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# Qi Open Wireless Charging Standard – A Wireless Technology for the Future

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***Abstract*** *– This paper is used to express the great capabilities of the wireless power transmission techniques. Wireless power transfer allows a convenient, easy to use battery charging of mobile phones and other mobile devices. No hassle with cables and plugs, just place the device on a pad and that's it. Such a system even has the potential to become a standard charging solution*
.

## I. Introduction:

Usage of Wireless power provides a convenient solution for the users of portable devices and also gives designers the ability to develop more creative answers to problems. Inductive coupling is the method by which efficient and versatile wireless power can be achieved. It is a technology which can be developed to great potential and which has the proficiency to change the way power is transferred between devices and the source. Therefore, in 2009 the Wireless Power Consortium was founded with meanwhile more than 80 international companies as members. The consortium recently released the first worldwide standard on wireless power for mobile devices of to 5W called "Qi". The contribution presents details of this standard and the rationale behind.

## II. WPC:

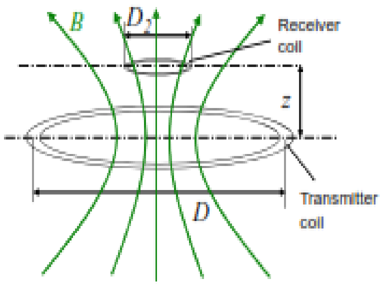
Wireless Power Consortium (WPC) has developed a standard that creates interoperability between the device providing power (power transmitter, charging station) and the device receiving power (power receiver, portable device).To make the whole idea a success, it is definitely necessary to come to widely accepted standard. Therefore, the WPC was established in 2008.The WPC standard defines the type of inductive coupling (coil configuration) and the communications protocol to be used for low-power wireless devices. Any device operating under this standard will be able to pair with any other WPC-compliant device.

## III. WPC Standard:

One key benefit to this approach is that it makes use of the coils for communications between the power transmitter and the power receiver. Under the WPC standard, "low power" for wireless transfer means a draw of 0 to 5 W. Systems that fall within the scope of this standard are those that use inductive coupling between two planar coils to transfer power from the power transmitter to the power receiver. The distance between the two coils is typically 5 mm. Regulation of the output voltage is provided by a global digital control loop where the power receiver communicates with the power transmitter and requests more or less power. Communication is unidirectional from the power receiver to the power transmitter. The WPC standard defines the three key areas of the system — the power transmitter, the power receiver, and the communications protocol between the two devices.

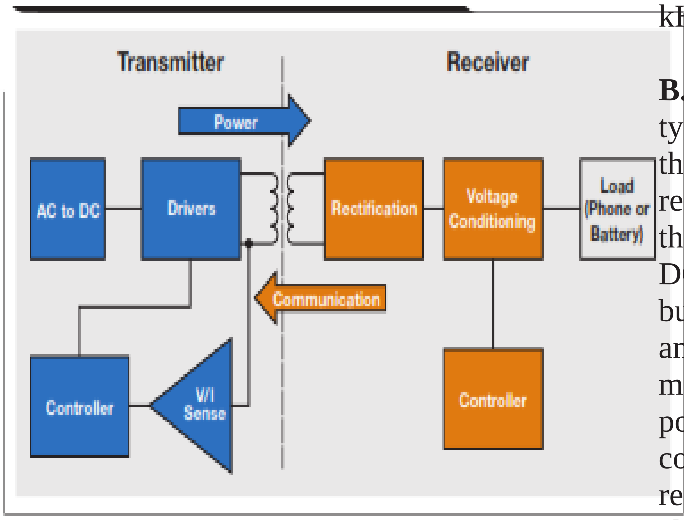
## IV. The Technology:

The device to be charged is first placed upon the device that provides the source for powerless transmission. The power is sent through layers of packets as shown in the figure. This is continually absorbed by the charging device.




Typical arrangement of a wireless inductive power transmission system.

The following diagram shows the transmission of power from the power to the end device. First, the power is converted from AC to DC which is then provided to the pad that provides charge through wireless means. It is then rectified which is followed by voltage conditioning, after which it finally reaches the device. The device can be a phone or directly a battery.




**Operation of Simple Wireless Charging**

## V. How it works:

**A. Power transmitter:** The direction of power transfer is always from the power transmitter to the power receiver. The key circuits of the power transmitter are the primary coil, used to transfer power to the power-receiver coil; the control unit for driving the primary coil; and the communications circuit for demodulating the voltage or current from the primary coil. Flexibility of the power-transmitter design is limited to provide consistent power and voltage levels to the power receiver. The power receiver identifies itself to the power transmitter as a compliant device and also provides configuration information. Once the transmitter initiates power transfer, the power receiver sends error packets to the power transmitter requesting more or less power. The power transmitters tops supplying power up on receiving an “End Power” message, or if no packets are received for more than 1.25 seconds. While no power is being transmitted, the power transmitter enters alow - power standby mode. The WPC specification allows for both fixed- and moving-coil configurations. A single fixed coil, referred to as typeA1, is the solution that Texas Instruments (TI) supports. The power transmitter, typically a flat surface upon which the user places the power receiver, is connected to the power source. The coils of a WPC-compliant device operate as are sonant half bridge on a 50% duty cycle, witha19-VDC input (±1V).If more or less power is needed at the power receiver, the frequency in the coil changes but stays between 110 and 205 kHz, depending on power demands.

**B. Power receiver:** The power receiver is typically a portable device. The key circuits of the power receiver are the secondary coil, used to receive power from the power-transmitter coil; the rectification circuit, used to convert AC to DC; the power-conditioning circuit, which buffers the unregulated DC into regulated DC; and the communications circuit, which modulates the signal to the secondary coil. The power receiver is responsible for all communications of its authentication and power requirements, as the power transmitter is only a “listener. “While design of the power transmitter is restricted to keep it WPC-compliant, much more freedom is permitted for designing the power receiver. The coil dimension of the power receiver can be adjusted to meet the device's form factor. The coil voltage at the power receiver is full-wave rectified, with a typical efficiency of 70% for a 5-V, 500-mA output. Because communication between the two devices is unidirectional, the WPC selected the power receiver to be the "talker." Inductive power transfer works by coupling a magnetic field from primary to secondary coils. Uncoupled field lines rotate around the primary coil and do not represent loss as long as the field lines don't couple a parasitic load (for example, eddy-current loss in metal).

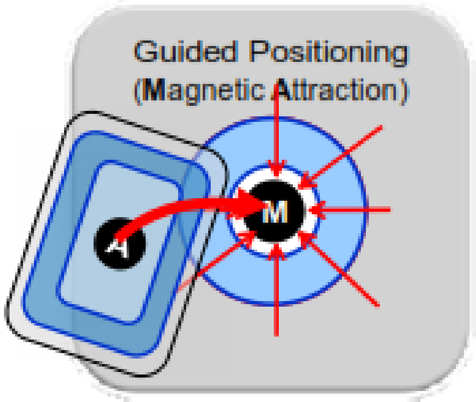
**C. Communications protocol:** The communications protocol includes analog and digital pinging; identification and configuration; and power transfer.Atypicalstart-upsequencethatoccurswhenapowerreceiverisplacedon
a power transmitter proceeds as follows:

i) An analog ping from the power transmitter detects the presence of an object.
ii) A digital ping from the power transmitter is a longer version of the analog ping and gives the power receiver time to reply with a signal-strength packet. If the signal strength packet is valid, the power transmitter keeps power on the coil and proceeds to the next phase.
iii) During the identification and configuration phase, the power receiver sends packets that identify it and that provide configuration and setup information to the power transmitter. In the power-transfer phase, the power receiver sends control error packets to the power transmitter to increase or decrease the power supply. These packets are sent approximately every 250 ms during normal operation or every 32 ms during large signal changes. Also during normal operation, the power transmitter sends power packets every 5 seconds.
iv) To end the power transfer, the power receiver sends an "End Power" message or sends no communications for1.25 seconds. Either of these events places the power transmitter in a low-power state.

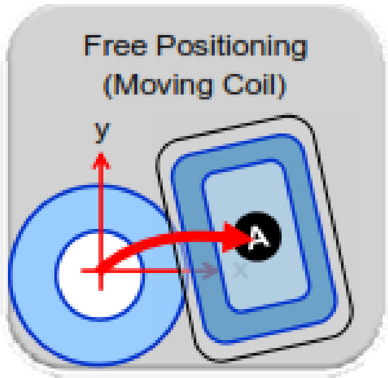
## VI. Types of Transmitters:

### A. Standard transmitters*:*

To guarantee interoperability, a precise specification of the magnetic interface would be necessary. However, specifying of a free positioning interface would require reference transmitters and receivers. But with this solution the consortium is not confident that interoperability could be guaranteed in all cases.




Therefore, the design freedom for the transmitter is limited to three standard transmitter types. The design of receivers is left free to the manufacturers, because here the pressure on cost and size is much higher than for transmitters. The Qi specification contains 3 basic transmitter types representing 3 different techniques to achieve good alignment between transmitter and receiver coils: Guided positioning, free positioning moving coil and free positioning coil matrix.




## VII. Applications:

According to these findings, inductive wireless power transfer is promising along a surface. A possible application can be the charging of mobile devices. Here, wireless communication already has become standard, and the consumer expects that charging would also be possible without the hassle of cables and plugs. For such an application, pads that charge wirelessly are proposed. One example is the Power pad which was presented by Philips Research. It provides very simple functionality to the user: Just place the mobile somewhere on the pad and it will charge. The Power pad consists of an array of transmitter cells, as proposed before by Ron Hui. However, the Power pad provides a local activation feature. Each cell comprises a detector, which activates the cell, if a device is placed on it. This way the magnetic field emissions are limited and the efficiency is improved. The pad can transmit upto 1.2 W with one transmitter cell and operates at500 kHz. The size is 20cm x 26cm and it contains 52transmitter cells of 40 mm diameter each. The pad is realized in printed circuit board (PCB) technology. The receiver circuits are also made from PCB such that they are less 1 mm thick with similar diameter. It is *not* compatible to the Qi standard.

Improvements: Wireless power consortium extends qi standard to include longer range Magnetic resonance wireless charging. The Wireless Power Consortium announced on April 20, 2012 that the Qi open wireless charging standard is capable of providing full support and compatibility for longer distance magnetic resonance technologies. The latest addition is a transmitter design that uses magnetic resonance technology. It increases the distance devices up to 5Watts can be charged, from 5mm to 40mm, while remaining fully Qi compatible. This transmission distance is suitable for charging through most tables and counter tops. The low-power specification delivers up to 5 watts; the medium-power specification will deliver up to 120 watts.

## VIII. Current usage:

Transcutaneous energy transfer (TET) systems in artificial hearts and other surgically implanted devices.

Oral-B rechargeable toothbrushes by the Braun company have used inductive charging since the early 1990s.

Hughes Electronics developed the Magnetic Charge interface for General Motors. The General Motors EV1 electric car was charged by inserting an inductive charging paddle into a receptacle on the vehicle. General Motors and Toyota agreed on this interface and it was also used in the Chevrolet S-10 EV and Toyota RAV4 EV vehicles.

**In 2006,** researchers at the Massachusetts Institute of Technology reported that they had discovered an efficient way to transfer power between coils separated by a few meters. The team, led by Marin Soljacic, theorized that they could extend the distance between the coils by adding resonance to the equation. The MIT wireless power project, called WiTricity, uses a curved coil and capacitive plates.

**At CES in January 2007**, Visteon unveiled their wireless charging system for in vehicle use that could charge anything from cell phones to mp3 players.

**April 28, 2009:** An Energizer inductive charging station for the Wii remote is reported on IGN.

**At CES in January 2009,** Palm, Inc. announced their new Pre smartphone would be available with an optional inductive charger accessory, the

"Touchstone". The charger came with a required special backplate that became standard on the subsequent Pre Plus model announced at CES 2010. This was also featured on later Pixi, Pixi Plus, and Veer 4G smartphones. Upon launch in 2011, the ill-fated HP Touchpad tablet (after HP's acquisition of Palm Inc.) had a built in touchstone coil that doubled as an antenna for their NFC-like Touch to Share feature.

**In August 2009,** A consortium of interested companies called the Wireless Power Consortium announced they were nearing completion for a new industry standard for low-power Inductive charging called Qi Intel and Samsung plan to launch Qi wireless charging devices for phones and laptops in 2013.

Nokia launched two smartphones (the Lumia 820 and Lumia 920) on 5th September 2012, which feature Qi wireless charging.

## IX. Advantages:

Lower risk of electrical shock or shorting out when wet because there are no exposed conductors. e.g., for tooth brushes and shavers, or outdoors.

**Consistent and secure connections** - no corrosion when the electronics are all enclosed away from water or oxygen in the atmosphere.

**Safer for implants** - for embedded medical devices, allows recharging/powering *through* the skin rather than having wires penetrate the skin, which would increase the risk of infection.

**Convenience** - rather than having to connect a power cable, the device can be placed on or close to a charge plate or stand.

## X. Disadvantages:

Lower efficiency, waste heat - The main disadvantages of inductive charging are its lower efficiency and increased resistive heating in comparison to direct contact. Implementations using lower frequencies or older drive technologies charge more slowly and generate heat within most portable electronics.

**More costly** - Inductive charging also requires drive electronics and coils in both device and charger, increasing the complexity and cost of manufacturing.

**Slower charging** - due to the lower efficiency, devices take longer to charge.

**Inconvenience** - When a mobile device is connected to a cable, it can be freely moved around and operated while charging. When using an inductive charging pad, the mobile device must be left on the pad, and thus can't be moved around or easily operated while charging.

**Standards** - There are no De facto standards, potentially leaving a consumer, organisation or manufacturer with redundant equipment when a standard emerges

## XI. Members of the WPC:

Some of the well-known members of the WPC include:

1. Alps Electric Co.
2. AudioDev
3. AVID Technologies
4. Convenient Power
5. Delta Energy Systems (Arizona) Inc.
6. Denso
7. E & E Magnetic Products
8. Energizer
9. Fairchild Semiconductor
10. Faraday Technology Corporation
11. Haier
12. HTC
13. Huawei
14. Integrated Device Technology
15. LG Electronics
16. Logah Technology Corp.
17. MCM Japan
18. MediaTek
19. Modelabs
20. Monolithic Power Systems
21. Motorola Mobility
22. Nokia
23. NTS
24. Opentech Inc.
25. Panasonic Corporation
26. Pantech
27. Philips
28. Samsung
29. Samsung Electro-Mechanics
30. Silicon Laboratories
31. SoftBank
32. Sony
33. Technocel
34. Tokai Rika Co., Ltd.
35. Triune Systems
36. U-Way Corporation
37. Verizon Wireless


## XII. Conclusion:

The WPC standard is a set of guidelines that allows manufacturers to develop solutions with the confidence
that their components will mesh with a variety of other
WPC certified components designed for inductive power transfer.

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