



IEC 63563-10

Edition 1.0 2025-02

INTERNATIONAL STANDARD

**Qi Specification version 2.0 –
Part 10: MPP System Specification**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240.99; 35.240.99

ISBN 978-2-8327-0183-6

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION

QI SPECIFICATION VERSION 2.0 –
Part 10: MPP System Specification**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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 63563-10 has been prepared by technical area 15: Wireless Power Transfer, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

It is based on *Qi Specification version 2.0, MPP System Specification* and was submitted as a Fast-Track document.

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

Draft	Report on voting
100/4254/FDIS	100/4275/RVD

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 International Standard is English.

The structure and editorial rules used in this publication reflect the practice of the organization which submitted it.

This document was 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.

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.



Qi Specification

MPP System Specification

Version 2.0

April 2023

DISCLAIMER

The information contained herein is believed to be accurate as of the date of publication, but is provided “as is” and may contain errors. The Wireless Power Consortium makes no warranty, express or implied, with respect to this document and its contents, including any warranty of title, ownership, merchantability, or fitness for a particular use or purpose. Neither the Wireless Power Consortium, nor any member of the Wireless Power Consortium will be liable for errors in this document or for any damages, including indirect or consequential, from use of or reliance on the accuracy of this document. For any further explanation of the contents of this document, or in case of any perceived inconsistency or ambiguity of interpretation, contact: info@wirelesspowerconsortium.com.

RELEASE HISTORY

Specification Version	Release Date	Description
2.0	April 2023	First release of this v2.0 specification.

Table of Contents

Table of Contents.....	2
List of Figures	6
List of Tables	9
1 General Description.....	10
1.1 Introduction	10
1.1.1 Scope.....	10
1.1.2 Document organization	10
1.1.3 Design goals.....	10
1.1.4 BPP and MPP interoperability	12
1.1.5 Related documents	12
1.2 Architectural overview.....	13
1.2.1 System Description	13
1.2.2 System block diagrams	14
1.3 Glossary	16
1.3.1 Definitions.....	16
1.3.2 Acronyms.....	17
1.3.3 Symbols	17
1.4 System Model vs Spec.....	18
2 Authentication Protocol.....	19
2.1 Authentication.....	19
3 Coil Design	20
3.1 Introduction and Background	20
3.2 PTx Coil System Model.....	20
3.2.1 Mechanical Construction	20
3.2.2 Electrical Properties	31
3.3 PRx Coil System Model.....	33
3.3.1 Mechanical Construction	33
3.3.2 Electrical Properties	42

3.4	Properties of Mated Coil System Models	43
3.4.1	Electrical measurement under mated conditions	43
3.5	Coil Specifications.....	44
3.5.1	PRx Coil Specifications	44
3.5.2	PTx Coil Specifications.....	50
4	Power Delivery	57
4.1	Power Profiles (BPP + MPP)	57
4.1.1	Specifications	57
4.1.2	Recommendations	57
4.1.3	Specification Notes	57
4.2	Power Receiver Functional Block Diagram	58
4.2.1	System Model	58
4.3	Power Transmitter Functional Block Diagram	65
4.3.1	System Model	65
4.4	Operating Frequency	68
4.4.1	System Model	68
4.4.2	Specifications	68
4.5	Object Detection	68
4.5.1	System Model	68
4.5.2	Specifications	69
4.6	Digital Pings 128kHz/360kHz	69
4.6.1	Need For Digital Pings 128kHz / 360kHz.....	69
4.6.2	Specifications	76
4.7	K Estimation	78
4.7.1	System Model	78
4.7.2	Specifications	82
4.8	Output Impedance and Load Transients	83
4.8.1	System Model	83
4.9	Set Pr_max	86
4.9.1	Background	86
4.9.2	System Model	86
4.9.3	PTx Specifications	92
4.9.4	PTx Specification Notes.....	92
4.10	Power Transfer Control.....	92
4.10.1	Intro and Background (Informative)	92

4.10.2	System Model	92
4.10.3	End-to-End Control Specifications	98
4.11	Mitigation of Side Effects of Cd at MPP Frequency	101
4.11.1	System Model	101
4.11.2	Specifications	104
4.12	Cloak.....	104
4.13	Common-mode Noise	104
5	Communications Physical Layer	105
5.1	Introduction	105
5.2	Frequency Shift Keying (PTx to PRx)	105
5.2.1	System Model	106
5.2.2	Frequency Shift Keying Specifications	108
5.3	Amplitude Shift Keying (PRx to PTx)	109
5.3.1	Modulation Scheme	109
5.3.2	System Model	110
5.3.3	ASK Specifications	115
6	Foreign Object Detection	117
6.1	Background	117
6.2	Open-air Q-Test (pre-power transfer FOD method).....	117
6.2.1	Introduction.....	117
6.2.2	Movement Timer.....	120
6.2.3	Settling Timer	120
6.2.4	Glossary	120
6.2.5	Open-air Q-Test Specifications.....	120
6.2.6	Theory of Operation.....	121
6.2.7	PRx movement and digital ping.....	125
6.3	MPP Power Loss Accounting (in-power transfer FOD method)	126
6.3.1	Introduction.....	126
6.3.2	MPLA Specifications.....	127
6.3.3	MPLA Equations.....	130
6.3.4	Eco-System Scaling	131
6.3.5	Process of Extracting LQK-Dependent Coefficients.....	133
6.3.6	FO power estimation error outside 2x2 cylinder	134
6.3.7	FO Detection Thresholds	135
6.3.8	In-Power FOD Action.....	138

6.3.9	Accessory Power Loss Requirements	140
6.3.10	Error Budget	140
6.3.11	Measuring coil current	147
7	Annex	149
7.1	PTx Working with Legacy PRx.....	149
7.1.1	Background.....	149
7.2	Mitigation of Saturation for BPP	149
7.2.1	System Model	149
7.2.2	SHO Specifications.....	153
7.3	Loss-Split Modeling: A framework for calculating localized eddy-current losses	153
7.3.1	Introduction.....	153
7.3.2	Comparison between the standard T-Model and Loss-Split Model	155
7.3.3	Determining the Loss-Split Model Parameters	156
7.3.4	Calculating Power Loss using Loss-Split Model	157
7.3.5	Loss-Split Model Validation	158
7.4	Resistive Coupling Factor	158
7.4.1	Introduction.....	158
7.4.2	Definition of Mutual Resistance and K_r	158
7.4.3	Cause of Mutual Resistance	159
7.4.4	Why is K_r non-negligible.....	161

List of Figures

Figure 2.1.3 : 1 Multipole magnet design that tightly couples strong permanent magnetic fields within the region of the magnet array	11
Figure 2.1.3 : 2 Accurate magnetic alignment within a 2mm radius (without case and with silicone case)	11
Figure 2.2.2 : 3 System block diagram	15
Figure 2.2.2 : 4 MPP PTx functional diagram	15
Figure 2.2.2 : 5 MPP accessory functional diagram (e.g., PRx case, wallet, automotive dash-mount)	15
Figure 2.2.2 : 6 MPP PRx functional diagram	16
Figure 4.2.1.1 : 7 Exploded view of PTx coil system model	20
Figure 4.2.1.3 : 8 Exploded view of the Coil Module for the PTx Coil System Model	21
Figure 4.2.1.3 : 9 Side view of PTx Coil Module	22
Figure 4.2.1.3 : 10 Top view of PTx ferrite	22
Figure 4.2.1.4 : 11 Magnet Array top view	24
Figure 4.2.1.5 : 12 Magnet assembly (Cross-section)	26
Figure 4.2.1.6 : 13 Side view of Bottom Enclosure	27
Figure 4.2.1.8 : 14 Side view of PTx coil system model assembly	29
Figure 4.2.1.9.1 : 15 Transmitter orientation magnets (Top View)	30
Figure 4.2.1.9.1 : 16 Transmitter Orientation Magnet Dimensions and Polarity	31
Figure 4.3.1.1 : 17 Exploded view of PRx coil system model	34
Figure 4.3.1.4 : 18 Exploded view of the coil module for the PRx coil system model	35
Figure 4.3.1.4 : 19 Cross-section of the coil module for the PRx coil system model	36
Figure 4.3.1.4 : 20 Cross-sectional view of coil for the PRx coil system model	36
Figure 4.3.1.4 : 21 Top view of PRx coil system model	37
Figure 4.3.1.5 : 22 Magnet of the PRx coil system model (top view)	40
Figure 4.3.1.5 : 23 Magnet of the PRx coil system model (side view)	40
Figure 4.3.1.5 : 24 Magnetic field of the PRx coil system model	41
Figure 4.3.1.5 : 25 Orientation magnet of the PRx coil system model (side view)	41
Figure 4.3.1.7 : 26 Cross-sectional view showing assembly of PRx coil system model	41
Figure 5.1.3.1 : 27 MPP minimum power delivery requirement shall be $P_I \geq 15W$ for $0mm \leq z \leq 2mm$, $0mm \leq r \leq 2mm$	57
Figure 5.1.3.1 : 28 An MPP PTx shall be able to deliver $P_I \geq 5W$ to an BPP system model PRx for $0mm \leq z \leq 3mm$, $0mm \leq r \leq 8mm$	58
Figure 5.1.3.1 : 29 Cross section view of the system model indicating the "z" gap	58
Figure 5.2.1.1 : 30 System model PRx circuit topology (with BPP and MPP compatibility)	59
Figure 5.2.1.3.1 : 31 Cantilever Equivalent Circuit	60
Figure 5.2.1.3.2.1 : 32 Efficiency vs Crx: sweep of Crx at the maximum coupling position in the system model shows that efficiency is low when $C_{rx} < 300nF$ (system is capacitive)	62
Figure 5.2.1.3.2.1 : 33 Bode plot of $Z_{in}(s)$ at maximum coupling location with two different Crx values. With $C_{rx}=60nF$, the system impedance is capacitive, which is undesirable.	63

Figure 5.2.1.3.2.1 : 34 Bode plot of $G(s)$ at maximum coupling location with two different C_{rx} values. $C_{rx}=710\text{nF}$ has ~1.4dB higher gain than $C_{rx}=60\text{nF}$	63
Figure 5.2.1.5 : 35 System model PRx Vrect/Irect profile	65
Figure 5.3.1 : 36 PTx power stage block diagram	66
Figure 5.3.1.1 : 37 Definition of inverter phase θ	66
Figure 5.6.1 : 38 MPP Power Negotiation Flow	70
Figure 5.6.1 : 39 Top-level diagram	72
Figure 5.6.1 : 40 Digital Ping Flowchart	73
Figure 5.6.1 : 41 Identification 128kHz Flowchart	74
Figure 5.6.1 : 42 Identification 360kHz Flowchart	75
Figure 5.6.1 : 43 Configuration Flowchart	76
Figure 5.7.1.2.1 : 44 E0 and E1 Fit Example	80
Figure 5.7.1.2.1 : 45 Kest E0 and E1 Extraction Flow	80
Figure 5.7.1.4 : 46 Example PTx/PRx Kest Error Stack-up	82
Figure 5.8.1.1 : 47 Typical Output Impedance Plot (Vrect vs Irect)	84
Figure 5.8.1.2.1 : 48 Vrect timing diagram during load step procedure in the system model	85
Figure 5.8.1.2.2 : 49 Vrect timing diagram during load dump procedure in the system model	85
Figure 5.9.2.3.1 : 50 Set Pr_max Overall Flow	88
Figure 5.9.2.3.1 : 51 Example Time Sequence	89
Figure 5.9.2.3.2 : 52 Gain Measurement Flow	90
Figure 5.9.2.3.3 : 53 Set initial Vrect_target and Pr_max based on $G1*G2$	91
Figure 5.9.2.3.3 : 54 Pr_max vs $G1*G2$	91
Figure 5.10.2.2.1 : 55 Tx Voltage Control Flow Chart	95
Figure 5.10.2.3.3 : 56 Ilim control diagram	97
Figure 5.11.1.0.1 : 57 Vrect vs inverter phase at light load	101
Figure 5.11.1.0.1 : 58 Output impedance with 50 and 120 degrees inverter phase	102
Figure 5.11.1.0.2 : 59 Gain (Vrect/Vin) with and without Cd	102
Figure 5.11.1.0.2 : 60 Load release from 7W to 0W, with and without Cd, and with mitigations implemented in the system model	103
Figure 5.11.1.0.3 : 61 ZVS state with and without Cd, and with mitigations implemented in the system model	103
Figure 6.1 : 62 MPP Comms Physical System Model	105
Figure 6.2.1.1 : 63 System Model for FSK Transmitter	106
Figure 6.2.1.2 : 64 System Model for FSK Receiver	107
Figure 6.2.1.2 : 65 Sample Waveform: Digital Ping 360 kHz AC2 node voltage	108
Figure 6.3.1 : 66 (a) Primary Resonant Capacitor Amplitude and (b) Primary Resonant Capacitor Phase Shift	110
Figure 6.3.2.1 : 67 System Model for ASK Modulator at 128 kHz	111
Figure 6.3.2.1 : 68 System Model for ASK Modulator at 360 kHz	112
Figure 6.3.2.1 : 69 Representative Waveforms for ASK Modulator at 360 kHz	112
Figure 6.3.2.2 : 70 System Model for ASK Receiver	113
Figure 6.3.2.3 : 71 ASK Modulation Trends for (a) DC Load Current and (b) Capacitor Modulation	114

Figure 7.2.1 : 72 Detection Capability V.S. Thermal Requirements 118

Figure 7.2.1 : 73 Simplified flow diagram for open-air Q test 119

Figure 7.2.6.1 : 74 Implementation of how to measure ring response 121

Figure 7.2.6.1.0.1 : 75 bias ping configuration 122

Figure 7.2.6.4.2 : 76 PRx replaced before the movement timer expires to prevent false fo flag 124

Figure 7.2.7 : 77 Example of q-deflection profile when Prx is approaching ptx 126

Figure 7.3.4.2 : 78 Eco-System Scaling Diagram 133

Figure 7.3.5 : 79 Linear fit error for coil and friendly metal losses. The resistances Rtx and Rx represent the free-air coil resistances at the switching frequency. 134

Figure 7.3.6 : 80 MPLA estimation error for P_FO grows monotonically away from origin. 135

Figure 7.3.7.2 : 81 15W PFO error distribution with and without FO at 85° critical heating radius (scenario 2: Q-test does detect no FO) 137

Figure 7.3.7.2 : 82 10W PFO error distribution with and without FO at 70° critical heating radius (scenario 1: Q-test detects FO) 137

Figure 7.3.8.1 : 83 Recommended flowchart for PTx FOD action. 139

Figure 7.3.10.3 : 84 PRx Compliance Test pFO Distribution 145

Figure 7.3.10.5 : 85 Compliance Test Ppr shift explanation for Scenario 2 (15W) 147

Figure 8.2.1.1 : 86 Comparison of PTx current with and without SHO 150

Figure 8.2.1.2 : 87 System Model SHO detection flowchart 151

Figure 8.2.1.3 : 88 System Model SHO mitigation flowchart 152

Figure 8.3.1 : 89 Simulation based power accounting flow 154

Figure 8.3.1 : 90 Loss-Split Power Accounting Flow 154

Figure 8.3.2 : 91 Standard T-Model 155

Figure 8.3.2 : 92 Loss-Split T-Model 155

Figure 8.4.2 : 93 Mutual Resistance Model at a Single Frequency 159

Figure 8.4.3.2 : 94 Non-linear B-H curve introduces phase offset between PTx current and the integral of PRx induced voltage, where the out-of-phase component is captured by mutual resistance 161

Figure 8.4.4 : 95 Example values of Kr measured with a mated MPP PTx/PRx coil sample 162

List of Tables

Table 4.2.1.3 : 1 Mechanical dimensions for the coil module of the PTx coil system model	23
Table 4.2.1.5 : 2 Magnetic field specifications for magnet array	26
Table 4.2.1.7 : 3 Mechanical dimensions for the bottom enclosure of the PTx coil system model	28
Table 4.2.1.8 : 4 Assembly dimensions of PTx coil system model	29
Table 4.2.1.9.1 : 5 Flux density at 0.85mm from PTx orientation magnet surface	31
Table 4.2.2.1 : 6 Electrical Parameters of the PTx Coil System Model in Free-Air	32
Table 4.3.1.4 : 7 Assembly specifications of coil module for the PRx coil system model	36
Table 4.3.1.4 : 8 Mechanical specifications of the PRx coil system model	38
Table 4.3.1.5 : 9 Magnet properties of the PRx coil system model	39
Table 4.3.1.7 : 10 Assembly specifications for the PRx coil system model	42
Table 4.3.1.7 : 11 Mechanical dimensions of support plate	42
Table 4.3.2.1 : 12 Electrical Parameters of the PRx Coil System Model in Free-Air	42
Table 4.4.1 : 13 Mated electrical parameters (Test case: $r=0, z=0$ mm)	43
Table 4.4.1 : 14 Mated electrical parameters (Test case: $r=2, z=2$ mm)	43
Table 5.2.1.1 : 15 PRx series tuning configuration	59
Table 5.2.1.4 : 16 PRx electrical properties (system model)	64
Table 5.3.1.2 : 17 PTx power stage capacitor switches configuration	67
Table 5.3.1.3 : 18 PTx electrical properties (system model), during power transfer	67
Table 6.3.2.1 : 19 Selection of MOD_BASE	111
Table 7.2.4 : 20 Glossary	120
Table 7.3.2.3 : 21 Eco-System Parameter Representation	130
Table 7.3.4.1 : 22 Eco-System scaling terms exchanged between PTx and PRx at startup	131
Table 7.3.7.1 : 23 MPLA Scenarios	136
Table 7.3.10.2 : 24 Measurement Error Calculation for Scenario 1 (10W) and Scenario 2 (15W)	143
Table 7.3.10.3 : 25 pFO Error Budget Calculation	144

1 General Description

1.1 Introduction

1.1.1 Scope

This specification defines MPP (Magnetic Power Profile), an extension to Qi v1.3 BPP (Baseline Power Profile). Manufacturers can use this specification to implement PTx and/or PRx that are interoperable.

1.1.2 Document organization

The MPP (Magnetic Power Profile) Specification is organized as these documents:

1. MPP System Specification (this document)
2. MPP Communications Protocol Specification

MPP is an extension of the Baseline Power Profile (BPP) and utilizes some (but not all) features defined in the Extended Power Profile (EPP). Where relevant, refer to the Qi v2.0 Specification.

1.1.3 Design goals

Magnetic Power Profile (MPP) is an interface which allows for:

- Never missing the sweet spot - ease of attach through ring of magnets
- Ecosystem of powered and unpowered accessories
- Conveniently using your device while charging
- Delivering high power (15W) safely
- Preventing interference with vehicle key fobs without regulatory issues by operating at 360 kHz
- Compatibility with Qi 2.0 BPP products and maintaining near-parity backward compatibility with Qi 1.x BPP products

Sweet spot

The goal for MPP is to enable a new wireless charging experience for users where they will never miss the charging "sweet spot" and can consistently, efficiently, and safely charge their devices at high power. To achieve accurate alignment between the PTx and PRx coils, a circular array of magnets has been added that surround the coils. The magnetic alignment provides tactile feedback to the user guiding accurate placement even in the case where the user isn't directly looking at the PTx. Conveniently, the magnetic attachment enables users to use their device while it is charging and greatly simplifies docking functionality.

Magnet array

The magnet array has been carefully designed so that it can coexist with the wireless power transfer system to deliver high power transfer at high efficiency. Figure 2.1.3: 1 shows the multipole magnet design that tightly couples strong permanent magnetic fields within the region of the magnet array, keeping most of the strong fields away from the magnetic shielding material of the power transfer coils.

Because of the consistent accurate alignment, the magnetic state-space that the system must be designed to work across is reduced. Figure 2.1.3: 2 shows data from a study where 99.9% of placements aligned the PTx and PRx within a 2mm radius¹. By reducing the state-space, the design of features like foreign object detection is simplified.

¹ The placement study used a case with integrated magnets as shown in Figure 2.1.3: **Error! Main Document Only.**

Benefits

The benefits of MPP also extend further than just wireless charging: it enables an ecosystem of powered and unpowered accessories. Because of the convenience of magnetic attach, it is expected that a new category of portable charging products will arise, and with this in mind, MPP has been designed to ensure that charging at 360 kHz will not cause interference with vehicle key fobs. All these benefits and experiences have been enabled in MPP while also being compatible with Qi 2.0 BPP and having nearly 100% backwards compatibility with Qi 1.x BPP.

Figure 2.1.3: 1 Multipole magnet design that tightly couples strong permanent magnetic fields within the region of the magnet array .

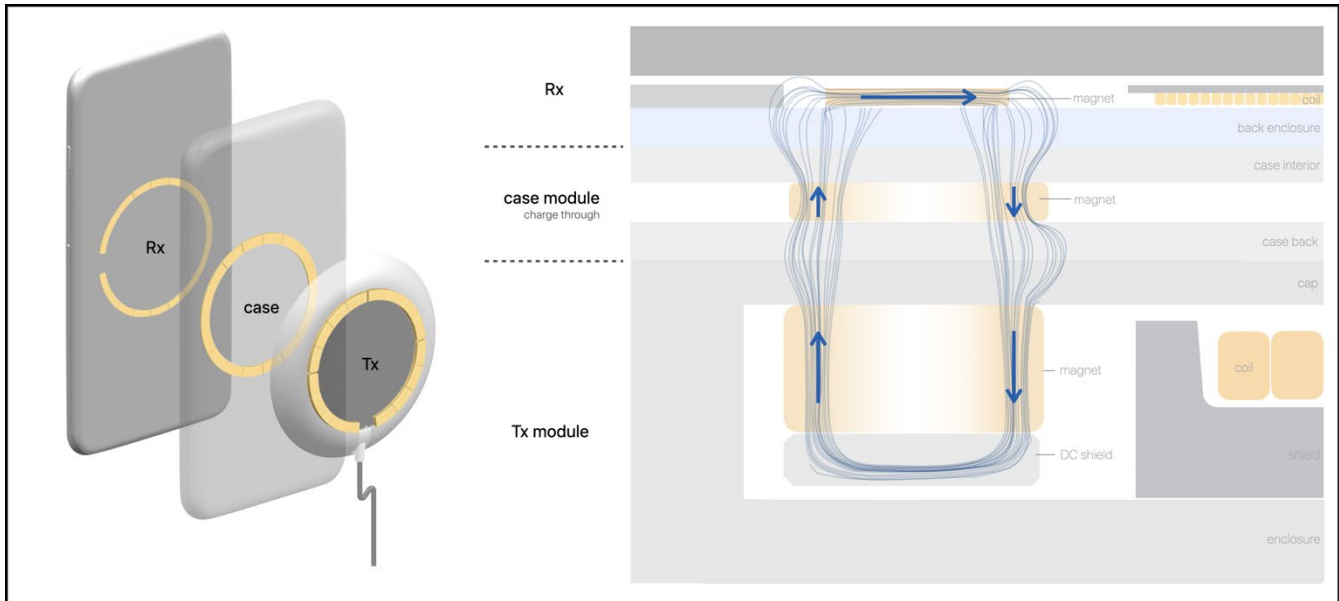


Figure 2.1.3: 2 Accurate magnetic alignment within a 2mm radius (without case and with silicone case).

