WIRELESS POWER CONSORTIUM

Qi Specification

Glossary

Definitions, Acronyms, and Symbols

Version 1.3

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RELEASE HISTORY

Specification Version	Release Date	Description
1.3	January 2021	Initial release of this document.

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1 Definitions

Active Area: The part of the Interface Surface of a Power Transmitter Product or Power Receiver Product through which a sufficiently high magnetic flux penetrates when the Power Transmitter Product is providing power to the Power Receiver Product.

Air Gap: The distance between the top surface of a Power Transmitter Product and the bottom surface of a Power Receiver Product.

NOTE The Air Gap also comprises any additional spacing between a Power Transmitter Product and a Power Receiver Product introduced by accessories added by a user to either product.

Analog Ping: A short-duration Power Signal applied by a Power Transmitter with the purpose of detecting the presence of an object, without waking up a Power Receiver.

Authentication: A tamper-resistant process of a Power Receiver verifying the identity of a Power Transmitter.

Baseline Protocol: The communications protocol introduced in version 1.0 of the *Qi Specification*.

Certificate: A digital form of identification that provides information about a Certificate Authority, a manufacturer, or a Power Transmitter Product Unit, and certifies ownership of a public key.

Certificate Authority: An organization that issues Certificates.

Certificate Chain: A series of two or more Certificates where each Certificate is signed by the owner of the preceding Certificate in the chain.

Communications and Control Unit:

The functional part of a Power Transmitter or Power Receiver that controls the power transfer.

Control Point: The combination of voltage and current provided at the output of the Power Receiver, and other parameters that are specific to a particular Power Receiver implementation.

Data Stream Initiator: A Power Transmitter or Power Receiver that can open a data transport stream.

Data Stream Responder:

A Power Transmitter or Power Receiver that can accept a data transport stream.

Detection Unit: The functional part of a Power Transmitter that detects the presence of a Power Receiver on the Interface Surface.

Digital Ping: A Power Signal applied by a Power Transmitter with the purpose to wake up a Power Receiver.

Evaluation Assurance Level:

A numerical rating describing the depth and rigor of a security evaluation.

Extended Protocol: The communications protocol introduced in version 1.2 and enhanced in later versions of the *Qi Specification*.

Foreign Object: An object that is neither part of a Power Transmitter Product nor of a Power Receiver Product and that can generate heat when exposed to a Power Signal.

Foreign Object Detection:

A process used by a Power Transmitter and Power Receiver to determine whether a Foreign Object is present in the Operating Volume and can generate heat beyond safe limits.

Friendly Metal: An integral part of a Power Receiver Product or a Power Transmitter Product that can unintentionally generate heat when exposed to a Power Signal.

Guaranteed Load Power:

A Load Power level agreed between the Power Receiver and the Power Transmitter.

Interface Surface: The flat part of the surface of a Power Transmitter Product that is closest to the Primary Coil(s).

Intermediate Certificate:

A Certificate that is positioned in a Certificate Chain between the Root Certificate and the Leaf Certificate.

Leaf Certificate: The last Certificate in a Certificate Chain.

Load: A subsystem that can draw power from a Power Receiver.

Load Power: The power dissipated in the Load.

Manufacturer Certificate:

A Certificate that describes a manufacturer. It is signed by the Certificate Authority and is used as an Intermediate Certificate.

Manufacturer Code: A 16-bit number that identifies the manufacturer of the Power Transmitter or Power Receiver. This number is also referred to as the Power Transmitter Manufacturer Code (PTMC) or the Power Receiver Manufacturer Code (PRMC).

Nonce: A number used only once in any given context of the Authentication protocol.

Operating Point: The combination of the frequency, duty cycle, and amplitude of the voltage that is applied to the Primary Cell.

Operating Volume: The set of Power Receiver spatial positions at which the Power Transmitter can sustain a power transfer.

NOTE The Operating Volume varies with the Power Receiver design as well as with the power level.

Policy: A set of rules defining the behavior of a Power Receiver depending on the outcome of Authentication.

Potential Load Power: The highest Guaranteed Load Power level the Power Transmitter can negotiate.

Power Conversion Unit:

The functional part of a Power Transmitter that converts electrical energy to a Power Signal.

Power Pick-up Unit: The functional part of a Power Receiver that converts a Power Signal to electrical energy.

Power Profile: A set of features that define a compliance level of a Power Transmitter or a Power Receiver.

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

Power Receiver Product:

A device containing a Power Receiver.

Power Signal: An alternating magnetic field.

Power Transfer Contract:

A collection of settings and limits governing a power transfer.

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

Power Transmitter Product:

A device containing one or more Power Transmitters.

Power Transmitter Product Unit:

A Power Transmitter Product with a unique identity.

Primary Cell: A single Primary Coil or a combination of Primary Coils that are used to provide a sufficiently high magnetic flux through the Active Area.

Primary Coil: A component of a Power Transmitter that converts electric current to magnetic flux.

Product Unit Certificate:

A Certificate that describes a Power Transmitter Product Unit. It only occurs as a Leaf Certificate.

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

Reference Quality Factor:

The lowest quality factor of a reference Power Transmitter's tank circuit, measured with a Power Receiver positioned in the reference Power Transmitter's Operating Volume at five reference positions.

NOTE The Reference Quality Factor is a design property of the Power Receiver and applies with the Power Receiver switched off.

Reference Resonance Frequency:

The highest resonance frequency of a reference Power Transmitter's tank circuit, measured with a Power Receiver positioned in the reference Power Transmitter's Operating Volume at five reference positions.

NOTE The Reference Resonance Frequency is a design property of the Power Receiver and applies with the Power Receiver switched off.

Reserved bits: The unused parts of data packets. Set to ZERO by an originator; ignored by a recipient.

Reserved values: The unused ranges of values associated with defined fields in data packets. Not to be used by an originator; can cause undefined behavior by a recipient.

Response Pattern: A sequence of eight consecutive bi-phase modulated bits transmitted by a Power Transmitter in response to a request from a Power Receiver.

Revocation: The act of removing the validity of a Certificate. Revocation is performed by the WPC CA.

Revocation List: A list identifying Certificates that have been revoked. The format of Revocation Lists is outside the scope of this specification.

Root Certificate: The first Certificate in a Certificate Chain. This Certificate is self-signed.

Secondary Certificate: A Certificate that may be used by the manufacturer to describe a product family or class. It is signed by the manufacturer and is used as an Intermediate Certificate.

Secondary Coil: The component of a Power Receiver that converts magnetic flux to electromotive force.

Shielding: A component in the Power Transmitter that restricts magnetic fields to the appropriate parts of the Power Transmitter Product, or a component in the Power Receiver that restricts magnetic fields to the appropriate parts of the Power Receiver Product.

Supply Power: The power dissipated from the supply.

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.

To Be Signed Authentication Data:

The data that is used to generate the signature for a response to an authentication challenge.

To Be Signed Certificate:

The data that is used to generate the signature for a Certificate.

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

WPID: A 48-bit number that uniquely identifies a Qi-compliant device.

2 Acronyms

AC	Alternating Current
AWG	American Wire Gauge
BPP	Baseline Power Profile
CA	Certificate Authority
CCU	Communications and Control Unit
DC	Direct Current
DCR	Direct Current Resistance
EAL	Evaluation Assurance Level
EM	Electro Magnetic
EMC	Electro Magnetic Compatibility
EMF	Electro Magnetic Fields
EPP	Extended Power Profile
ESR	Equivalent Series Resistance
FET	Field Effect Transistor
FOD	Foreign Object Detection
FSK	Frequency-Shift Keying
lsb	Least Significant Bit
msb	Most Significant Bit
N/A	Not Applicable
NFC	Near Field Communication
PICC	Proximity Integrated Circuit Card
PID	Proportional Integral Differential
PRNG	Pseudo-random Number Generator
PRx	Power Receiver
PTx	Power Transmitter
RFID	Radio Frequency Identification
rms	Root Mean Square
TBSAuth	To Be Signed Authentication data
TBSCertificate	To Be Signed Certificate
TPR	Test Power Receiver
TPT	Test Power Transmitter
UART	Universal Asynchronous Receiver Transmitter

USB	Universal Serial Bus
WPC	Wireless Power Consortium
WPID	Wireless Power Identifier

NOTE: See the *Qi Specification, Communications Protocol*, for data packet mnemonics.

3 Symbols

By convention, an uppercase symbol represents an average or root-mean-square quantity and a lowercase symbol represents a peak quantity. For example, P_t represents an average amount of Transmitted Power, and p_t represents a peak Transmitted Power.

The addition of a prime to a symbol serves as a reminder that the physical quantity represented by that symbol changes with the relative positions of a Power Transmitter, Power Receiver, and/or Foreign Object(s). The non-primed symbol represents the nominal (unchanged) value of the physical quantity. For example, L_t represents the inductance of a Power Transmitter when its Operating Volume is empty, and L'_t represents the inductance as modified by the presence of a Power Receiver and/or Foreign Object(s). The coupling coefficient *k* is an exception to this rule. Whereas the coupling coefficient changes with the relative position of the Power Transmitter and Power Receiver, for ease of notation, its symbol does not add a prime.

b_x	Bit *x* (*x* = 0, ... ,7)
B_x	Byte *x* (*x* = 0, ... ,7)
C_r and C'_r	Capacitance of a Power Receiver's tank circuit; in nanofarads
C_t and C'_t	Capacitance of a Power Transmitter's tank circuit; in nanofarads
C_d	Capacitance parallel to the Secondary Coil; in nanofarads
C_m	Capacitance in the impedance matching network; in nanofarads
C_p	Capacitance in series with the Primary Coil; in nanofarads
C_s	Capacitance in series with the Secondary Coil; in nanofarads
d	Duty cycle of the inverter in the Power Transmitter
D_S	Distance between a coil and its Shielding; in millimeters
D_z	Distance between a coil and the Interface Surface; in millimeters
f_{CLK}	Clock frequency of the Load modulation communications, in kilohertz
f_{mod}	Modulated operating frequency; in kilohertz
f_d	Resonant detection frequency; in kilohertz
f_{op}	Operating Frequency; in kilohertz
f_r and f'_r	Resonance frequency of a Power Receiver's tank circuit; in kilohertz
f_s	Secondary resonance frequency; in kilohertz
f_t and f'_t	Resonance frequency of a Power Transmitter's tank circuit; in kilohertz
$f_t'^{(ref)}$	Reference Resonance Frequency; in kilohertz
h	Air Gap; in millimeters
i_r and I_r	Current in a Power Receiver's tank circuit; in amperes

i_t and I_t	Current in a Power Transmitter's tank circuit; in amperes
$i_t^{(lim)}$ and $I_t^{(lim)}$	Current limit of a Power Receiver's tank circuit; in amperes
I_m	Primary Coil current modulation depth; in milliamperes
I_o	Power Receiver output current; in milliamperes
I_p	Primary Coil current; in milliamperes
k	Coupling factor; dimensionless
L_m	Inductance in the impedance matching network; in microhenries
L_p	Primary Coil self-inductance (Power Receiver Product away from Base Station); in microhenries
L_r and L_r'	Inductance of a Power Receiver's tank circuit; in microhenries
L_t and L_t'	Inductance of a Power Transmitter's tank circuit; in microhenries
L_s	Secondary Coil self-inductance (Power Receiver Product away from Base Station); in microhenries
L_s'	Secondary Coil self-inductance (Power Receiver Product on top of Base Station); in microhenries
M'	Mutual inductance; in microhenries
p_{FO} and P_{FO}	Power loss to a Foreign Object; in watts
p_i and P_i	Input Power to the Power Transmitter; in watts
p_L and P_L	Load Power; in watts
$p_L^{(gtd)}$ and $P_L^{(gtd)}$	Guaranteed Load Power; in watts
$p_L^{(neg)}$ and $P_L^{(neg)}$	Negotiable Load Power; in watts
$p_L^{(pot)}$ and $P_L^{(pot)}$	Potential Load Power; in watts
$p_L^{(req)}$ and $P_L^{(req)}$	Requested Load Power; in watts
p_o and P_o	Output Power of the Power Receiver; in watts
p_r and P_r	Actual Received Power; in watts
$p_r^{(est)}$ and $P_r^{(est)}$	Estimated Received Power; in watts
$p_r^{(loss)}$ and $P_r^{(loss)}$	Power Receiver loss; in watts
$p_r^{(ref)}$ and $P_r^{(ref)}$	Received Power Reference; in watts
P_{PR}	Total amount of power received through the Interface Surface; in watts
P_{PT}	Total amount of power transmitted through the Interface Surface; in watts
p_t and P_t	Actual Transmitted Power; in watts

$p_t^{(loss)}$ and $P_t^{(loss)}$	Power Transmitter loss; in watts
Q	Quality factor
t_{active}	Power Control window; in milliseconds
t_{atn}	ATN Response Pattern window; in milliseconds
$t_{calibrate}$	Calibration timeout; in milliseconds
t_{CLK}	Communications clock period; in microseconds
$t_{control}$	Power control window; in milliseconds
t_{delay}	Power Control Hold-off Time; in milliseconds
t_{detect}	Detection time window; in milliseconds
t_{dsr}	DSR data packet window; in milliseconds
t_{dts}	Data Transport Stream window; in milliseconds
t_{FOD}	FOD grace window; in milliseconds
$t_{interval}$	Control Error (CE) data packet interval; in milliseconds
t_{nak}	NAK Response Pattern window; in milliseconds
$t_{negotiate}$	Negotiation timeout; in milliseconds
t_{next}	Next data packet timeout; in milliseconds
$t_{nextping}$	Next Digital Ping window; in milliseconds
t_{offset}	Received Power window offset; in milliseconds
t_{ping}	Digital Ping window; in milliseconds
t_{power}	Received Power (RP8 and RP) data packet timeout; in milliseconds
$t_{received}$	Received Power (RP8 and RP) data packet interval; in milliseconds
$t_{renegotiate}$	Renegotiation window; in milliseconds
t_{reping}	Re-ping delay; in milliseconds
t_{reset}	Reset window; in milliseconds
$t_{response}$	Response start window; in milliseconds
$t_{responsetimeout}$	Response timeout; in milliseconds
t_{silent}	Silent window; in milliseconds
t_{start}	Next data packet window; in milliseconds
t_T	Maximum transition time of the communications; in microseconds
$t_{terminate}$	Power termination window; in milliseconds
$t_{timeout}$	Control Error (CE) data packet timeout; in milliseconds

t_{wake}	Wake-up window; in milliseconds
t_{window}	Received Power window size; in milliseconds
u_{ro} and U_{ro}	Voltage across the inputs of the rectifier; in volts
V_{o}	Power Receiver output voltage; in volts
V_{r}	Rectified voltage; in volts