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Specifikacija Qi - Različica 2.3 - 5-4. del: Mpp - Odkrivanje, zaznavanje tujkov (hitri postopek)

Qi specification - Version 2.3 - Part 5-4: Mpp - Foreign object detection (Fast Track)

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29.240.99	Druga oprema v zvezi z omrežji za prenos in distribucijo električne energije	Other equipment related to power transmission and distribution networks
33.160.99	Druga avdio, video in avdiovizuelna oprema	Other audio, video and audiovisual equipment
35.200	Vmesniška in povezovalna oprema	Interface and interconnection equipment

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100/4546/CDV

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OF INTEREST TO THE FOLLOWING COMMITTEES: TC 106,TC 108	HORIZONTAL FUNCTION(S):
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WIRELESS POWER

CONSORTIUM

Qi Specification

MPP – Foreign Object Detection



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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. An important application area comprises flat-surface devices such as mobile phones and chargers operating at power levels up to 25 W.

1.1 Structure of the Qi Specification

General documents

- Introduction
- Glossary, Acronyms, and Symbols
- Technical System Overview
- Power Profiles

System description documents

- Mechanical, Thermal, and User Interface
- Power Delivery
- Communications Physical Layer
- Communications Protocol
- Foreign Object Detection
- NFC Tag Protection
- Authentication Protocol
- MPP Communications Protocol
- MPP Magnetics Design
- MPP Power Delivery
- MPP Communications Physical Layer
- MPP Foreign Object Detection
- MPP Design Guidelines (Informative)
- Magnetic Covers
- Active Alignment System
- Thermal Management Protocol

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1.2 Scope

The *Qi Specification*, *MPP Foreign Object Detection* (this document) defines methods for ensuring that the power transfer proceeds without heating metal objects in the magnetic field of a Power Transmitter. Although the Power Transmitter may optionally use any of these methods, some of them require assistance by the Power Receiver.

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.

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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 (table)

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	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
B_0	(msb)							
B_1	16-bit Numeric Data Field							(lsb)
B_2	Other Field					(msb)		
B_3	16-bit Numeric Data Field						(lsb)	Field

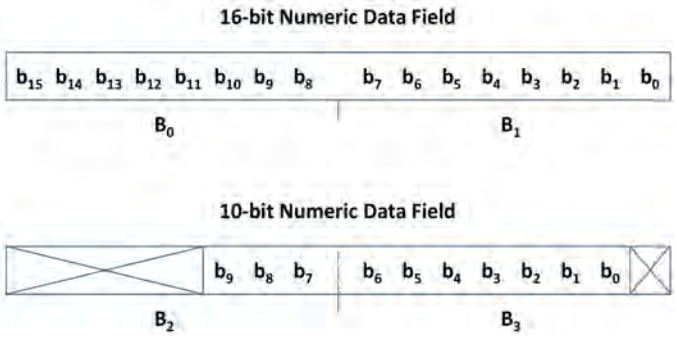


Figure 1 - Examples of fields in a data packet

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 fields 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.

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2. Foreign Object Detection

2.1 Background

To support higher power up to 25 W, MPP uses a multi-step approach to foreign object detection (FOD). The most common situation in which an FO arrives between the PTx and PRx is if it is placed on the PTx first (sequential placement of FO). Compared with the case where the FO is placed simultaneously with the PRx, the user is more easily exposed to an over-heated FO if power delivery starts. When the FO is placed on the PTx prior to placement of the PRx it can easily be detected using an Open-air Q-Test (pre-power transfer FOD method) which is executed during the analogue ping phase. Because the open-air Q test is so accurate and is not affected by the presence of a PRx, it can be used to guarantee there is no FO which will over-heat even at maximum power delivery.

In the case that the FO arrives with the placement of the PRx, the PTx can detect the presence of an FO using Mated Q-Deflection Test (see *Section 4, Mated Q-Deflection Test (pre-power transfer FOD method)*), which leverages the same measurements collected during the Open-air Q-Test. Mated Q-Deflection for MPP assures the detection of an FO placed with a PRx due to the tightly defined magnetic state space.

In the case the FO is placed between a PTx and PRx during power transfer, there are two methods to detect an FO. The first is MPP Power Loss Accounting (in-power transfer FOD method) which is used for FO detection up to 15 W. The second is Delta P_loss (ΔPloss) which is used to extend FO detection up to 25 W. Accurately detecting the presence of an FO during power transfer is a challenging task. It may be the case that FO detection which is completely dependent on in-power transfer FOD will have to limit the power transfer to something lower than maximum.

Table 3 summarizes any power limitations that occur depending on the result of the open-air Q test.

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Table 3 - Power limitations depending on open-air Q test results.

Open-Air Q Test	Result
Not implemented	Limit maximum power delivery to the level supported by *Section 5, MPP Power Loss Accounting (in-power transfer FOD method)* alone and set the *Section 5.8, FO Detection Thresholds* to the IEC 62368 compliance level.
PRx placed on PTx prior to power being applied to PTx	
FO arrives with PRx	
FO detected on PTX	
No FO detected	Allow maximum power delivery.

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3. Open-air Q-Test (pre-power transfer FOD method)

3.1 Introduction

This section introduces a pre-power foreign object detection (FOD) method that is useful for detecting foreign objects placed on the PTx mat prior to the arrival of the PRx.

This open-air Q test is not a substitute for in-power transfer FOD, nor a mated-Q method. The open-air Q test will not detect FOs which arrive on the PTx simultaneously with the PRx, or if the FO is inserted in the power transmitter's field after the PRx has arrived.

The basic functionality of the additional method described in this document consists in comparing the response to an analogue ping when PTx is running, with the stored-in-unit response to analogue ping when PTx is in free air.

During the start-up phase, the PTx uses analogue ping to measure a deflection to Q defined as:
Equation: 1

$$\Delta Q = 1 - \frac{Q}{Q_0}$$

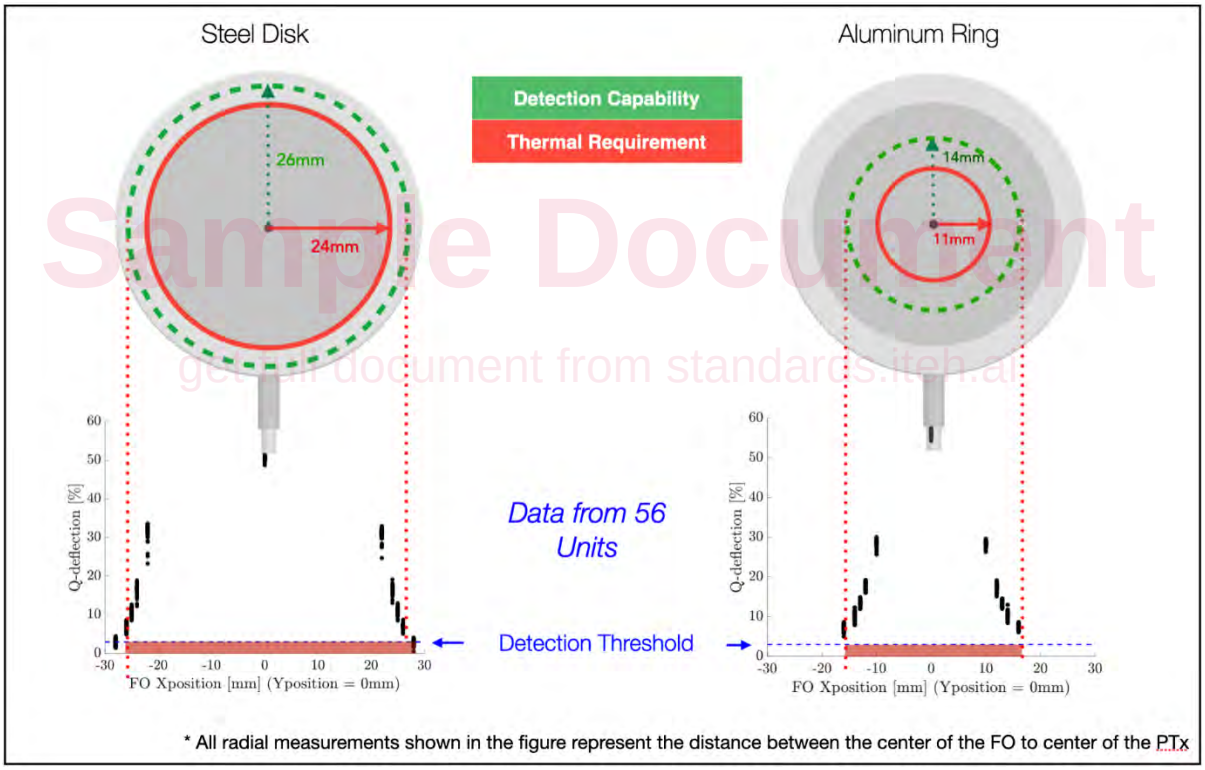


Figure 2 - Detection Capability V.S. Thermal Requirements .

where Q_0 is the calibrated value for open-air Q measured at production and Q is measured by analogue ping or calculated from a direct impedance measurement at run-time. Note that $\Delta Q_0 \approx 0$ if there is no FO present, but it's not exactly zero because of effects such as temperature drift as discussed later in this document. Component aging will also cause $\Delta Q_0 \neq 0$ when PTx is operating in free air.

When an object is placed on the mat, the Q will be deflected by some amount. If ΔQ is large enough, an object can be inferred. A response from digital ping can then be used to distinguish between whether an FO or a power receiver was placed on the mat. A basic flow is provided in Figure 3.

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