US010454318B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.: US 10,454,318 B2**
(45) **Date of Patent: Oct. 22, 2019**

(54) **WIRELESS POWER TRANSMITTING UNIT, WIRELESS POWER RECEIVING UNIT, AND CONTROL METHODS THEREOF**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/038,843**

(22) Filed: **Jul. 18, 2018**

(65) **Prior Publication Data**

US 2018/0342906 A1 Nov. 29, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/370,671, filed on Dec. 6, 2016, now Pat. No. 10,038,344, which is a (Continued)

(30) **Foreign Application Priority Data**

Mar. 21, 2013 (KR) 10-2013-0030568
Dec. 13, 2013 (KR) 10-2013-0155925

(51) **Int. Cl.**
H02J 50/40 (2016.01)
H02J 50/80 (2016.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H02J 50/40*** (2016.02); ***H02J 7/025*** (2013.01); ***H02J 50/12*** (2016.02); ***H02J 50/80*** (2016.02)

(58) **Field of Classification Search**
CPC .. H02J 50/40; H02J 50/12; H02J 7/025; H02J 50/80
(Continued)

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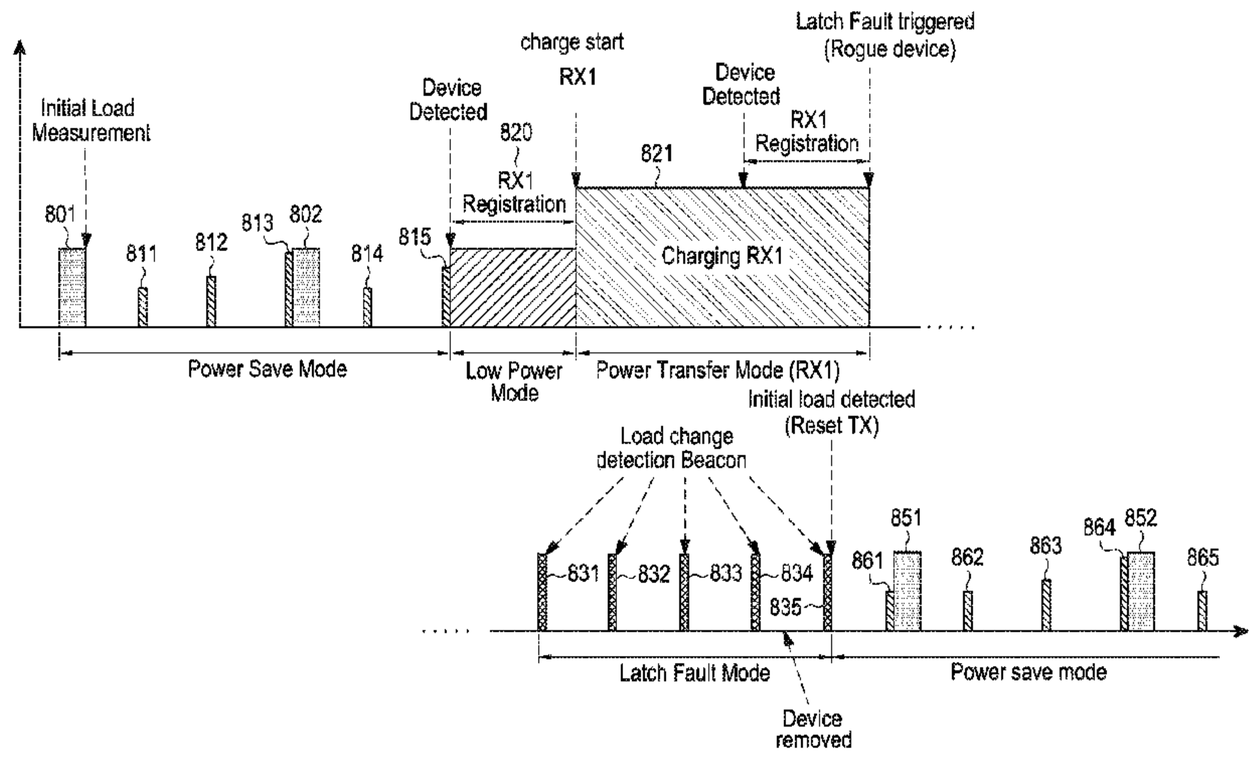
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(57) **ABSTRACT**

A control method of a wireless power receiving unit for receiving charging power from a wireless power transmitting unit to perform wireless charging is provided. The control method includes receiving the charging power from the wireless power transmitting unit; detecting a change in a wireless charging environment; generating a message notifying of the change in the wireless charging environment; and transmitting the message notifying of the change in the wireless charging environment to the wireless power transmitting unit.

32 Claims, 14 Drawing Sheets



Related U.S. Application Data

continuation of application No. 14/221,530, filed on Mar. 21, 2014, now Pat. No. 9,515,514.

(51) **Int. Cl.**
H02J 50/12 (2016.01)
H02J 7/02 (2016.01)

(58) **Field of Classification Search**
USPC 320/108
See application file for complete search history.

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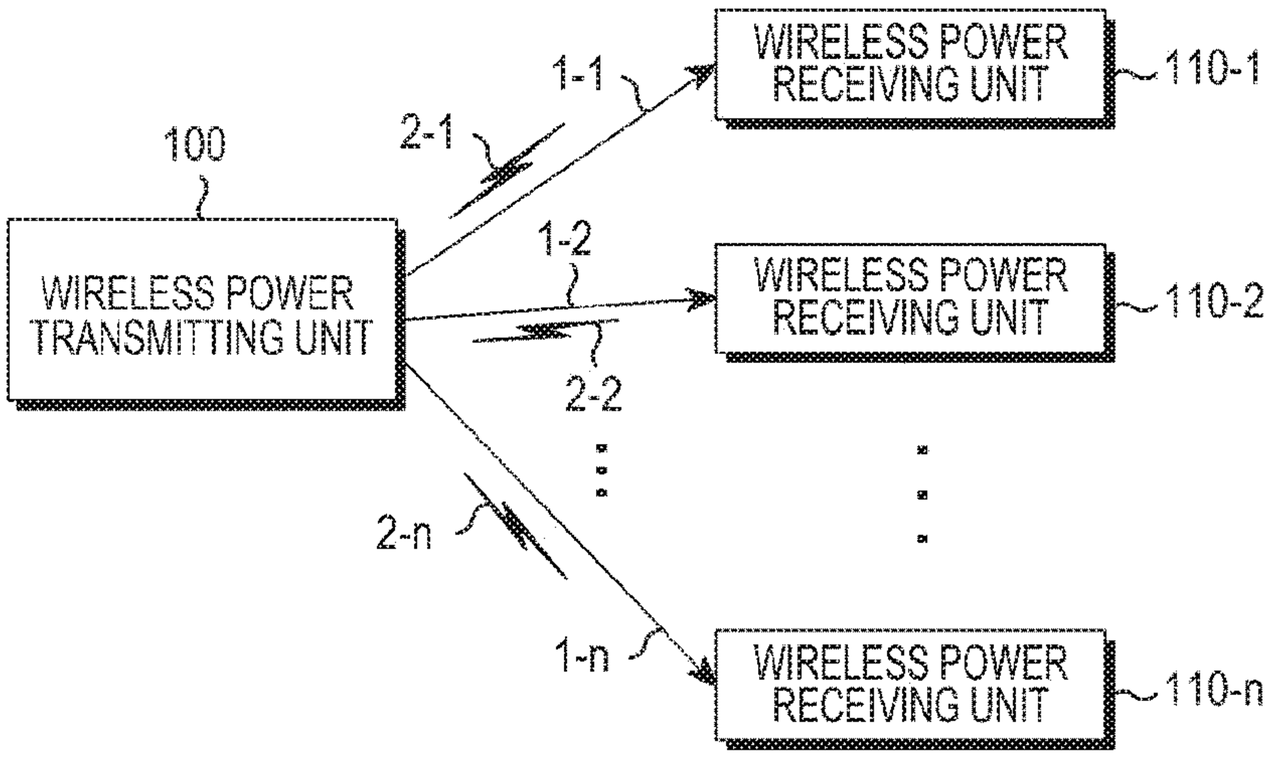

100
WIRELESS POWER TRANSMITTING UNIT
1-1
2-1
1-2
2-2
2-n
1-n
WIRELESS POWER RECEIVING UNIT
110-1
WIRELESS POWER RECEIVING UNIT
110-2
WIRELESS POWER RECEIVING UNIT
110-n

FIG.1

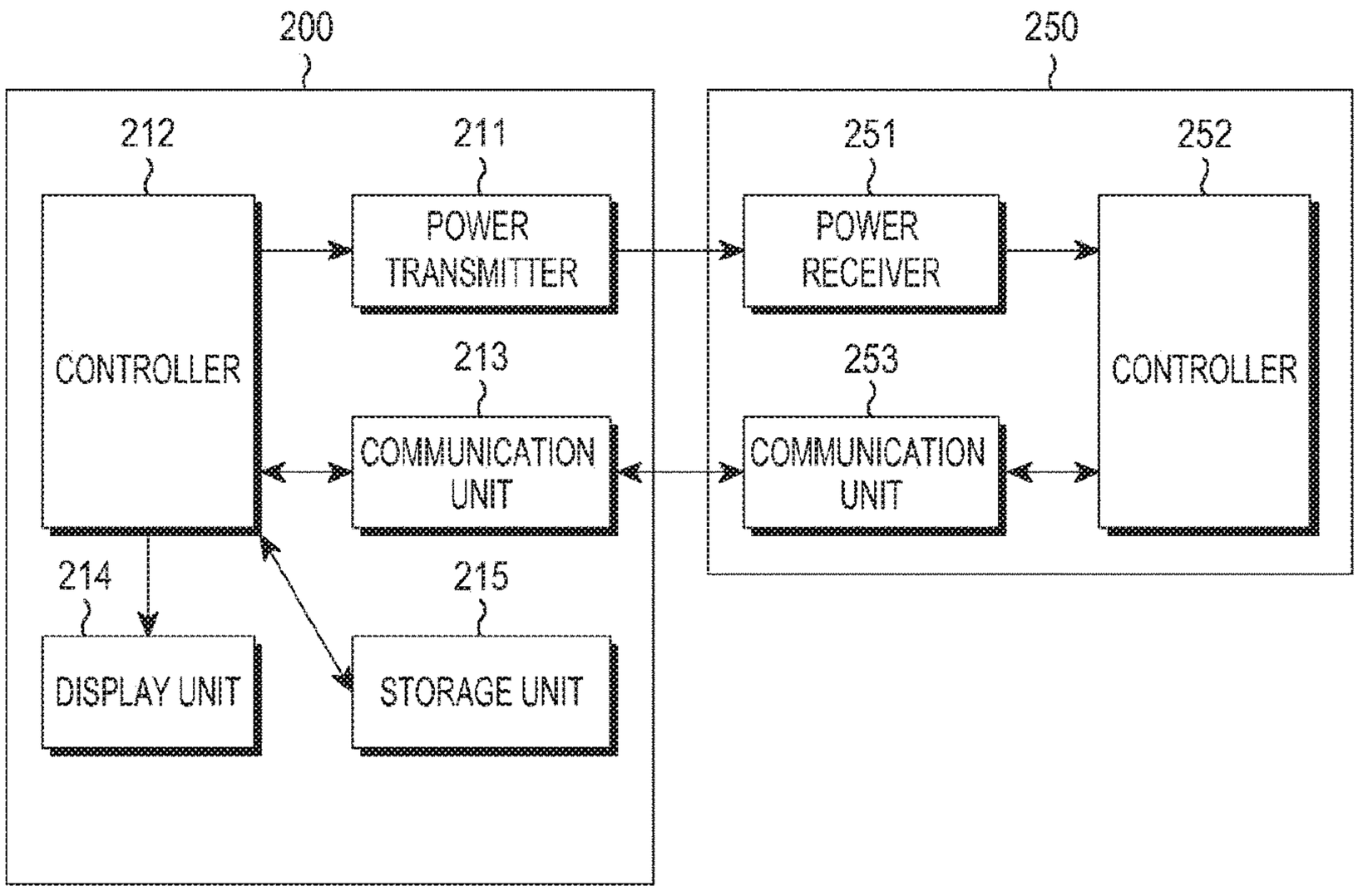

200
250
212
211
251
252
CONTROLLER
POWER TRANSMITTER
POWER RECEIVER
CONTROLLER
213
253
COMMUNICATION UNIT
COMMUNICATION UNIT
214
215
DISPLAY UNIT
STORAGE UNIT

FIG.2

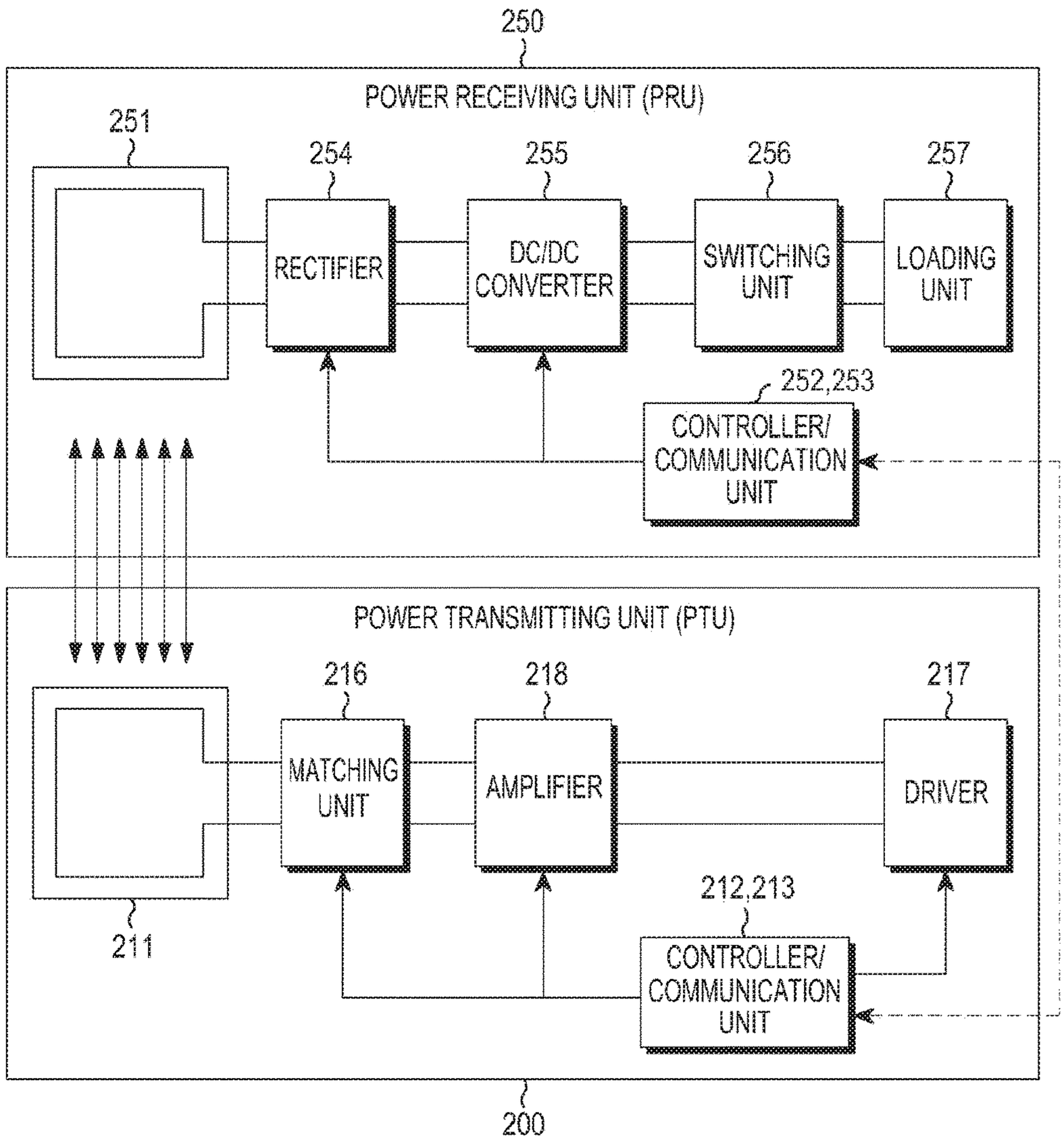

250
POWER RECEIVING UNIT (PRU)
251
254
255
256
257
RECTIFIER
DC/DC CONVERTER
SWITCHING UNIT
LOADING UNIT
252,253
CONTROLLER/ COMMUNICATION UNIT
POWER TRANSMITTING UNIT (PTU)
216
218
217
MATCHING UNIT
AMPLIFIER
DRIVER
212,213
CONTROLLER/ COMMUNICATION UNIT
211
200

FIG.3

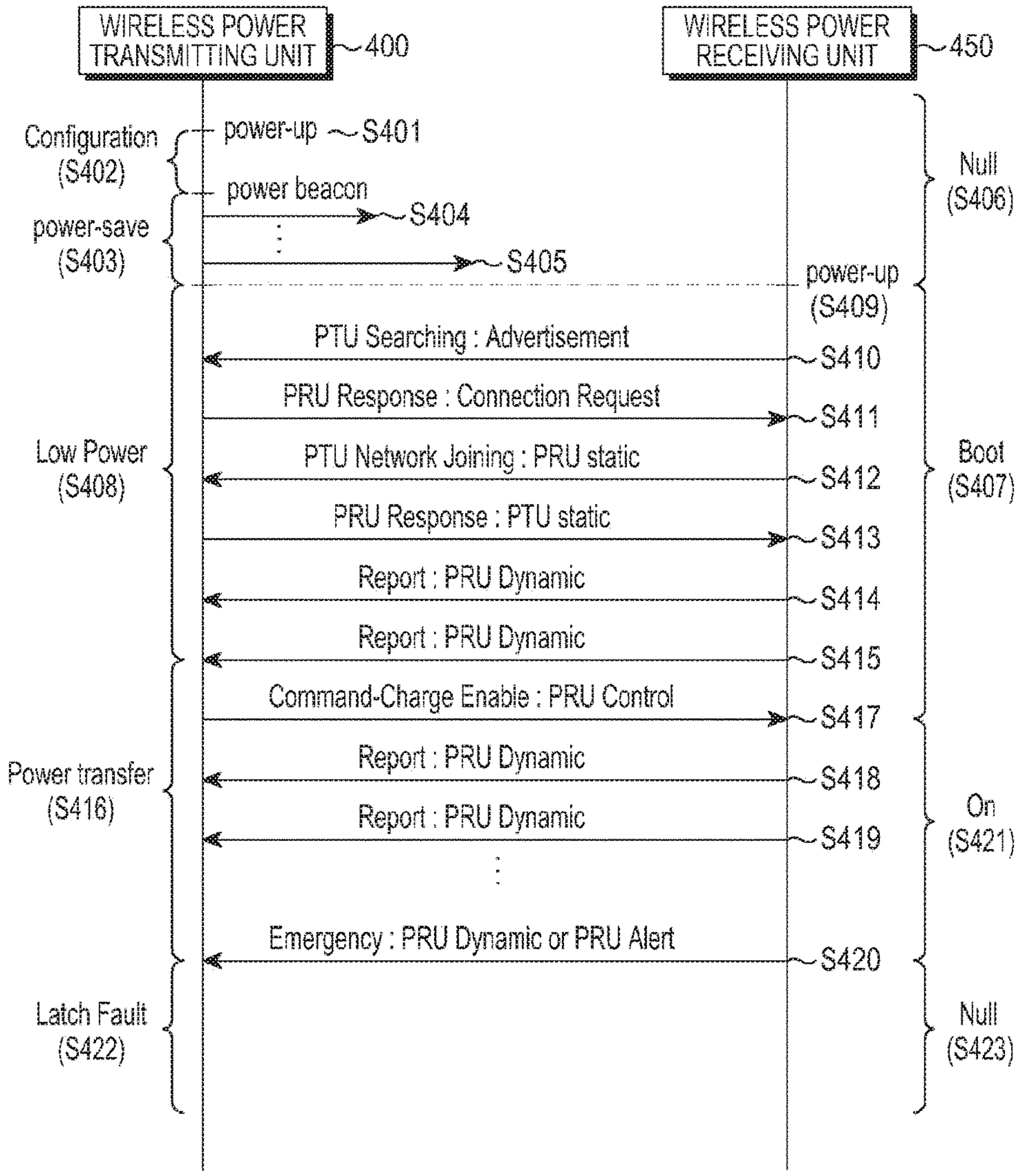

WIRELESS POWER TRANSMITTING UNIT
400
WIRELESS POWER RECEIVING UNIT
450
Configuration (S402)
power-up
S401
power beacon
S404
power-save (S403)
S405
Null (S406)
power-up (S409)
PTU Searching : Advertisement
S410
PRU Response : Connection Request
S411
Low Power (S408)
PTU Network Joining : PRU static
S412
Boot (S407)
PRU Response : PTU static
S413
Report : PRU Dynamic
S414
Report : PRU Dynamic
S415
Command-Charge Enable : PRU Control
S417
Power transfer (S416)
Report : PRU Dynamic
S418
Report : PRU Dynamic
S419
On (S421)
Emergency : PRU Dynamic or PRU Alert
S420
Latch Fault (S422)
Null (S423)

FIG.4

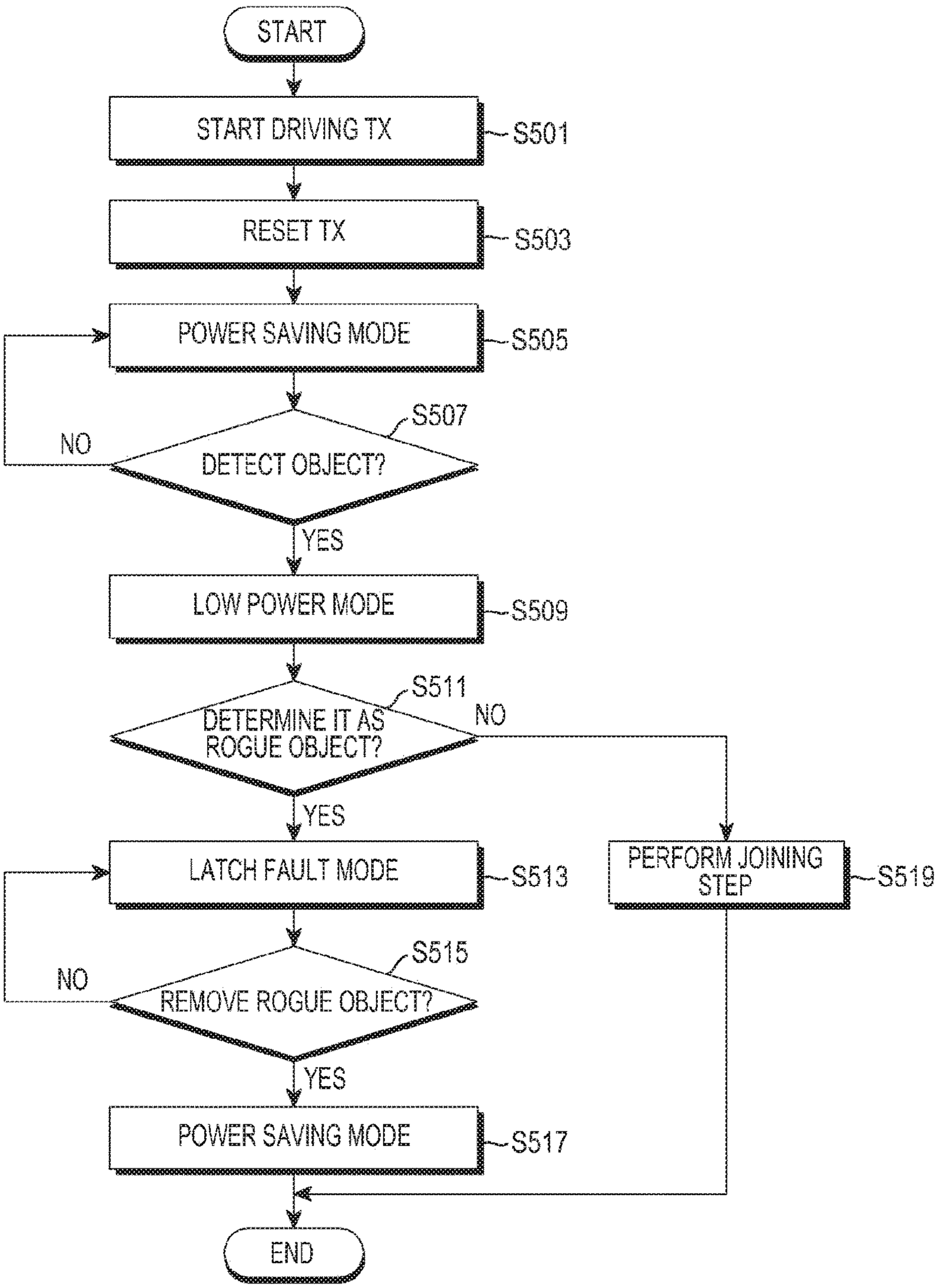

START
START DRIVING TX
S501
RESET TX
S503
POWER SAVING MODE
S505
S507
NO
DETECT OBJECT?
YES
LOW POWER MODE
S509
S511
DETERMINE IT AS ROGUE OBJECT?
NO
YES
LATCH FAULT MODE
S513
PERFORM JOINING STEP
S519
S515
NO
REMOVE ROGUE OBJECT?
YES
POWER SAVING MODE
S517
END

FIG.5

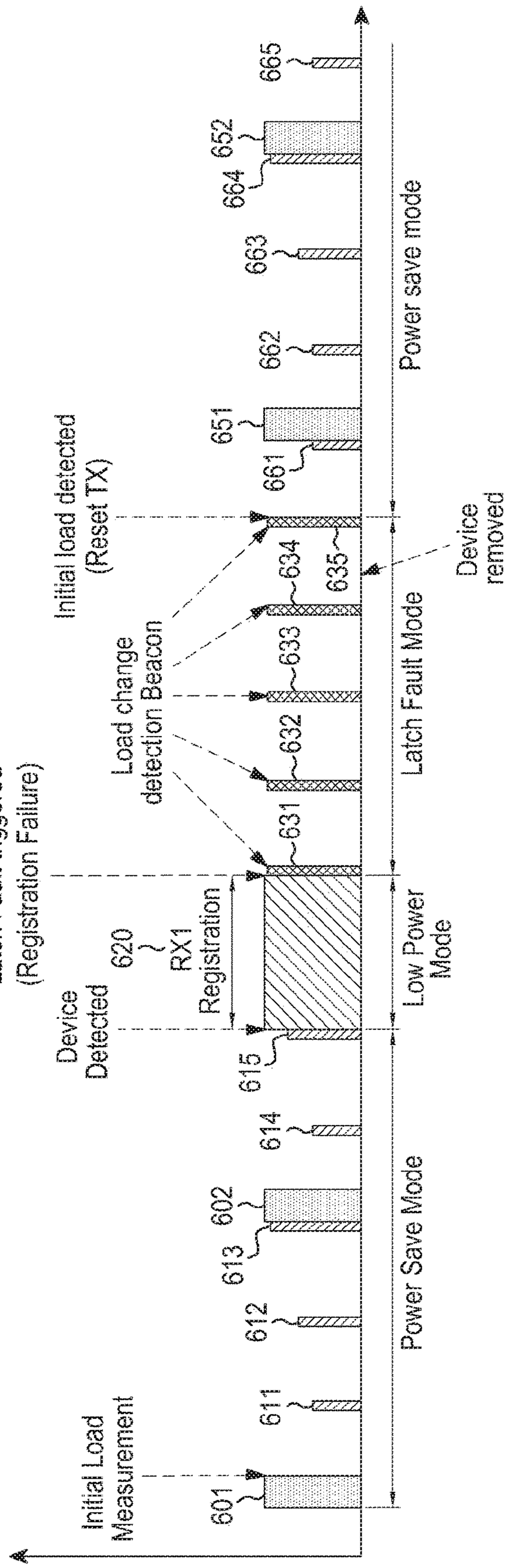

Initial Load Measurement
601
611
612
602
613
614
Power Save Mode
Device Detected
620
RX1 Registration
615
Latch Fault triggered (Registration Failure)
631
632
Load change detection Beacon
633
634
635
Initial load detected (Reset TX)
661
651
Latch Fault Mode
Low Power Mode
Device removed
662
663
664
652
665
Power save mode

FIG.6

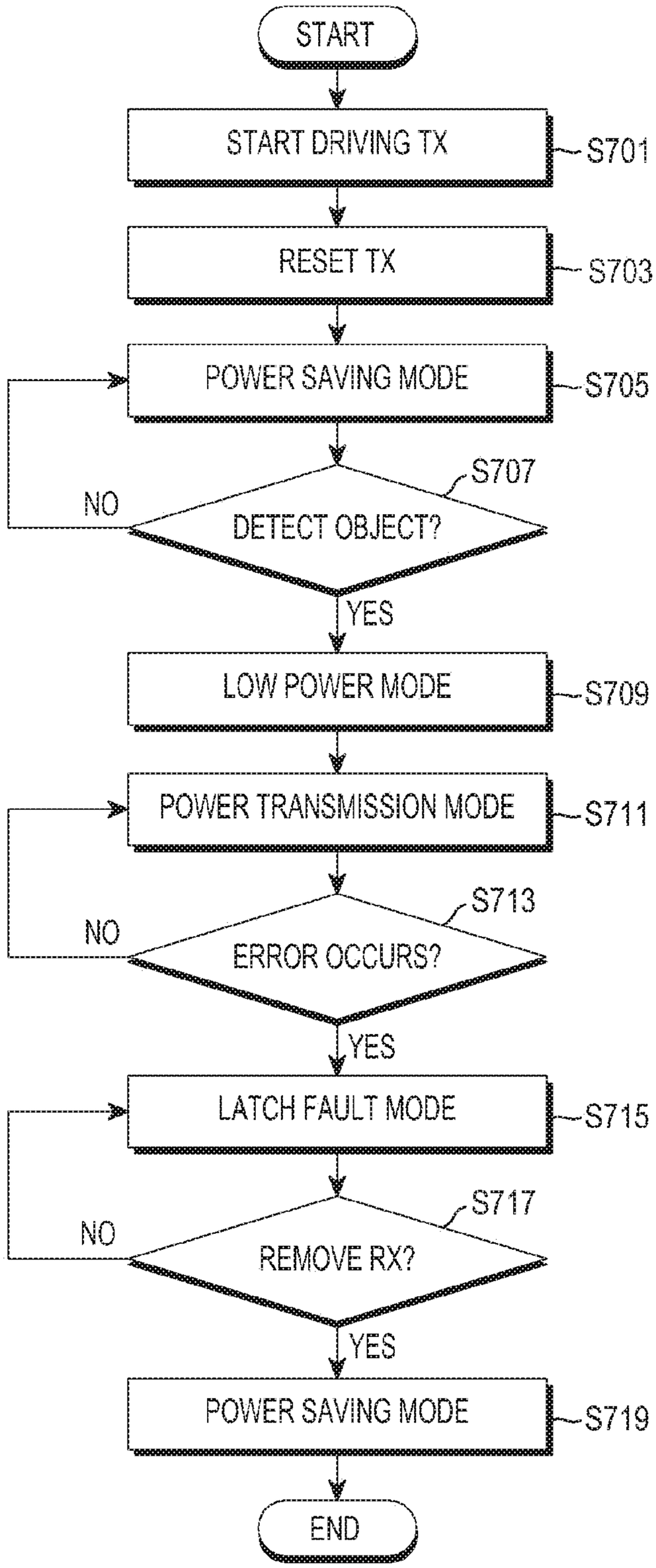

START
START DRIVING TX
S701
RESET TX
S703
POWER SAVING MODE
S705
S707
NO
DETECT OBJECT?
YES
LOW POWER MODE
S709
POWER TRANSMISSION MODE
S711
S713
NO
ERROR OCCURS?
YES
LATCH FAULT MODE
S715
S717
NO
REMOVE RX?
YES
POWER SAVING MODE
S719
END

FIG.7

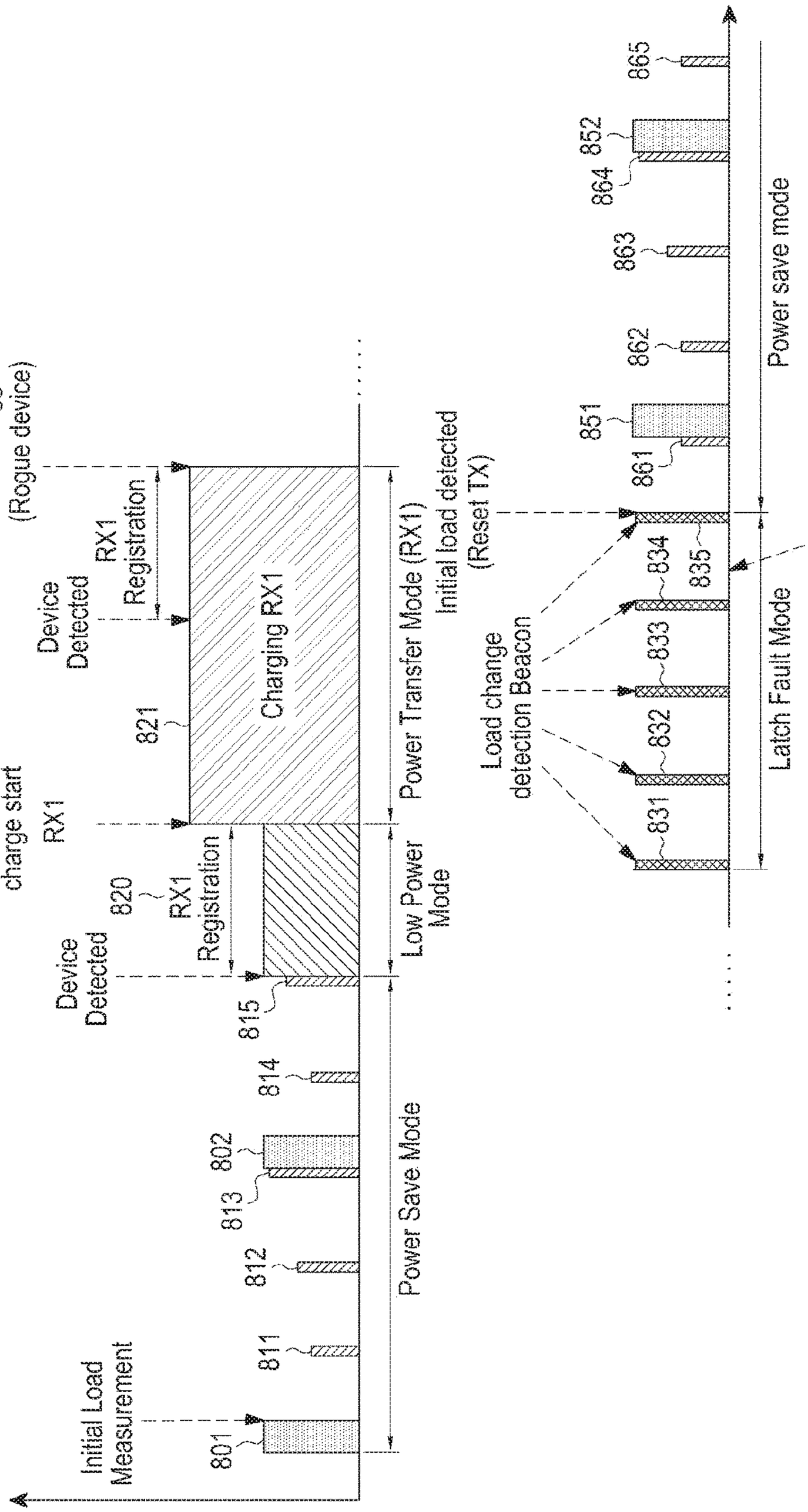

Initial Load Measurement
801
811
812
813
802
814
Power Save Mode
charge start
Device Detected
820
RX1 Registration
815
Low Power Mode
RX1 Registration
Device Detected
821
Charging RX1
Power Transfer Mode (RX1)
Latch Fault triggered (Rogue device)
Initial load detected (Reset TX)
Load change detection Beacon
831
832
833
834
835
Latch Fault Mode
Device removed
851
861
862
863
864
852
865
Power save mode

FIG. 8

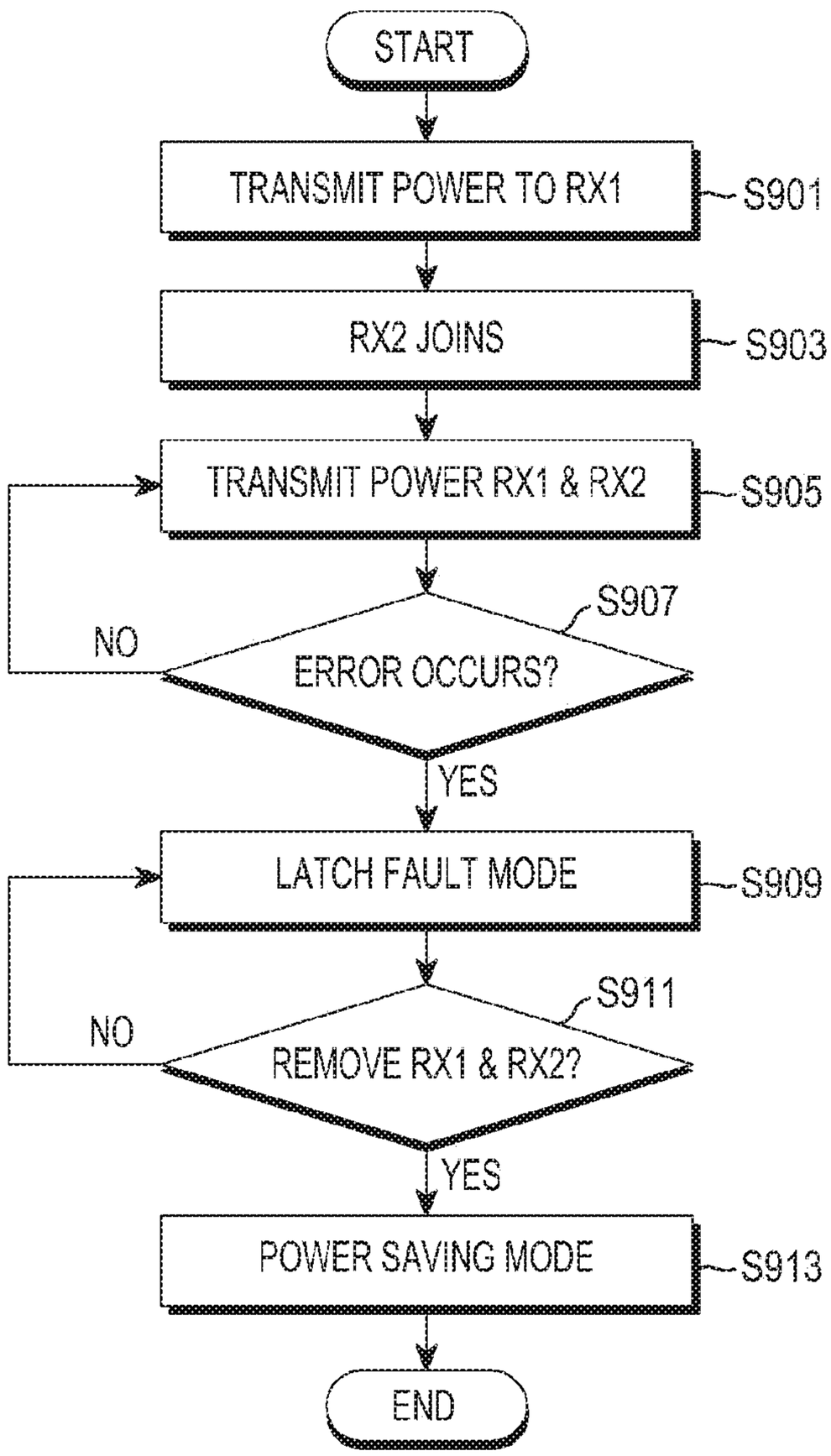

START
TRANSMIT POWER TO RX1
S901
RX2 JOINS
S903
TRANSMIT POWER RX1 & RX2
S905
S907
NO
ERROR OCCURS?
YES
LATCH FAULT MODE
S909
S911
NO
REMOVE RX1 & RX2?
YES
POWER SAVING MODE
S913
END

FIG.9

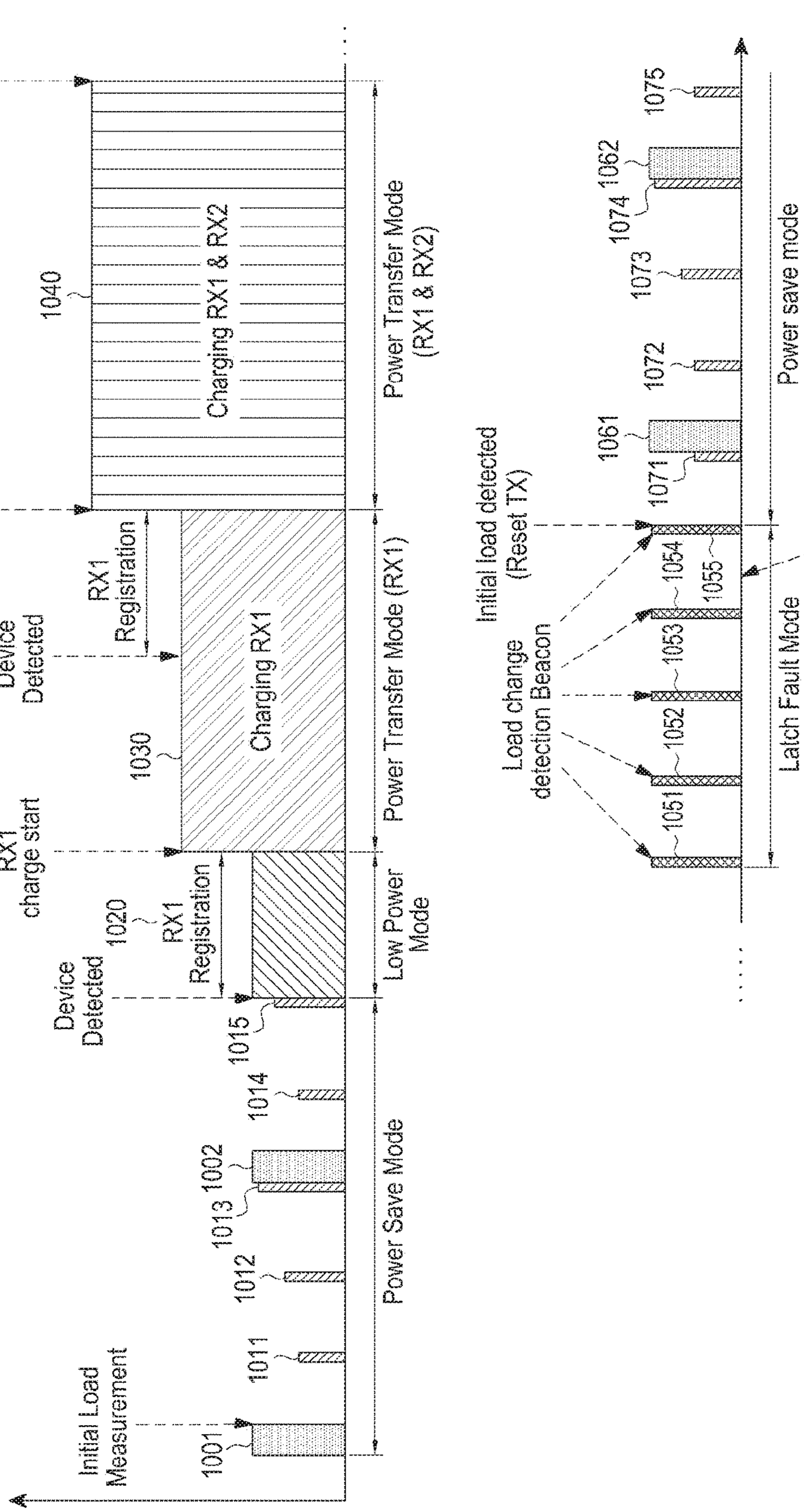

Initial Load Measurement
1001
1011
1012
1013
1002
1014
Power Save Mode
RX1 charge start
Device Detected
1020
RX1 Registration
1015
Low Power Mode
1030
Charging RX1
Power Transfer Mode (RX1)
RX2 charge start
Device Detected
RX1 Registration
1040
Charging RX1 & RX2
Power Transfer Mode (RX1 & RX2)
Latch Fault triggered by RX2
Initial load detected (Reset TX)
Load change detection Beacon
1051
1052
1053
1054
1055
Latch Fault Mode
Device removed
1061
1071
1072
1073
1074
1062
1075
Power save mode

FIG. 10

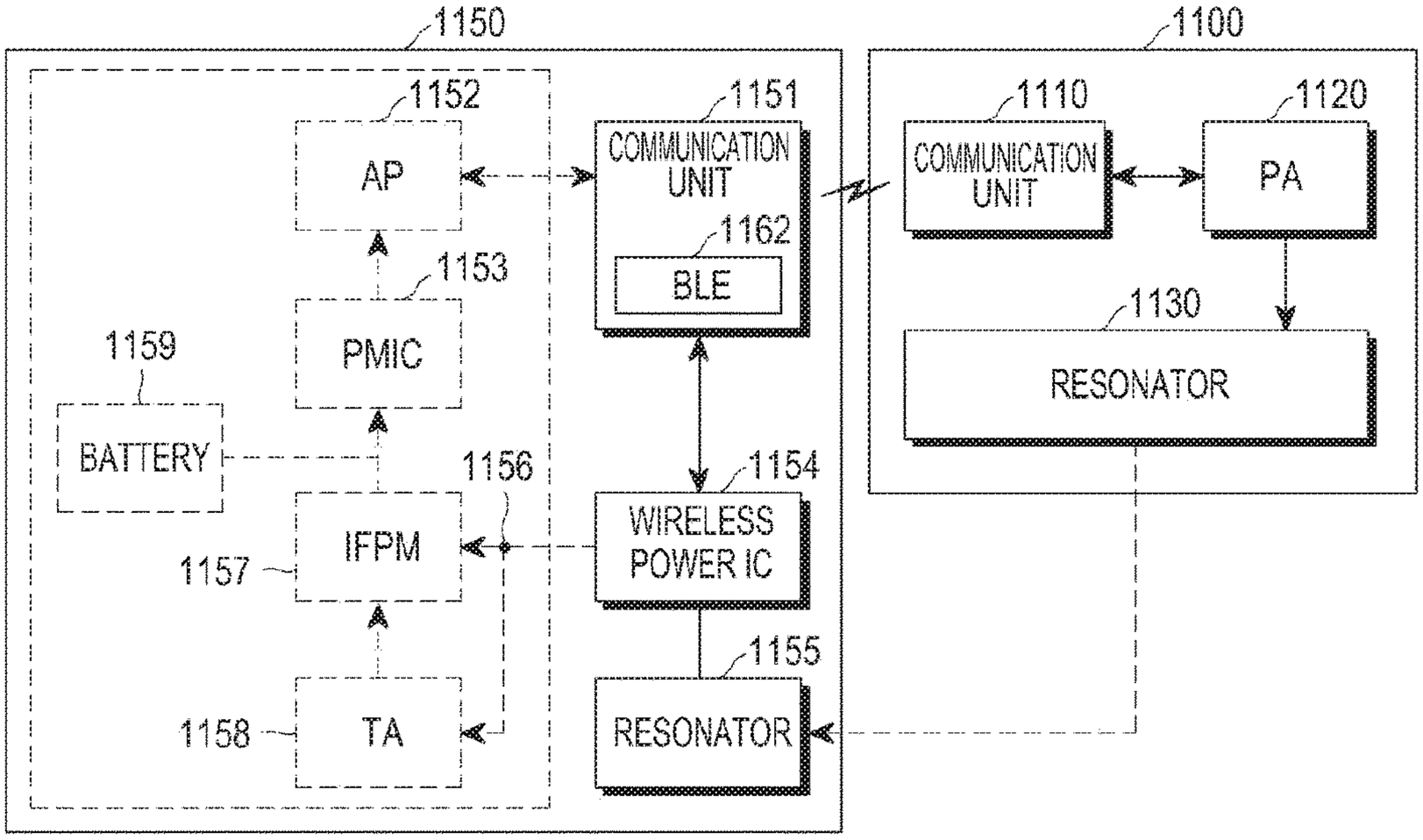

1150
1152
AP
1153
PMIC
1159
BATTERY
1156
IFPM
1157
1158
TA
1151
COMMUNICATION UNIT
1162
BLE
1154
WIRELESS POWER IC
1155
RESONATOR
1100
1110
COMMUNICATION UNIT
1120
PA
1130
RESONATOR

FIG.11

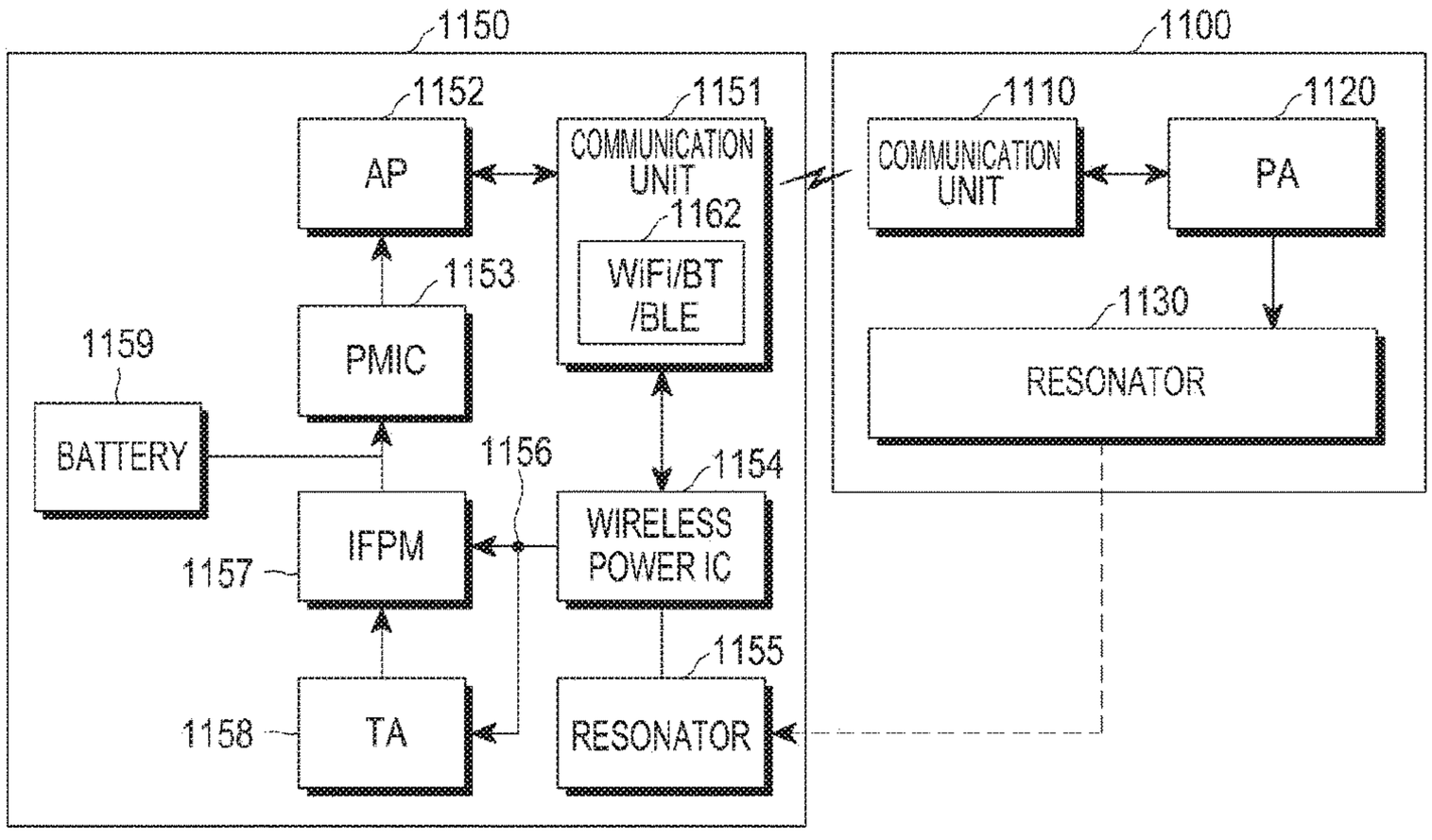

1150
1152
AP
1151
COMMUNICATION UNIT
1162
WiFi/BT /BLE
1153
PMIC
1159
BATTERY
1156
1154
WIRELESS POWER IC
IFPM
1157
1155
TA
1158
RESONATOR
1100
1110
COMMUNICATION UNIT
1120
PA
1130
RESONATOR

FIG.12

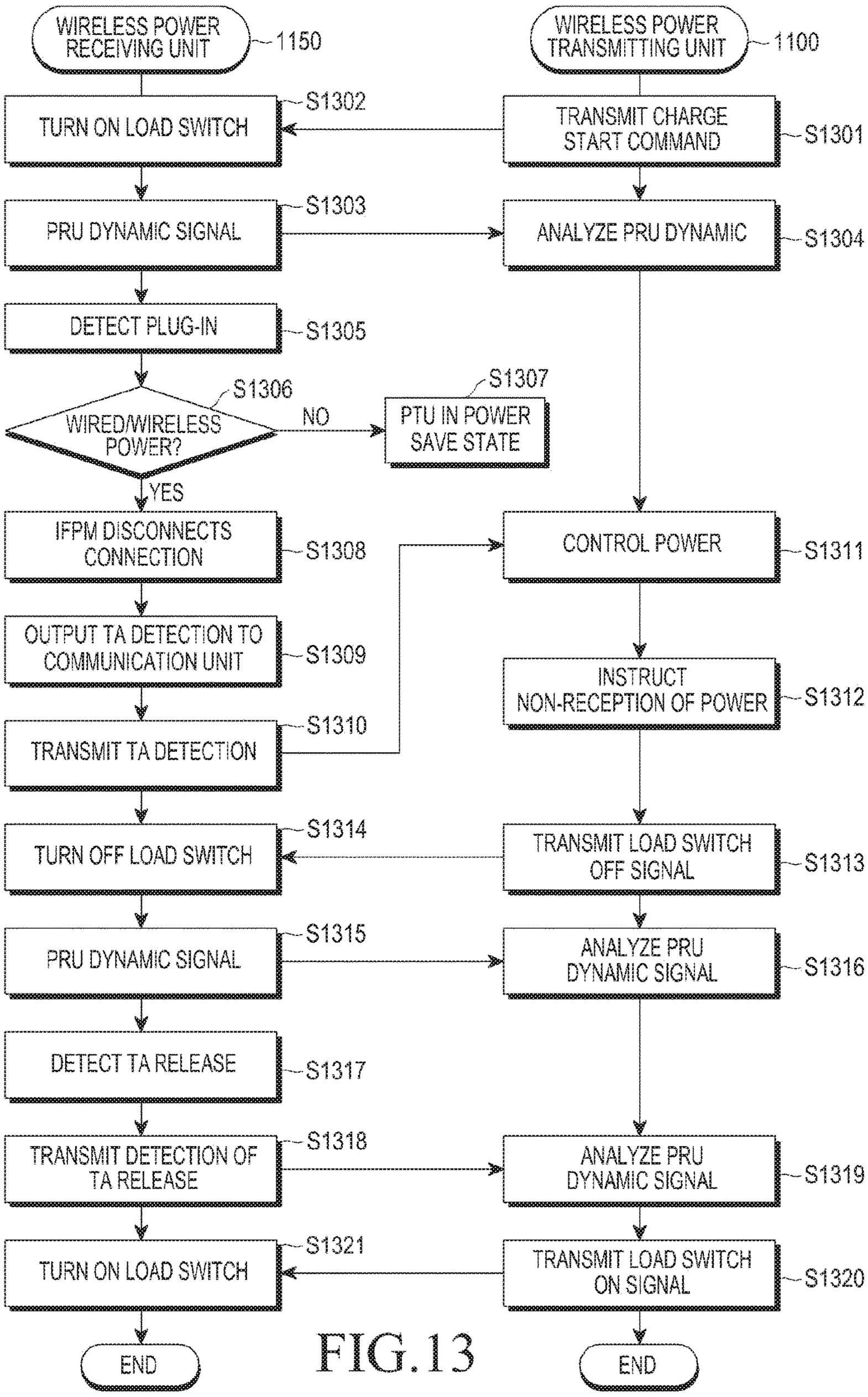

WIRELESS POWER RECEIVING UNIT
1150
WIRELESS POWER TRANSMITTING UNIT
1100
TURN ON LOAD SWITCH
S1302
TRANSMIT CHARGE START COMMAND
S1301
PRU DYNAMIC SIGNAL
S1303
ANALYZE PRU DYNAMIC
S1304
DETECT PLUG-IN
S1305
S1306
WIRED/WIRELESS POWER?
NO
S1307
PTU IN POWER SAVE STATE
YES
IFPM DISCONNECTS CONNECTION
S1308
CONTROL POWER
S1311
OUTPUT TA DETECTION TO COMMUNICATION UNIT
S1309
INSTRUCT NON-RECEPTION OF POWER
S1312
TRANSMIT TA DETECTION
S1310
TURN OFF LOAD SWITCH
S1314
TRANSMIT LOAD SWITCH OFF SIGNAL
S1313
PRU DYNAMIC SIGNAL
S1315
ANALYZE PRU DYNAMIC SIGNAL
S1316
DETECT TA RELEASE
S1317
TRANSMIT DETECTION OF TA RELEASE
S1318
ANALYZE PRU DYNAMIC SIGNAL
S1319
TURN ON LOAD SWITCH
S1321
TRANSMIT LOAD SWITCH ON SIGNAL
S1320
END
END

FIG.13

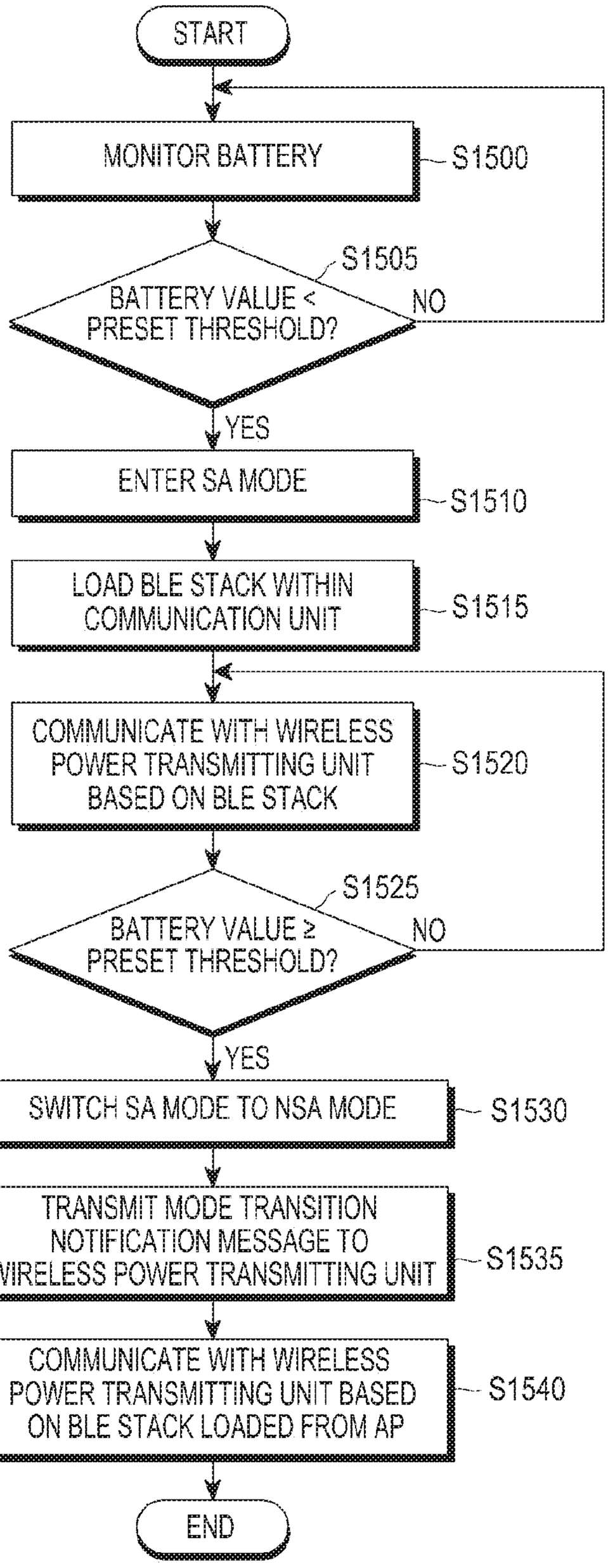

START
MONITOR BATTERY
S1500
S1505
BATTERY VALUE < PRESET THRESHOLD?
NO
YES
ENTER SA MODE
S1510
LOAD BLE STACK WITHIN COMMUNICATION UNIT
S1515
COMMUNICATE WITH WIRELESS POWER TRANSMITTING UNIT BASED ON BLE STACK
S1520
S1525
BATTERY VALUE ≥ PRESET THRESHOLD?
NO
YES
SWITCH SA MODE TO NSA MODE
S1530
TRANSMIT MODE TRANSITION NOTIFICATION MESSAGE TO WIRELESS POWER TRANSMITTING UNIT
S1535
COMMUNICATE WITH WIRELESS POWER TRANSMITTING UNIT BASED ON BLE STACK LOADED FROM AP
S1540
END

FIG.14

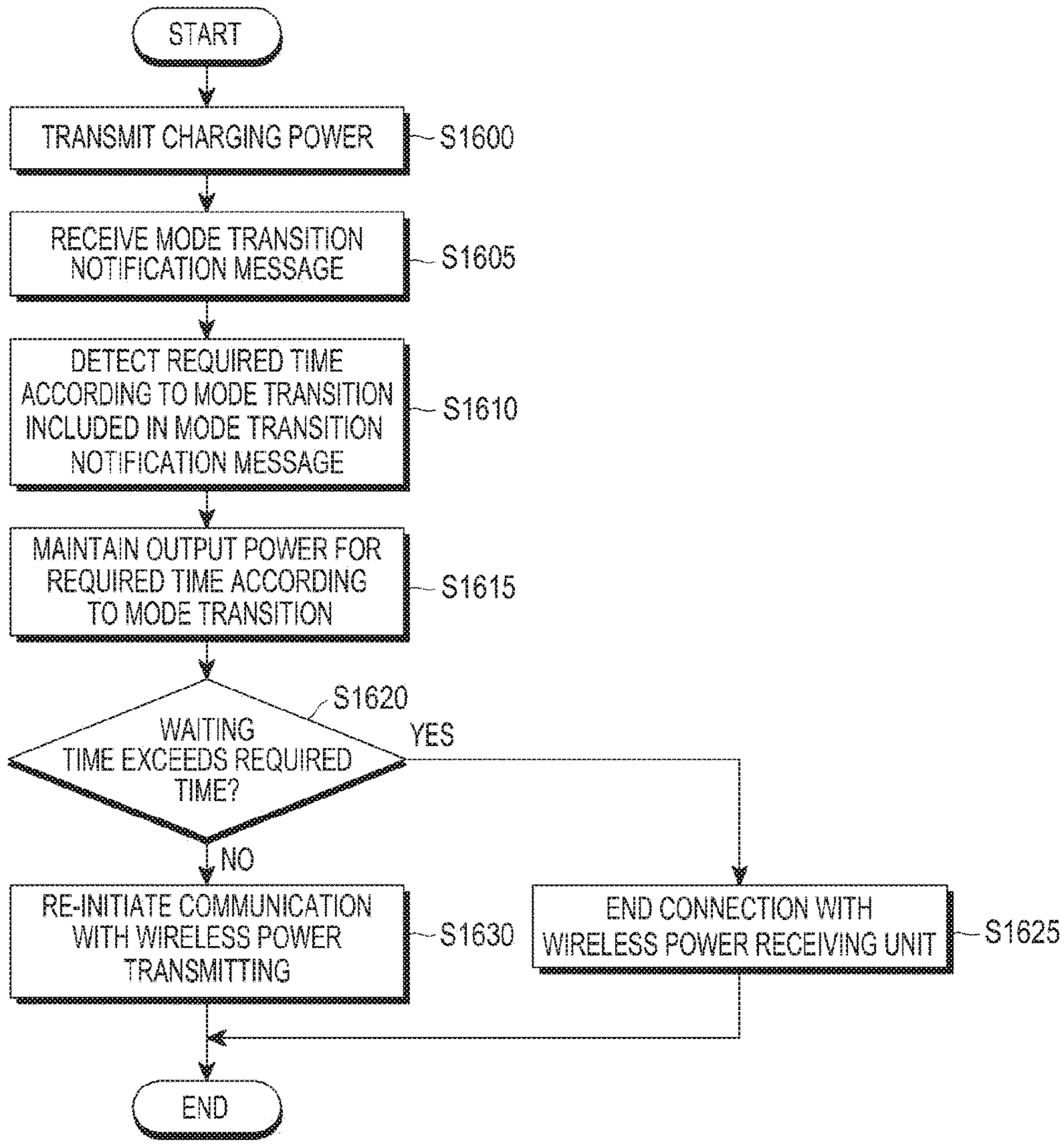

START
TRANSMIT CHARGING POWER
S1600
RECEIVE MODE TRANSITION NOTIFICATION MESSAGE
S1605
DETECT REQUIRED TIME ACCORDING TO MODE TRANSITION INCLUDED IN MODE TRANSITION NOTIFICATION MESSAGE
S1610
MAINTAIN OUTPUT POWER FOR REQUIRED TIME ACCORDING TO MODE TRANSITION
S1615
S1620
WAITING TIME EXCEEDS REQUIRED TIME?
YES
NO
RE-INITIATE COMMUNICATION WITH WIRELESS POWER TRANSMITTING
S1630
END CONNECTION WITH WIRELESS POWER RECEIVING UNIT
S1625
END

FIG.15

WIRELESS POWER TRANSMITTING UNIT, WIRELESS POWER RECEIVING UNIT, AND CONTROL METHODS THEREOF

PRIORITY

This application is a continuation of and claims priority under 35 U.S.C. § 120 to U.S. patent application Ser. No. 15/370,671, filed on Dec. 6, 2016 and issuing on Jul. 31, 2018 as U.S. patent Ser. No. 10/038,344, which is a continuation of and claims priority under 35 U.S.C. § 120 to U.S. patent application Ser. No. 14/221,530, filed on Mar. 21, 2014, now U.S. Pat. No. 9,515,514, which claimed priority under 35 U.S.C. § 119(a) to Korean Pat. App. Ser. Nos. 10-2013-0030568 and 10-2013-0155925, which were filed in the Korean Intellectual Property Office on Mar. 21, 2013 and Dec. 13, 2013, respectively; the entire content of all of the above is incorporated herein by reference.

BACKGROUND

1. Field of the Invention

The present invention generally relates to a wireless power transmitting unit, a wireless power receiving unit, and control methods thereof, and more particularly, to a wireless power transmitting unit, a wireless power receiving unit, and control methods thereof, which can wirelessly transmit/receive charging power.

2. Description of the Related Art

Wireless charging or non-contact charging technologies have been developed to be currently used for many electronic devices. Such a wireless charging technology employs wireless power transmission/reception, and corresponds to, for example, a system in which a battery can be automatically charged if the battery is placed on a charging pad, without the need for connecting the electronic device to a separate charging connector. The wireless charging technology can increase a waterproof function through wirelessly charging electronic products and increase portability of the electronic device because there is no need for a wired charger.

Among the wireless charging technologies, charging using a resonance scheme is performed as follows. When a wireless power receiving unit (for example, a portable terminal) requiring charging is located on a wireless power transmitting unit (for example, a charging pad) transmitting wireless power, the wireless power transmitting unit may charge the wireless power receiving unit. When a plurality of wireless power receiving units are located on a charging area of one wireless power transmitting unit, power required by each of the wireless power receiving units may be different from the transmitted power, so that efficient charging can be made for each of the wireless power receiving units.

While research on a wireless charging method is currently progressing, standards for a wireless charging order, a search for a wireless power transmitting unit/receiving unit, selection of a communication frequency between the wireless power transmitting unit/receiving unit, a wireless power control, selection of a matching circuit, and communication time distribution to each wireless power receiving unit in one charging cycle have not yet been proposed. Specifically, there is a need for a technology which can deal with a situation where the wireless power receiving unit detects a charging environment change by notifying the wireless power transmitting unit of the detected environment change.

SUMMARY

The present invention has been made to address at least the above problems and disadvantages, and to provide at least the advantages described below.

Accordingly, an aspect of the present invention provides a wireless power transmitting unit, a wireless power receiving unit, and control methods thereof, which wireless transmit and receive charging power.

In accordance with an aspect of the present invention, a control method of a wireless power receiving unit receiving charging power from a wireless power transmitting unit to perform wireless charging is provided. The control method includes receiving the charging power from the wireless power transmitting unit; detecting a change in a wireless charging environment; generating a message notifying of the change in the wireless charging environment; and transmitting the message notifying of the change in the wireless charging environment to the wireless power transmitting unit.

In accordance with another aspect of the present invention, a control method of a wireless power transmitting unit transmitting charging power to a wireless power receiving unit to perform wireless charging is provided. The control method includes transmitting the charging power to the wireless power receiving unit; receiving a message including a request for maintaining output power for a mode transition time from the wireless power receiving unit; and maintaining the output power to the wireless power receiving unit for the mode transition time included in the message.

In accordance with another aspect of the present invention, a wireless power receiving unit receiving charging power from a wireless power transmitting unit to perform wireless charging is provided. The wireless power receiving unit includes a power receiver configured to receive the charging power from the wireless power transmitting unit; and a communication unit configured to detect a change in a wireless charging environment, generate a message notifying of the change in the wireless charging environment, and transmit the message to the wireless power transmitting unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram which illustrates a wireless charging system;

FIG. **2** is a block diagram which illustrates a wireless power transmitting unit and a wireless power receiving unit according to an embodiment of the present invention;

FIG. **3** is a block diagram illustrating in detail a wireless power transmitting unit and a wireless power receiving unit according to an embodiment of the present invention;

FIG. **4** is a flow diagram illustrating operations of a wireless power transmitting unit and a wireless power receiving unit according to an embodiment of the present invention;

FIG. **5** is a flowchart illustrating operations of a wireless power transmitting unit and a wireless power receiving unit according to another embodiment of the present invention;

FIG. **6** is a graph on an x axis of an amount of power applied by a wireless power transmitting unit;

FIG. **7** is a flowchart illustrating a control method of a wireless power transmitting unit according to an embodiment of the present invention;

FIG. **8** is a graph on an x axis of an amount of power applied by a wireless power transmitting unit according to the embodiment of FIG. **7**;

FIG. **9** is a flowchart illustrating a control method of a wireless power transmitting unit according to an embodiment of the present invention;

FIG. **10** is a graph on an x axis of an amount of power applied by a wireless power transmitting unit according to the embodiment of FIG. **9**;

FIG. **11** is a block diagram of a wireless power transmitting unit and a wireless power receiving unit in an SA mode according to an embodiment of the present invention;

FIG. **12** is a block diagram of a wireless power transmitting unit and a wireless power receiving unit in an NSA mode according to an embodiment of the present invention;

FIG. **13** is a flowchart illustrating operations of a wireless power transmitting unit and a wireless power receiving unit according to an embodiment of the present invention;

FIG. **14** is a flowchart illustrating a control method of a wireless power receiving unit based on a mode transition according to an embodiment of the present invention; and

FIG. **15** is a flowchart illustrating a control method of a wireless power transmitting unit based on a mode transition according to an embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

Hereinafter, various embodiments of the present invention will be described more specifically with reference to the accompanying drawings. It should be noted that the same components of the drawings are designated by the same reference numeral throughout the figures. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present disclosure unclear.

According to at least one embodiment of the present invention, a wireless power transmitting unit supplying wireless power and a wireless power receiving unit receiving the wireless power to perform charging perform communication with each other for controlling wireless power transmission by using non-contact short-range wireless communication. In a dead battery state in which power sufficient to turn on an Application Processor (hereinafter referred to as an AP) cannot be supplied, wireless charging can be performed using only some components for the wireless charging within the wireless power receiving unit. For example, it is possible to perform wireless charging by using a non-contact short-range wireless communication module basically embedded in a wireless power receiving unit without a separate communication module for performing the wireless charging. Thereafter, when the AP is driven as a battery is charged, the wireless charging can be performed by loading a stack from the AP. At this time, as the AP is driven, a predetermined time is spent until a mode transition is completed.

In an embodiment of the present invention, the wireless power transmitting unit is informed of the mode transition and thus can stand by for a time spent when the mode transition is completed. According to the mode transition, the wireless power transmitting unit recognizes a mode transition condition in the wireless power receiving unit to maintain a connection with the wireless power receiving unit even though the wireless power transmitting unit does not receive a response from the wireless power receiving unit for a predetermined time.

In an embodiment of the present invention, a BlueTooth (BT) scheme or a Bluetooth Low Energy (BLE) scheme may be used as an example of a low energy wireless communication scheme of the non-contact short-range wireless communication scheme. The low energy wireless communication scheme consuming a minimum of power may include other short-range wireless communication schemes such as Zigbee communication, wireless IrDA, and the like, as well as the aforementioned schemes. Further, a non-contact short-range wireless communication unit may be configured by one chip which can support a wireless network scheme as well as the low energy wireless communication scheme. Accordingly, a WiFi scheme is used as an example of the wireless network scheme.

Further, a wireless charging method according to an embodiment of the present invention can be applied to any device which receives wireless power to perform charging through electronic device wireless charging, an electric car wireless power supply, a long-distance wireless power supply, a ubiquitous wireless sensor power supply, and the like. In addition, wireless charging is performed using a non-contact short-range wireless communication module basically embedded in the wireless power receiving unit without a separate communication module for the wireless charging, so that the separate communication module for the wireless charging is not needed. As a result, manufacturing costs can be reduced.

FIG. **1** illustrates a wireless charging system. As shown in FIG. **1**, the wireless charging system includes a wireless power transmitting unit **100** and one or more wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***.

The wireless power transmitting unit **100** wirelessly transmits power **1-1**, **1-2**, . . . , and **1-*n*** to the one or more wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***, respectively. The wireless power transmitting unit **100** may wirelessly transmit the power **1-1**, **1-2**, . . . , and **1-*n*** only to the wireless power receiving units authorized through a preset authentication process.

The wireless power transmitting unit **100** forms wireless connections with the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***. For example, the wireless power transmitting unit **100** transmits wireless power to the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** through electromagnetic waves.

The one or more wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** wirelessly receive power from the wireless power transmitting unit **100** to charge batteries inside the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***. Further, the one or more wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** may transmit messages **2-1**, **2-2**, . . . , and **2-*n*** including a request of wireless power transmission, information required for reception of wireless power, state information of the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** and information (that is, control information) for controlling the wireless power transmitting unit **100** to the wireless power transmitting unit **100**. Similarly, the wireless power transmitting unit **100** may transmit a message including state information of the wireless power transmitting unit **100** and information (that is, control information) for controlling the

wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** to the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***.

Further, each of the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** may transmit a message indicating a charging state to the wireless power transmitting unit **100**.

The wireless power transmitting unit **100** includes a display unit such as a display, and displays a state of each of the wireless power receiving units **110-1**, **110-2**, and **110-*n*** based on the message received from each of the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***. Further, the wireless power transmitting unit **100** may also display a time expected to be spent until each of the wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n*** is completely charged.

The wireless power transmitting unit **100** transmits a control signal (or control message) for disabling a wireless charging function of each of the one or more wireless power receiving units **110-1**, **110-2**, . . . , and **110-*n***. The wireless power receiving units having received the disable control signal of the wireless charging function from the wireless power transmitting unit **100** disable the wireless charging function.

FIG. **2** illustrates a wireless power transmitting unit and a wireless power receiving unit according to an embodiment of the present invention.

As illustrated in FIG. **2**, the wireless power transmitting unit **200** includes at least a power transmitter **211**, a controller **212**, a communication unit **213** and may also include, a display unit **214**, and a storage unit **215**. Further, the wireless power receiving unit **250** includes a power receiver **251**, a controller **252**, and a communication unit **253**.

The power transmitter **211** supplies power which is required by the wireless power transmitting unit **200**, and wirelessly provides power to the wireless power receiving unit **250**. The power transmitter **211** may supply power in an Alternating Current (AC) waveform type, or convert power in a Direct Current (DC) waveform type to the power in the AC waveform type by using an inverter, and then supply the power in the AC waveform type. The power transmitter **211** may be implemented in a form of an embedded battery or in a form of a power receiving interface so as to receive the power from outside thereof and supply the power to the other components. It will be easily understood by those skilled in the art that the power transmitter **211** is not limited if it supplies power of constant alternate current waves.

The controller **212** controls overall operations of the wireless power transmitting unit **200**. The controller **212** controls overall operations of the wireless power transmitting unit **200** by using an algorithm, a program, or an application which is required for a control and read from the storage unit **215**. The controller **212** may be implemented in a form of a CPU, a microprocessor, a mini computer and the like.

The communication unit **213** communicates with the wireless power receiving unit **250** in a specific manner. The communication unit **213** receives power information from the wireless power receiving unit **250**. Here, the power information includes at least one of a capacity of the wireless power receiving unit **250**, a residual amount of the battery, a number of times of charging, an amount of use, a battery capacity, and a proportion of the remaining battery capacity. Further, the communication unit **213** transmits a signal of controlling a charging function in order to control the charging function of the wireless power receiving unit **250**. The signal of controlling the charging function may be a control signal of controlling the power receiver **251** of the wireless power receiving unit **250** so as to enable or disable the charging function. More specifically, the power information may include information on an insertion of a wireless charging terminal, a transition from a Stand Alone (SA) mode to a Non-Stand Alone (NSA) mode, error state release and the like.

The communication unit **213** may receive a signal from another wireless power transmitting unit (not shown) as well as from the wireless power receiving unit **250**.

The controller **212** may display a state of the wireless power receiving unit **250** on a display unit **214** based on the message received from the wireless power receiving unit **250** through the communication unit **213**. Further, the controller **212** may also display a time expected to be spent until the wireless power receiving unit is completely charged on the display unit **214**.

FIG. **3** is a block diagram illustrating in detail the wireless power transmitting unit and the wireless power receiving unit according to an embodiment of the present invention.

As illustrated in FIG. **3**, the wireless power transmitting unit **200** includes the power transmitter **211**, the controller/communication unit (MCU & Out-of-band Signaling) **212/213**, a driver (Power Supply) **217**, an amplifier (Power Amp) **218**, and a matching unit (Matching Circuit) **216**. The wireless power receiving unit **250** includes the power receiver **251**, the controller/communication unit **252/253**, a DC/DC converter **255**, a switching unit (Switch) **256**, and a loading unit (Client Device Load) **257**.

The driver **217** may output DC power having a preset voltage value. The voltage value of the DC power output by the driver **217** may be controlled by the controller/communication unit **212/213**.

The DC power output from the driver **217** is output to the amplifier **218**, which amplifies the DC power by a preset gain. Further, the amplifier **218** converts DC power to AC power based on a signal input from the controller/communication unit **212/213**. Accordingly, the amplifier **218** outputs AC power.

The matching unit **216** performs impedance matching. For example, the matching unit **216** may adjust impedance viewed from the matching unit **216** to control output power to be high efficient or high output power. The matching unit **216** may also adjust impedance based on a control of the controller/communication unit **212/213**. The matching unit **216** includes at least one of a coil and a capacitor. The controller/communication unit **212/213** controls a connection state with at least one of the coil and the capacitor, and accordingly, performs impedance matching.

The power transmitter **211** transmits input AC power to the power receiver **251**. The power transmitter **211** and the power receiver **251** may be implemented by resonant circuits having the same resonance frequency. For example, the resonance frequency may be determined to be 6.78 MHz.

Meanwhile, the controller/communication unit **212/213** communicates with the controller/communication unit **252/253** of the wireless power receiving unit **250**, and perform communication (WiFi, ZigBee, or BT/BLE), for example, with a bi-directional 2.4 GHz frequency.

The power receiver **251** receives charging power.

The rectifying unit **254** rectifies wireless power received by the power receiver **251** in the form of direct current, and is implemented in a form of bridge diode. The DC/DC converter **255** converts the rectified electric current into a predetermined gain. For example, the DC/DC converter **255** converts the rectified electric current so that a voltage of an output end **259** becomes 5V. Meanwhile, a minimum value

and a maximum value of the voltage which can be applied may be preset for a front end **258** of the DC/DC converter **255**.

The switching unit **256** connects the DC/DC converter **255** to the loading unit **257**. The switching unit **256** is held in an on/off state under a control of the controller **252**. In a case where the switch **256** is in the on state, the loading unit **257** stores converted electric power which is input from the DC/DC converter **255**.

FIG. **4** is a flow diagram illustrating operations of the wireless power transmitting unit and the wireless power receiving unit according to an embodiment of the present invention. As illustrated in FIG. **4**, a wireless power transmitting unit **400** applies power in step S**401**. When the power is applied, the wireless power transmitting unit **400** configures an environment in S**402**.

The wireless power transmitting unit **400** enters a power saving mode in step S**403**. In the power saving mode, the wireless power transmitting unit **400** may apply different types of power beacons for detection according to their own periods, which will be described in more detail with reference to FIG. **6**. For example, in FIG. **4**, the wireless power transmitting unit **400** applies detection power beacons **404** and **405**, and the sizes of power values of the detection power beacons **404** and **405** may be different. A part or all of the detection power beacons **404** and **405** may have power enough to drive the communication unit of the wireless power receiving unit **450**. For example, the wireless power receiving unit **450** may drive the communication unit by the part or all of the detection power beacons **404** and **405** to communicate with the wireless power transmitting unit **400**. The above state may be named a null state in step S**406**.

The wireless power transmitting unit **400** detects a load change by an arrangement of the wireless power receiving unit **450**. The wireless power transmitting unit **400** may enter a low power mode in step S**409**. The low power mode will be described in more detail with reference to FIG. **6**. Meanwhile, the wireless power receiving unit **450** may drive the communication unit based on power received from the wireless power transmitting unit **400** in step S**409**.

The wireless power receiving unit **450** transmits a Power Transmitting Unit (PTU) searching signal to the wireless power transmitting unit **400** in step S**410**. The wireless power receiving unit **450** transmits the PTU searching signal as an advertisement signal based on a Bluetooth Low Energy (BLE) scheme. The wireless power receiving unit **450** may transmit the PTU searching signal periodically or until a preset time arrives, and receives a response signal from the wireless power transmitting unit **400**.

When receiving the PTU searching signal from the wireless power receiving unit **450**, the wireless power transmitting unit **400** transmits a PRU response signal in step S**411**. The Power Receiving Unit (PRU) response signal forms a connection between the wireless power transmitting unit **400** and the wireless power receiving unit **450**. The wireless power receiving unit **450** transmits a PRU static signal in step S**412**. The PRU static signal may be a signal indicating that the wireless power receiving unit **450** may make a request for joining the wireless power network managed by the wireless power transmitting unit **400**.

The wireless power transmitting unit **400** transmits a PTU static signal in step S**413**. The PTU static signal transmitted by the wireless power transmitting unit **400** may be a signal indicating a capability of the wireless power transmitting unit **400**.

When the wireless power transmitting unit **400** and the wireless power receiving unit **450** transmit and receive the PRU static signal and the PTU static signal, the wireless power receiving unit **450** periodically transmits a PRU dynamic signal in steps S**414** and S**415**. The PRU dynamic signal includes at least one parameter information measured by the wireless power receiving unit **450**. For example, the PRU dynamic signal may include voltage information of a back end of the rectifier of the wireless power receiving unit **450**. The state of the wireless power receiving unit **450** may be called a boot state in step S**407**.

The wireless power transmitting unit **400** enters a power transmission mode in step S**416** and transmits a PRU control signal corresponding to a command signal to allow the wireless power receiving unit **450** to be charged in step S**417**. In the power transmission mode, the wireless power transmitting unit **400** transmits charging power.

The PRU control signal transmitted by the wireless power transmitting unit **400** may include information enabling/disabling the charging of the wireless power receiving unit **450** and permission information. The PRU control signal is transmitted whenever a charging state is changed. The PRU control signal may be transmitted, for example, every 250 ms, or transmitted when a parameter is changed. The PRU control signal may be set to be transmitted within a preset threshold, for example, within one second even though the parameter is not changed.

The wireless power receiving unit **450** may change a configuration according to the PRU control signal and transmits the PRU dynamic signal for reporting the state of the wireless power receiving unit **450** in steps S**418** and S**419**. The PRU dynamic signal transmitted by the wireless power receiving unit **450** may include at least one of information on a voltage, a current, a state of the wireless power receiving unit, and temperature. The state of the wireless power receiving unit **450** is called an on state in step S**421**.

Meanwhile, the PRU dynamic signal may have a data structure as shown in Table 1 below.

TABLE 1

Field	octets	description	use	units
optional fields	1	defines which optional fields are populated	mandatory	
Vrect	2	DC voltage at the output of the rectifier.	mandatory	mV
Irect	2	DC current at the output of the rectifier.	mandatory	mA
Vout	2	voltage at charge/battery port	optional	mV
Iout	2	current at charge/battery port	optional	mA
temperature	1	temperature of PRU	optional	Deg C. from −40 C.
Vrect min dyn	2	The current dynamic minimum rectifier voltage desired	optional	mV

TABLE 1-continued

Field	octets	description	use	units
Vrect set dyn	2	desired Vrect (dynamic value)	optional	mV
Vrect high dyn	2	The current dynamic maximum rectifier voltage desired	optional	mV
PRU alert	1	warnings	mandatory	Bit field
RFU	3	undefined		

As shown in Table 1, the PRU dynamic signal may include one or more fields. The fields include optional field information, voltage information of a back end of the rectifier of the wireless power receiving unit ('Vrect'), current information of the back end of the rectifier of the wireless power receiving unit ('Irect'), voltage information of a back end of the DC/DC converter of the wireless power receiving unit ('Vout'), current information of the back end of the DC/DC converter of the wireless power receiving unit ('Iout'), temperature information ('temperature'), minimum voltage value information of the back end of the rectifier of the wireless power receiving unit ('Vrect min dyn'), optimal voltage value information of the back end of the rectifier of the wireless power receiving unit ('Vrect set dyn'), maximum voltage value information of the back end of the rectifier of the wireless power receiving unit ('Vrect high dyn'), alert information ('PRU alert') and RFU (Reserved for Future Use). The PRU dynamic signal may include at least one of the above fields.

For example, one or more voltage setting values (for example, the minimum voltage value information (Vrect min dyn) of the back end of the rectifier of the wireless power receiving unit, the optimal voltage value information (Vrect set dyn) of the back end of the rectifier of the wireless power receiving unit, and the maximum voltage value information (Vrect high dyn) of the back end of the rectifier of the wireless power receiving unit) determined according to a charging state may be inserted into corresponding fields and then transmitted. As described above, the wireless power receiving unit having received the PRU dynamic signal controls a wireless charging voltage to be transmitted to each of the wireless power receiving units with reference to the voltage setting values included in the PRU dynamic signal.

Among them, the alert information (PRU Alert) may have a data structure shown in Table 2 below.

TABLE 2

7	6	5	4	3	2	1	0
over-voltage	over-current	over-temperature	Charge Complete	TA detect	Transition	restart request	RFU

Referring to Table 2, the alert information (PRU Alert) may include a bit for a restart request, a bit for a transition, and a bit for detecting an insertion of a Travel Adapter (TA) (TA detect). The TA detect indicates a bit informing of a connection between the wireless power transmitting unit providing wireless charging and a terminal for wired charging by the wireless power receiving unit. The transition indicates a bit informing the wireless power transmitting unit that the wireless power receiving unit is reset before a communication Integrated Circuit (IC) of the wireless power receiving unit is switched from a Stand Alone (SA) mode to a Non Stand Alone (NSA) mode. Lastly, the restart request indicates a bit informing the wireless power receiving unit that the wireless power transmitting unit is ready to restart the charging when the charging is disconnected since the wireless power transmitting unit reduces power due to the generation of an over current state or a over temperature state and then the state is returned to an original state.

Further, the alert information (PRU Alert) may also have a data structure shown in Table 3 below.

TABLE 3

7	6	5	4	3	2	1	0
PRU over-voltage	PRU over-current	PRU over-temperature	PRU Self Protection	Charge Complete	Wired Charger Detect	Mode Transition Bit 1	Mode Transition Bit 0

Referring to Table 3 above, the alert information may include over voltage, over current, over temperature, PRU self protection, charge compete, wired charger detect, mode transition and the like. When the over voltage field is set as "1", it may indicate that a voltage Vrect of the wireless power receiving unit exceeds a limit of the over voltage. Further, the over current and the over temperature may be set in the same way as the over voltage. The PRU self protection indicates that the wireless power receiving unit directly reduces a load of power and thus protects itself. In this event, the wireless power transmitting unit is not required to change a charging state.

Bits for a mode transition according to an embodiment of the present invention may be set as a value informing the wireless power transmitting unit of a period during which a mode transition process is performed. The bits indicating the mode transition period may be expressed as shown in Table 4 below.

TABLE 4

Value (Bit)	Mode Transition Bit Description
00	No Mode Transition
01	2 s Mode Transition time limit
10	3 s Mode Transition time limit
11	6 s Mode Transition time limit

Referring to Table 4 above, "00" indicates that there is no mode transition, "01" indicates that a time required for completing the mode transition is a maximum of two seconds, "10" indicates that a time required for completing the mode transition is a maximum of three seconds, and "11" indicates that a time required for completing the mode transition is a maximum of six seconds.

For example, when three seconds or less are spent for completing the mode transition, the mode transition bit may be set as "10". Prior to starting the mode transition process, the wireless power receiving unit may make a restriction such that there is no change in impedance during the mode transition process by changing an input impedance setting to match 1.1 W power draw. Accordingly, the wireless power transmitting unit may control power (ITX_COIL) for the wireless power receiving unit in accordance with the setting, and accordingly, maintain the power (ITX_COIL) for the wireless power receiving unit during the mode transition period.

Accordingly, when the mode transition period is set by the mode transition bit, the wireless power transmitting unit maintains the power (ITX_COIL) for the wireless power receiving unit during the mode transition time, for example, three seconds. That is, the wireless power transmitting unit may maintain a connection even though a response is not received from the wireless power receiving unit for three seconds. However, after the mode transition time passes, the wireless power receiving unit may be considered as a rogue object (foreign substance) and thus power transmission may be terminated.

Meanwhile, the wireless power receiving unit **450** may detect generation of errors. The wireless power receiving unit **450** transmits an alert signal to the wireless power transmitting unit **400** in step S**420**. The alert signal may be transmitted as the PRU dynamic signal or the alert signal. For example, the wireless power receiving unit **450** may transmit the PRU alert field of Table 3 reflecting an error state to the wireless power transmitting unit **400**. Alternatively, the wireless power receiving unit **450** may transmit a single alert signal indicating the error state to the wireless power transmitting unit **400**. When receiving the alert signal, the wireless power transmitting unit **400** enters a latch fault mode in step S**422**, and the wireless power receiving unit **450** may enter a null state in step S**423**.

FIG. **5** is a flowchart illustrating operations of the wireless power transmitting unit and the wireless power receiving unit according to another embodiment of the present invention. A control method of FIG. **5** will be described in more detail with reference to FIG. **6**. FIG. **6** is a graph on an x axis of a power amount applied by the wireless power transmitting unit according to the embodiment of FIG. **5**.

As illustrated in FIG. **5**, the wireless power transmitting unit initiates the operation in step S**501**. Further, the wireless power transmitting unit resets an initial configuration in step S**503**. The wireless power transmitting unit enters a power saving mode in step S**505**. The power saving mode may correspond to an interval where the wireless power transmitting unit applies power having different amounts to the power transmitter. For example, the power saving mode may correspond to an interval where the wireless power transmitting unit applies second power **601** and **602** and third power **611**, **612**, **613**, **614**, and **615** to the power transmitter in FIG. **6**. The wireless power transmitting unit periodically applies the second power **601** and **602** according to a second period. When the wireless power transmitting unit applies the second power **601** and **602**, the application continues for a second term. The wireless power transmitting unit periodically applies the third power **611**, **612**, **613**, **614**, and **615** according to a third period. When the wireless power transmitting unit applies the third power **611**, **612**, **613**, **614**, and **615**, the application continues for a third term. Meanwhile, although it is illustrated that power values of the third power **611**, **612**, **613**, **614**, and **615** are different from each other, the power values of the third power **611**, **612**, **613**, **614**, and **615** may be different or the same.

The wireless power transmitting unit may output the third power **611** and then output the third power **612** having the same size of the power amount. As described above, when the wireless power transmitting unit outputs the third power having the same size, the power amount of the third power may have a power amount by which a smallest wireless power receiving unit, for example, a wireless power receiving unit designated as Category 1 can be detected.

The wireless power transmitting unit may output the third power **611** and then output the third power **612** having a different size of the power amount. As described above, when the wireless power transmitting unit outputs the third power having the different size, the power amount of the third power may be a power amount by which a wireless power receiving unit designated as Category 1 to Category 5 can be detected. For example, when the third power **611** may have a power amount by which a wireless power receiving unit of Category 5 can be detected, the third power **612** may have a power amount by which a wireless power receiving unit designated as Category 3 can be detected, and the third power **613** may have a power amount by which a wireless power receiving unit designated as Category 1 can be detected.

Meanwhile, the second power **601** and **602** may be power which can drive the wireless power receiving unit. More specifically, the second power **601** and **602** may have a power amount which can drive the controller and the communication unit of the wireless power receiving unit.

The wireless power transmitting unit applies the second power **601** and **602** and the third power **611**, **612**, **613**, **614**, and **615** to the power receiver according to a second period and a third period, respectively. When the wireless power receiving unit is arranged on the wireless power transmitting unit, impedance viewed from a point of the wireless power transmitting unit may be changed. The wireless power transmitting unit detects a change in the impedance while the second power **601** and **602** and the third power **611**, **612**, **613**, **614**, and **615** are applied. For example, the wireless power transmitting unit may detect the change in the impedance while the third power **615** is applied. Accordingly, referring back to FIG. **5**, the wireless power transmitting unit detects an object in step S**507**. When the object is not detected in step S**507**, the wireless power transmitting unit maintains a power saving mode in which different power is periodically applied.

Meanwhile, when there is the change in the impedance and thus the object is detected in step S**507**, the wireless power transmitting unit enters a low power mode in step S**509**. The low power mode is a mode in which the wireless power transmitting unit applies driving power having a

power amount by which the controller and the communication unit of the wireless power receiving unit can be driven. For example, in FIG. **6**, the wireless power transmitting unit applies driving power **620** to the power transmitter. The wireless power receiving unit receives the driving power **620** to drive the controller and the communication unit. The wireless power receiving unit performs communication with the wireless power transmitting unit according to a predetermined scheme based on the driving power **620**. For example, the wireless power receiving unit may transmit/receive data required for an authentication and join the wireless power network managed by the wireless power transmitting unit based on the data. However, when a rogue object is arranged instead of the wireless power receiving unit, data transmission/reception cannot be performed. Accordingly, the wireless power transmitting unit determines whether the arranged object is a rogue object in step S**511**. For example, when the wireless power transmitting unit does not receive a response from the object within a preset time, the wireless power transmitting unit may determine the object as a rogue object.

When the object is determined as a rogue object in step S**511**, the wireless power transmitting unit enters a latch fault mode. When the object is not determined as a rogue object in step S**511**, the wireless power transmitting unit performs a joining step in step S**519**. For example, the wireless power transmitting unit may periodically apply first power **631** to **634** according to a first period in FIG. **6**. The wireless power transmitting unit may detect a change in impedance while applying the first power. For example, when the rogue object is withdrawn, the impedance change may be detected and the wireless power transmitting unit determines that the rogue object is withdrawn. Alternatively, when the rogue object is not withdrawn, the wireless power transmitting unit does not detect the impedance change and determines that the rogue object is not withdrawn. When the rogue object is not withdrawn, the wireless power transmitting unit may output at least one of a lamp and a warning sound to inform a user that a state of the wireless power transmitting unit is an error state. Accordingly, the wireless power transmitting unit includes an output unit that outputs at least one of a lamp and a warning sound.

When it is determined that the rogue object is not withdrawn in step S**515**, the wireless power transmitting unit maintains the latch fault mode in step S**513**. When it is determined that the rogue object is withdrawn in step S**515**, the wireless power transmitting unit enters the power saving mode again in step S**517**. For example, the wireless power transmitting unit may apply second power **651** and **652** and third power **661** to **665**, as shown in FIG. **6**.

As described above, when the rogue object is arranged instead of the wireless power receiving unit, the wireless power transmitting unit enters the latch fault mode. Further, the wireless power transmitting unit determines whether to withdraw the rogue object by the impedance change based on the power applied in the latch fault mode. That is, a condition of the entrance into the latch fault mode in the embodiment of FIGS. **5** and **6** may be the arrangement of the rogue object. Meanwhile, the wireless power transmitting unit may have various latch fault mode entrance conditions as well as the arrangement of the rogue object. For example, the wireless power transmitting unit may be cross-connected with the arranged wireless power receiving unit and may enter the latch fault mode in the above case.

Accordingly, when cross-connection is generated, the wireless power transmitting unit is required to return to an initial state and the wireless power receiving unit is required to be withdrawn. The wireless power transmitting unit may set the cross-connection by which the wireless power receiving unit arranged on another wireless power transmitting unit joins the wireless power network as the latch fault mode entrance condition. An operation of the wireless power transmitting unit when the error is generated which includes the cross-connection will be described with reference to FIG. **7**.

FIG. **7** is a flowchart illustrating a control method of the wireless power transmitting unit according to an embodiment of the present invention. The control method of FIG. **7** will be described in more detail with reference to FIG. **8**. FIG. **8** is a graph on an x axis of a power amount applied by the wireless power transmitting unit according to the embodiment of FIG. **7**.

The wireless power transmitting unit initiates the operation in step S**701**. Further, the wireless power transmitting unit resets an initial configuration in step S**703**. The wireless power transmitting unit enters the power saving mode in step S**705**. The power saving mode is an interval where the wireless power transmitting unit applies power having different amounts to the power transmitter. For example, the power saving mode may correspond to an interval where the wireless power transmitting unit applies second power **801** and **802** and third power **811**, **812**, **813**, **814**, and **815** to the power transmitter in FIG. **8**. The wireless power transmitting unit periodically applies the second power **801** and **802** according to a second period. When the wireless power transmitting unit applies the second power **801** and **802**, the application continues for a second term. The wireless power transmitting unit periodically applies the third power **811**, **812**, **813**, **814**, and **815** according to a third period. When the wireless power transmitting unit applies the third power **811**, **812**, **813**, **814**, and **815**, the application continues for a third term. Meanwhile, although it is illustrated that power values of the third power **811**, **812**, **813**, **814**, and **815** are different from each other, the power values of the third power **811**, **812**, **813**, **814**, and **815** may be different or the same.

Meanwhile, the second power **801** and **802** may be power which can drive the wireless power receiving unit. More specifically, the second power **601** and **602** may have a power amount which can drive the controller and the communication unit of the wireless power receiving unit.

The wireless power transmitting unit applies the second power **801** and **802** and the third power **811**, **812**, **813**, **814**, and **815** to the power receiver according to a second period and a third period, respectively. When the wireless power receiving unit is arranged on the wireless power transmitting unit, impedance viewed from a point of the wireless power transmitting unit may be changed. The wireless power transmitting unit detects the impedance change while the second power **801** and **802** and the third power **811**, **812**, **813**, **814**, and **815** are applied. For example, the wireless power transmitting unit may detect the impedance change while the third power **815** is applied. Accordingly, referring back to FIG. **7**, the wireless power transmitting unit detects an object in step S**707**. When the object is not detected in step S**707**, the wireless power transmitting unit maintains the power saving mode in which different power is periodically applied in step S**705**.

Meanwhile, when the impedance is changed and thus the object is detected in step S**707**, the wireless power transmitting unit enters the low power mode in step S**709**. The low power mode is a mode in which the wireless power transmitting unit applies driving power having a power amount by which the controller and the communication unit of the wireless power receiving unit can be driven. For

example, in FIG. **8**, the wireless power transmitting unit applies driving power **820** to the power transmitter. The wireless power receiving unit receives the driving power **820** to drive the controller and the communication unit. The wireless power receiving unit performs communication with the wireless power transmitting unit according to a predetermined scheme based on the driving power **820**. For example, the wireless power receiving unit may transmit/receive data required for an authentication and join the wireless power network managed by the wireless power transmitting unit based on the data.

Thereafter, the wireless power transmitting unit enters the power transmission mode in which charging power is transmitted in step S**711**. For example, the wireless power transmitting unit applies charging power **821** and the charging power may be transmitted to the wireless power receiving unit as illustrated in FIG. **8**.

The wireless power transmitting unit determines whether an error is generated in the power transmission mode. The error may be the arrangement of a rogue object on the wireless power transmitting unit, the cross-connection, over voltage, over current, over temperature and the like. The wireless power transmitting unit may include a sensing unit that may measure the over voltage, the over current, over temperature and the like. For example, the wireless power transmitting unit may measure a voltage or a current at a reference position. When the measured voltage or current is larger than a threshold, it is determined that conditions of the over voltage or the over current are satisfied. Alternatively, the wireless power transmitting unit may include a temperature sensing means which measures temperature at a reference position of the wireless power transmitting unit. When temperature at the reference position is larger than a threshold, the wireless power transmitting unit determines that a condition of the over temperature is satisfied.

Meanwhile, when an over voltage, over current, or over temperature state is determined according to a measurement value of the temperature, voltage, or current, the wireless power transmitting unit prevents the over voltage, over current, or over temperature by reducing the wireless charging power by a preset value. At this time, when a voltage value of the reduced wireless charging power is less than a preset minimum value (for example, the minimum voltage value (VRECT MIN DYN) of the back end of the rectifier of the wireless power receiving unit), the wireless charging is interrupted or stopped, so that the voltage setting value may be re-controlled according to an embodiment of the present invention.

Although it has been illustrated that the error is generated since the rogue object is additionally arranged on the wireless power transmitting unit in the embodiment of FIG. **8**, the type of error is not limited thereto and it will be easily understood by those skilled in the art that the wireless power transmitting unit operates through a similar process with respect to the arrangement of the rogue object, the cross-connection, the over voltage, the over current, and the over temperature.

When the error is not generated in step S**713**, the wireless power transmitting unit maintains the power transmission mode in step S**711**. Meanwhile, when the error is generated in step S**713**, the wireless power transmitting unit enters the latch fault mode in step S**715**. For example, the wireless power transmitting unit applies first power **831** to **835** as illustrated in FIG. **8**. Further, the wireless power transmitting unit may output an error generation display including at least one of a lamp and a warning sound during the latch fault mode. When it is determined that the rogue object is not withdrawn in step S**717**, the wireless power transmitting unit maintains the latch fault mode in step S**715**. Meanwhile, when it is determined that the rogue object is withdrawn in step S**717**, the wireless power transmitting unit enters the power saving mode again in step S**719**. For example, the wireless power transmitting unit applies second power **851** and **852** and third power **861** to **865** of FIG. **8**.

In the above description, the operation in a case where the error is generated while the wireless power transmitting unit transmits the charging power has been discussed. Hereinafter, an operation in a case where a plurality of wireless power receiving units on the wireless power transmitting unit receive charging power will be described.

FIG. **9** is a flowchart for describing a control method of a wireless power transmitting unit according to an embodiment of the present invention. The control method of FIG. **9** will be described in more detail with reference to FIG. **10**. FIG. **10** is a graph on an x axis of an amount of power applied by a wireless power transmitting unit according to the embodiment of FIG. **9**.

As illustrated in FIG. **9**, the wireless power transmitting unit transmits charging power to a first wireless power receiving unit in step S**901**. Further, the wireless power transmitting unit may allow a second wireless power receiving unit to additionally join the wireless power network in step S**903**. The wireless power transmitting unit transmits charging power to the second wireless power receiving unit in step S**905**. More specifically, the wireless power transmitting unit applies a sum of the charging power required by the first wireless power receiving unit and the second wireless power receiving unit to the power receiver.

FIG. **10** illustrates an embodiment of steps S**901** to S**905**. For example, the wireless power transmitting unit maintains the power saving mode in which second power **1001** and **1002** and third power **1011** to **1015** are applied. Thereafter, the wireless power transmitting unit detects the first wireless power receiving unit and enters the low power mode in which a detection power **1020** applied to the first wireless power receiving unit to detect is maintained. Next, the wireless power transmitting unit enters the power transmission mode in which first charging power **1030** is applied. The wireless power transmitting unit detects the second wireless power receiving unit and allows the second wireless power receiving unit to join the wireless power network. Further, the wireless power transmitting unit applies second charging power **1040** having a power amount corresponding to a sum of power amounts required by the first wireless power receiving unit and the second wireless power receiving unit.

Referring back to FIG. **9**, the wireless power transmitting unit detects error generation in step S**907** while charging power is transmitted to both the first and second wireless power receiving units in step S**905**. As described above, the error may be the arrangement of the rogue object, the cross-connection, the over voltage, the over current, the over temperature and the like. When the error is not generated in step S**907**, the wireless power transmitting unit maintains the application of the second charging power **1040**.

Meanwhile, when the error is generated in step, the wireless power transmitting unit enters the latch fault mode in step S**909**. For example, the wireless power transmitting unit applies first power **1051** to **1055** according to a first period in FIG. **10**. The wireless power transmitting unit determines whether both the first wireless power receiving unit and the second wireless power receiving unit are withdrawn in step S**911**. For example, the wireless power transmitting unit may detect an impedance change while

applying the first power **1051** to **1055**. The wireless power transmitting unit determines whether both the first wireless power receiving unit and the second wireless power receiving unit are withdrawn based on whether the impedance is returned to an initial value.

When it is determined that both the first wireless power receiving unit and the second wireless power receiving unit are withdrawn in step S**911**, the wireless power receiving unit enters the power saving mode in step S**913**. For example, the wireless power transmitting unit applies second power **1061** and **1062** and third power **1071** to **1075** according to a second period and a third period, respectively.

As described above, even when the wireless power transmitting unit applies charging power to at least one wireless power receiving unit, the wireless power transmitting unit may determine whether the wireless power receiving unit or the rogue object is easily withdrawn when the error is generated.

FIG. **11** is a block diagram of a wireless power transmitting unit and a wireless power receiving unit in a Stand Alone (SA) mode according to an embodiment of the present invention.

A wireless power transmitting unit **1100** includes a communication unit **1110**, a Power Amplifier (PA) **1120**, and a resonator **1130**. A wireless power receiving unit **1150** includes a communication unit (WPT Communication IC) **1151**, an Application Processor (AP) **1152**, a Power Management Integrated Circuit (PMIC) **1153**, a Wireless Power Integrated Circuit (WPIC) **1154**, a resonator **1155**, an Inter-Face Power Management (IFPM) IC **1157**, a Travel Adapter (TA) **1158**, and a battery **1159**.

The communication unit **1110** may be implemented by WiFi/BlueTooth (BT) Combo IC and communicates with the communication unit **1151** in a predetermined scheme, for example, a BLE scheme. For example, the communication unit **1151** of the wireless power receiving unit **1150** transmits a PRU dynamic signal having the data structure as shown in Table 3 to the communication unit **1110** of the wireless power transmitting unit **1100**. As described above, the PRU dynamic signal includes at least one of voltage information, current information, temperature information, and alert information of the wireless power receiving unit **1150**.

Based on the received PRU dynamic signal, a power value output from the power amplifier **1120** is adjusted. For example, when the over voltage, the over current, and the over temperature are applied to the wireless power receiving unit **1150**, a power value output from the power amplifier **1120** is reduced. Further, when a voltage or current of the wireless power receiving unit **1150** is less than a preset value, a power value output from the power amplifier **1120** is increased.

Charging power from the resonator **1130** is wirelessly transmitted to the resonator **1155**.

The WPIC **1154** rectifies the charging power received from the resonator **1155** and performs DC/DC conversion. The WPIC **1154** drives the communication unit **1151** or charges the battery **1159** by using the converted power.

Meanwhile, a wired charging terminal may be inserted into the travel adapter **1158**. A wired charging terminal such as 30-pin connector or a Universal Serial Bus (USB) connector may be inserted into the travel adapter **1158**, and the travel adapter **1158** receives power supplied from an external power source to charge the battery **1159**.

The IFPM **1157** processes power applied from the wired charging terminal and outputs the processed power to the battery **1159** and the PMIC **1153**.

The PMIC **1153** manages wirelessly received power, power received through a wire, and power applied to each of the components of the wireless power receiving unit **1150**. The AP **1152** receives power information from the PMIC **1153** and controls the communication unit **1151** to transmit the PRU dynamic signal for reporting the power information.

Meanwhile, the travel adapter **1158** may be connected to a node **1156** connected to the WPIC **1154**. When the wired charging connector is inserted into the travel adapter **1158**, a preset voltage, for example, 5 V may be applied to the node **1156**. The WPIC **1154** monitors the voltage applied to the node **1156** to determine whether the travel adapter is inserted.

Meanwhile, the AP **1152** has a stack in a predetermined communication scheme, for example, a WiFi/BT/BLE stack. Accordingly, in communication for the wireless charging, the communication unit **1151** loads the stack from the AP **1152** and then communicates with the communication unit **1110** of the wireless power transmitting unit **1100** by using a BT or BLE communication scheme based on the stack.

However, a state may occur in which data for performing wireless power transmission cannot be fetched from the AP **1152** since the AP **1152** is turned off or in which power is lost so that the AP **1152** cannot remain in an on state while the data is fetched from a memory within the AP **1152**.

When a residual capacity of the battery **1159** is less than a minimum power threshold, the AP **1152** is turned off, and the wireless charging can be performed using some components for the wireless charging within the wireless power receiving unit, for example, the communication unit **1151**, the WPIC **1154**, and the resonator **1155**. A state where the AP **1152** cannot be turned on may be referred to as a dead battery state.

Since the AP **1152** is not driven in the dead battery state, the communication unit **1151** cannot receive a stack in a predetermined communication scheme, for example, a WiFi/BT/BLE stack from the AP **1152**. For such a case, some of the stacks in the predetermined communication scheme, for example, the BLE stack, are fetched within the memory **1162** of the communication unit **1151** from the AP **1152** and stored in the memory **1162**. Accordingly, the communication unit **1151** communicates with the wireless power transmitting unit **1100** for the wireless charging by using the stack in the communication scheme stored in the memory **1162**, that is, a wireless charging protocol. At this time, the communication unit **1151** may include a memory therewithin, and the BLE stack may be stored in a memory in a form of a ROM in the SA mode.

As described above, a mode in which the communication unit **1151** performs the communication by using the stack of the communication scheme stored in the memory **1162** is referred to as the SA mode. Accordingly, the communication unit **1151** manages a charging process based on the BLE stack.

A concept of the wireless charging system which can be applied to the embodiment of the present invention has been described with reference to FIGS. **1** to **11**. Hereinafter, a charging control process according to a mode transition according to an embodiment of the present invention will be described in detail with reference to FIGS. **12** to **15**.

FIG. **12** is a block diagram of the wireless power transmitting unit and the wireless power receiving unit in a Non Stand Alone (NSA) mode according to an embodiment of the present invention. Since each of components in FIG. **12** is the same as each of the components in FIG. **11**, a detailed description thereof will be omitted. However, FIG. **12**

illustrates a case where the residual capacity of the battery **1159** is greater than the preset threshold and thus the components such as the AP **1152**, the PMIC **1153**, the IFPM **1157**, and the TA **1158** are activated.

When the residual capacity of the battery **1159** is greater than or equal to a minimum power threshold in a state where the AP **1152** is turned off, the AP **1152** awakens to be driven. When the AP **1152** is driven, the communication unit **1151** receives a stack of a predetermined communication scheme, for example, a WiFi/BT/BLE stack from the AP **1152**, and loads it to the memory **1162**. At this time, the communication unit **1151** may load a communication stack in a form of a ROM fetched from the AP **1152** in the NSA mode and stores the communication stack. As described above, a mode in which the communication unit **1151** receives a stack of a predetermined communication scheme for the wireless charging from the AP **1152** and loads the stack to the memory **1162** is referred to as the Non Stand Alone (NSA) mode.

At this time, as the AP **1152** is driven, a predetermined time is spent until the mode transition is completed.

A mode transition time corresponds to a time required when the wireless power receiving unit **1150** is switched from the SA mode to the NSA mode and may be generally "three seconds". Since the wireless power receiving unit **1150** does not receive a communication response from the wireless power transmitting unit **1100** during the mode transition time, registration time out may occur for one second. Therefore, in the embodiment of the present invention, the wireless power receiving unit **1150** makes a request for maintaining power during the mode transition time by notifying the wireless power transmitting unit **1100** of the generation of the mode transition from the SA mode to the NSA mode through the mode transition bit as shown in Table 3.

Operations in the wireless power transmitting unit and the wireless power receiving unit having the above configuration will be described with reference to FIG. **13**.

FIG. **13** is a flowchart illustrating operations of the wireless power transmitting unit and the wireless power receiving unit according to an embodiment of the present invention.

The wireless power transmitting unit **1100** transmits a charging initiation command signal to the wireless power receiving unit **1150** in step S**1301**. In response to the signal, the wireless power receiving unit **1150** performs the wireless charging by controlling a load switch to be in an on state in step S**1302**. The wireless power receiving unit **1150** transmits the PRU dynamic signal in step S**1303** and the wireless power transmitting unit **1100** receives and analyzes the PRU dynamic signal in step S**1304**. Accordingly, the wireless power transmitting unit **1100** may identify information such as the voltage, current, temperature of the wireless power receiving unit **1150** or wireless charging environment change such as the wired charging terminal insertion.

Meanwhile, the user may insert the wired charging terminal into the wireless power receiving unit **1150** and the wireless power receiving unit **1150** detects the insertion in step S**1305**. The wireless power receiving unit **1150** determines whether wired or wireless power is provided in step S**1306**. When neither the wired nor wireless power is provided in step S**1306**, the wireless power transmitting unit **1100** enters the low power mode. When it is determined that both the wired charging and the wireless charging are performed in step S**1306**, the IFPM **1157** of the wireless power receiving unit **1150** stops the wireless charging by releasing the connection with the resonator **1155** in step S**1308**.

The wireless power receiving unit **1150** outputs wired charging terminal insertion detection (=TA (Travel Adapter) detection) to the communication unit **1151** in step S**1309** and the communication unit **1151** transmits a wired charging terminal insertion detection (=TA (Travel Adapter) detection) signal to the wireless power transmitting unit **1100** in step S**1310**. The wireless power transmitting unit **1100** controls the charging power in accordance with the wired charging terminal insertion detection signal in step S**1311**. For example, the wireless power transmitting unit **1100** may make a control such that the wireless charging is stopped by adjusting the charging power to 0.

The wireless power transmitting unit **1100** instructs non-reception of power in step S**1312** and transmits a load switch off signal to the wireless power receiving unit **1150** in step S**1313**. The wireless power receiving unit **1150** receives the load switch off signal to control a load switch to be in an off state in step S**1314**.

The wireless power receiving unit **1150** periodically transmits the PRU dynamic signal in step S**1315**. The wireless power transmitting unit **1100** receives and analyzes the PRU dynamic signal in step S**1316**.

Meanwhile, the wireless power receiving unit **1150** detects that the wired charging terminal insertion has been released in step S**1317**. For example, the wireless power receiving unit **1150** may detect the release of the wired charging terminal insertion by detecting a changing in a voltage applied to a back end of the travel adapter **1158**. The wireless power receiving unit **1150** transmits a wired charging terminal insertion release detection signal to the wireless power transmitting unit **1100** in step S**1318**. For example, the wireless power receiving unit **1150** may transmit the wired charging terminal insertion release detection signal as the PRU dynamic signal or a single signal. The wireless power transmitting unit **1100** detects the release of the wired charging terminal insertion from the wireless power receiving unit **1150** by analyzing the PRU dynamic signal or the single signal in step S**1319**.

The wireless power transmitting unit **1100** transmits a load switch on signal to the wireless power receiving unit **1150** in step S**1320** and the wireless power receiving unit **1150** receives the load switch on signal to control the load switch to be in the on state in step S**1321**. Meanwhile, the wireless power transmitting unit **1100** performs the wireless charging by controlling the charging power again and the wireless power receiving unit **1150** performs the wireless charging by controlling the load switch to be in the on state.

According to the above description, the wireless power transmitting unit **1100** detects the insertion or withdrawal of the wired charging terminal into/from the wireless power receiving unit **1150**. The wireless power transmitting unit may prevent power waste and over power from being applied to the wireless power receiving unit **1150** by controlling the charging power according to the insertion or the withdrawal of the wired charging terminal.

Meanwhile, when the battery **1159** is discharged while the wireless power receiving unit **1150** performs the above described operation, the AP **1152** cannot be driven. At this time, the wireless power receiving unit **1150** may be arranged on the wireless power transmitting unit **1100** in a state where the battery **1159** is discharged.

In this event, the wireless power receiving unit **1150** drives the communication unit **1151** of the wireless power receiving unit **1150** by receiving a power detection beacon.

However, since the AP **1152** is not driven as described above, the communication unit **1151** cannot fetch a stack of a predetermined communication scheme, for example, a wireless charging protocol from the AP **1152**. Accordingly, the communication unit **1151** operates in the SA mode in which the communication is performed using the stack of the communication scheme stored in the memory within the communication unit **1151**.

Hereinafter, a control process according to the mode transition in the wireless power receiving unit will be described with reference to FIG. **14**.

Referring to FIG. **14**, the wireless power receiving unit **1150** monitors the battery **1159** in step S**1500** and determines whether a battery value is less than a preset threshold in step S**1505**. When the battery value is less than the preset threshold, the wireless power receiving unit **1150** may be turned off due to discharging of the battery **1159**. In the embodiment of the present invention, it is assumed that the wireless power receiving unit **1150** is arranged on the wireless power transmitting unit **1100** in a state where the battery **1159** is discharged. Accordingly, the wireless power receiving unit **1150** receives first power which can drive the communication unit **1151** from the wireless power transmitting unit **1100** and drives the communication **1151** by using the first power. Therefore, when the battery **1159** is discharged and the battery value is less than the preset threshold, the wireless power receiving unit **1150** enters the SA mode in step S**1510**.

When entering the SA mode, the wireless power receiving unit **1150** may load, for example, a BLE stack from the memory **1162** within the communication unit **1151** in step S**1515**. The communication unit **1151** of the wireless power receiving unit **1150** communicates with the wireless power transmitting unit **1100** by using the loaded BLE stack in step S**1520**.

As described above, the wireless power receiving unit **1150** performs the wireless charging while operating in the SA mode. Based on the performance of the wireless charging, the battery **1159** starts to be charged. Accordingly, it is determined whether the battery value is greater than or equal to the preset threshold in step S**1525**. When the battery value is greater than or equal to the preset threshold, the wireless power receiving unit **1150** turns on the battery **1159** and the AP **1152**. Accordingly, the wireless power receiving unit **1150** switches the SA mode to the NSA mode in step S**1530**. However, when the battery value is less than the preset threshold, the charged power is not enough to turn on the AP **1152**, so the wireless power receiving unit **1150** returns to step S**1520** and communicates with the wireless power transmitting unit **1100** for the wireless charging in the SA mode.

At this time, the wireless power transmitting unit **1100** is in a power transfer state, and the communication unit **1151** does not need to be re-initialized during a charging session when the wireless power receiving unit **1150** is turned on. That is, in a process of resetting the communication unit **1151**, it is required to end a BLE link between the wireless power receiving unit **1150** and the wireless power transmitting unit **1100** and re-initiate the BLE link. Accordingly, when the wireless power receiving unit **1150** is turned on and thus the re-initiation of the BLE link between the wireless power receiving unit **1150** and wireless power transmitting unit **1100** is needed, the wireless power receiving unit **1150** informs the wireless power transmitting unit **1100** of such a condition by generating a mode transition notification message.

The mode transition notification message may use the alert information (PRU Alert) as shown in Table 3 above. Accordingly, the mode transition notification message is a message making a request for maintaining power for the mode transition time and may include a time required when the mode transition is completed as shown in Table 4, that is, a required time according to the mode transition. The mode transition notification message may be generated and transmitted by the communication unit **1151** or the AP **1152**.

Accordingly, the wireless power receiving unit **1150** transmits the mode transition notification message to the wireless power transmitting unit **1100** in step S**1535**. Subsequently, the wireless power receiving unit **1150** loads the WiFi/BT/BLE stack from the AP **1152** and reinitiates the communication with the wireless power transmitting unit **1100** based on the stack in step S**1540**.

Meanwhile, FIG. **15** is a flowchart illustrating a control method of the wireless power transmitting unit based on the mode transition according to an embodiment of the present invention.

Referring to FIG. **15**, the wireless power transmitting unit **1100** transmits charging power to the wireless power receiving unit **1150** in step S**1600**. The wireless power transmitting unit **1100** receives a mode transition notification message notifying of switching from the SA mode to the NSA mode from the wireless power receiving unit **1150** in step S**1605**. The mode transition notification message includes a required time according to the mode transition set by the wireless power receiving unit **1150**. Therefore, the wireless power transmitting unit **1100** detects the required time according to the mode transition included in the mode transition notification message in step S**1610**. Accordingly, the wireless power transmitting unit **1100** may stand by for the preset time and maintains output power for the required time according to the mode transition in step S**1615**.

In general, when the wireless power transmitting unit **1100** does not receive a signal from the wireless power receiving unit **1150** for one second, the wireless power transmitting unit **1100** may be set to exclude the wireless power receiving unit **1150** from the wireless power network. However, according to an embodiment of the present invention, when the wireless power transmitting unit **1100** receives the mode transition notification message from the wireless power receiving unit **1150**, the wireless power transmitting unit **1100** may not exclude the wireless power receiving unit **1150** from the wireless power network even though the signal is not received from the wireless power receiving unit **1150** for the preset required time.

Accordingly, the wireless power transmitting unit **1100** determines whether the waiting time exceeds the preset required time in step S**1620**. When the waiting time exceeds the preset required time, the wireless power transmitting unit **1100** may consider the wireless power receiving unit as a rogue object and excludes the wireless power receiving unit from the wireless power network in step S**1630**. That is, the wireless power transmitting unit **1100** terminates the connection with the wireless power receiving unit **1150**. However, when the waiting time is within the preset required time, the wireless power transmitting unit **1100** communicates with the wireless power receiving unit **1150** again in step S**1630**.

According to the above description, when the wireless power receiving unit **1150** switches the SA mode to the NSA mode, the communication with the wireless power transmitting unit **1100** may be disconnected for a predetermined time. However, even though the signal is not received from the wireless power receiving unit **1150** for the preset waiting

time, the wireless power transmitting unit **1100** may not exclude the wireless power receiving unit **1150** from the wireless power network by receiving the switching signal from the SA mode to the NSA mode. Accordingly, an unintended error by the mode transition of the wireless power receiving unit can be prevented.

According to the above description, the wireless power transmitting unit **1100** may detect a change in a wireless power transmission environment such as the mode transition and may not exclude the wireless power receiving unit **1150** from the wireless power network.

Various embodiments of the present invention provide a wireless power receiving unit which can notify of, when a wireless power transmission environment change is detected, the change to a wireless power transmitting unit, and a control method thereof. Further, the present invention provides a wireless power transmitting unit which receives a signal for the detection of the wireless power transmission environment change from a wireless power receiving unit and a control method thereof.

In addition, when a charging environment is changed like in a case where the wireless power receiving unit switches from the SA mode to the NSA mode, the wireless transmitting unit recognizes a mode transition condition of the wireless power receiving unit through a message notifying of the change. Accordingly, even though the wireless power transmitting unit does not receive a signal from the wireless power receiving unit for a predetermined time, the wireless power transmitting unit can stand by for a predetermined time until the mode transition is completed without a disconnection with the wireless power receiving unit.

While the present invention has been shown and described with reference to certain embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the appended claims. Therefore, various modified implementations can be made without departing from the substance of the present invention claimed in the appended claims, and the modified implementations should not be construed separately from the technical idea or concept of the present invention.

What is claimed is:

1. A control method of a wireless power receiver, the control method comprising:

establishing a communication connection with a wireless power transmitter;

joining a wireless power network corresponding to the wireless power transmitter based on the communication connection;

after joining the wireless power network, wirelessly receiving power for charging from the wireless power transmitter;

determining to re-initialize the communication connection with the wireless power transmitter;

in response to determining to re-initialize the communication connection with the wireless power transmitter, transmitting a message including a time period required to complete a procedure for re-initializing the communication connection; and

wirelessly receiving the power from the wireless power transmitter while re-initializing the communication connection.

2. The control method of claim **1**, wherein the joining of the wireless power network corresponding to the wireless power transmitter comprises:

communicating with the wireless power transmitter based on a communication stack stored in a memory of a communication unit of the wireless power receiver.

3. The control method of claim **2**, wherein the determining to re-initialize the communication connection with the wireless power transmitter comprises:

determining to stop communicating with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver, and

determining to communicate with the wireless power transmitter based on a communication stack stored outside of the memory of the communication unit of the wireless power receiver.

4. The control method of claim **2**, wherein the communicating with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver comprises:

determining to communicate with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver, in response to a residual capacity of a battery of the wireless power receiver being less than a minimum power threshold.

5. The control method of claim **3**, wherein the determining to stop communicating with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver comprises:

determining to stop communicating with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver, in response to a residual capacity of a battery of the wireless power receiver being more than or equal to a minimum power threshold.

6. The control method of claim **1**, wherein the message is also for notifying the wireless power transmitter that no communication between the wireless power transmitter and the wireless power receiver is possible for the time period.

7. The control method of claim **1**, wherein the determining to re-initialize the communication connection with the wireless power transmitter comprises:

determining to re-initialize the communication connection with the wireless power transmitter, in response to a residual capacity of a battery of the wireless power receiver being more than or equal to a minimum power threshold.

8. The control method of claim **1**, wherein the message is one of a Power Receiving Unit (PRU) dynamic signal or a PRU alert signal, and

wherein the PRU alert signal includes information regarding the time period.

9. The control method of claim **8**, wherein the information regarding the time period includes bits for indicating the time period, and

wherein the bits for indicating the time period are one of a first value, a second value, a third value and a fourth value.

10. The control method of claim **9**, wherein the first value indicates no mode transition, the second value indicates that the time period is 2 seconds, the third value indicates that the time period is 3 seconds, and the fourth value indicates that the time period is 6 seconds.

11. A wireless power receiver, comprising:
a controller;
a communication unit; and
a power receiving resonator configured to wirelessly receive power for charging from a wireless power transmitter,
wherein the controller is configured to:
establish, through the communication unit, a communication connection with the wireless power transmitter,
join a wireless power network corresponding to the wireless power transmitter based on the communication connection, wherein the power receiving resonator wirelessly receives the power for charging from the wireless power transmitter after joining the wireless power network,
determine to re-initialize the communication connection with the wireless power transmitter,
in response to determining to re-initialize the communication connection with the wireless power transmitter, transmit, through the communication unit, a message including a time period required to complete a procedure for re-initializing the communication connection; and
perform the procedure for re-initializing the communication connection, while the power receiving resonator wirelessly receives the power for charging from the wireless power transmitter.

12. The wireless power receiver of claim 11, wherein the controller is further configured to communicate, through the communication unit, with the wireless power transmitter based on a communication stack stored in a memory of the communication unit of the wireless power receiver.

13. The wireless power receiver of claim 12, wherein the controller is further configured to:
determine to stop communicating with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver, and
determine to communicate with the wireless power transmitter based on a communication stack stored outside of the memory of the communication unit of the wireless power receiver.

14. The wireless power receiver of claim 12, wherein the controller is further configured to:
determine to communicate with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver, in response to a residual capacity of a battery of the wireless power receiver being less than a minimum power threshold.

15. The wireless power receiver of claim 13, wherein the controller is further configured to:
determine to stop communicating with the wireless power transmitter based on the communication stack stored in the memory of the communication unit of the wireless power receiver, in response to a residual capacity of a battery of the wireless power receiver being more than or equal to a minimum power threshold.

16. The wireless power receiver of claim 11, wherein the message is also for notifying the wireless power transmitter that no communication between the wireless power transmitter and the wireless power receiver is possible for the time period.

17. The wireless power receiver of claim 11, wherein the controller is further configured to:
determine to re-initialize the communication connection with the wireless power transmitter, in response to a residual capacity of a battery of the wireless power receiver being more than or equal to a minimum power threshold.

18. The wireless power receiver of claim 11, wherein the message is one of a Power Receiving Unit (PRU) dynamic signal or a PRU alert signal, and
wherein the PRU alert signal includes information regarding the time period.

19. The wireless power receiver of claim 18, wherein the information regarding the time period includes bits for indicating the time period, and
wherein the bits for indicating the time period are one of a first value, a second value, a third value and a fourth value.

20. The wireless power receiver of claim 19, wherein the first value indicates no mode transition, the second value indicates that the time period is 2 seconds, the third value indicates that the time period is 3 seconds, and the fourth value indicates that the time period is 6 seconds.

21. A control method of a wireless power transmitter, the control method comprising:
establishing a communication connection with a wireless power receiver;
registering the wireless power receiver to a wireless power network corresponding to the wireless power transmitter based on the communication connection;
after registering the wireless power receiver to the wireless power network, wirelessly transmitting power for charging the wireless power receiver;
receiving a message including a time period required to complete a procedure for re-initializing the communication connection; and
wirelessly transmitting the power for charging the wireless power receiver for the time period, while the wireless power receiver is re-initializing the communication connection.

22. The control method of claim 21, wherein the message is also for notifying the wireless power transmitter that no communication between the wireless power transmitter and the wireless power receiver is possible for the time period.

23. The control method of claim 21, wherein the wirelessly transmitting the power for charging the wireless power receiver for the time period comprises maintaining transmitting the power for charging for the time period starting from a time point at which the message is received.

24. The control method of claim 21, wherein the message is one of a Power Receiving Unit (PRU) dynamic signal or a PRU alert signal, and
wherein the PRU alert signal includes information regarding the time period.

25. The control method of claim 24, wherein the information regarding the time period includes bits for indicating the time period, and
wherein the bits for indicating the time period are one of a first value, a second value, a third value and a fourth value.

26. The control method of claim 25, wherein the first value indicates no mode transition, the second value indicates that the time period is 2 seconds, the third value indicates that the time period is 3 seconds, and the fourth value indicates that the time period is 6 seconds.

27. A wireless power transmitter, comprising:
a power transmitting resonator configured to wirelessly transmit power for charging to a wireless power receiver;

a communication unit; and

a controller configured to:

establish, through the communication unit, a communication connection with a wireless power receiver,

register the wireless power receiver to a wireless power network corresponding to the wireless power transmitter based on the communication connection,

after registering the wireless power receiver to the wireless power network, wirelessly transmit, through the power transmitting resonator, the power for charging the wireless power receiver;

receive, through the communication unit, a message including a time period required to complete a procedure for re-initializing the communication connection, and

wirelessly transmit, through the power transmitting resonator, the power for charging the wireless power receiver for the time period, while the wireless power receiver is re-initializing the communication connection.

28. The wireless power transmitter of claim **27**, wherein the message is also for notifying the wireless power transmitter that no communication between the wireless power transmitter and the wireless power receiver is possible for the time period.

29. The wireless power transmitter of claim **27**, wherein the controller is further configured to:

maintain transmitting the power for charging for the time period starting from a time point at which the message is received.

30. The wireless power transmitter of claim **27**, wherein the message is one of a Power Receiving Unit (PRU) dynamic signal or a PRU alert signal, and

wherein the PRU alert signal includes information regarding the time period.

31. The wireless power transmitter of claim **30**, wherein the information regarding the time period includes bits for indicating the time period, and

wherein the bits for indicating the time period are one of a first value, a second value, a third value and a fourth value.

32. The wireless power transmitter of claim **31**, wherein the first value indicates no mode transition, the second value indicates that the time period is 2 seconds, the third value indicates that the time period is 3 seconds, and the fourth value indicates that time period is 6 seconds.

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