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Infineon cuts the cables!

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Wireless charging eliminates the cable mazes in your homes

End-to-end solutions with key components from Infineon - MOSFETs, driver ICs, voltage regulators and microcontroller units with software

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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 compered 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.

Figure 1: Wireless charging eliminates the cables in our homes

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.

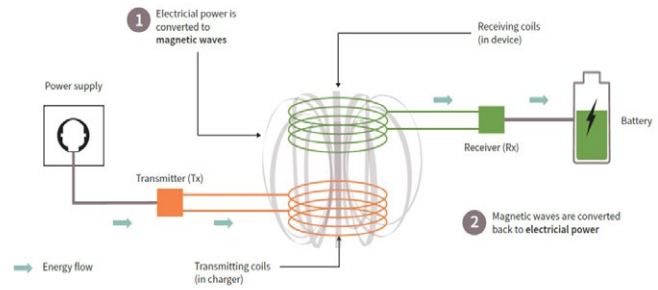

Figure 2: Wireless charging solutions typically have three key elements: the adapter/charger, the transmitter and the receiver

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 specifications.

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 to position 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 solution) or via in-band communication (proprietary solution).

The resonant technology allows for a “drop and go” near-field charging experience and offers considerable user experience 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 specifications 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 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 centimeters then the resonant approach gives a far more efficient energy transfer with spatial freedom. The technology is not affected 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 knowledge 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 components 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 capacitances 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 architecture 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 industry’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 charging 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.

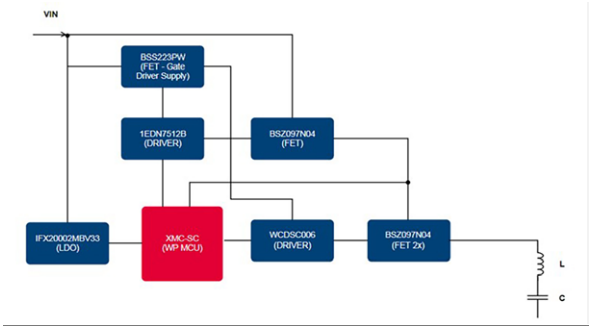

Figure 3: The block diagram shows an example for a 15 W inductive wireless charging transmitter solution

An 80 W inductive wireless charging solution for various devices provides industry's highest power levels with the smallest coils. It offers highly efficient charging up to 80 W without exotic thermal management. The solution is backward-compatible with smartphone charging standards (5 W or 15 W) and fast-charge devices. Typical applications are power tools, laptops, robots, small appliances, drones, handheld terminals, medical instruments and industrial automation.

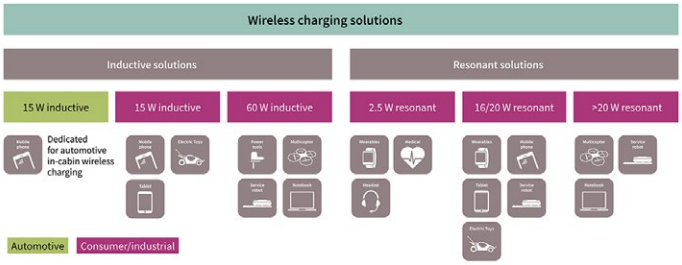

Figure 4: Infineon's broad product portfolio offers solution for a variety of inductive and resonant wireless charging applications

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, trough 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 system provides enhanced detection accuracy to meet critical manufacturer safety requirements. Infineon's microcontrollers provide a powerful and cost-effective platform.

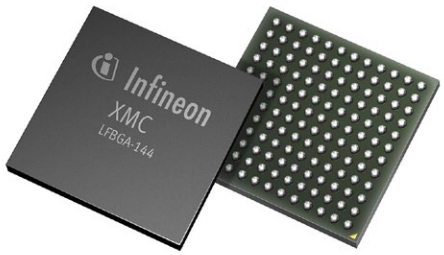

Figure 5: XMC™ microcontrollers provide a powerful and cost-effective platform ranging from a fast charge smartphone, through a 20 W robot, to a 60 W drone and beyond.

Summary

The market for wireless charging will grow quite strong in the next years. Independent from the preferred technology (inductive or resonant), there are several key design requirements to be considered. Modern engineering designs stress how important it is to have efficient and easy-to-use transmitter solutions.

Engineers also have their arrow-eye on smart heat management that keeps the surface and transmitter at a comfortable temperature, and avoids heating the battery of the device that is being charged. A small footprint is highly valued, especially for devices that are small in size like wearables. Fitting designs with a high power rating results in faster charging speed for end users' convenience.

Take a look at Infineon's supreme portfolio of wireless power offerings and solutions, visit www.infineon.com/wirelesscharging.