SYSTEM AND METHOD FOR CHARGING RECEIVER DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is related to India patent application entitled "SYSTEM AND METHOD FOR CHARGING RECEIVER DEVICES" filed concurrently herewith under attorney docket number 314788-1.

BACKGROUND

[0002] Embodiments of the present invention relate generally to wireless power transfer systems and more particularly to a system and method for charging receiver devices.

[0003] In general, power transfer systems are widely used to transfer power from a power source to one or more receiver devices, such as for example, mobile devices, biomedical devices, and portable consumer devices. Typically, the power transfer systems may be contact based power transfer systems or wireless power transfer systems. In certain applications, where instantaneous or continuous power transfer is required but interconnecting wires are inconvenient, the wireless power transfer systems are desirable.

[0004] In the wireless power transfer systems, a charging device is used to convert an input power to a transferrable power which is further transmitted to charge one or batteries in the receiver devices. However, these receiver devices are compatible with one of the wireless frequency standards. For example, there are currently three competing frequency standards: the Alliance for Wireless Power (A4WP), the Wireless Power Consortium (WPC), and the Power Matters Alliance (PMA). The WPC standard (Qi) is defined in a frequency range of 100 kHz to 200 kHz. The PMA standard is defined in a frequency range of 200 kHz to 400 kHz. Further, the A4WP standard is defined at a frequency of about 7

MHz. A conventional charging device cannot be used to charge the receiver devices operating at different frequency standards.

[0005] Thus, there is a need for an improved system and method for charging receiver devices operating at different frequency standards.

BRIEF DESCRIPTION

[0006] In accordance with one embodiment of the present invention, a charging pad is disclosed. The charging pad includes at least one first frequency coil operable at a first frequency band. Further, the charging pad includes at least one second frequency coil operable at a second frequency band different from the first frequency band. Also, the charging pad includes an excitation unit operationally coupled to the at least one first frequency coil and the at least one second frequency coil and configured to drive the at least one first frequency coil and the at least one second frequency coil.

[0007] In accordance with another embodiment of the present invention, a wireless charging device is disclosed. The wireless charging device includes a charging pad including an excitation unit configured to convert a DC voltage of an input power to at least one of a first AC voltage having a frequency from a first frequency band and a second AC voltage having a frequency from a second frequency band. Also, the charging pad includes a transmitting unit operatively coupled to the excitation unit, wherein the transmitting unit comprises at least one first frequency coil configured to transmit the first AC voltage having the frequency from the first frequency band. Further, the transmitting unit includes at least one second frequency coil configured to transmit the second AC voltage having the frequency from the second frequency band. In addition, the wireless charging device includes a control unit operatively coupled to the excitation unit and configured to feed at least one of a first frequency control signal and a second frequency control signal to the excitation unit.

[0008] In accordance with another embodiment of the present invention, a method for charging one or more receiver devices is disclosed. The method includes receiving, by an excitation unit, at least one of a first frequency control signal and a second frequency control signal. Further, the method includes converting, by the excitation unit, a DC voltage of an input power to a first AC voltage having a frequency from a first frequency band if the first frequency control signal is received. Also, the method includes converting, by the excitation unit, the DC voltage of the input power to a second AC voltage having a frequency from a second frequency band if the second frequency control signal is received. Furthermore, the method includes transmitting, by at least one first frequency coil, the first AC voltage having the frequency from the first frequency band, to a first receiver device. In addition, the method includes transmitting, by at least one second frequency coil, the second AC voltage having the frequency from the second frequency band, to a second receiver device.

DRAWINGS

[0009] These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0010] FIG. 1 is a block diagram representation of a wireless power transfer system in accordance with an embodiment of the present invention;

[0011] FIG. 2 is a schematic representation of a wireless power transfer system in accordance with an embodiment of the present invention;

[0012] FIG. 3 is a schematic representation of a wireless power transfer system in accordance with another embodiment of the present invention;

[0013] FIG. 4 is a diagrammatic representation of a charging pad having first frequency and second frequency coils in accordance with an embodiment of the present invention;

[0014] FIG. 5 is a diagrammatic representation of a charging pad having first frequency and second frequency coils in accordance with another embodiment of the present invention;

[0015] FIG. 6 is a diagrammatic representation of a charging pad having first frequency and second frequency coils inductively coupled to receiver devices in accordance with an embodiment of the present invention;

[0016] FIG. 7 is a flow chart illustrating a method for charging a plurality of receiver devices in accordance with an embodiment of the present invention; and

[0017] FIG. 8 is a graphical representation of different control signals in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

[0018] As will be described in detail hereinafter, various embodiments of a system and method for charging one or more wireless receiver devices are disclosed. In particular, the system and method disclosed herein employ an excitation unit that is capable of driving first frequency and second frequency coils enabling charging of the wireless receiver devices designed based on different frequency standards.

[0019] Unless defined otherwise, technical and scientific terms used herein have the same meaning as is commonly understood by one of ordinary skill in the art to which this specification belongs. The terms "first", "second", and the like, as used herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. Also, the terms "a" and "an" do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items. The term "or" is meant to be inclusive and mean one, some,

or all of the listed items. The use of "including," "comprising" or "having" and variations thereof herein are meant to encompass the items listed thereafter and equivalents thereof as well as additional items. The terms "connected" and "coupled" are not restricted to physical or mechanical connections or couplings, and can include electrical connections or couplings, whether direct or indirect. Furthermore, terms "circuit" and "circuitry" and "controlling unit" may include either a single component or a plurality of components, which are either active and/or passive and are connected or otherwise coupled together to provide the described function. In addition, the term operationally coupled as used herein includes wired coupling, wireless coupling, electrical coupling, magnetic coupling, radio communication, software based communication, or combinations thereof.

[0020] FIG. 1 is a diagrammatical representation of a wireless power transfer system 100 in accordance with an embodiment of the present invention. The wireless power transfer system 100 is used to transmit an electrical power from a power source 102 to one or more receiver devices such as mobile devices, biomedical devices, and portable consumer devices. Particularly, in an automobile industry, a vehicle includes one or more charging pads that are used for supplying electrical power from the power source 102 to the mobile devices like cell phones, laptops, heating ventilation and air-conditioning (HVAC) units *etc.* In one embodiment, the wireless power transfer system 100 may also be referred to as a contactless power transfer system.

[0021] In the illustrated embodiment, the wireless power transfer system 100 includes a wireless charging device 104 that is wirelessly coupled to a first receiver device 106 and a second receiver device 108. It may be noted that the wireless power transfer system 100 is not limited to the first receiver device 106 and the second receiver device 108 and may include any number of receiver devices.

[0022] The first and second receiver devices 106, 108 may be compatible with one of the wireless frequency standards. For example, one of the receiver devices may be compatible with Alliance for Wireless Power (A4WP) standard that is defined at a frequency of about 7 MHz. Similarly, another receiver device may be compatible with Wireless Power Consortium (WPC) standard (Qi) that is defined in a frequency range of 100 kHz to 200 kHz. One of the receiver devices may be compatible with Power Matters Alliance (PMA) standard that is defined in a frequency range of 200 kHz to 400 kHz. One of the other receiver devices may be compatible with Air Fuel Alliance standard that is defined at a frequency of about 6.7 MHz. For ease of understanding of the embodiment of the invention, the first receiver device 106 is considered to be compatible with a first frequency standard such as Air Fuel Alliance standard defined at a frequency of about 6.7 MHz. The first frequency standard may also be referred to as a high frequency standard. Similarly, the second receiver device 108 is considered to be compatible with a second frequency standard such as WPC standard defined in a frequency range of 100 kHz to 200 kHz. The second frequency standard may also be referred to as a low frequency standard. It may be noted that the receiver devices 106, 108 may be of any frequency standard and are not limited to the frequency standards mentioned herein. Further, any number of receiver devices that are compatible with any number of frequency standards may be envisioned for charging.

[0023] In conventional power transfer systems that are compatible with different frequency standards for each of the receiver devices/gadgets, a charging device may not supply power to each of the receiver devices at their corresponding frequency standards. In one of the conventional power transfer systems, separate charging devices having a dedicated converter and dedicated frequency coils for each frequency standard, are employed to supply power to the corresponding receiver device. However, using separate charging devices for each frequency standard may substantially increase set-up cost and maintenance cost of the conventional power transfer systems.

[0024] To overcome the above problems/drawbacks associated with conventional systems, the exemplary power transfer system 100 includes the wireless charging device 104 that is configured to charge the first and second receiver devices 106, 108 of any frequency standard. The wireless charging device 104 includes a charging pad 130 and a control unit 112 that are used for supplying electrical power from the power source 102 to the first and second receiver devices 106, 108. The charging pad 130 may be referred to as an electrical enclosure upon which the one or more receiver devices 106, 108 may be placed for charging one or more batteries in the corresponding receiver devices 106, 108. In one embodiment, the control unit 112 may be positioned within the charging pad 130. In another embodiment, the control unit 112 may be positioned external to the charging pad 130. Further, the charging pad 130 includes an excitation unit 110 and a transmitting unit 114. In one embodiment, the excitation unit 110 may include one or more converters (not shown) that are used for providing electrical power at a desired frequency to the first and second receiver devices 106, 108.

[0025] The excitation unit 110 is electrically coupled to the power source 102 and the control unit 112. The power source 102 is configured to supply an input power 120 having a DC voltage to the excitation unit 110. In some embodiments, the input power 120 may be in a range from about 1W to 200W. In one embodiment, the power source 102 may be a part of the wireless charging device 104. In another embodiment, the power source 102 may be positioned external to the wireless charging device 104.

[0026] Furthermore, the excitation unit 110 is configured to receive the input power 120 having the DC voltage from the power source 102. Further, the excitation unit 110 is configured to convert the DC voltage of the input power 120 to a first AC voltage having a frequency in a first frequency band and/or a second AC voltage having a frequency in a second frequency band. It may be noted that the first frequency band may be referred to as a range of frequencies from about 4 MHz to about 9 MHz. In a similar manner, the second frequency band may be

referred to as a range of frequencies from about 100 kHz to about 1 MHz. Also, it may be noted that the terms “frequency in a first frequency band” and “first frequency” may be used interchangeably in the below specification. Similarly, the terms “frequency in a second frequency band” and “second frequency” may be used interchangeably in the below specification.

[0027] Additionally, the excitation unit 110 is configured to receive a first frequency control signal 122 and/or a second frequency control signal 124 from the control unit 112. If the first frequency control signal 122 is received from the control unit 112, the excitation unit 110 is configured to convert the DC voltage of the input power 120 to the first AC voltage having the first frequency. In a similar manner, if the second frequency control signal 124 is received from the control unit 112, the excitation unit 110 is configured to convert the DC voltage of the input power 120 to the second AC voltage having the second frequency. In one example, the first and second AC voltages may be in a range from about 5 Volts to about 50 Volts. The details pertaining to converting the DC voltage to the first AC voltage or the second AC voltage are explained in greater detail below with reference to FIGS. 2 and 3.

[0028] In one embodiment, the control unit 112 is configured to alternately send the first frequency control signal 122 and the second frequency control signal 124 at regular time intervals to the excitation unit 110. In one specific embodiment, the control unit 112 is configured to send a modulation signal including the first frequency control signal 122 and the second frequency control signal 124. In another embodiment, the control unit 112 is configured to concurrently send the first frequency control signal 122 and the second frequency control signal 124 to different sets of switches in the excitation unit 110.

[0029] The excitation unit 110 is further configured to transmit the input power having the first AC voltage or the second AC voltage to the transmitting unit 114. The transmitting unit 114 includes one or more first frequency coils 116 and one or more second frequency coils 118 that are electrically coupled to the excitation

unit 110. In one embodiment, the one or more first frequency coils 116 and the one or more second frequency coils 118 may be stacked one above the other. In another embodiment, the one of more first frequency coils 116 and the one or more second frequency coils 118 may be positioned side-by-side on a same plane or on a different plane. Further, the one or more first frequency coils 116 are inductively coupled to a receiver coil (not shown in FIG. 1) in the first receiver device 106. One or more second frequency coils 118 are inductively coupled to a receiver coil (not shown in FIG. 1) in the second receiver device 108. Further, the first frequency and second frequency coils 116, 118 are used to wirelessly transmit the input power having the first AC voltage or the second AC voltage to the first and second receiver devices 106, 108. Particularly, if the excitation unit 110 converts the DC voltage to the first AC voltage having the first frequency, the first frequency coils 116 are excited to transmit the first AC voltage having the first frequency to the first receiver device 106. In a similar manner, if the excitation unit 110 converts the DC voltage to the second AC voltage having the second frequency, the second frequency coils 118 are excited to transmit the second AC voltage having the second frequency to the second receiver device 108.

[0030] Further, the first and second receiver devices 106, 108 are configured to use the first AC voltage having the first frequency or the second AC voltage having the second frequency for charging one or more batteries 126, 128 included in the first and second receiver devices 106, 108. In one embodiment, the first and second receiver devices 106, 108 such as mobile phones and laptops may be inductively coupled to the first frequency coils 116 and/or the second frequency coils 118 based on the frequency standards for which the first and second receiver devices 106, 108 are designed. For example, if the first receiver device 106 is designed to the first frequency standard such as Air Fuel Alliance standard, the first receiver device 106 receives the first AC voltage having the first frequency from the first frequency coils 116. Similarly, if the second receiver device 108 is designed to a second frequency standard such as WPC standard, the second

receiver device 108 receives the second AC voltage having the second frequency from the second frequency coils 118. In one example, the first and second receiver devices 106, 108 may be placed on the charging pad 130 for charging the batteries 126, 128 in the first and second receiver devices 106, 108.

[0031] Thus, by employing the exemplary wireless power transfer system 100, the single charging device 104 is configured to transfer power to the first and second receiver devices 106, 108 that are compatible with one or more frequency standards.

[0032] Referring to FIG. 2, a detailed schematic representation of the wireless power transfer system 100 in accordance with an embodiment of the present invention is depicted. The wireless power transfer system 100 is used to transmit the input power 120 from the power source 102 to the first and second receiver devices 106, 108.

[0033] The wireless power transfer system 100 includes the wireless charging device 104, the first receiver device 106, and the second receiver device 108. The wireless charging device 104 is wirelessly coupled to the first receiver device 106 and the second receiver device 108. The first receiver device 106 and the second receiver device 108 may be compatible with one of the wireless frequency standards.

[0034] Further, the wireless charging device 104 includes the charging pad 130 and the control unit 112 that are used for supplying electrical power from the power source 102 to the first and second receiver devices 106, 108. The charging pad 130 includes the excitation unit 110 and the transmitting unit 114. It may be noted that the wireless power transfer system 100 may include other components and is not be limited to the components shown in FIG. 2.

[0035] In the illustrated embodiment, the excitation unit 110 includes only a single converter 216 that is electrically coupled to the power source 102 and configured to receive the input power 120 having the DC voltage from the power

source 102. The single converter 216 is defined as an electrically coupled device that has single DC or line frequency input. It may be noted that in other embodiments, the excitation unit 110 may include any number of converters and is not limited to a single converter. Further, the single converter 216 includes a first switch 208, a second switch 210, a plurality of diodes 212, and a plurality of capacitors 214 that are arranged to form a half bridge inverter circuit. The first and second switches 208, 210, the diodes 212, and the capacitors 214 are electrically coupled between input terminals 217 and output terminals 218 of the excitation unit 110. In one embodiment, the switches 208, 210 may include electronic switches such as MOSFETs or IGBTs. It may be noted that the switches 208, 210 may include other semiconductor switches and is not limited to MOSFETs and IGBTs. Further, the first switch 208 and the second switch 210 are operated complimentary to each other. For example, if the first switch 208 is activated for a time duration T_{on}, the second switch 210 is deactivated for this time duration T_{on}. Similarly, if the second switch 210 is activated for the time duration T_{off}, the first switch 208 is deactivated for this time duration T_{off}.

[0036] Furthermore, the control unit 112 is configured to alternately and repeatedly send a first frequency control signal 122 and a second frequency control signal 124 to the first switch 208 and the second switch 210. In one embodiment, the control unit 112 may generate the first and second frequency control signals 122, 124 based on change in characteristics of the first and second frequency coils 116, 118. For example, if the first receiver device 106 and/or the second receiver device 108 are placed on the charging pad 130, the characteristics such as electrical current in the first and/or second frequency coils 116, 118 may change. Further, the change in the characteristics of the first and second frequency coils 116, 118 may be used by the control unit 112 to generate the first and second frequency control signals 122, 124.

[0037] Furthermore, the control unit 112 sends the first frequency control signal 122 to the first switch 208 for a first time period. Concurrently, the control unit 112 sends a signal that is complimentary to the first frequency control signal 122

to the second switch 210 for the first time period. In one example, the first frequency control signal 122 may have a high switching pulse frequency of about 6.7 MHz. During the first time period, the first switch 208 and the second switch 210 are operated complimentary to each other to convert the DC voltage of the input power 120 to the first AC voltage having a first frequency. In one embodiment, the first frequency may be in a range from about 4 MHz to about 9 MHz. In one specific embodiment, the first switch 208 and the second switch 210 is configured to modulate the DC voltage of the input power 120 based on the first frequency control signal 122 to generate the first AC voltage having the first frequency at the output terminals 218 of the excitation unit 110.

[0038] In a similar manner, the control unit 112 sends the second frequency control signal 124 to the first switch 208 for a second time period. Concurrently, the control unit 112 sends a signal that is complimentary to the second frequency control signal to the second switch 210 for the second time period. In one embodiment, the second frequency control signal 124 may have a low switching pulse frequency of about 100 kHz. During the second time period, the first switch 208 and the second switch 210 are operated complimentary to each other to convert the DC voltage of the input power 120 to the second AC voltage having a second frequency. In one embodiment, the second frequency may be in a range from about 100 kHz to about 1 MHz. In one embodiment, the first switch 208 and the second switch 210 are configured to modulate the DC voltage of the input power 120 based on the second frequency control signal 124 to provide the second AC voltage having the second frequency at the output terminals 218 of the excitation unit 110.

[0039] Further, the input power having the first AC voltage or the second AC voltage is transmitted from the excitation unit 110 to the transmitting unit 114. The transmitting unit 114 includes the first frequency coils 116 and the second frequency coils 118. In the illustrated embodiment, only one first frequency coil 116 and one second frequency coil 118 are shown. The first frequency coils 116 are electrically coupled to the excitation unit 110 and inductively coupled to a

corresponding receiver coil 224 in the first receiver device 106. The first frequency coils 116 are used to transfer the power having the first AC voltage to the receiver coil 224 in the first receiver device 106. Further, the power having the first AC voltage is then transmitted from the receiver coil 224 to an electric load 228 such as a battery in the first receiver device 106 via a power conditioner 232.

[0040] In a similar manner, the second frequency coils 118 are electrically coupled to the excitation unit 110 and inductively coupled to a corresponding receiver coil 226 in the second receiver device 108. The second frequency coils 118 are used to transfer the power having the second AC voltage to the receiver coil 226 in the second receiver device 108. Further, the power having the second AC voltage is then transmitted from the receiver coil 226 to an electric load 230 such as a battery in the second receiver device 108 via a power conditioner 234.

[0041] During normal operation of the wireless power transfer system 100, the control unit 112 is configured to periodically and/or alternately send the first frequency control signal 122 and the second frequency control signal 124 to the excitation unit 110. Particularly, the control unit 112 sends the first frequency control signal 122 to the first switch 208 and a signal that is complimentary to the first frequency control signal 122 to the second switch 210 for the first time period. Further, during the first time period, the first switch 208 and the second switch 210 toggles between ON state and OFF state based on switching pulse of the first frequency control signal 122 to convert the DC voltage of the input power to the corresponding first AC voltage having the first frequency. It may be noted that the ON state may be referred to as a state where the switches 208, 210 are activated. The OFF state may be referred to as a state where the switches 208, 210 are deactivated. Furthermore, the first AC voltage having the first frequency is provided to the first frequency coil 116 to transmit the power having the first AC voltage to the receiver coil 224 in the first receiver device 106. Thereafter, the receiver coil 224 transmits the first AC voltage having the first frequency to the load 228 via the power conditioner 232.

[0042] Furthermore, at the end of the first time period, the control unit 112 sends the second frequency control signal 122 to the first switch 208 and a signal that is complimentary to the first frequency control signal 122 to the second switch 210 for the second time period. Further, during the second time period, the first switch 208 and the second switch 210 toggles between ON state and OFF state based on switching pulse of the second frequency control signal 124 to convert the DC voltage of the input power to the corresponding second AC voltage having the second frequency. The second AC voltage having the second frequency is provided the second frequency coil 118 to transmit the power having the second AC voltage to the receiver coil 226 in the second receiver device 108. Thereafter, the receiver coil 226 transmits the second AC voltage having the second frequency to the load 230 via the power conditioner 234. In one embodiment, the control unit 112 may alternately send the first frequency control signal 122 and the second frequency control signal 124 to the excitation unit 110 to provide the first AC voltage having the first frequency and the second AC voltage having the second frequency to the corresponding receiver devices 106, 108.

[0043] In the exemplary power transfer system 100, the excitation unit 110 drives the first frequency coils 116 and the second frequency coils 118 to transfer the power from the power source 102 to the receiver devices 106, 108 of different frequency standards.

[0044] Referring to FIG. 3, a schematic representation of a wireless power transfer system 300 in accordance with another embodiment of the present invention is depicted. The wireless power transfer system 300 of FIG. 3 is similar to the wireless power transfer system 100 of FIG. 2 except that the excitation unit 302 includes a single converter 304 having a full bridge inverter circuit. Particularly, the single converter 304 includes a first leg of switches 306 and a second leg of switches 308. The first leg of switches 306 is configured to receive a first frequency control signal 122 from the control unit 112 and the second leg of switches 308 is configured to receive a second frequency control signal 124

from the control unit 112. In this embodiment, the first frequency control signal 122 is a continuous signal having a high switching pulse frequency of about 6.7 MHz and the second frequency control signal 124 is a continuous signal having a low switching pulse frequency of about 200 kHz.

[0045] The first leg of switches 306 is activated if the first frequency control signal 122 is received. Further, the first leg of switches 306 is configured to convert a DC voltage of the input power 120 to a first AC voltage having a first frequency. In one embodiment, the first frequency may be in a range from about 4 MHz to about 9 MHz. The first AC voltage having the first frequency is transmitted to the first frequency coil 116 which in turn inductively transfers the power having the first AC voltage to the first receiver device 106.

[0046] In a similar manner, the second leg of switches 308 is activated if the second frequency control signal 124 is received. Further, the second leg of switches 308 is configured to convert the DC voltage of the input power 120 to a second AC voltage having a second frequency. In one embodiment, the second frequency may be in a range from about 100 kHz to about 1 MHz. The second AC voltage having the second frequency is transmitted to the second frequency coil 118 which in turn inductively transfers the power having the second AC voltage to the second receiver device 108.

[0047] Referring to FIG. 4, a schematic representation of a charging pad 402 in accordance with an exemplary embodiment is depicted. The charging pad 402 may be similar to the charging pad 130 of FIG. 1. Further, the charging pad 402 includes the one or more first frequency coils 116 and the one or more second frequency coils 118. Particularly, the charging pad 402 includes a first layer 404 having the one or more first frequency coils 116 and a second layer 406 having the one or more second frequency coils 118. The first and second layers 404, 406 may be referred to as electrical carrier having one or more frequency coils. The first layer 404 and the second layer 406 are positioned proximate to each other in the charging pad 402. In one embodiment, the first layer 404 may include a

plurality of first frequency coils 116 that are arranged in parallel configuration and/or serial configuration. Similarly, the second layer 406 may include a plurality of second frequency coils 118 that are arranged in parallel configuration and/or serial configuration. In one embodiment, the charging pad 402 may also include the excitation unit that is capable of independently driving the one or more first frequency coils 116 and/or the one or more second frequency coils 118.

[0048] The one or more first frequency coils 116 and the one or more second frequency coils 118 are stacked one above the other within the charging pad 402. The receiver devices are placed at a predefined location on a top surface of the charging pad 402 in such a way that the one or more first frequency coils 116 and the one or more second frequency coils 118 are disposed below the predefined location, within the charging pad 402. The excitation unit 130 drives the one or more first frequency coils 116 and/or the one or more second frequency coils 118 based on the frequency standard of the receiver devices.

[0049] Referring to FIG. 5, a schematic representation of a charging pad 502 in accordance with another embodiment is depicted. The charging pad 502 includes a single layer 504 having the one or more first frequency coils 116 and the one or more second frequency coils 118. Particularly, the first frequency coils 116 and the second frequency coils 118 are alternately positioned in the single layer 504 of the charging pad 502. Specifically, the one or more first frequency coils 116 and the one or more second frequency coils 118 are embedded within the charging pad 502. In one embodiment, the one of more first frequency coils 116 and the one or more second frequency coils 118 may be positioned side-by-side on a same plane or on a different plane. The single layer 504 may be referred to as an electrical carrier having different frequency coils.

[0050] Referring to FIG. 6, a schematic representation of the charging pad 402 in accordance with an exemplary embodiment is depicted. The charging pad 402 includes a first layer 404 having the one or more first frequency coils 116 and a second layer 406 having the one or more second frequency coils 118. Further, the

first frequency coils 116 are inductively coupled to the first receiver device 106 and the second frequency coils 118 are inductively coupled to the second receiver device 108. In one embodiment, the charging pad 402 includes a surface upon which the first and second receiver devices 106, 108 are positioned.

[0051] Referring to FIG. 7, a flow chart illustrating a method for charging a plurality of receiver devices in accordance with an embodiment of the present invention is depicted. The method 700 is described with reference to FIGs. 1 and 2. At step 702, the excitation unit 110 receives at least one of the first frequency control signal 122 and the second frequency control signal 124 from the control unit 112. Particularly, the control unit 112 sends the first frequency control signal 122 and the second frequency control signal 124 alternately and repeatedly to the excitation unit 110. The power source 102 supplies the input power 120 having the DC voltage to the excitation unit 110.

[0052] Subsequently, at step 704, the excitation unit 110 converts the DC voltage of the input power 120 to the first AC voltage having a first frequency if the first frequency control signal 122 is received. Particularly, the control unit 112 sends the first frequency control signal 122 to the first switch 208 and a signal that is complimentary to the first frequency control signal 122 to the second switch 210 for the first time period. Further, during the first time period, the first switch 208 and the second switch 210 in the excitation unit 110 toggles between ON state and OFF state based on switching pulse of the first frequency control signal 122 to convert the DC voltage of the input power to the corresponding first AC voltage having the first frequency. In one embodiment, the first frequency may be in a range from about 4 MHz to about 9 MHz.

[0053] Furthermore, at step 706, the excitation unit 110 converts the DC voltage of the input power to the second AC voltage having a second frequency if the second frequency control signal 124 is received. Particularly, the control unit 112 sends the second frequency control signal 122 to the first switch 208 and a signal that is complimentary to the first frequency control signal 122 to the

second switch 210 for the second time period. Further, during the second time period, the first switch 208 and the second switch 210 in the excitation unit 110 toggles between ON state and OFF state based on switching pulse of the second frequency control signal 124 to convert the DC voltage of the input power to the corresponding second AC voltage having the second frequency. In one embodiment, the second frequency may be in a range from about 100 kHz to about 1 MHz.

[0054] At step 708, at least one first frequency coil 116 transmits the first AC voltage having the first frequency to the first receiver device 106. Further, the excitation unit 110 drives the first frequency coil 116 in the transmitting unit 114 to transfer the first AC voltage having the first frequency to the receiver coil 224 of the first receiver device 106. Further, the first AC voltage is conditioned by the power conditioner 232 and supplied to the load 228 such as a battery in the first receiver device 106.

[0055] Furthermore, at step 710, at least one second frequency coil 118 transmits the second AC voltage having the second frequency to the second receiver device 108. Further, the excitation unit 110 drives the second frequency coil 118 in the transmitting unit 114 to transfer the second AC voltage having the second frequency to the receiver coil 226 of the second receiver device 108. Further, the second AC voltage is conditioned by the power conditioner 234 and supplied to the load 230 such as a battery in the second receiver device 108.

[0056] In accordance with the exemplary embodiments discussed herein, the exemplary system and method facilitate to charge the receiver devices of any frequency standard, using the excitation unit 110.

[0057] Referring to FIG. 8, a graphical representation of different control signals in accordance with aspects of the present invention is shown. Reference numeral 802 is representative of a first frequency control signal transmitted from the control unit to the excitation unit for converting the DC voltage of the input power to the first AC voltage. The first frequency control signal 802 includes a

plurality of switching pulses 804 during a first time period represented by 806. Further, reference numeral 808 is representative of a second frequency control signal transmitted from the control unit to the excitation unit for converting the DC voltage of the input power to the second AC voltage. The second frequency control signal 808 includes a single switching pulse 810 during a second time period represented by 820. It should be noted herein that the second frequency control signal 808 includes more number of switching pulses within the second time period 820. However, the number of switching pulses of the second frequency control signal 808 within the second time period 820 is less than the number of switching pulses for the first frequency control signal 802 within the first time period 806. Reference numeral 812 is representative of a modulation signal which includes the first frequency control signal 814 and the second frequency control signal 816. Particularly, the first frequency control signal 814 is generated during the first time period 806 and the second frequency control signal 816 is generated during the second time period 820.

[0058] While only certain features of the present disclosure have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the present disclosure.

CLAIMS:

1. A charging pad (130, 402, 502) comprising:

at least one first frequency coil (116) operable at a first frequency band;

at least one second frequency coil (118) operable at a second frequency band different from the first frequency band; and

an excitation unit (110, 302) operationally coupled to the at least one first frequency coil (116) and the at least one second frequency coil (118) and configured to drive the at least one first frequency coil (116) and the at least one second frequency coil (118).

2. The charging pad (130, 402, 502) of claim 1, wherein the excitation unit (110, 302) is further configured to:

receive at least one of a first frequency control signal (122) and a second frequency control signal (124) from a control unit;

convert a DC voltage of an input power (120) to a first AC voltage having a frequency from the first frequency band if the first frequency control signal (122) is received; and

convert the DC voltage of the input power (120) to a second AC voltage having a frequency from the second frequency band if the second frequency control signal (124) is received.

3. The charging pad (130, 402, 502) of claim 2, wherein the excitation unit (110, 302) is configured to drive the at least one first frequency

coil (116) to transfer the first AC voltage having the frequency from the first frequency band, to a first receiver device (106).

4. The charging pad (130, 402, 502) of claim 2, wherein the excitation unit (110, 302) is configured to drive the at least one second frequency coil (118) to transfer the second AC voltage having the frequency from the second frequency band, to a second receiver device (108).

5. The charging pad (130, 402, 502) of claim 1, further comprising:

a first layer (404) comprising the at least one first frequency coil (116); and

a second layer (406) comprising the at least one second frequency coil (118).

6. The charging pad (130, 402, 502) of claim 1, further comprising a single layer (504) comprising the at least one first frequency coil (116) and the at least one second frequency coil (118).

7. The charging pad (130, 402, 502) of claim 1, wherein the excitation unit (110, 302) comprises only a single converter (216, 304) that is configured to drive the at least one first frequency coil (116) and the at least one second frequency coil (118).

8. The charging pad (130, 402, 502) of claim 1, wherein the at least one first frequency coil (116) and the at least one second frequency coil (118) are stacked one above the other.

9. A wireless charging device comprising:

a charging pad (130, 402, 502) comprising:

an excitation unit (110, 302) configured to convert a DC voltage of an input power (120) to at least one of a first AC voltage having a frequency from a first frequency band and a second AC voltage having a frequency from a second frequency band; and

a transmitting unit (114) operatively coupled to the excitation unit (110, 302), wherein the transmitting unit (114) comprises:

at least one first frequency coil (116) configured to transmit the first AC voltage having the frequency from the first frequency band; and

at least one second frequency coil (118) configured to transmit the second AC voltage having the frequency from the second frequency band; and

a control unit (112) operatively coupled to the excitation unit (110, 302) and configured to feed at least one of a first frequency control signal (122) and a second frequency control signal (124) to the excitation unit (110, 302).

10. The wireless charging device of claim 9, wherein the control unit (112) is configured to feed a modulation signal (812) comprising at least one of

the first frequency control signal (122, 814) and the second frequency control signal (124, 816).

11. The wireless charging device of claim 10, wherein the excitation unit (110, 302) is configured to:

convert the DC voltage of the input power (120) to the first AC voltage having the frequency from the first frequency band if the first frequency control signal (122) is received; and

convert the DC voltage of the input power (120) to the second AC voltage having the frequency from the second frequency band if the second frequency control signal (124) is received.

12. The wireless charging device of claim 11, wherein the excitation unit (110, 302) is configured to drive the at least one first frequency coil (116) to transmit the first AC voltage having the frequency from the first frequency band, to a first receiver device (106).

13. The wireless charging device of claim 12, wherein the at least one first frequency coil (116) is inductively coupled to a receiver coil (140) in the first receiver device (106) to transmit the first AC voltage having the frequency from the first frequency band to the first receiver device (106).

14. The wireless charging device of claim 11, wherein the excitation unit (110, 302) is configured to drive the at least one second frequency coil (118)

to transmit the second AC voltage having the frequency from the second frequency band, to a second receiver device (108).

15. The wireless charging device of claim 14, wherein the at least one second frequency coil (118) is inductively coupled to a receiver coil (142) in the second receiver device (108) to transmit the second AC voltage having the frequency from the second frequency band to the second receiver device (108).

16. A method comprising:

receiving, by an excitation unit (110, 302), at least one of a first frequency control signal (122) and a second frequency control signal (124);

converting, by the excitation unit (110, 302), a DC voltage of an input power (120) to a first AC voltage having a frequency from a first frequency band if the first frequency control signal (122) is received;

converting, by the excitation unit (110, 302), the DC voltage of the input power (120) to a second AC voltage having a frequency from a second frequency band if the second frequency control signal (124) is received;

transmitting, by at least one first frequency coil (116), the first AC voltage having the frequency from the first frequency band, to a first receiver device (106); and

transmitting, by at least one second frequency coil (118), the second AC voltage having the frequency from the second frequency band, to a second receiver device (108).

17. The method of claim 16, further comprising:

feeding, by a control unit (112), at least one of the first frequency control signal (122) and the second frequency control signal (124) to the excitation unit (110, 302); and

supplying, by a power source (102), the input power (120) having the DC voltage to the excitation unit (110, 302).

18. The method of claim 17, further comprising:

driving, by the excitation unit (110, 302), the at least one first frequency coil (116) if the first frequency control signal (122) is received from the control unit (112); and

driving, by the excitation unit (110, 302), the at least one second frequency coil (118) if the second frequency control signal (124) is received from the control unit (112).

19. The method of claim 16, further comprising transmitting the first AC voltage having the frequency from the first frequency band to charge at least one battery (126) in the first receiver device (106).

20. The method of claim 16, further comprising transmitting the second AC voltage having the frequency from the second frequency band to charge at least one battery (128) in the second receiver device (108).