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INTERNATIONAL STANDARD

Qi Specification version 2.0 –
Part 1: Introduction

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QI SPECIFICATION VERSION 2.0 –

Part 1: Introduction

FOREWORD

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IEC 63563-1 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, Introduction* and was submitted as a Fast-Track document.

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

Draft	Report on voting
100/4247/FDIS	100/4274/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- withdrawn, or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.

WIRELESS POWER
CONSORTIUM

Qi Specification

Introduction

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 About the Wireless Power Consortium

The Wireless Power Consortium (WPC) is a worldwide organization that develops and promotes the global interface standard for wireless power transfer called *Qi*[1]. Interface standards ensure the interoperability of devices that conform to that standard. Supported by more than 600 companies and with thousands of certified products, Qi has become the international wireless-charging standard for hand-held consumer electronics.

This document introduces the *Qi Specification*, which applies to flat surface devices such as mobile phones and tablets that use up to 15 W of power.[2]

The WPC actively investigates new applications for wireless power transfer, such as a cordless kitchen solution that uses Power Transmitters installed underneath countertops and tables that enable a variety of kitchen appliances and smart cookware to operate without power cords.

1 Qi (氣 ; qì) is pronounced "chee," and is the Chinese word for energy flow or life force.

2 Version 1.2 of the *Qi Specification* introduced fast charging, which covers transmitter and receiver products that use up to 15 W of power. However, the architectural limit of the extended power profile is about 30 W, which will accommodate a growing family of Qi product designs.

2 What is the Qi wireless power transfer system?

The powering of hand-held devices is continuing to evolve. Originally, electrical devices had to be plugged directly into outlets, and the range of operation was limited by the length of the power cord. Next came disposable batteries that severed the power cord's range restriction.

Figure 1. Corded appliance (c. 1950) to battery-powered consumer electronics (c. 1955)

In recent years, rechargeable batteries have all but replaced disposable batteries, eliminating the need to purchase, store, and throw large quantities of these batteries into landfills. But for frequently-used devices—smartphones in particular—recharging became a daily ritual of plugging and unplugging charging cables.

A new era of convenience emerged in 2011 when the first Qi wireless smartphone case was introduced, followed shortly thereafter by smartphones with built-in Qi wireless support. Qi wireless devices need only to be set down on a Qi wireless charger for recharging to occur. The device remains unplugged and ready to be picked up and used at any moment. With the deployment of Qi chargers in cars, enterprises, and public locations, it becomes possible to no longer worry about running out of charge or carrying charger cables.

Figure 1 and Figure 2 show the evolution of corded power to wirelessly-charged portable devices.

Figure 2. Plug-in rechargeable mobile phones (c. 1999) to wirelessly-charged[1] smartphones (since 2012)

The adoption of the Qi standard has grown significantly since the first products were introduced. In a 2014 consumer survey conducted by IHS Inc., 36% of consumers in China, the UK, and the U.S. said they had heard of wireless charging. One year later that number doubled, reaching 76% consumer awareness. In 2015 more than 150 million Qi systems have been shipped, over 83% of smartphone users wanted wireless charging, and over 80 phone models around the world were Qi-enabled. From 2016 to 2018, the number of consumers who use wireless charging has grown from 10% to 40%, and awareness of the wireless power technology has increased to 89%.

Qi wireless chargers are becoming more prevalent and are appearing in varied forms. There are three basic categories of chargers: desktop chargers, power banks, and embedded chargers. Desktop chargers may be in the form of a charging pad or stand, and power banks are similar but are designed for travel and contain batteries to provide power when it cannot be plugged into an outlet. Embedded chargers may be built into furniture, automobiles, other appliances like clock-radios or computer monitors, or provided in public locations like restaurants and hotel rooms. The largest demand for chargers is for home use, autos, and offices, but the deployment of public chargers has contributed significantly to public awareness.

The continued growth of Qi wireless devices and chargers is also reducing the need for product-specific cables (see Figure 3). This simplifies charging for consumers and reduces the frequent failure of the device's charging connector. As wireless charging becomes ubiquitous throughout the consumer's journey, it will be possible to decrease the size of the battery, and with it, the size, weight, and cost of the device itself.

The Qi wireless power transfer system offers both a solution to the daily inconvenience of handling cables and adapters, as well as an opportunity for manufacturers to further distinguish their products in the marketplace.

[1] Photo of the TYLT Vu wireless charger (right) is reprinted by permission from Technocel.

Figure 3. Cable clutter can be replaced with Qi wireless charging

3 How Qi wireless power transfer works

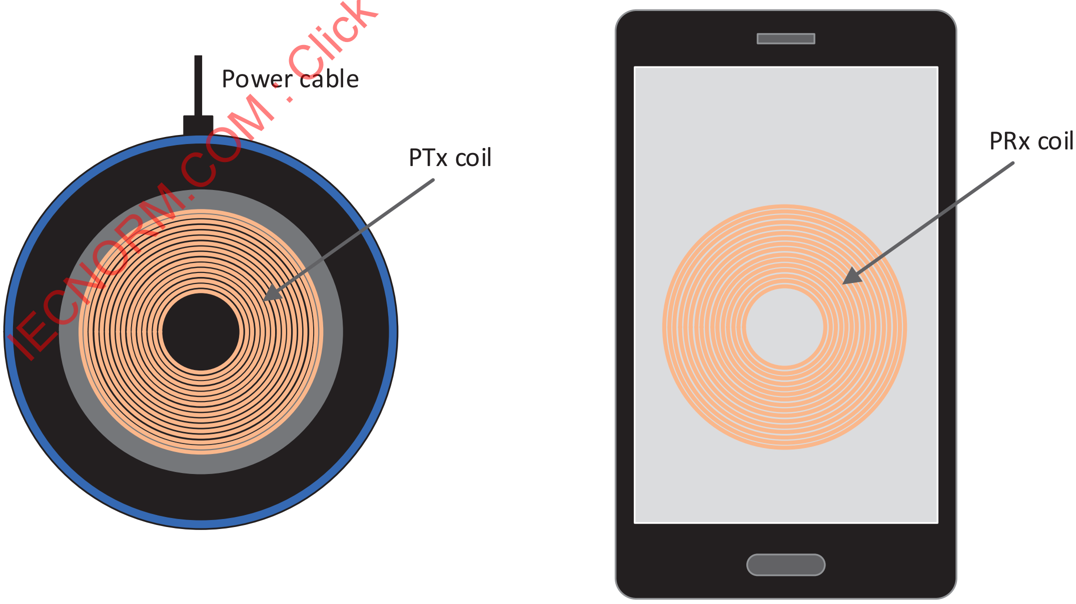
3.1 Basic concepts

The Qi wireless power transfer system uses magnetic induction to transfer power from a Power Transmitter Product (charger) to a Power Receiver Product (smartphone).

Figure 1. A Qi wireless smartphone on a charging pad

Within these products are Power Transmitter (PTx) and Power Receiver (PRx) subsystems, which contain coils, as shown in the conceptual diagram in Figure 2, as well as circuitry that handles the communication and power transfer between them.

Figure 2. Coils in charger and smartphone



The basic physical principle that governs the functionality defined in the Qi wireless power transfer specification is magnetic induction: the phenomenon that a time-varying magnetic field generates an electromotive force in a suitably positioned inductor. In a Qi wireless power transfer system, this electromotive force produces a voltage across the terminals of a coil-shaped inductor, and is used to drive the electronics of an appropriate load to which it is connected. Conventional transformers use the same effect to achieve inductive power transfer between a primary and a secondary coil that are strongly coupled by means of a magnetic core.

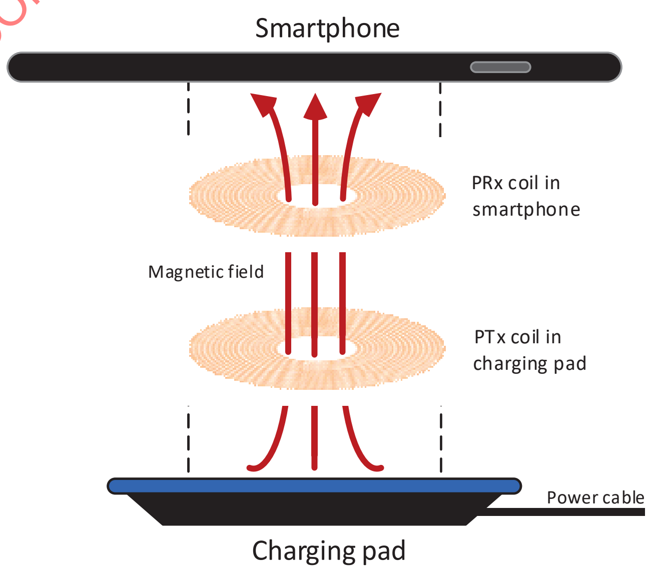
Although a Qi-based system is similar to a conventional transformer in the sense that power is transferred from a first coil to a second coil, it is also very different because of the much lower magnetic coupling between those coils. A conventional transformer has a magnetic coupling coefficient close to one, whereas a Qi-based system typically has a magnetic coupling coefficient in the range of 0.5 or below.

In the Qi-based system illustrated in Figure 1, power is transferred from the Power Transmitter contained in the Qi charging pad to a Power Receiver contained in the Qi smartphone. Before charging begins, the Power Receiver and Power Transmitter communicate with each other to establish that the Power Receiver Product is indeed capable of being charged, whether it needs to be charged, how much power is required, etc. In short, the communication ensures an appropriate power transfer from the Power Transmitter Product to the Power Receiver Product. The communication channel can also be used to trigger location based services by providing an SSID, a Bluetooth® link, or a unique ID.

When charging begins, the Power Transmitter runs an alternating electrical current through its coil(s), which generates an alternating magnetic field in accordance with Faraday's law. This magnetic field is in turn picked up by the coil inside the Power Receiver and transformed by a power converter back into a direct electrical current that can be used to charge the battery.

A critical feature of the magnetic field is that it can transfer through any non-metallic, non-ferrous materials, such as plastics, glass, water, wood, and air. In other words, wires and connectors are not needed between the Power Transmitter Product and Power Receiver Product.

Figure 3. Qi wireless power transfer using magnetic induction



3.2 Examples of Qi wireless products

3.2.1 Power Receiver Products

Qi wireless charging is a feature available in dozens of smartphones, and many of the major smartphone makers are participating members of the WPC.

Wireless charging is also appearing in a growing number of other consumer product categories—smart watches, power banks, Bluetooth headsets, cameras, electric shavers, etc. Virtually anything that uses a rechargeable battery can be designed to use Qi wireless technology. However, Qi wireless power transfer is not limited to charging batteries: it can also be used to power devices that require electric current and will remain stationary while in use, such as desktop lamps or speakers.

3.2.2 Chargers

Qi wireless Power Transmitter Products are generally either standalone wireless chargers or they are integrated into other products, such as furniture, lamps, alarm clocks, audio speakers, etc.

Examples of standalone Power Transmitter Products include:

- charging pads, which lie flat on a table or desktop
- charging stands, which are designed to hold a smartphone upright in a viewing position while charging
- power banks, which are similar to charging pads, but contain internal batteries as a portable power source

Standalone charging pads, charging stands, and power banks typically require a sufficiently capable adapter in order to draw sufficient power from an electrical outlet, as well as a USB cable from the adapter to the charger.

Power Transmitters that are embedded in lamps, clocks, or other plug-in appliances do not require a separate AC adapter, because the product plugs directly into an electrical outlet and internal circuitry routes the necessary power to the Power Transmitter component. Similarly, autos that feature an integrated Power Transmitter Product in the dash or console use the internal wiring to draw power from the car's electrical system.

4 Qi wireless power transfer features

4.1 Power levels

The *Qi Specification* applies to wireless power transfers of at least 5 W and up to the architectural limit of about 30 W of load power. The actual amount of power that can be transferred between the Power Transmitter and Power Receiver is subject to negotiation between them during the communication phases that occur before power transfer. The Power Receiver requests a certain amount of power appropriate for the device to be charged, and the Power Transmitter will deliver the requested amount. This communication assures interoperability between Qi wireless products in the Baseline Power Profile (≤ 5 W) and in the Extended Power Profile (up to 15 W).

For example, if the Power Receiver is designed to be charged by a 15 W Power Transmitter but is placed on a 5 W Power Transmitter, the Power Receiver may allow charging at a slower rate. Conversely, if a 5 W Power Receiver is placed on a 15 W Power Transmitter, the Power Receiver will instruct the Power Transmitter to send no more than 5 W of power.

Power profiles also describe the communication capabilities between the Power Receiver and Power Transmitter. The earliest versions of *Qi Specification* (versions 1.0 and 1.1) introduced a simple unidirectional communication protocol from the Power Receiver to the Power Transmitter for power transfers ≤ 5 W. This is now known as the *Baseline Protocol*.

Version 1.2 of *Qi Specification* introduced an Extended Protocol for bidirectional communication between the Power Receiver and the Power Transmitter. This extended communications protocol enables enhanced foreign object detection features (see section 4.6), and applies to power transfers up to 15 W.

4.2 Operating frequency

The operating frequency typically is in the range of 87 to 205 kHz. A Power Transmitter can—but does not have to—use the operating frequency to control the amount of power that is transferred to a Power Receiver. For this purpose, the frequency response of the Power Transmitter/Power Receiver system typically has a resonance near the lower end of the operating frequency range. A lower operating frequency results in a higher amount of power transferred and a higher frequency in a lower amount of power.

4.3 Charging area

The power transfer system in the *Qi Specification* is based on a single coil in the Power Transmitter that has an outer diameter of 50 mm (2 in), and a coil in the Power Receiver that has an outer diameter of 40 mm (1.6 in). Actual Power Transmitter and Power Receiver implementations may deviate from these dimensions, as long as they are able to pass all relevant Qi compliance tests.

In a typical use case, a Power Receiver Product is positioned on the top surface of a Power Transmitter Product with the Power Transmitter coil and the Power Receiver coil aligned. Ideally, the coils should be perfectly aligned for maximum power transfer, but misaligning the coils by several millimeters mm (about ¼ inch) should not be a problem.

To accommodate products that require a larger charging area or more tolerance for misalignment, the specification allows for multiple coils in the Power Transmitter to be connected in an array, as seen in triple-coil charging stands that work with Power Receiver Products of different sizes and with different coil locations. Manufacturers can also submit new coil types to be included in the specification to accommodate their design innovations.

4.4 Coupling requirements

Coupling occurs when current changes in one coil creates a voltage in the other coil via magnetic induction. Coupling is highest—with the most efficient power transfer—when:

- the Power Transmitter and Power Receiver use exactly the same coil
- the Power Transmitter and Power Receiver are perfectly aligned
- the distance between the coils is small (less than the diameter of the coils)
- the coils are externally shielded by ferrite

Conditions that decrease coupling (and power transfer efficiency) include different Power Transmitter/Power Receiver coil sizes and shapes, coil misalignment, excessive distance between coils, and the presence of foreign objects on the Power Transmitter Product.

4.5 Communication protocol

To set up power transfer and assist in its control, a Power Transmitter and Power Receiver execute a communication protocol with each other. The Power Receiver uses amplitude shift keying to communicate requests and other information to the Power Transmitter by modulating its reflected impedance. The Power Transmitter uses frequency shift keying (FSK) to provide synchronization and other information to the Power Receiver by modulating its operating frequency.