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

(10) **Patent No.: US 12,395,200 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **ELECTRONIC DEVICE COMPRISING ANTENNA, AND OPERATION METHOD THEREOF**

(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)

(72) Inventors: **Himchan Yun**, Suwon-si (KR); **Nakchung Choi**, Suwon-si (KR); **Shinho Yoon**, Suwon-si (KR); **Soonho Hwang**, Suwon-si (KR)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (KR)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 383 days.

(21) Appl. No.: **18/105,667**

(22) Filed: **Feb. 3, 2023**

(65) **Prior Publication Data**

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**Related U.S. Application Data**

(63) Continuation of application No. PCT/KR2021/010191, filed on Aug. 4, 2021.

(30) **Foreign Application Priority Data**

Aug. 4, 2020 (KR) ........................ 10-2020-0097307

(51) **Int. Cl.**

| | |
|---|---|
| ***H04B 1/3888*** | (2015.01) |
| ***H04B 1/3827*** | (2015.01) |
| ***H04M 1/02*** | (2006.01) |

(52) **U.S. Cl.**

CPC ......... ***H04B 1/3838*** (2013.01); ***H04B 1/3888*** (2013.01); ***H04M 1/0202*** (2013.01)

(58) **Field of Classification Search**

CPC .. H04B 1/3838; H04B 1/3888; H04M 1/0202

(Continued)

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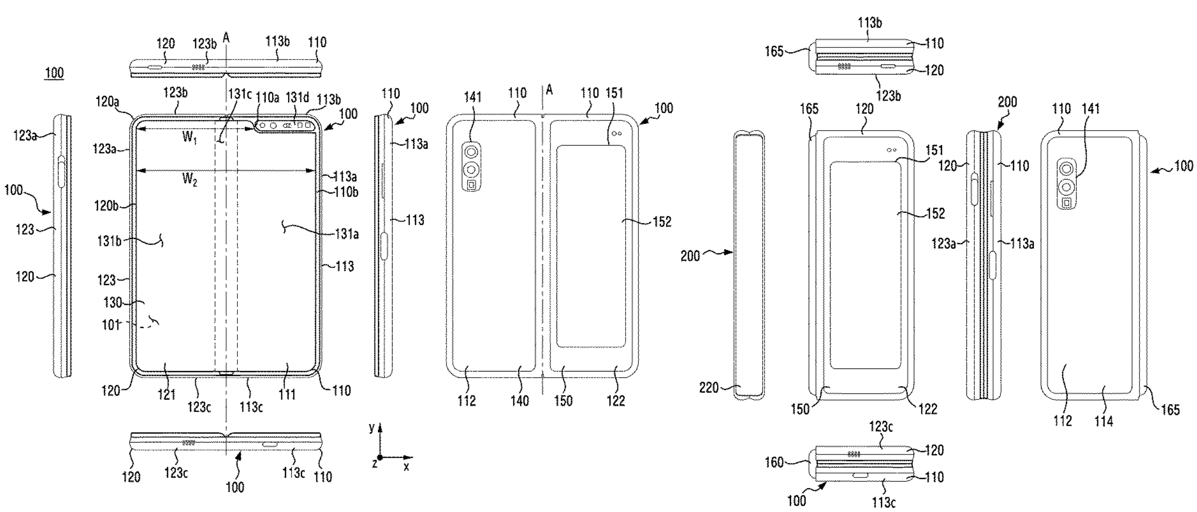
*Primary Examiner* — April G Gonzales
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

An electronic device includes a frame structure forming at least a part of the side surface of the electronic device, the frame structure including a first insulating portion, a second insulating portion, a third insulating portion, a first conductive portion, a second conductive portion and a third conductive portion, a wireless communication circuit, a first switching circuit configured to connect the wireless communication circuit and at least one of the first conductive portion and the second conductive portion, a second switching circuit configured to connect the wireless communication circuit and at least one of the second conductive portion and the third conductive portion, and a proximity sensor configured to detect a proximity of a human body.

**20 Claims, 24 Drawing Sheets**



(58) **Field of Classification Search**
USPC ........................................................ 455/552.1
See application file for complete search history.

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| WO | 2020/122598 | A1 | 6/2020 |


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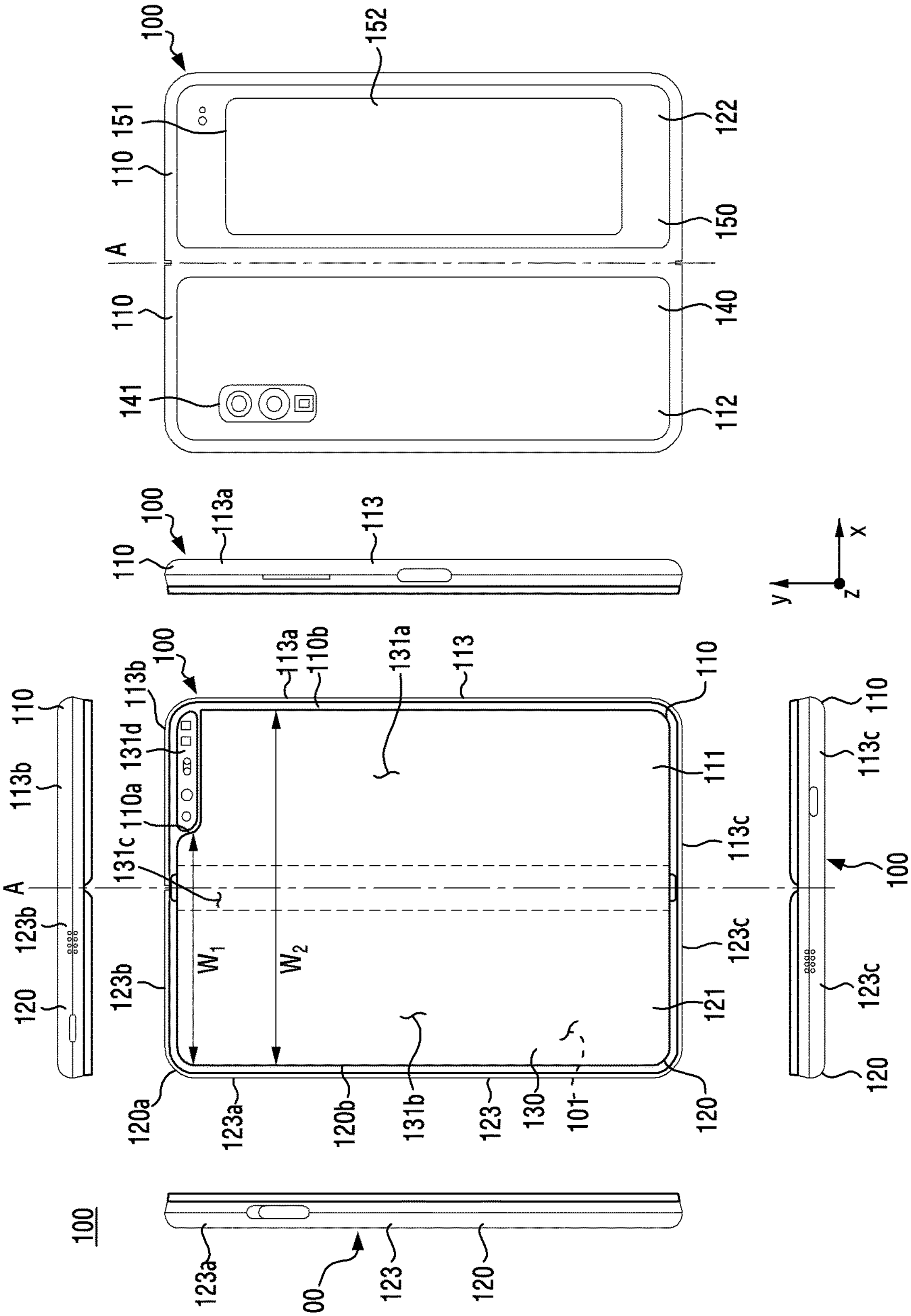

100
152
110
151
122
150
A
140
141
112
113a
113
y
x
z
113b
110b
131a
131d
110a
131c
111
113c
123b
W1
W2
123c
120
120a
123a
120b
131b
123
130
101

FIG. 1A

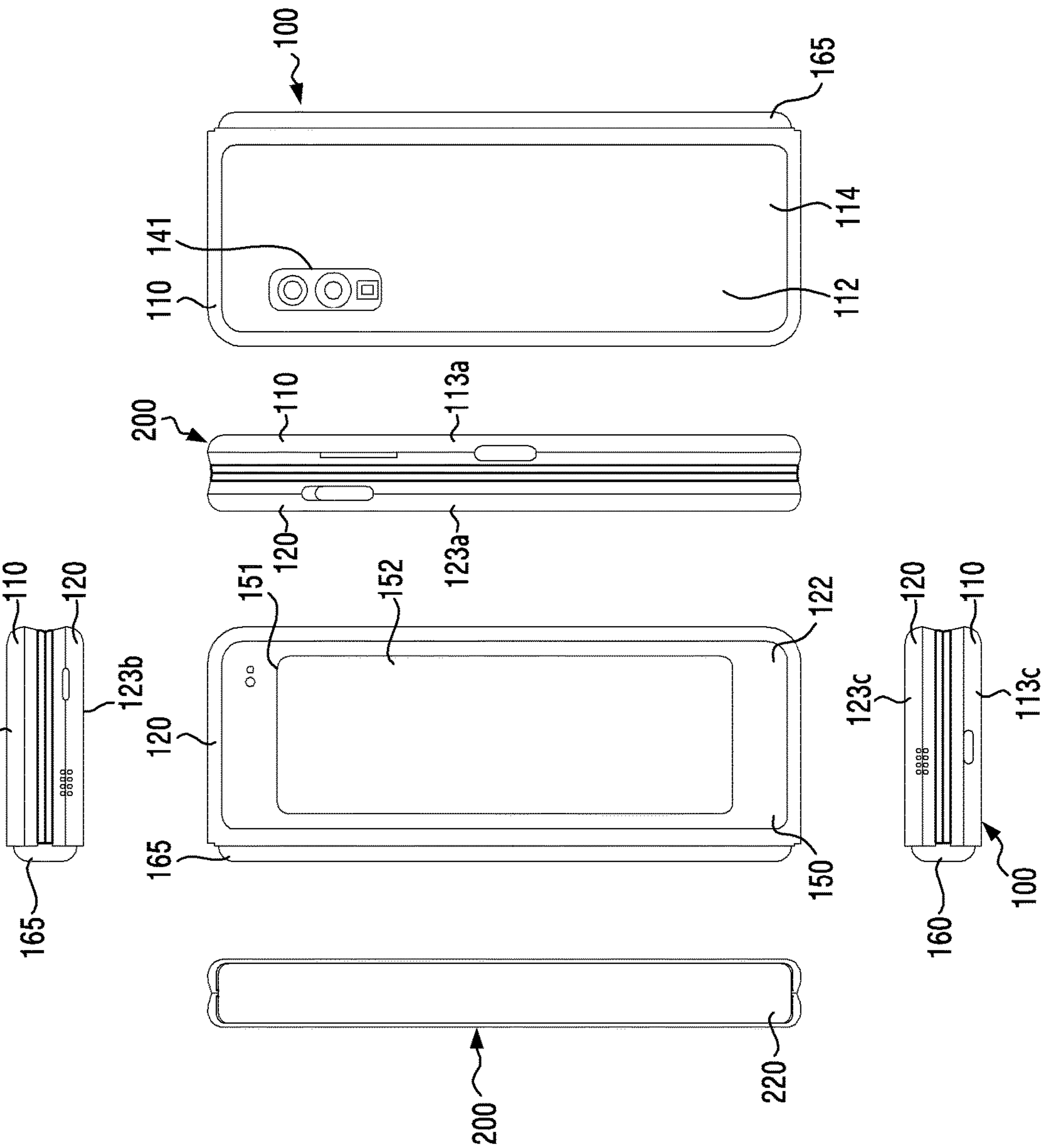

100
165
141
110
114
112
200
110
113a
120
123a
151
152
122
120
165
150
113b
110
120
123b
165
123c
120
110
113c
160
100
220
200

FIG.1B

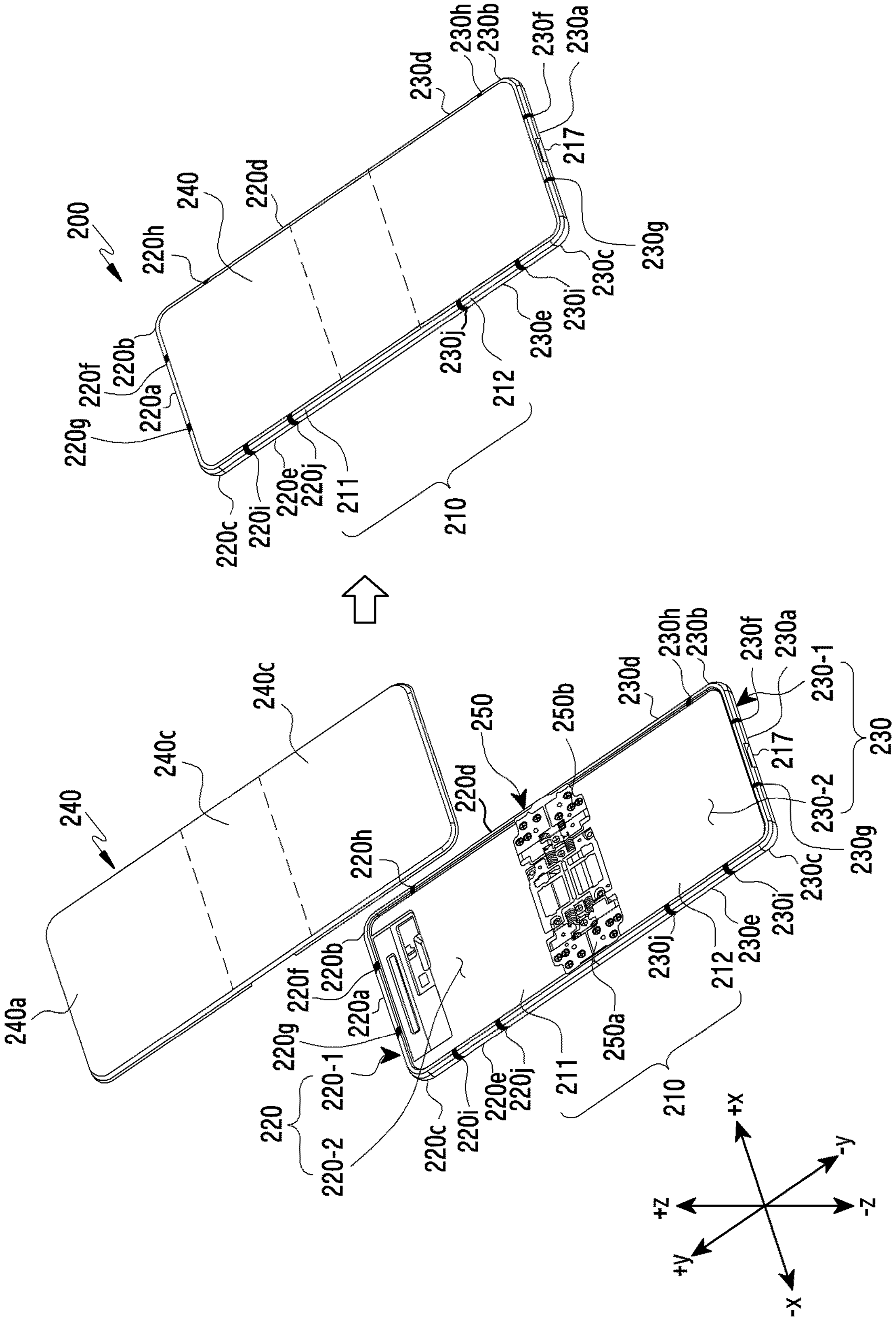

200
240
220h
220d
230d
230h
230b
230f
230a
217
230g
230c
230i
230e
230j
212
220b
220f
220a
220g
220c
220i
220e
220j
211
210
240c
240c
240c
240a
250
250b
250a
220-1
220
220-2
230-1
230-2
230
+x
-x
+y
-y
+z
-z

FIG.2A

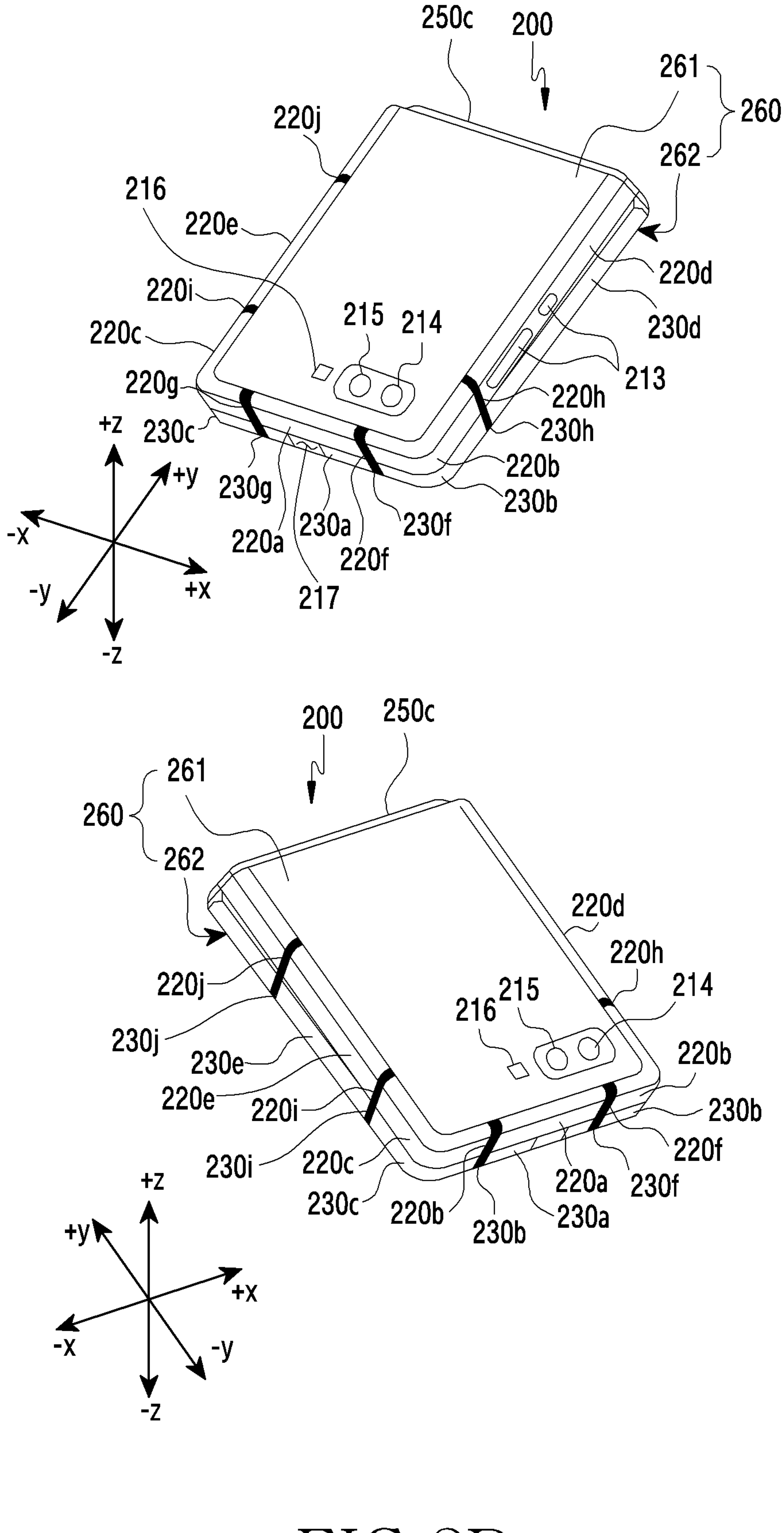
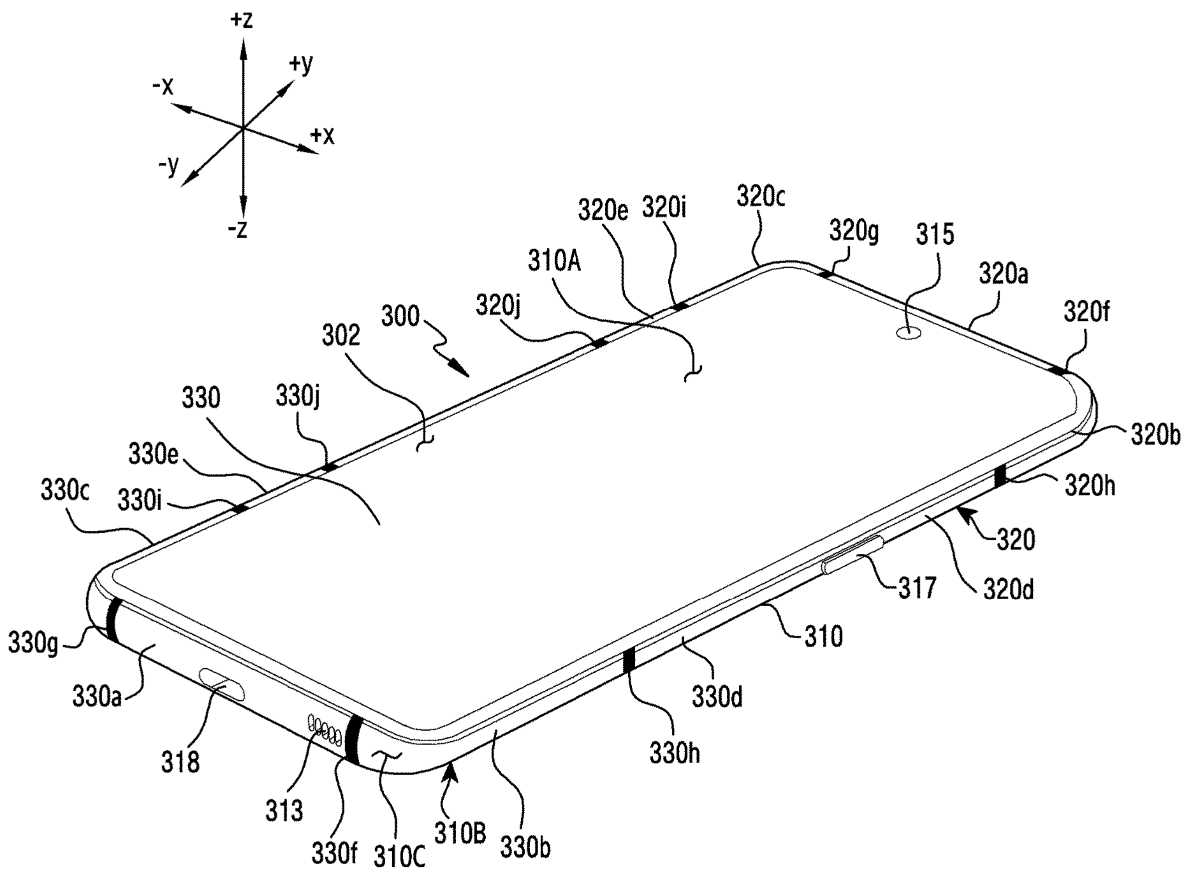

250c
200
261
260
262
220j
216
220e
220d
230d
220i
215
214
213
220c
220g
220h
230h
+z
230c
+y
220b
230g
230b
230a
230f
-x
220a
220f
-y
+x
217
-z
200
250c
261
260
262
220d
220h
220j
215
214
216
230j
230e
220b
220e
220i
230b
220f
230i
220c
220a
230f
230c
220b
230b
230a
+z
+y
+x
-x
-y
-z

FIG.2B



+z
+y
-x
+x
-y
-z
320e
320i
320c
320g
315
310A
320a
320j
320f
300
302
330
330j
320b
330e
330c
330i
320h
320
317
320d
310
330g
330a
330d
330h
318
313
310B
330b
330f
310C


FIG.3

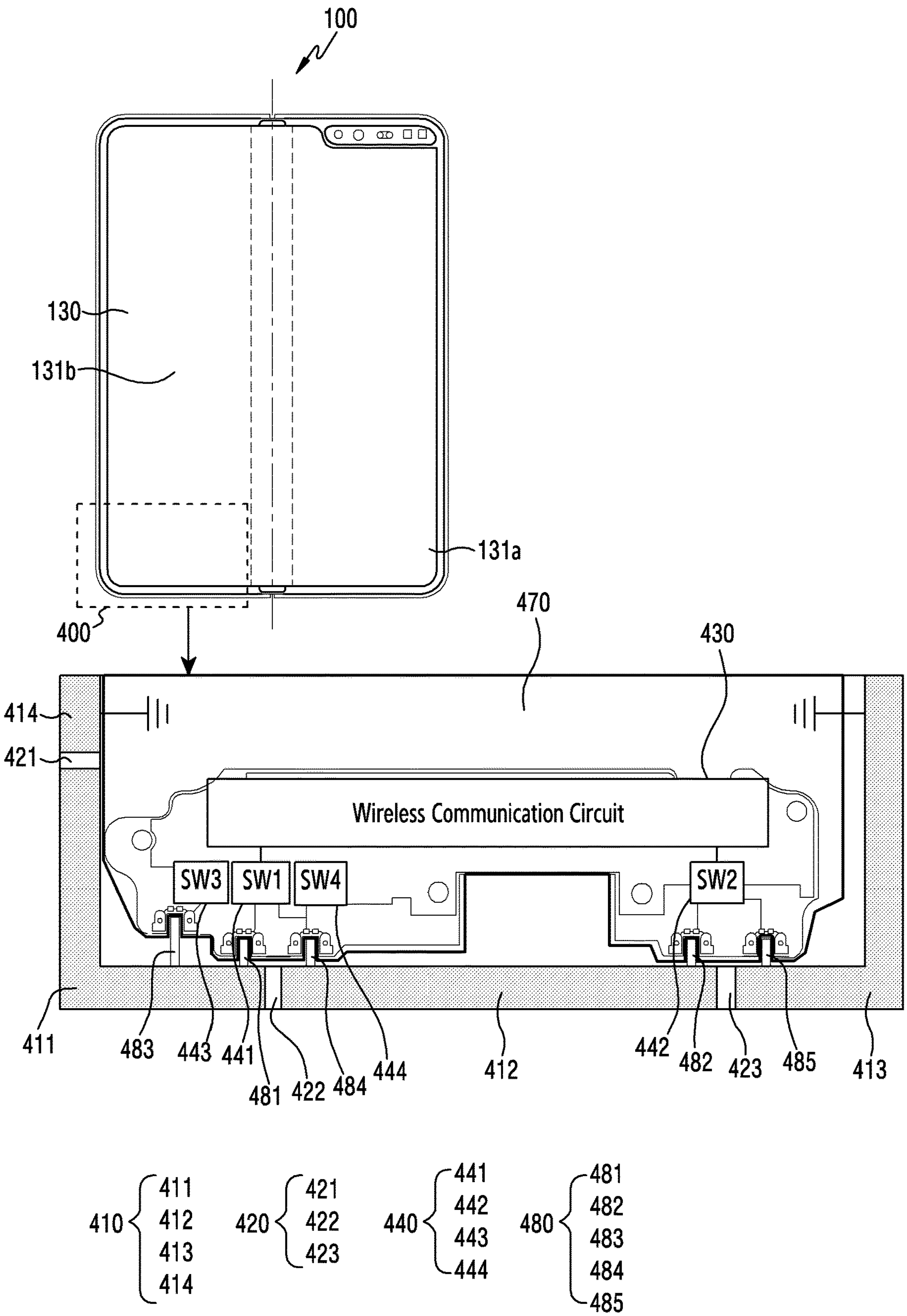

100
130
131b
131a
400
470
430
414
421
Wireless Communication Circuit
SW3
SW1
SW4
SW2
411
483
443
441
481
422
484
444
412
442
482
423
485
413
410
411
412
413
414
420
421
422
423
440
441
442
443
444
480
481
482
483
484
485

FIG.4

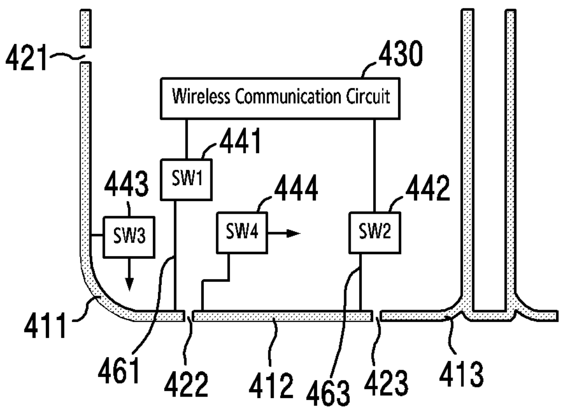



FIG.5A

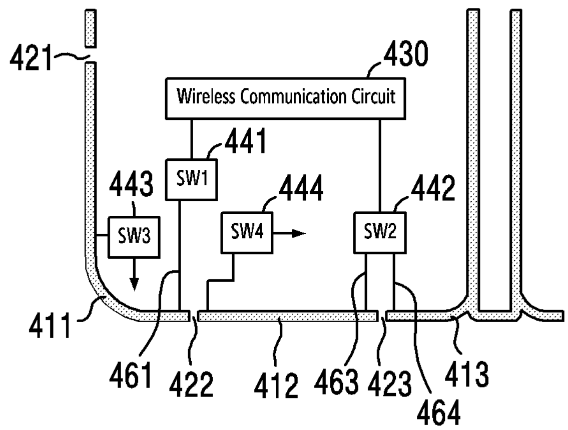



FIG.5B

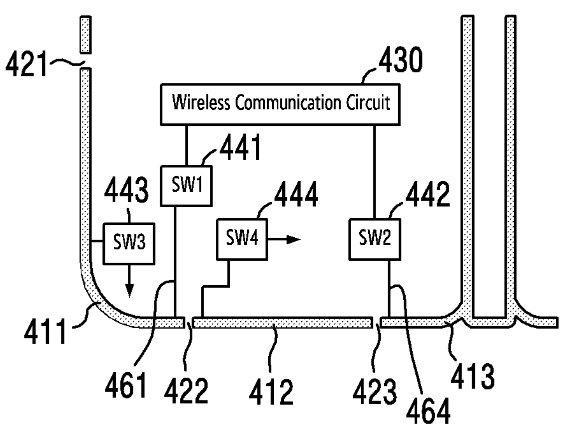



FIG.5C

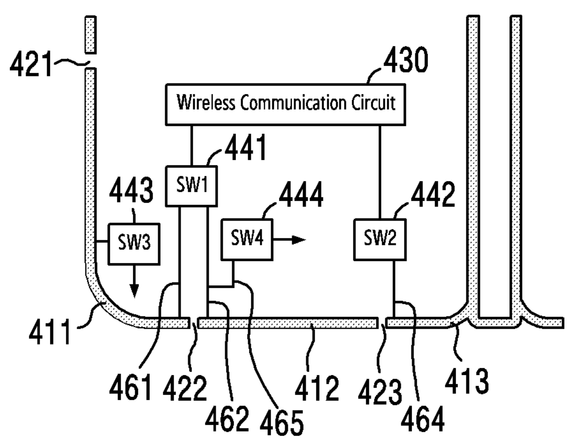



FIG.5D

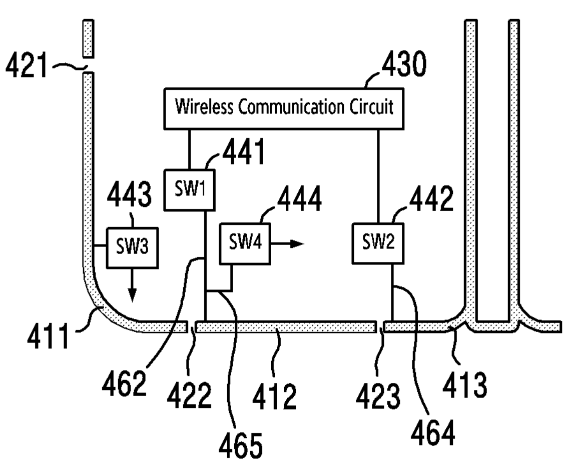



FIG.5E

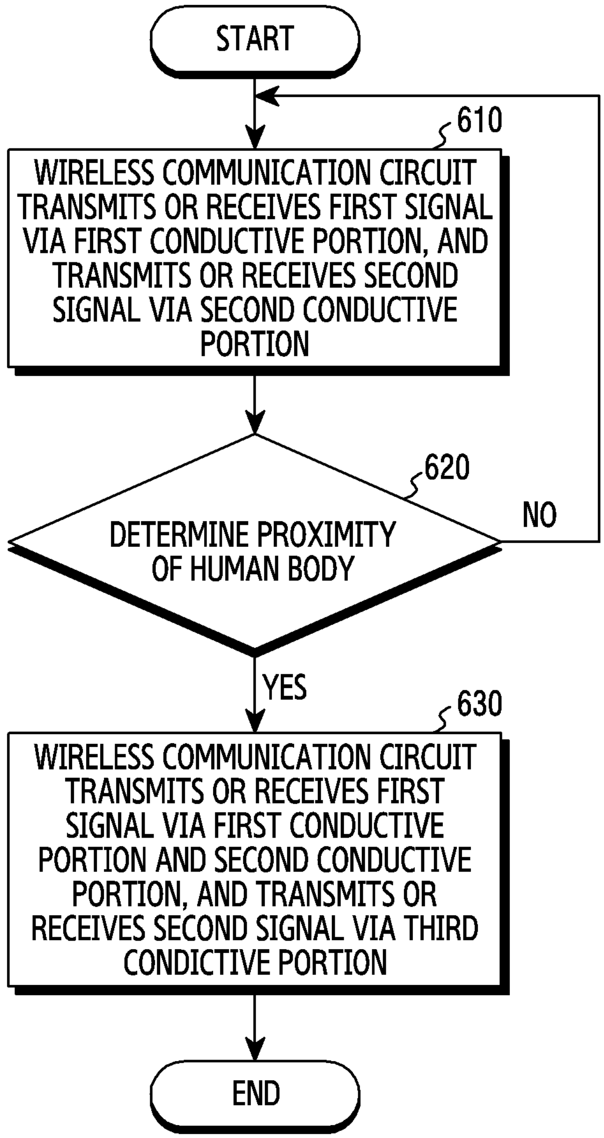

START
610
WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES FIRST SIGNAL VIA FIRST CONDUCTIVE PORTION, AND TRANSMITS OR RECEIVES SECOND SIGNAL VIA SECOND CONDUCTIVE PORTION
620
DETERMINE PROXIMITY OF HUMAN BODY
NO
YES
630
WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES FIRST SIGNAL VIA FIRST CONDUCTIVE PORTION AND SECOND CONDUCTIVE PORTION, AND TRANSMITS OR RECEIVES SECOND SIGNAL VIA THIRD CONDICTIVE PORTION
END

FIG.6

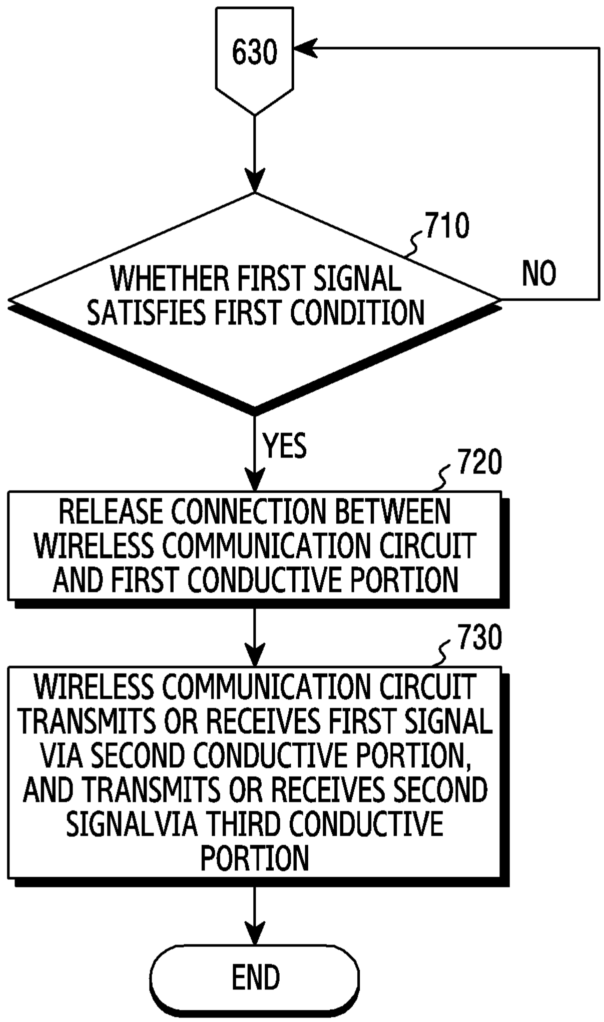
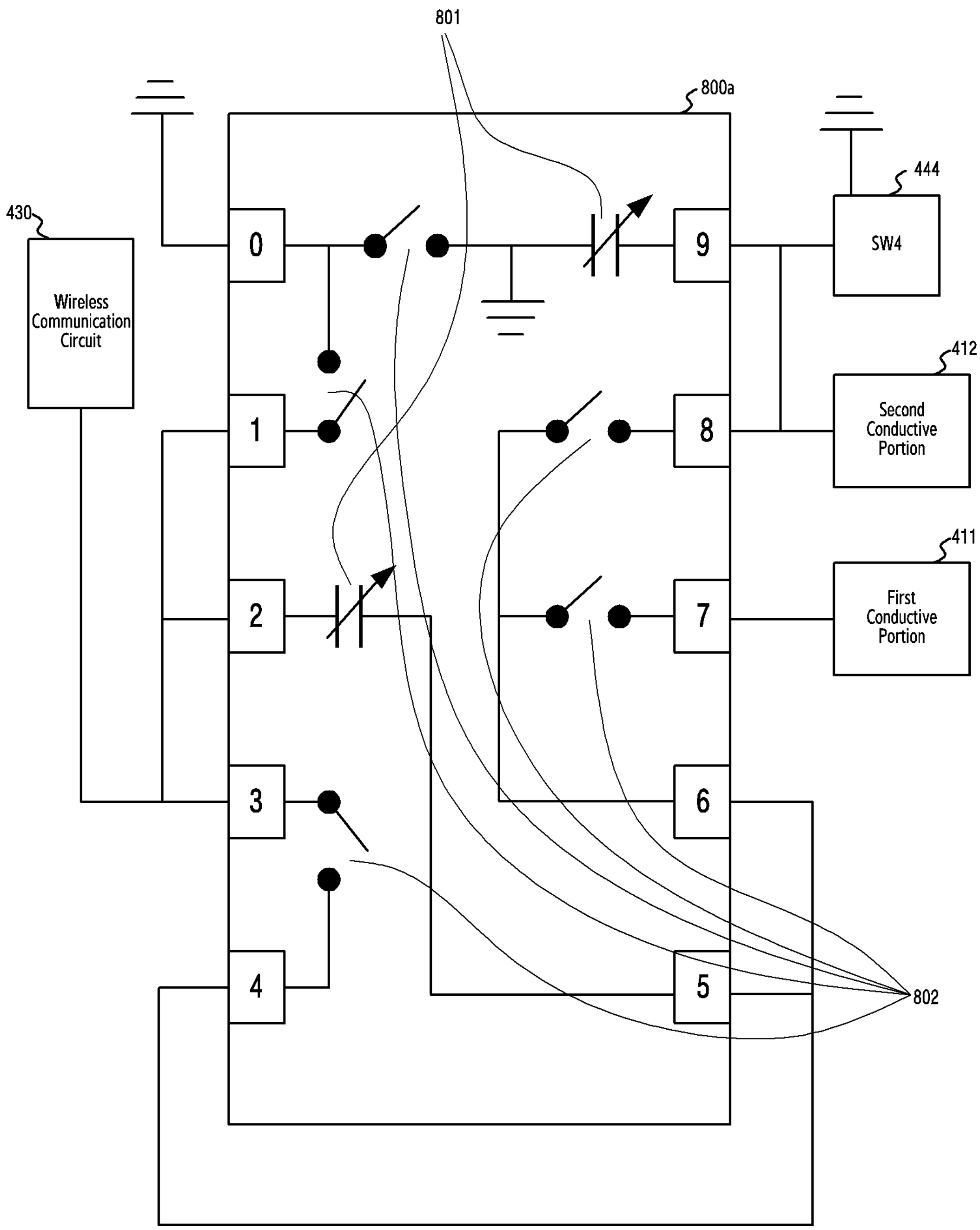
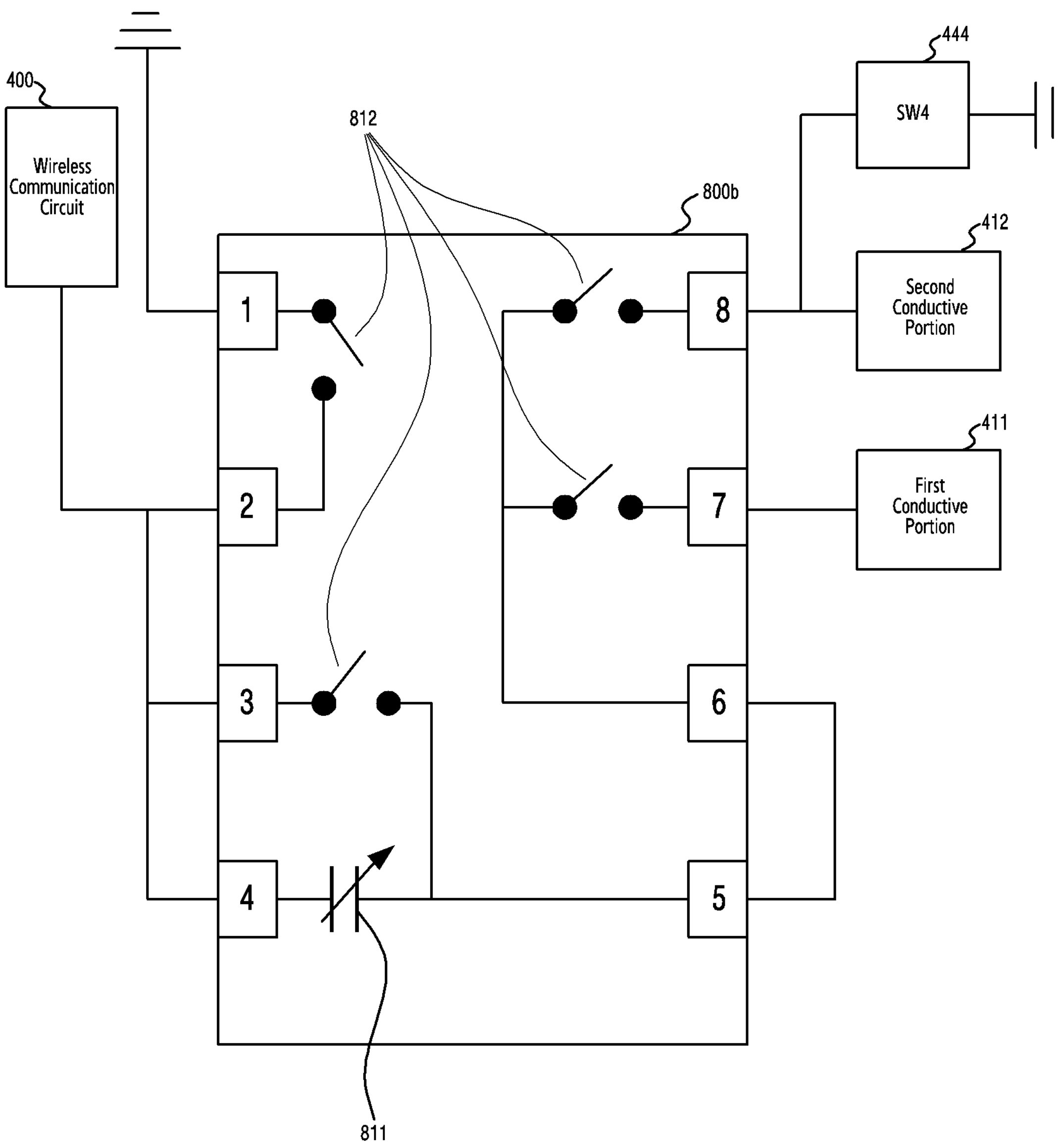

630
710
WHETHER FIRST SIGNAL SATISFIES FIRST CONDITION
NO
YES
720
RELEASE CONNECTION BETWEEN WIRELESS COMMUNICATION CIRCUIT AND FIRST CONDUCTIVE PORTION
730
WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES FIRST SIGNAL VIA SECOND CONDUCTIVE PORTION, AND TRANSMITS OR RECEIVES SECOND SIGNALVIA THIRD CONDUCTIVE PORTION
END

FIG.7



801
800a
444
430
Wireless Communication Circuit
0
9
SW4
412
1
8
Second Conductive Portion
411
2
7
First Conductive Portion
3
6
4
5
802


FIG.8A



400
Wireless Communication Circuit
812
800b
444
SW4
412
Second Conductive Portion
411
First Conductive Portion
1
2
3
4
5
6
7
8
811


FIG.8B

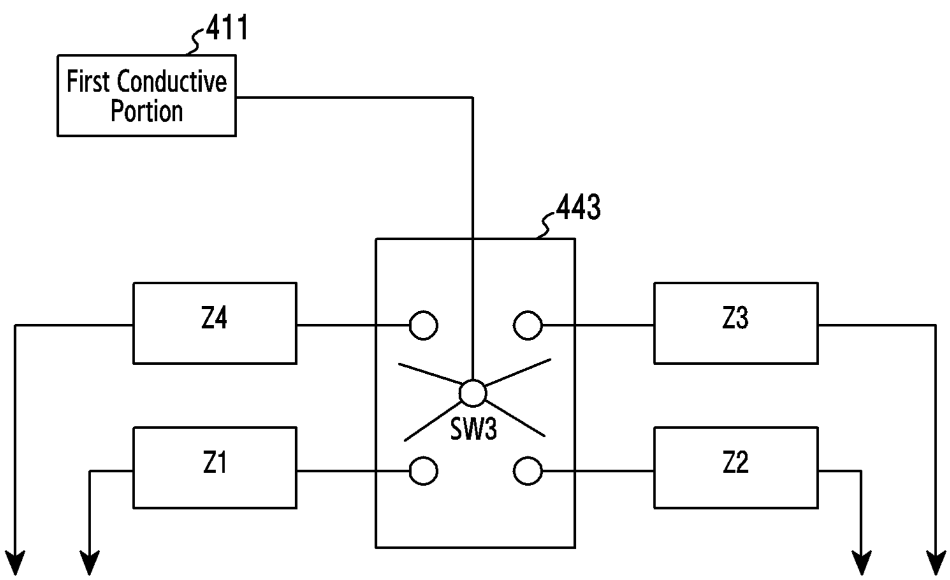



FIG.8C

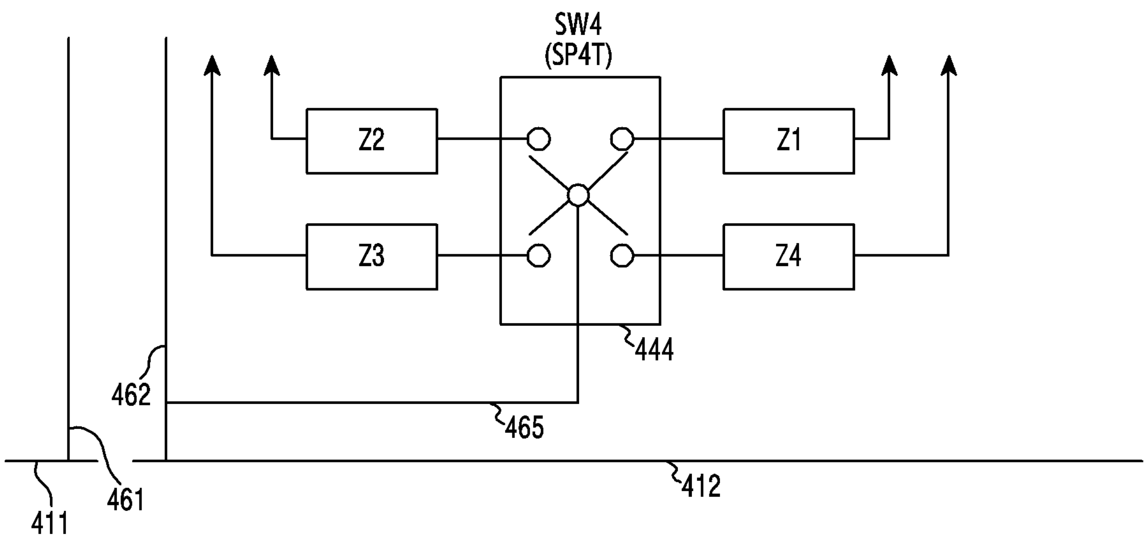



FIG.8D

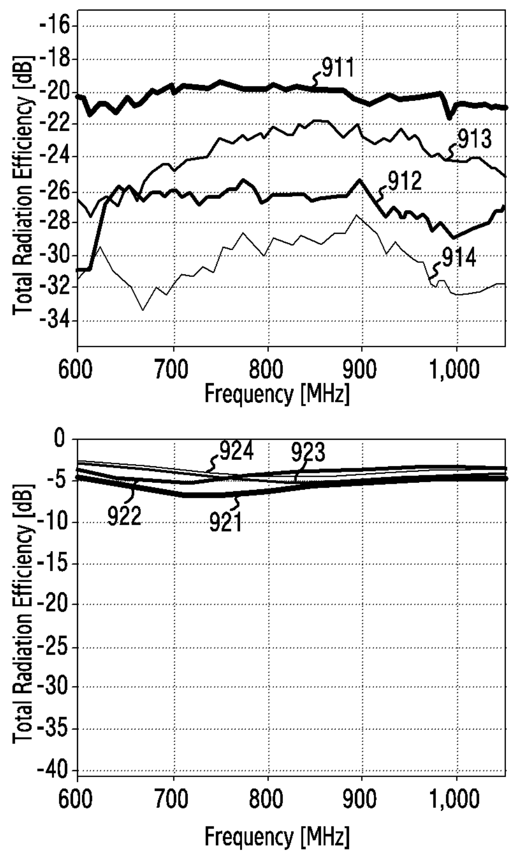

-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
Total Radiation Efficiency [dB]
911
913
912
914
600
700
800
900
1,000
Frequency [MHz]
0
-5
-10
-15
-20
-25
-30
-35
-40
Total Radiation Efficiency [dB]
924
923
922
921
600
700
800
900
1,000
Frequency [MHz]

FIG.9A

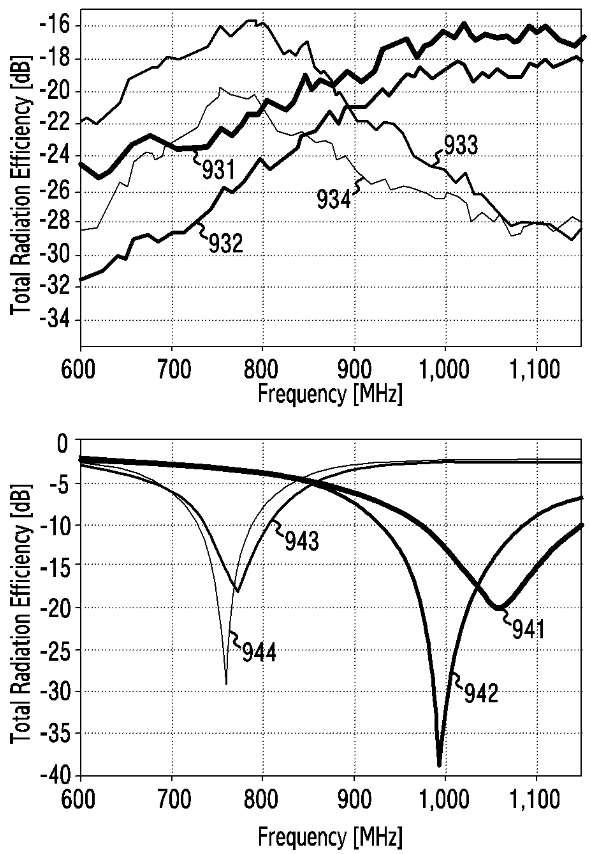

-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
Total Radiation Efficiency [dB]
931
932
933
934
600
700
800
900
1,000
1,100
Frequency [MHz]
0
-5
-10
-15
-20
-25
-30
-35
-40
Total Radiation Efficiency [dB]
941
942
943
944
600
700
800
900
1,000
1,100
Frequency [MHz]

FIG.9B

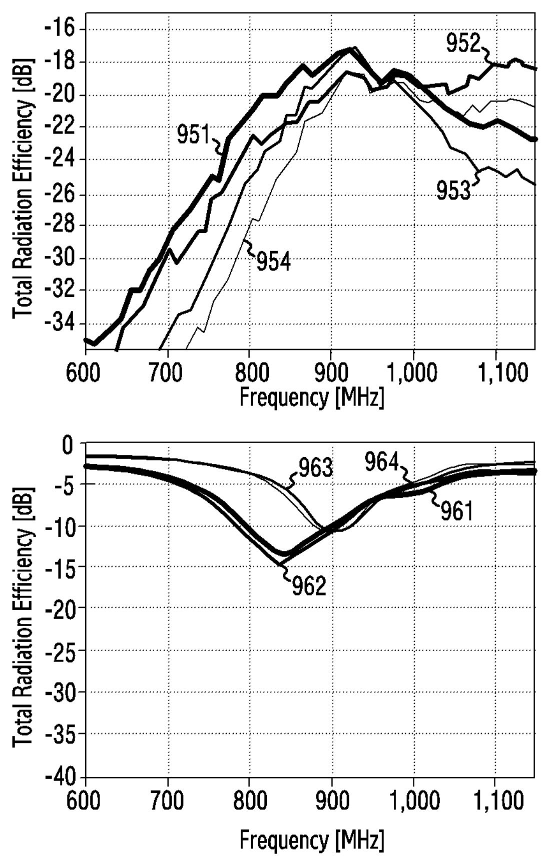

Total Radiation Efficiency [dB]
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
951
952
953
954
600
700
800
900
1,000
1,100
Frequency [MHz]
Total Radiation Efficiency [dB]
0
-5
-10
-15
-20
-25
-30
-35
-40
961
962
963
964
600
700
800
900
1,000
1,100
Frequency [MHz]

FIG.9C

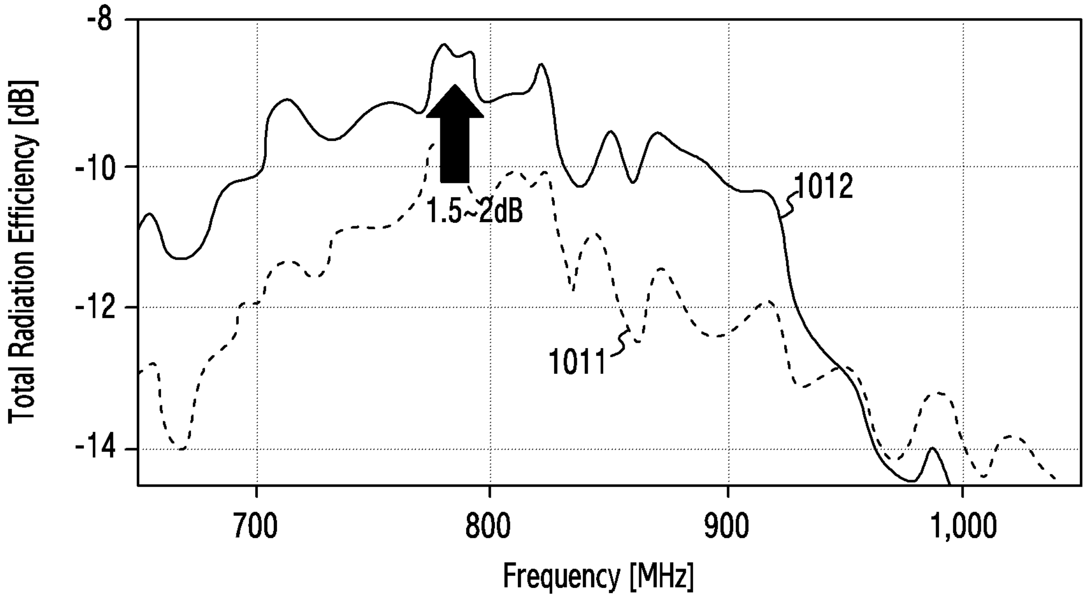



FIG.10A

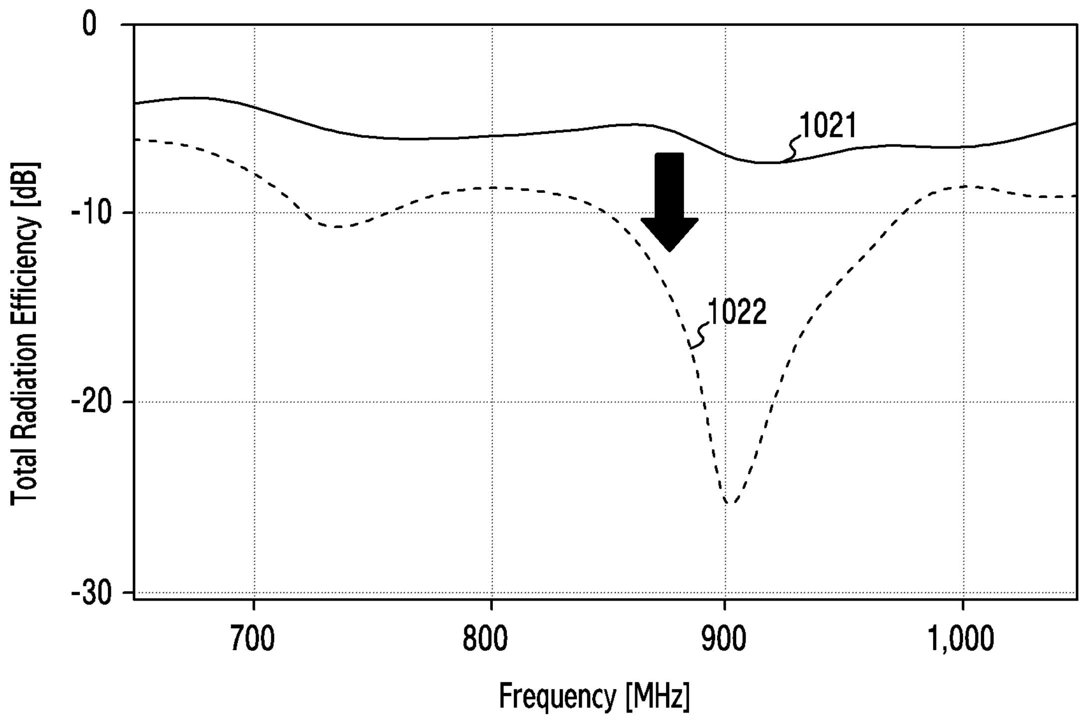



FIG.10B

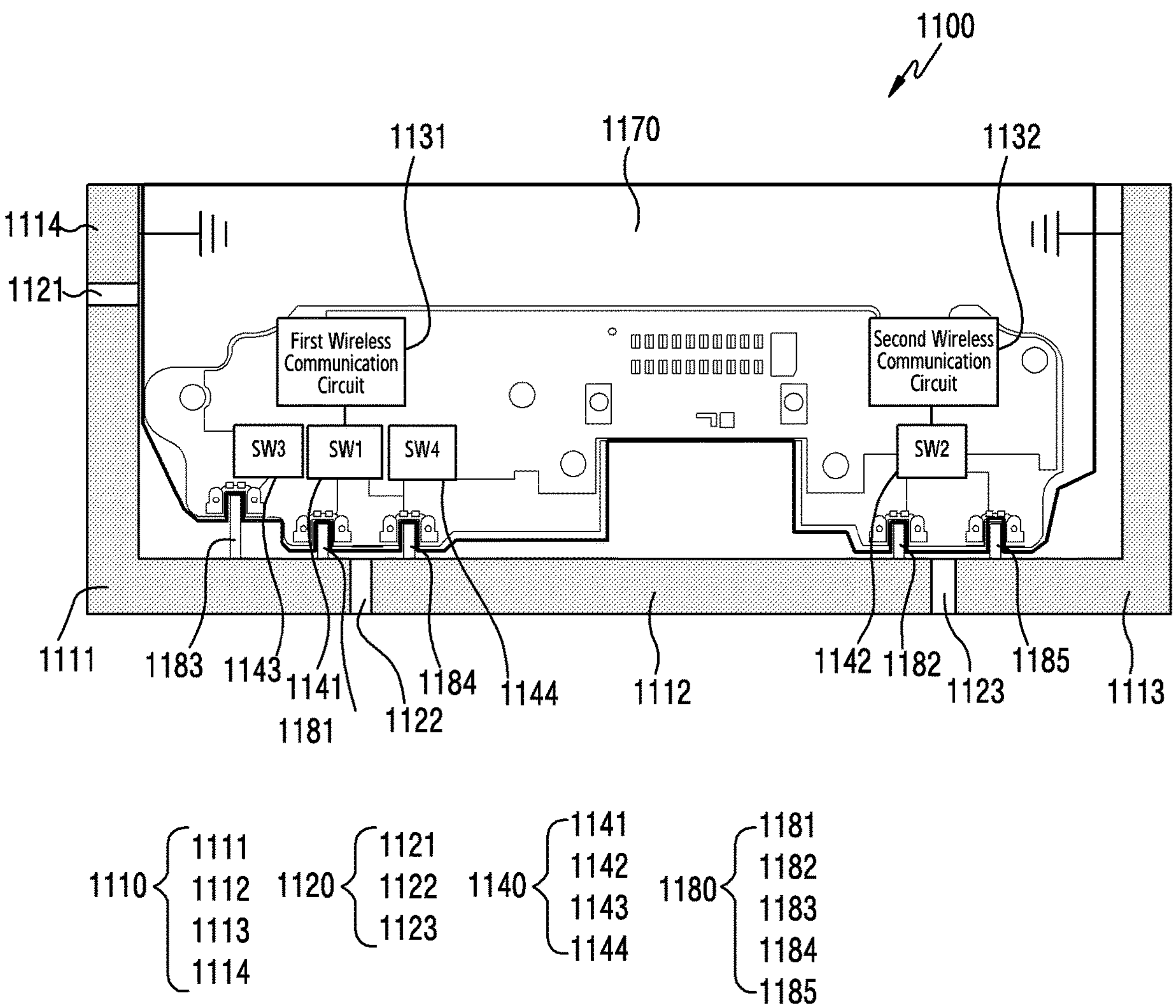

1100
1131
1170
1132
1114
1121
First Wireless Communication Circuit
Second Wireless Communication Circuit
SW3
SW1
SW4
SW2
1111
1183
1143
1141
1181
1122
1184
1144
1112
1142
1182
1123
1185
1113
1110 1111 1112 1113 1114
1120 1121 1122 1123
1140 1141 1142 1143 1144
1180 1181 1182 1183 1184 1185

FIG.11

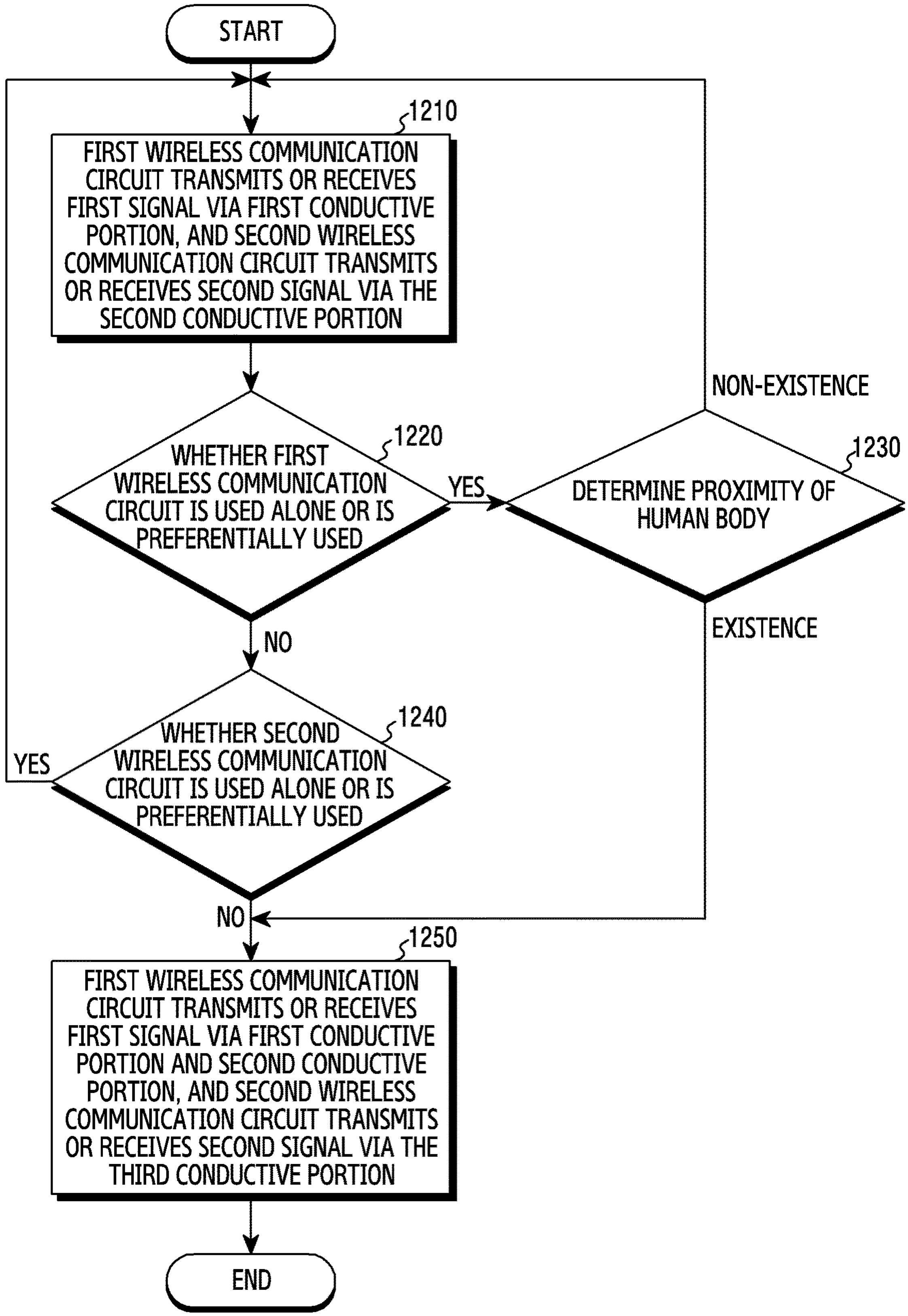

START
1210
FIRST WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES FIRST SIGNAL VIA FIRST CONDUCTIVE PORTION, AND SECOND WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES SECOND SIGNAL VIA THE SECOND CONDUCTIVE PORTION
1220
WHETHER FIRST WIRELESS COMMUNICATION CIRCUIT IS USED ALONE OR IS PREFERENTIALLY USED
YES
1230
DETERMINE PROXIMITY OF HUMAN BODY
NON-EXISTENCE
EXISTENCE
NO
1240
WHETHER SECOND WIRELESS COMMUNICATION CIRCUIT IS USED ALONE OR IS PREFERENTIALLY USED
YES
NO
1250
FIRST WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES FIRST SIGNAL VIA FIRST CONDUCTIVE PORTION AND SECOND CONDUCTIVE PORTION, AND SECOND WIRELESS COMMUNICATION CIRCUIT TRANSMITS OR RECEIVES SECOND SIGNAL VIA THE THIRD CONDUCTIVE PORTION
END

FIG.12

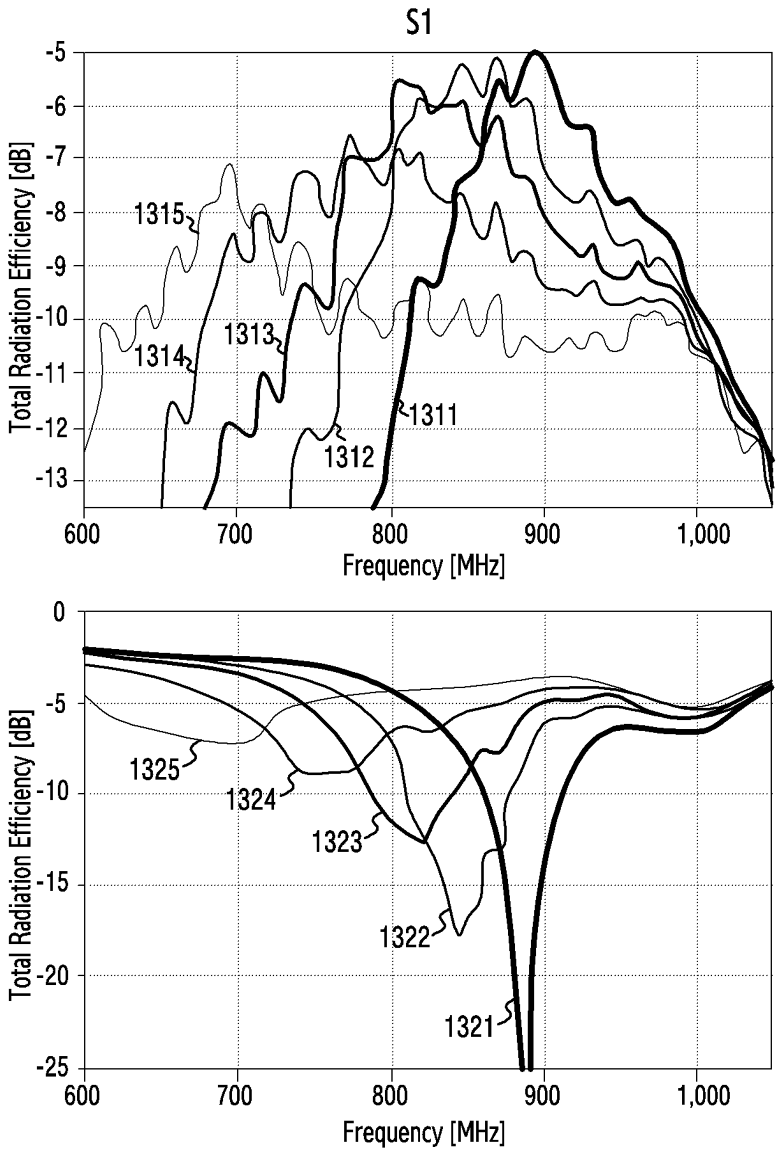

S1
-5
-6
-7
-8
-9
-10
-11
-12
-13
Total Radiation Efficiency [dB]
1315
1314
1313
1312
1311
600
700
800
900
1,000
Frequency [MHz]
0
-5
-10
-15
-20
-25
Total Radiation Efficiency [dB]
1325
1324
1323
1322
1321
600
700
800
900
1,000
Frequency [MHz]

FIG.13A

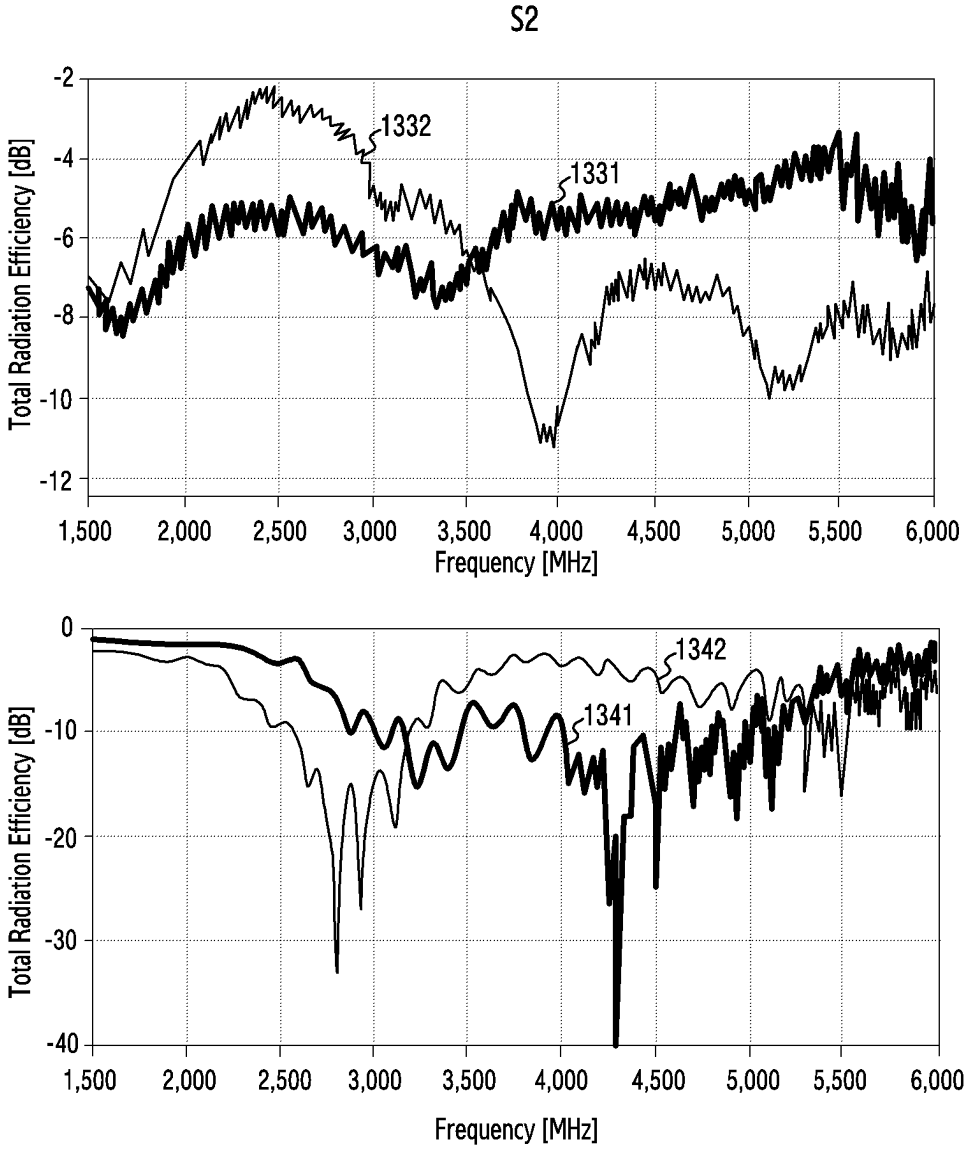

S2
-2
-4
-6
-8
-10
-12
Total Radiation Efficiency [dB]
1332
1331
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
Frequency [MHz]
0
-10
-20
-30
-40
Total Radiation Efficiency [dB]
1342
1341
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
Frequency [MHz]

FIG.13B

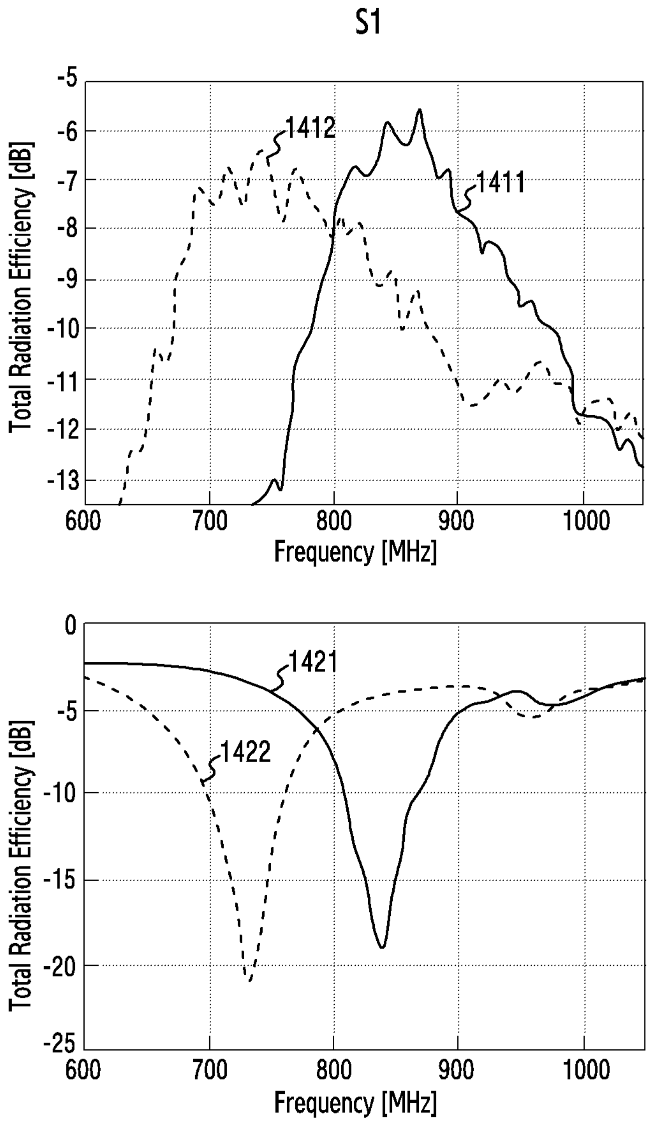

S1
Total Radiation Efficiency [dB]
-5
-6
-7
-8
-9
-10
-11
-12
-13
1412
1411
600
700
800
900
1000
Frequency [MHz]
Total Radiation Efficiency [dB]
0
-5
-10
-15
-20
-25
1421
1422
600
700
800
900
1000
Frequency [MHz]

FIG.14A

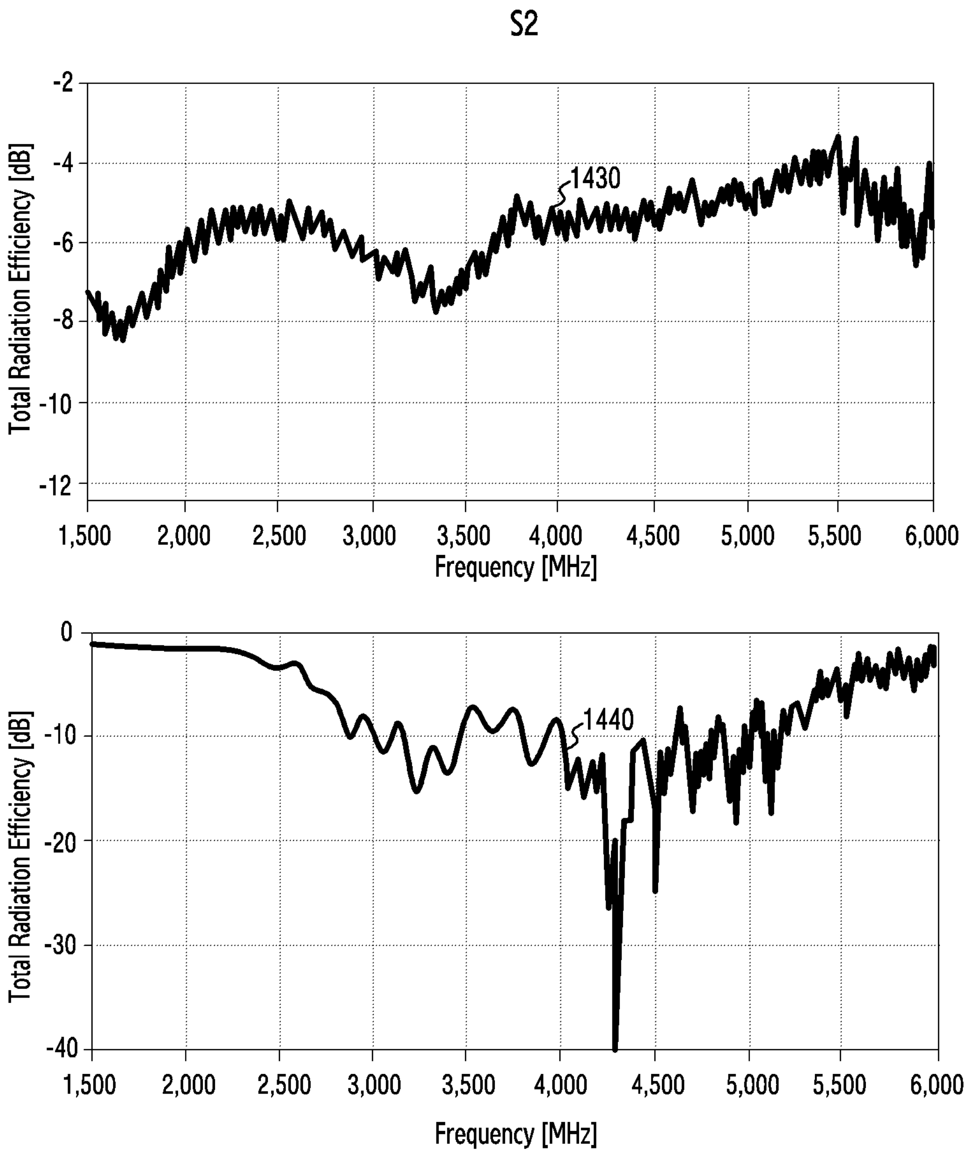

S2
Total Radiation Efficiency [dB]
-2
-4
-6
-8
-10
-12
1430
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
Frequency [MHz]
Total Radiation Efficiency [dB]
0
-10
-20
-30
-40
1440
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
5,500
6,000
Frequency [MHz]

FIG.14B

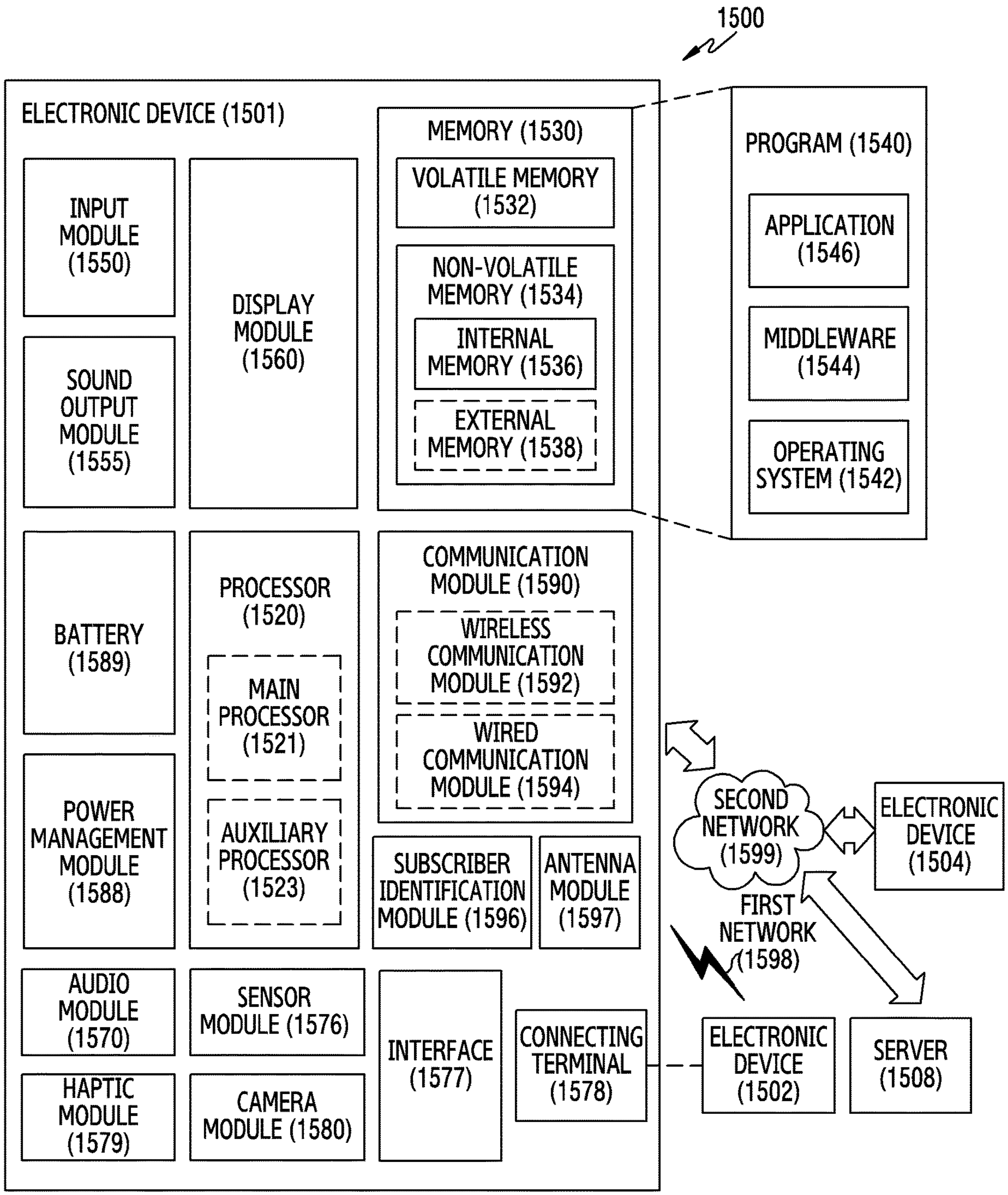

1500
ELECTRONIC DEVICE (1501)
INPUT MODULE (1550)
SOUND OUTPUT MODULE (1555)
DISPLAY MODULE (1560)
MEMORY (1530)
VOLATILE MEMORY (1532)
NON-VOLATILE MEMORY (1534)
INTERNAL MEMORY (1536)
EXTERNAL MEMORY (1538)
PROGRAM (1540)
APPLICATION (1546)
MIDDLEWARE (1544)
OPERATING SYSTEM (1542)
BATTERY (1589)
PROCESSOR (1520)
MAIN PROCESSOR (1521)
AUXILIARY PROCESSOR (1523)
COMMUNICATION MODULE (1590)
WIRELESS COMMUNICATION MODULE (1592)
WIRED COMMUNICATION MODULE (1594)
POWER MANAGEMENT MODULE (1588)
SUBSCRIBER IDENTIFICATION MODULE (1596)
ANTENNA MODULE (1597)
SECOND NETWORK (1599)
ELECTRONIC DEVICE (1504)
FIRST NETWORK (1598)
AUDIO MODULE (1570)
SENSOR MODULE (1576)
INTERFACE (1577)
CONNECTING TERMINAL (1578)
ELECTRONIC DEVICE (1502)
SERVER (1508)
HAPTIC MODULE (1579)
CAMERA MODULE (1580)

FIG.15

# ELECTRONIC DEVICE COMPRISING ANTENNA, AND OPERATION METHOD THEREOF

## CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is a bypass continuation of International Application No. PCT/KR2021/010191, filed on Aug. 4, 2021, which is based on and claims priority to Korean Patent Application No. 10-2020-0097307, filed on Aug. 4, 2020, in the Korean Intellectual Property Office, the disclosures of which are incorporated by reference herein in their entireties.

## BACKGROUND

### 1. Field

The disclosure relates to an antenna for overcoming human body effects and an electronic device including the same.

### 2. Description of Related Art

A portable electronic device such as a portable communication device, a mobile terminal, a mobile communication terminal, or a smart phone may communicate with an external electronic device using a communication circuit and an antenna, or may use a predetermined network to be connected to an external device disposed in a short distance.

Technologies have been developed to increase the rigidity of the electronic device, strengthen the design aspect, and slim down in order to satisfy the purchasing desire of consumers. As part of this trend, an electronic device has been developed to efficiently secure an arrangement space for at least one antenna device, which should be essentially provided for communication among elements, prevent degradation of radiation performance in advance, and achieve excellent performance.

According to various embodiments, an antenna device used in an electronic device may include an Inverted-F Antenna (IFA) or a monopole antenna. In addition, the volume and number of antenna radiators mounted in a portable electronic device may be determined according to the frequency, bandwidth, and type of each communication service. For example, there are differences in frequency by regional groups of the world, but usually a low-band of 600 MHz to 1000 MHz, a mid-band of 1700 MHz to 2200 MHz, a high-band of 2300 MHz to 2700 MHz, and the like are used as major communication bands. Alternatively, an electronic device may use various frequencies for various wireless communication services such as Bluetooth (BT), global navigation satellite system (GNSS), and Wi-Fi.

In order to satisfy all of the above-described communication bands in a limited antenna volume, an electronic device has a practical difficulty in securing all bands with only one antenna. Antennas of an electronic device are designed to be separated into several service bands having similar frequency bands so as to overcome the difficulty.

An electronic device may include a metal member (e.g., a metal bezel, etc.) in the exterior of the electronic device. An electronic device may utilize a metal member forming an exterior as an antenna radiator. For example, when a metal bezel used for an edge of an electronic device is used as an antenna radiator, the electronic device may include a main antenna radiator and at least one coupling antenna radiator, having a segmentation portion made of a dielectric material interposed therebetween. In an electronic device, an electrical gap may be formed by a segmentation portion between a main antenna radiator and a coupling antenna radiator, and thus resonance may be formed in a desired frequency band using the coupling antenna radiator.



However, in a case where a user grips an electronic device to bring the user in contact with a segmentation portion of an antenna, the electronic device may have a problem in that radiation performance of the antenna is significantly deteriorated due to a change in capacitance and an increase in dielectric loss of the segmentation portion.

## SUMMARY

Provided are a device and method for preventing degradation of radiation performance due to a change in capacitance of a bezel portion used as an antenna in an electronic device.

According to an aspect of the disclosure, an electronic device includes a frame structure forming at least a part of a side surface of the electronic device, the side surface surrounding a space between a front surface of the electronic device and a rear surface of the electronic device and including a first edge, a second edge extending from the first edge and perpendicular to the first edge, and a third edge extending from the second edge and parallel to the first edge, and the frame structure including a first insulating portion disposed in the first edge, a second insulating portion disposed in the second edge, a third insulating portion disposed in the second edge, a first conductive portion extending from the first insulating portion to the second edge, a second conductive portion spaced apart from the first conductive portion by the second insulating portion and corresponding to a part of the second edge, a third conductive portion spaced apart from the second conductive portion by the third insulating portion and extending to the third edge; a wireless communication circuit disposed in the space; a first switching circuit configured to connect the wireless communication circuit and at least one of the first conductive portion and the second conductive portion; a second switching circuit configured to connect the wireless communication circuit and at least one of the second conductive portion and the third conductive portion; and a proximity sensor configured to detect a proximity of a human body with respect to the first edge, and the wireless communication circuit is configured to, based on the proximity of the human body being not detected by the proximity sensor, feed power to the first conductive portion via the first switching circuit and feed power to the second conductive portion via the second switching circuit, and based on the proximity of the human body being detected by the proximity sensor, feed power to the first conductive portion and the second conductive portion via the first switching circuit and feed power to the third conductive portion via the second switching circuit.

The electronic device may further include a processor electrically connected to the wireless communication circuit, and a third switching circuit connected to the first conductive portion, and the wireless communication circuit or the processor may be configured to, based on the proximity of the human body being detected by the proximity sensor, control the third switching circuit to change electrical paths related to the first conductive portion.

The wireless communication circuit may be configured to, based on the proximity of the human body being detected by the proximity sensor, feed power to the first conductive

portion and the second conductive portion via the first switching circuit, feed power to the third conductive portion via the second switching circuit, and then release a connection of the wireless communication circuit with the first conductive portion.

The electronic device may further include a processor electrically connected to the wireless communication circuit, and a fourth switching circuit connected to the second conductive portion, and the processor may be configured to control the fourth switching circuit to change electrical paths related to the second conductive portion.

The proximity sensor may be disposed in the space.

The wireless communication circuit may be configured to, based on the proximity of the human body being not detected by the proximity sensor, feed power to the first conductive portion via the first switching circuit, and feed power to the second conductive portion and the third conductive portion via the second switching circuit.

According an aspect of the disclosure, a method of operating an antenna of an electronic device includes detecting proximity of a human body with respect to a first edge of the electronic device, based on the proximity of the human body being not detected, feeding, by a wireless communication circuit of the electronic device, power to a first conductive portion formed in at least a part of the first edge via a first switching circuit of the electronic device and feeding by the wireless communication circuit, power to a second conductive portion spaced apart from the first conductive portion via a second switching circuit of the electronic device, and based on the proximity of the human body being detected, feeding, by the wireless communication circuit, power to the first conductive portion and the second conductive portion via the first switching circuit and feeding, by the wireless communication circuit, power to a third conductive portion spaced apart from the second conductive portion via the second switching circuit.

The method may further include, based on the proximity of the human body being detected, changing electrical paths related to the first conductive portion via a third switching circuit of the electronic device.

The method may further include, based on the proximity of the human body being detected, feeding, by the wireless communication circuit, power to the first conductive portion and the second conductive portion via the first switching circuit, feeding, by the wireless communication circuit, power to the third conductive portion via the second switching circuit, and then releasing a connection of the wireless communication circuit with the first conductive portion.

The method may further include changing electrical paths related to the second conductive portion via a fourth switching circuit of the electronic device.

The method may further include, based on the proximity of the human body being not detected, feeding, by the wireless communication circuit, power to the first conductive portion via the first switching circuit and feeding, by the wireless communication circuit, power to the second conductive portion and the third conductive portion via the second switching circuit.

The method may further include, based on the proximity of the human body being not detected, feeding, by the wireless communication circuit, power to the first conductive portion via the first switching circuit and feeding, by the wireless communication circuit, power to the third conductive portion via the second switching circuit.

The detecting of the proximity of the human body may be performed by a proximity sensor disposed in the electronic device.

The electronic device may further include a second edge extending from the first edge and perpendicular to the first edge, and a third edge extending from the second edge and parallel to the first edge, and the electronic device further include a first insulating portion formed in the first edge, a second insulating portion formed in the second edge and disposed between the first conductive portion and the second conductive portion, and a third insulating portion formed in the second edge and disposed between the second conductive portion and the third conductive portion.

According to an aspect of the disclosure, an electronic device includes a frame structure forming at least a part of the side surface of the electronic device, the side surface surrounding a space between a front surface of the electronic device and a rear surface of the electronic device and including a first edge, a second edge extending from the first edge and perpendicular to the first edge, and a third edge extending from the second edge and parallel to the first edge, and the frame structure including a first insulating portion disposed in the first edge, a second insulating portion disposed in the second edge, a third insulating portion positioned in the second edge, a first conductive portion extending from the first insulating portion to the second edge, a second conductive portion spaced apart from the first conductive portion by the second insulating portion and corresponding to a part of the second edge, a third conductive portion spaced apart from the second conductive portion by the third insulating portion and extending to the third edge; a first wireless communication circuit and a second wireless communication circuit disposed in the space; a first switching circuit configured to connect the first wireless communication circuit and at least one of the first conductive portion and the second conductive portion; a second switching circuit configured to connect the second wireless communication circuit and at least one of the second conductive portion and the third conductive portion; and a proximity sensor configured to detect a proximity of a human body with respect to the first edge, and based on the proximity of the human body being not detected by the proximity sensor, the first wireless communication circuit is configured to feed power to the first conductive portion via the first switching circuit and feed power to the second conductive portion via the second switching circuit, and based on the proximity of the human body being detected by the proximity sensor, the first wireless communication circuit is configured to feed power to the first conductive portion and the second conductive portion via the first switching circuit and the second wireless communication circuit is configured to feed power to the third conductive portion via the second switching circuit.

Based on the proximity of the human body being detected by the proximity sensor, the first wireless communication circuit may be configured to transmit or receive a first signal in a first frequency band via the first conductive portion and the second conductive portion, and the second wireless communication circuit may be configured to transmit or receive a second signal in a second frequency band different from the first frequency band via the third conductive portion.

The electronic device may further include a third switching circuit connected to the first conductive portion and configured to change electrical paths related to the first conductive portion.

The electronic device may further include a fourth switching circuit to the second conductive portion and configured to change electrical paths related to the second conductive portion.

The electronic device may further include a processor electrically connected to the first wireless communication circuit and the second wireless communication circuit, and the processor is configured to determine whether the first wireless communication circuit is used alone or the first wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit is preferentially used to transmit or receive a signal, and based on the first wireless communication circuit being used alone or the first wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit being preferentially used, determine whether the proximity of the human body is detected by the proximity sensor.

The processor may be further configured to, based on the first wireless communication circuit being not used alone or the first wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit being not preferentially used, determine whether the second first wireless communication circuit is used alone or the second wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit is preferentially used to transmit or receive the signal.

## BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. **1**A illustrates an unfolded state of an electronic device according to an embodiment;

FIG. **1**B illustrates a folded state of an electronic device according to an embodiment;

FIG. **2**A illustrates an exploded view and an unfolded state of an electronic device according to an embodiment;

FIG. **2**B illustrates a folded state of the electronic device of FIG. **2**A;

FIG. **3** is a perspective view of an electronic device viewed from one side thereof according to another embodiment;

FIG. **4** illustrates an electronic device including an antenna structure according to an embodiment;

FIG. **5**A to FIG. **5**E illustrate connection relations between a wireless communication circuit and conductive portions according to various embodiments;

FIG. **6** is a flowchart for determining a connection relation between a wireless communication circuit and conductive portions according to an embodiment;

FIG. **7** is a flowchart for changing a connection relation between a wireless communication circuit and conductive portions according to an embodiment;

FIG. **8**A illustrates a switching circuit including internal elements according to an embodiment;

FIG. **8**B illustrates a switching circuit including internal elements according to another embodiment;

FIG. **8**C illustrates a third switching circuit connected to a first conductive portion according to an embodiment;

FIG. **8**D illustrates a fourth switching circuit connected to a second conductive portion according to an embodiment;

FIG. **9**A illustrates results of signal radiation via a wireless communication circuit of an electronic device according to an embodiment;

FIG. **9**B illustrates results of signal radiation via a wireless communication circuit of an electronic device according to another embodiment;

FIG. **9**C illustrates results of signal radiation via a wireless communication circuit of an electronic device according to another embodiment;

FIGS. **10**A and **10**B illustrate results of signal radiation via a wireless communication circuit of an electronic device according to another embodiment;

FIG. **11** illustrates an electronic device including a first wireless communication circuit and a second wireless communication circuit according to an embodiment;

FIG. **12** is a flowchart for determining a connection relation between wireless communication circuits and conductive portions according to an embodiment;

FIG. **13**A illustrates results of signal radiation via a first wireless communication circuit in a first state in which the proximity of a human body is not detected according to an embodiment;

FIG. **13**B illustrates results of signal radiation via a second wireless communication circuit in a first state in which the proximity of a human body is not detected according to an embodiment;

FIG. **14**A illustrates results of signal radiation via a first wireless communication circuit in a second state in which the proximity of a human body is detected according to an embodiment;

FIG. **14**B illustrates results of signal radiation via a second wireless communication circuit in a second state in which the proximity of a human body is detected according to an embodiment; and

FIG. **15** is a block diagram of an electronic device in a network environment according to various embodiments.

## DETAILED DESCRIPTION

FIG. **1**A illustrates an unfolded state of an electronic device **100** according to various embodiments of the disclosure. FIG. **1**B illustrates a folded state of the electronic device **100** of FIG. **1**A according to various embodiments of the disclosure.

Referring to FIG. **1**A, the electronic device **100** may include a pair of housing structures **110** and **120** rotatably coupled via a hinge structure to be folded with respect to each other, a hinge cover **165** configured to cover a foldable portion of the pair of housing structures **110** and **120**, and a display **130** (e.g., a flexible display or a foldable display) disposed in a space formed by the pair of housing structures **110** and **120**. In the disclosure, a surface on which the display **130** is disposed may be defined as a front surface of the electronic device **100**, and the opposite surface of the front surface may be defined as a rear surface of the electronic device **100**. In addition, a surface surrounding a space between the front surface and the rear surface may be defined as a side surface of the electronic device **100**.

In an embodiment, the pair of housing structures **110** and **120** may include a first housing structure **110** including a sensor area **131***d*, a second housing structure **120**, a first rear cover **140**, and a second rear cover **150**. The pair of housing structures **110** and **120** of the electronic device **100** may not be limited by the form and coupling illustrated in FIG. **1**A and FIG. **1**B, and may be implemented by another form or a combination and/or coupling of components. For example, in another embodiment, the first housing structure **110** and the first rear cover **140** may be integrally formed, and the second housing structure **120** and the second rear cover **150** may be integrally formed. According to an embodiment, the first housing structure **110** and the second housing structure **120** may be arranged at opposite sides around a folding axis (axis A), and may have an entirely symmetrical shape with respect to the folding axis (axis A). According to an embodiment, the angle or distance between the first housing structure **110** and the second housing structure **120** may vary according to whether the electronic device **100** is in an unfolded state (flat stage or opening state), a folded state (folding state), or an intermediate state. According to an embodiment, unlike the second housing structure **120**, the first housing structure **110** may additionally include the sensor area **131***d* in which various sensors are arranged, but may have a mutually symmetrical shape in the other areas. In another embodiment, the sensor area **131***d* may be additionally disposed or replaced in at least a partial area of the second housing structure **120**.

In an embodiment, in an unfolded state of the electronic device **100**, the first housing structure **110** may be connected to a hinge structure and may include a first surface **111** disposed to face the front surface of the electronic device **100**, a second surface **112** facing a direction opposite to the first surface **111**, and a first side surface member **113** surrounding at least a part of a space between the first surface **111** and the second surface **112**. In an embodiment, the first side surface member **113** may include a first side surface **113***a* disposed parallel to the folding axis (axis A), a second side surface **113***b* extending from one end of the first side surface **113***a* in a direction perpendicular to the folding axis, and a third side surface **113***c* extending from the other end of the first side surface **113***a* in a direction perpendicular to the folding axis (axis A).

In an embodiment, in an unfolded state of the electronic device **100**, the second housing structure **120** may be connected to a hinge structure (e.g., a hinge structure **160** of FIG. **1**B), and may include a third surface **121** disposed to face the front surface of the electronic device **100**, a fourth surface **122** facing a direction opposite to the third surface **121**, and a second side surface member **123** surrounding at least a part of a space between the third surface **121** and the fourth surface **122**. In an embodiment, the second side surface member **123** may include a fourth side surface **123***a* disposed parallel to the folding axis (axis A), a fifth side surface **123***b* extending from one end of the fourth side surface **123***a* in a direction perpendicular to the folding axis (axis A), and a sixth side surface **123***c* extending from the other end of the fourth side surface **123***a* in a direction perpendicular to the folding axis (axis A). In an embodiment, the third surface **121** may face the first surface **111** in a folded state.

In an embodiment, the electronic device **100** may include a recess **101** configured to receive the display **130** via the structural shape combination of the first housing structure **110** and the second housing structure **120**. The recess **101** may have substantially the same size as the display **130**. In an embodiment, due to the sensor area **131***d*, the recess **101** may have two or more widths different from each other in a direction perpendicular to the folding axis (axis A). For example, the recess **101** may have a first width (W**1**) between a first portion **120***a* parallel to the folding axis (axis A) in the second housing structure **120** and a first portion **110***a* disposed at an edge of the sensor area **131***d* in the first housing structure **110**, and a second width (W**2**) configured by a second portion **110***b* of the second housing structure **110** and a second portion **110***b* parallel to the folding axis (axis A) in the first housing structure **110** while the second portion **110***b* does not correspond to the sensor area **113***d*. The second width (W**2**) may be configured longer than the first width (W**1**). For example, the recess **101** may be configured to have the first width (W**1**) formed from the first portion **110***a* of the first housing structure **110** having a mutually asymmetrical shape to the first portion **120***a* of the second housing structure **120** and a second width (W**2**) formed from the second portion **110***b* of the first housing structure **110** having a mutually symmetrical shape to the second portion **120***b* of the second housing structure **120**. In an embodiment, the first portion **110***a* and the second portion **110***b* of the first housing structure **110** may be configured to have distances, which are different from each other, from the folding axis (axis A). The width of the recess **101** is not limited by the illustrated example. In various embodiments, the recess **101** may have one or more widths different from each other by the form of the sensor area **113***d* or a portion, which has an asymmetrical shape, of the first housing structure **110** and the second housing structure **120**.

In an embodiment, at least a part of the first housing structure **110** and the second housing structure **120** may be configured of a metal material or a non-metal material having a rigidity of the magnitude selected to support the display **130**.

In an embodiment, the sensor area **131***d* may be disposed adjacent to one side corner of the first housing structure **110** to have a predetermined area. The arrangement, shape, or size of the sensor area **131***d* is not limited to the shown example. For example, in another embodiment, the sensor area **131***d* may be provided in another corner of the first housing structure **110** or in an arbitrary area between an upper end corner of the first housing structure **110** and a lower end corner of the first housing structure **110**. In another embodiment, the sensor area **131***d* may be disposed in at least a partial area of the second housing structure **120**. In another embodiment, the sensor area **231***d* may be disposed in a first housing **211** or be disposed to extend to the first housing **211**. In an embodiment, the electronic device **200** may be components configured to perform various functions arranged to be exposed to the front surface of the electronic device **100** via a sensor area **213***d* or via one or more openings provided in the sensor area **131***d*. In various embodiments, the components may include, for example, at least one among a front camera device, a receiver, a proximity sensor, an illuminance sensor, an iris recognition sensor, an ultrasonic sensor, or an indicator.

In an embodiment, the first rear cover **140** may be disposed on the second surface **112** of the first housing structure **110** and may have a substantially rectangular periphery. In an embodiment, at least a part of the periphery may be surrounded by the first housing structure **110**. Similarly, the second rear cover **150** may be disposed on the fourth surface **122** of the second housing structure **120**, and at least a part of the periphery may be surrounded by the second housing structure **120**.

In the shown embodiment, the first rear cover **140** and the second rear cover **150** may have a substantially symmetrical shape based on the folding axis (axis A). In another embodiment, the first rear cover **140** and the second rear cover **150** may include various shapes different from each other. In another embodiment, the first rear cover **140** may be integrally disposed with the first housing structure **110**, and the second rear cover **150** may be integrally disposed with the second housing structure **120**.

In an embodiment, the first rear cover **140**, the second rear cover **150**, the first housing structure **110**, and the second housing structure **120** may provide, via a structure coupled to each other, a space in which various components (e.g., a printed circuit board, an antenna module, a sensor module, or a battery) of the electronic device **100** may be arranged. In an embodiment, one or more components may be arranged or visually exposed on the rear surface of the electronic device **100**. For example, one or more components or sensors may be visually exposed via a first rear area **141** of the first rear cover **140**. In various embodiments, the sensors may include a proximity sensor, a rear surface camera device, and/or a flash. In another embodiment, at least a part of a sub display **152** may be visually exposed via a second rear area **151** of the second rear cover **150**. The display **130** may be disposed in a space formed by the foldable housing structures **110** and **120**. For example, the display **130** may be stably seated in a recess formed by the pair of housing structures **110** and **120**, and may be disposed to substantially occupy most of the front surface of the electronic device **100**. Therefore, the front surface of the electronic device **100** may include the display **130** and a partial area (e.g., a peripheral area) of the first housing structure **110**, adjacent to the display **130**, and a partial area (e.g., a peripheral area) of the first housing structure **110**. In an embodiment, the rear surface of the electronic device **100** may include the first rear cover **140**, a partial area (e.g., a peripheral area) of the first housing structure **110** adjacent to the first rear cover **140**, the second rear cover **150**, and a partial area (e.g., a peripheral area) of the first housing structure **110** adjacent to the second rear cover **150**.

In an embodiment, the display **130** may refer to a display in which at least a partial area may be transformed into a flat surface or a curved surface. In an embodiment, the display **130** may include a folding area **131***c*, a first area **131***a* disposed at one side (e.g., a right area of the folding area **131***c*) based on the folding area **131***c*, and a second area **131***b* disposed at the other side (e.g., a left area of the folding area **131***c*). For example, the first area **131***a* may be disposed on the first surface **111** of the first housing structure **110**, and the second area **131***b* may be disposed on the third surface **121** of the first housing structure **110**. In an embodiment, the area division of the display **130** is exemplary, and the display **130** may be divided into a plurality (four or more, or one) of areas according to the structure or function thereof. As an example, in the embodiment shown in FIG. **1**A, the area of the display **130** may be divided by the folding axis (axis A) or the folding area **131***c* extending parallel to they axis, but in another embodiment, the area of the display **130** may be divided based on another folding axis (e.g., the folding axis parallel to the x axis) or another folding area (e.g., the folding area parallel to the x axis). The area division of the display described above is only a physical division by the pair of housing structures **110** and **120** and the hinge structure, and substantially, the display **130** may be displayed as one full screen via the pair of housing structures **110** and **120** and the hinge structure (e.g., a hinge structure **160** of FIG. **1**B). In an embodiment, the first area **131***a* and the second area **131***b* may have an entirely symmetrical shape around the folding area **131***c*. Unlike the second area **131***b*, the first area **131***a* may include a cut notch area (e.g., a notch area of FIG. **3**) depending on the presence of the sensor area **131***d*, but may have a shape symmetrical to the second area **131***b* in the other area. For example, the first area **131***a* and the second area **131***b* may include a portion having a shape symmetrical to each other and a portion having a shape asymmetrical to each other.

Referring to FIG. **1**B, the hinge cover **165** may be configured to be disposed between the first housing structure **110** and the second housing structure **120** to cover internal components (e.g., the hinge structure **160** of FIG. **1**B). In an embodiment, the hinge cover **165** may be covered by a part of the first housing structure **110** and the second housing structure **120** or be exposed to the outside, according to the operation state (an unfolded state (flat state) or a folded state) of the electronic device **100**.

As an example, as shown in FIG. **1**A, in a case where the electronic device **100** is in an unfolded state, the hinge cover **165** may be covered by the first housing structure **110** and the second housing structure **120**, and thus may not be exposed. As an example, as shown in FIG. **1**B, in a case where the electronic device **100** is in a folded state (e.g., a completely folded state), the hinge cover **165** may be exposed to the outside between the first housing structure **110** and the second housing structure **120**. In an embodiment, the hinge cover **165** may include a curved surface.

Hereinafter, the operations of the first housing structure **110** and the second housing structure **120** and each area of the display **130** according to the operation state (e.g., an unfolded state (flat state) and a folded state (folded state)) of the electronic device **100** are described. In an embodiment, in a case where the electronic device **100** is in an unfolded state (flat state) (e.g., the state of FIG. **1**A), the first housing structure **110** and the second housing structure **120** form an angle of 180 degrees, and the first area **131***a* and the second area **131***b* of the display may be arranged to face the same direction. In addition, the folding area **131***c* may form the same plane as the first area **131***a* and the second area **131***b*.

In an embodiment, in a case where the electronic device **100** is in a folded state (e.g., the state of FIG. **1**B), the first housing structure **110** and the second housing structure **120** may be arranged to face each other. The first area **131***a* and the second area **131***b* of the display **130** may form a narrow angle (e.g., between 0 degree and 10 degrees) with each other, and may face each other. At least a part of the folding area **131***c* may be formed as a curved surface having a predetermined curvature.

In an embodiment, in a case where the electronic device **100** is in an intermediate state, the first housing structure **110** and the second housing structure **120** may be arranged to form a certain angle with each other. The first area **131***a* and the second area **131***b* of the display **130** may form an angle greater than that in a folded state and smaller than that in an unfolded state. At least a part of the folding area **131***c* may be formed as a curved surface having a predetermined curvature, and the curvature of the curved surface may be smaller than that in a folded state.

FIG. **2**A illustrates an exploded view and an unfolded state of an electronic device according to an embodiment. FIG. **2**B illustrates a folded state of the electronic device of FIG. **2**A.

FIG. **2**A illustrates an exploded view and an unfolded state of an electronic device **200** according to an embodiment, and FIG. **2**B illustrates a folded state of the electronic device **200** of FIG. **2**A.

Referring to FIG. **2**A and FIG. **2**B, the electronic device **200** according to an embodiment may include a foldable housing **210** (or "housing") including a first housing **211** and a second housing **212**, a first side surface member **220**, a second side surface member **230**, a flexible display **240**, a connection structure **250**, and/or a cover **260** (or "rear cover").

According to an embodiment, the first housing **211** and the second housing **212** may form an inner space in which electronic components included in the electronic device **200** may be arranged. In an embodiment, a plurality of electronic components configured to perform various functions of the electronic device **200** may be arranged in the inner space of the first housing **211** and the second housing **212**. For example, electronic components such as a front surface camera, rear surface cameras **214** and **215**, an interface, a receiver, or a sensor module may be arranged in the inner space of the first housing **211** and the second housing **212**. According to an embodiment, a part of the electronic components may be viewed in the front surface of the electronic device **200** via at least one opening or recess arranged on the flexible display **240**.

In an example (e.g., see FIG. **2**A), when the electronic device **200** is in an unfolded state, the first housing **211** and the second housing **212** may be arranged parallel to each other. In another example (e.g., see FIG. **4**), when the electronic device **200** is in a folded state, the first housing **211** may rotate (or pivot) with respect to the second housing **212** via the connection structure **250**, and as a result, one surface of the first housing **211** and one surface of the second housing **212** may be arranged to face each other.

According to an embodiment, a recess configured to receive the flexible display **240** may be disposed in the first housing **211** and the second housing **212**. For example, the flexible display **240** may be stably seated in the recess to be supported by the first side surface member **220** and/or the second side surface member **230** arranged between the flexible display **240** and the first housing **211** and the second housing **212**.

According to an embodiment, the first side surface member **220** may form a side surface of the first housing **211** of the foldable housing **210**. In an example, the first side surface member **220** may include a first structure **220-1** forming a side surface of the first housing **211** and/or a second structure **220-2** which provide a space in which electronic components arranged in the first housing **211** are to be arranged. In an example, the first structure **220-1** of the first side surface member **220** may include a plurality of conductive portions (e.g., **220***a*, **220***b*, **220***c*, **220***d*, and **220***e*) having conductivity and a plurality of non-conductive portions (e.g., **220***f*, **220***g*, **220***h*, **220***i*, and **220***j*) (or "segmented areas") arranged among the plurality of conductive portions. Some of the plurality of non-conductive portions may be omitted. In an embodiment, the first structure **220-1** and the second structure **220-2** may be integrally arranged or coupled to be arranged. As another example, the first structure **220-1** and the second structure **220-2** may include the same material or include materials different from each other.

In an example, the first structure **220-1** of the first side surface member **220** may include a first conductive portion **220***a* disposed on an upper end (e.g., the +y direction of FIG. **2**A) of the side surface of the first housing **221**, a second conductive portion **220***b* disposed in an area adjacent to one right end (e.g., the +x direction of FIG. **2**A) of the first conductive portion **220***a*, a third conductive portion **220***c* disposed in an area adjacent to one left end (e.g., the −x direction of FIG. **2**A) of the first conductive portion **220***a*, a fourth conductive portion **220***d* adjacent to the second conductive portion **220***b* and disposed on the right side surface (e.g., a side surface in the +x direction of FIG. **2**A) of the first housing **211**, and/or a fifth conductive portion **220***e* adjacent to the third conductive portion **220***c* and disposed on the left side surface (e.g., a side surface in the −x direction of FIG. **2**A) of the first housing **211**.

In another example, the plurality of non-conductive portions may include a first non-conductive portion **220***f* disposed between the first conductive portion **220***a* and the second conductive portion **220***b*, a second non-conductive portion **220***g* disposed between the first conductive portion **220***a* and the third conductive portion **220***c*, a third non-conductive portion **220***h* disposed between the second conductive portion **220***b* and the fourth conductive portion **220***d*, a fourth non-conductive portion **220***i* disposed between the third conductive portion **220***c* and one end of the fifth conductive portion **220***e*, and/or a fifth non-conductive portion **220***j* disposed at the other end of the fifth conductive portion **220***e*. The plurality of non-conductive portions described above may be arranged among the first conductive portion **220***a*, the second conductive portion **220***b*, the third conductive portion **220***c*, the fourth conductive portion **220***d*, and/or the fifth conductive portion **220***e* to insulate the plurality of conductive portions, and accordingly, the first structure **220-1** of the first side surface member **220** may be segmented into five areas. The electronic device **200** according to an embodiment may use at least one among the first conductive portion **220***a*, the second conductive portion **220***b*, the third conductive portion **220***c*, the fourth conductive portion **220***d*, and the fifth conductive portion **220***e*, which are insulated, as an antenna radiator. In an example, the plurality of non-conductive portions may be filled with a non-conductive material such as synthetic resin.

In an example, the second structure **220-2** of the first side surface member **220** may be configured of a non-metal material and/or a metal material having a predetermined rigidity so as to support the electronic components (e.g., the flexible display **240** and a printed circuit board). In an example, at least a partial area (e.g., a first area **240***a*) of the flexible display **240** may be disposed on one surface (e.g., a surface in the +z direction of FIG. **2**A) of the second structure **220-2**, a printed circuit board may be disposed on another surface (e.g., a surface in the −z direction of FIG. **2**A) facing a direction opposite to the one surface.

According to an embodiment, the second side surface member **230** may form a side surface of the second housing **212** of the foldable housing **210**. In an example, the second side surface member **230** may include a third structure **230-1** forming a side surface of the second housing **212** and a fourth structure **230-2** configured to provide a space in which electronic components arranged in the second housing **212** are to be arranged. In an example, the third structure **230-1** of the second side surface member **230** may include a plurality of conductive portions (e.g., **230***a*, **230***b*, **230***c*, **230***d*, and **230***e*) having conductivity, and a plurality of non-conductive portions (e.g., **230***f*, **230***g*, **230***h*, **230***i*, and **230***j*) (or "segmented areas") arranged among the plurality of conductive portions. In an embodiment, the third structure **230-1** and the fourth structure **230-2** may be integrally formed or coupled to be arranged. As another example, the third structure **230-1** and the fourth structure **230-2** may include the same material or materials different from each other.

In an example, the third structure **230-1** of the second side surface member **230** may include a sixth conductive portion **230***a* disposed at a lower end (e.g., the −y direction of FIG. **2**A) of a side surface of the second housing **212**, a seventh conductive portion **230***b* disposed in an area adjacent to one end of a right side (e.g., the +x direction of FIG. **2**A) of the sixth conductive portion **230***a*, an eighth conductive portion **230***c* disposed in an area adjacent to one end of a left side (e.g., the −x direction of FIG. **2**A) of the sixth conductive portion **230***a*, a ninth conductive portion **230***d* adjacent to the seventh conductive portion **230***b* disposed at a right side surface (e.g., a side surface in the +x direction of FIG. **2**A) of the second housing **212**, and/or a tenth conductive portion **230***e* adjacent to the eighth conductive portion **230***c* and disposed at a left side surface (e.g., a side surface in the −x direction of FIG. **2**A) of the second housing **212**.

In another example, the plurality of non-conductive portions may include a sixth non-conductive portion **230***f* disposed between the sixth conductive portion **230***a* and the seventh conductive portion **230***b*, a seventh non-conductive portion **230***g* disposed between the sixth conductive portion **230***a* and the eighth conductive portion **230***c*, an eighth non-conductive portion **230***h* disposed between the seventh conductive portion **230***b* and the ninth conductive portion **230***d*, a ninth non-conductive portion **230***i* disposed between the eighth conductive portion **230***c* and one end of the tenth conductive portion **230***e*, and/or a tenth non-conductive portion **230***j* disposed at the other end of the tenth conductive portion **230***e*. The plurality of non-conductive portions described above are arranged among the sixth conductive portion **230***a*, the seventh conductive portion **230***b*, the eighth conductive portion **230***c*, the ninth conductive portion **230***d*, and/or the tenth conductive portion **230***e* to insulate the plurality of conductive portions, and accordingly, the third structure **230-1** of the second side surface member **230** may be segmented into five areas. The electronic device **200** according to an embodiment may use at least one among the sixth conductive portion **230***a*, the seventh conductive portion **230***b*, the eighth conductive portion **230***c*, the ninth conductive portion **230***d*, and the tenth conductive portion **230***e*, which are insulated, as an antenna radiator.

According to an embodiment, when the electronic device **200** is in a folded state, the first conductive portion **220***a* of the first side surface member **220** may be disposed at a position corresponding to the sixth conductive portion **230***a* of the second side surface member **230**, and the second conductive portion **220***b* of the first side surface member **220** may be disposed at a position corresponding to the seventh conductive portion **230***b* of the second side surface member **230**. According to an embodiment, when the electronic device **200** is in a folded state, the third conductive portion **220***c* may be disposed at a position corresponding to the eighth conductive portion **230***c*, the fourth conductive portion **220***d* may be disposed at a position corresponding to the ninth conductive portion **230***d*, and the fifth conductive portion **220***e* may be disposed at a position corresponding to the tenth conductive portion **230***e*. The electronic device **200** according to an embodiment may reduce interference among the plurality of conductive portions used as an antenna radiator via the above-described arrangement structure.

In an example, the fourth structure **230-2** of the second side surface member **230** may be formed of a non-metal material and/or a metal material having a predetermined rigidity so as to support the electronic components (e.g., the flexible display **240** and a printed circuit board). In an example, at least a partial area (e.g., a second area **240***b*) of the flexible display **240** may be disposed on one surface (e.g., a surface in the +z direction of FIG. **2**A) of the fourth structure **230-2**, and a printed circuit board may be disposed on another surface (e.g., a surface in the −z direction of FIG. **2**A) facing a direction opposite to the one surface.

According to an embodiment, the flexible display **240** may be disposed in the first housing **211** and the second housing **212** to configure a front surface (e.g., a surface in the +z direction of FIG. **3**) of the electronic device **200** when the electronic device **200** is in an unfolded state. For example, the flexible display **240** may be disposed to extend from one area of the first housing **211** to at least one area of the second housing **212** across the connection structure **250**. According to an embodiment, the flexible display **240** may be stably seated in a recess formed by the first housing **211** and the second housing **212** to be disposed in the first housing **211** and the second housing **212**.

In an example, the flexible display **240** may include a first area **240***a* corresponding to at least one area of the first housing **211**, a second area **240***b* corresponding to at least one area of the second housing **212**, or a folding area **240***c* positioned between the first area **240***a* and the second area **240***b* and having flexible characteristics. The flexible display **240** is not limited to the above-described embodiment, and according to another embodiment, at least one among the first area **240***a*, the second area **240***b*, or the folding area **240***c* of the flexible display **240** may be configured to have flexible characteristics. In an example, when the electronic device **200** is in an unfolded state, the first area **240***a*, the folding area **240***c*, and the second area **240***b* may be arranged in parallel to face the same direction (e.g., the +z direction of FIG. **3**). As another example, when the electronic device **200** is in a folding state, at least a part of the folding area **240***c* may be disposed to be bended to allow the first area **240***a* and the second area **240***b* to face each other.

According to an embodiment, the connection structure **250** may connect the first housing **211** and the second housing **212**. Accordingly, the second housing **212** may rotate with respect to the first housing **211** within a designated rotation range, or on the contrary, the first housing **211** may rotate with respect to the second housing **212** within a designated rotation range. In an example, a recess is disposed in an area in which the first housing **211** and the second housing **212** are connected to allow the connection structure **250** to be disposed between the first housing **211** and the second housing **212**. As an example, the above-described recess may be disposed in a groove shape having a predetermined curvature, but is not limited thereto.

According to an embodiment, the connection structure **250** may be a hinge assembly. In an example, the hinge assembly may include at least one hinge structure **250***a* and **250***b* and a hinge housing **250***c*. The at least one hinge structure **250***a* and **250***b* may include a plurality of gears, a plurality of gear shafts, and/or a plurality of rotational side surface members (brackets), and may be connected to the first housing **211** and/or the second housing **212** to allow the first housing **211** and/or the second housing **212** to rotate within a designated rotation range. As an embodiment, the hinge housing **240***c* may be exposed to the outside of the electronic device **200** or be covered by the foldable housing **210**, depending on the state of the electronic device **200**. In an example (e.g., see FIG. **2**A), when the electronic device **200** is in an unfolded state, the hinge housing **240***c* may be covered by the foldable housing **210** to be prevented from being exposed to the outside of the electronic device **200**. In another example (e.g., see FIG. **2**B), when the electronic device **200** is in a folded state, the hinge housing **240***c* may be exposed to the outside of the electronic device **200** by the rotation of the first housing **211** and the second housing **212**.

According to an embodiment, the cover **260** may be disposed at lower ends (e.g., the −z direction of FIG. **2**A) of the first housing **211** and the second housing **212** to form a rear surface of the electronic device **200**. As an example, the cover **260** may include a first cover **261** coupled to a lower end (e.g., the −z direction of FIG. **2**A) of the first housing **211**, and a second cover **262** coupled to a lower end of the second housing **212**. As another example, the first cover **261** and the first housing **211** may be integrally formed. As still another example, the second cover **262** and the second housing **212** may be integrally formed.

The electronic device **200** according to an embodiment may further include a sensor module, a key input device **213**, camera modules **214**, **215**, and **216**, and/or a connector hole **217**.

According to an embodiment, the key input device **213** may be disposed on at least one side surface of the foldable housing **210**. As an example (e.g., see FIG. **2**B), the key input device **213** may be disposed on one side surface of the first housing **211**. In another example, the key input device **317** may be disposed on one side surface of the second housing **212**. In another embodiment, the electronic device **200** may not include a part or all of the above-described key input device **213**, and the key input device **213**, which is not included, may be implemented on the flexible display **240** in another form such as a soft key.

According to an embodiment, the camera modules **214**, **215**, and **216** may include a first camera device (or "front camera") facing the flexible display **240**, second camera devices **214** and **215** (or "rear camera") arranged on the cover **260**, and/or a flash **216**. For example, the camera devices **214** and **215** may include at least one lens, an image sensor, and/or an image signal processor. For example, the flash **216** may include a light emitting diode or a xenon lamp.

According to an embodiment, the connector hole **217** may receive a connector configured to transmit/receive power and/or data to/from an external electronic device, and/or a connector configured to transmit/receive an audio signal to/from the external electronic device. For example, the connector hole **217** may include a USB connector or an earphone jack (or "earphone interface").

FIG. **3** is a perspective view of an electronic device **300** viewed from one side of the electronic device **300** according to another embodiment. FIG. **3** illustrates the electronic device **300** of a bar type.

Referring to FIG. **3**, the electronic device **300** according to another embodiment may include a housing **310**, an audio module **313**, a camera module **315**, a key input device **317**, a connector hole **318**, and/or a display **330**.

According to an embodiment, the housing **310** may include a first surface (or a front surface) **310**A, a second surface (or a rear surface) **310**B, and a side surface (or a side wall) **310**C configured to surround a space between the first surface **310**A and the second surface **310**B. According to another embodiment, the housing **310** may refer to a structure forming at least a part among the first surface **310**A, the second surface **310**B, and/or the side surface **310**C of FIG. **3**.

According to an embodiment, the first surface **310**A may be configured by a front plate **302** (e.g., a polymer plate or a glass plate including various coating layers) of which at least a part is substantially transparent. According to an embodiment, the front plate **302** may include a curved surface portion which extends seamlessly by being bended toward the rear plate from the first surface **310**A in at least one side edge portion.

According to an embodiment, the second surface **310**B may be configured by a substantially opaque rear plate. In an example, the rear plate may be configured of coated or tinted glass, ceramic, polymer, metal (e.g., aluminum, stainless steel (STS), or magnesium), or a combination of at least two of the above-described materials. According to an embodiment, the rear plate may include a curved surface portion which extends seamlessly by being bended toward the front plate **302** from the second surface **310**B in at least one side edge portion.

According to an embodiment, the side surface **310**C may be coupled to the front plate **302** and the rear plate and may be configured by the side surface member **320** including metal and/or polymer. According to another embodiment, the rear plate and the side surface member **320** may be integrally formed and include the same material (e.g., a metal material such as aluminum).

According to an embodiment, the side surface member **320** may include a plurality of conductive portions (e.g., **320***a*, **320***b*, **320***c*, **320***d*, **320***e*, **330***a*, **330***b*, **330***c*, **330***d*, and **330***e*) having conductivity and/or a plurality of non-conductive portions (e.g., **320***f*, **320***g*, **320***h*, **320***i*, **320***j*, **330***f*, **330***g*, **330***h*, **330***i*, and **330***j*) (or "segmented areas") arranged among the plurality of conductive portions.

In an example, the plurality of conductive portions may include a first conductive portion **320***a* disposed on an upper end of a side surface (e.g., a side surface in the +y direction of FIG. **3**) of the housing **310**, a second conductive portion **320***b* disposed in an area adjacent to a right end (e.g., the +x direction of FIG. **3**) of the first conductive portion **320***a*, a third conductive portion **320***c* disposed in an area adjacent to a left end (e.g., the −x direction of FIG. **3**) of the first conductive portion **320***a*, a fourth conductive portion **320***d* adjacent to the second conductive portion **320***b* and disposed on a right side surface (e.g., a side surface in the +x direction of FIG. **3**) of the housing **310**, and/or a fifth conductive portion **320***e* adjacent to the third conductive portion **320***c* and disposed on a left side surface (e.g., a side surface in the −x direction of FIG. **3**) of the housing **310**.

In another example, the plurality of conductive portions may include a sixth conductive portion **330***a* disposed on a lower end of a side surface (e.g., a side surface in the −y direction of FIG. **3**) of the housing **310**, a seventh conductive portion **330***b* disposed in an area adjacent to a right end (e.g., the +x direction of FIG. **3**) of the sixth conductive portion **330***a*, an eighth conductive portion **330***c* disposed in an area adjacent to a left end (e.g., the −x direction of FIG. **3**) of the sixth conductive portion **330***a*, a ninth conductive portion **330***d* adjacent to the seventh conductive portion **330***b* and/or the fourth conductive portion **320***d* and disposed on a right side surface (e.g., a surface in the +x direction of FIG. **3**) of the housing **310**, and/or a tenth conductive portion **330***e* adjacent to the eighth conductive portion **330***c* and/or the fifth conductive portion **320***e* and disposed on a left side surface (e.g., a surface in the −x direction of FIG. **3**) of the housing **310**.

In an example, the plurality of non-conductive portions may include a first non-conductive portion **320***f* disposed between the first conductive portion **320***a* and the second conductive portion **320***b*, a second non-conductive portion **320***g* disposed between the first conductive portion **320***a* and the third conductive portion **320***c*, a third non-conductive portion **320***h* disposed between the second conductive portion **320***b* and the fourth conductive portion **320***d*, a fourth non-conductive portion **320***i* disposed between the third conductive portion **320***c* and one end of the fifth conductive portion **320***e*, and/or a fifth non-conductive portion **320***j* disposed at the other end of the fifth conductive portion **320***e*.

In another example, the plurality of non-conductive portions may include a sixth non-conductive portion **330***f* disposed between the sixth conductive portion **330***a* and the seventh conductive portion **330***b*, a seventh non-conductive portion **330***g* disposed between the sixth conductive portion **330***a* and the eighth conductive portion **330***c*, an eighth non-conductive portion **330***h* disposed between the seventh conductive portion **330***b* and the ninth conductive portion **330***d*, a ninth non-conductive portion **330***i* disposed between the eighth conductive portion **330***c* and one end of the tenth conductive portion **330***e*, and/or a tenth non-conductive portion **330***j* disposed at the other end of the tenth conductive portion **330***e*.

According to an embodiment, the plurality of non-conductive portions may be filled with a non-conductive material such as synthetic resin. In an example, the plurality of non-conductive portions (e.g., the first non-conductive portion **320***f*, the second non-conductive portion **320***g*, the third non-conductive portion **320***h*, the fourth non-conductive portion **320***i*, and the fifth non-conductive portion **320***j*) may be arranged among the first conductive portion **320***a*, the second conductive portion **320***b*, the second conductive portion **320***c*, the fourth conductive portion **320***d*, and/or the fifth conductive portion **320***e* to insulate the plurality of conductive portions, and accordingly, the upper end area (e.g., an area in the +y direction of FIG. **3**) of the side surface member **320** may be segmented into five areas. In another example, the plurality of non-conductive portions (e.g., the sixth non-conductive portion **330***f*, the seventh non-conductive portion **330***g*, the eighth non-conductive portion **330***h*, the ninth non-conductive portion **330***i*, and the tenth non-conductive portion **330***j*) may be arranged among the sixth conductive portion **330***a*, the seventh conductive portion **330***b*, the eighth conductive portion **330***c*, the ninth conductive portion **330***d*, and/or the tenth conductive portion **330***e* to insulate the plurality of conductive portions, and accordingly, the lower end area (e.g., an area in the −y direction of FIG. **3**) of the side surface member **320** may be segmented into five areas.

According to an embodiment, the electronic device **300** may use at least one among the first conductive portion **320***a*, the second conductive portion **320***b*, the third conductive portion **320***c*, the fourth conductive portion **320***d*, and/or the fifth conductive portion **320***e*, which are insulated, as an antenna radiator. According to another embodiment, the electronic device **300** may use at least one among the sixth conductive portion **330***a*, the seventh conductive portion **330***b*, the eighth conductive portion **330***c*, the ninth conductive portion **330***d*, and/or the tenth conductive portion **330***e*, which are insulated, as an antenna radiator. For example, the plurality of conductive portions may be electrically connected to a wireless communication circuit disposed in the housing **310**, and the wireless communication circuit may transmit RF signals of a designated frequency band to the plurality of conductive portions or receive RF signals from the plurality of conductive portions.

According to an embodiment, the audio module **313** may include a microphone hole and a speaker hole **313**. A microphone configured to acquire external sound may be disposed in the microphone hole, and in an embodiment, a plurality of microphones may be arranged to detect a direction of sound. In an embodiment, the speaker hole and the microphone hole may be implemented as one hole, or a speaker may be included without a speaker hole (e.g., piezo speaker). The speaker hole **313** may include an external speaker hole and a receiver hole for a call.

According to an embodiment, the camera module **315** may include a first camera device **315** disposed on the first surface **310**A, a second camera device disposed on the second surface **310**B, and/or a flash of the electronic device **300**. The above-described camera devices **315** may include one or more lenses, an image sensor, and/or an image signal processor. For example, the flash may include a light emitting diode or a xenon lamp. In an embodiment, two or more lenses (infrared camera, wide-angle, and telephoto lenses) and image sensors may be arranged on one surface of the electronic device **300**.

According to an embodiment, the key input device **317** may be disposed on the side surface **310**C of the housing **310**. In another embodiment, the electronic device **300** may not include a part or all of the above-described key input device **317**, and the key input device **317**, which is not included, may be implemented on the display **330** in another form such as a soft key.

According to an embodiment, the connector hole **318** may accommodate a connector configured to transmit/receive power and/or data to/from an external electronic device, and/or a connector configured to transmit/receive an audio signal to/from an external electronic device. For example, the connector hole **318** may include a USB connector or an earphone jack.

According to an embodiment, the display **330** may be exposed via a substantial portion of the front plate **302**. In an example, the edge of the display **330** may be configured to be substantially the same as an adjacent outer shape (e.g., a curved surface) of the front plate **302**. In another embodiment, the gap between the border of the display **330** and the border of the front plate **302** may be configured to be substantially the same, so as to expand the area in which the display **330** is exposed. In another embodiment, a recess or an opening may be disposed on a part of the screen display area of the display **330**, and may include other electronic components aligned with the recess or the opening, for example, a camera module **315**, a proximity sensor, or an illuminance sensor.

FIG. **4** illustrates an electronic device including an antenna structure according to an embodiment. The same reference numerals have been used for the same or substantially the same components as those described above, and the overlapping descriptions will be omitted.

Referring to FIG. **4**, an electronic device **100** according to an embodiment may include an antenna structure (or frame structure) **400** in the electronic device **100**. The antenna structure **400** according to an embodiment may be disposed in a first area **131***a* and/or a second area **131***b*. In an embodiment of FIG. **4**, the antenna structure **400** is described to be disposed in the second area **131***b*.

The antenna structure **400** according to an embodiment may include a wireless communication circuit **430**, a plurality of switching circuits **440**, a plurality of conductive portions **410**, a printed circuit board (PCB) **470** including a ground layer, and a plurality of insulating portions **420**. The plurality of insulating portions **420** according to an embodiment may be filled with a non-conductive material such as synthetic polymer.

The wireless communication circuit **430** according to an embodiment may be disposed in the electronic device **100**. The wireless communication circuit **430** according to an embodiment may be electrically connected to the plurality of conductive portions **410**. The wireless communication circuit **430** according to an embodiment may transmit a signal of a designated frequency band to the plurality of conductive portions **410**, or may receive a signal of a designated frequency band from the plurality of conductive portions **410**.

The plurality of conductive portions **410** according to an embodiment may form at least a part of the housing of the electronic device **100**. A first conductive portion **411** and a second conductive portion **412** according to an embodiment may be spaced apart from each other by a second insulating portion **422**. The second conductive portion **412** and a third conductive portion **413** according to an embodiment may be spaced apart from each other by a third insulating portion **423**. The plurality of conductive portions **410** according to an embodiment may be fed with power from the wireless communication circuit **430** to operate as antenna radiators.

In an example, the electronic device **100** may include a sensor module, and thus may produce data values or electric signals corresponding to an internal operation state or an external environment state. In an example, the electronic device **100** may further include a sensor module, for example, at least one of a gesture sensor, a gyro sensor, an air pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor. The electronic device **100** according to an embodiment may detect the proximity of a human body via a grip sensor. The grip sensor according to an embodiment may be disposed at a first point at which the first conductive portion **411** is connected to the third switching circuit **443** or a second point at which the first conductive portion **411** is connected to the first switching circuit **441**. According to another embodiment, the grip sensor may be disposed at a position symmetrical to the first point or the second point (e.g., the first side surface member **113** of FIG. 1A), but is not limited thereto.

For example, the electric device **100** may detect the proximity of a human body with respect to the first insulating portion **421** via a grip sensor, but the portion which detects the proximity of a human body by a grip sensor is not limited thereto.

At least a part of the plurality of switching circuits **440** according to an embodiment may be electrically connected to the wireless communication circuit **430**. At least a part of the plurality of switching circuits **440** according to an embodiment may be electrically connected to the plurality of conductive portions **410**. The electronic device **100** according to an embodiment may control the electrical connection between the wireless communication circuit **430** and the plurality of conductive portions **410** via at least a part of the plurality of switching circuits **440**. For example, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** and/or the second conductive portion **412** by a first switching circuit **441**. In an example, the wireless communication circuit **430** may be electrically connected to the second conductive portion **412** and/or the third conductive portion **413** by a second switching circuit **442**.

The electronic device **100** according to an embodiment may include a plurality of connection portions **480**. The plurality of connection portions **480** according to an embodiment may be a part of the plurality of conductive portions **410**. A plurality of connection portions **480** according to another embodiment may include a connection structure (e.g., a C-clip, a pogo pin, and a screw) disposed on the printed circuit board **470**, but is not limited thereto. For example, the first conductive portion **411** may be electrically connected to the third switching circuit **443** via a third connection portion **483**. The second conductive portion **412** may be electrically connected to a fourth switching circuit **444** via a fourth connection portion **484**, and may be electrically connected to the second switching circuit **442** via a second connection portion **482**.

According to an embodiment, the third conductive portion **413** and/or a fourth conductive portion **414** may be connected to the ground layer included in the printed circuit board **470**.

The plurality of switching circuits **440** according to an embodiment may include internal elements. At least a part of the plurality of switching circuits **440** according to an embodiment may control the internal elements to change electrical paths related to the plurality of conductive portions **410**. The detailed description for the change of the electrical paths via the plurality of switching circuits **440** will be described later.



FIG. **5**A to FIG. **5**E illustrate connection relations between a wireless communication circuit and conductive portions according to various embodiments.

Referring to FIG. **5**A to FIG. **5**E, according to various embodiments, electrical connections between the wireless communication circuit **430** and the plurality of conductive portions **410** may be controlled by the plurality of switching circuits **440**.

Referring to FIG. **5**A, according to an embodiment, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** via the first switching circuit **441** and a first feeding line **461**. According to an embodiment, in a first mode, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** by the first switching circuit **441**, and may transmit or receive a signal of a first frequency band (e.g., a low-band frequency) via the first conductive portion **411** by feeding power to the first conductive portion **411**. According to an embodiment, the wireless communication circuit **430** may be electrically connected to the second conductive portion **412** via the second switching circuit **442** and a third feeding line **463**. The wireless communication circuit **430** may be electrically connected to the second conductive portion **412** by the second switching circuit **442**, and may transmit or receive a signal of a second frequency band (e.g., a mid-band frequency, a high-band frequency, or an ultra-high-band frequency) via the second conductive portion **412** by feeding power to the second conductive portion **412**.

Referring to FIG. **5**B, according to an embodiment, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** via the first switching circuit **441** and the first feeding line **461**. According to an embodiment, in a second mode, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** by the first switching circuit **441**, and may transmit or receive a signal of the first frequency band (e.g., a low-band frequency) via the first conductive portion **411** by feeding power to the first conductive portion **411**. According to an embodiment, the wireless communication circuit **430** may be electrically connected to the second conductive portion **412** via the third feeding line **463**. The wireless communication circuit **430** may be electrically connected to the third conductive portion **413** via a fourth feeding line **464**. The wireless communication circuit **430** may be electrically connected to the second conductive portion **412** and the third conductive portion **413** by the second switching circuit **442**, and may transmit or receive a signal of a second frequency band (e.g., a mid-band frequency, a high-band frequency, or an ultra-high-band frequency) via the second conductive portion **412** and the third conductive portion **413** by feeding power to the second conductive portion **412** and the third conductive portion **413**.

Referring to FIG. **5**C, according to an embodiment, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** via the first switching circuit **441** and the first feeding line **461**. According to an embodiment, in a third mode, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** by the first switching circuit **441**, and may transmit or receive a signal of the first frequency band (e.g., a low-band frequency) via the first conductive portion **411** by feeding power to the first conductive portion **411**. According to an embodiment, the wireless communication circuit **430** may be electrically connected to the third conductive portion **413** via the second switching circuit **442** and the fourth feeding line **464**. The wireless communication circuit **430** may be electrically connected to the third conductive portion **413** by the second switching circuit **442**, and may transmit or receive a signal of the second frequency band (e.g., a mid-band frequency, a high-band frequency, or an ultra-high-band frequency) via the third conductive portion **413** by feeding power to the third conductive portion **413**.

Referring to FIG. **5**D, according to an embodiment, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** via the first switching circuit **441** and the first feeding line **461**. The wireless communication circuit **430** may be electrically connected to the second conductive portion **412** via the first switching circuit **441** and the second feeding line **462**. According to an embodiment, the fourth switching circuit **444** may be electrically connected to the second feeding line **462** via a fifth feeding line **465**. According to an embodiment, in a fourth mode, the wireless communication circuit **430** may be electrically connected to the first conductive portion **411** and the second conductive portion **412** by the first switching circuit **441**, and may transmit or receive a signal of the first frequency band (e.g., a low-band frequency) via the first conductive portion **411** and the second conductive portion **412** by feeding power to the first conductive portion **411** and the second conductive portion **412**. According to an embodiment, the wireless communication circuit **430** may be electrically connected to the third conductive portion **413** via the second switching circuit **442** and the fourth feeding line **464**. The wireless communication circuit **430** may be electrically connected to the third conductive portion **413** by the second switching circuit **442**, and feed power to the third conductive portion **413** to transmit or receive a signal of the second frequency band (e.g., a mid-band frequency, a high-band frequency, or an ultra-high-band frequency) via the third conductive portion **413**. The third switching circuit **443** according to an embodiment may control an internal element to have an impedance which is electrically close to a short circuit. The third switching circuit **443** according to an embodiment may have an impedance which is electrically close to a short circuit, and may thus change electrical paths connected to the first conductive portion **411** via the first switching circuit **441** from the wireless communication circuit **430**. For example, the third switching circuit **443** may be electrically connected to a ground disposed in the printed circuit board (e.g., the printed circuit board **470** in FIG. **4**).

Referring to FIG. **5**E, according to an embodiment, the wireless communication circuit **430** may be electrically connected to the second conductive portion **412** via the first switching circuit **441** and the second feeding line **462**. According to an embodiment, the fourth switching circuit **444** may be electrically connected to the second feeding line **462** via the fifth feeding line **465**. According to an embodiment, in a fifth mode, the wireless communication circuit **430** may be electrically connected to the second conductive portion **412** by the first switching circuit **441**, and may transmit or receive a signal of the first frequency band (e.g., a low-band frequency) via the second conductive portion **412** by feeding power to the second conductive portion **412**. According to an embodiment, the wireless communication circuit **430** may be electrically connected to the third conductive portion **413** via the second switching circuit **442** and the fourth feeding line **464**. The wireless communication circuit **430** may be electrically connected to the third conductive portion **413** by the second switching circuit **442**, and may transmit or receive a signal of the second frequency band (e.g., a mid-band frequency, a high-band frequency, or an ultra-high-band frequency) via the third conductive portion **413** by feeding power to the third conductive portion **413**. The fourth switching circuit **444** according to an embodiment may control an internal element to change electrical paths connected to the second conductive portion **412** via the first switching circuit **441** from the wireless communication circuit **430**. According to an embodiment, the fourth switching circuit **444** may be electrically connected to a ground disposed in the printed circuit board (e.g., the printed circuit board **470** of FIG. **4**).

According to an embodiment, the third switching circuit **443** and/or the fourth switching circuit **444** may be connected to a ground disposed in the printed circuit board (e.g., the printed circuit board **470** in FIG. **4**) by a control signal of the wireless communication circuit **430**.

According to an embodiment, the wireless communication circuit **430** may be switched from the first mode to the fifth mode. According to an embodiment, in the process of switching from the first mode to the fifth mode, the wireless communication circuit **430** may include at least one among the second mode, the third mode, and the fourth mode. For example, after switching from the first mode to the fourth mode, the wireless communication circuit may be switched to the fifth mode. According to an embodiment, while the mode of the wireless communication circuit **430** is changed, the conductive portion **411**, **412**, **413**, or **414** transmitting and/or receiving a signal of the first frequency band and the second frequency band may be changed. For example, in a case of being switched from the first mode to the fifth mode, the conductive portion transmitting/receiving a signal of the first frequency band may be switched from the first conductive portion **411** to the second conductive portion **412**, and the conductive portion transmitting/receiving a signal of the second frequency band may be switched from the second conductive portion **412** to the third conductive portion **413**.

FIG. **6** is a flowchart for determining a connection relation between a wireless communication circuit and conductive portions according to an embodiment.

Referring to FIG. **6**, the wireless communication circuit **430** may change the feeding structure for transmitting and receiving a signal of the first frequency band and a signal of the second frequency band, depending on proximity of a human body.

According to an embodiment, in operation **610**, the wireless communication circuit **430** may be electrically connected to the first conductive portion, feed power to the first conductive portion, and may thus transmit or receive a first signal including the first frequency band via the first conductive portion, and may be electrically connected to the second conductive portion, feed power to the second conductive portion, and may thus transmit or receive a second signal including the second frequency band via the second conductive portion. For example, via the structure of FIG. **5**A or FIG. **5**B, the wireless communication circuit **430** may feed power to the first conductive portion to transmit/receive the first signal, and may feed power to the second conductive portion to transmit/receive the second signal.

According to an embodiment, in operation **620**, a grip sensor may detect the proximity of a human body. In operation **620** according to an embodiment, in a case where a human body is not close according to the result of the grip sensor which has detected the proximity of a human body, operation **610** may be performed. According to another embodiment, in a case where the human body is close according to the result of the determination of operation **620**, operation **630** may be performed.

In operation **630** according to an embodiment, the wireless communication circuit **430** may be electrically connected to the first conductive portion and the second conductive portion, feed power to the first conductive portion and the second conductive portion, and may thus transmit or receive a first signal including the first frequency band via the first conductive portion and the second conductive portion. For example, via the structure of FIG. **5**D, the wireless communication circuit **430** may feed power to the first conductive portion and the second conductive portion, and may thus transmit or receive the first signal including the first frequency band via the first conductive portion and the second conductive portion.

In operation **630** according to an embodiment, the wireless communication circuit **430** may be electrically connected to the third conductive portion, feed power to the third conductive portion, and may thus transmit or receive a second signal including the second frequency band. For example, via the structure of FIG. **5**D, FIG. **5**B, FIG. **5**C, and FIG. **5**E, the wireless communication circuit **430** may feed power to the third conductive portion, and may thus transmit or receive the second signal including the second frequency band.

FIG. **7** is a flowchart for changing a connection relation between a wireless communication circuit and conductive portions according to an embodiment. The descriptions overlapping those of FIG. **6** will be omitted.

Referring to both FIG. **6** and FIG. **7**, an electronic device according to an embodiment may change electrical connection paths between the wireless communication circuit and the plurality of conductive portions depending on whether a specific condition is satisfied.

In operation **710** according to an embodiment, an electronic device may determine whether a first condition is satisfied, while performing operation **630**. The first condition according to an embodiment may be a condition in which radiation performance (e.g., radiation intensity, coverage, or resonance degree) of the first signal is below a predetermined level, but is not limited thereto. The first condition according to another embodiment may be whether or not a user inputs. An electronic device according to an embodiment may provide a guide for the above-described input of the user. According to an embodiment, in a case where the first signal does not satisfy the first condition, the electronic device may perform operation **630**. According to another embodiment, in a case where the first signal satisfies the first condition, the electronic device may perform operation **720**.

In operation **720** according to an embodiment, the electronic device may release the connection between the wireless communication circuit and the first conductive portion. Referring to both FIGS. **5**A-**5**E and FIG. **7**, in operation **720**, the connection between the wireless communication circuit **430** and the conductive portions may be switched, by the first switching circuit **441**, from one mode among the first mode, the second mode, or the third mode to the fifth mode. According to another embodiment, in operation **720**, the connection between the wireless communication circuit **430** and the conductive portions may be switched, by the first switching circuit **441**, from one mode among the first mode, the second mode, or the third mode to the fourth mode, and then may be switched to the fifth mode.

In operation **730** according to an embodiment, the wireless communication circuit **430** may be electrically connected to the second conductive portion, feed power to the second conductive portion, and may thus transmit or receive the first signal including the first frequency band via the second conductive portion. In operation **730** according to an embodiment, the wireless communication circuit **430** may be electrically connected to the third conductive portion, feed power to the third conductive portion, and may thus transmit or receive the second signal including the second frequency band via the third conductive portion. Referring to both FIGS. **5**A-**5**E and FIG. **7**, in operation **730**, the connection between the wireless communication circuit **430** and the conductive portions may be switched, by the second switching circuit **442**, from the first mode to one mode among the third mode, the fourth mode, or the fifth mode. For example, in operation **730**, the connection between the wireless communication circuit **430** and the conductive portions may be switched, by the second switching circuit **442**, from the first mode to the second mode, and then may be switched to one mode among the third mode, the fourth mode, or the fifth mode.

FIG. **8**A illustrates a switching circuit including internal elements according to an embodiment. FIG. **8**B illustrates a switching circuit including internal elements according to another embodiment. FIG. **8**C illustrates a third switching circuit connected to a first conductive portion according to an embodiment. FIG. **8**D illustrates a fourth switching circuit connected to a second conductive portion according to an embodiment.

Referring to both FIG. **8**A and FIG. **8**B, a switching circuit **800***a* or **800***b* according to an embodiment may include a plurality of internal elements **801** or **811** and switches **802** or **812**.

Referring to FIGS. **5**A-**5**E, FIG. **8**A, and FIG. **8**B together, the switching circuit (e.g., the first switching circuit **441** of FIGS. **5**A-**5**E) according to an embodiment may be a tuner including the plurality of internal elements **801** or **811** and the plurality of internal switches **802** or **812**, but is not limited thereto. The switching circuit **800***a* or **800***b* according to an embodiment may be electrically connected to a plurality of conductive portions **411** or **412**. According to an embodiment, the switching circuit **800***a* or **800***b* may be electrically connected to the fourth switching circuit **444**. According to an embodiment, the fourth switching circuit **444** may be connected to a ground.

According to an embodiment, in a case where a grip sensor has detected proximity of a human body, the switching circuit **800***a* or **800***b* may control the internal switches **802** or **812** to allow the wireless communication circuit **430** to be electrically connected to the first conductive portion **411** and/or the second conductive portion **412**. According to an embodiment, in a case where the grip sensor has detected proximity of a human body, the switching circuit **800***a* or **800***b* may control the internal elements **801** or **811** to have an impedance which is electrically close to a short circuit. The switching circuit **800***a* or **800***b* according to an embodiment may have an impedance which is electrically close to a short circuit, and may thus change electrical paths connected to the first conductive portion **411** via the switching circuit **800***a* or **800***b* from the wireless communication circuit **430**. According to an embodiment, by changing electrical paths connected to the first conductive portion **411** from the wireless communication circuit **430**, the wireless communication circuit **430** may adjust the frequency band of the first signal transmitted or received via the first conductive portion **411**.

According to another embodiment, in a case where a proximity sensor does not detect the proximity of a human body, the switching circuit **800***a* or **800***b* may control the internal switches **802** or **812** to allow the wireless communication circuit **430** to be electrically connected to the first conductive portion **411**. The switching circuit **800***a* or **800***b* according to an embodiment may control the internal switches **802** or **812** to allow the wireless communication circuit **430** to be electrically connected to the second conductive portion **412**. The switching circuit **800***a* or **800***b* according to an embodiment may control the internal elements **801** or **811** to change the length of the electrical path connected to the first conductive portion **411** from the wireless communication circuit **430**. The switching circuit **800** according to an embodiment may control the internal elements **801** or **811** to change the length of the electrical path connected to the second conductive portion **412** from the wireless communication circuit **430**. According to an embodiment, by changing the electrical path connected to the second conductive portion **412** from the wireless communication circuit **430**, the wireless communication circuit **430** may adjust the frequency band of the first signal transmitted or received via the second conductive portion **412**.

Referring to both FIG. **8**C and FIG. **8**D, the third switching circuit **443** and/or the fourth switching circuit **444** may include a single pole 4 throw (SP4T) switch. According to an embodiment, the third switching circuit **443** and/or the fourth switching circuit **444** may include a single pole double throw (SPDT) switch, but is not limited thereto.

The third switching circuit **443** and/or the fourth switching circuit **444** according to an embodiment may be electrically connected to a plurality of impedances Z**1**, Z**2**, Z**3**, and Z**4**. For example, at least one among the plurality of impedances Z**1**, Z**2**, Z**3**, and Z**4** may be 100 pF, but is not limited thereto. According to an embodiment, the third switching circuit **443** and the fourth switching circuit **444** may control an internal path or the plurality of impedances Z**1**, Z**2**, Z**3**, and Z**4**, and may thus change the feeding structure of the conductive portions **410** and the wireless communication circuit **430**.

The third switching circuit **443** according to an embodiment may be electrically connected to the first conductive portion **411**. The fourth switching circuit **444** according to an embodiment may be electrically connected to the second feeding line **462** via the fifth feeding line **465**. According to an embodiment, the fourth switching circuit **444** may be electrically connected to the second conductive portion **412** via the fifth feeding line **465** and the second feeding line **462**.

FIG. **9**A illustrates results of a signal radiation via a wireless communication circuit of an electronic device according to an embodiment. FIG. **9**B illustrates results of a signal radiation via a wireless communication circuit of an electronic device according to another embodiment. FIG. **9**C illustrates results of a signal radiation via a wireless communication circuit of an electronic device according to another embodiment.

Referring to FIG. **4**, FIGS. **5**A-**5**E, FIG. **9**A, FIG. **9**B, and FIG. **9**C together, the performance (e.g., resonance degree or radiation intensity of a signal) of an antenna structure **400** may be improved by changing an electrical connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** of the electronic device **100** according to an embodiment.

Referring to FIGS. **5**A-**5**E and FIG. **9**A, in a case where a connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** has a connection path of FIG. **5**A, FIG. **5**B, or FIG. **5**C, the results of a first right grip **911**, a first left grip **912**, a second right grip **913**, and a second left grip **914** may be equal to or less than the target performance of the antenna structure **400** in radiation efficiency. According to an embodiment, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** has the connection path of FIG. **5**A, FIG. **5**B, or FIG. **5**C, the results of a first right grip **921**, a first left grip **922**, a second right grip **923**, and a second left grip **924** may be equal to or less than the target performance of the antenna structure **400** in reflection coefficient.

Referring to FIGS. **5**A-**5**E and FIG. **9**B, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** has a connection path of FIG. **5**D, at least a part of the results of a first right grip **931**, a first left grip **932**, a second right grip **933**, and a second left grip **934** may be greater than the target performance of the antenna structure **400** in radiation efficiency. According to an embodiment, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** has a connection path of FIG. **5**D, at least a part of the results of a first right grip **941**, a first left grip **942**, a second right grip **943**, and a second left grip **944** may be greater than the target performance of the antenna structure **400** in reflection coefficient.

Referring to FIGS. **5**A-**5**E and FIG. **9**C, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** has a connection path of FIG. **5**D, at least a part of the results of a first right grip **951**, a first left grip **952**, a second right grip **953**, and a second left grip **954** may be greater than the target performance of the antenna structure **400** in radiation performance. According to an embodiment, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** has a connection path of FIG. **5**D, at least a part of the results of a first right grip **961**, a first left grip **962**, a second right grip **963**, and a second left grip **964** may be greater than the target performance of the antenna structure **400** in reflection coefficient.

FIG. **10** illustrates results of signal radiation via a wireless communication circuit of an electronic device according to another embodiment.

Referring to FIG. **4**, FIGS. **5**A-**5**E, and FIG. **10** together, the performance (e.g., resonance degree or radiation intensity of a signal) of an antenna structure **400** may be improved by changing the electrical connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** of the electronic device **100** according to an embodiment.

Referring to FIGS. **5**A-**5**E and FIG. **10**A, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** is changed from the connection path of FIG. **5**A to a connection path of FIG. **5**E, the radiation efficiency may be improved by about 1.5 dB to about 2.0 dB from a first radiation **1011** to a second radiation **1012**, but is not limited to these values.

Referring to FIGS. **5**A-**5**E and FIG. **10**B, in a case where the connection path between the wireless communication circuit **430** and the plurality of conductive portions **410** is changed from the connection path of FIG. **5**A to the connection path of FIG. **5**E, the radiation coefficient may be improved from a first reflection coefficient **1021** to a second reflection coefficient.

FIG. **11** illustrates an electronic device including a first wireless communication circuit and a second wireless communication circuit according to an embodiment.

Referring to FIG. **11**, an antenna structure **1100** according to an embodiment may include a first wireless communication circuit **1131**, a second wireless communication circuit **1132**, a plurality of switching circuits **1140**, a plurality of conductive portions **1110**, a printed circuit board (PCB) **1170** including a ground layer, and a plurality of insulating portions **1120**. The same/similar reference numerals have been used for the same or substantially the same components as those described above, and the overlapping descriptions will be omitted.

Referring to FIG. **11**, the first wireless communication circuit **1131** may be electrically connected to the first switching circuit **1141**. The first wireless communication circuit **1131** according to an embodiment may be electrically connected to a first conductive portion **1111** and/or a second conductive portion **1112** via the first switching circuit **1141**. The first wireless communication circuit **1131** according to an embodiment may feed power to the first conductive portion **1111** and/or the second conductive portion **1112**, and may thus transmit or receive a first signal including the first frequency band.

The second wireless communication circuit **1132** according to an embodiment may be electrically connected to a second switching circuit **1142**. The second wireless communication circuit **1132** according to an embodiment may be electrically connected to the second conductive portion **1112** and/or a third conductive portion **1113** via the second switching circuit **1142**. The second wireless communication circuit **1132** according to an embodiment may feed power to the second conductive portion **1112** and/or the third conductive portion **1113**, and may thus transmit or receive a second signal including the second frequency band.

A third switching circuit **1143** according to an embodiment may be electrically connected to the first conductive portion **1111**. The third switching circuit **1143** according to an embodiment may include internal elements, control the internal elements, and may thus change the electrical path related to the first conductive portion **1111**. For example, the internal variable capacitor of the third switching circuit **1143** may be adjusted to configure the impedance of the third switching circuit **1143** to be very small, and thus an electrical path leading from the first wireless communication circuit **1131** via the first switching circuit **1141** to a point on the first conductive portion **1111** connected to the third switching circuit **1143** may be configured.

A fourth switching circuit **1144** according to an embodiment may be electrically connected to the second conductive portion **1112**. The fourth switching circuit **1144** according to an embodiment may include internal elements, control the internal elements, and may thus change the electrical path related to the second conductive portion **1112**. For example, the internal variable capacitor of the fourth switching circuit **1144** may be adjusted, and thus the length of an electrical path connected from the first wireless communication circuit **1131** via the first switching circuit **1141** to the second conductive portion **1112** may be changed.

The second switching circuit **1142** according to an embodiment may include internal elements. The second switching circuit **1142** according to an embodiment may control the internal elements, and may thus change the length of an electrical path extending from the second wireless communication circuit **1132** via the second switching circuit **1142** to the second conductive portion **1112** and/or the third conductive portion **1113**.

An electronic device **1100** according to an embodiment may include a plurality of connection portions **1180**. The plurality of connection portions **1180** according to an embodiment may be a part of the plurality of conductive portions **1110**. A plurality of connection portions **1180** according to another embodiment may include a connection structure (e.g., a C-clip, a pogo pin, and a screw) disposed on a printed circuit board **1170**, but are not limited thereto. For example, the first conductive portion **1111** may be electrically connected to the third switching circuit **1143** via a third connection portion **1183**. The second conductive portion **1112** may be electrically connected to the fourth switching circuit **1144** via a fourth connection portion **1184**, and may be electrically connected to the second switching circuit **1142** via a second connection portion **1182**.

According to an embodiment, the third conductive portion **1113** and/or a fourth conductive portion **1114** may be connected to a ground layer included in the printed circuit board **1170**.

FIG. **12** is a flowchart for determining a connection relation between wireless communication circuits and conductive portions according to an embodiment.

Referring to FIG. **11** and FIG. **12** together, in operation **1210**, the first wireless communication circuit **1131** according to an embodiment may feed power to the first conductive portion **1111** and may thus transmit or receive a first signal including the first frequency band via the first conductive portion **1111**. The second wireless communication circuit **1132** according to an embodiment may feed power to the second conductive portion **1112** in operation **1210**, and may thus transmit or receive a second signal including the second frequency band via the second conductive portion **1112**.

An electronic device according to an embodiment may include a processor. A processor according to an embodiment may determine whether the first wireless communication circuit **1131** is used alone or the first wireless communication circuit **1131** among the first wireless communication circuit **1131** and the second wireless communication circuit **1132** is preferentially used to transmit or receive a signal in operation **1220**. According to the result of determination, in a case where the first wireless communication circuit **1131** is used alone or the first wireless communication circuit **1131** among the first wireless communication circuit **1131** and the second wireless communication circuit **1132** is preferentially used, a processor according to an embodiment may detect and determine proximity of a human body by using a grip sensor in operation **1230**. The member configured to detect the proximity of a human body is not limited to a grip sensor.

In a case where the grip sensor does not detect the proximity of a human body, the antenna structure **1100** according to an embodiment may perform operation **1210**. According to another embodiment, in a case where the grip sensor detects the proximity of a human body, in operation **1250**, the first wireless communication circuit **1131** may be electrically connected to the first conductive portion **1111** and the second conductive portion **1112**, feed power to the first conductive portion **1111** and the second conductive portion **1112**, and may thus transmit or receive a first signal including the first frequency band via the first conductive portion **1111** and the second conductive portion **1112**. In an embodiment, in a case where the grip sensor detects the proximity of a human body, in operation **1250**, the second wireless communication circuit **1131** may be electrically connected to the third conductive portion **1113**, feed power to the third conductive portion **1113**, and may thus transmit or receive a second signal including the second frequency band via the third conductive portion **1113**.

A processor according to an embodiment may determine whether the second wireless communication circuit **1132** is used alone or the second wireless communication circuit **1132** is preferentially used to transmit or receive a signal in operation **1240**. According to the result of determination, in a case where the second wireless communication circuit **1132** is used alone or the second wireless communication circuit **1132** among the first wireless communication circuit **1131** and the second wireless communication circuit **1132** is preferentially used to transmit or receive a signal, operation **1210** may be performed. In another embodiment, in a case where the second wireless communication circuit **1132** is not used alone and the second wireless communication circuit **1132** among the first wireless communication circuit **1131** and the second wireless communication circuit **1132** is not preferentially used to transmit or receive a signal, operation **1250** may be performed.

According to an embodiment, in operation **1250**, the first wireless communication circuit **1131** may feed power to the first conductive portion **1111** and the second conductive portion **1112**, and may thus transmit or receive a first signal including the first frequency band via the first conductive portion **1111** and the second conductive portion **1112**. In operation **1250**, the second wireless communication circuit **1132** according to an embodiment may feed power to the third conductive portion **1113**, and may thus transmit or receive a second signal including the second frequency band via the third conductive portion **1113**.

FIG. **13**A illustrates results of signal radiation via a first wireless communication circuit in a first state in which the proximity of a human body is not detected according to an embodiment. FIG. **13**B illustrates results of signal radiation via a second wireless communication circuit in a first state in which the proximity of a human body is not detected according to an embodiment.

Referring to FIG. **11** and FIG. **13**A together, in a case where proximity of a human body is not detected according to an embodiment, radiation efficiency and reflection coefficient of a first signal via the first wireless communication circuit **1131** are shown. The first wireless communication circuit **1131** according to an embodiment may secure constant radiation efficiency and reflection coefficient for normal operation of the antenna structure **1100** in a frequency range of about 850 MHz to about 950 MHz.

According to an embodiment, according to the state of the plurality of switching circuits **1140**, electrical paths connected from the first wireless communication circuit **1131** to the plurality of conductive portions **1110** may be changed.

According to an embodiment, the first wireless communication circuit **1131** may secure a plurality of radiation efficiencies **1311** to **1315** according to the state of the third switching circuit **1143** or the fourth switching circuit **1144**. For example, the third switching circuit **1143** may obtain a first radiation efficiency **1311** by configuring a low impedance. According to an embodiment, the first wireless communication circuit **1131** may secure a plurality of reflection coefficients **1321** to **1325** according to the state of the third switching circuit **1143** or the fourth switching circuit **1144**. For example, the third switching circuit **1311** may obtain a fifth reflection coefficient **1325** by configuring a high impedance.

Referring to FIG. **11** and FIG. **13**B together, in a case where proximity of a human body is not detected according to an embodiment, radiation efficiency and reflection coefficient of a second signal via the second wireless communication circuit **1132** are shown.

According to an embodiment, according to the state of the plurality of switching circuits **1140**, electrical paths connected from the second wireless communication circuit **1132** to the plurality of conductive portions **1110** may be changed.

According to an embodiment, the second wireless communication circuit **1132** may secure a plurality of radiation efficiencies **1331** and **1332** according to the state of the first switching circuit **1141** and the second switching circuit **1142**. For example, the first switching circuit **1141** may obtain a first radiation efficiency **1331** in a case of being connected to the first conductive portion **1111**. According to another example, in a case where the first switching circuit **1141** is connected to the second conductive portion **1112**, a second radiation efficiency **1332** may be obtained. According to an embodiment, the second wireless communication circuit **1132** may secure a plurality of reflection coefficients **1341** and **1342** according to the state of the first switching circuit **1141** and the second switching circuit **1142**. For example, in a case where the first switching circuit **1141** is connected to the first conductive portion **1111**, a first reflection coefficient **1341** may be obtained. According to another example, in a case where the first switching circuit **1141** is connected to the second conductive portion **1112**, a second reflection coefficient **1342** may be obtained.

FIG. **14**A illustrates results of signal radiation via a first wireless communication circuit in a second state in which the proximity of a human body is detected according to an embodiment. FIG. **14**B illustrates results of signal radiation via a second wireless communication circuit in a second state in which the proximity of a human body is detected according to an embodiment.

Referring to FIGS. **5**A-**5**E, FIG. **11**, and FIG. **14**A, in a case where proximity of a human body is detected according to an embodiment, radiation efficiency and reflection coefficient of a first signal via the first wireless communication circuit **1131** are shown. The first wireless communication circuit **1131** according to an embodiment may secure constant radiation efficiency and reflection coefficient in a frequency band of about 750 MHz or about 880 MHz according to the connection relationship between the first wireless communication circuit **1131** and the plurality of conductive portions **1110**. For example, in a case where the first switching circuit **1141** is connected to the first conductive portion **1111**, a first radiation efficiency **1411** and a first reflection coefficient **1421** may be obtained. According to another example, in a case where the first switching circuit **1141** is connected to the second conductive portion **1112**, a second radiation efficiency **1412** and a second reflection coefficient **1422** may be obtained.

Referring to FIGS. **5**A-**5**E, FIG. **11**, and FIG. **14**B, in a case where proximity of a human body is detected according to an embodiment, radiation efficiency and reflection coefficient of a second signal via the second wireless communication circuit **1132** are shown. For example, in a case where proximity of a human body is detected, radiation efficiency **1430** and reflection coefficient **1440** of a second signal via the second wireless communication circuit **1132** may be obtained.

FIG. **15** is a block diagram of an electronic device in a network environment according to various embodiments.

Referring to FIG. **15**, the electronic device **1501** in the network environment **1500** may communicate with an electronic device **1502** via a first network **1598** (e.g., a short-range wireless communication network), or an electronic device **1504** or a server **1508** via a second network **1599** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **1501** may communicate with the electronic device **1504** via the server **1508**. According to an embodiment, the electronic device **1501** may include a processor **1520**, memory **1530**, an input module **1550**, a sound output module **1555**, a display module **1560**, an audio module **1570**, a sensor module **1576**, an interface **1577**, a connecting terminal **1578**, a haptic module **1579**, a camera module **1580**, a power management module **1588**, a battery **1589**, a communication module **1590**, a subscriber identification module (SIM) **1596**, or an antenna module **1597**. In some embodiments, at least one of the components (e.g., the connecting terminal **1578**) may be omitted from the electronic device **1501**, or one or more other components may be added in the electronic device **1501**. In some embodiments, some of the components (e.g., the sensor module **1576**, the camera module **1580**, or the antenna module **1597**) may be implemented as a single component (e.g., the display module **1560**).

The processor **1520** may execute, for example, software (e.g., a program **1540**) to control at least one other component (e.g., a hardware or software component) of the electronic device **1501** coupled with the processor **1520**, and may perform various data processing or computation. According to one embodiment, as at least part of the data processing or computation, the processor **1520** may store a command or data received from another component (e.g., the sensor module **1576** or the communication module **1590**) in volatile memory **1532**, process the command or the data stored in the volatile memory **1532**, and store resulting data in non-volatile memory **1534**. According to an embodiment, the processor **1520** may include a main processor **1521** (e.g., a central processing unit (CPU) or an application processor (AP)), or an auxiliary processor **1523** (e.g., a graphics processing unit (GPU), a neural processing unit (NPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **1521**. For example, when the electronic device **1501** includes the main processor **1521** and the auxiliary processor **1523**, the auxiliary processor **1523** may be adapted to consume less power than the main processor **1521**, or to be specific to a specified function. The auxiliary processor **1523** may be implemented as separate from, or as part of the main processor **1521**.

The auxiliary processor **1523** may control, for example, at least some of functions or states related to at least one component (e.g., the display module **1560**, the sensor module **1576**, or the communication module **1590**) among the components of the electronic device **1501**, instead of the main processor **1521** while the main processor **1521** is in an inactive (e.g., sleep) state, or together with the main processor **1521** while the main processor **1521** is in an active (e.g., executing an application) state. According to an embodiment, the auxiliary processor **1523** (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module **1580** or the communication module **1590**) functionally related to the auxiliary processor **1523**. According to an embodiment, the auxiliary processor **1523** (e.g., the neural processing unit) may include a hardware structure specified for artificial intelligence model processing. An artificial intelligence model may be generated by machine learning. Such learning may be performed, e.g., by the electronic device **1501** where the artificial intelligence model is performed or via a separate server (e.g., the server **1508**). Learning algorithms may include, but are not limited to, e.g., supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The artificial intelligence model may include a plurality of artificial neural network layers. The artificial neural network may be a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted Boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), deep Q-network or a combination of two or more thereof but is not limited thereto. The artificial intelligence model may, additionally or alternatively, include a software structure other than the hardware structure.

The memory **1530** may store various data used by at least one component (e.g., the processor **1520** or the sensor module **1576**) of the electronic device **1501**. The various data may include, for example, software (e.g., the program **1540**) and input data or output data for a command related thereto. The memory **1530** may include the volatile memory **1532** or the non-volatile memory **1534**.

The program **1540** may be stored in the memory **1530** as software, and may include, for example, an operating system (OS) **1542**, middleware **1544**, or an application **1546**.

The input module **1550** may receive a command or data to be used by another component (e.g., the processor **1520**) of the electronic device **1501**, from the outside (e.g., a user) of the electronic device **1501**. The input module **1550** may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

The sound output module **1555** may output sound signals to the outside of the electronic device **1501**. The sound output module **1555** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used for receiving incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

The display module **1560** may visually provide information to the outside (e.g., a user) of the electronic device **1501**. The display module **1560** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display module **1560** may include a touch sensor adapted to detect a touch, or a pressure sensor adapted to measure the intensity of force incurred by the touch.

The audio module **1570** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **1570** may obtain the sound via the input module **1550**, or output the sound via the sound output module **1555** or an external electronic device (e.g., an electronic device **1502** (e.g., a speaker or a headphone)) directly or wirelessly coupled with the electronic device **1501**.

The sensor module **1576** may detect an operational state (e.g., power or temperature) of the electronic device **1501** or an environmental state (e.g., a state of a user) external to the electronic device **1501**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **1576** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

The interface **1577** may support one or more specified protocols to be used for the electronic device **1501** to be coupled with the external electronic device (e.g., the electronic device **1502**) directly or wirelessly. According to an embodiment, the interface **1577** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

The connecting terminal **1578** may include a connector via which the electronic device **1501** may be physically connected with the external electronic device (e.g., the electronic device **1502**). According to an embodiment, the connecting terminal **1578** may include, for example, an HDMI connector, a USB connector, an SD card connector, or an audio connector (e.g., a headphone connector).

The haptic module **1579** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **1579** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

The camera module **1580** may capture a still image or moving images. According to an embodiment, the camera module **1580** may include one or more lenses, image sensors, image signal processors, or flashes.

The power management module **1588** may manage power supplied to the electronic device **1501**. According to one embodiment, the power management module **1588** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

The battery **1589** may supply power to at least one component of the electronic device **1501**. According to an embodiment, the battery **1589** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

The communication module **1590** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **1501** and the external electronic device (e.g., the electronic device **1502**, the electronic device **1504**, or the server **1508**) and performing communication via the established communication channel. The communication module **1590** may include one or more communication processors that are operable independently from the processor **1520** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **1590** may include a wireless communication module **1592** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **1594** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device **1504** via the first network **1598** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network **1599** (e.g., a long-range communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **1592** may identify or authenticate the electronic device **1501** in a communication network, such as the first network **1598** or the second network **1599**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **1596**.

The wireless communication module **1592** may support a 5G network, after a 4G network, and next-generation communication technology, e.g., new radio (NR) access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module **1592** may support a high-frequency band (e.g., the mmWave band) to achieve, e.g., a high data transmission rate. The wireless communication module **1592** may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (massive MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beam-forming, or large scale antenna. The wireless communication module **1592** may support various requirements specified in the electronic device **1501**, an external electronic device (e.g., the electronic device **1504**), or a network system (e.g., the second network **1599**). According to an embodiment, the wireless communication module **1592** may support a peak data rate (e.g., 20 Gbps or more) for implementing eMBB, loss coverage (e.g., 164 dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5 ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1 ms or less) for implementing URLLC.

The antenna module **1597** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **1501**. According to an embodiment, the antenna module **1597** may include an antenna including a radiating element composed of a conductive material or a conductive pattern formed in or on a substrate (e.g., a printed circuit board (PCB)). According to an embodiment, the antenna module **1597** may include a plurality of antennas (e.g., array antennas). In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **1598** or the second network **1599**, may be selected, for example, by the communication module **1590** from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module **1590** and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module **1597**.

According to various embodiments, the antenna module **1597** may form a mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, an RFIC disposed on a first surface (e.g., the bottom surface) of the printed circuit board, or adjacent to the first surface and capable of supporting a designated high-frequency band (e.g., the mmWave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the printed circuit board, or adjacent to the second surface and capable of transmitting or receiving signals of the designated high-frequency band.

At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

According to an embodiment, commands or data may be transmitted or received between the electronic device **1501** and the external electronic device **1504** via the server **1508** coupled with the second network **1599**. Each of the external electronic devices **1502** or **1504** may be a device of a same type as, or a different type, from the electronic device **1501**.

According to an embodiment, all or some of operations to be executed at the electronic device **1501** may be executed at one or more of the external electronic devices **1502**, **1504**, or **1508**. For example, if the electronic device **1501** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **1501**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **1501**. The electronic device **1501** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device **1501** may provide ultra low-latency services using, e.g., distributed computing or mobile edge computing. In another embodiment, the external electronic device **1504** may include an internet-of-things (IoT) device. The server **1508** may be an intelligent server using machine learning and/or a neural network. According to an embodiment, the external electronic device **1504** or the server **1508** may be included in the second network **1599**. The electronic device **1501** may be applied to intelligent services (e.g., smart home, smart city, smart car, or healthcare) based on 5G communication technology or IoT-related technology.

The electronic device according to various embodiments disclosed herein may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smart phone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance. The electronic device according to embodiments of the disclosure is not limited to those described above.

It should be appreciated that various embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or alternatives for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to designate similar or relevant elements. A singular form of a noun corresponding to an item may include one or more of the items, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C" may include all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "a first", "a second", "the first", and "the second" may be used to simply distinguish a corresponding element from another, and does not limit the elements in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively", as "coupled with/to" or "connected with/to" another element (e.g., a second element), it means that the element may be coupled/connected with/to the other element directly (e.g., wiredly), wirelessly, or via a third element.

As used herein, the term "module" may include a unit implemented in hardware, software, or firmware, and may be interchangeably used with other terms, for example, "logic," "logic block," "component," or "circuit". The "module" may be a minimum unit of a single integrated component adapted to perform one or more functions, or a part thereof. For example, according to an embodiment, the "module" may be implemented in the form of an application-specific integrated circuit (ASIC).

Various embodiments as set forth herein may be implemented as software (e.g., the program **1540**) including one or more instructions that are stored in a storage medium (e.g., the internal memory **1536** or external memory **1538**) that is readable by a machine. For example, a processor (e.g., the processor **1520**) of the machine may invoke at least one of the one or more stored instructions from the storage medium, and execute it. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

According to an embodiment, a method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., Play Store™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

According to various embodiments, each element (e.g., a module or a program) of the above-described elements may include a single entity or multiple entities, and some of the multiple entities may be separately disposed in any other element. According to various embodiments, one or more of the above-described elements may be omitted, or one or more other elements may be added. Alternatively or additionally, a plurality of elements (e.g., modules or programs) may be integrated into a single element. In such a case, according to various embodiments, the integrated element may still perform one or more functions of each of the plurality of elements in the same or similar manner as they are performed by a corresponding one of the plurality of elements before the integration. According to various embodiments, operations performed by the module, the program, or another element may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

Various embodiments of the disclosure may provide a device and method for preventing degradation of radiation performance due to a change in capacitance of a bezel portion used as an antenna in an electronic device.

Embodiments of the disclosure disclosed in the specification and the drawings are only specific examples given to easily describe technical contents according to embodiments of the disclosure and to help understanding of embodiments of the disclosure, and are not intended to limit the scope of embodiments of the disclosure. Therefore, the scope of various embodiments of the disclosure are to be interpreted as encompassing all changed or modified forms derived based on technical ideas of various embodiments of the disclosure, in addition to the embodiments disclosed herein.

What is claimed is:

1. An electronic device comprising:

a frame structure forming at least a part of a side surface of the electronic device,

the side surface surrounding a space between a front surface of the electronic device and a rear surface of the electronic device and comprising a first edge, a second edge extending from the first edge and perpendicular to the first edge, and a third edge extending from the second edge and parallel to the first edge, and the frame structure comprising:

a first insulating portion disposed in the first edge,

a second insulating portion disposed in the second edge,

a third insulating portion disposed in the second edge,

a first conductive portion extending from the first insulating portion to the second edge,

a second conductive portion spaced apart from the first conductive portion by the second insulating portion and corresponding to a part of the second edge, and

a third conductive portion spaced apart from the second conductive portion by the third insulating portion and extending to the third edge;

a wireless communication circuit disposed in the space;

a first switching circuit configured to connect the wireless communication circuit and at least one of the first conductive portion and the second conductive portion;

a second switching circuit configured to connect the wireless communication circuit and at least one of the second conductive portion and the third conductive portion; and

a proximity sensor configured to detect a proximity of a human body with respect to the first edge,

wherein the wireless communication circuit is configured to:

based on the proximity of the human body being not detected by the proximity sensor, feed power to the first conductive portion via the first switching circuit and feed power to the second conductive portion via the second switching circuit, and

based on the proximity of the human body being detected by the proximity sensor, feed power to the first conductive portion and the second conductive portion via the first switching circuit and feed power to the third conductive portion via the second switching circuit.

2. The electronic device of claim 1, further comprising:

a processor electrically connected to the wireless communication circuit; and

a third switching circuit connected to the first conductive portion,

wherein the wireless communication circuit or the processor is configured to, based on the proximity of the human body being detected by the proximity sensor, control the third switching circuit to change electrical paths related to the first conductive portion.

3. The electronic device of claim 1, wherein the wireless communication circuit is configured to, based on the proximity of the human body being detected by the proximity sensor, feed power to the first conductive portion and the second conductive portion via the first switching circuit, feed power to the third conductive portion via the second switching circuit, and then release a connection of the wireless communication circuit with the first conductive portion.

4. The electronic device of claim 3, further comprising:

a processor electrically connected to the wireless communication circuit; and

a fourth switching circuit connected to the second conductive portion,

wherein the processor is configured to control the fourth switching circuit to change electrical paths related to the second conductive portion.

5. The electronic device of claim 1, wherein the proximity sensor is disposed in the space.

6. The electronic device of claim 1, wherein the wireless communication circuit is configured to, based on the proximity of the human body being not detected by the proximity sensor, feed power to the first conductive portion via the first switching circuit, and feed power to the second conductive portion and the third conductive portion via the second switching circuit.

7. A method of operating an antenna of an electronic device, the method comprising:

detecting a proximity of a human body with respect to a first edge of the electronic device;

based on the proximity of the human body being not detected, feeding, by a wireless communication circuit of the electronic device, power to a first conductive portion formed in at least a part of the first edge via a first switching circuit of the electronic device and feeding, by the wireless communication circuit, power to a second conductive portion spaced apart from the first conductive portion via a second switching circuit of the electronic device; and

based on the proximity of the human body being detected, feeding, by the wireless communication circuit, power to the first conductive portion and the second conductive portion via the first switching circuit and feeding, by the wireless communication circuit, power to a third conductive portion spaced apart from the second conductive portion via the second switching circuit.

8. The method of claim 7, further comprising, based on the proximity of the human body being detected, changing electrical paths related to the first conductive portion via a third switching circuit of the electronic device.

9. The method of claim 7, further comprising, based on the proximity of the human body being detected, feeding, by the wireless communication circuit, power to the first conductive portion and the second conductive portion via the first switching circuit, feeding, by the wireless communication circuit, power to the third conductive portion via the second switching circuit, and then releasing a connection of the wireless communication circuit with the first conductive portion.

10. The method of claim 9, further comprising changing electrical paths related to the second conductive portion via a fourth switching circuit of the electronic device.

11. The method of claim 7, further comprising, based on the proximity of the human body being not detected, feeding, by the wireless communication circuit, power to the first conductive portion via the first switching circuit and feeding, by the wireless communication circuit, power to the second conductive portion and the third conductive portion via the second switching circuit.

12. The method of claim 7, further comprising, based on the proximity of the human body being not detected, feeding, by the wireless communication circuit, power to the first

conductive portion via the first switching circuit and feeding, by the wireless communication circuit, power to the third conductive portion via the second switching circuit.

**13**. The method of claim **7**, wherein the detecting of the proximity of the human body is performed by a proximity sensor disposed in the electronic device.

**14**. The method of claim **7**, wherein the electronic device further comprises a second edge extending from the first edge and perpendicular to the first edge, and a third edge extending from the second edge and parallel to the first edge, and

wherein the electronic device further comprises a first insulating portion formed in the first edge, a second insulating portion formed in the second edge and disposed between the first conductive portion and the second conductive portion, and a third insulating portion formed in the second edge and disposed between the second conductive portion and the third conductive portion.

**15**. An electronic device comprising:

a frame structure forming at least a part of a side surface of the electronic device, the side surface surrounding a space between a front surface of the electronic device and a rear surface of the electronic device and comprising a first edge, a second edge extending from the first edge and perpendicular to the first edge, and a third edge extending from the second edge and parallel to the first edge, and the frame structure comprising:

a first insulating portion disposed in the first edge,

a second insulating portion disposed in the second edge,

a third insulating portion positioned in the second edge,

a first conductive portion extending from the first insulating portion to the second edge,

a second conductive portion spaced apart from the first conductive portion by the second insulating portion and corresponding to a part of the second edge, and

a third conductive portion spaced apart from the second conductive portion by the third insulating portion and extending to the third edge;

a first wireless communication circuit and a second wireless communication circuit disposed in the space;

a first switching circuit configured to connect the first wireless communication circuit and at least one of the first conductive portion and the second conductive portion;

a second switching circuit configured to connect the second wireless communication circuit and at least one of the second conductive portion and the third conductive portion; and

a proximity sensor configured to detect a proximity of a human body with respect to the first edge,

wherein based on the proximity of the human body being not detected by the proximity sensor, the first wireless communication circuit is configured to feed power to the first conductive portion via the first switching circuit and feed power to the second conductive portion via the second switching circuit, and

wherein based on the proximity of the human body being detected by the proximity sensor, the first wireless communication circuit is configured to feed power to the first conductive portion and the second conductive portion via the first switching circuit and the second wireless communication circuit is configured feed power to the third conductive portion via the second switching circuit.



**16**. The electronic device of claim **15**, wherein based on the proximity of the human body being detected by the proximity sensor, the first wireless communication circuit is configured to transmit or receive a first signal in a first frequency band via the first conductive portion and the second conductive portion, and the second wireless communication circuit is configured to transmit or receive a second signal in a second frequency band different from the first frequency band via the third conductive portion.

**17**. The electronic device of claim **15**, further comprising a third switching circuit connected to the first conductive portion and configured to change electrical paths related to the first conductive portion.

**18**. The electronic device of claim **17**, further comprising a fourth switching circuit to the second conductive portion and configured to change electrical paths related to the second conductive portion.

**19**. The electronic device of claim **15**, further comprising a processor electrically connected to the first wireless communication circuit and the second wireless communication circuit,

wherein the processor is configured to:

determine whether the first wireless communication circuit is used alone or the first wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit is preferentially used to transmit or receive a signal, and

based on the first wireless communication circuit being used alone or the first wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit being preferentially used, determine whether the proximity of the human body is detected by the proximity sensor.

**20**. The electronic device of claim **19**, wherein the processor is further configured to:

based on the first wireless communication circuit being not used alone or the first wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit being not preferentially used, determine whether the second wireless communication circuit is used alone or the second wireless communication circuit among the first wireless communication circuit and the second wireless communication circuit is preferentially used to transmit or receive the signal.

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