Infineon cuts the cables!
The current trend of “smartening” our devices is not dying down; nay, we find even more new areas for automation and connectivity. Smart solutions are everywhere, invading our everyday life, even our homes. In our households more and more devices are being connected to the Internet, providing real-time data about the condition of our property, enabling us to set up a well-optimized system. The overall objective is to level up our quality of life and convenience in our homes. We have devices in a continuously growing number that have constant connection to the Internet, consuming more energy due to the persistent hard work of the processor in the background. For those that are battery-powered, battery charging is essential. However, the more machines, gadgets we have, the more cables we need to connect them to the grid. Or not? With wireless charging you can easily get rid of tangled charging cables that have become a real issue in our life in the past couple of years.

In this article we will provide an overview of wireless charging solutions. We give a special attention to the two wireless charging technologies, their most common design criteria and the benefits they offer compared to wired technology.

Energy efficiency, shorter charging time and higher power density have been on the agenda for engineers for a while and significant improvement has been made in recent years. The overall wireless charging market is growing at a rapid pace. It is expected to have a CAGR (compound annual growth rate) of more than 25 percent for receiver and transmitter during the period 2018-2023. The various benefits like convenience, integration with multiple devices, mobility and flexibility drive the market. Meanwhile, the technology is moving from transmitters that charge single devices to transmitters that can charge several devices simultaneously. Current solutions rely on either inductive or resonant power transfer. Infineon's array of wireless charging solutions range from low-power support, using very small coils and multi-device charging, to a flexible high-power offering that is backward compatible for lower-power products such as smartphones.

**Wireless charging pays off in comfort**

Smart home denotes the use of technical systems, automated processes and connected, remote-controlled devices in apartments and houses. The main objective of the functions is to improve the quality of life and convenience in the home. Other goals are greater security and more efficient use of energy thanks to connected, remote-controllable devices. Therefore, wireless charging is not just about charging phones. As people mostly charge at home, there is a plenty of devices that can utilize wireless power transfer technology, so you can easily eliminate the cable jungle in your living space.

But of course, it is about more than making your home beautiful. It is for your comfort and flexibility to charge anywhere and everywhere. You can charge your service robot (e.g., vacuum cleaner or lawn mower), laptops, desk phones, drones, security cameras, portable Bluetooth speakers, kitchen appliances, wearables, headphones, gaming controllers, chargers integrated into lamps or furniture, power tools - the list is almost endless. Wireless charging removes the need for grid connection, thus eliminating plug compatibility issues, damaged cables with a risk of electric shock. As the devices can also be powered through their surface, there is no need of drilling holes into them, which makes them hermetically sealed enabling a higher level of safety.

**Two main technologies: inductive and resonant**

Wireless charging solutions typically have three key elements; the transmitter, the receiver and the power supply. The adapter connects to the main supply and powers the transmitter, usually with a regulated DC voltage between 5 V and 20 V. The transmitter contains a MOSFET-based inverter to convert the DC power into an AC waveform and create the alternating magnetic field. In order to provide the flexibility and functionality required, the inverter is controlled by a microcontroller and associated MOSFET driver components. There are differences in the types of magnetic induction technology - inductive and resonant.
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For standard-conform resonant solutions (devices with

operating at 6.78 MHz, the resonant charging approach

charge energy far more efficiently. The resonant approach is

able to charge multiple devices from a single-coil and allows for

a greater distance (up to 50 mm) between the transmitter and

receiver, and also a broader field of operation, meaning that the

charger has a larger “sweet spot” for efficiency.

Although a very closely coupled inductive solution can
deliver more power in a very precisely defined and controlled
scenario, as soon as the placement alters more than a few cen-
timeters then the resonant approach gives a far more efficient
ergy transfer with spatial freedom. The technology is not af-
fected by the presence of metallic objects in the charging area.

Innovative and cost-effective wireless charging designs

Achieving high efficiency, a superior user experience, and safety
- all at the same time - requires a deep level of system knowl-
edge and expertise as well as the use of excellent components.
The designer must understand antennas and interaction with
surrounding structures, and how to implement precise control
of power delivery. In the inductive, the main challenges are FOD
(foreign object detection), stable in-band communication and
authentication to protect the Qi ecosystem from non-certified
and potentially dangerous solutions. FOD needs reliable com-
ponents and enhanced methods to provide a good and safe
user experience. Quality components also play a key role in
stable in-band communication. Resonant is all about capaci-
tances and advanced FET technology (silicon MOSFET and
GaN eMode HEMTs). To master the efficiency challenge, high
performance driver ICs play an important role.

Infineon helps designers to master all these challenges and
develops dedicated reference designs, for both technologies,
which support many of the current and next-generation wireless
charging applications for consumer, industrial and automotive
sectors (e.g., in-cabin smartphone charging). These reference
designs include the hardware design, bill of materials, example
PCB layout and all the documentation required to integrate
wireless charging into the end products. The transmitter archi-
tecture is software-based, which can be updated as standards
evolve or new products are introduced to the market. The
flexible transmitter architecture supports standard or custom
coils, either in single-coil or multi-coil applications. For selected
applications, Infineon offers also receiver solutions, and has a
broad variety of semiconductors for the power supply unit. With
these new designs and supreme components, Infineon meets
and exceeds even the most rigorous design expectations.

The 2.5 W low-power proprietary solution is the indus-
try’s lowest cost resonant wireless charger. By using a higher
frequency (6.78 MHz), very small coils can be employed in
a variety of form factors, with no regard to nearby metallic
objects. These benefits make the technology ideal for charging
wearables, headphones, smart clothing and other connected
IoT applications.

An inductive smartphone/handheld solution provides charg-
ing at 15 W and is adhering to existing standard requirements,
including fast-charge smartphones with high efficiency charging
without special thermal management. It achieves charging rates
equivalent to wired solutions, and supports custom charging
profiles and industry standards on the same hardware.

Figure 2: Wireless charging solutions typically have three
key elements: the adapter/charger, the transmitter and the
receiver.

Qi (inductive) is currently the mainstream technology in the
market, which is based on 110-205 kHz and communicates
via in-band communication. Besides the standard-conform Qi
solutions, also proprietary inductive designs, especially for watt
classes above 15 Watts, are also available. The Wireless Power
Consortium (WPC) supports the Qi and inductive standard for
wireless charging and is continuously developing new specifica-
tions.

From a technical perspective, Qi is an inductive standard that
supports tightly coupled charging. This technology uses the
standard single-coil inductive charge transmitter. This approach
is the simplest and most prevalent solution, and consists of
a single transmitter coil. It requires careful positioning of the
device to be charged in relation to the transmitter coil and is only
able to charge a single receiver device at a time. This requires
position to the device being charged directly over the coil on the
charger, and is limited to power a single device.

Extending this approach to multi-coil brings a number of
benefits. The positioning of the device needs to be much less
precise, and smart systems can detect which coil is closest to
the device being charged, and direct the power accordingly.
Multi-coil inductive chargers provide more horizontal and/or
vertical freedom in terms of device positioning.

For resonant wireless charging, which is based on 6.78 MHz,
the communication between transmitter and receiver takes
place via Bluetooth low energy (AirFuel standard-conform solu-
tion) or via in-band communication (proprietary solution).

The resonant technology allows for a “drop and go” near-
field charging experience and offers considerable user ex-
perience benefits over inductive solutions. This technology
is suitable for devices that have high metallic content, have
compound shapes (unlike a smartphone), or can benefit from
multi-device charging.

For standard-conform resonant solutions (devices with
Bluetooth communication), engineers can utilize the specifica-
tions from the AirFuel Alliance. AirFuel has a broad technology
platform encompassing resonant and uncoupled technologies.
AirFuel’s uncoupled technology relies on radio frequency (RF)
transmission to transfer power, which allows multiple devices to
be charged at larger distances.

Operating at 6.78 MHz, the resonant charging approach
relies on resonance between the transmitter and receiver to
transfer energy far more efficiently. The resonant approach is

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Flexible software-based architecture

Rather than rely on an application specific IC for protocol and power delivery, the strength of the Infineon wireless charging solution lies in its modular software-based architecture. Wireless charging is continually evolving, as standards mature, and new products and applications are introduced to the market. The high software content of the solution allows a common hardware architecture to be used across several reference designs, with each reference design flexible enough to support several types of applications. In addition, future changes to the wireless charging standards can be supported by a software upgrade, which creates a future-proof product design that can span multiple generations.

The software is responsible for directing all major wireless charging functions in the system. A fully digital demodulation scheme provides greater sensitivity for decoding communication in times of weak coil coupling due to misalignment, and also ensures the highest level of interoperability with legacy receivers. Next-generation parameter measurement techniques ensure the highest accuracy for optimal power delivery and FOD. Precise control of frequency, duty cycle and voltage provides the correct level of rectified power at the receiver. In some systems, two-way communication enables smart charging with two-way authentication. Underneath the higher-level functions, a real-time engine keeps track of every aspect of the transmitter operation from input supply, through efficiency, to thermal performance, and makes adjustments as required. Finally, a self-calibration step during initial transmitter power-up provides a predictable baseline performance ensuring each product meets the requirements of the application.

Efficient and easy-to-use wireless charging for smartphones, wearables, medical and industrial devices is supported by the XMC™ microcontroller families. For automotive qualified solutions, such as charging your smartphone in your car, the AURIX™ is the perfect product to choose. Flexible chip sets for high performance, including software IP for smart and safe wireless charging applications, are available. Working with a systems solution partner, Infineon provides reference designs for both inductive and resonant wireless charging solutions: for on-the-go charging - in the car, at home or in public places.

Infineon’s wireless power controller based on the ARM® Cortex®-M0 core, works seamlessly with Infineon’s power devices in a scalable and cost-effective architecture to provide a complete charging solution for everything ranging from a fast-charge smartphone, through a 20 W robot, to a 60 W drone and beyond. Paired with related power products, like MOSFETs and driver ICs, this system can provide full wireless power without complicated thermal management, often achieving charging rates equivalent to wired charging. Complete solutions support future changes with a software update. Enhanced power stage architecture improves EMI performance 10-15 dB over existing solutions on the market. A newly developed supplemental FOD architecture improves detection accuracy to meet critical manufacturer safety requirements. Infineon’s microcontrollers provide a powerful and cost-effective platform.

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