet all the requirements for a compatibility class B supply device listed in Clause 7.

10 Protection against electric shock

IEC 61980-1:2020, Clause 10, applies.

NOTE Specific requirements for D-WPT are under consideration.

11 Specific requirements for WPT systems

IEC 61980-1:2020, Clause 11, applies.

NOTE Specific requirements for D-WPT are under consideration.

12 Power cable requirements

IEC 61980-1:2020, Clause 11, applies.

NOTE Specific requirements for D-WPT are under consideration.

13 Constructional requirements

IEC 61980-1:2020, Clause 13, applies.

NOTE Specific requirements for D-WPT are under consideration.

14 Strength of materials and parts

IEC 61980-1:2020, Clause 14, is applicable.

NOTE Specific requirements for D-WPT are under consideration.

15 Service and test conditions

IEC 61980-1:2020, Clause 15, applies.

NOTE Specific requirements for D-WPT are under consideration.

16 Electromagnetic compatibility (EMC)

IEC 61980-1:2020, Clause 16, applies.

NOTE Specific requirements for D-WPT are under consideration.

17 Marking and instructions

IEC 61980-1:2020, Clause 17, applies.

NOTE Specific requirements for D-WPT are under consideration.

Additional clause:

18 Test procedure for protection against heating effects of foreign objects

Test procedure for D-WPT is under consideration.

Annex A
(informative)

DDQ reference EVPCs MF-WPT4/5

A.1 DDQ reference EVPCs for MF-WPT4

A.1.1 General

Clause A.1 describes reference EVPC proposals for MF-WPT4 for Z classes Z1, Z2 and Z3.

The centre alignment points for the MF-WPT4 reference secondary devices described in Clause A.1 is 0 mm in X- direction (direction of travel) and 0 mm in Y- direction (lateral direction) with respect to the geometric centre of ferrites of the secondary device.

The rated output power of MF-WPT4 reference EVPCs is 20 kW. The reference EVPCs specified in this Clause A.1 will perform over the system frequency range of 79 kHz to 90 kHz.

A.1.2 MF-WPT4/Z1 reference EVPC

A.1.2.1 General

The Z1 class EVPC covers the ground clearance range of 100 mm to 150 mm. It is divided in a low voltage version that can deliver full power at output voltages of 280 V DC to 420 V DC when used with the SPC specified in ISO 19363:2020, Annex B<, and a high voltage version that can deliver full power at output voltages of 550 V DC to 850 V DC.

A.1.2.2 Mechanical

Figure A.1 shows the general layout and Figure A.2 shows the mechanical dimensions of the MF-WPT4/Z1 reference secondary device.

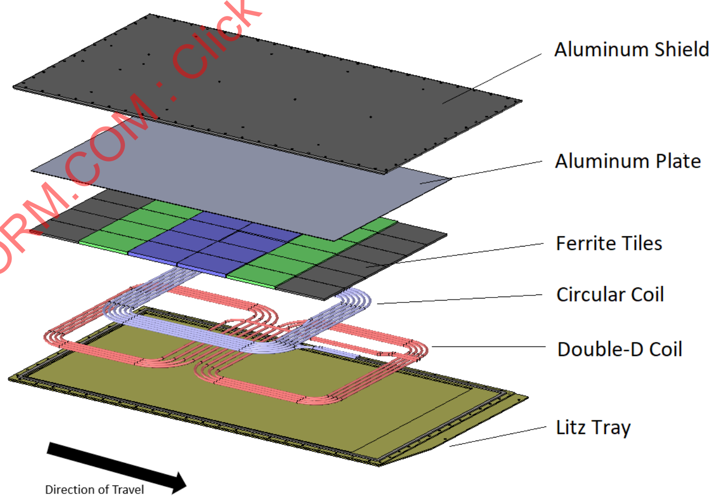


Figure A.1 – General layout of the MF-WPT4/Z1 reference secondary device

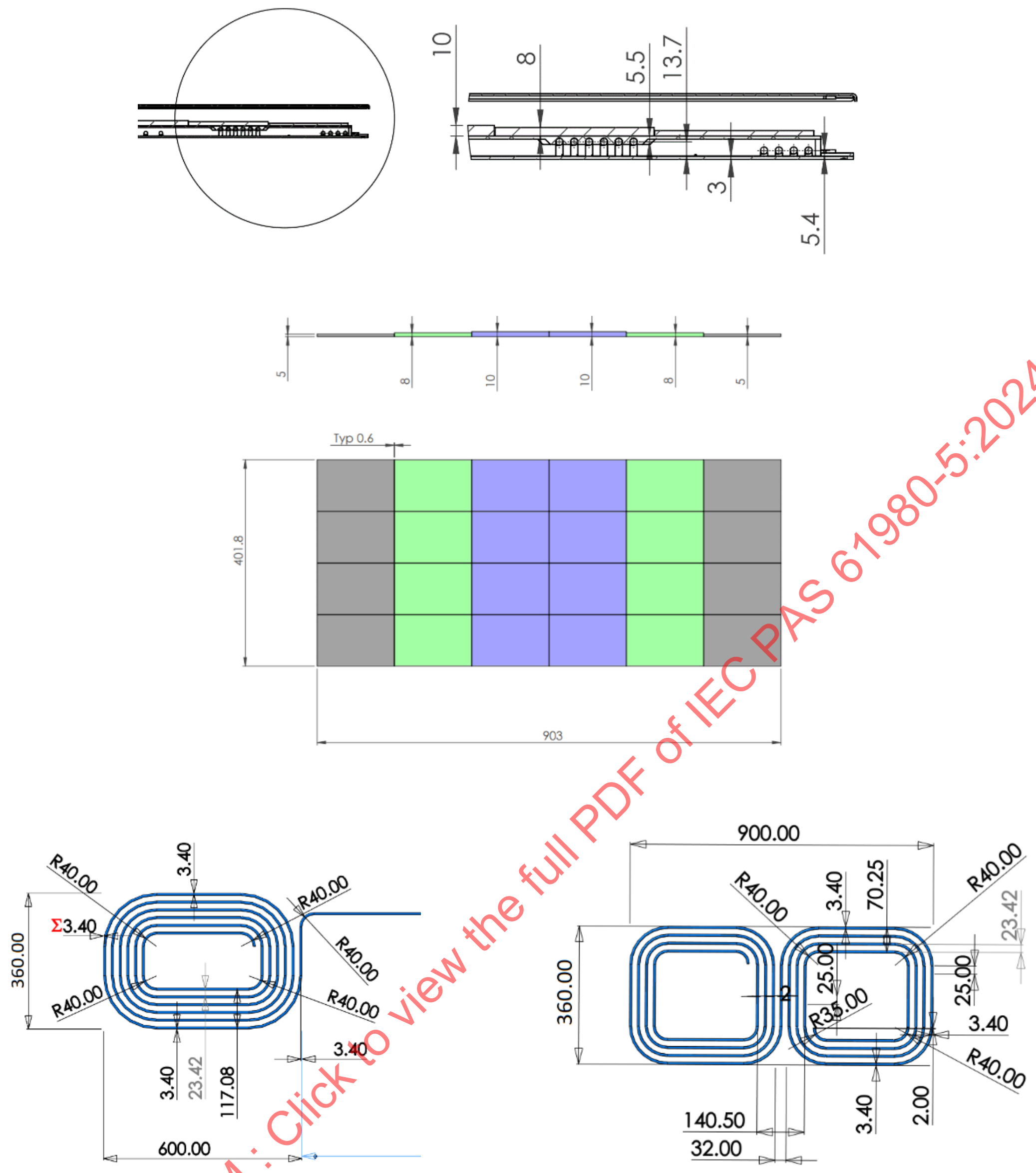
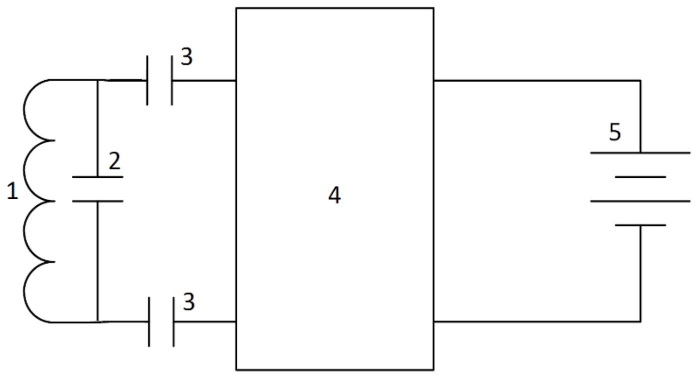


Figure A.2 – Mechanical dimensions of the MF-WPT4/Z1 reference secondary device

The mechanical configuration of the MF-WPT4/Z1 reference secondary device includes an aluminum shield 1 200 mm × 700 mm × 1 mm (shown in Figure A.2). A litz wire diameter of at least 6,5 mm is recommended. If multiple receivers are installed, the shield can be omitted between the receivers.

A.1.2.3 Electrical

Figure A.3 shows the schematic of the EV power electronics for the MF-WPT4/Z1 reference EVPC, and Table A.1 the values of the corresponding circuit elements. The double-D and the circular coils are connected to two independent power electronic units (compensation and rectifier).



Key

1 L2 (double-D or circular coil)

2 C_Parallel (parallel tuning capacitance)

3 C_Serial (serial tuning capacitance)

4 rectifier

5 battery

Figure A.3 – Schematic of the EV power electronics for the MF-WPT4 reference EVPC

Table A.1 – Values of circuit elements for Figure A.3

Battery voltage V DC		Double-D coil C_Parallel nF	Double-D coil C_Serial nF	Circular coil C_Parallel nF	Circular coil C_Serial nF
280 to 420		32,0	139,8	43,8	78,5
550 to 850		10,9	182,0	21,5	136,5

The coupling factors and maximum coil current of the MF-WPT4/Z1 reference secondary device when used in combination with the various referenced primary devices are shown in Table A.2. The values are obtained with an aluminum shield equal to 1 200 mm × 700 mm × 1 mm. If there is a coupling from the respective SPC to both coils, the higher value is given.

Table A.2 – Coupling factors and coil current MF-WPT4/Z1

Reference SPC	Coil-to-coil gap mm	Double-D coil L2 µH	Circular coil L2 µH	Minimum coupling factor	Maximum coupling factor	Maximum coil current
ISO 19363:2020, Annex B	60 to 110	50,8 to 51,2	47,0 to 52,2	0,269	0,484	60 A RMS
IEC 61980-5:—, Annex A	205	36,3	43,6	0,126	0,137	90 A RMS

A.1.3 MF-WPT4/Z2 reference EVPC

A.1.3.1 General

The Z2 class EVPC covers the ground clearance range of 140 mm to 210 mm. It is divided in a low voltage version that can deliver full power at output voltages of 280 V DC to 420 V DC when used with the SPC specified in ISO 19363:2020, Annex B, and a high voltage version that can deliver full power at output voltages of 550 V DC to 850 V DC.

A.1.3.2 Mechanical

Figure A.4 shows the general layout and Figure A.5 shows the mechanical dimensions of the MF-WPT4/Z2 reference secondary device.

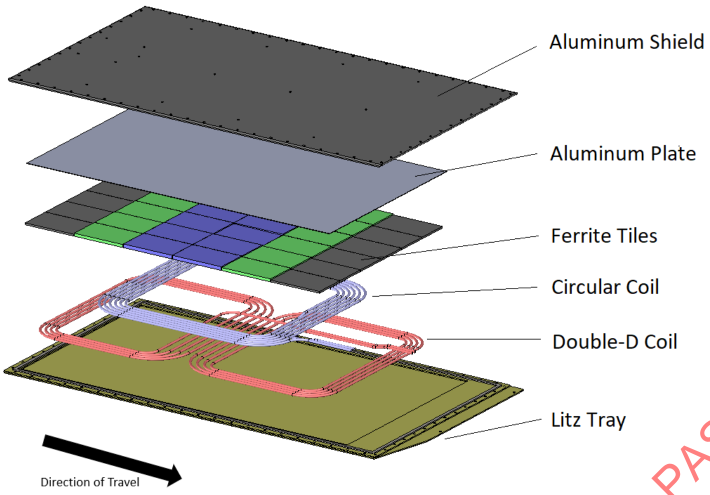


Figure A.4 – General layout of the MF-WPT4/Z2 reference secondary device

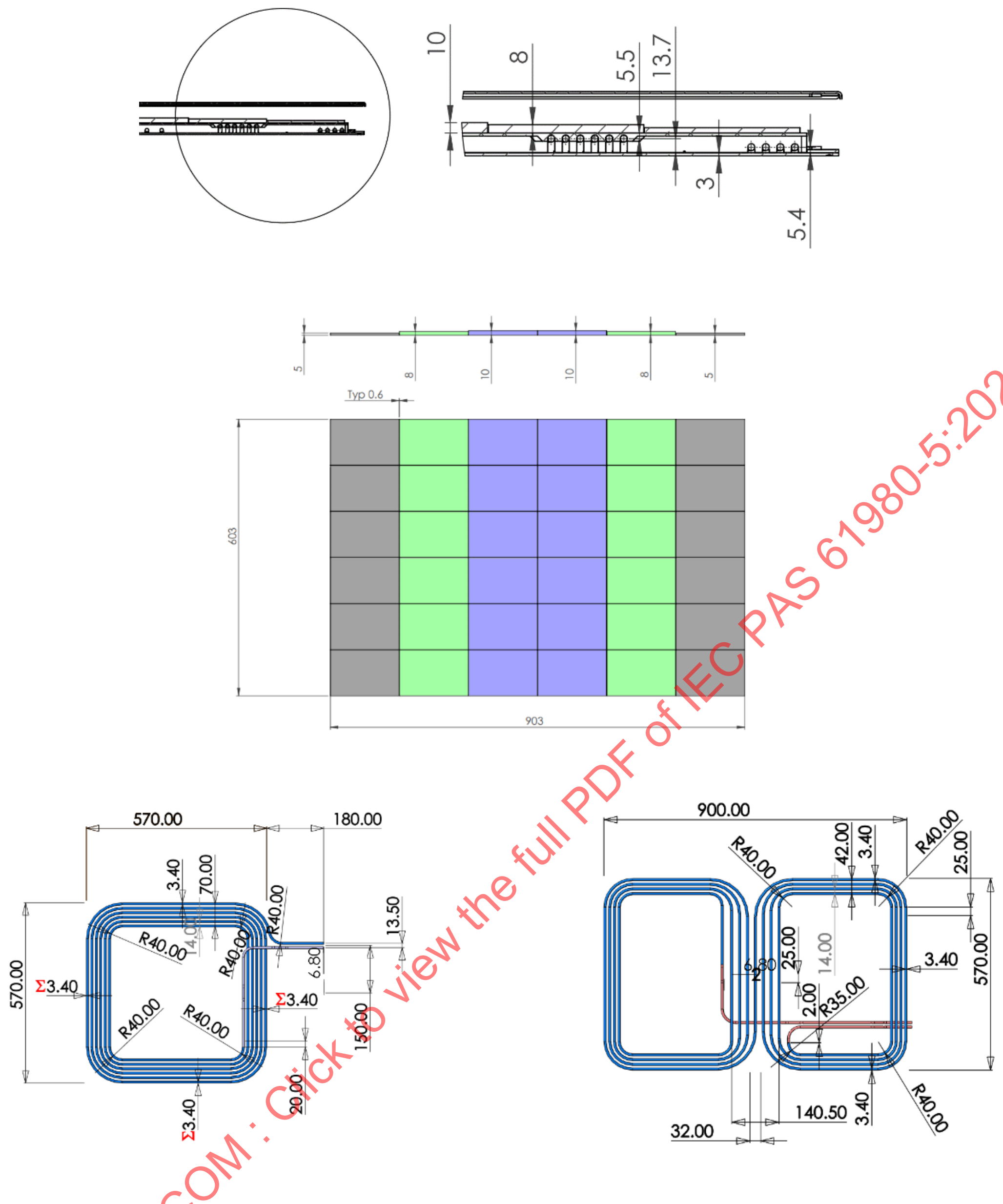
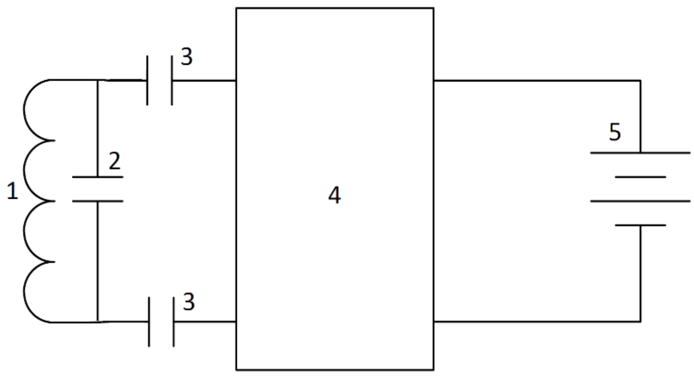


Figure A.5 – Mechanical dimensions of the MF-WPT4/Z2 reference secondary device

The mechanical configuration of the MF-WPT4/Z2 reference secondary device includes an aluminum shield 1 200 mm × 900 mm × 1 mm (shown in Figure A.5). A litz wire diameter of at least 6,5 mm is recommended. If multiple receivers are installed, the shield can be omitted between the receivers.

A.1.3.3 Electrical

Figure A.6 shows the schematic of the EV power electronics for the MF-WPT4/Z2 reference EVPC, and Table A.3 the values of the corresponding circuit elements. The double-D and the circular coils are connected to two independent power electronic units (compensation and rectifier).



Key

1 L2 (double-D or circular coil)

2 C_Parallel (parallel tuning capacitance)

3 C_Serial (serial tuning capacitance)

4 rectifier

5 battery

Figure A.6 – Schematic of the EV power electronics for the MF-WPT4 reference EVPC

Table A.3 – Values of circuit elements for Figure A.6

Battery voltage V DC	**Double-D coil C_Parallel** nF	**Double-D coil C_Serial** nF	**Circular coil C_Parallel** nF	**Circular coil C_Serial** nF
280 to 420	21,1	92,2	28,9	55,8
550 to 850	7,2	120,0	14,2	90,0

The coupling factors and maximum coil current of the MF-WPT4/Z2 reference secondary device when used in combination with the various referenced primary devices are shown in Table A.4. The values are obtained with an aluminum shield equal to 1 200 mm × 900 mm × 1 mm. If there is a coupling from the respective SPC to both coils, the higher value is given.

Table A.4 – Coupling factors and coil current MF-WPT4/Z2

Reference SPC	**Coil-to-coil gap** mm	**Double-D coil L2** µH	**Circular coil L2** µH	**Minimum coupling factor**	**Maximum coupling factor**	**Maximum coil current**
ISO 19363:2020, Annex B	100 to 170	59,6 to 68,1	63,7 to 65,7	0,213	0,433	60 A RMS
IEC 61980-5:—, Annex A	255	55,5	63,2	0,120	0,129	90 A RMS

A.1.4 MF-WPT4/Z3 reference EVPC

A.1.4.1 General

The Z3 class EVPC covers the ground clearance range of 170 mm to 250 mm. It is divided in a low voltage version that can deliver full power at output voltages of 280 V DC to 420 V DC when used with the SPC specified in ISO 19363:2020, Annex B, and a high voltage version that can deliver full power at output voltages of 550 V DC to 850 V DC.

A.1.4.2 Mechanical

Figure A.7 shows the general layout and Figure A.8 shows the mechanical dimensions of the MF-WPT4/Z3 reference secondary device.

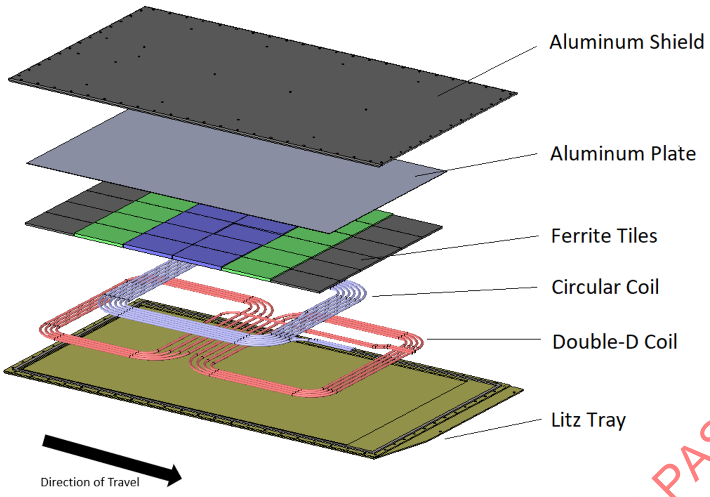


Figure A.7 – General layout of the MF-WPT4/Z3 reference secondary device

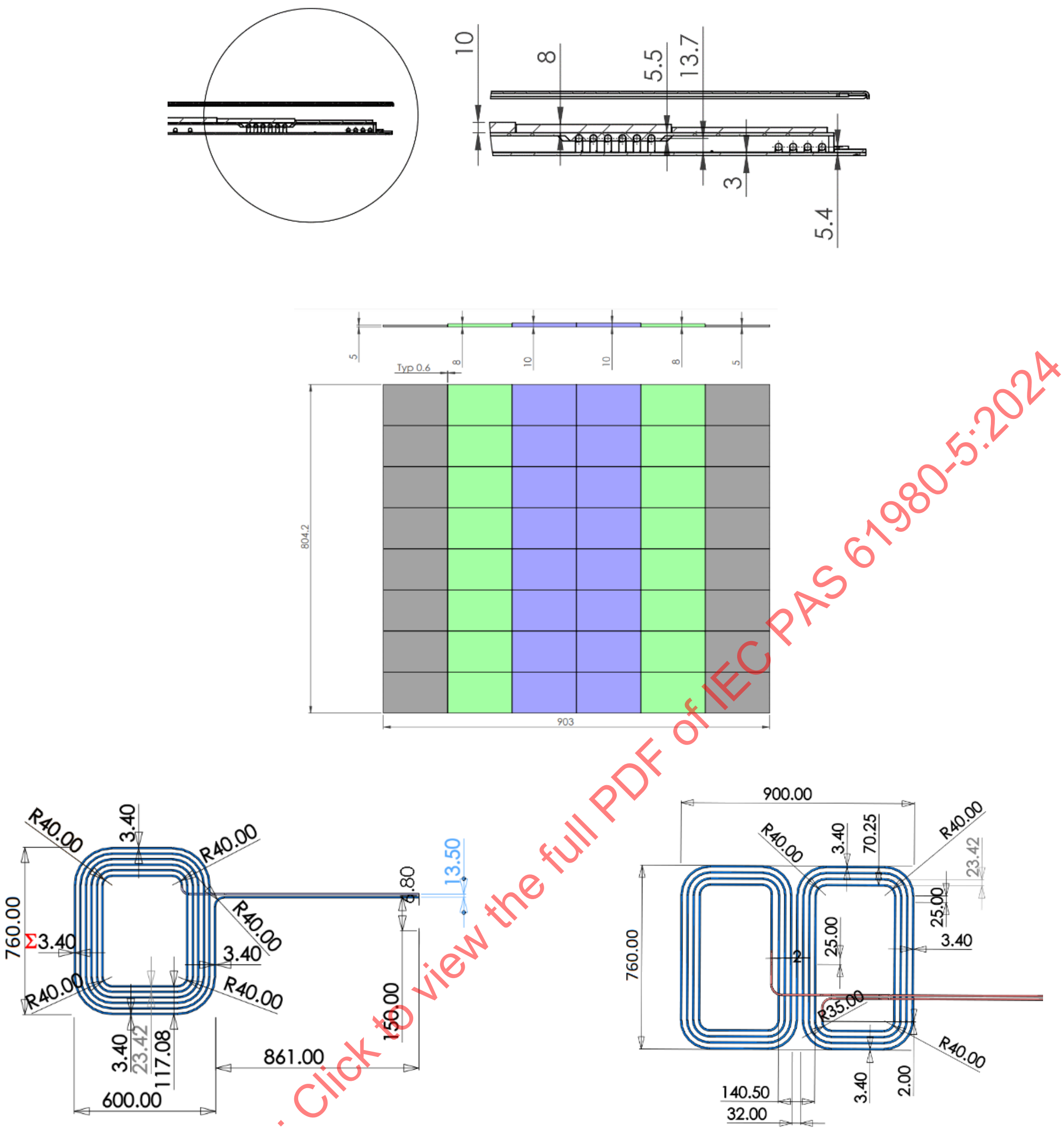
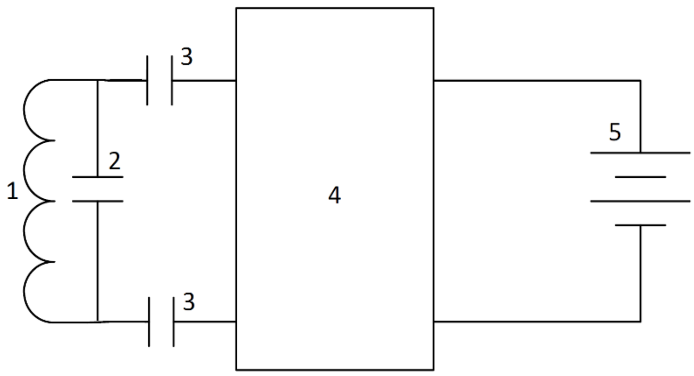


Figure A.8 – Mechanical dimensions of the MF-WPT4/Z3 reference secondary device

The mechanical configuration of the MF-WPT4/Z3 reference secondary device includes an aluminum shield 1 200 mm × 1 100 mm × 1 mm (shown in Figure A.8). A litz wire diameter of at least 6,5 mm is recommended. If multiple receivers are installed, the shield can be omitted between the receivers.

A.1.4.3 Electrical

Figure A.9 shows the schematic of the EV power electronics for the MF-WPT4/Z3 reference EVPC, and Table A.5 shows the values of the corresponding circuit elements. The double-D and the circular coils are connected to two independent power electronic units (compensation and rectifier).



Key

1 L2 (double-D or circular coil)

2 C_Parallel (parallel tuning capacitance)

3 C_Serial (serial tuning capacitance)

4 rectifier

5 battery

Figure A.9 – Schematic of the EV power electronics for the MF-WPT4 reference EVPC

Table A.5 – Values of circuit elements for Figure A.9

Battery voltage V DC	**Double-D coil C_Parallel** nF	**Double-D coil C_Serial** nF	**Circular coil C_Parallel** nF	**Circular coil C_Serial** nF
280 to 420	15,9	66,4	21,3	43,3
550 to 850	5,4	90,4	10,5	66,2

The coupling factors and maximum coil current of the MF-WPT4/Z3 reference secondary device when used in combination with the various referenced primary devices are shown in Table A.6. The values are obtained with an aluminum shield equal to 1 200 mm × 1 100 mm × 1 mm. If there is a coupling from the respective SPC to both coils, the higher value is given.

Table A.6 – Coupling factors and coil current MF-WPT4/Z3

Reference SPC	**Coil-to-coil gap** mm	**Double-D coil L2** µH	**Circular coil L2** µH	**Minimum coupling factor**	**Maximum coupling factor**	**Maximum coil current**
ISO 19363:2020, Annex B	160 to 210	77,5 to 81,2	79,9 to 81,0	0,173	0,274	60 A RMS
IEC 61980-5:—, Annex A	305	73,7	83,3	0,104	0,109	90 A RMS

A.2 DDQ reference EVPCs for MF-WPT5

A.2.1 General

Clause A.2 describes reference EVPC proposals for MF-WPT5 for Z classes HD-Z1, HD-Z2 and HD-Z3. The centre alignment points for the MF-WPT5 reference secondary devices described in this Annex A is 0 mm in X- direction (direction of travel) and 0 mm in Y- direction (lateral direction) with respect to the geometric centre of ferrites of the secondary device when paired with any primary devices listed above. The rated output power of MF-WPT5 reference EVPCs is 50 kW. The reference EVPCs specified in this Clause A.2 will perform over the system frequency range of 79 kHz to 90 kHz.

A.2.2 MF-WPT5/Z1 reference EVPC

A.2.2.1 General

The HD-Z1 class EVPC covers the ground clearance range of 100 mm to 150 mm and can deliver full power at output voltages of 550 V DC to 850 V DC.

A.2.2.2 Mechanical

Figure A.10 shows the general layout and Figure A.11 shows the mechanical dimensions of the MF-WPT5/Z1 reference secondary device.

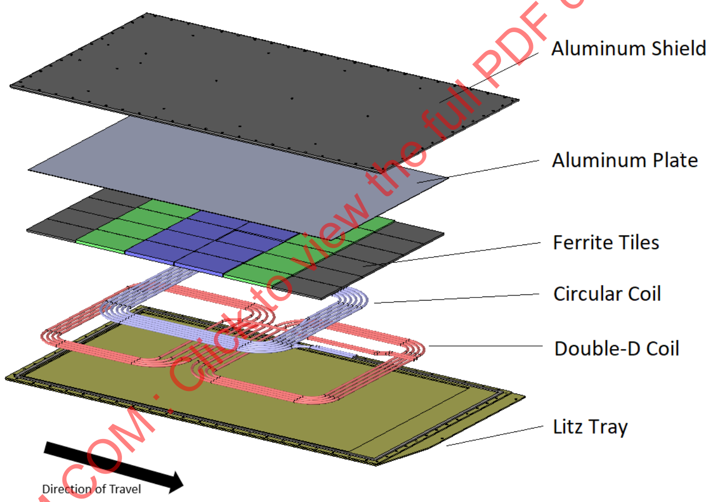


Figure A.10 – General layout of the MF-WPT5/Z1 reference secondary device

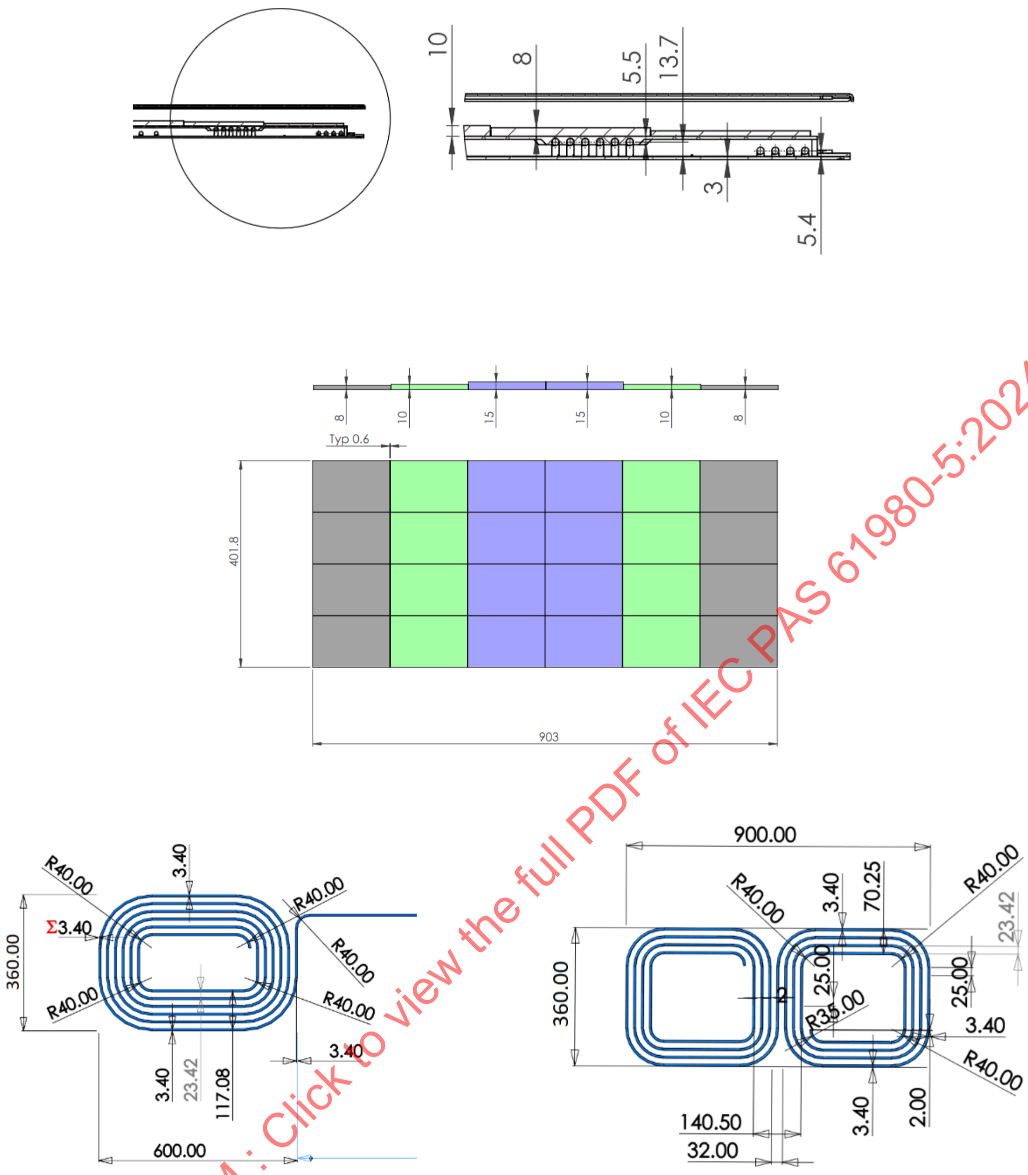
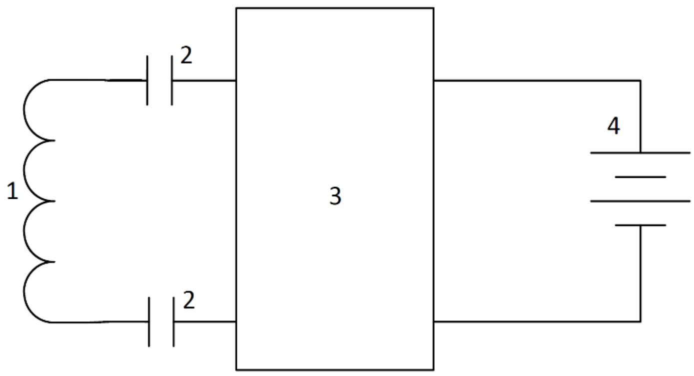


Figure A.11 – Mechanical dimensions of the MF-WPT4/Z1 reference secondary device

The mechanical configuration of the MF-WPT5/Z1 reference secondary device includes an aluminum shield 1 200 mm × 700 mm × 1 mm. A litz wire diameter of at least 8 mm is recommended. If multiple receivers are installed, the shield can be omitted between the receivers.

A.2.2.3 Electrical

Figure A.12 shows the schematic of the EV power electronics for the MF-WPT4/Z1 reference EVPC, and Table A.7 shows the values of the corresponding circuit elements. The double-D and the circular coils are connected to two independent power electronic units (compensation and rectifier).



Key

1 L2 (double-D or circular coil)

2 C_Serial (serial tuning capacitance)

3 rectifier

4 battery

Figure A.12 – Schematic of the EV power electronics for the MF-WPT5 reference EVPC

Table A.7 – Values of circuit elements for Figure A.12

Battery voltage V DC	Double-D coil C_Serial nF	Circular coil C_Serial nF
550 to 850	179,4	151,2

The coupling factors and maximum coil current of the MF-WPT5/Z1 reference secondary device when used in combination with the various referenced primary devices are shown in Table A.8. The values are obtained with an aluminum shield equal to 1 200 mm × 700 mm × 1 mm. If there is a coupling from the respective SPC to both coils, the higher value is given.

Table A.8 – Coupling factors and coil current MF-WPT5/Z1

Reference SPC	Coil-to-coil gap mm	Double-D coil L2 µH	Circular coil L2 µH	Minimum coupling factor	Maximum coupling factor	Maximum coil current
IEC 61980-5:—, Annex A	205	36,3	43,6	0,126	0,137	120 A RMS

A.2.3 MF-WPT5/Z2 reference EVPC

A.2.3.1 General

The HD-Z2 class EVPC covers the ground clearance range of 150 mm to 200 mm and can deliver full power at output voltages of 550 V DC to 850 V DC.

A.2.3.2 Mechanical

Figure A.13 shows the general layout and Figure A.14 shows the mechanical dimensions of the MF-WPT4/Z2 reference secondary device.

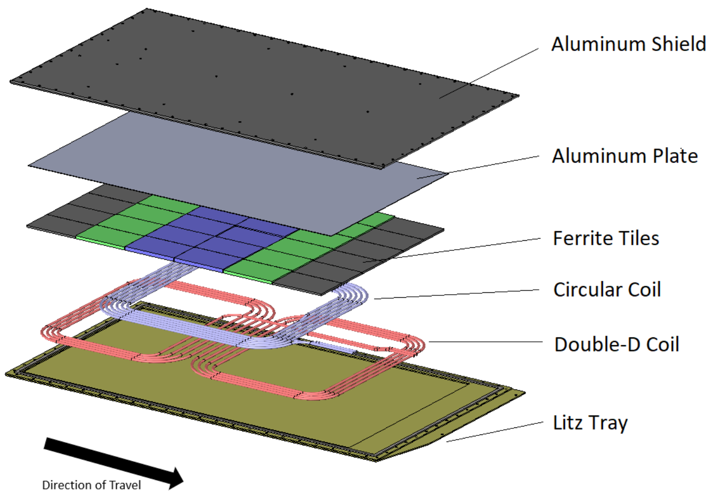


Figure A.13 – General layout of the MF-WPT5/Z2 reference secondary device

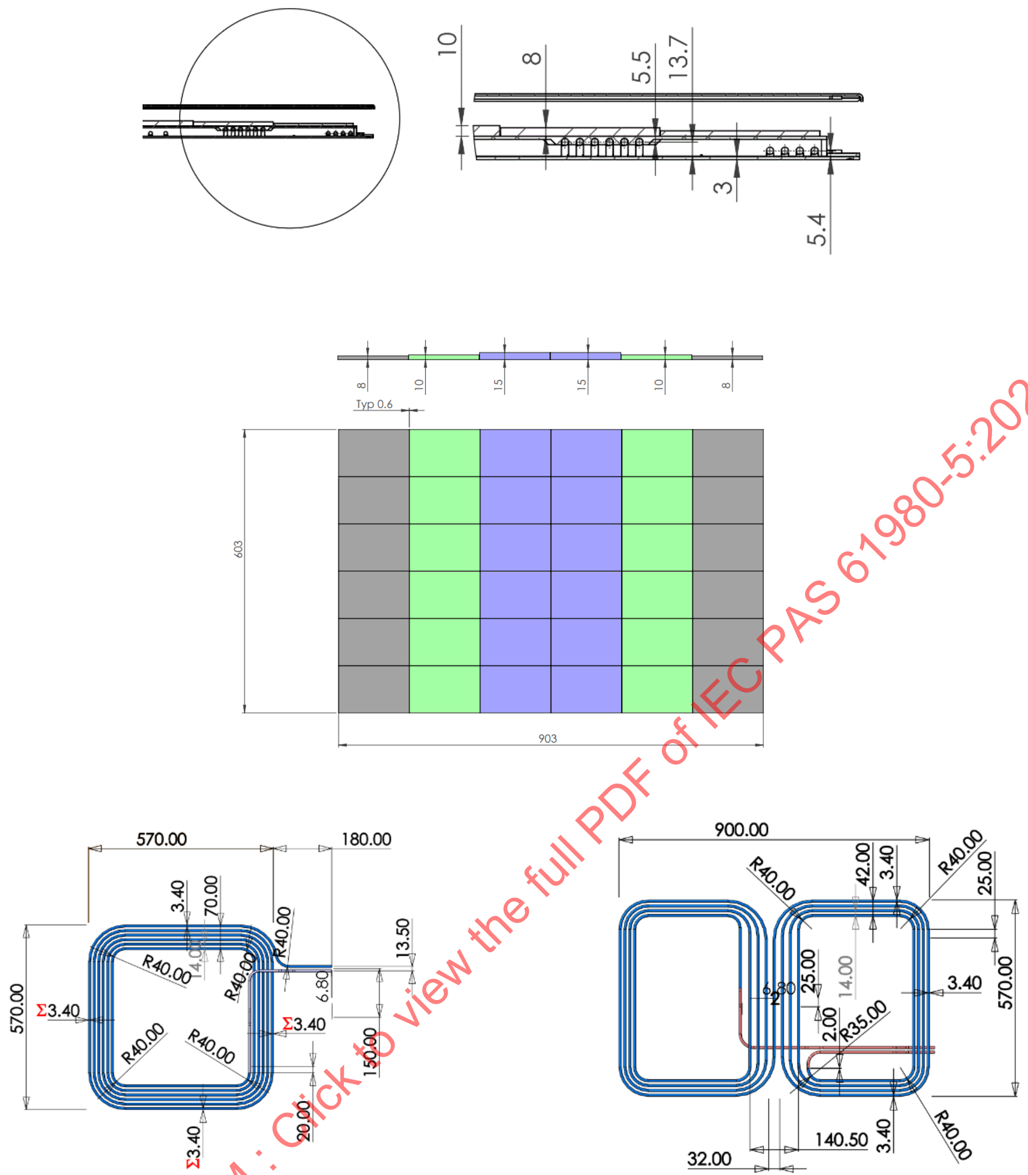
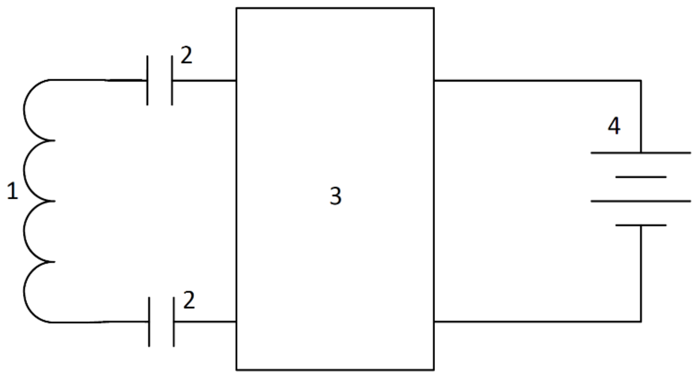


Figure A.14 – Mechanical dimensions of the MF-WPT5/Z2 reference secondary device

The mechanical configuration of the MF-WPT5/Z2 reference secondary device includes an aluminum shield 1 200 mm × 900 mm × 1 mm (shown in Figure A.13). A litz wire diameter of at least 8 mm is recommended. If multiple receivers are installed, the shield can be omitted between the receivers.

A.2.3.3 Electrical

Figure A.15 shows the schematic of the EV power electronics for the MF-WPT5/Z2 reference EVPC, and Table A.9 the values of the corresponding circuit elements. The double-D and the circular coils are connected to two independent power electronic units (compensation and rectifier).



Key

1 L2 (double-D or circular coil)

2 C_Serial (serial tuning capacitance)

3 rectifier

4 battery

Figure A.15 – Schematic of the EV power electronics for the MF-WPT4 reference EVPC

Table A.9 – Values of circuit elements for Figure A.15

Battery voltage V DC	**Double-D coil C_Serial** nF	**Circular coil C_Serial** nF
550 to 850	117,4	104,3

The coupling factors and maximum coil current of the MF-WPT5/Z2 reference secondary device when used in combination with the various referenced primary devices are shown in Table A.10. The values are obtained with an aluminum shield equal to 1 200 mm × 900 mm × 1 mm. If there is a coupling from the respective SPC to both coils, the higher value is given.

Table A.10 – Coupling factors and coil current MF-WPT5/Z2

Reference SPC	**Coil-to-coil gap** mm	**Double-D coil L2** µH	**Circular coil L2** µH	**Minimum coupling factor**	**Maximum coupling factor**	**Maximum coil current**
IEC 61980-5:—, Annex A	255	55,5	63,2	0,120	0,129	120 A RMS

A.2.4 MF-WPT5/Z3 reference EVPC

A.2.4.1 General

The HD-Z3 class EVPC covers the ground clearance range of 200 mm to 250 mm and can deliver full power at output voltages of 550 V DC to 850 V DC.

A.2.4.2 Mechanical

Figure A.16 shows the general layout and Figure A.17 shows the mechanical dimensions of the MF-WPT5/Z3 reference secondary device.

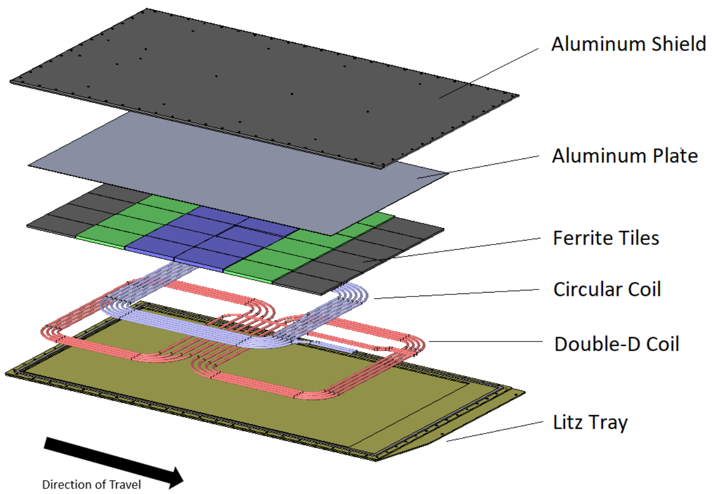


Figure A.16 – General layout of the MF-WPT5/Z3 reference secondary device

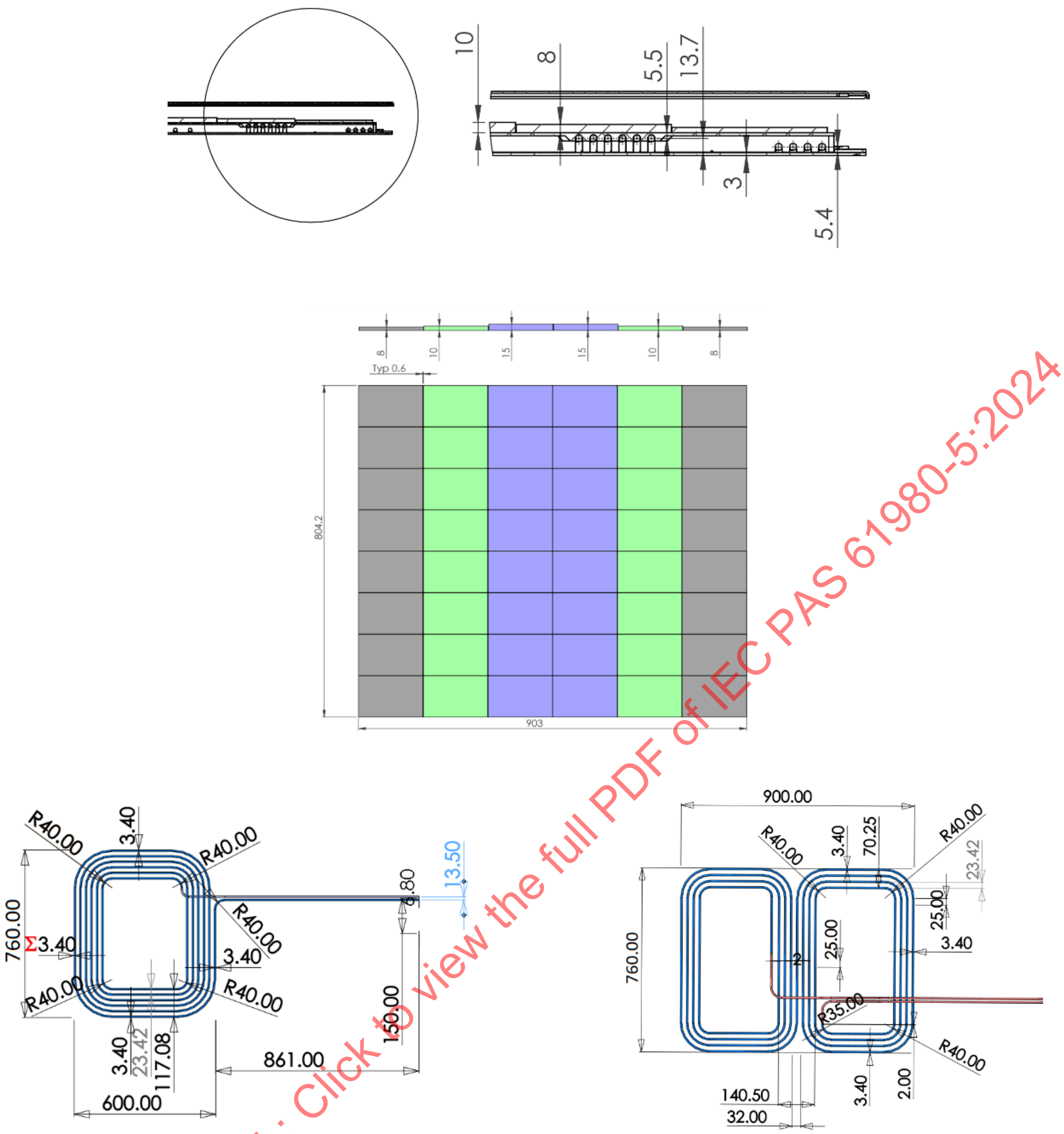
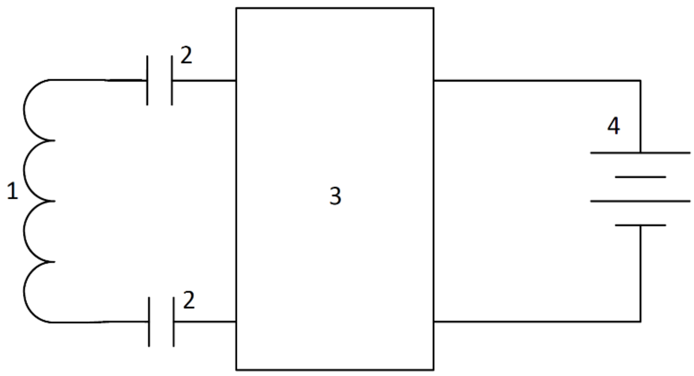


Figure A.17 – Mechanical dimensions of the MF-WPT5/Z3 reference secondary device

The mechanical configuration of the MF-WPT5/Z3 reference secondary device includes an aluminum shield 1 200 mm × 1 100 mm × 1 mm (shown in Figure A.16). A litz wire diameter of at least 8 mm is recommended. If multiple receivers are installed, the shield can be omitted between the receivers.

A.2.4.3 Electrical

Figure A.18 shows the schematic of the EV power electronics for the MF-WPT5/Z3 reference EVPC and Table A.11 shows the values of the corresponding circuit elements. The double-D and the circular coils are connected to two independent power electronic units (compensation and rectifier).



Key

1 L2 (double-D or circular coil)

2 C_Serial (serial tuning capacitance)

3 rectifier

4 battery

Figure A.18 – Schematic of the EV power electronics for the MF-WPT5 reference EVPC

Table A.11 – Values of circuit elements for Figure A.18

Battery voltage V DC	**Double-D coil C_Serial** nF	**Circular coil C_Serial** nF
550 to 850	88,5	79,0

The coupling factors and maximum coil current of the MF-WPT5/Z3 reference secondary device when used in combination with the various referenced primary devices are shown in Table A.12. The values are obtained with an aluminum shield equal to 1 200 mm × 1 100 mm × 1 mm. If there is a coupling from the respective SPC to both coils, the higher value is given.

Table A.12 – Coupling factors and coil current MF-WPT5/Z3

Reference SPC	**Coil-to-coil gap** mm	**Double-D coil L2** µH	**Circular coil L2** µH	**Minimum coupling factor**	**Maximum coupling factor**	**Maximum coil current**
IEC 61980-5:—, Annex A	305	73,7	83,3	0,104	0,109	120 A RMS

Annex B
(informative)

Multi-phase coil reference EVPCs for MF-WPT4/5

B.1 Multi-phase coil reference EVPCs for MF-WPT4

B.1.1 General

Clause B.1 describes reference EVPCs for MF-WPT4, Z classes Z1, Z2 and Z3.

The centre alignment point for the MF-WPT4 reference secondary devices described in Clause B.1 is 0 mm in X- direction and 0 mm in Y- direction with respect to the geometric centre of the secondary device when paired with the primary devices.

The rated output power of MF-WPT4 reference EVPCs is 22 kW.

B.1.2 MF-WPT4/Z1 reference EVPC

B.1.2.1 General

The Z1 class reference EVPC covers the ground clearance range of 100 mm to 150 mm and can deliver full power at output voltages of 300 V DC to 750 V DC.

B.1.2.2 Mechanical specification

Figure B.1 shows the general layout and Figure B.2 shows the mechanical dimensions of the MF-WPT4/Z1 reference secondary device.

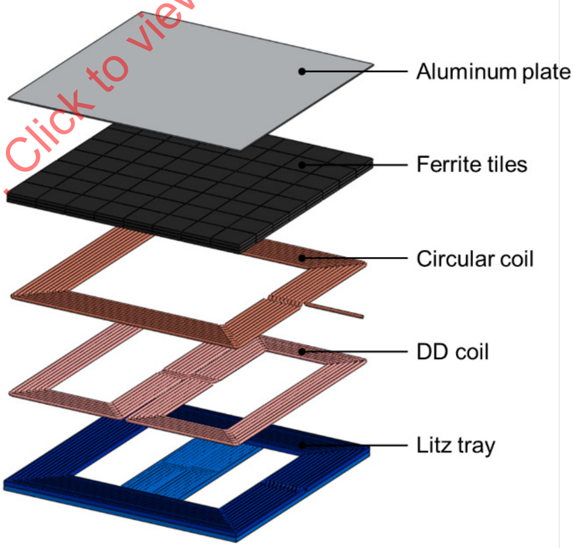


Figure B.1 – General layout of the MF-WPT4/Z1 reference secondary device

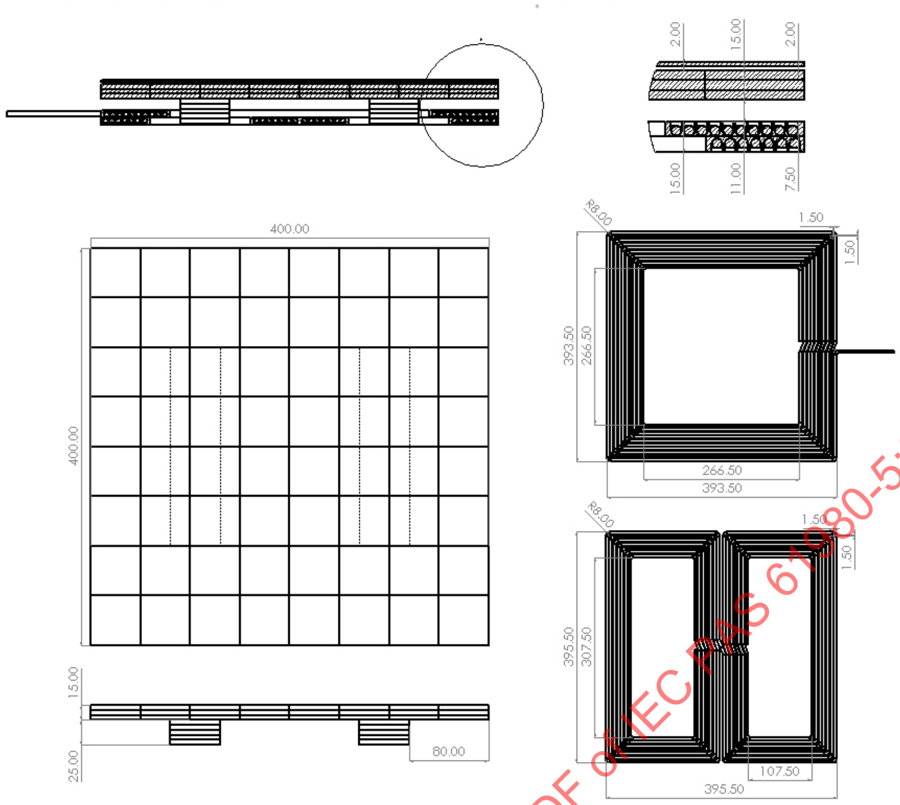
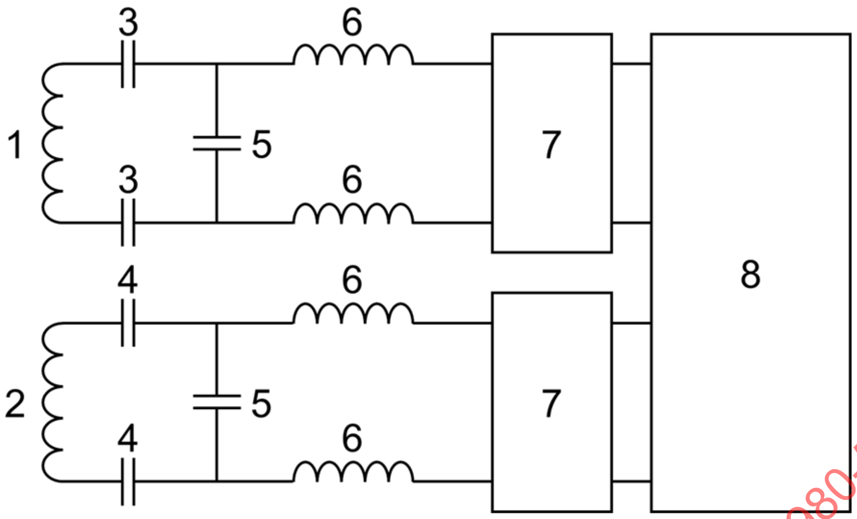


Figure B.2 – Mechanical dimensions of the MF-WPT4/Z1 reference secondary device

B.1.2.3 Electrical specifications

Figure B.3 shows the schematic of the power electronics for the MF-WPT4/Z1 reference EVPC. This circuit consists of independent circuits of a circular coil or a DD coil, connected in parallel at each rectifier output to charge the battery.

Table B.1 and Table B.2 show the electrical specification of the MF-WPT4/Z1 reference EVPC.



1. Secondary coil (Circular coil)
2. Secondary coil (DD coil)
3. Capacitance for Circular coil compensation (Series tuning capacitance)
4. Capacitance for DD coil compensation (Series tuning capacitance)
5. Parallel capacitance (Parallel tuning capacitance, Cx)
6. Matching inductance (Tuning inductance, Lx)
7. Rectifier
8. Battery

Figure B.3 – Schematic of the EV power electronics for the MF-WPT4/Z1 reference EVPC

Table B.1 – Values of circuit elements

Battery voltage V DC	Circular coil_cap., 3 nF	DD coil_cap., 4 nF	Parallel cap., 5 nF	Matching_ind., 6 uH
300 to 750	108,96	140,45	145,63	12,04

Table B.2 – Secondary coil inductance and coupling factor

Air gap mm	Circular coil1 uH	DD coil uH	Min. k	Max. k	Max. current
<200	88,83	74,20	0,09	0,15	40

B.1.3 MF-WPT4/Z2 reference EVPC

B.1.3.1 General

The Z2 class reference EVPC covers the ground clearance range of 140 mm to 210 mm and can deliver full power at output voltages of 300 V DC to 750 V DC.

B.1.3.2 Mechanical specifications

Figure B.4 shows the general layout and Figure B.5 shows the mechanical dimensions of the MF-WPT4/Z2 reference secondary device.

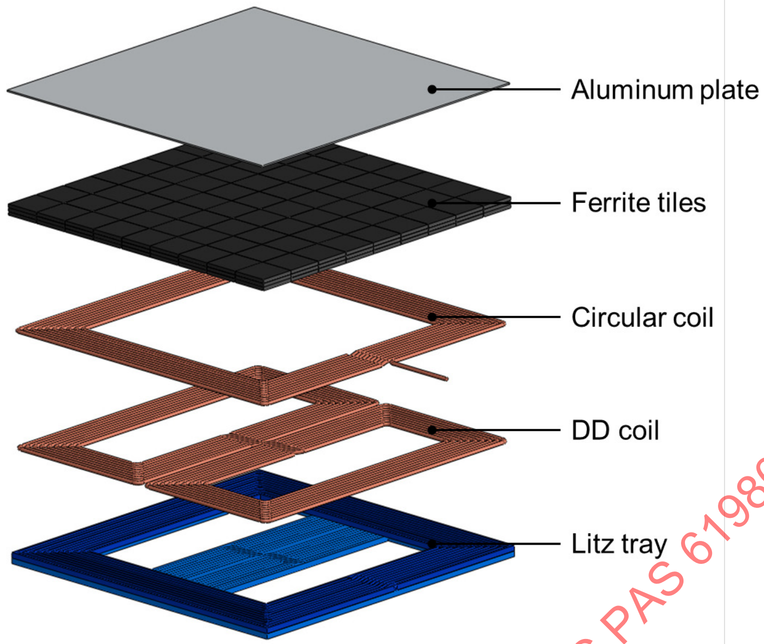


Figure B.4 – General layout of the MF-WPT4/Z2 reference secondary device

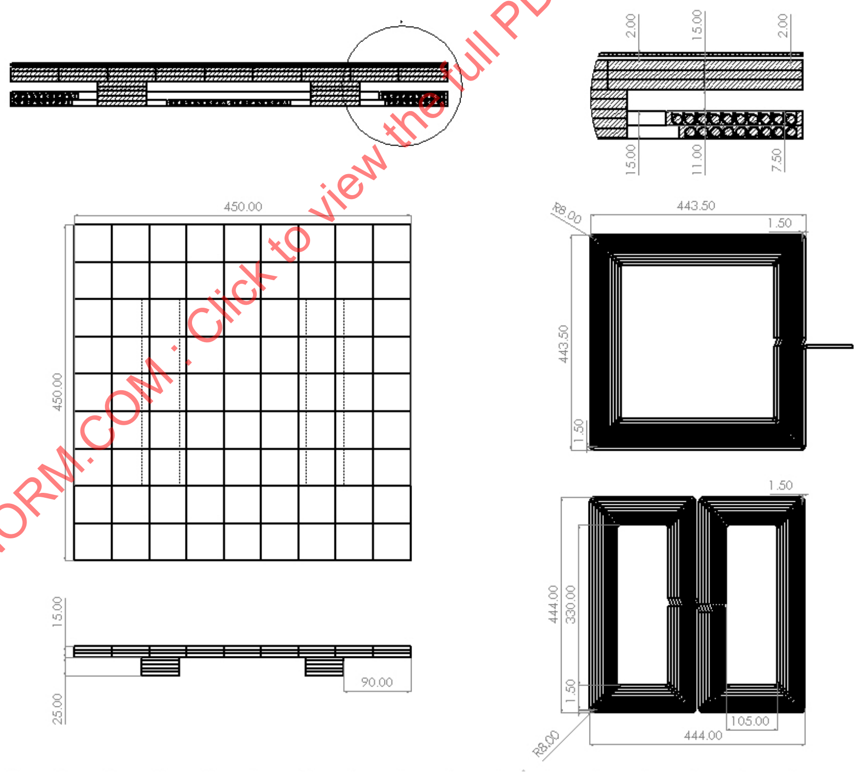
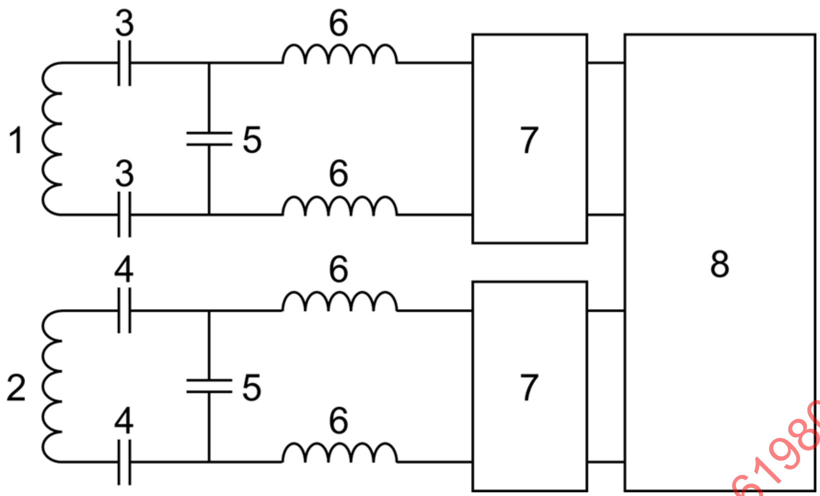


Figure B.5 – Mechanical dimensions of the MF-WPT4/Z2 reference secondary device

B.1.3.3 Electrical specifications

Figure B.6 shows the schematic of the power electronics for the MF-WPT4/Z2 reference EVPC. This circuit consists of independent circuits of a circular coil or a DD coil, connected in parallel at each rectifier output to charge the battery.

Table B.3 and Table B.4 show the electrical specification of the MF-WPT4/Z2 reference EVPC.



1. Secondary coil (Circular coil)
2. Secondary coil (DD coil)
3. Capacitance for Circular coil compensation (Series tuning capacitance)
4. Capacitance for DD coil compensation (Series tuning capacitance)
5. Parallel capacitance (Parallel tuning capacitance, Cx)
6. Matching inductance (Tuning inductance, Lx)
7. Rectifier
8. Battery

Figure B.6 – Schematic of the EV power electronics for the MF-WPT4/Z2 reference EVPC

Table B.3 – Values of circuit elements

Battery voltage V DC	Circular coil_cap., 3 nF	DD coil_cap., 4 nF	Parallel cap., 5 nF	Matching_ind., 6 uH
300 to 750	88,61	68,47	138,70	12,64

Table B.4 – Secondary coil inductance and coupling factor

Air gap mm	Circular coil, 1 uH	DD coil, 2 uH	Min. k	Max. k	Max. current
<260	104,41	127,88	0,08	0,13	40

B.1.4 MF-WPT4/Z3 reference EVPC

B.1.4.1 General

The Z3 class reference EVPC covers the ground clearance range of 170 mm to 250 mm and can deliver full power at output voltages of 300 V DC to 750 V DC.

B.1.4.2 Mechanical specifications

Figure B.7 shows the general layout and Figure B.8 shows the mechanical dimensions of the MF-WPT4/Z3 reference secondary device.

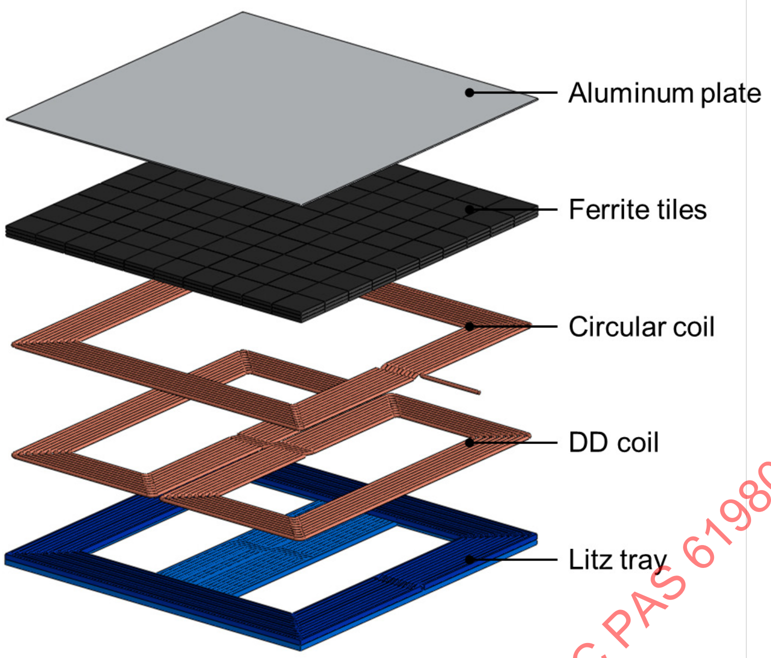


Figure B.7 – General layout of the MF-WPT4/Z3 reference secondary device

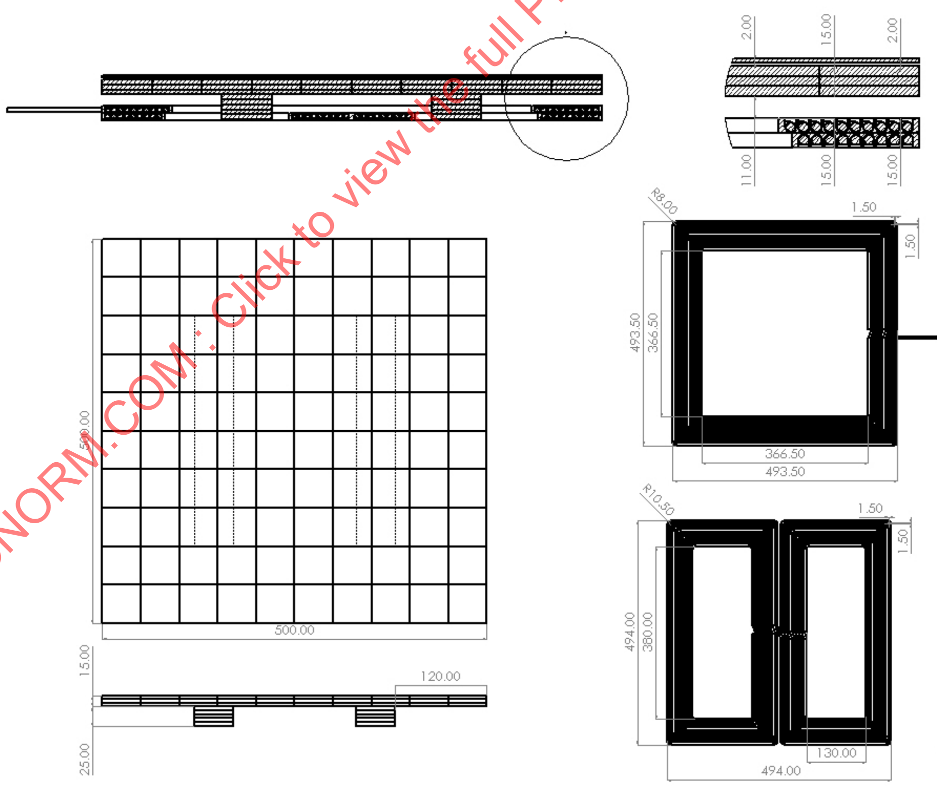
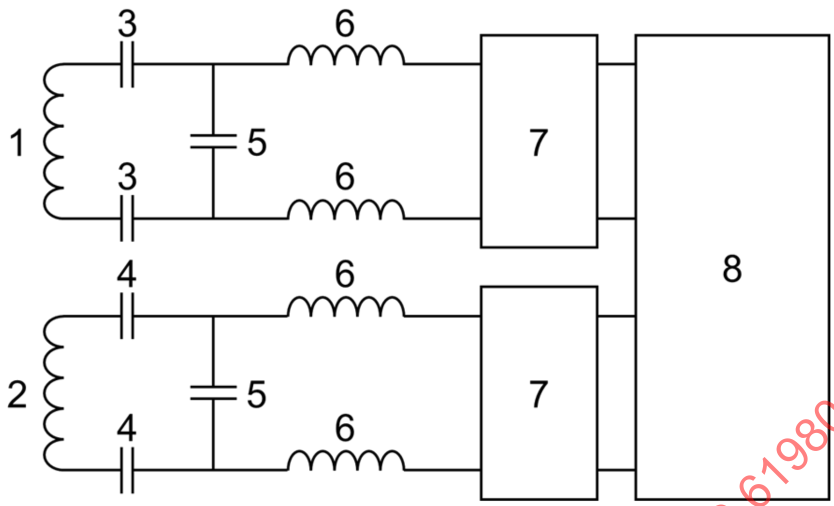


Figure B.8 – Mechanical dimensions of the MF-WPT4/Z3 reference secondary device

B.1.4.3 Electrical specifications

Figure B.9 shows the schematic of the power electronics for the MF-WPT4/Z3 reference EVPC. This circuit consists of independent circuits of a circular coil or a DD coil, connected in parallel at each rectifier output to charge the battery.

Table B.5 and Table B.6 show the electrical specification of the MF-WPT4/Z3 reference EVPC.



1. Secondary coil (Circular coil)
2. Secondary coil (DD coil)
3. Capacitance for Circular coil compensation (Series tuning capacitance)
4. Capacitance for DD coil compensation (Series tuning capacitance)
5. Parallel capacitance (Parallel tuning capacitance, Cx)
6. Matching inductance (Tuning inductance, Lx)
7. Rectifier
8. Battery

Figure B.9 – Schematic of the EV power electronics for the MF-WPT4/Z3 reference EVPC

Table B.5 – Values of circuit elements

Battery voltage V DC	Circular coil_cap., 3 nF	DD coil_cap., 4 nF	Parallel cap., 5 nF	Matching_ind., 6 uH
300 to 750	72,43	53,12	152,57	11,49

Table B.6 – Secondary coil inductance and coupling factor

Air gap mm	Circular Coil, 1 uH	DD Coil, 2 uH	Min. k	Max. k	Max. current
<300	120,03	155,32	0,07	0,11	40

B.2 Multi-phase coil reference EVPCs for MF-WPT5

B.2.1 General

Clause B.2 describes reference EVPCs for MF-WPT5, Z classes Z1, Z2 and Z3.

The centre alignment point for the MF-WPT5 reference secondary devices described in Clause B.2 is 0 mm in X- direction and 0 mm in Y- direction with respect to the geometric centre of the secondary device when paired with the primary devices.

The rated output power of MF-WPT5 reference EVPCs is 50 kW.

B.2.2 MF-WPT5/Z1 reference EVPC

B.2.2.1 General

The Z1 class reference EVPC covers the ground clearance range of 100 mm to 150 mm and can deliver full power at output voltages of 300 V DC to 750 V DC.

B.2.2.2 Mechanical specifications

Figure B.10 shows the general layout and Figure B.11 shows the mechanical dimensions of the MF-WPT5/Z1 reference secondary device.

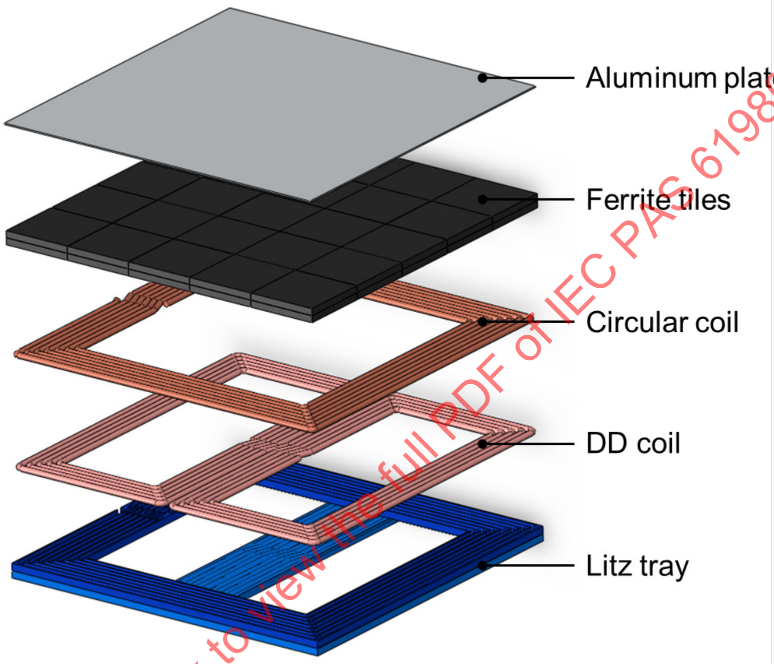


Figure B.10 – General layout of the MF-WPT5/Z1 reference secondary device

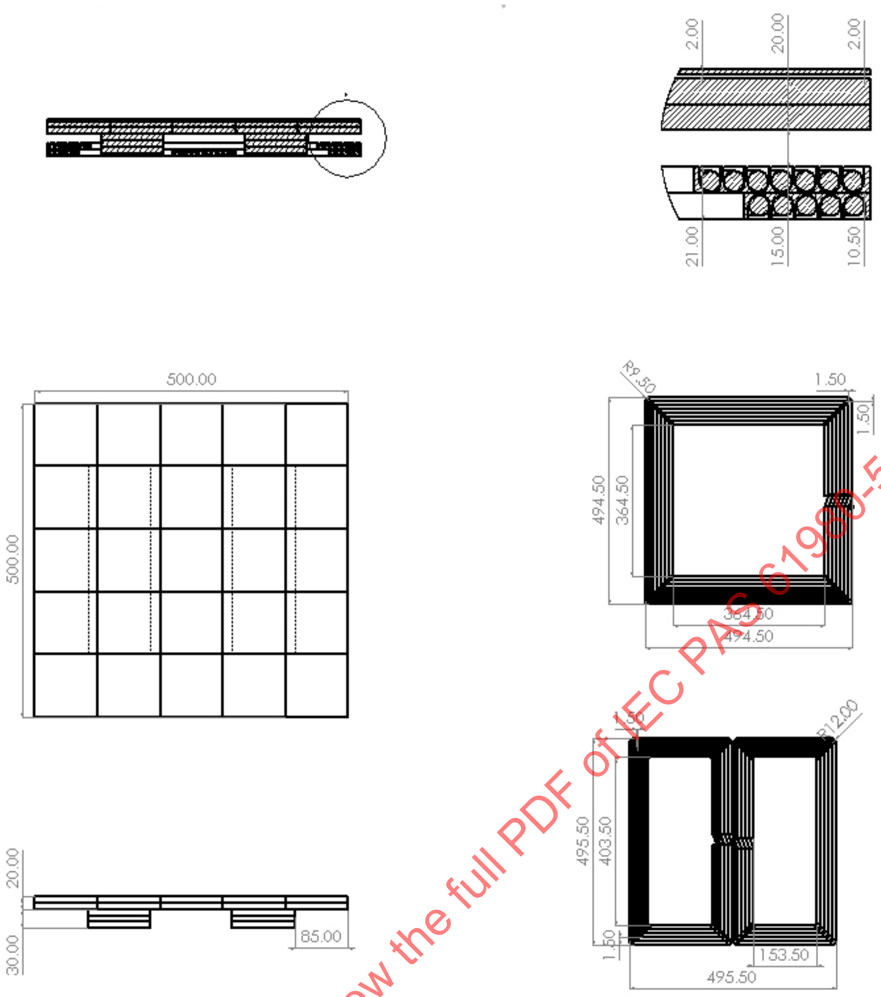
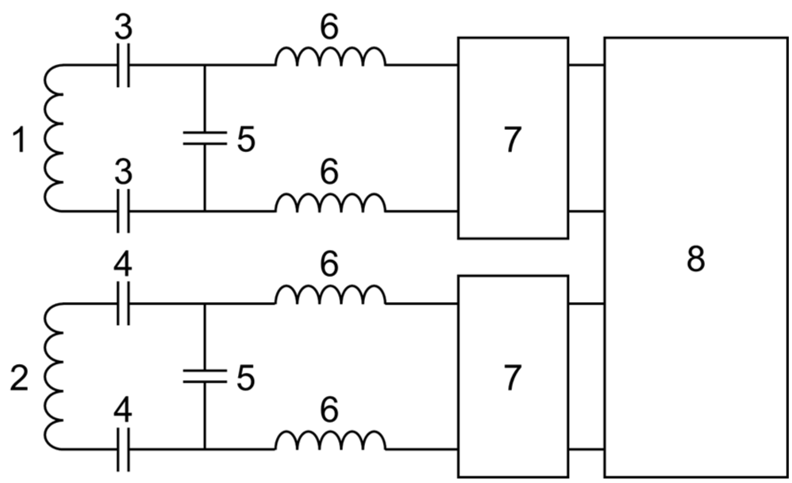


Figure B.11 – Mechanical dimensions of the MF-WPT5/Z1 reference secondary device

B.2.2.3 Electrical specifications

Figure B.12 shows the schematic of the power electronics for the MF-WPT5/Z1 reference EVPC. This circuit consists of independent circuits of a circular coil or a DD coil, connected in parallel at each rectifier output to charge the battery.

Table B.7 and Table B.8 show the electrical specification of the MF-WPT5/Z1 reference EVPC.



1. Secondary coil (Circular coil)
2. Secondary coil (DD coil)
3. Capacitance for Circular coil compensation (Series tuning capacitance)
4. Capacitance for DD coil compensation (Series tuning capacitance)
5. Parallel capacitance (Parallel tuning capacitance, Cx)
6. Matching inductance (Tuning inductance, Lx)
7. Rectifier
8. Battery

Figure B.12 – Schematic of the EV power electronics for the MF-WPT5/Z1 reference EVPC

Table B.7 – Values of circuit elements

Battery voltage V DC	**Circular coil_cap., 3** nF	**DD coil_cap., 4** nF	**Parallel cap., 5** nF	**Matching_ind., 6** uH
300 to 750	90,08	110,59	330,98	5,30

Table B.8 – Secondary coil inductance and coupling factor

Air gap mm	**Circular Coil, 1** uH	**DD Coil, 2** uH	**Min. k**	**Max. k**	**Max. current**
<200	60,46	55,17	0,12	0,20	85

B.2.3 MF-WPT5/Z2 reference EVPC

B.2.3.1 General

The Z2 class reference EVPC covers the ground clearance range of 140 mm to 210 mm and can deliver full power at output voltages of 300 V DC to 750 V DC.

B.2.3.2 Mechanical specifications

Figure B.13 shows the general layout and Figure B.14 shows the mechanical dimensions of the MF-WPT5/Z2 reference secondary device.

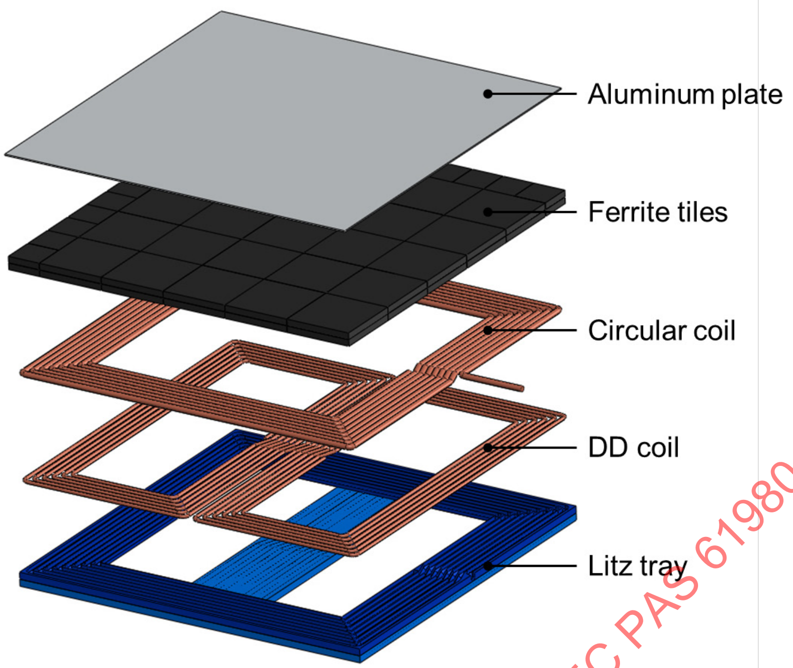


Figure B.13 – General layout of the MF-WPT5/Z2 reference secondary device

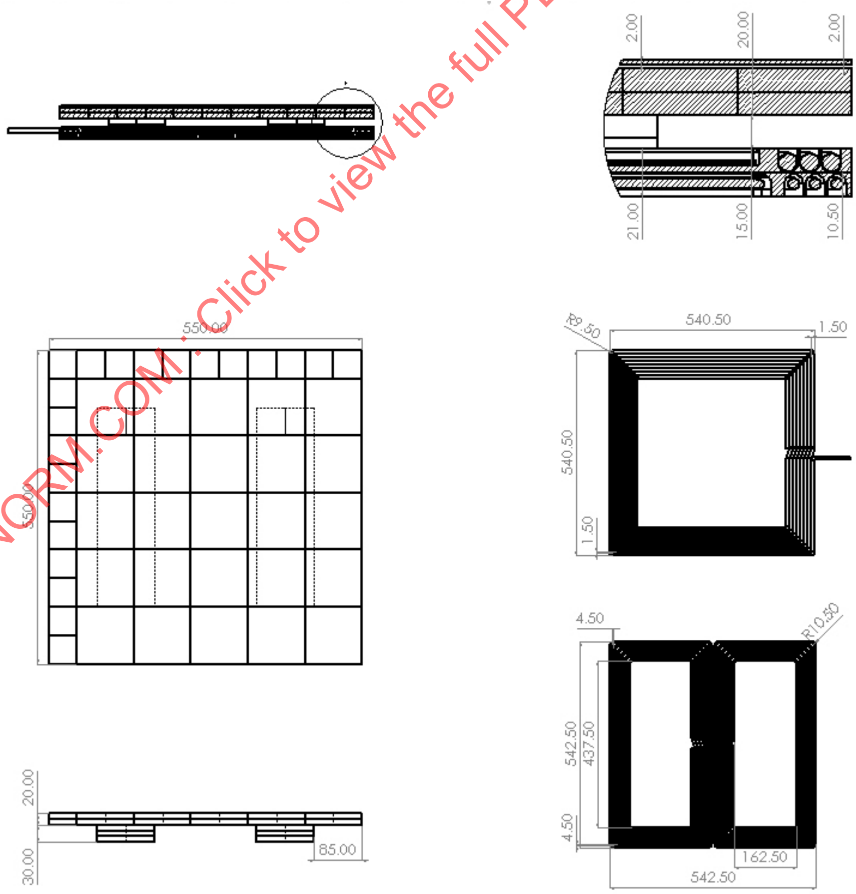
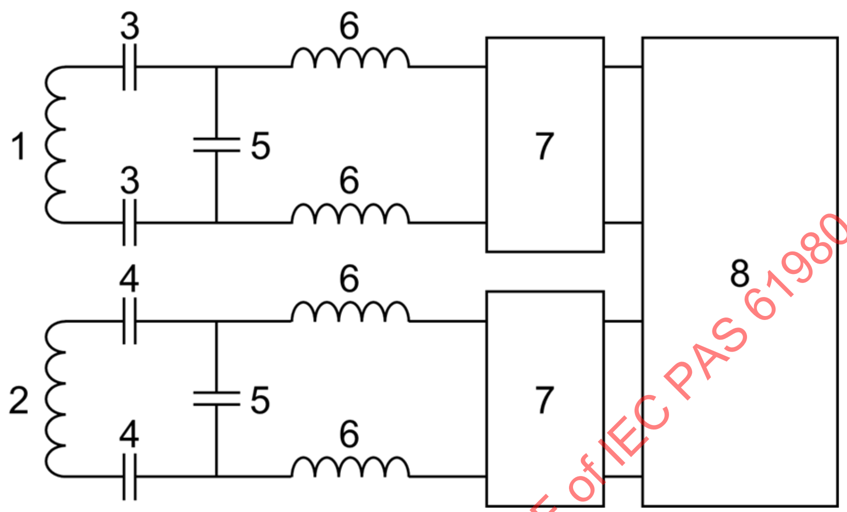


Figure B.14 – Mechanical dimensions of the MF-WPT5/Z2 reference secondary device

B.2.3.3 Electrical specifications

Figure B.15 shows the schematic of the power electronics for the MF-WPT5/Z2 reference EVPC. This circuit consists of independent circuits of a circular coil or a DD coil, connected in parallel at each rectifier output to charge the battery.

Table B.9 and Table B.10 show the electrical specification of the MF-WPT5/Z2 reference EVPC.



1. Secondary coil (Circular coil)
2. Secondary coil (DD coil)
3. Capacitance for Circular coil compensation (Series tuning capacitance)
4. Capacitance for DD coil compensation (Series tuning capacitance)
5. Parallel capacitance (Parallel tuning capacitance, Cx)
6. Matching inductance (Tuning inductance, Lx)
7. Rectifier
8. Battery

Figure B.15 – Schematic of the EV power electronics for the MF-WPT5/Z2 reference EVPC

Table B.9 – Values of circuit elements

Battery voltage V DC	Circular coil_cap., 3 nF	DD coil_cap., 4 nF	Parallel cap., 5 nF	Matching_ind., 6 uH
300 to 750	75,16	60,16	315,22	5,56

Table B.10 – Secondary coil inductance and coupling factor

Air gap mm	Circular coil, 1 uH	DD coil, 2 uH	Min. k	Max. k	Max. current
<260	85,72	83,39	0,11	0,17	85

B.2.4 MF-WPT5/Z3 reference EVPC

B.2.4.1 General

The Z3 class reference EVPC covers the ground clearance range of 170 mm to 250 mm and can deliver full power at output voltages of 300 V DC to 750 V DC.

B.2.4.2 Mechanical specifications

Figure B.16 shows the general layout and Figure B.17 shows the mechanical dimensions of the MF-WPT5/Z3 reference secondary device.

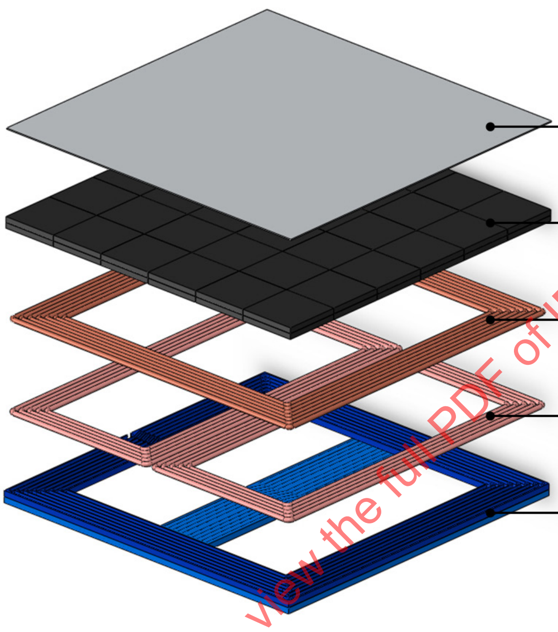


Figure B.16 – General layout of the MF-WPT5/Z3 reference secondary device

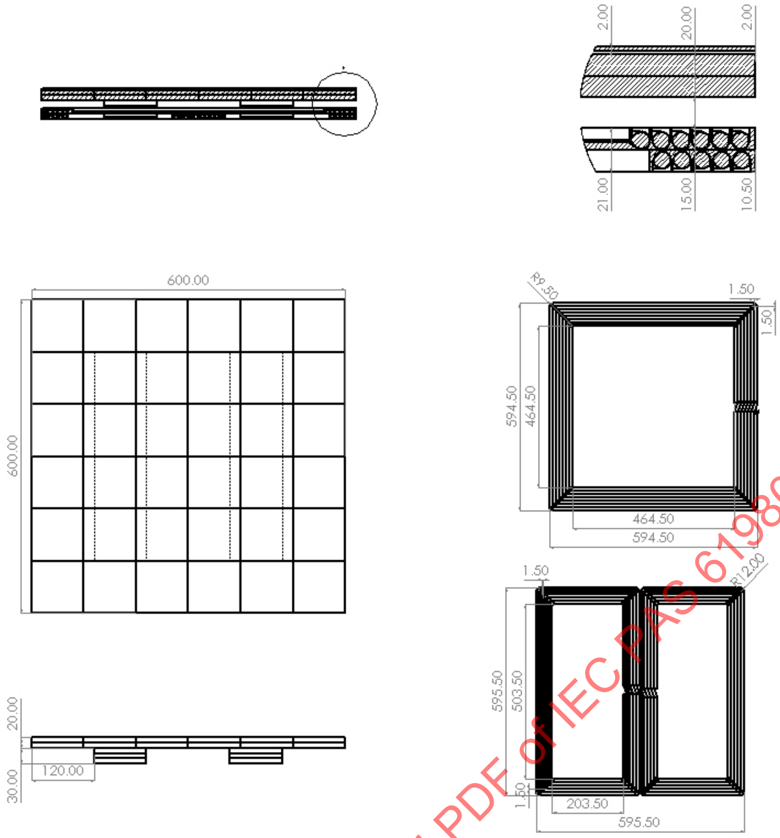
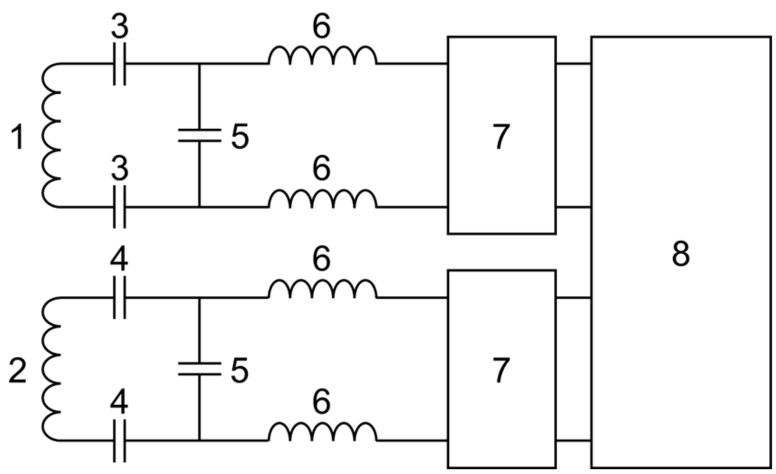


Figure B.17 – Mechanical dimensions of the MF-WPT5/Z3 reference secondary device

B.2.4.3 Electrical specifications

Figure B.18 shows the schematic of the power electronics for the MF-WPT5/Z2 reference EVPC. This circuit consists of independent circuits of a circular coil or a DD coil, connected in parallel at each rectifier output to charge the battery.

Table B.11 and Table B.12 show the electrical specification of the MF-WPT5/Z3 reference EVPC.



1. Secondary coil (Circular coil)
2. Secondary coil (DD coil)
3. Capacitance for Circular coil compensation (Series tuning capacitance)
4. Capacitance for DD coil compensation (Series tuning capacitance)
5. Parallel capacitance (Parallel tuning capacitance, Cx)
6. Matching inductance (Tuning inductance, Lx)
7. Rectifier
8. Battery

Figure B.18 – Schematic of the EV power electronics for the MF-WPT5/Z3 reference EVPC

Table B.11 – Values of circuit elements

Battery voltage V DC	Circular coil_cap., 3 nF	DD coil_cap., 4 nF	Parallel Cap., 5 nF	Matching_ind., 6 uH
300 to 750	63,93	48,40	346,74	5,06

Table B.12 – Secondary coil inductance and coupling factor

Air gap mm	Circular coil, 1 uh	DD coil, 2 uh	Min. k	Max. k	Max. current
<300	75,20	72,02	0,09	0,14	85

Annex C
(informative)

Multi-phase coil topology for DWPT power transfer

C.1 System description of the power transfer system

The dynamic wireless power transfer system as described in Clause C.1 is based on the principle of power transfer via alternating magnetic field. The system consists of several primary devices (transmitter coil segments) which are installed at the ground side and a vehicle side secondary receiver coil device. The primary coil devices of the segments are of similar type, the length of the primary segments is flexible. The minimum length consists of 2,5 pole pitches. The primary devices shall be in-ground mounted. Electric power of up to 50 kW can be transferred and therefore the system is designed for the light duty power class. Electric power of more than 50 kW is possible in heavy duty power class. Several primary coil sections form a track section. The track section length depends on the application. See Figure C.1.

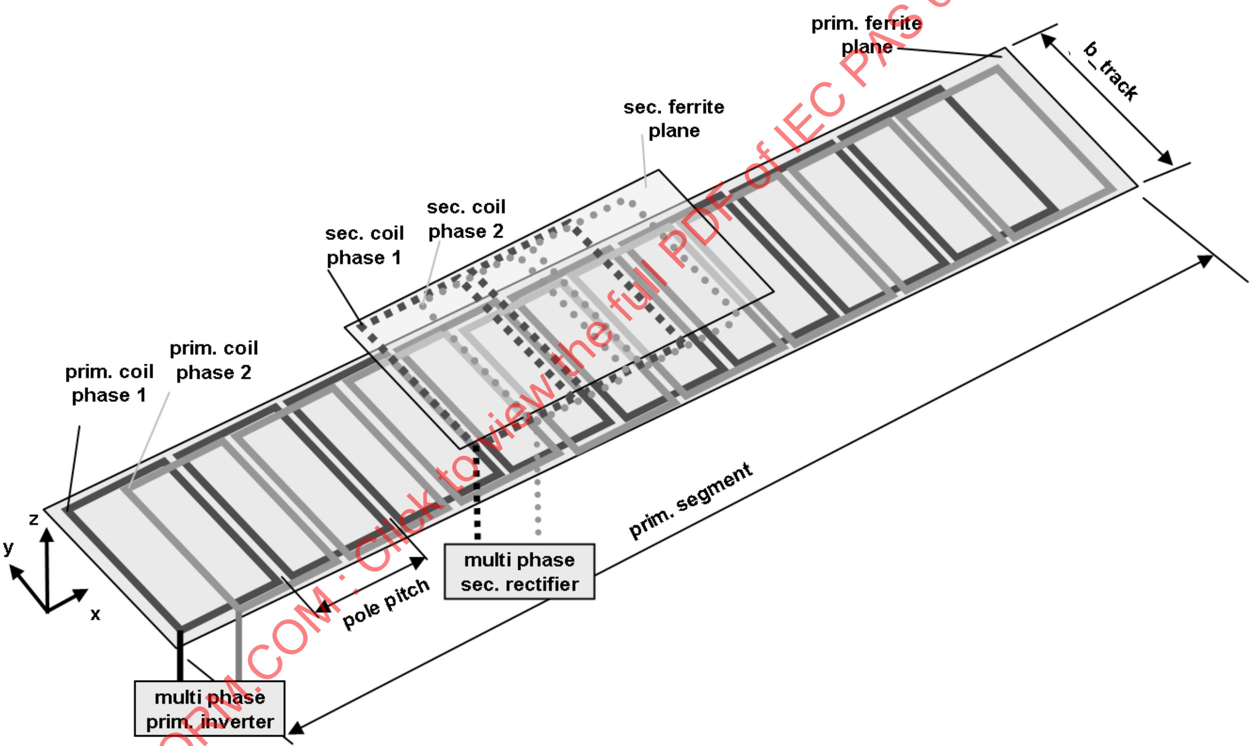


Figure C.1 – Mechanical arrangement of multi-phase coil topology DWPT power transfer

The primary coil segment consists of a road side transmitter coil segment for dynamic wireless power transfer in the light and heavy duty power class depending on the coil design. The primary device consists of a multi-phase coil system which generates an alternating magnetic field distribution which moves along the track in traveling direction X. The primary coil system might consist of a back side ferrite plate. See Figure C.2.

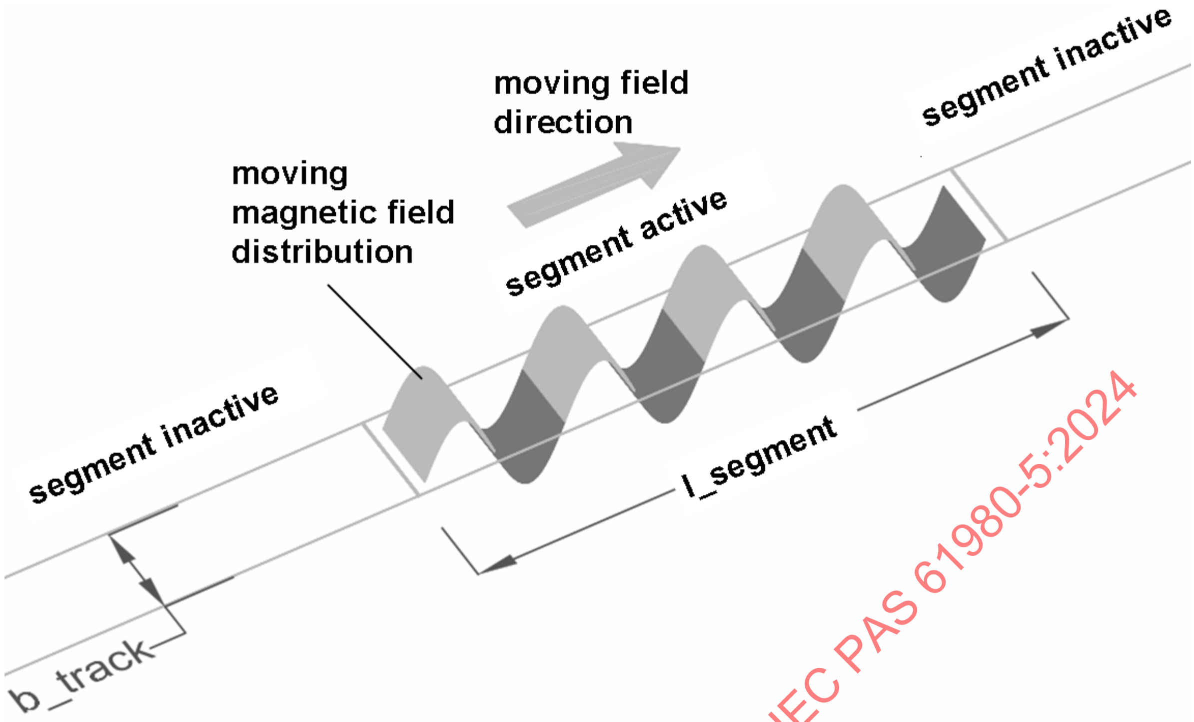


Figure C.2 – Magnetic field distribution of reference primary coil device

The moving speed of the alternating magnetic field distribution depends on the pole pitch and the AC-frequency. At pole pitch = 0,6 m and frequency f = 85 kHz, the moving speed is vx = 102,000 m/s. The secondary coil device might consist of a single phase topology or a multi-phase coil topology.

C.2 Primary device

C.2.1 Primary coil segment

The primary device supports Z-gaps from 100 mm to 300 mm. Similar coil segments, each consisting of several pole pitch pairs installed in one single line in driving direction (X) provide continuous power. Also, a single secondary coil device receives continuous power independent from the secondary coil position due to the moving primary field characteristic. Primary coil device individual multi-phase power inverters provide electric alternating current for coil magnetic field generation. The coil segments do not activate (section inactive) until the presence of the receiver coil of a vehicle is detected (section active). The inductance of each coil segment is to be compensated by a suitable compensation network (resonance at operating frequency).

A primary coil device consists of multiple phase coil sets each of identical coils – one after the other – which are of rectangular shape with no overlap. Each set of phase coils is shifted against the other set of phase coils in accordance to the number of phases (half pole pitch length in a 2-phse system) The coils are planar coils preferably placed on a plane of material with high permeability (e.g. ferrite). The magnetic field generated by the primary device is of longitudinal type (circle-coil topology).

Annex C does not give a predefinition of the resonance circuit of the primary device. The manufacturer of the primary device is free to choose whether the current source capacity is reached by passive resonance circuit means or active current control.