(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 February 2017 (23.02.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/027917 A1

(51) International Patent Classification:
H02J 50/80 (2016.01) *H04B 1/713* (2011.01)
H02J 50/12 (2016.01) *H04B 1/7136* (2011.01)
H04B 1/69 (2011.01)

(21) International Application Number: PCT/AU2016/050751

(22) International Filing Date: 14 August 2016 (14.08.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2015903346 19 August 2015 (19.08.2015) AU
2015903400 21 August 2015 (21.08.2015) AU

(72) Inventor; and
(71) Applicant : MANDEVILLE-CLARKE, Ben [AU/AU]; 30 Smiths Road, Tinbeerwah, Queensland 4563 (AU).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR ACTIVE USER CONTROL OF WIRELESS POWER SECURITY PARAMETERS

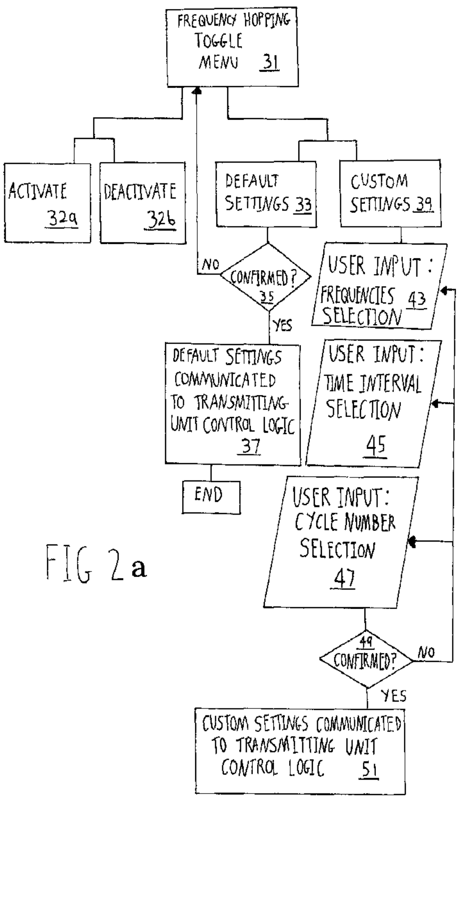


FIG 2a

(57) Abstract: A system for actively controlling the security parameters applied to a wireless power transmission network to prevent unauthorized wireless power receiving units from effectively receiving wireless power. The customization of frequency hopping and / or phase changing parameters may additionally or simultaneously be for the purpose of preventing or minimising wireless power signal attrition that may arise due to signal interference with proximal wireless communications or wireless power signals, or due to uncontrollable environmental factors. An authorised user is able to customize at least one parameter of at least one frequency hopping and/or phase change sequence or algorithm implemented during wireless power transmission and reception.

WO 2017/027917 A1

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

SYSTEM AND METHOD FOR ACTIVE USER CONTROL OF WIRELESS POWER SECURITY

US PATENT PRIOR ART REFERENCES

6,798,716 B1	28/2004	Charych
7,741,734 B2	22/2010	Joannopoulos et al.
8,076,800 B2	13/2010	Joannopoulos et al.
8,253,278 B2	28/2012	Cook et al.
8,446,248 B2	21/2013	Zeine
8,854,176 B2	07/2014	Zeine
8,879,995 B2	04/2014	Viglione et al.

This application claims the benefit of Australian Provisional Application No. 2015903346, filed Aug. 19, 2015 and Australian Provisional Application No. 2015903400, filed Aug. 21, 2015.

FIELD OF THE INVENTION

The present disclosure relates to wireless power transmission, and more particularly to providing a standard software platform for customizing wireless power transmission parameters for the primary purpose of wireless power security across one or more wireless power transmission networks and across one or more unique wireless power transmission technologies.

BACKGROUND OF THE INVENTION

Many portable electronics devices are powered by batteries, with rechargeable batteries being the most common type of battery used. However, rechargeable batteries require frequent access to an alternating current (A.C.) power outlet, which may not always be available to the user in a convenient and easy-to-access capacity. It is therefore desirable for electronics devices and portable electronics devices to derive a suitable source of power from electromagnetic energy, in the form of wireless power.

As such, a number of diverse wireless power transmission technologies have been developed, or are currently being developed, in order to increase the convenience and safety of power access. The variety of wireless power transmission technologies that do not require the transmitting device and the receiving device to be in physical or near-field contact are of particular interest, as these technologies promise greater convenience and access compared to wireless power transmission technologies requiring substantial physical or near-field contact. Feasible wireless power technologies include magnetic resonance coupling, which involves low-frequency energy transfer, long distance and preferably receiver-focused wireless power transmissions in the higher radio frequency and microwave regions of the electromagnetic spectrum, and mid-range, preferably receiver-focused, ultrasonic wireless power transmissions.

Magnetic resonance coupling, ideal for mid-range wireless power transmission of up to two metres, involves tuning an at least one inductive element and an at least one capacitor on a transmitting unit and tuning an at least one inductive element and an at least one capacitor on a receiving unit to achieve a matching resonant state as found by the formula:

$$Fc = 1/2\pi\sqrt{LC}$$

Where “C” is the capacitance value and “L” is the inductance value. At resonance, reactance impedance is at a minimum, hence allowing for efficient wireless power transfer. Said inductive element is optimally an air core coil, or alternatively a coil wound magnetically permeable material. Said capacitor optimally comprises an at least one reconfigurable capacitor. Magnetic resonance coupling is most suitable for powering high-power electronics devices, such as but not limited to, laptops, computers, and electric vehicles.

Higher radio frequency and microwave wireless power transmissions, most suitable for distances exceeding two metres, involves isotropic antennas or, for increased gain, phased array techniques for a constructively beamformed signal or receiver-focused signal that successfully challenges the inverse square law, or mechanically directional antennas such as Yagi antennas, and the like, that also successfully challenge the inverse square law. International ISM bands are the ideal frequencies of transmission in most cases due to the minimum regulatory approval requirements with regards to devices utilizing the ISM bands. Higher radio frequency and microwave wireless power transmissions are most suitable for powering low-power and substantially portable electronics devices, such as but not limited to, the Internet of Things, sensors, smartphones, tablets, and the like.

Ultrasound or ultrasonic wireless power transmission, most suitable for distances up to fifteen metres, involves directional ultrasound as the wireless power transfer medium. A transmitting device comprises a plurality of ultrasound transducers forming an ultrasound transducer array, and a receiver operable to absorb preferably focused ultrasound and convert the absorbed ultrasound into useable direct current (D.C.) energy. Ultrasound wireless power transmissions are most suitable for powering low-power and substantially portable electronics devices, such as but not limited to, the Internet of Things, sensors, smartphones, tablets, and the like. Ultrasonic wireless power transmission is most suitable in physical environments wherein the density of electromagnetic energy and interference is high and hence the use of radio-frequency or microwave wireless power transmission systems are impractical or dangerous.

Due to each wireless power transmission technology's respective advantages and disadvantages, many physical environments will comprise several different wireless power transmission technologies in proximity in order to service the plurality of different electronics devices requiring wireless power.

Appropriate mechanisms to prevent unauthorized wireless power receiving units from accessing and using wireless power signals, or to prevent a malicious third party from signal jamming a wireless power network with destructive interference and causing significant inefficiencies, is especially important in scenarios such as the utilization of wireless power in critical infrastructure or medical applications, where a prevention of efficient wireless power transfer could lead to potentially life threatening situations. Alternatively, homes or businesses in which wireless power is used to power or charge a plurality of electronic devices may be at risk of allowing neighbouring homes, businesses or passerbys to pick up an unsecured wireless power signal and use this unsecured wireless power signal without permission. Extensive unauthorized usage may lead to significant negative financial repercussions. Implementing security mechanisms for wireless power transfer over distance is extremely different to wireless data encryption techniques; unlike wireless communications, wireless power cannot be scrambled as it is the raw radio frequency, microwave, electromagnetic or magnetic signal that is rectified to usable d.c. power.

It is well known within the art that a receiving antenna should be optimally tuned to the frequency of the transmission antenna. Based on the laws of physics, any wireless power receiver that is tuned to the frequency of transmission from a wireless power transmitter, and is within sufficient distance, will be able to efficiently receive that signal and rectify it to usable d.c. power. The wireless power over distance systems being developed for various applications are generally being designed to operate at 13.56MHz, 2.4GHz, or 5.8GHz. Single frequency wireless power transmission maximises wireless power transfer, however, any receiver tuned to, for example, 13.56MHz, 2.4GHz, or 5.8GHz, will be able to efficiently receive and rectify wireless power transmissions. In wireless communications scenarios, collection of the transmitted radio-frequency signal by an unauthorized receiver is not a security risk, because without knowing the “decoding key”, the unauthorized receiver will not be able to extract meaningful information from the collected radio-frequency waveform.

Hence, without a proper security mechanism in place, an unauthorized receiver only needs to be tuned to the frequency of wireless power transmission within range of a transmitting unit to steal useful power.

Presently, wireless power network operators and owners dealing with a variety of wireless power transmission technologies are unable to utilize a standard wireless power security platform to manage security settings to prevent unauthorized access to wireless power transmissions across one or more wireless power transmission networks. Wireless power security is a fundamental part of ensuring that non-contact wireless power technologies are feasible and viable. Hence, to ensure that maximum security is provided and maintained, especially on wireless power networks servicing critical electronics devices and infrastructure, it is essential that user-convenience and seamlessness is maximized for customizing wireless power security settings across a variety of wireless power transmission technologies. Wireless power security standardization across the plurality of wireless power transmission technologies decreases the total learning requirements for a wireless power operator or owner, and hence, significantly assists in ensuring that the wireless power operator or owner is consistently competent in applying the appropriate wireless power security setting customizations for a particular wireless power transmission network without undue room for error. Furthermore, in the instance of a security breach to a particular wireless power network by signal jamming or one or more unauthorized wireless power receiving units, it is essential that a wireless power network operator or owner is able to respond quickly to mitigate the security threat. A universally standard wireless power security platform assists in minimizing confusion, hence saving critical time and assisting in minimizing damage caused to the wireless power network by the signal jamming or unauthorized access.

Therefore a need exists in the art to solve the aforementioned problems.

BRIEF DESCRIPTION OF THE INVENTION

There exists a need in the art for a technique that enables an authorised user, such as an owner or manager, of a wireless power transmission network, or an appropriate non-human agent such as an artificial intelligence module or advanced software process, to actively customize the frequency hopping and / or phase changing parameters of the wireless power security process system and method and hence implement a range of "active security measures" to prevent or remove an unauthorized wireless power receiving unit from accessing the wireless power transmission network.

Under certain substantially uncontrollable environmental conditions, such as high humidity, or a high density of radio-frequency signals, some radio or microwave frequencies are prone to greater attrition rates than others. By enabling active customization of the frequency hopping and / or phase changing parameters, signal attrition due to uncontrollable environmental factors, such as high humidity, can be minimized by enabling a wireless power transmitting unit to transmit at frequencies and / or phases that are less prone to signal attrition from the uncontrollable environmental conditions.

Therefore, there exists a need in the art for a technique that enables an authorised user, such as an owner or manager, of a wireless power transmission network, to actively customize the frequency hopping and / or phase changing parameters to prevent or minimise wireless power transfer attrition arising from interference with surrounding wireless communications or wireless power signals, or surrounding uncontrollable environmental factors.

Finally, by enabling an authorized user to extensively customize frequency hopping and / or phase changing parameters, the authorized user can determine the appropriate weightings between security and efficiency. The greater the complexity of a frequency hopping and / or phase changing process, the higher the inefficiencies of wireless power transfer will be. In some wireless power networks, such as critical wireless sensor networks, a high level of security will merit a slight decline in efficiency; in other wireless power networks, such as home or professional networks, a moderate level of security is generally more suitable to ensure high efficiency.

The invention disclosed herein can be used to simultaneously provide wireless power signal security and minimise inefficiencies from signal interference and environmental interferences, and to simultaneously be applied to a plurality of wireless power transmitters.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic block diagram of an example embodiment wireless power transmission system to which the present invention may be integrated with or applied to.

FIG. **2a** is an exemplary schematic block diagram showing a process method by which an authorised user may actively customize frequency hopping and / or phase changing parameters in accordance with the present invention.

FIG. **2b** is an example embodiment schematic diagram showing a process method by which a frequency hopping sequence is recalibrated by an artificial intelligence module in accordance with the present invention.

FIG. **2c** is an example embodiment schematic diagram showing a process method by which environmental sensors relay data on the external environment to an artificial intelligence module, and the artificial intelligence module subsequently recalibrates frequency hopping and / or phase changing parameters, in accordance with the present invention.

FIG. **3** is an exemplary schematic block diagram of an example embodiment transmitting unit control logic in accordance with the present invention.

FIG. **4** is an example embodiment schematic diagram showing an authorised third party user interface device with an active communication link to a wireless power transmitting unit in accordance with the present invention.

FIG. **5** shows a waveform of an example embodiment frequency hop / change in accordance with the present invention.

DETAILED DESCRIPTIONS OF THE DRAWINGS

The present invention provides a means for an authorised user of a wireless power transmission network, such as an owner or manager, to actively control, activate, deactivate, change, and modify parameters relating to a frequency hopping and / or phase changing algorithm or sequence generated by a wireless power transmitting unit control logic in order to (1) minimise the risk of an unauthorized wireless power receiving unit from effectively receiving wireless power; (2) to minimise the risk of extended signal attrition due to the proximity of other wireless communications or wireless power signals, or due to uncontrollable environmental factors, such as high humidity; and (3) to minimize the risk of extended signal attrition due to a malicious third party attempting to perform "signal jamming" of the wireless power network.

The present invention provides a means for an authorised user of a wireless power transmission network, wherein the authorised user is a non-human agent such as an artificial intelligence module or advanced software process, to actively control, activate, deactivate, change, and modify parameters relating to a frequency hopping and / or phase changing algorithm or sequence generated by a wireless power transmitting unit control logic in order to (1) minimise the risk of an unauthorized wireless power receiving unit from effectively receiving wireless power; (2) to minimise the risk of extended signal attrition due to the proximity of other wireless communications or wireless power signals, or due to uncontrollable environmental factors, such as high humidity; and (3) to minimize the risk of extended signal attrition due to a malicious third party attempting to perform "signal jamming" of the wireless power network.

In the following detailed description and appended claims, "wireless power" refers to the transmission of wireless electrical power, wireless energy, electromagnetic signals, radio frequency signals, microwave signals, magnetic energy, ultrasound energy, or any other means known in the art for transmitting electrical power over distance wirelessly.

In the following detailed description and appended claims, "wireless power unit" may refer to any electronics device, circuitry, componentry, or elements, involved in the effective transmission or reception of wireless power.

In the following detailed description and appended claims, "frequency hopping" refers to a change in the wireless power transmission frequency during active operation.

In the following detailed description and appended Claims, "user" may refer to a human agent who is an authorised owner or manager of a wireless power transmission network, or a non-human agent, such as a software module, machine, robot, artificial intelligence, microprocessor, and the like, that is capable of appropriately executing upon the process methods of the present invention. Said non-human agent is able to actively modify and customize the frequency hopping and / or phase changing parameters, in accordance with the process methods of the present invention, in order to (1) prevent unauthorized wireless power receiving units from being able to effectively receive a wireless power signal and convert it to d.c. power; (2) minimise extended signal attrition due to signal interference with other wireless communications or wireless power signals, and due to uncontrollable environmental factors, such as high humidity; or (3) to minimize the risk of extended signal attrition due to a malicious third party attempting to perform "signal jamming" of the wireless power network.

In the following detailed description and appended Claims, "input / output device" may be a third party device, a user-interface device, a controller, a microprocessor, a plurality of microprocessors, a processing unit, a plurality of processing units, a microprocessor coupled to a non-human agent, a processing unit coupled to a non-human agent, and the like. Said microprocessor may be wireless power transmitting unit control logic **13**, or aspects **53** of wireless power transmitting unit control logic **13** responsible for generating and implementing frequency hopping and / or phase changing algorithms in the wireless power network.

In the following detailed description and appended Claims, "menu" may refer to a means of accessing a plurality of separate information or options either as a visual, audio, or sensatory prompt to a human agent, or an operational procedure or process, or a plurality of operational procedures or processes, or software modules and processes.

FIG. **1** is an example embodiment wireless power transmission system that the present invention may be integrated with or applied to. A wireless power transmitting unit **5** and a wireless power receiving unit **17** is shown. The wireless power transmitting unit **5** comprises a power supply **7** that connects to a matching network **9**; the matching network connects to a primary wireless power antenna **11**; the primary wireless power antenna transmits a wireless power radio frequency signal **15** to the wireless power receiving unit **17**. A control logic **13** connects to, respectively, the power supply **7**, matching network **9**, primary wireless power antenna **11**, and a communications module and antenna **12**. Said control logic **13** issues operational instructions to each electronic element, component or circuitry of the wireless power transmitting unit **5**. Such operational instructions may pertain to, but is not limited to, an at least one frequency and / or phase of transmission, operational voltages and currents, retuning or reconfiguring electrical component and impedance matching parameters, communicating over a preferably secure data channel such as, but not limited to, Wi-Fi, IEEE 802.11x, ZigBee, cellular networks, fibre optic cable, Ethernet cable, and the like, to the wireless power receiving unit **17** or an authorised input / output device (not shown). Said control logic **13** may also receive data pertaining to, but not limited to, operational voltage, current, power levels, operational frequencies and / or phases of wireless power transmission, authorised user input comprising custom parameters for said operational frequencies and / or phases of wireless power transmission, and so on.

A generic operation of wireless power transmitting unit **5** is as follows: (1) the power source **7** generates a radio frequency wireless power signal in accordance with operational instructions received by control logic **13**; (2) said radio frequency signal is passed through a matching network **9**, which may comprise an impedance matching network to match the impedance of the power source **7** to primary antenna **11** to minimise signal reflections, circuit losses, and ensure the stability of the wireless power transmission signal at a desired frequency and phase; (3) said radio frequency wireless power signal is transmitted by the primary antenna **11**. The primary antenna **11** may comprise one or more elements in combination, such as a dipole, loop, annular slot or other slot configuration, rectangular aperture, circular aperture, line source, helical element, inductor, capacitor, phased array configuration, Yagi, integrated circuit or other element or antenna configuration capable of transmitting a wireless power signal to a wireless power receiving unit antenna not directly coupled to the wireless power transmitting unit.

The matching network **9** and primary antenna **11** is sufficiently tunable by a controller coupled to control logic **13** that is directly responsible for implementing and generating a frequency hopping and / or phase changing algorithm or sequence in accordance with the present invention.

The control logic **13** may be a central processing unit (CPU), microprocessor, any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration allowing for the execution of operational instructions. Said control logic **13** may be coupled to a memory module or a plurality of memory modules storing or containing data, information, and instructions to be implemented or executed by the control logic **13**.

The general design and implementation of a wireless power transmitting unit, such as electrical component, element, or circuitry specifics, is well known in the art and will not be further discussed here.

Returning to FIG. **1**, a secondary antenna **19** on wireless power receiving unit **17** receives wireless power radio-frequency transmission **15**. The secondary antenna **19** connects to a matching network **20**, which may comprise an impedance matching network; the matching network **20** connects to a rectifier **21**; the rectifier **21** connects to a d.c. to d.c.

converter **23**; the d.c. to d.c. converter **23** connects to a load **25**. A control logic **27** connects to, respectively, the secondary antenna **19**, matching network **20**, rectifier **21**, d.c. to d.c. converter **23**, load **25**, and a communications module and antenna **29**. Said control logic **27** issues operational instructions to each electronic element or circuitry of the wireless power receiving unit **17**. Such operational instructions may pertain to, but is not limited to, retuning or reconfiguring receiving antenna elements and circuitry to effectively receive an at least one frequency and / or phase of wireless power transmission, implementing operational voltages and currents, modifying electrical component values and impedance matching parameters, directing communications over a preferably secure data channel such as, but not limited to, Wi-Fi, IEEE 802.11x, ZigBee, cellular networks, fibre optic cable, Ethernet cable, etc., to wireless power transmitting unit **5**, or an authorised third party device (not shown). Said control logic **27** may also receive data pertaining to, but not limited to, operational voltage, current, power levels, operational frequencies and / or phases of wireless power transmission, authorised user input comprising custom parameters for said operational frequencies and / or phases of wireless power transmission, and so on. The control logic **27** may be a central processing unit (CPU), microprocessor, any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration allowing for the execution of operational instructions. Said control logic **27** may be coupled to a memory module or a plurality of memory modules storing or containing data, information, and instructions to be implemented or executed by the control logic **27**. Said control logic **27** may additionally be coupled to a second controller or control logic (not shown), wherein the second controller or control logic allows for successful execution of the "non-human agent" of the present invention, such as the artificial intelligence module or advanced software algorithm.

A generic operation of wireless power receiving unit **17** is as follows: (1) wireless power radio frequency signal **15** is received by secondary antenna **19**; (2) said wireless power radio frequency signal **15** is then impedance matched by matching network **20**; (3) impedance matched wireless power radio frequency signal is rectified by rectifying unit **21**; (3) the rectified wireless power signal is then regulated to a desired voltage of operation by d.c to d.c. converter **23**; (4) the rectified and voltage regulated wireless power signal is consumed by the load **25**. The rectifying unit **21** may comprise a half bridge rectifier, full wave rectifier, or any electrical component or element that converts an a.c. signal into a d.c. signal. The secondary antenna **19** may comprise one or more elements in combination, such as a dipole, loop, annular slot or other slot configuration, rectangular aperture, circular aperture, line source, helical element, inductor, capacitor, phased array configuration, Yagi, integrated circuit or other element or antenna configuration capable of transmitting a wireless power signal to a wireless power receiving unit antenna not directly coupled to the wireless power transmitting unit. The load **25** may comprise a storage battery, capacitor, or electronic device.

Secondary antenna **19** and a secondary matching network **20** are sufficiently tunable by the controller coupled to control logic **13**, via a controller coupled to control logic **27**, responsible for implementing and generating a frequency hopping and / or phase changing algorithm or sequence in accordance with the present invention.

The general design and implementation of a wireless power receiving unit, such as electrical component, element, or circuit specifics, is well known in the art and will not be further discussed here.

As one skilled in the art will appreciate, different embodiment wireless power transmission and receiving architectures, designs, configurations, and operations may exist, congruent with the spirit and aims of the present invention.

FIG. **1**, and its associated description, is provided herein so one skilled in the art will understand the basic architecture and design of a wireless power system to which the present invention is applied to or integrated with. Most pertinent from FIG. **1** to the successful operation of the present invention is control logic **5** and communications module and antenna **12** on wireless power transmitting unit **5** for communicating with, receiving instructions, and implementing said instructions from an authorised third party device.

FIG. **2a** is a schematic diagram of an exemplary process method of the present invention. On an authorised third party device, preferably with a user display screen or monitor, a user input means, equipped with software pertaining to the present invention, and configured to communicate over preferably secure data channels such as, but not limited to, Wi-Fi, IEEE 802.11x, Zigbee, cellular networks, fibre optic cable, Ethernet cable, and the like, a user navigates to a frequency hopping toggle menu **31**. From said frequency hopping toggle menu **31**, said user is presented with multiple options pertaining to the level of control said user may choose to exercise over parameters relating to an at least one frequency hopping and / or phase changing algorithm or sequence designed to minimise risk of one or more unauthorized wireless power receiving units effectively receiving and using wireless power, or otherwise minimise the risk of any third party negatively interfering with the wireless power transmission signal. The process method enables or prompts said user to select from default settings **33** or custom settings **39**. If user commands, directs, inputs, or selects default settings **33** for said frequency hopping and / or phase changing algorithm or sequence parameters, the process method requests, prompts, directs, or asks for user input confirming the default setting selection **35**. Upon confirmation **35**, the process method communicates said default settings on frequency hopping and / or phase changing algorithm or sequence parameters to the wireless power transmitting unit control logic **37**, specifically a controller coupled to wireless power transmitting unit control logic directly responsible for generating, implementing and controlling an at least one frequency hopping and / or phase changing algorithm or sequence, then the process method terminates. If user input denies, declines, or rescinds confirmation of default settings, the process method terminates and returns to the main frequency hopping toggle menu **31**. In some embodiments, the confirmation **35** may be omitted.

In an alternative embodiment, upon confirmation **35**, the process method communicates said default settings on frequency hopping and / or phase changing algorithm or sequence parameters to the wireless power receiving unit control logic **27**, specifically the controller coupled to wireless power receiving unit control logic directly responsible for generating, implementing and controlling a frequency hopping and / or phase changing algorithm or sequence, and the process method terminates. Said default settings of parameters relating to said at least one frequency hopping and / or phase changing algorithm or sequence, for the purposes of wireless power security and preventing wireless power signal attrition, come preprogrammed or stored in the wireless power transmitting unit control logic or coupled control logic memory module, and wireless power receiving unit control logic or coupled control logic memory module (preprogrammed logic). In one non-limiting example embodiment of operation, said default settings comprise a random frequency hopping sequence involving the 2.4GHz and 5.8GHz ISM worldwide radio-frequency bands. Said frequency hopping sequence involves seven frequency hopping changes spaced across a regular time interval of two seconds to complete one cycle. Said frequency hopping sequence repeats no more than twenty consecutive times and then the algorithm or sequence is modified. A new random frequency hopping and / or phase changing algorithm or sequence may comply with, or depart from, the overall parameters designated above, i.e. involving the 2.4GHz and 5.8GHz

ISM worldwide radio-frequency bands. In this example, the changed frequency hopping sequence involves seven frequency hopping changes spaced across a regular time interval of two seconds to complete one cycle, and where said frequency hopping sequence repeats no more than twenty consecutive times and then the algorithm or sequence is modified. Those skilled in the art will recognize and appreciate that "default settings" may refer to a range of different parameters on selection of frequencies and / or phases of transmission, time intervals between each frequency hopping and / or phase change, quantity of frequency hopping and / or phase changes involved in one cycle, and so forth. The specific default settings are the prerogative of a manufacturer, maker, creator, seller, or designer of the present invention.

Returning to the process method of FIG. **2a**, if the user commands, directs, inputs, or selects custom settings **39** for the frequency hopping and / or phase changing algorithm or sequence parameters from the frequency hopping toggle menu **31**, the process method prompts or enables user input for a plurality of parameters for the frequency hopping and / or phase changing algorithm or sequence that may be toggled, modified or changed by said user input. User input is prompted or enabled to select the frequencies to be used for the frequency hopping and / or phase changing algorithm or sequence **43**. The user may signify input by actively selecting from a range of presented options an at least one frequency to be used in the frequency hopping and / or phase changing algorithm or sequence, actively selecting from a range of options an at least one frequency range to be used in the frequency hopping and / or phase changing algorithm or sequence, actively inputting via a touch keyboard, touchscreen, pointer, keyboard, audio input device, motion input device, visual input device, or other I/O device, process, algorithm, software, or method, an at least one frequency or frequency range to be used in the frequency hopping and / or phase changing algorithm or sequence.

The frequencies presented that may be used for the frequency hopping and / or phase changing algorithm or sequence can be any frequencies from the Hertz, Kilohertz, Megahertz, Gigahertz or even Terahertz ranges. In many embodiments, customization will be restricted to the worldwide ISM radio frequency bands and ranges, unless prior approval is sought and successfully acquired from a national, state, or local authority depending on the jurisdiction. Hence, a party commercialising the present invention may choose to restrict the settings options of **43** to ensure that the user cannot choose an unauthorized frequency, such as a frequency used by emergency departments.

In terms of an at least one phase change that may be built into the generated frequency hopping and / or phase changing algorithm or sequence in accordance with the present invention, in a preferred embodiment of operation, a process involved in generating the frequency hopping algorithm or sequence may also randomly generate phase changes, unless potential wireless power signal attritions and / or wireless power security risks needs to be mitigated, in which case user-controlled phase changes may be enabled following substantially the same process methods involved in modifying parameters relating to an at least one frequency of wireless power transmission.

Returning to the process method of FIG. **2a**, user input is prompted or enabled to select the time interval or time intervals between each frequency and / or phase change in a frequency hopping and / or phase changing algorithm or sequence **45**. The user may signify input by actively selecting from a range of presented options, such as a constant time interval for frequency hopping, an irregular time interval for frequency hopping, a randomized time interval, or a combination thereof. The user may also signify input on a time interval selection by actively inputting via a touch keyboard, keyboard, audio input device, visual input device, motion input device, or other I/O device, process, algorithm, software, or method. Should a constant time interval be chosen, the user may signify input relating to a specific constant time interval between frequency hopping or phase changes. Said time interval to select from may extend from nano-seconds through to hours. Should an irregular time interval be chosen, the user may signify input relating to the range of time intervals to be used in randomly generating the irregular time interval. In a non-limiting example of operation, an irregular time interval between frequency hopping and / or phase changing may be user-inputted or user-defined as follows: (1) a first frequency at a first phase is transmitted for a total of five seconds; (2) a frequency hop and phase change occurs; (3) a second frequency at a second phase is transmitted for a total of three seconds; (4) a frequency hop and phase change occurs; (5) a third frequency at a third phase is transmitted for a total of four seconds; (6) and so on.

In terms of a time interval for an at least one phase change that may be built into the generated frequency hopping and / or phase changing algorithm or sequence in accordance with the present invention, the process involved in generating the algorithm may also generate a consistent or random time interval or some combination thereof, for an at least one phase change if an at least one phase change is part of the algorithm.

The cycle time, or total time to complete at least one complete sequence for a particular frequency hopping and / or phase changing algorithm or sequence, is determined by a combination of **43** and **45**.

Returning to the process method of FIG. **2a**, user input is prompted or enabled to select a frequency hopping and / or phase changing algorithm or sequence cycle number or iteration number, before a new frequency hopping and / or phase changing algorithm or sequence is generated in accordance with user inputted parameters **47**. The user may signify input by actively selecting from a range of presented options, such as choosing from a plurality of cycle numbers or iteration numbers per unique frequency hopping and / or phase changing algorithm or sequence. The user may also choose to make random the cycle number or iteration number for a unique random frequency and / or phase changing algorithm or sequence. The user may also signify input by actively inputting via a touch keyboard, keyboard, touchscreen, pointer, audio input device, visual input device, motion input device, or other I/O device, process, algorithm, software, or method, a cycle or iteration execution number before a frequency hopping and / or phase changing algorithm or sequence is changed or modified.

As a non-limiting example, a user may choose for a particular unique frequency hopping and / or phase changing algorithm or sequence to iterate for seven complete cycles before the frequency hopping and / or phase change generation controller or software process coupled to wireless power transmitting unit control logic directs for the generation of a new frequency hopping and / or phase changing algorithm or sequence in accordance, wholly or partially, with parameters set by **43** and **45**.

If the user commands, directs, inputs, or selects custom settings for **43**, **45**, and **47** on the frequency hopping and / or phase changing algorithm or sequence parameters, the process method requests, prompts, directs, enables or asks for user input confirming the settings selections **49**. Upon confirmation **49**, the process method communicates said custom settings on frequency hopping and / or phase changing algorithm or sequence parameters to the wireless power transmitting unit control logic **51** and the process method terminates. If user input denies, declines, or rescinds confirmation of default settings, the process method returns to settings selection for **43**, **45**, and **47**. In other embodiments, the process method may omit the step of asking for user input confirming the settings selections **49** in order to, for example, streamline execution and implementation of the present invention, take up less memory on the storage device, and the like.

In an alternative embodiment, if the user commands, directs, inputs, or selects custom settings **39** for frequency hopping and / or phase changing algorithm or sequence parameters from the frequency hopping toggle menu **31**, the process method prompts for, or enables, user input relating only to one parameter for the frequency hopping and / or phase changing algorithm or sequence that may be toggled, modified or changed by user input. In this non-limiting example, user input is prompted to select the frequencies to be used for the frequency hopping and / or phase changing algorithm or sequence **43**.

In an alternative embodiment, if the user commands, directs, inputs, or selects custom settings **39** for frequency hopping and / or phase changing algorithm or sequence parameters from the frequency hopping toggle menu **31**, the process method prompts for, or enables, user input relating only to one parameter for the frequency hopping and / or phase changing algorithm or sequence that may be toggled, modified or changed by user input. In this non-limiting example, user input is prompted to select the time interval to be used for the frequency hopping and / or phase changing algorithm or sequence **45**.

In an alternative embodiment, if the user commands, directs, inputs, or selects custom settings **39** for frequency hopping and / or phase changing algorithm or sequence parameters from the frequency hopping toggle menu **31**, the process method prompts for, or enables, user input relating only to one parameter for the frequency hopping and / or phase changing algorithm or sequence that may be toggled, modified or changed by user input. In this non-limiting example, user input is prompted to select the cycle number for a frequency hopping and / or phase changing algorithm or sequence **47**.

In yet another embodiment, if the user commands, directs, inputs, or selects custom settings **39** for frequency hopping and / or phase changing algorithm or sequence parameters from the frequency hopping toggle menu **31**, the process method prompts for, or enables, user input relating to, in combination, any two parameters for the frequency hopping and / or phase changing algorithm or sequence that may be toggled, modified or changed by user input, such as, but not limited to, **43** and **47**, or **45** and **43**.

In most embodiments, if user-input associated with or relating to custom parameters for any particular parameter of the frequency hopping and / or phase changing sequence is removed, deleted, or rescinded, the process method will implement default settings for that particular parameter. For example, if the user removes all custom settings for the frequencies to be utilized in a frequency hopping and / or phase changing sequence, the process method will implement default settings.

In some embodiments, non-human agent customization of frequency hopping and / or phase changing parameters may override some, or all, human-user defined parameters for frequency hopping and / or phase changing parameters, for example, in order to effectively overcome a malicious third party attempting to "signal jam" the wireless power network. In a non-limiting example, if human-user defined parameters for frequency hopping and / or phase changing includes using the frequencies 2.6GHz, 2.9GHz, and 3.1GHz, and the non-human agent has detected that abnormally high wireless power transmission inefficiencies are occurring at these frequencies, due to a malicious third party attempting to "signal jam" wireless power transmissions, the non-human agent may adjust the frequencies to be used in future generated frequency hopping and / or phase changing sequences to 3.8GHz, 4.7GHz, and 5.4GHz. Those with skill in the art will readily recognize that such adjustments by the non-human agent beyond the scope of user-defined frequency hopping and / or phase changing parameters may apply to other parameters involved in providing wireless power security, such as the time value(s) between each individual frequency and / or phase change, and the total cycle number for a particular frequency hopping and / or phase changing sequence.

In yet another embodiment, upon navigating or selecting frequency hopping toggle menu **31**, a user is presented with only the default settings **33**, which the user can view or read in order to understand the parameters applied to the frequency hopping and / or phase changing algorithm or sequence.

Said communicated settings of default parameters relating to the frequency hopping and / or phase changing algorithm or sequence for the purposes of wireless power security are stored in the wireless power transmitting unit control logic or coupled control logic memory module, and / or wireless power receiving unit control logic or coupled control logic memory module.

In an alternative embodiment, said communicated settings of custom parameters relating to the frequency hopping and / or phase changing algorithm or sequence for the purposes of wireless power security are stored in the wireless power receiving unit control logic or coupled control logic memory module, and / or wireless power transmitting unit control logic or coupled control logic memory module.

Returning to the process method of FIG. **2**, the frequency hopping toggle menu **31** enables an authorised user to activate frequency hopping and / or phase changing **32a** in accordance with the default or custom parameters selected. The authorised user may also deactivate frequency hopping and / or phase changing **32b** via frequency hopping toggle menu **31**.

The third party device may be any electronics device sufficiently equipped to enable a user to review information on a medium such as a screen and respond accordingly via an input device, feature, or software module such as a keyboard, clicker, pointer, microphone, headset, speaker, motion input, visual input, and so on. Hence, said electronics device may be a smartphone, cellular phone, Bluetooth headset, notebook computer, laptop computer, portable computer, iPod, MP3 player, music player, media player, tablet, PDA, blackberry, desktop computer, kindle, e-reader, audio device, motion detector, infrared sensor, visual sensor, and the like. Additionally, said electronics device may be a chipset, output device, and / or input device that is attached, appended, coupled to, or integrated with wireless power transmitting unit **5** and / or wireless power receiving unit **17**.

The software modules involved in the process method of FIG. **2a** may be any application, web portal, graphical user interface, audio user interface, motion user interface, command prompt, programming logic, operational process, that effectively allows for user input and subsequent communication of said input to an authorised wireless power transmitting unit control logic and / or authorised wireless power receiving unit control logic.

The software modules involved in the process method of FIG. **2a** are coupled to, and hence control, the chipset, controller, microprocessor, CPU, or plurality of chipsets, controllers, microprocessors, or CPUs responsible for executing the operational instructions for the generation and control of the frequency hopping and / or phase changing algorithms or sequences of a wireless power network.

The software modules and associated operational logic, including user input, involved in the process method of FIG. **2a** may be stored and retrieved from a memory module on, integrated with, coupled to, or attached to, the third party device. Alternatively, the software modules involved in the process method of FIG. **2a** may be wholly or partially stored on another party or medium, such as a cloud storage mechanism or flash drive memory. For example, the operational logic of the present invention may be wholly or partially stored on another party, whilst the third party device wholly or partially stores the graphical user interface or command prompt, or other input prompt, associated with facilitating user input in accordance with the present invention. Alternatively, the software modules involved in the process method of FIG. **2a** may be wholly or partially stored on a memory module coupled to the wireless power transmitting unit control logic. For example, the operational logic of the present invention may be wholly or partially stored on the memory module coupled to the wireless power transmitting unit control logic, whilst the third party user interface device wholly or partially stores the graphical user interface or command prompt, or other user input prompt, associated with facilitating user input in accordance with the present invention. Those skilled in the art will recognize that yet further alternative configurations and embodiments may exist congruent with the spirit and aims of the present invention.

In embodiments involving non-human agents, the software modules and associated operational logic involved in the process method of FIG. **2a** may be stored and retrieved from a memory module on, integrated with, coupled to, or attached to, the input / output device. Alternatively, the software modules involved in the process method of FIG. **2a** may be wholly or partially stored on another party or medium, such as a cloud storage mechanism or flash drive memory. For example, the operational logic of the present invention may be wholly or partially stored on another party, whilst the input / output device wholly or partially stores the input prompt, associated with facilitating user input in accordance with the present invention. Alternatively, the software modules involved in the process method of FIG. **2a** may be wholly or partially stored on a memory module coupled to the wireless power transmitting unit control logic. For example, the operational logic of the present invention may be wholly or partially stored on the memory module coupled to the wireless power transmitting unit control logic, whilst the input / output device wholly or partially stores the input prompt associated with facilitating user input in accordance with the present invention. Those skilled in the art will recognize that yet further alternative configurations and embodiments may exist congruent with the spirit and aims of the present invention.

The "Frequency Hopping Toggle Menu" **31** described in FIG. **2a** refers to any interface an authorised user may access to toggle the described frequency hopping and / or phase changing parameters. The appended name, "Frequency Hopping Toggle Menu", has been chosen in order to effectively describe the present invention and is not intended to limit the aims, spirit or scope of the present invention.

In some embodiments, all the parameters involved with toggling the frequency and / or phase for wireless power transmission, including activating and deactivating frequency hopping and / or phase changing for wireless power transmission, may be accessed from the same "Frequency Hopping Toggle Menu" **31**.

In some embodiments, some parameters involved with toggling the frequency and / or phase for wireless power transmission may be accessed from separate menus. In a non-limiting example, the selection of the frequencies of transmission, the selection of the time interval between frequency changes, and the selection of the frequency hopping and / or phase change sequence cycle number, may each be accessed from a common portal, or menu, or interface, whilst activating and deactivating frequency hopping and / or phase changing for wireless power transmission may be accessed from a separate portal, menu, or interface.

Where the user is a non-human agent, preferred embodiments will involve the non-human agent setting custom parameters for the frequency hopping and / or phase changing algorithm or sequence.

In embodiments where the user is a non-human agent, the non-human agent may be coupled to wireless power transmitting unit control logic **13** responsible for generating and implementing frequency hopping and / or phase changing algorithms and sequences. For example, the non-human agent may be executed by the transmitting unit control logic **13**, or executed by a controller or control logic substantially coupled to the control logic **13** and that can effectively coordinate with the control logic **13**.

In some embodiments, the process methods of FIG. **2a** may be applied simultaneously or substantially simultaneously to a plurality of wireless power transmitter units, including, but not limited to, an at least two wireless power transmitter units comprising differing wireless power transmission technologies.

FIG. **2b** is an example schematic of operation wherein a non-human agent, in this case an artificial intelligence module, recalibrates various parameters of the frequency hopping and / or phase changing sequence. At a step **207**, an initial frequency hopping sequence is generated and actively implemented in wireless power transmissions in accordance with one or more aspects of the present invention In this case, the frequency hopping sequence comprises (1) a frequency hopping sequence “A”, wherein frequency hopping sequence “A” may comprise a plurality of individual frequencies such as 910MHz, 2.5GHz, 4.6GHz, 5.4GHz; (2) A time-set “A” comprising one or more time-values that may be executed as the one or more time durations between each frequency change of the generated frequency hopping sequence, for example, 10 milliseconds, 100 milliseconds, and 4 seconds; (3) a frequency cycle number “A” comprising a cycle number that a particular generated frequency hopping sequence is extant before a new frequency hopping sequence is generated. For example, 12 complete cycles. At a step **209**, the current frequency hopping sequence, or a frequency hopping sequence to be actively executed by the wireless power transmission system in the proximal future, is analyzed by a non-human agent of the present invention, which in this case is an artificial intelligence module. This analysis of the frequency hopping and / or phase changing algorithm or sequence may occur arbitrarily or periodically. At the step **209**, the artificial intelligence module modifies one or more parameters for generating future frequency hopping sequences. This step **209** may be executed in response to abnormally high inefficiencies reported by one or more wireless power receivers on the network, which may suggest that unauthorized users have gained access to the wireless power network, a malicious third party is successfully "signal jamming" the wireless power network at one or more of the frequencies currently being utilized for wireless power transmission, or external environmental conditions are causing high signal attenuation for one or more of the frequencies currently being utilized for wireless power transmission. The present invention enables a non-human agent to receive data on abnormally high wireless power transmission inefficiencies and respond swiftly and efficiently in order to maximise wireless power network uptime, compared to being reliant solely on a human-user to modify frequency hopping parameters in an attempt to return wireless power transmissions to maximum efficiencies. The non-human agent can detect the inefficiency, respond by modifying frequency hopping and / or phase changing parameters, detect if the efficiency has gone up, down, or remained the same, and adjust frequency hopping and / or phase changing parameters again in a time period of milliseconds to seconds. At a step **211**, the artificial intelligence module recalibrated frequency hopping sequence is generated and implemented in wireless power transmissions. The recalibrated frequency hopping sequence comprises a plurality of modified parameters. In this case, the frequency hopping sequence comprises: (1) a frequency hopping sequence "B", wherein frequency hopping sequence "B" may comprise a plurality of individual frequencies such as 1.9GHz, 2.8GHz, 3.9GHz, 5.4GHz; (2) A time-set "B" comprising one or more time-values that may be executed as the one or more time durations between each frequency change of the generated frequency hopping sequence, for example, 250 milliseconds, 550 milliseconds, 5 seconds and 8 seconds; (3) a frequency cycle number "A" comprising a cycle number that a particular generated frequency hopping sequence is extant before a new frequency hopping sequence is generated. For example, 12 complete cycles. In some embodiments, the process method presented in this FIG. **2b** may iterate until wireless power transmission efficiencies are returned to substantially optimum levels.

In an example embodiment of operation, a user who is a human agent, such as an owner of a wireless power network, may initially customize the frequency hopping and / or phase changing algorithm or sequence for a wireless power transmitting unit, in accordance with the process method of FIG. **2a**. At a later stage of operation, feedback mechanisms described further in this specification, may detect that extended signal attrition is occurring due to the crowding of proximal wireless power signals transmitting at substantially the same frequencies at substantially the same times. In response to said feedback mechanisms, a user who is a non-human agent is presented with the process method of FIG. **2b** and proceeds to customize the frequency hopping and / or phase changing parameters for said wireless power transmitting unit, in order to minimise said extended wireless power signal attrition by ensuring that the wireless power signal is not at substantially the same frequencies at substantially the same times. The presenting of the process method of FIG. **2b** to a non-human agent, and the subsequent execution of the process method of FIG. **2b** performed by said non-human agent, will involve similar operational logic procedures and internal processing, such as is undertaken by any central processing unit or controller with an effective input / output means in executing a set of operational instructions, whereby pertinent information, calculations, equations, data and the like are initially presented to said processing unit or controller prior to operational logic procedures, such as the process method of FIG. **2b**, taking place; this is well known in the art. Hence, the non-human agent is unlikely to require a graphical user interface, or other input means commonly required by a human agent, to effectively execute upon the process method of FIG. **2b**. The non-human agent is presented with the plurality of customization options available to the human agent in the process method of FIG. **2b**. In this example embodiment, the custom parameters of an at least one frequency and / or phase set by said non-human agent are communicated to the wireless power transmitting unit control logic **13** or controller **53**. In some embodiments wherein the security risk to a wireless power network is non-critical, transmitting unit control logic **13** or controller **53** determines if human agent input for the customization of an at least one frequency and / or phase of an at least one wireless power signal has been received in time since receiving non-human agent input for the customization of an at least one frequency and / or phase for an at least one wireless power signal. If said human agent input has been received by **13** or **53**, said human agent input is implemented by **13** or **53** as the priority. If said human agent input has not been received in the time since receiving said non-human agent input, said non-human agent input is implemented by **13** or **53** as the priority.

FIG. **2c** is an example schematic diagram depicting a process method wherein one or more external environmental sensors periodically or aperiodically relays data on one or more environmental variables to the non-human agent of the present invention, in this case an artificial intelligence module. Environmental sensors may be attached to the wireless power transmitting unit, one or more of the wireless power receiving units, the walls, ceiling, or furniture within the scope of the wireless power transmission area, and the like. A singular or a plurality of environmental sensors **213** may monitor environmental variables at a single area in 3D space, or at a plurality of areas in 3D space, within the scope of the wireless power transmission area. The one or more environmental sensors **213** may measure one or more environmental variables such as, but not limited to, humidity, temperature, density of radio-waves at one or more frequencies, and the like. Data captured by the one or more environmental sensors **213** may be converted into a digital or analogue format, or some combination thereof, and relayed to a non-human agent via an at least one data channel **215**. The data channel **215** may be a wired communication protocol such as, but not limited to, Ethernet, or fibre optic, or may be a wireless communications protocol such as, but not limited to, IEEE 802.11x, Bluetooth, ZigBee, satellite communications, cellular network, and the like, or some combination may be used, thereof. A non-human agent, in this case an artificial intelligence module **209** receives and processes the data captured by the one or more environmental sensors **213** and may compare the data to information on nominal signal attrition rates of the frequencies of transmission currently utilized by the wireless power network under the different environmental conditions of which data has been received. For example, if high humidity is recorded and relayed to the artificial intelligence module **209**, the artificial intelligence module will determine if any of the frequencies of transmission currently utilized or to be utilized in the near future are abnormally negatively affected more than all the other frequencies that may be used to generate a frequency hopping sequence. If a process such as this returns affirmative, the artificial intelligence module **209** will omit the one or more frequencies abnormally negatively affected by, in this non-limiting example, high humidity, and may instead substitute in frequencies less negatively affected by high humidity. Those with skill in the art will readily recognize that this process may be repeated for any number or combination of environmental variables and data, and any number or combination of radio-frequencies. In order for the artificial intelligence module **209** to make one or more comparisons between received data on external environmental conditions and how the current frequencies of transmission may be negatively affected by the external environmental conditions, the artificial intelligence module **209** is optimally able to access a database or dataset comprising information on all the frequencies that may be utilized to generate a frequency hopping and / or phase changing sequence and how each individual frequency is attenuated by a range of environmental variables, such as, but not limited to, humidity. If the frequency hopping sequence is modified by the artificial intelligence module **209**, the modified frequency hopping sequence is transmitted to a wireless power transmitter **219** – preferably, an aspect of the wireless power transmitter **219** responsible for electronically controlling the antenna elements, such as an aspect of control logic **13** – via a data channel **217**. The data channel **215** may be a wired communication protocol such as, but not limited to, Ethernet, copper, or fibre optic, or may be a wireless communications protocol such as, but not limited to, IEEE 802.11x, Bluetooth, ZigBee, satellite communications, cellular network, and the like, or some combination may be used, thereof. In most embodiments, the artificial intelligence module **209** will be directly coupled to, or integrated with, the control logic **13**.

FIG. **3** is an exemplary schematic block diagram of the most pertinent modules coupled to the wireless power transmitting unit control logic **13** associated with implementation of the aims of the present invention in a wireless power transmission network. The wireless power transmitting unit control logic **13** moderates and facilitates data, information, operational instructions, and programming logic inflow and outflow between the wireless power transmission / reception / regulation circuits and the processing modules coupled to said wireless power transmitting unit control logic **13**. The wireless power transmitting unit control logic **13** is coupled to a module containing the operational processes, instructions, or programming logic for generating, selecting, and / or implementing a frequency hopping and / or phase changing algorithm or sequence **53**. Said module **53** may be a general purpose processor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein in accordance with the present invention. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Said module **53** may exchange information, data, operational instructions, or programming logic with the main wireless power transmitting unit control logic **13**, receive new information, data, operational instructions, or programming logic from control logic **13** or, alternatively, route or reroute data to another part of the wireless power transmission circuit as related to the scope and aims of the present invention. The processing unit involved in the generation of a unique frequency hopping and / or phase changing algorithm or sequence may comprise formulas, mathematical equations, calculations and variable and constant programming parameters partially or wholly based on user input data on the input / output device. Hence, it will be apparent to one skilled in the art that the generation of each frequency hopping and / or phase changing algorithm or sequence is in accordance with the parameters, rules, values and variables wholly or partially inputted or selected by user input on the input / output device in accordance with the present invention, and wherein user input permits, said frequency hopping and / or phase changing algorithm or sequence may comprise parameters generated randomly by said controller **53**.

In one example embodiment, controller **53** may be substantially integrated with a user that is a non-human agent, such as a software process, Artificial Intelligence, robot, machine, microprocessor, and the like.

In another example embodiment, wireless power transmitting unit control logic **13** may be substantially integrated with a user that is a non-human agent, such as a software process, Artificial Intelligence module, robot, machine, microprocessor, and the like.

The results or returned values of the process method of FIGS. **2a**, **2b** and **2c**. are routed to module **53** via the wireless power transmitting unit control logic **13**. The frequency hopping and / or phase changing algorithm or sequence generation, selection, and implementation module **53** subsequently generates and instructs implementation of a frequency hopping and / or phase changing algorithm or sequence according to the user inputted parameters from the process methods of FIGS. **2a**, **2b** and **2c**.

Returning to the schematic block diagram of FIG. **3**, the wireless power transmitting unit control logic **13** may be coupled to a memory module **55**. Said memory module **55** may comprise temporary memory storage **57** and long term memory storage **59**. Data, operational instructions, software modules, process methods, and programming logic in accordance with the present invention may be stored in said temporary memory **57** where said temporary memory **57** may comprise Random Access Memory (RAM), flash memory, Read Only Memory (ROM), Electrically Programmable ROM (EPROM), Electrically Erasable Programmable ROM (EEPROM), registers, hard disk, a removable disk, virtual memory, or any other form of storage medium known in the art. An exemplary temporary memory storage medium **57** is coupled to the control logic processor **13** such that the control logic processor **13** can read information from, and write information to, the temporary memory storage medium **57**. Data, operational instructions, software modules, process methods, and programming logic in accordance with the present invention may be stored in said long-term memory storage **59**, where said long term memory storage **59** may comprise flash memory, Read Only Memory (ROM), Electrically Programmable ROM (EPROM), Electrically Erasable Programmable ROM (EEPROM), registers, hard disk, optical / and or magnetic storage devices, a removable disk, virtual memory, or any other form of storage medium known in the art. An exemplary long-term storage medium **59** is coupled to the control logic processor **13** such that the control logic processor **13** can read information from, and write information to, the long-term memory storage medium **59**. Further, information, data, operational instructions, software modules, and programming logic is periodically read, written, and exchanged between temporary memory **57** and long-term memory **59** as necessary in order to execute upon the aims, spirit, and scope of the present invention.

The wireless power transmitting unit control logic **13** periodically exchanges information, data, operational instructions and signals in accordance with the present invention with power supply, antennas, oscillating circuits, sensor nodes, and any other electrical components or circuitry associated or coupled with the wireless power transmission network **65**. Said information, data, operational instructions and signals exchanged in **65** may be routed or rerouted via the wireless power transmitting unit control logic **13** to coupled processing and / or storage modules, such as the modules of **53** and **55**.

The wireless power transmitting unit control logic **13** periodically exchanges information, data, operational instructions, programming logic, and software modules, in accordance with the present invention with wireless power receiving unit control logic **27** and authorised input / output devices or authorised third party devices (not shown) via communications antenna and module **12** over preferably secure data channels such as, but not limited to, Wi-Fi, IEEE 802.11x, Zigbee, cellular networks, satellite links, fibre optic cables, Ethernet cables, etc. Information inflow from communications antenna and module **12** is routed or rerouted via the wireless power transmitting unit control logic **13** to process modules and / or storage modules such as **53** and **55**, depending on the nature of the information processed by **13**. Similarly, particular information outflow from process modules and / or storage modules such as **53** and **55** is processed, routed or rerouted to communication antenna and module **13** via the wireless power transmitting unit control logic **13**.

In a different embodiment, the wireless power transmitting unit control logic **13** periodically exchanges information, data, operational instructions, programming logic, and software modules, in accordance with the present invention with the wireless power receiving unit control logic **27** and authorised input / output devices or authorised third party devices (not shown) via communications antenna and module **12** over preferably secure data channels such as, but not limited to, Wi-Fi, IEEE 802.11x, Zigbee, cellular networks, satellite links, fibre optic cables, Ethernet cables, etc. Accordingly, the wireless power transmitting unit control logic **13** comprises a means of decrypting any received information that is encrypted, and encrypting any information to be transmitted to wireless power receiving unit and / or authorised input / output device, as necessary. Information inflow from communications antenna and module **12** may be decrypted, routed or rerouted via the wireless power transmitting unit control logic **13** to process modules and / or storage modules such as **53** and **55**, depending on the nature of the information processed by **13**. Similarly, particular information outflow from process modules and / or storage modules such as **53** and **55** may be encrypted, processed, routed or rerouted to communication antenna and module **13** via the wireless power transmitting unit control logic **13** prior to transmission.

Those skilled in the art will recognize and appreciate that alternative embodiments may exist and that may be designed, architected or implemented without departing from the spirit and aims of the present invention.

FIG. **4** is a diagram showing an example embodiment of a communications link between the wireless power transmitting unit **5** and an authorised third party device **67**, in accordance with the present invention. Communications signal **69** enables an exchange of information, data, programming logic, and software modules between authorised third party device **67** and the wireless power transmitting unit control logic **13** and coupled modules (not shown) via communications antenna and module **12**. In accordance with the present invention, the substance of said information, data, programming logic, and software modules exchanged between authorised third party device **67** and wireless power transmitting unit control logic **13** via communications link **69** relates to the process method, outcomes and / or returned results or values as described in FIG. **2a**. Communications signal **69** is preferably an at least one secure data channel such as, but not limited to, Wi-Fi, IEEE 802.11x, Zigbee, cellular networks, satellite links, etc. To ensure the integrity of the aims of the present invention to minimise risk of unauthorized wireless power receiving units from accessing wireless power from the wireless power transmitting unit **5**, the information exchange between authorised third party device **67** and wireless power transmitting unit control logic **13** should be appropriately encrypted in preferred embodiments. In an alternative embodiment, the communication signal **69** is a physical link such as, but not limited to, an Ethernet cable, copper cable, fibre optic cable, telcom cable, thin Ethernet cable, twisted pair Ethernet cable, and any other physical cable or conductor capable of transferring information, data, operational instructions, programming logic and software modules in accordance with the present invention. In yet another embodiment, the communication link **69** may be facilitated via infrared, digital or ultrasound technologies.

In some embodiments, information, data, operational instructions, programming logic and software modules in accordance with the present invention may be sent and received simultaneously by the authorised third party device and information, data, operational instructions, programming logic and software modules in accordance with the present invention may be sent and received simultaneously by the wireless power transmitting unit control logic, facilitated by communications antenna **12**.

In an alternative embodiment, communications signal **69** enables an exchange of information, data, operational instructions, programming logic, and software modules between authorised third party device **67** and wireless power receiving unit control logic **27** and coupled modules (not shown) via communications antenna and module **12**. In accordance with the present invention, the substance of said information, data, programming logic, and software modules exchanged between authorised third party device **67** and the wireless power receiving unit control logic **27** via communications link **69** relates to the process method, outcomes and / or returned results or values as described in FIG. **2a**.

In yet another embodiment, the exchange of information, data, operational instructions, programming logic and software modules may occur simultaneously, ad-hoc, or in sequence, between a plurality of authorised third party devices and a wireless power transmitting unit control logic. In a non-limiting example, the process method of FIG. **2a** may be facilitated by user input from a plurality of authorised third party devices; the first half of the process method of FIG. **2a** may be completed on a first authorised third party device, such as a smartphone, and the second half of the process method of FIG. 2a may be completed on a second authorised third party device, such as a notebook computer.

In another embodiment, information, data, operational instructions, programming logic and software modules, in accordance with the present invention, exchanged between authorised third party device 67 and wireless power transmitting unit control logic 13, and / or wireless power receiving unit control logic 27 (not shown), may be temporarily stored or held in an intermediate memory module or data storage unit not directly associated with authorised third party device 67, or wireless power transmitting unit 5, or wireless power receiving unit 17 (not shown).

In yet another embodiment, information, data, operational instructions, programming logic and software modules, in accordance with the present invention, exchanged between authorised third party device 67 and wireless power transmitting unit control logic 13 and / or wireless power receiving unit control logic 27 (not shown) may be temporarily stored or held in a memory module or data storage unit coupled to authorised third party device 67 prior to being received by control logic 13 or 27, or prior to being displayed, viewed, or received by a user operating or interacting with third party device 67.

In another embodiment, where the user is a non-human agent, information, data, operational instructions, programming logic and software modules, in accordance with the present invention, may be communicated between the non-human agent and aspects 53 of the wireless power transmitting unit control logic 13 responsible for generating, implementing, and customizing, the frequency hopping and / or phase changing algorithms or sequences, using wireless or wired links as described above.

In another embodiment, where the user is a non-human agent, and where the non-human agent is substantially integrated with, or substantially coupled to, aspects 53 of the wireless power transmitting unit control logic 13 responsible for generating, implementing and customizing, the frequency hopping and / or phase changing algorithms or sequences, the exchange of information, data, operational instructions, programming logic and software modules, in accordance with the present invention between the non-human agent and aspects 53 may be facilitated by communications means known in the art to be used by microprocessors, controllers, central processing units, and the like, in communicating internally to different aspects of said microprocessors, controllers, central processing units, responsible for different operational procedures, and the like.

FIG. 5 shows an example embodiment frequency hopping and / or phase change electromagnetic or magnetic waveform in accordance with the present invention. A wireless power signal at a first frequency and at a first phase **201** completes four cycles before the operational control aspect of the wireless power network responsible for the generation and control of frequency hopping and / or phase changing algorithms modifies the frequency and phase of the wireless power signal at **203**. A wireless power signal at a second frequency and a second phase is transmitted at **205**.

With active user control of the frequency hopping and / or phase change algorithms and sequences involved in wireless power transmission by either a human agent or a non-human agent, or some combination, the ability of wireless power over distance to dramatically improve the use, convenience and safety of current technology, forge the way to a greener and more environmentally cleaner global society, and to improve the use of medical devices to help people live higher quality lives, just to name a select few of the plurality of applications, becomes substantially more viable.

In a non-limiting example, a human agent may set the initial frequency hopping and / or phase change parameters for the purposes of wireless power signal security for a wireless power transmitter that is solely providing wireless power to an implanted cardiac pacemaker device. Via feedback mechanisms as described in FIG. **2c**, the wireless power transmitting unit control logic may determine that wireless power signal attrition is occurring due to the proximity of high density wireless signals transmitting at substantially the same frequencies at substantially the same time. Subsequently, a non-human agent, such as an Artificial Intelligence module, software module, and the like, customizes the frequency hopping and / or phase changing algorithm or sequence to be substantially different to the proximal wireless signals. The initial customization of the frequency hopping and / or phase changing algorithms or sequences using the process method of the present invention was for the purpose of wireless power security, whilst the subsequent customization of the frequency hopping and / or phase changing algorithms or sequences using the process method of the present invention was for the purpose of maximising power transfer efficiencies to a highly critical device, as well as maintaining the security of the transmitted wireless power signal. The use of wireless power will obviate the need for dangerous and stressful battery replacement procedures for people with cardiac pacemaker devices. However, without the process methods of the present invention to simultaneously actively ensure the security of the wireless power signal and to actively ensure that any substantial signal attrition can be eliminated or mitigated, wireless power will not be a feasible technology to charge cardiac pacemakers and other related implantable medical devices.

Further, without the process methods of the present invention, wireless power will not be a feasible technology to charge wireless sensors located in terrains unable to be accessed by traditional cables. The value of wirelessly powering sensors is that sensors can be placed in many more applicable locations that would otherwise be impractical or impossible to implement. Many sensors are used to monitor various safety factors of hazardous structures such as underground mines, or used to monitor for various potential building faults of common physical structures such as bridges and the like. Wirelessly powering such sensors will mean that such sensors can be placed in many more locations within the structures of underground mines or bridges in order to increase the quality of information on safety factors and potential faults, and as a result, allow the relevant parties to detect and respond to faults much more effectively. Due to the high potential for structural faults to cause severe human injury and casualties, it is essential that wireless sensors are able to provide feedback to the relevant parties constantly. Downtime due to a malicious third party “signal jamming” wireless power transmission to one or more wireless sensors may lead to the loss of accurate data, and this may mean the difference between detecting and mitigating a safety hazard and real human injury being caused. With the process methods of the present invention, “signal jamming” attempts or other environmental causes of detrimental wireless power inefficiencies to one or more wireless sensors would be able to be mitigated through swift detection and response to the threat by the non-human agent, examples of which have been described in this specification. The non-human agent related process methods of the present invention are especially critical wherein a human operator may not be present to detect and respond to the potential security or environmental threat via modification and of the frequency hopping and / or phase changing parameters using one or more of the process methods of the present invention. Furthermore, the plurality of wireless power transmission networks may comprise a plurality of non-contact wireless power transmission technologies, such as an at least any two of magnetic resonance, ultrasound wireless power transmission, and radio-frequency or microwave wireless power transmission. A universally standard user-control wireless power security platform ensures that a wireless power network operator or owner will be optimally equipped to set appropriate wireless power security parameters for each wireless power network without undue confusion or inconsistency.

In another non-limiting example, a plurality of wireless power transmitting units may be arranged under, or substantially near, a road, such as a highway, in order to provide wireless power to an at least one electric vehicle travelling on said road. This arrangement constitutes critical infrastructure. A human or non-human agent sets the initial frequency hopping and / or phase change parameters for the plurality of wireless power transmitting units for the purpose of not only wireless power signal security, but to ensure that the frequency hopping and / or phase changing algorithms or sequences for each individual wireless power transmitting unit is substantially different to another at substantially the same time in order to minimise the risk of extended signal attrition and thereby minimising risk of inefficiencies. Continuing this example, at a latter stage, the external environmental conditions change uncontrollably in the form of increasingly high humidity. Through one or more of the process methods described in the present invention, it is detected that several individual wireless power transmitting units are transmitting using frequency and / or phase sequences subject to signal attrition due to the high humidity. For each affected individual wireless power transmitting unit, a non-human agent uses the process methods of the present invention in order to modify the frequency hopping and / or phase changing parameters in order to minimise signal attrition due to the uncontrollable environmental factors, whilst simultaneously ensuring continued wireless power signal security and minimized signal attrition from proximal wireless communications and wireless power signals. Where such wireless power critical infrastructure is ubiquitous in a nation's roadways, inefficiencies arising from a lack of sufficient wireless power security, or extensive signal attrition from interference with other wireless signals or uncontrollable environmental factors, may lead to extremely widespread hazardous road conditions, and subsequent injury and even, under extreme worst case scenarios, loss of life.

In another non-limiting example, a manufacturing plant may be equipped with a plurality of wireless power transmission networks to wirelessly power, for example, a plurality of autonomous robots critical to the manufacturing plant's productivity and output. A human or non-human agent sets the initial frequency hopping and / or phase change parameters for the plurality of wireless power transmitting units for the purpose of not only wireless power signal security, but to ensure that the frequency hopping and / or phase changing algorithms or sequences for each individual wireless power transmitting unit is substantially different to another at the same time in order to minimise the risk of extended signal attrition and thereby minimising risk of inefficiencies. Should inefficiencies be detected in the wireless power network by environmental sensors integrated with the systems and process methods of the present invention in the form of extended signal attrition from proximal wireless signal interferences, uncontrollable environmental factors, or unauthorized usage of wireless power, it is essential from an economic perspective that the a human agent or non-human agent can customize the frequency hopping and / or phase changing parameters of an individual wireless power transmitting unit in order to minimize this signal attrition. Furthermore, the plurality of wireless power transmission networks may comprise a plurality of non-contact wireless power transmission technologies, such as an at least any two of magnetic resonance, ultrasound wireless power transmission, and radio-frequency or microwave wireless power transmission. A universally standard user-control wireless power security platform ensures that a wireless power network operator or owner will be optimally equipped to set appropriate wireless power security parameters for each wireless power network without undue confusion or inconsistency and therefore better ensure more secure wireless power transmission networks.

In another non-limiting example, a non-human agent may be responsible for modifying the frequency hopping and / or phase changing parameters for a wireless power network up until such a time as a human agent accesses an authorised input / output device, which may be an authorised third party device, and engages in the process method of the present invention. The human agent selected or inputted parameters for the frequency hopping and / or phase changing algorithms or sequences may overrule parameters set by the non-human agent.

The present invention can be readily adapted and applied to any "frequency-based" wireless power transmission system. As non-limiting examples, the present invention may be readily applied to magnetic resonance wireless power transmission systems, directional microwave wireless power transmission systems, for example, via phased antenna arrays, or ultrasound-based wireless power transmission systems. Underpinning this cross-compatibility to different wireless power transmission systems is the fact that each different wireless power transmission system has limitations. For example, phased antenna arrays are suitable for charging a smartphone or tablet via directional microwaves, but are unsuitable, due to human and animal safety factors, for charging high-power devices such as laptops or electric vehicles. Magnetic resonance wireless power transmission systems are suitable for charging high-power devices such as laptops and electric vehicles over a range extending up to approximately one metre, but are unsuitable, due to the electromagnetic inverse square law for charging portable electronics such as smartphones and tablets over significant distance. Hence, the market is open for different and complimentary wireless power transmission systems to co-exist simultaneously to fulfill the overall demand for wireless power. The present invention will provide security and environmental interference minimization for this plurality of wireless power solutions. The significant applicability of the present invention to a plurality of different wireless power transmission systems means that the present invention can ensure convenience and accessibility for consumers by ensuring that consumers are only required to familiarize themselves with one software system in order to be able to effectively customize wireless power security settings for a range of different wireless power transmission systems. This convenience is especially useful in professional settings wherein different wireless power networks may be utilized in order to charge high-power devices, such as laptops, and low-power devices, such as smartphones. The adaptability of the present invention to a plurality of different wireless power transmission systems has the benefits of maximising productivity for businesses and minimizing overheads as less time has to be spent learning how to implement wireless power security across the range of different wireless power transmission systems. This means that a greater amount of time can be focused on revenue-producing activities.

Those of skill in the art would understand that control information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

Those of skill would further appreciate that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, and controlled by computer software, or combinations of both. To clearly illustrate this inter-changeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented and controlled as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the exemplary embodiments of the invention.

The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be controlled with a general purpose processor, a Digital Signal Processor (DSP), an Application Specific Integrated Circuit

(ASIC), a Field Programmable Gate Array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

The control steps of a method or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in Random Access Memory (RAM), flash memory, Read Only Memory (ROM), Electrically Programmable ROM (EPROM), Electrically Erasable Programmable ROM (EEPROM), registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

In one or more exemplary embodiments, the control functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

While every effort has been made to adequately describe the wireless power technologies to which the present invention can be applied, those skilled in the art will appreciate that further wireless power technological embodiments may exist to which the present invention can be applied congruently and without departing from the spirit of this disclosure.

While the present invention has been illustrated by the description of the embodiments thereof, and while the embodiments have been described in detail, it is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative apparatus and methods, and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of the Applicant's general inventive concept.

CLAIMS

1. A method for customizing an at least one parameter of an at least one frequency hopping and / or phase change sequence operable to be used for wireless power transmission for the purposes of wireless power security, the method comprising:

providing a user input means for controlling an antenna control aspect of a controller wherein said antenna control aspect has substantial control of the properties of an antenna operable to transmit or receive wireless power, wherein said antenna control aspect is operable to control an at least one parameter of an at least one frequency hopping and / or phase change sequence involved in wireless power transmission;

wherein said user input means is operable to customize wireless power security parameters;

2. The method of Claim 1, wherein said user input means is facilitated by an input / output device;

3. The method of Claim 1, wherein said means involves the method of:

enabling a user to access a software module on a user-interface device that allows or enables customization of an at least one parameter of an at least one frequency hopping and / or phase change sequence involved in an at least one wireless power signal for wireless power transmission and reception;

presenting the user with an at least one option on said software module to modify the at least one parameter of the at least one frequency hopping and / or phase change sequence involved in the at least one wireless power signal for wireless power transmission and reception;

enabling the user to select an at least one option or provide input on said software module to modify the at least one frequency hopping and / or phase change sequence involved in the at least one wireless power signal for wireless power transmission and reception; and communicating the at least one selected option, or other user provided input, on said software module to modify the at least one parameter of the at least one frequency hopping and / or phase change sequence involved in the at least one wireless power signal for wireless power transmission and reception from the input / output device to an at least one processing unit coupled with a wireless power unit.

4. The method of Claim 1, wherein the at least one parameter is an at least one frequency;
5. The method of Claim 1, wherein the at least one parameter is an at least one phase;
6. The method of Claim 1, wherein the at least one parameter is an at least one amplitude;
7. The method of Claim 1, wherein the at least one parameter is an at least one time interval between a first frequency of wireless power transmission and a second frequency of wireless power transmission;
8. The method of Claim 1, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of frequencies;
9. The method of Claim 1, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of phases;
10. The method of Claim 1, wherein said means comprises an artificial intelligence and / or an advanced software module;
11. The method of Claim 10, wherein the artificial intelligence module is operable to modify an at least one parameter of the at least one frequency hopping and / or phase change sequence;
12. The method of Claim 11, wherein the at least one parameter is an at least one frequency;
13. The method of Claim 11, wherein the at least one parameter is an at least one phase;
14. The method of Claim 11, wherein the at least one parameter is an at least one time interval between a first frequency of wireless power transmission and a second frequency of wireless power transmission;
15. The method of Claim 11, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of frequencies;

16. The method of Claim 1, wherein the input / output device may include a smartphone, tablet, PDA, computer, motion sensor device, audio device;

17. The method Claim 1, wherein said user input means enables frequency hopping and / or phase changing sequences to be generated and implemented by the controller;

18. The method of Claim 1, wherein said controller is a microcontroller;

19. A system for customizing an at least one parameter of an at least one frequency hopping and / or phase change sequence operable to be used for wireless power transmission for the purposes of wireless power security and interference minimisation, the system comprising:

an antenna control aspect of a controller substantially disposed to control an at least one property of an antenna operable to transmit or receive wireless power, wherein said antenna control aspect is operable to control an at least one parameter of an at least one frequency involved in wireless power transmission;

wherein said antenna control aspect may simultaneously prevent unauthorized wireless power receivers from efficiently receiving, and converting to direct current power, a transmitted wireless power signal and minimise potential environmental interferences during wireless power transmission;

20. The system of Claim 19, wherein the controller is coupled to a user-interface device via a communications protocol;

21. The system of Claim 20, wherein the user-interface device comprises a software module with user-input functionality, and wherein the software module is operable to:

present the user with an at least one option on said software module to modify the at least one parameter of the at least one frequency hopping and / or phase change sequence involved in the at least one wireless power signal for wireless power transmission and reception;

enable the user to select an at least one option or provide input on said software module to modify the at least one frequency hopping and / or phase change sequence involved in the at least one wireless power signal for wireless power transmission and reception; and

communicate the at least one selected option, or other user provided input, on said software module to modify the at least one parameter of the at least one frequency hopping and / or phase change sequence involved in the at least one wireless power signal for wireless power transmission and reception from the user-interface device to the controller;

22. The system of Claim 21, wherein the controller is operably disposed to substantially simultaneously modify a property of a plurality of respective antennas in accordance with the at least one selected option;

23. The system of Claim 21, wherein the user-interface device may include, a smartphone, tablet, PDA, computer, motion recognition device, audio-input device, and the like;

24. The system of Claim 20, wherein the communications protocol is wireless, including IEEE 802.11x, Bluetooth, ZigBee, cellular network, satellite link;

25. The system of Claim 20, wherein the communications protocol is wired, including copper, PCB etches, fibre optic, Ethernet;

26. The system of Claim 19, wherein the antenna control aspect is substantially coupled to an artificial intelligence module and / or advanced software module;

27. The system of Claim 26, wherein the artificial intelligence module is operable to modify an at least one parameter of the at least one frequency hopping and / or phase change sequence;

28. The system of Claim 27, wherein the at least one parameter is an at least one frequency;

29. The system of Claim 27, wherein the at least one parameter is an at least one phase;

30. The system of Claim 27, wherein the at least one parameter is an at least one time interval between a first frequency of wireless power transmission and a second frequency of wireless power transmission;

31. The system of Claim 27, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of frequencies;

32. The system of Claim 27, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of phases;

33. The system of Claim 21, wherein the at least one parameter is an at least one frequency;
34. The system of Claim 21, wherein the at least one parameter is an at least one phase;
35. The system of Claim 21, wherein the at least one parameter is an at least one time interval between a first frequency of wireless power transmission and a second frequency of wireless power transmission;
36. The system of Claim 21, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of frequencies;
37. The system of Claim 21, further comprising:

a storage medium for storing the at least one selected option in a substantially non-transient electronic state;

38. A system for customizing an at least one parameter of an at least one frequency hopping and / or phase change sequence operable to be used for wireless power transmission for the purposes of wireless power security and interference minimisation, the method comprising:

an at least one sensor operable to measure an at least one environmental variable;

an antenna control aspect of a controller substantially disposed to control an at least one property of an antenna operable to transmit or receive wireless power, wherein said antenna control aspect is operable to control an at least one parameter of an at least one frequency involved in wireless power transmission;

wherein the antenna control aspect is substantially coupled to a software module able to analyze and compare the at least one frequency hopping and / or phase change sequence to a dataset comprising information on signal attenuation characteristics for an at least one environmental variable for an at least one frequency comprising the at least one frequency hopping and / or phase change sequence;

wherein the at least one sensor is operable to communicate collected environmental data to the software machine; and wherein the software module is able to instruct the modification of an at least one parameter of the at least one frequency hopping and / or phase change sequence;

39. The system of Claim 38, wherein the software module is operable to communicate instructions for the at least one modification of the at least one parameter of the at least one frequency hopping and / or phase change sequence to the antenna control aspect;
40. The system of Claim 38, wherein the at least one sensor may measure environmental variables, including, humidity, temperature, Wi-Fi, radio-frequency density;
41. The system of Claim 38, wherein the software module comprises an artificial intelligence module or advanced software module;
42. The system of Claim 38, wherein the at least one environmental variable includes humidity, temperature, radio-frequency density;
43. The system of Claim 38, wherein the at least one parameter is an at least one frequency;
44. The system of Claim 38, wherein the at least one parameter is an at least one phase;
45. The system of Claim 38, wherein the at least one parameter is an at least one time interval between a first frequency of wireless power transmission and a second frequency of wireless power transmission;
46. The system of Claim 38, wherein the at least one parameter is an at least one cycle number, wherein said cycle is defined as an arbitrary or pre-determined sequence of a plurality of frequencies;
47. A method for customizing an at least one parameter of an at least one frequency hopping and / or phase change sequence operable to be used for wireless power transmission for the purposes of wireless power security, the method comprising:

providing a user input means for controlling an antenna control aspect of a controller wherein said antenna control aspect has substantial control of the properties of an antenna operable to transmit or receive wireless power, wherein said antenna control aspect is operable to control an at least one parameter of an at least one frequency hopping and / or phase change sequence involved in wireless power transmission, wherein said user input means is operable to customize wireless power security parameters, and wherein said user input means includes user-input via a user-interface device and user-input via a non-human agent stored in a non-transient computer medium accessible by the controller;

storing user-input via the user-interface device on a computer-readable storage medium;

determining prioritization of controlling the antenna control aspect of the controller at an instance in time, wherein prioritization is one of user-input via the user-interface device or the non-human agent;

controlling the antenna control aspect of the controller with the result of the prioritization;

FIGURES

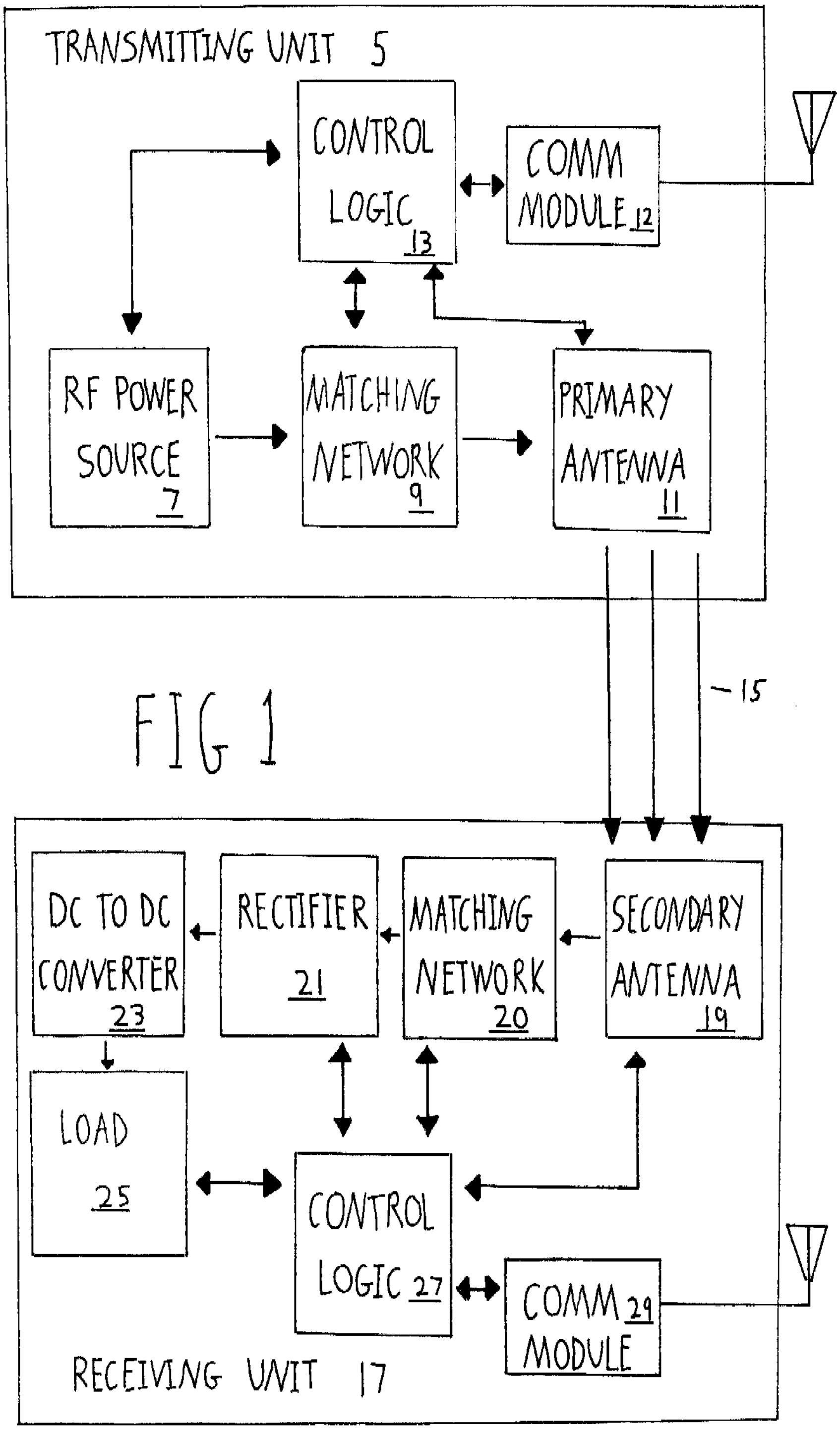


FIG 1

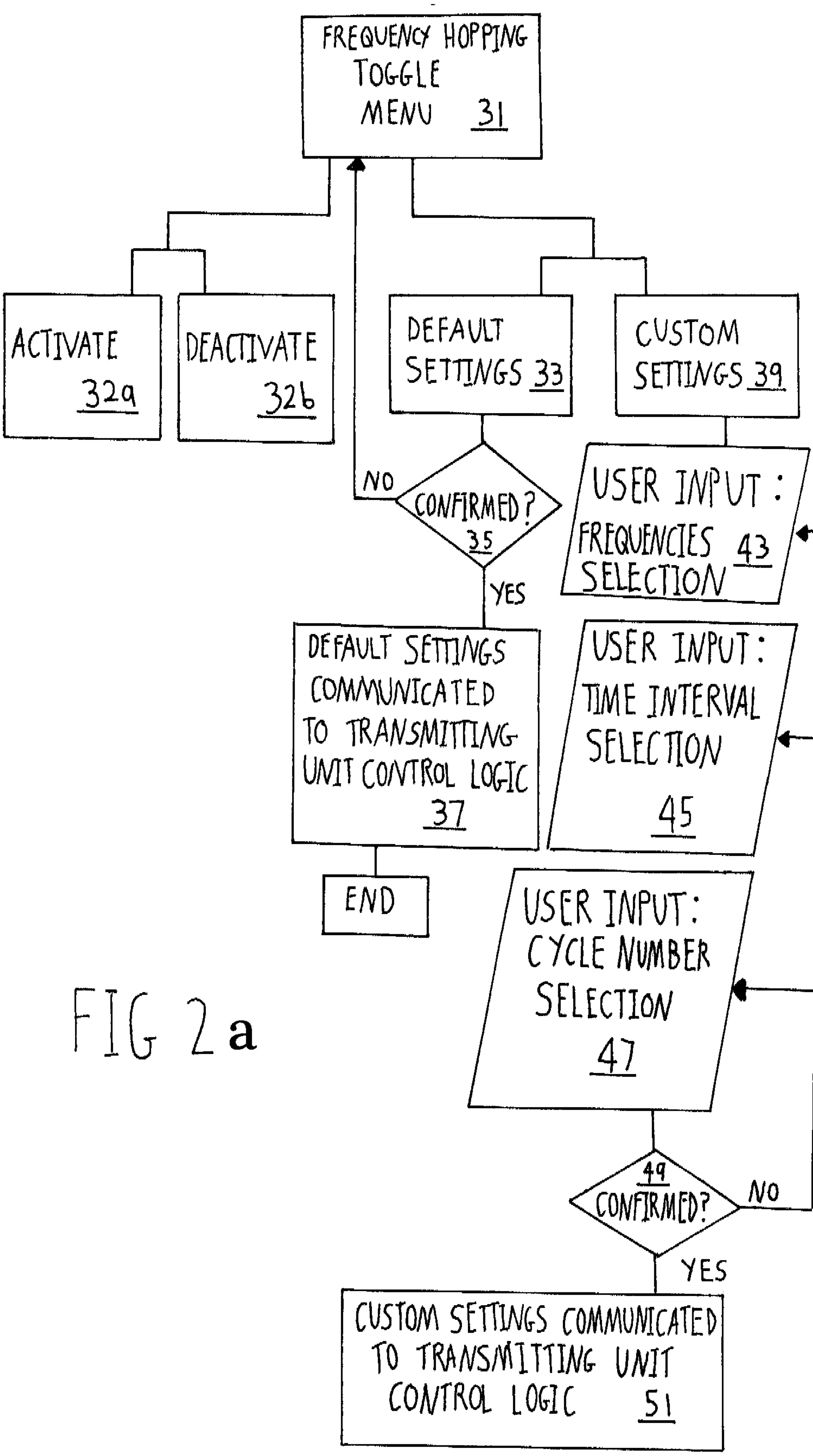

FREQUENCY HOPPING TOGGLE MENU 31
ACTIVATE 32a
DEACTIVATE 32b
DEFAULT SETTINGS 33
CUSTOM SETTINGS 39
NO
CONFIRMED? 35
YES
DEFAULT SETTINGS COMMUNICATED TO TRANSMITTING UNIT CONTROL LOGIC 37
END
USER INPUT: FREQUENCIES SELECTION 43
USER INPUT: TIME INTERVAL SELECTION 45
USER INPUT: CYCLE NUMBER SELECTION 47
49 CONFIRMED?
NO
YES
CUSTOM SETTINGS COMMUNICATED TO TRANSMITTING UNIT CONTROL LOGIC 51

FIG 2a

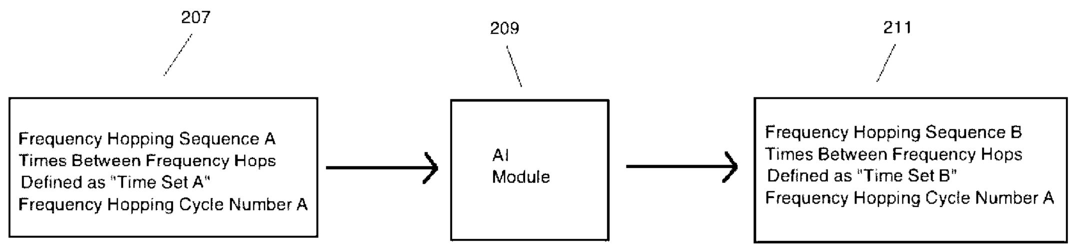

207
209
211
Frequency Hopping Sequence A
Times Between Frequency Hops
Defined as "Time Set A"
Frequency Hopping Cycle Number A
AI
Module
Frequency Hopping Sequence B
Times Between Frequency Hops
Defined as "Time Set B"
Frequency Hopping Cycle Number A

FIG 2b

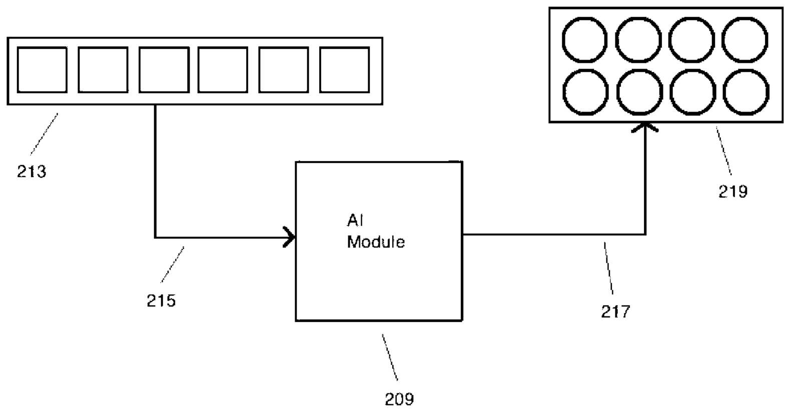


FIG 2c

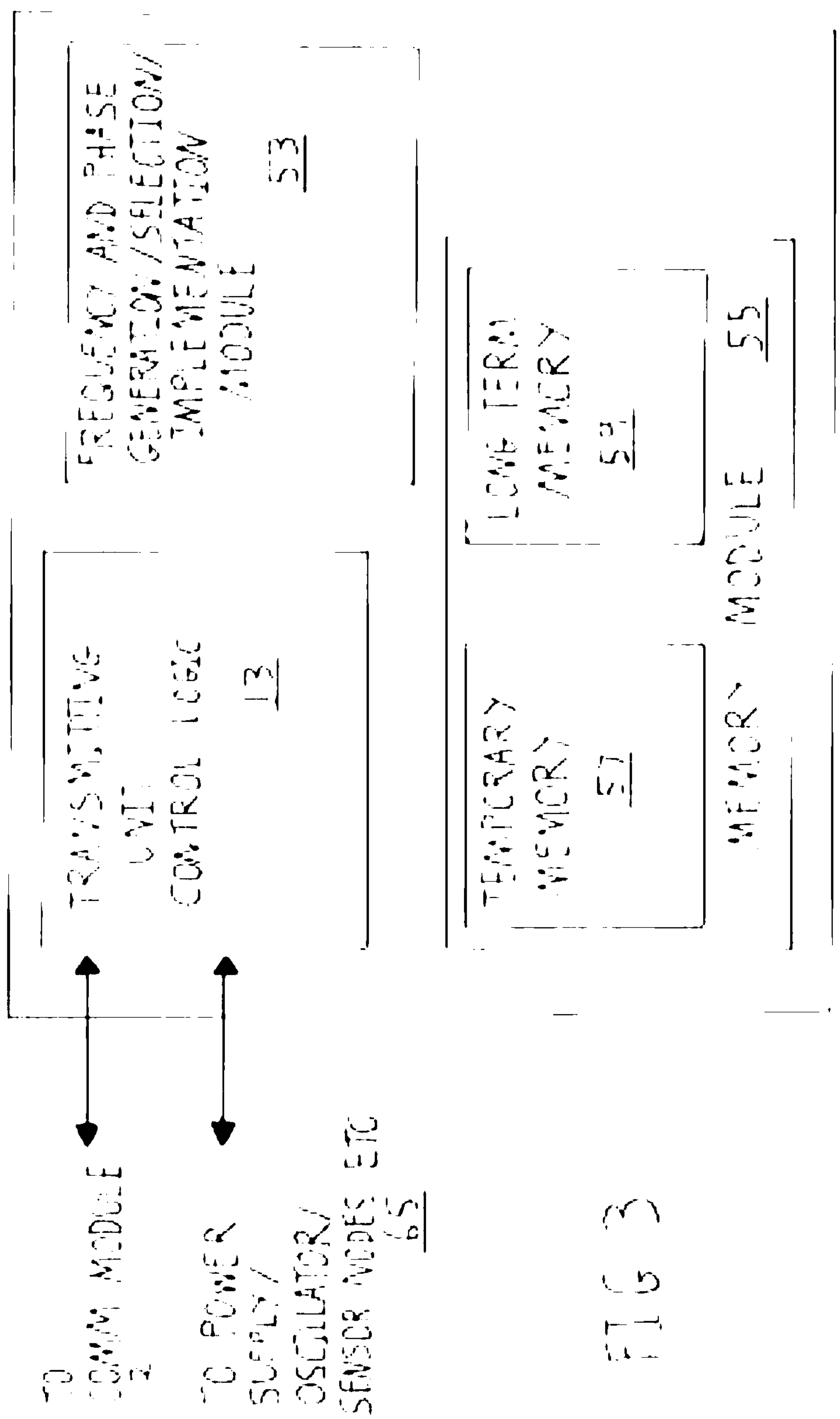

FREQUENCY AND PHASE GENERATION/SELECTION/ IMPLEMENTATION MODULE
53
TRANSMITTING UNIT CONTROL LOGIC
13
LONG TERM MEMORY
TEMPORARY MEMORY
57
MEMORY MODULE
55
TO COMM MODULE
3
TO POWER SUPPLY/ OSCILLATOR/ SENSOR NODES ETC
65

FIG 3

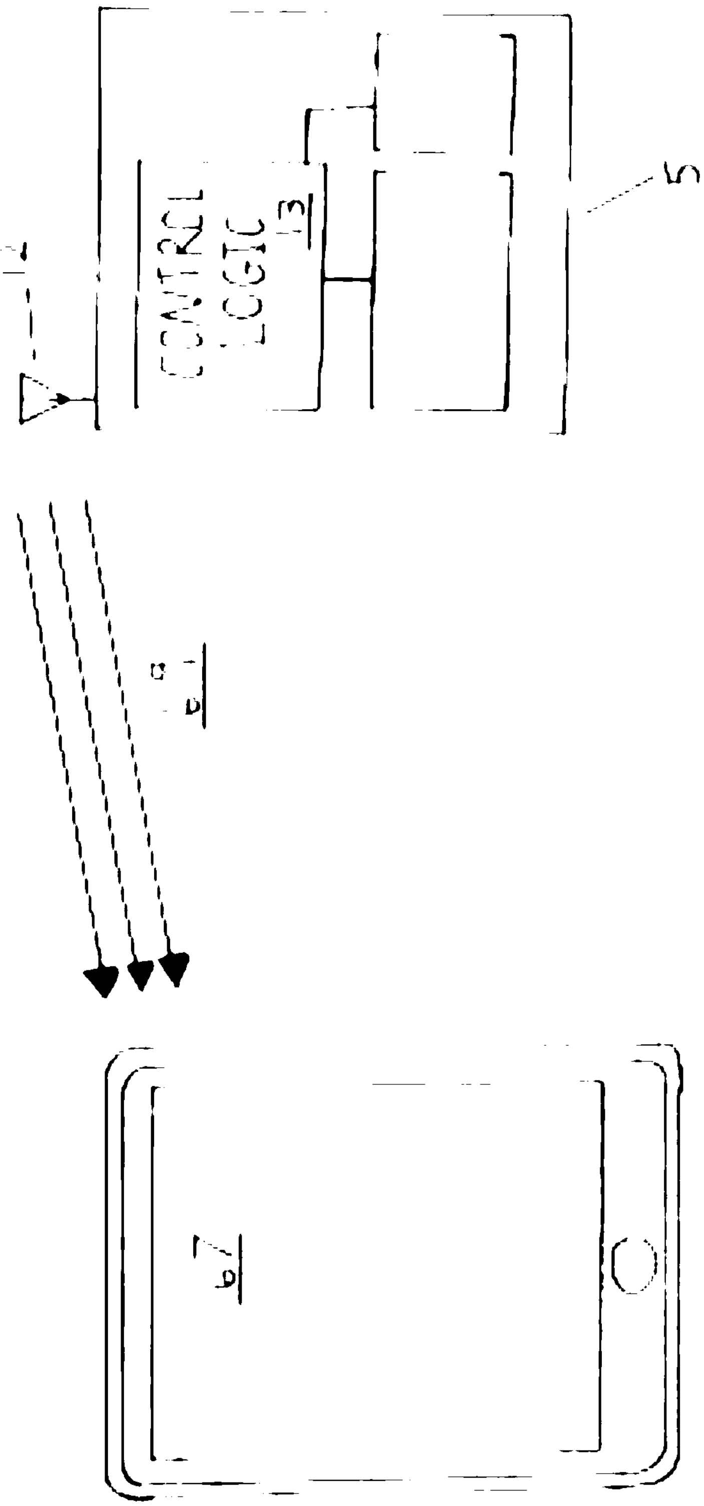
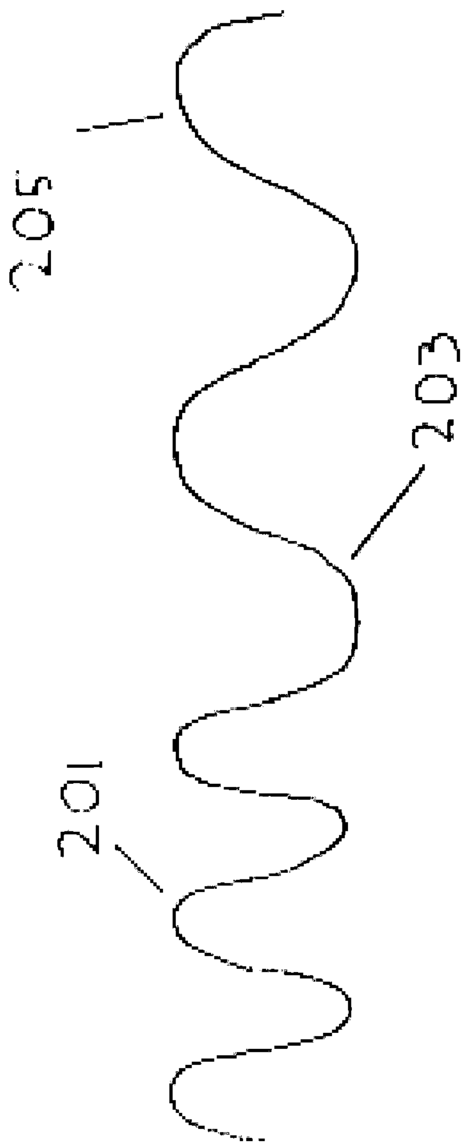


FIG. 4

FIG 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2016/050751

A. CLASSIFICATION OF SUBJECT MATTER

H02J 50/80 (2016.01) H02J 50/12 (2016.01) H04B 1/69 (2011.01) H04B 1/713 (2011.01) H04B 1/7136 (2011.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIAP, EPODOC, TXTE (TXTE English full text TXPEA, TXPEB, TXPEC, TXPEE, TXPEF, TXPEH, TXPEI, TXPEP, TXPES, TXPEPEA, TXPUSE0A, TXPUSE1A, TXPUSEA, TXPUSEB, TXPWOEA), Google Scholar, Google Patents and Google Web: Keywords: (adaptive, frequency hop, control, antenna, parameter, channel assessment, sensor, humidity, interference) and like terms.

IPC and CPC marks: H02J/-, H02J 17/-, H02J50/-

Applicant (MANDEVILLE-CLARKE, Ben) and Inventor (MANDEVILLE-CLARKE, Ben) search on Espacenet, AUSPAT, Internal databases provided by IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [ ] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 October 2016	04 October 2016

Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au	Shruthi Sreevatsa AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832538

INTERNATIONAL SEARCH REPORT

International application No. **PCT/AU2016/050751**

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Rao S. "Implementing a Bidirectional frequency Hopping Application With TRF6903 and MSP430", Texas Instruments, Application Report SWRA041 - September 2004. Abstract and Item 2.1, 2.2, 2.3.1 last Paragraph	1 - 37
X	ELSEMA, 3, 4-Channel, 915MHz Receiver with Frequency Hopping - MCR91503R, MCR9150R [Retrieved from the internet on 25 Spetember 2016] Url <http://www.elsema.com/datasheet/mcr91504r.pdf> Published on 17 Oct 2009 as per Wayback Machine. Page 1, first Paragraph; Pages 7 – 8	1 - 37
X	US 2015/0022016 A1 (SAMSUNG ELECTRONICS CO., LTD.,) 22 January 2015 Abstract; Figs 1, 12; Paragraphs [0003], [0008] - [0012], [0015], [0059], [0135] – [0140], [152] – [154], [0187], [0189]	1 - 47
X	US 2006/0245470 A1 (BALACHANDRAN et al.) 02 November 2006 Abstract; Paragraphs [0013], [0016] - [0018], [0020]	1 - 47
A	EP 2151906 A2 (BROADCOM CORPORATION) 10 February 2010 Whole Document	1 - 47