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Date: 16 May 2024

Origin: International

Latest date for receipt of comments: 26 June 2024

Project No. 2024/00873

Responsible committee: EPL/100 Audio-visual and Electronic equipment

Interested committees:

Title: BS EN IEC 63563-4 Qi Specification version 2.0

Part 4: Power Delivery (Fast track)

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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.

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Template for comments and secretariat observations

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



100/4125/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 63563-4 ED1

DATE OF CIRCULATION:

2024-05-03

CLOSING DATE FOR VOTING:

2024-07-26

SUPERSEDES DOCUMENTS:

IEC TA 15 : WIRELESS POWER TRANSFER	
SECRETARIAT: Korea, Republic of	SECRETARY: Mr Ockwoo Nam
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 106,TC 108	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	
☐ SUBMITTED FOR CENELEC PARALLEL VOTING	☒ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

Qi Specification version 2.0 - Part 4: Power Delivery (Fast track)

PROPOSED STABILITY DATE: 2029

NOTE FROM TC/SC OFFICERS:

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Qi Specification

Power Delivery

Version 2.0

April 2023

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RELEASE HISTORY

Specification Version	Release Date	Description
2.0	April 2023	Initial release of the v2.0 Qi Specification.

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1 General

The Wireless Power Consortium (WPC) is a worldwide organization that aims to develop and promote global standards for wireless power transfer in various application areas. A first application area comprises flat-surface devices such as mobile phones and chargers in the Baseline Power Profile (up to 5 W) and Extended Power Profile (above 5 W).

1.1 Structure of the Qi Specification

General documents

- Introduction
- Glossary, Acronyms, and Symbols

System description documents

- Mechanical, Thermal, and User Interface
- Power Delivery
- Communications Physical Layer
- Communications Protocol
- Foreign Object Detection
- NFC Tag Protection
- Authentication Protocol

Reference design documents

- Power Transmitter Reference Designs
- Power Receiver Design Examples

Compliance testing documents

- Power Transmitter Test Tools
- Power Receiver Test Tools
- Power Transmitter Compliance Tests
- Power Receiver Compliance Tests

NOTE: The compliance testing documents are restricted and require signing in to the WPC members' website. All other specification documents are available for download on both the WPC public website and the WPC website for members.

1.2 Scope

The *Qi Specification, Power Delivery* (this document) comprises guidelines and requirements for Power Receiver design, including circuitry, power consumption, operating power levels, power transfer efficiency, and standby power.

1.3 Compliance

All provisions in the *Qi Specification* are mandatory, unless specifically indicated as recommended, optional, note, example, or informative. Verbal expression of provisions in this Specification follow the rules provided in ISO/IEC Directives, Part 2.

Table 1: Verbal forms for expressions of provisions

Provision	Verbal form
requirement	“shall” or “shall not”
recommendation	“should” or “should not”
permission	“may” or “may not”
capability	“can” or “cannot”

1.4 References

For undated references, the most recently published document applies. The most recent WPC publications can be downloaded from <http://www.wirelesspowerconsortium.com>. In addition, the *Qi Specification* references documents listed below. Documents marked here with an asterisk (*) are restricted and require signing in to the WPC website for members.

- [Product Registration Procedure Web page](#)*
- [Qi Product Registration Manual, Logo Licensee/Manufacturer](#)*
- [Qi Product Registration Manual, Authorized Test Lab](#)*
- [Power Receiver Manufacturer Codes](#)*, Wireless Power Consortium
- [The International System of Units \(SI\)](#), Bureau International des Poids et Mesures
- [Verbal forms for expressions of provisions](#), International Electrotechnical Commission

For regulatory information about product safety, emissions, energy efficiency, and use of the frequency spectrum, visit [the regulatory environment](#) page of the WPC members' website.

1.5 Conventions

1.5.1 Notation of numbers

- Real numbers use the digits 0 to 9, a decimal point, and optionally an exponential part.
- Integer numbers in decimal notation use the digits 0 to 9.
- Integer numbers in hexadecimal notation use the hexadecimal digits 0 to 9 and A to F, and are prefixed by "0x" unless explicitly indicated otherwise.
- Single bit values use the words ZERO and ONE.

1.5.2 Tolerances

Unless indicated otherwise, all numeric values in the *Qi Specification* are exactly as specified and do not have any implied tolerance.

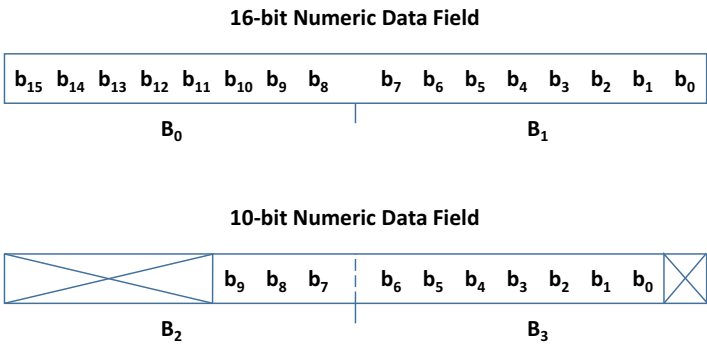
1.5.3 Fields in a data packet

A numeric value stored in a field of a data packet uses a big-endian format. Bits that are more significant are stored at a lower byte offset than bits that are less significant. [Table 2](#) and [Figure 1](#) provide examples of the interpretation of such fields.

Table 2: Example of fields in a data packet

	b ₇	b ₆	b ₅	b ₄	b ₃	b ₂	b ₁	b ₀
B ₀	(msb) 16-bit Numeric Data Field (lsb)							
B ₁								
B ₂	Other Field					(msb)		
B ₃	10-bit Numeric Data Field						(lsb)	Field

Figure 1. Examples of fields in a data packet



1.5.4 Notation of text strings

Text strings consist of a sequence of printable ASCII characters (i.e. in the range of 0x20 to 0x7E) enclosed in double quotes ("). Text strings are stored in fields of data structures with the first character of the string at the lowest byte offset, and are padded with ASCII NUL (0x00) characters to the end of the field where necessary.

EXAMPLE: The text string "WPC" is stored in a six-byte field as the sequence of characters 'W', 'P', 'C', NUL, NUL, and NUL. The text string "M:4D3A" is stored in a six-byte field as the sequence 'M', ':', '4', 'D', '3', and 'A'.

1.5.5 Short-hand notation for data packets

In many instances, the *Qi Specification* refers to a data packet using the following shorthand notation:

<MNEMONIC>/<modifier>

In this notation, <MNEMONIC> refers to the data packet's mnemonic defined in the *Qi Specification, Communications Protocol*, and <modifier> refers to a particular value in a field of the data packet. The definitions of the data packets in the *Qi Specification, Communications Protocol*, list the meanings of the modifiers.

For example, EPT/cc refers to an End Power Transfer data packet having its End Power Transfer code field set to 0x01.

1.6 Power Profiles

A Power Profile determines the level of compatibility between a Power Transmitter and a Power Receiver. [Table 3](#) defines the available Power Profiles.

- *BPP PTx*: A Baseline Power Profile Power Transmitter.
- *EPP5 PTx*: An Extended Power Profile Power Transmitter having a restricted power transfer capability, i.e. $P_L^{(pot)} = 5 \text{ W}$.
- *EPP PTx*: An Extended Power Profile Power Transmitter.
- *BPP PRx*: A Baseline Power Profile Power Receiver.
- *EPP PRx*: An Extended Power Profile Power Receiver.

Table 3: Capabilities included in a Power Profile

Feature	BPP PTx	EPP5 PTx	EPP PTx	BPP PRx	EPP PRx
Ax or Bx design	Yes	Yes	No	N/A	N/A
MP-Ax or MP-Bx design	No	No	Yes	N/A	N/A
Baseline Protocol	Yes	Yes	Yes	Yes	Yes
Extended Protocol	No	Yes	Yes	No	Yes
Authentication	N/A	Optional	Yes	N/A	Optional

2 Introduction

Figure 2 provides a simplified model of a wireless power system, consisting of six blocks. The three blocks to the left of the power transfer interface represent a Power Transmitter and its supply. The three to the right represent a Power Receiver and its Load. Typically, these blocks comprise the following elements.

Supply: in many cases a separate adapter such as a USB PD brick.

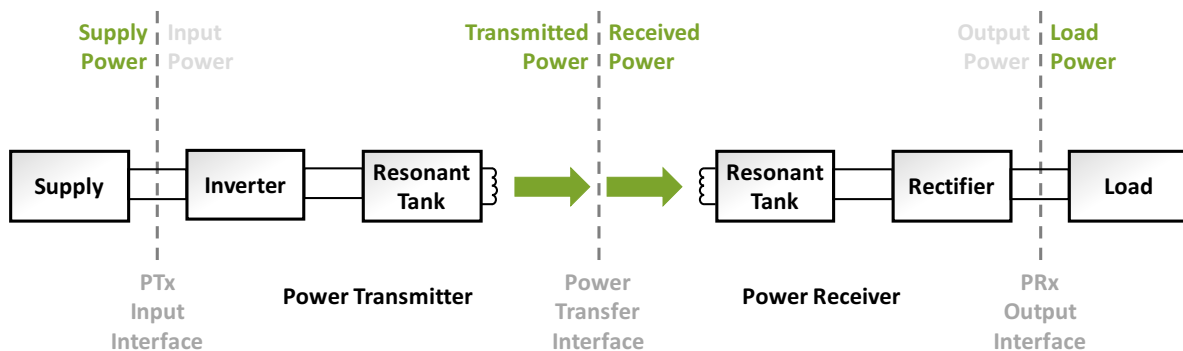
Inverter: a half-bridge or full-bridge for DC/AC conversion.

Resonant Tank: a coil and series capacitor boosting the power transfer capability.

Rectifier: either a diode bridge or an active (synchronous) bridge for AC/DC conversion.

Load: a power sink drawn by the Power Receiver Product, typically a mobile phone's power input to an internal battery charger.

Figure 2. Simplified model of a wireless power transfer system



With reference to Figure 2, the following definitions are central to the understanding of a wireless power system.

Power Signal—An alternating magnetic field.

Supply Power—The power dissipated from the supply.

Power Transmitter—A subsystem that can generate a Power Signal.

Power Transmitter Product—A device containing one or more Power Transmitters.

Transmitted Power—The power from the Power Signal dissipated by any object that is not an integral part of the Power Transmitter Product.

Power Receiver—A subsystem that can extract electric power from a Power Signal.

Power Receiver Product—A device containing a Power Receiver.

Received Power—The power from the Power Signal dissipated by any component that is an integral part of the Power Receiver Product.

Test Power Transmitter—A Power Transmitter Product designed to analyze and check the operation of a Power Receiver Product's wireless power functionality.

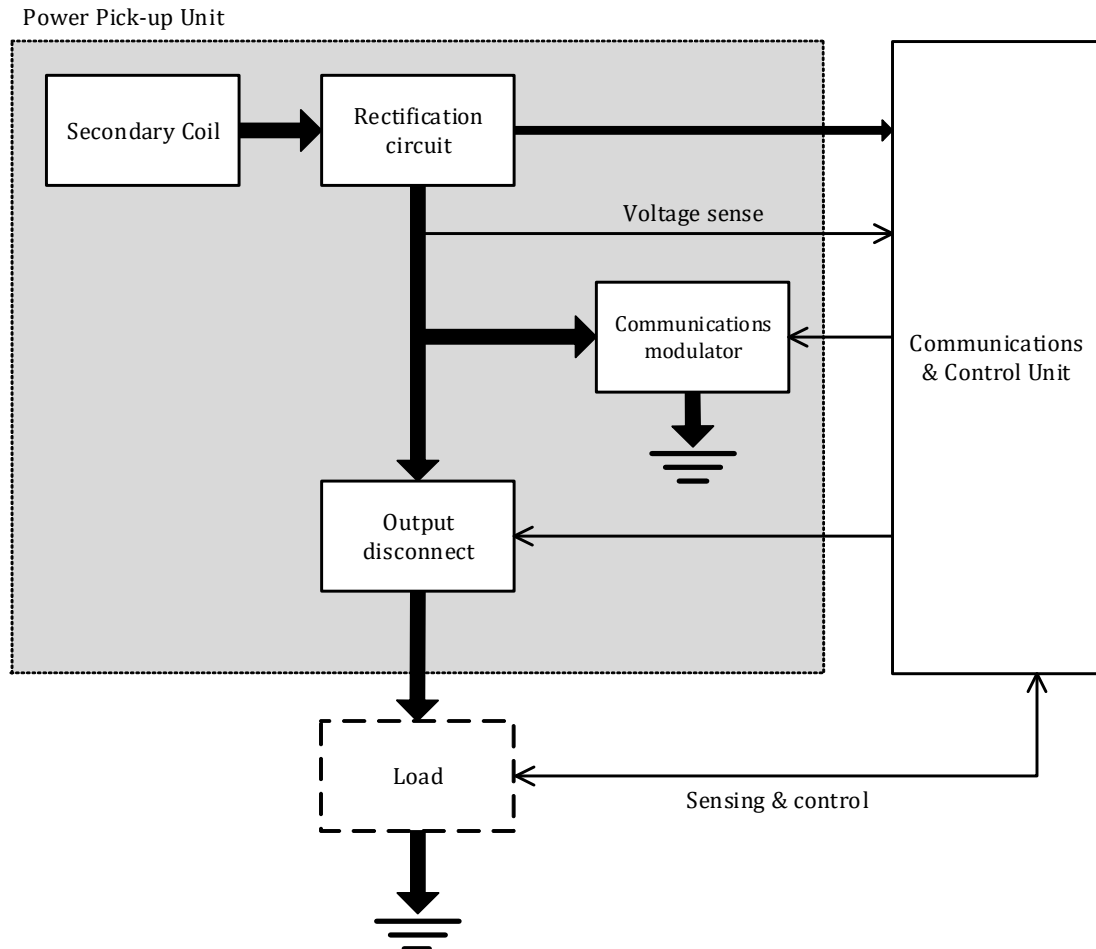
Test Power Receiver—A Power Receiver Product designed to analyze and check the operation of a Power Transmitter Product's wireless power functionality.

Load Power—The power dissipated in the Load.

3 Power Receiver construction

Figure 3 illustrates an example of a functional block diagram for a Baseline Power Profile Power Receiver.

Figure 3. Functional block diagram for a Baseline Power Profile Power Receiver



In this example, the Power Receiver consists of a Power Pick-up Unit and a Communications and Control Unit. The Power Pick-up Unit on the left-hand side of Figure 3 comprises the analog components of the Power Receiver:

- A dual resonant circuit consisting of a Secondary Coil plus series and parallel capacitances to enhance the power transfer efficiency and enable a resonant detection method (see Section 3.1, *Dual resonant circuit*).
- A rectification circuit that provides full-wave rectification of the AC waveform using, for example, four diodes in a full-bridge configuration or a suitable configuration of active components (see Section 3.2, *Rectification circuit*). The rectification circuit may perform output smoothing as well. In this example, the rectification circuit provides power to both the Communications and Control Unit of the Power Receiver and the output of the Power Receiver.

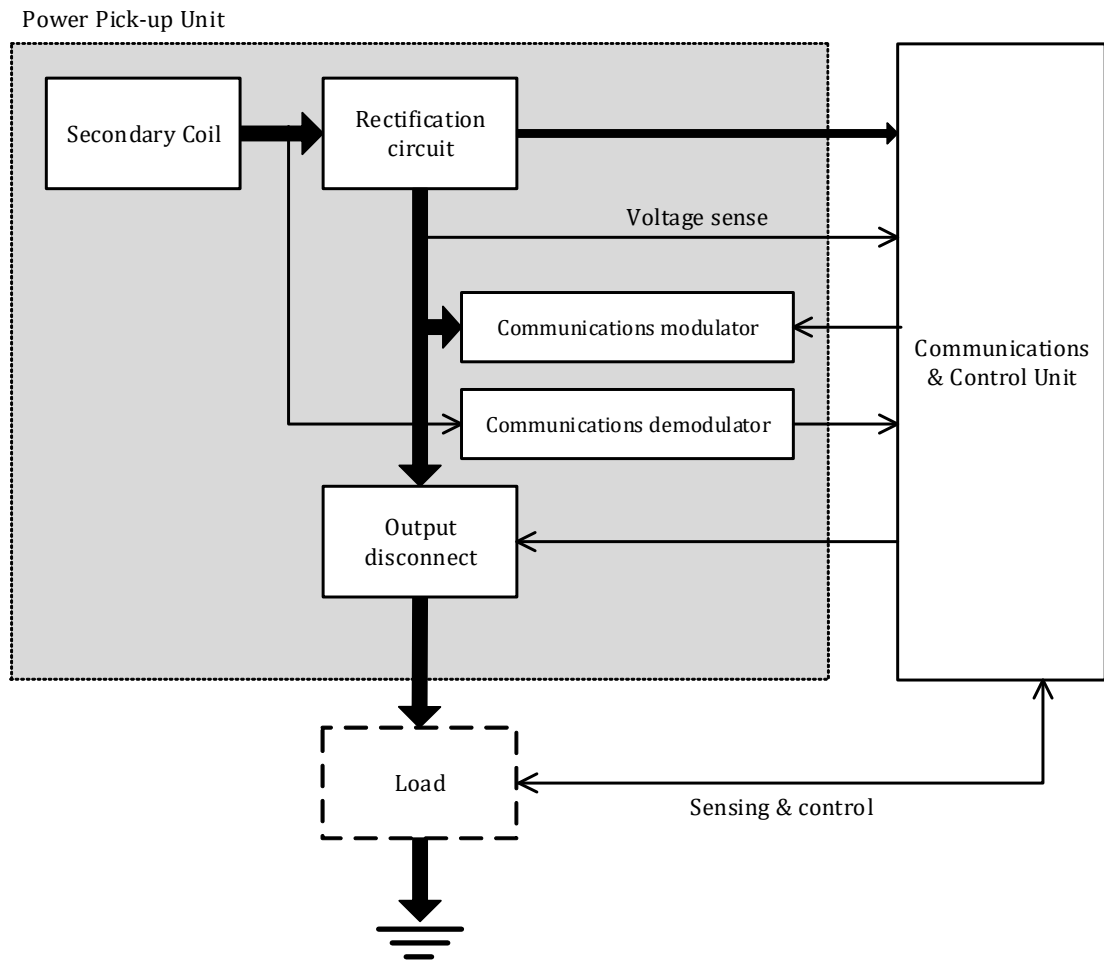
- A communications modulator (see [Section 3.4, Communications modulator](#)). On the DC side of the Power Receiver, the communications modulator typically consists of a resistor in series with a switch. On the AC side of the Power Receiver, the communications modulator typically consists of a capacitor in series with a switch (not shown in [Figure 3](#)).
- An output disconnect switch, which prevents current from flowing to the output when the Power Receiver does not provide power at its output. In addition, the output disconnect switch prevents current back flow into the Power Receiver when the Power Receiver does not provide power at its output. Moreover, the output disconnect switch minimizes the power that the Power Receiver draws from the Power Transmitter when a Power Signal is first applied to the Secondary Coil.
- A rectified voltage sense.

The Communications and Control Unit on the right-hand side of [Figure 3](#) comprises the digital logic part of the Power Receiver. This unit executes the relevant power control algorithms and protocols, drives the communications modulator, controls the output disconnect switch, and monitors several sensing circuits in both the Power Pick-up Unit and the load. (A good example of a sensing circuit in the load is a circuit that measures the temperature of a rechargeable battery.)

NOTE: This version of the Specification minimizes the set of Power Receiver design requirements defined in this section. Accordingly, compliant Power Receiver designs that differ from the sample functional block diagram shown in [Figure 3](#) are possible. For example, an alternative design includes post-regulation of the output of the rectification circuit (e.g., by using a buck converter, battery charging circuit, power management unit, etc.). In yet another design, the Communications and Control Unit interfaces with other subsystems of the Power Receiver Product, e.g. for user interface purposes.

[Figure 4](#) illustrates an example of a functional block diagram for an Extended Power Profile Power Receiver. The communications demodulator enables the communication of data from the Power Transmitter to an Extended Power Profile Power Receiver. The presence of a communications demodulator is the only difference with the functional block diagram of a Baseline Power Profile Power Receiver.

Figure 4. Functional block diagram for an Extended Power Profile Power Receiver



Power Pick-up Unit components are described in the subsections below.

A Power Receiver design shall include a dual resonant circuit as defined in [Section 3.1, Dual resonant circuit](#), a rectification circuit as defined in [Section 3.2, Rectification circuit](#), sensing circuits as defined in [Section 3.3, Sensing circuits](#), a communications modulator as defined in [Section 3.4, Communications modulator](#), and an output disconnect switch as defined in [Section 3.6, Output disconnect](#).

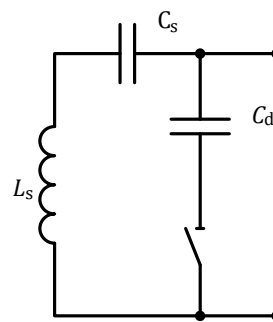
A Power Receiver design for the Extended Power Profile shall also include a communications demodulator as defined in [Section 3.5, Communications demodulator](#), and shall be able to function meaningfully if the Power Transmitter restrictions limit the output of power from the Power Receiver to 5 W; see [Section 3.7, Shielding](#).

3.1 Dual resonant circuit

The dual resonant circuit of the Power Receiver comprises the Secondary Coil and two resonant capacitances. The purpose of the first resonant capacitance C_s is to enhance the power transfer efficiency. The purpose of the second resonant capacitance C_d is to enable a resonant detection of the receiver position on some Power Transmitter designs.

Figure 5 illustrates the dual resonant circuit. The switch in the dual resonant circuit is optional. If the switch is not present, the capacitance C_d shall have a fixed connection to the Secondary Coil L_s . If the switch is present, it shall remain closed¹ until the Power Receiver transmits its first Packet (see the *Qi Specification, Communications Protocol*).

Figure 5. Dual resonant circuit of a Power Receiver



The dual resonant circuit shall have the following resonant frequencies:

$$f'_s = \frac{1}{2\pi \cdot \sqrt{L'_s \cdot C_s}} = 100^{+x}_{-y} \text{ kHz},$$

$$f_d = \frac{1}{2\pi \cdot \sqrt{L_s \cdot \left(\frac{1}{C_s} + \frac{1}{C_d}\right)^{-1}}} = (1000 \pm 10\%) \text{ kHz}.$$

In these equations, L'_s is the self-inductance of the Secondary Coil when placed on the Interface Surface of a Power Transmitter and—if necessary—aligned to the Primary Cell; and L_s is the self-inductance of the Secondary Coil without magnetically active material that is not part of the Power Receiver design close to the Secondary Coil (e.g. away from the Interface Surface of a Power Transmitter). Moreover, the tolerances x and y on the resonant frequency f'_s are $x = y = 5\%$ for Power Receivers that specify a Maximum Power value in the Configuration Packet of 3 W and above, and $x = 5\%$ and $y = 10\%$ for all other Power Receivers.

NOTE: When determining the capacitance value C_d , make sure to account for any parasitic capacitances between the terminals of the dual resonant circuit that may affect the resonance frequency value f_d .

¹ The switch shall remain closed even if no power is available from the Secondary Coil.