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Efficient wireless charging of peripheral devices

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ABSTRACT

Wireless charging is an attractive charging option for peripheral devices like styluses, digital pens, etc. The peripheral devices are commonly charged using the main computing device as a power source. The main device uses an induction transmit coil (Tx coil) to create an alternating electromagnetic field, which a receiver coil (Rx coil) in the peripheral device converts into electricity to be fed into a battery in the peripheral device. Magnets are provided at suitable locations on the peripheral device and the main device to align and attach the peripheral device to the main device, thereby reducing the air-gap between Rx and Tx cores. This enables a relatively high magnetic flux (Φ_M) and limits leakage flux (Φ_{Lk}), leading to a high coupling coefficient and a high charging efficiency.

KEYWORDS

- Stylus
- Digital pen
- Magnetic reluctance
- Coupling coefficient
- Peripheral device
- Wireless charging
- Magnetic flux
- Leakage flux

BACKGROUND

Computing devices such as mobile phones, laptops, tablets, etc. often have peripheral devices such as digital pens, styluses, etc. Wireless charging is an attractive charging option for these peripheral devices, including wirelessly charging the peripheral device using the main computing device as the power source.

Wireless charging of the peripheral device works by the transfer of energy from the main device (transmitter) to a receiver in the peripheral device via electromagnetic induction. The main device uses an induction coil (Tx coil) to create an alternating electromagnetic field, which a receiver coil (Rx coil) in the peripheral device converts back into electricity to be fed into a battery in the peripheral device. An induction coil typically consists of a central cylindrical core of magnetic materials such as ferrite on which turns of copper wire are wound. Cores are referred to by their shape, e.g. C-core, I-core, E-core, planar core, toroidal core, pot core, etc.

The shape of the peripheral device and limited available surface area for electromagnetic field coupling available in peripheral devices such as digital pens and styluses can lead to low charging efficiency and increased power consumption from the main device battery. Additionally, providing suitable alignment between the power transmitter and the peripheral device such as a stylus can be challenging.

DESCRIPTION

This disclosure describes techniques and designs for efficient wireless charging of peripheral devices with relatively small form factors. Per techniques of this disclosure, the peripheral device and the charging source are designed to boost efficiency of wireless charging when the peripheral device is placed in a charging position. Designs described in this disclosure can provide a high ratio of magnetic flux to leakage flux, thereby boosting the coupling coefficient between the induction coil and the receiver coil.

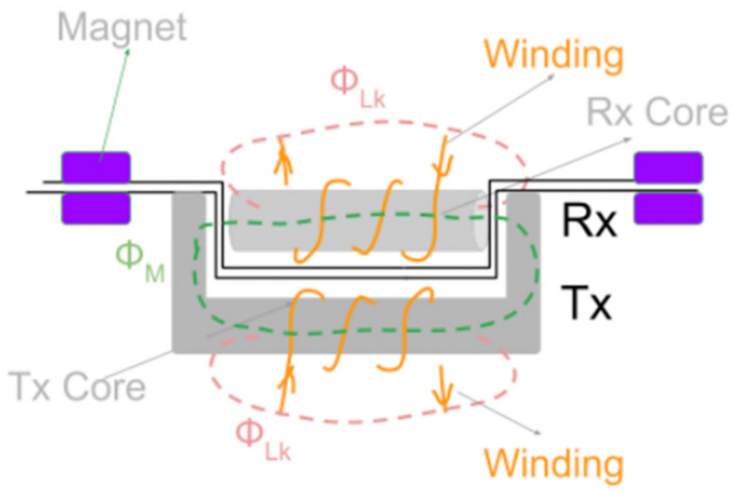

Fig. 1(a): Coil geometry provides increased coupling efficiency

Fig. 1(a) illustrates an example design for efficient wireless charging, per techniques of this disclosure. A C-shaped core (C-core) is used as a Tx core which is placed to surround a notch provided in the main device. A cylindrical core (I-core) is utilized as the Rx core on the peripheral that is to be charged and is placed within an enclosure created by the notch.

Magnets are provided at suitable locations to align and attach the peripheral device to the main device, thereby reducing the air-gap between Rx and Tx cores. This design enables a relatively high magnetic flux (Φ_M) and limits leakage flux (Φ_{Lk}), thereby providing a high coupling coefficient and a high charging efficiency.

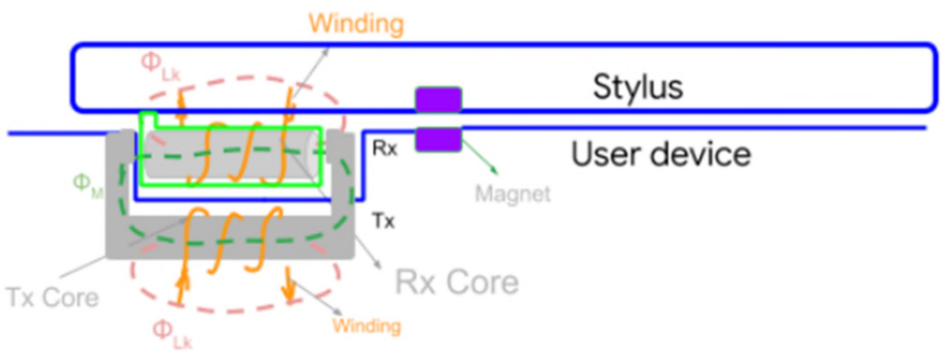

Fig. 1(b): Coil geometry integrated into a clip of a peripheral device

Fig. 1(b) depicts an example stylus designed per the techniques described earlier. The receiver coil and core are embedded in a clip (shown in fluorescent green) that is attached to the stylus. When the stylus is not in use, it can be placed aligned with the notch of a mobile phone or other computing device, where it is wirelessly charged.

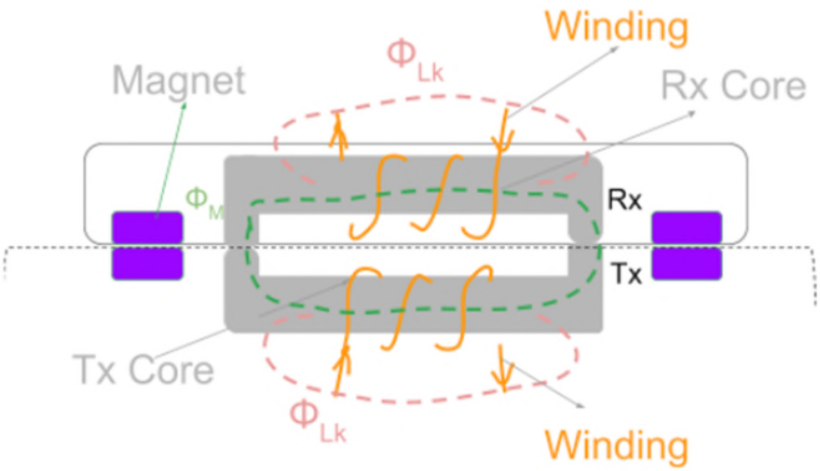

Fig. 2: Example of coil geometry with 2 C-cores

Fig. 2 depicts another example configuration for wireless charging, per techniques of this disclosure. Some device designs may not be suitable for a notch based design, as described with reference to Fig. 1. In the illustrative example of Fig. 2, two C-shaped cores are used to improve the coupling between the transmitter and receive coils. Magnets are used for alignment of the coils, and to reduce the air-gap between Rx and Tx coils.

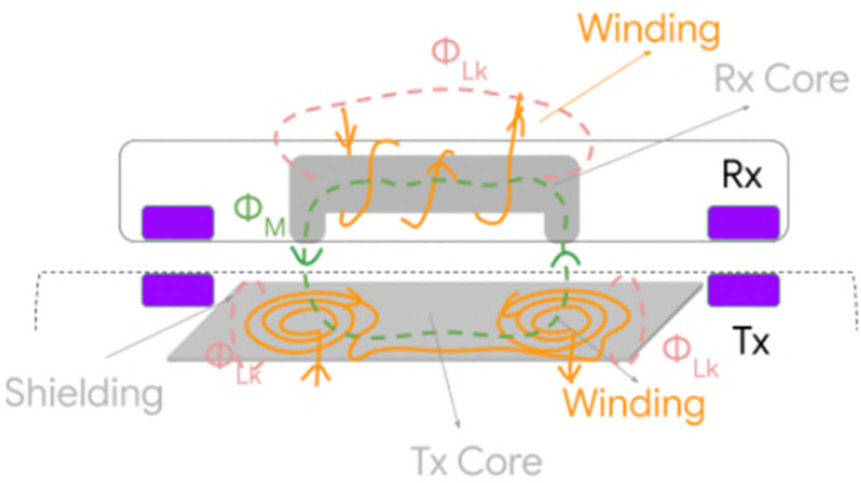

Fig. 3: Example coil geometry with planar core Tx and C-core Rx

Fig. 3 depicts another example configuration for efficient wireless charging, per techniques of this disclosure. In this illustrative example, a planar transmit core is used with 2 Tx coils. A C-core is used as the Rx core, and magnets are utilized to align the Tx and Rx coils. The polarity of the coils is adjusted such that a single magnetic field is created that couples the Rx coil to the Tx coils to enable high charging efficiency.

The techniques and design described in this disclosure enable efficient wireless charging of peripheral devices such as styluses, digital pens, etc.

CONCLUSION

Wireless charging is an attractive charging option for peripheral devices like styluses, digital pens, etc. The peripheral devices are commonly charged using the main computing device as a power source. The main device uses an induction transmit coil (Tx coil) to create an alternating electromagnetic field, which a receiver coil (Rx coil) in the peripheral device converts into electricity to be fed into a battery in the peripheral device. Magnets are provided at suitable locations on the peripheral device and the main device to align and attach the peripheral device to the main device, thereby reducing the air-gap between Rx and Tx cores. This enables a relatively high magnetic flux (Φ_M) and limits leakage flux (Φ_{Lk}), leading to a high coupling coefficient and a high charging efficiency.

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