CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. application Ser. No. 15/195,390, filed Jun. 28, 2016, entitled "Wireless Power Receiver and Control Method Thereof", which is a continuation of U.S. application Ser. No. 13/658,116, filed Oct. 23, 2012, now U.S. Pat. No. 9,461,364, issued on Oct. 4, 2016, entitled "Wireless Power Receiver and Control Method Thereof", which claims the benefit under 35 U.S.C. .sctn.119 of Korean Patent Application No. 10-2011-0114721, filed Nov. 4, 2011, entitled "Apparatus for Receiving Wireless Power and Method for Controlling Thereof", all of which are incorporated herein by reference in their entirety.

BACKGROUND

[0002] The embodiment relates to a wireless power receiver and a control method thereof.

[0003] A wireless power transmission or a wireless energy transfer refers to a technology of wirelessly transferring electric energy to desired devices. In the 1800's, an electric motor or a transformer employing the principle of electromagnetic induction has been extensively used and then a method for transmitting electrical energy by irradiating electromagnetic waves, such as radio waves or lasers, has been suggested. Actually, electrical toothbrushes or electrical razors, which are frequently used in daily life, are charged based on the principle of electromagnetic induction. Until now, the long-distance transmission using the magnetic induction, the resonance and the short-wavelength radio frequency has been used as the wireless energy transfer scheme.

[0004] Recently, among wireless power transmitting technologies, an energy transmitting scheme employing resonance has been widely used.

[0005] Since an electric signal generated between the wireless power transmitter and the wireless power receiver is wirelessly transferred through coils in a wireless power transmitting system using electromagnetic induction, a user may easily charge electronic appliances such as a portable device.

[0006] However, due to the thickness of each of a receiving coil, a short-range communication antenna and a printed circuit board constituting a receiving side, a size of an electronic appliance becomes larger and it is not easy to embed them in the electronic appliance. Specifically, the size of the electronic appliance is increased corresponding to the thickness of the receiving coil, the short-range communication antenna and the printed circuit board.

[0007] Further, when an overcurrent flows through the short-range communication module, it is difficult to effectively cope with the overcurrent.

[0008] Further, a magnetic field generated from the receiving coil exerts an influence on an inside of an electronic appliance, so that the electronic appliance malfunctions.

~~BRIEF~~ SUMMARY

[0009] The embodiment provides a wireless power receiver with a minimized thickness by suitably arranging a receiving coil, a short-range communication antenna and a printed circuit board.

[0010] The embodiment provides a wireless power receiver with a reduced thickness by allowing a short-range communication antenna to be included in a printed circuit board.

[0011] The embodiment provides a wireless power receiver which prevents an electronic appliance from malfunctioning using a shielding unit.

[0012] The embodiment provides a wireless power receiver which breaks an overcurrent by using a protecting unit to protect a short-range communication module.

[0013] A wireless power receiver according to ~~an~~the embodiment wirelessly receives power from a wireless power transmitter. The wireless power receiver includes: a printed circuit board having a reception space in a predetermined area; a receiving coil disposed ~~on~~in the reception space of the printed circuit board~~, the~~ for receiving ~~coil configured to receive~~ power from the wireless power transmitter~~ in a charging mode;~~; and a short-range communication antenna disposed on the printed circuit board while surrounding the receiving coil~~, the short-range communication antenna configured to transmit and receive information in a communication mode; a shielding unit disposed on the receiving coil and the short-range communication antenna; and a controller configured to change an operating mode of the wireless power receiver into the charging mode or the communication mode~~.

[0014] A wireless power receiver according to the embodiment wirelessly receives power from a wireless power transmitter. The wireless power receiver includes: a short-range communication antenna for performing short-range communication; a receiving coil ~~disposed in a reception space of the printed circuit board, the~~for wirelessly receiving ~~coil configured to receive~~ power from the wireless power transmitter~~ in a charging mode; a short-range communication antenna disposed in the printed circuit board surrounding the receiving coil, the~~ ; and a switch for changing a conducting state of the short-range communication antenna ~~configured to transmit and receive information in a communication mode; a shielding unit disposed on the receiving coil and the short-range communication antenna; and a controller configured to change an operating mode~~ according to a reception of the power, wherein the wireless power receiver ~~into~~opens or shorts the ~~charging mode or~~ switch according to the ~~communication mode~~reception of the power.

[0015] A method of controlling a wireless power receiver, which includes a short-range communication antenna for communicating with an outside, according to the embodiment includes determining whether power is received from a transmitting coil through electromagnetic induction; opening a switch which changes a conducting state of the short-range communication antenna when the power is received; identifying whether an amount of received power is equal to or greater than a threshold value; and shorting the switch when the amount of the received power is equal to or greater than the threshold value.

[0016] According to the embodiments, the thickness of the wireless power receiver can be minimized by suitably arranging the receiving coil, the short-range communication antenna and the printed circuit board.

[0017] According to the embodiments, the wireless power receiver can be prevented from being broken by preventing an overcurrent from flowing in the wireless power receiver and malfunction of the wireless power receiver can be prevented by shielding a magnetic field.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a view showing a wireless power transmission system according to the embodiment;

[0019] FIG. 2 is an equivalent circuit diagram of a transmitting coil according to the embodiment;

[0020] FIG. 3 is an equivalent circuit diagram of the wireless power transmission system according to the embodiment;

[0021] FIG. 4 is a block diagram of a wireless power receiver according to the embodiment;

[0022] FIG. 5 is a view showing an example of a configuration of the wireless power receiver according to the embodiment;

[0023] FIG. 6 is a exploded perspective and sectional view illustrating the wireless power receiver according to the embodiment;

[0024] FIG. 7 is a sectional view showing an arrangement of elements of the wireless power receiver according to the embodiment;

[0025] FIG. 8 is a view illustrating a top surface and a bottom surface of the wireless power receiver according to the embodiment;

[0026] FIG. 9 is a view illustrating one example of attaching a shielding unit onto the wireless power receiver according to the embodiment;

[0027] FIG. 10 is a view illustrating one example of inserting the shielding unit into the wireless power receiver according to the embodiment; and

[0028] FIG. 11 is a flowchart illustrating a control method of the wireless power receiver according to the embodiment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0029] Hereinafter, exemplary embodiments of the disclosure will be described in detail so that those skilled in the art can easily comprehend the disclosure.

[0030] FIG. 1 illustrates a wireless power transmission system according to an embodiment.

[0031] The power generated from a power source 100 is provided to a wireless power transmitter 200, such that the power is transferred by electromagnetic induction to a wireless power receiver 300.

[0032] In detail, the power source 100 is an AC power source for supplying AC power of a predetermined frequency.

[0033] The wireless power transmitter 200 includes a transmitting coil 210. The transmitting coil 210 is connected to the power source 100, such that an AC current flows through the transmitting coil 210. When the AC current flows through the transmitting coil 210, an AC current is induced to the receiving coil 310 physically apart from the transmitting coil 210 due to electromagnetic induction, so that the AC power is transferred to the wireless power receiver 300.

[0034] Power may be transferred by electromagnetic induction between two LC circuits which are impedance-matched with each other. The power transmission through electromagnetic induction may enable high efficiency power transmission.

[0035] The wireless power receiver 300 may include a receiving coil 310, a rectifier circuit 320 and a load 330. In the embodiment, the load 330 may be not included in the wireless power receiver 300, but may be provided separately. The power transmitted through the transmitting coil 210 is received at the receiving coil 310 by electromagnetic induction. The power transferred to the receiving coil 310 is transferred through the rectifier circuit 320 to the load 330.

[0036] FIG. 2 is an equivalent circuit diagram of the transmitting coil 210 according to the embodiment.

[0037] As shown in FIG. 2, the transmitting coil 210 may include an inductor L1 and a capacitor C1, and form a circuit having a suitable inductance value and a suitable capacitance value. The capacitor C1 may be a variable capacitor. By controlling the variable capacitor, an impedance matching may be performed. Meanwhile, an equivalent circuit of the receiving coil 320 may be equal to that depicted in FIG. 2.

[0038] FIG. 3 is an equivalent circuit diagram of the wireless power transmitting system according to the embodiment.

[0039] As shown in FIG. 3, the transmitting coil 210 may include an inductor L1 having a predetermined inductance value and a capacitor C1 having a predetermined capacitance value.

[0040] Further, as shown in FIG. 3, the receiving coil 310 may include an inductor L2 having a predetermined inductance value and a capacitor C2 having a predetermined capacitance value. The rectifier circuit 320 may include a diode D1 and a rectifying capacitor C3 such that the rectifier circuit 320 converts AC power into DC power and outputs the DC power.

[0041] Although the load 330 is denoted as a DC power source, the load 330 may be a battery or other devices requiring DC power.

[0042] Next, a wireless power receiver according to the embodiment will be described with reference to FIGS. 4 to 10.

[0043] FIG. 4 is a block diagram of a wireless power receiver according to the embodiment, FIG. 5 is a view showing an example of a configuration of the wireless power receiver according to the embodiment, FIG. 6 is a exploded perspective and sectional view illustrating the wireless power receiver according to the embodiment, FIG. 7 is a sectional view showing an arrangement of elements of the wireless power receiver according to the embodiment, FIG. 8 is a view illustrating a top surface and a bottom surface of the wireless power receiver according to the embodiment, FIG. 9 is a view illustrating one example of attaching a shielding unit onto the wireless power receiver according to the embodiment, and FIG. 10 is a view illustrating one example of inserting the shielding unit into the wireless power receiver according to the embodiment.

[0044] First, referring to FIG. 4, the wireless power receiver 300 may include a receiving coil 310, a short-range communication antenna 340, a switch 350, a protecting unit 360, a short-range communication module 370, a shielding unit 380, and a controller 390.

[0045] The wireless power receiver 300 according to the embodiment may be installed in a terminal or an electronic appliance requiring power, such as a portable terminal, a laptop computer, and a mouse.

[0046] The receiving coil 310 receives power from the transmitting coil 210 of the wireless power transmitter 200 through electromagnetic induction. That is, if a magnetic field is generated as an AC current flows through the transmitting coil 210, a current is induced to the receiving coil 310 by the generated magnetic field so that an AC current flows therethrough.

[0047] In the embodiment, the receiving coil 310 may be disposed in a reception space of a printed circuit board 301.

[0048] The receiving coil 310 may be provided by winding a conducting wire server times. In the embodiment, the receiving coil 310 may have a spiral shape, but the embodiment is not limited thereto.

[0049] The short-range communication antenna 340 may communicate with a reader capable of performing a short-range communication. The short-range communication antenna 340 may perform a function of an antenna which transmits and receives information to and from the reader. In the embodiment, the short-range communication antenna 340 may be disposed at an outside of the receiving coil 310. In the embodiment, the receiving coil 310 may be disposed in the reception space inside the printed circuit board 301, and the short-range communication antenna 340 may be disposed to surround the receiving coil 310 on the printed circuit board 301.

[0050] The above configuration will be described in more detail with reference to FIG. 6.

[0051] Referring to the exploded perspective view of the wireless power receiver 300 shown in FIG. 6(a), the wireless power receiver 300 may include a case 302, the printed circuit board 301, the receiving coil 310, the short-range communication antenna 340 and the shielding unit 380.

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