



US 20180048050A1

(19) **United States**

(12) **Patent Application Publication**
Sayem et al.

(10) **Pub. No.: US 2018/0048050 A1**

(43) **Pub. Date: Feb. 15, 2018**

(54) **ANTENNA SYSTEM INCLUDING CLOSELY SPACED ANTENNAS ADAPTED FOR OPERATING AT THE SAME OR SIMILAR FREQUENCIES**

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 1/50* (2013.01); *H01Q 1/48* (2013.01); *H01Q 1/38* (2013.01)

(71) Applicant: **Motorola Mobility LLC**, Chicago, IL (US)

(57) **ABSTRACT**

(72) Inventors: **Abu Sayem**, Aurora, IL (US); **Ugur Olgun**, Chicago, IL (US); **Mohammed Abdul-Gaffoor**, Palatine, IL (US); **John Mura**, Clarendon Hills, IL (US); **Minh Duong**, Lake Bluff, IL (US)

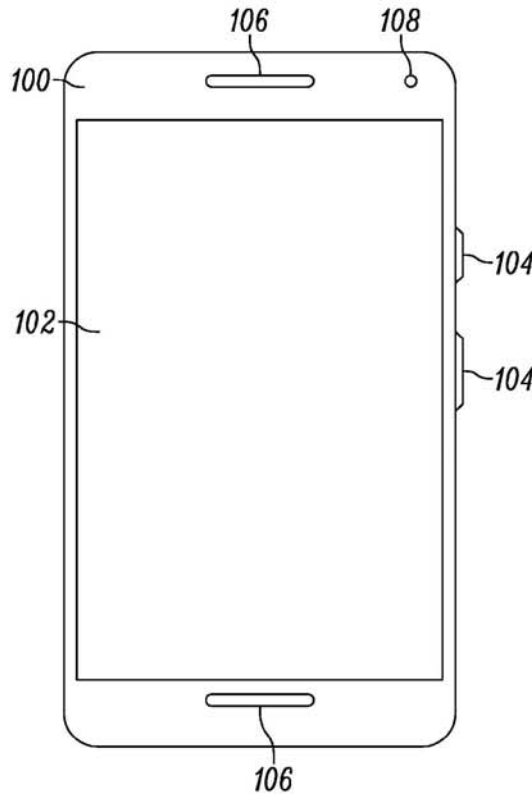
The present application provides an antenna system for use in an electronic device. The antenna system includes a conductive housing for the electronic device having a perimeter, which extends around the device. The conductive housing has a plurality of arms formed in the conductive housing at or near the perimeter. The antenna system further includes a conductive substrate, coupled to the conductive housing and located within the perimeter of the conductive housing. The conductive substrate has a notch located proximate the position of one of the plurality of arms in the conductive housing, where each of the plurality of arms respectively couples to the conductive substrate proximate the perimeter, and where the notch causes one of the plurality of arms to couple to the conductive substrate at a point having a different relative distance along the length of the perimeter of the conductive housing. The antenna system still further includes a plurality of signal sources, respectively coupled between the conductive substrate and a corresponding one of the plurality of arms. In at least some or other embodiments a selectable shunt circuit can be used to affect the polarization of the wireless signals associated with one or more of the antenna arms.

(21) Appl. No.: **15/235,757**

(22) Filed: **Aug. 12, 2016**

Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)





US 20180048359A1

(19) **United States**

(12) **Patent Application Publication**
KIM et al.

(10) **Pub. No.: US 2018/0048359 A1**
(43) **Pub. Date: Feb. 15, 2018**

(54) **ANTENNA DEVICE AND ELECTRONIC DEVICE INCLUDING THE SAME**

Publication Classification

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

(51) **Int. Cl.**
H04B 7/0404 (2006.01)
H04B 1/40 (2006.01)

(72) Inventors: **Jaehyung KIM**, Gyeonggi-do (KR);
Jae-Ho LIM, Gyeonggi-do (KR);
Hosaeng KIM, Gyeonggi-do (KR);
Jesun MOON, Gyeonggi-do (KR);
Sungyeul HONG, Gyeonggi-do (KR);
Kyung-Jong LEE, Gyeonggi-do (KR);
Jinkyu BANG, Gyeonggi-do (KR);
Hanbin LEE, Gyeonggi-do (KR);
Kyung-Bae KO, Gyeonggi-do (KR);
Donghwan KIM, Gyeonggi-do (KR);
Taegy KIM, Gyeonggi-do (KR);
Jae-Bong CHUN, Gyeonggi-do (KR)

(52) **U.S. Cl.**
CPC **H04B 7/0404** (2013.01); **H04B 1/40**
(2013.01); **H04M 2250/16** (2013.01); **H04M**
1/0268 (2013.01)

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a first housing a second housing, a first display disposed on the first housing and a second display disposed on the second housing, a connecting member configured to couple the first housing to the second housing such that the first housing and the second housing are foldable relative to each other, and the second surface and the fourth surface face each other when the first housing and the second housing are folded toward each other, a first conductive element disposed within the first housing and between the second surface and the first display, and an intermediate conductive plate disposed within the second housing and between the fourth surface and the second display, the intermediate conductive plate having an opening that faces the first conductive element when the first housing and the second housing are in a folded configuration.

(21) Appl. No.: **15/792,017**

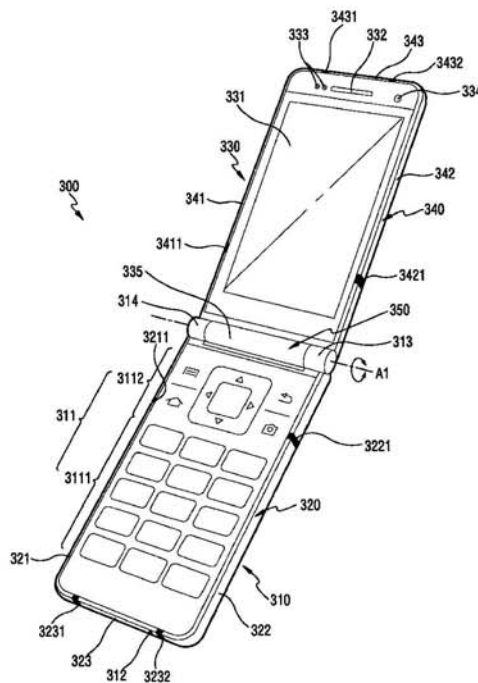
(22) Filed: **Oct. 24, 2017**

Related U.S. Application Data

(63) Continuation of application No. 15/351,142, filed on Nov. 14, 2016, now Pat. No. 9,831,928.

(30) **Foreign Application Priority Data**

Nov. 13, 2015 (KR) 10-2015-0159674
Apr. 8, 2016 (KR) 10-2016-0043135





US 20180048745A1

(19) **United States**

(12) **Patent Application Publication**
Karilainen

(10) **Pub. No.: US 2018/0048745 A1**

(43) **Pub. Date: Feb. 15, 2018**

(54) **PROVIDING SENSING ABILITY WITH A WIRELESS COMMUNICATION APPARATUS**

(52) **U.S. Cl.**
CPC *H04M 1/0245* (2013.01); *H04B 1/3838* (2013.01); *H04M 2250/12* (2013.01)

(71) Applicant: **Microsoft Technology Licensing, LLC,**
Redmond, WA (US)

(72) Inventor: **Antti Karilainen,** Helsinki (FI)

(57) **ABSTRACT**

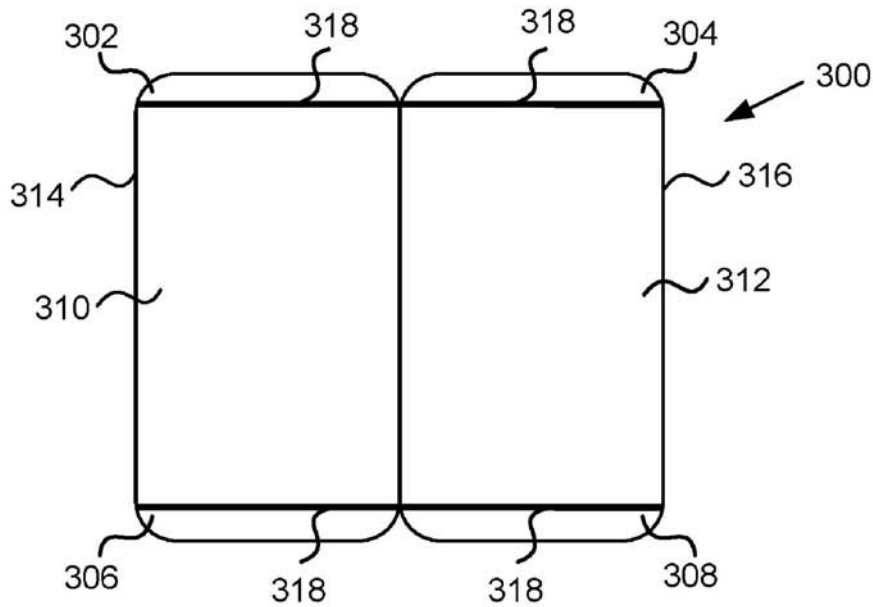
(21) Appl. No.: **15/232,679**

(22) Filed: **Aug. 9, 2016**

According to one aspect, there is provided a wireless communication apparatus comprising an antenna configured to operate as an antenna and as an electrode, a reference part configured to provide a reference potential, and a sensor module connected to the electrode and to the reference potential, the sensor module being configured to measure a change in the potential between the electrode and the reference potential.

Publication Classification

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H04B 1/3827 (2006.01)





US 20180053990A1

(19) **United States**

(12) **Patent Application Publication**
Caballero et al.

(10) **Pub. No.: US 2018/0053990 A1**

(43) **Pub. Date: Feb. 22, 2018**

(54) **ANTENNA SYSTEM WITH ANTENNA SWAPPING AND ANTENNA TUNING**

H01Q 9/04 (2006.01)

H01Q 9/42 (2006.01)

H01Q 21/28 (2006.01)

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

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

CPC *H01Q 1/243* (2013.01); *H04M 1/0202*

(2013.01); *H01Q 9/0421* (2013.01); *H04B*

7/0689 (2013.01); *H01Q 21/28* (2013.01);

H01Q 9/42 (2013.01)

(72) Inventors: **Ruben Caballero**, San Jose, CA (US);
Mattia Pascolini, San Francisco, CA (US);
Mohit Narang, Cupertino, CA (US);
Matt A. Mow, Los Altos, CA (US);
Robert W. Schlub, Cupertino, CA (US)

(57)

ABSTRACT

Electronic devices may be provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and first and second antennas. An electronic device may include a housing. The first antenna may be located at an upper end of the housing and the second antenna may be located at a lower end of the housing. A peripheral conductive member may run around the edges of the housing and may be used in forming the first and second antennas. The radio-frequency transceiver circuitry may have a transmit-receive port and a receive port. Switching circuitry may connect the first antenna to the transmit-receive port and the second antenna to the receiver port or may connect the first antenna to the receiver port and the second antenna to the transmit-receive port.

(21) Appl. No.: **15/795,810**

(22) Filed: **Oct. 27, 2017**

Related U.S. Application Data

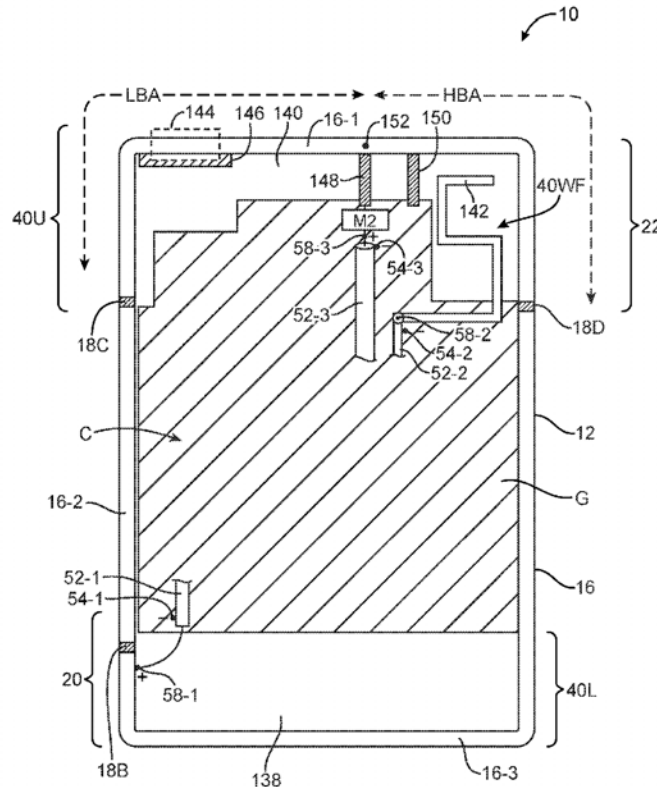
(63) Continuation of application No. 14/608,048, filed on Jan. 28, 2015, now Pat. No. 9,806,401, which is a continuation of application No. 12/941,011, filed on Nov. 5, 2010, now Pat. No. 8,947,302.

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H04M 1/02 (2006.01)





US 20180062243A1

(19) **United States**

(12) **Patent Application Publication**
YANG

(10) **Pub. No.: US 2018/0062243 A1**

(43) **Pub. Date: Mar. 1, 2018**

(54) **MOBILE DEVICE**

H01Q 1/36 (2006.01)

H01Q 1/22 (2006.01)

(71) Applicant: **Acer Incorporated**, New Taipei City (TW)

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

CPC *H01Q 1/243* (2013.01); *H01Q 1/2291* (2013.01); *H01Q 1/36* (2013.01); *H01Q 1/48* (2013.01)

(72) Inventor: **Chung-Wen YANG**, New Taipei City (TW)

(21) Appl. No.: **15/331,087**

(57)

ABSTRACT

(22) Filed: **Oct. 21, 2016**

A mobile device includes an antenna structure. The antenna structure includes a main radiation element, a first parasitic element, and a second parasitic element. The main radiation element has a feeding point. The first parasitic element has a first grounding point. The first parasitic element is adjacent to the main radiation element, and the first grounding point is adjacent to the feeding point. The second parasitic element has a second grounding point. The second parasitic element is adjacent to an end of the main radiation element.

(30) **Foreign Application Priority Data**

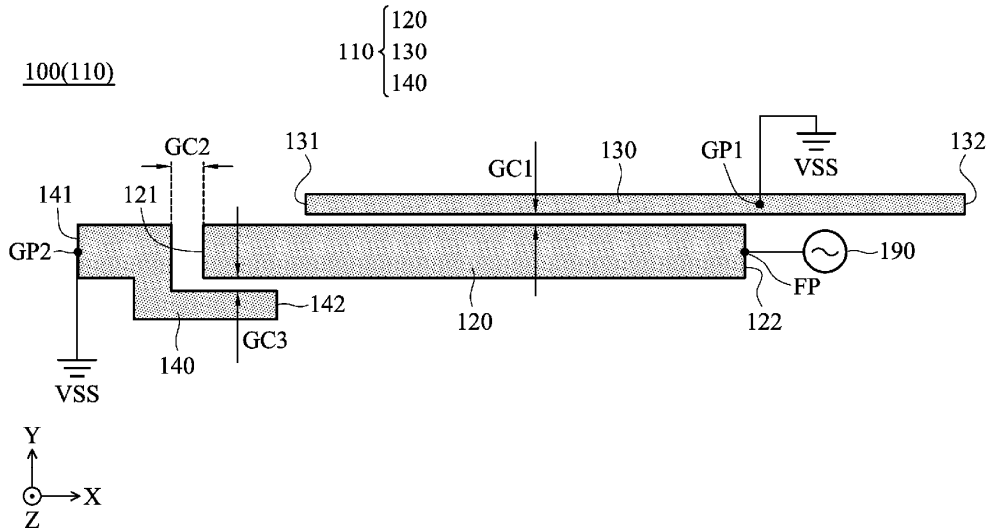
Aug. 25, 2016 (TW) 105127217

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/48 (2006.01)





US 20180062244A1

(19) **United States**

(12) **Patent Application Publication**
HUANG et al.

(10) **Pub. No.: US 2018/0062244 A1**

(43) **Pub. Date: Mar. 1, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

H01Q 5/10 (2006.01)

H01Q 13/10 (2006.01)

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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

CPC *H01Q 1/243* (2013.01); *H01Q 13/10*

(2013.01); *H01Q 5/10* (2015.01); *H01Q 5/371*

(2015.01)

(72) Inventors: **Kuo-Lun HUANG**, New Taipei (TW);
Ming-Yu CHOU, New Taipei (TW);
Yu-Kai TSENG, New Taipei (TW)

(57)

ABSTRACT

(21) Appl. No.: **15/653,668**

(22) Filed: **Jul. 19, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/382,762, filed on Sep. 1, 2016.

(30) **Foreign Application Priority Data**

Jun. 23, 2017 (CN) 201710487851.7

Publication Classification

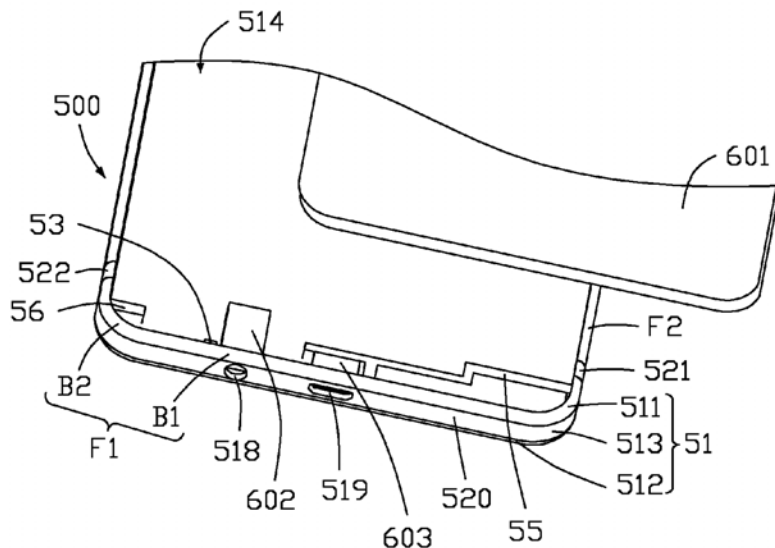
(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 5/371 (2006.01)

An antenna structure which is switchable between low, middle, and high frequencies includes a metal housing, a feed portion, a resonance portion, and a connecting portion. The metal housing includes a front frame, a backboard, and a side frame. The side frame defines a slot and the front frame defines a first gap and a second gap. The slot, the first gap, and the second gap separate a continuous antenna portion from the metal housing. The feed portion is electrically connected to the antenna portion for feeding current to the antenna portion. One end of the resonance portion is electrically connected to a first location of the antenna portion and another end grounded. One end of the connecting portion is electrically connected to a second location of the antenna portion and another end is electrically connected to the resonance portion.

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US 20180062267A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2018/0062267 A1**
(43) **Pub. Date: Mar. 1, 2018**

(54) **ANTENNA STRUCTURE**

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

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

CPC **H01Q 9/14** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01)

(72) Inventors: **CHO-KANG HSU**, New Taipei (TW);
TE-CHANG LIN, New Taipei (TW)

(57) **ABSTRACT**

(21) Appl. No.: **15/684,853**

(22) Filed: **Aug. 23, 2017**

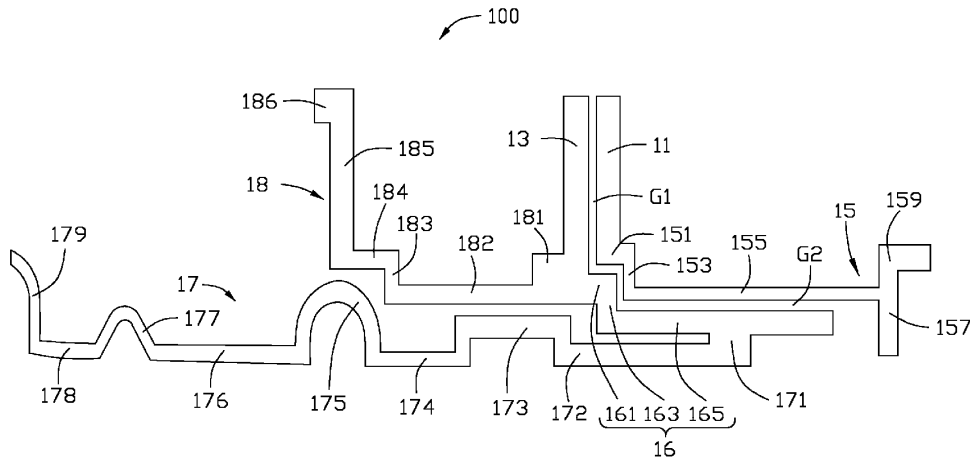
(30) **Foreign Application Priority Data**

Aug. 31, 2016 (CN) 201610774852.5

Publication Classification

(51) **Int. Cl.**
H01Q 9/14 (2006.01)
H01Q 1/50 (2006.01)
H01Q 1/48 (2006.01)

An antenna structure includes a feed portion, a high-frequency radiating portion, a low-frequency radiating portion, an extension portion, and a switching unit. The high-frequency radiating portion is electrically connected to the feed portion. The low-frequency radiating portion is electrically connected to the high-frequency radiating portion. The extension portion is electrically connected to the feed portion and the high-frequency radiating portion. The switching unit is electrically connected to the extension portion to control the extension portion to be in one of an open-circuit state and a short-circuit state.





US 20180062270A1

(19) **United States**

(12) **Patent Application Publication**
LIANG et al.

(10) **Pub. No.: US 2018/0062270 A1**

(43) **Pub. Date: Mar. 1, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

H01Q 5/328 (2006.01)

H01Q 1/42 (2006.01)

H01Q 3/24 (2006.01)

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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

CPC *H01Q 13/106* (2013.01); *H01Q 5/335* (2015.01); *H01Q 3/24* (2013.01); *H01Q 1/42* (2013.01); *H01Q 5/328* (2015.01)

(72) Inventors: **CHIA-MING LIANG**, New Taipei (TW); **SHENG-CHIEH LIANG**, New Taipei (TW); **MING-YU CHOU**, New Taipei (TW); **CHANG-HSIN OU**, New Taipei (TW); **CHENG-I CHANG**, New Taipei (TW)

(57) **ABSTRACT**

(21) Appl. No.: **15/690,304**

(22) Filed: **Aug. 30, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/382,762, filed on Sep. 1, 2016.

(30) **Foreign Application Priority Data**

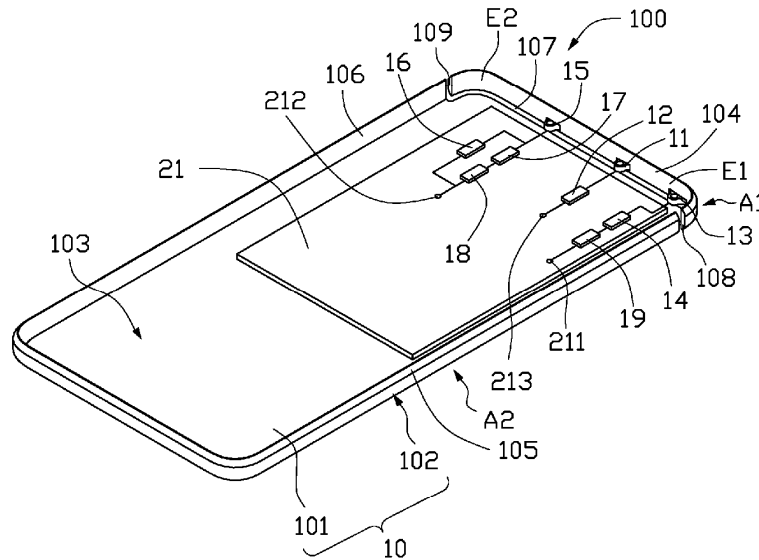
Dec. 29, 2016 (CN) 201611243441.X

Publication Classification

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 5/335 (2006.01)

An antenna structure includes a housing, a first connecting portion, a matching unit, a second connecting portion, and a first switching circuit. The housing defines a slot, a first gap, and a second gap. The housing is divided into a first portion and a second portion by the slot, the first gap, and the second gap. The second portion is grounded. One end of the first connecting portion electrically connected to the first portion and another end of the first connecting portion electrically connected to a feed point through the matching unit. The first portion is divided into a first radiating portion and a second radiating portion by the first connecting portion. One end of the second connecting portion is electrically connected to the first radiating portion and another end of the second connecting portion is grounded through the first switching circuit.

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US 20180069293A1

(19) **United States**

(12) **Patent Application Publication**
HU et al.

(10) **Pub. No.: US 2018/0069293 A1**
(43) **Pub. Date: Mar. 8, 2018**

(54) **HOUSING, ANTENNA DEVICE AND MOBILE TERMINAL**

(30) **Foreign Application Priority Data**

(71) Applicant: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (CN)

Mar. 21, 2016 (CN) 201610163702.0
Apr. 29, 2016 (CN) 201610287114.8
Apr. 29, 2016 (CN) 201610287147.2

Publication Classification

(72) Inventors: **Shasha HU**, Dongguan (CN); **Ning ZHAO**, Dongguan (CN); **Shengzhao XIANG**, Dongguan (CN)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/30 (2006.01)

(73) Assignee: **GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP., LTD.**, Dongguan (CN)

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01); **H01Q 21/30** (2013.01)

(21) Appl. No.: **15/798,823**

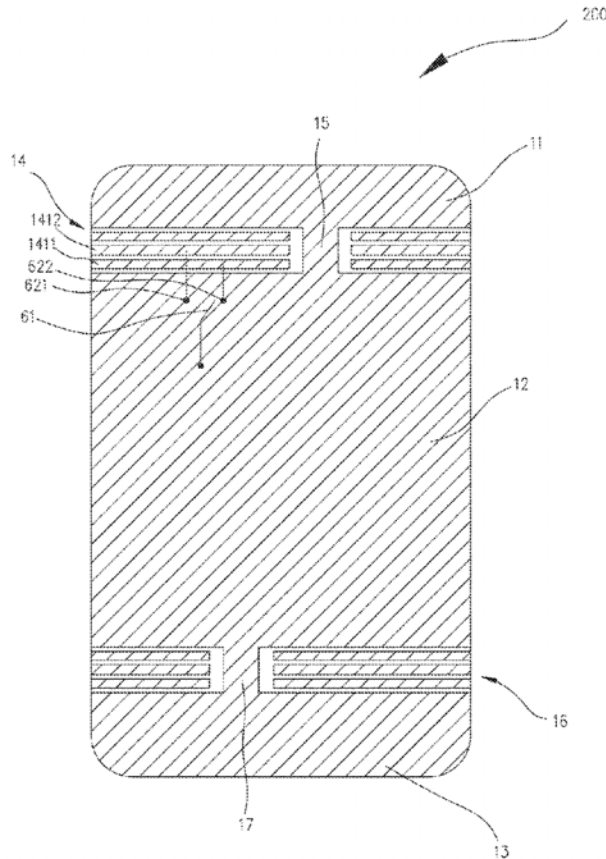
(22) Filed: **Oct. 31, 2017**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2016/086566, filed on Jun. 21, 2016.

(57) **ABSTRACT**

A housing is provided. The housing includes a first housing area, a second housing area, a slit strip and a connecting segment, the slit strip includes at least one slit, the first housing area and the second housing area are located at two sides of the slit strip, the connecting segment are located at an extending path of the slit strip, the connecting segment electrically conductively couples the first housing area and the second housing area. An antenna device and a mobile terminal are also provided by the present disclosure.





US 20180069297A1

(19) **United States**

(12) **Patent Application Publication**
Jin et al.

(10) **Pub. No.: US 2018/0069297 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **ELECTRONIC DEVICE ANTENNA WITH SUPPRESSED PARASITIC RESONANCE**

H01Q 1/42 (2006.01)

H01Q 1/22 (2006.01)

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

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

CPC *H01Q 1/243* (2013.01); *H01Q 1/48* (2013.01); *H01Q 1/2291* (2013.01); *H01Q 1/42* (2013.01); *H01Q 9/0421* (2013.01)

(72) Inventors: **Nanbo Jin**, Milpitas, CA (US); **Anand Lakshmanan**, San Jose, CA (US); **Christopher T. Cheng**, Sunnyvale, CA (US); **Erica J. Tong**, Pacifica, CA (US); **Han Wang**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Scott A. Myers**, San Francisco, CA (US); **Xu Gao**, Santa Clara, CA (US); **Richard H. Dinh**, San Jose, CA (US); **Tang Yew Tan**, Palo Alto, CA (US)

(57)

ABSTRACT

An electronic device may be provided with wireless circuitry. The wireless circuitry may include one or more antennas. The antennas may include cellular telephone antennas, wireless local area network antennas, antenna structures for receiving satellite navigation system signals, and other antennas. An antenna may have an antenna resonating element such as an inverted-F antenna resonating element. The inverted-F antenna resonating element may have an inverted-F antenna resonating element arm formed from metal traces on a flexible printed circuit. The flexible printed circuit may be soldered to an antenna grounding clip. A screw may attach the clip, a speaker tab, a connector bracket, and other metal structures to a metal device housing that serves as ground for the antenna. The screw may be isolated from the antenna grounding clip and the other metal structures by an insulating structure such as an insulating gasket.

(21) Appl. No.: **15/257,542**

(22) Filed: **Sep. 6, 2016**

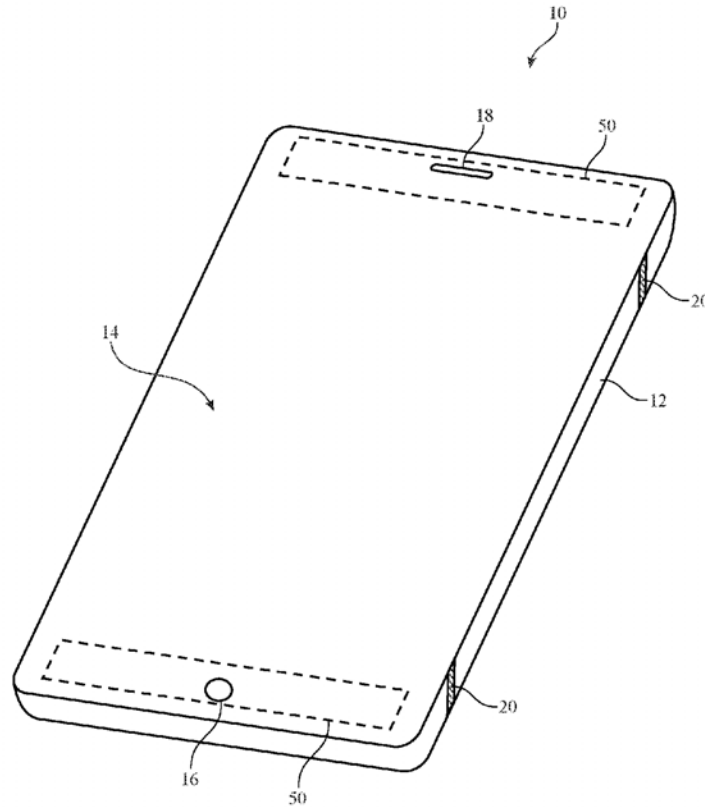
Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/48 (2006.01)

H01Q 9/04 (2006.01)





US 20180069298A1

(19) **United States**

(12) **Patent Application Publication**
WOO

(10) **Pub. No.: US 2018/0069298 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **MOBILE TERMINAL**

(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)

(72) Inventor: **Seungmin WOO**, Seoul (KR)

(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)

(21) Appl. No.: **15/461,412**

(22) Filed: **Mar. 16, 2017**

(30) **Foreign Application Priority Data**

Sep. 7, 2016 (KR) 10-2016-0115094

Publication Classification

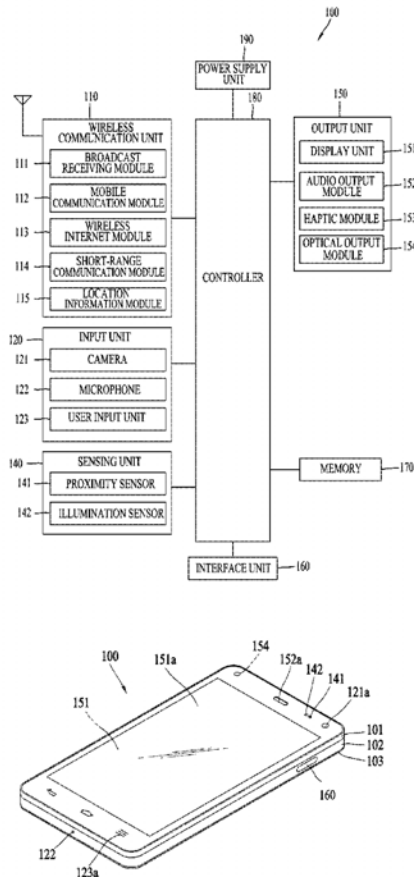
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/335 (2006.01)
H01Q 1/52 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 5/335** (2015.01)

(57) **ABSTRACT**

A mobile terminal comprises a case; a main board packaged in the case; a signal supply unit packaged on the main board, supplying a radio signal; an antenna radiator packaged in the case, including a conductive material and transmitting and receiving a signal of a first frequency; an antenna tuner packaged in the case, including a conductive material; a feeding line located on the main board, having one end connected with the signal supply unit and the other end connected with the antenna radiator; and a tuning line located on the main board, having one end connected to the feeding line and the other end connected with the antenna tuner, wherein the tuning line and the antenna tuner compensate for impedance of the feeding line and the antenna radiator. The mobile terminal can prevent wireless communication performance from being deteriorated by impedance distorted by an external environment like that a body of a user approaches the antenna radiator.





US 20180069301A1

(19) **United States**

(12) **Patent Application Publication**
Choi et al.

(10) **Pub. No.: US 2018/0069301 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **ANTENNA FOR WIRELESS COMMUNICATION AND ELECTRONIC DEVICE INCLUDING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

(72) Inventors: **Nak Chung Choi**, Seoul (KR); **Gyu Sub Kim**, Seoul (KR); **Hyung Joo Lee**,
Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**

(21) Appl. No.: **15/698,187**

(22) Filed: **Sep. 7, 2017**

(30) **Foreign Application Priority Data**

Sep. 7, 2016 (KR) 10-2016-0114921

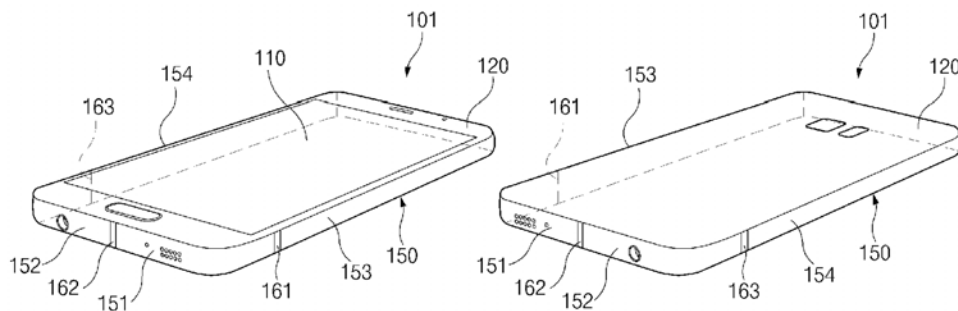
Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 1/245** (2013.01)

(57) **ABSTRACT**

An electronic device is provided, which includes a housing; a conductive member forming at least a part of the housing; first to third nonconductive members separating the conductive member, wherein the conductive member includes a first conductive pattern disposed between the first nonconductive member and the second nonconductive member, and a second conductive pattern disposed between the second nonconductive member and the third nonconductive member; a first feeding part connected to the first conductive pattern; a second feeding part connected to the second conductive pattern; a first ground part connected to the first conductive pattern at a point adjacent to the second nonconductive member; and a communication circuit electrically connected with the conductive member.





US 20180069306A1

(19) **United States**

(12) **Patent Application Publication**
XUE et al.

(10) **Pub. No.: US 2018/0069306 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **TERMINAL**

(71) Applicant: **Huawei Technologies Co., Ltd.**,
Shenzhen (CN)

(72) Inventors: **Liang XUE**, Shanghai (CN); **Dong YU**,
Shanghai (CN); **Hanyang WANG**,
Reading (GB); **Jiaqing YOU**, Shanghai
(CN); **Kun FENG**, Shanghai (CN); **Rui
ZHANG**, Shanghai (CN); **Meng HOU**,
Shanghai (CN)

(21) Appl. No.: **15/560,405**

(22) PCT Filed: **Mar. 30, 2015**

(86) PCT No.: **PCT/CN2015/075390**

§ 371 (e)(1),

(2) Date: **Sep. 21, 2017**

Publication Classification

(51) **Int. Cl.**

H01Q 1/44 (2006.01)

H01Q 13/10 (2006.01)

H01Q 21/28 (2006.01)

H01Q 1/24 (2006.01)

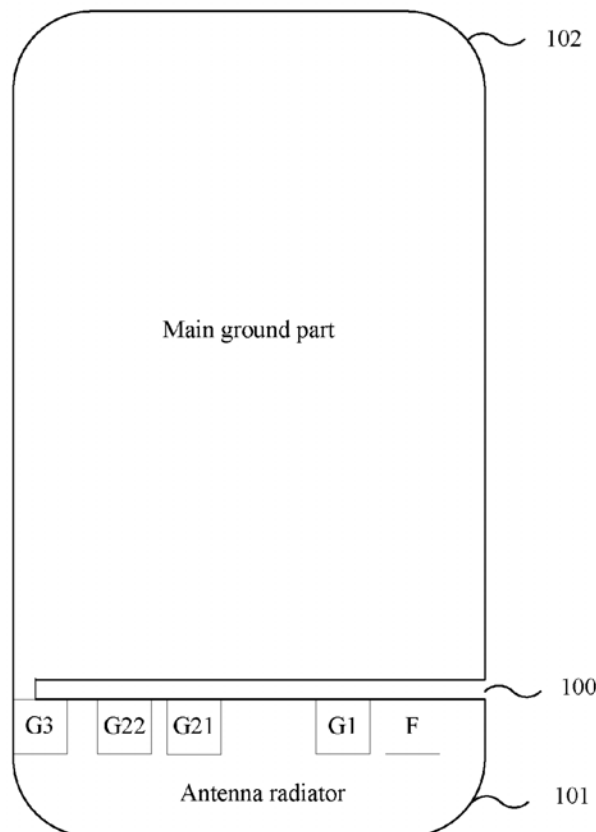
(52) **U.S. Cl.**

CPC **H01Q 1/44** (2013.01); **H01Q 13/106**
(2013.01); **H01Q 9/0421** (2013.01); **H01Q**
1/243 (2013.01); **H01Q 21/28** (2013.01)

(57)

ABSTRACT

A terminal is disclosed, wherein a metal back cover of the terminal includes a slot. The slot divides the metal back cover into two parts. One of the two parts is used as an antenna radiator. The antenna radiator includes a signal feed point, a first ground point, and at least one second ground point, so that an antenna of the terminal has four resonance points. The signal feed point is connected to a matching network, the first ground point is grounded by a switch device, and the second ground point is grounded. A distance between the signal feed point and the first ground point is less than a distance between the signal feed point and the second ground point, and none of the signal feed point, the first ground point, and the second ground point is located in an end of the slot.





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(19) **United States**

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DURNING et al.

(10) **Pub. No.: US 2018/0069308 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **SWITCHED ANTENNA ASSEMBLY**

Publication Classification

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(51) **Int. Cl.**
H01Q 3/24 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

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(52) **U.S. Cl.**
CPC *H01Q 3/24* (2013.01); *H01Q 9/0421* (2013.01); *H01Q 1/48* (2013.01); *H01Q 1/243* (2013.01)

(57) **ABSTRACT**

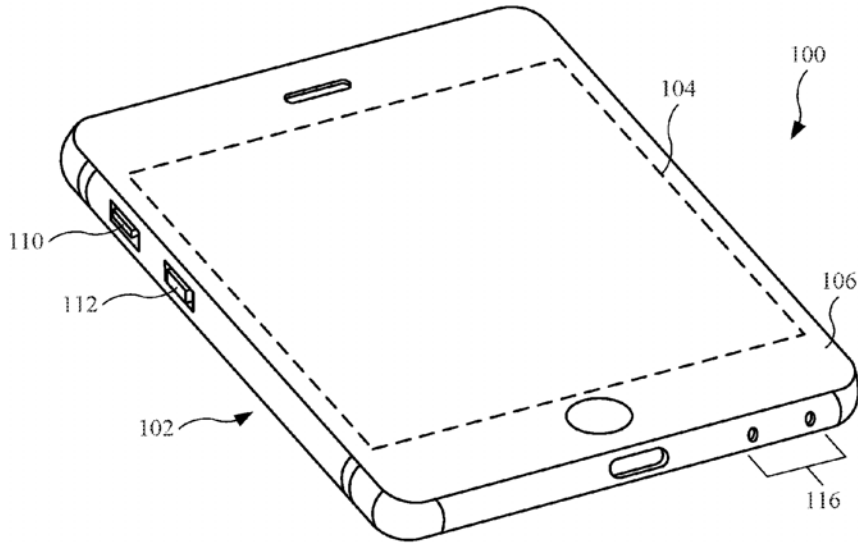
A consumer electronic product includes a switchable inductor array coupled to the RF antenna, the switchable inductor array comprising inductive elements and a switch circuit coupled to the inductor array to select at least one of the inductive elements and couple the selected inductive element with the RF antenna. The product can further include an assembly having a mesh that is strengthened by a stiffener. A multi-layer adhesive have a conductive layer that can be used to shield the RF antenna and adhesive layers that can provide adhesion between the stiffener and the housing of the product. The assembly can be covered by a cowling that is made of metal to provide further shielding. To reduce potential coupling between the RF antenna and the cowling, the cowling can have a portion that is formed of plastic to distance its metal portion from the antenna.

(21) Appl. No.: **15/461,248**

(22) Filed: **Mar. 16, 2017**

Related U.S. Application Data

(60) Provisional application No. 62/384,109, filed on Sep. 6, 2016.





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(19) **United States**

(12) **Patent Application Publication**
Ayala Vazquez et al.

(10) **Pub. No.: US 2018/0069317 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **ELECTRONIC DEVICE ANTENNA WITH SWITCHABLE RETURN PATHS**

Publication Classification

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)

(72) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Nanbo Jin**, San Jose, CA (US); **Matthew A. Mow**, Los Altos, CA (US); **Liang Han**, Sunnyvale, CA (US); **Ming-Ju Tsai**, Sunnyvale, CA (US); **Erica J. Tong**, Pacifica, CA (US); **Erdinc Irci**, Sunnyvale, CA (US); **Salih Yarga**, Sunnyvale, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Benjamin Shane Bustle**, Cupertino, CA (US); **Ruben Caballero**, San Jose, CA (US)

(52) **U.S. Cl.**
CPC **H01Q 13/103** (2013.01); **H01Q 1/245** (2013.01)

(21) Appl. No.: **15/806,986**

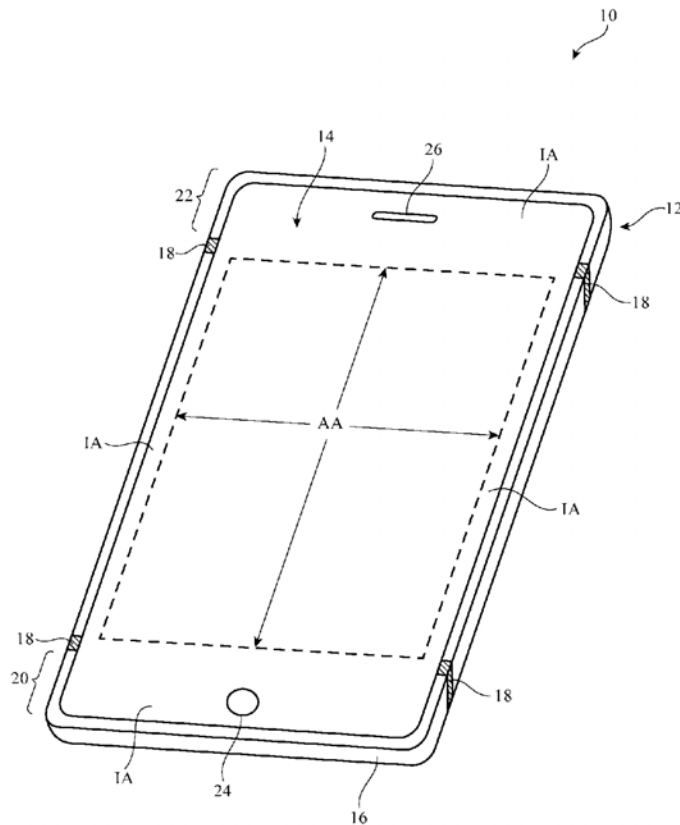
(22) Filed: **Nov. 8, 2017**

Related U.S. Application Data

(63) Continuation of application No. 14/811,714, filed on Jul. 28, 2015.

(57) **ABSTRACT**

An electronic device may have wireless circuitry with antennas. An antenna resonating element arm for an antenna may be formed from conductive housing structures running along the edges of a device. The antenna may have a pair of switchable return paths that bridge a slot between the antenna resonating element and an antenna ground. An adjustable component and a feed may be coupled in parallel across the slot. The adjustable component may switch a capacitor into use or out of use and the return paths may be selectively opened and closed to compensate for antenna loading due to the presence of external objects near the electronic device.





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(19) **United States**

(12) **Patent Application Publication**
YOSUI

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(43) **Pub. Date: Mar. 8, 2018**

(54) **ANTENNA DEVICE AND ELECTRONIC APPARATUS**

(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi (JP)

(72) Inventor: **Kuniaki YOSUI**, Nagaokakyo-shi (JP)

(21) Appl. No.: **15/807,697**

(22) Filed: **Nov. 9, 2017**

Related U.S. Application Data

(63) Continuation of application No. 14/592,984, filed on Jan. 9, 2015, now Pat. No. 9,847,585, which is a continuation of application No. 14/591,038, filed on Jan. 7, 2015, now Pat. No. 9,705,206, which is a continuation of application No. PCT/JP2013/083601, filed on Dec. 16, 2013.

(30) **Foreign Application Priority Data**

Dec. 21, 2012 (JP) 2012-280243

Publication Classification

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 5/371 (2006.01)

H01Q 5/335 (2006.01)
H01Q 5/328 (2006.01)
H01Q 9/42 (2006.01)
H01Q 7/00 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)

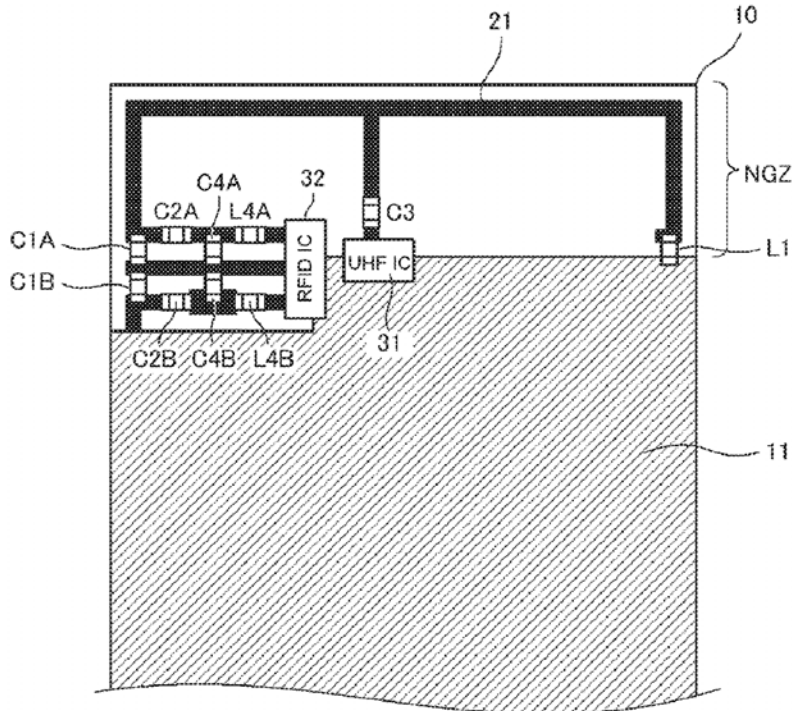
(52) **U.S. Cl.**

CPC **H01Q 21/28** (2013.01); **H01Q 5/371** (2015.01); **H01Q 5/335** (2015.01); **H01Q 5/328** (2015.01); **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/2216** (2013.01); **H01Q 1/2208** (2013.01); **H01Q 7/00** (2013.01)

(57)

ABSTRACT

A square bracket-shaped radiation element is in a non-ground region of a board. A first reactance element that equivalently enters a short-circuited state in a second frequency band is connected between a second end of the radiation element and a ground conductor. A second reactance element that equivalently enters a short-circuited state in a first frequency band is connected between a first end of the radiation element and the ground conductor. In the UHF band, the radiation element and the ground conductor function as an inverted F antenna that contributes to field emission. In the HF band, a loop including the radiation element and the ground conductor functions as a loop antenna that contributes to magnetic field emission.





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(19) **United States**

(12) **Patent Application Publication**
Kim et al.

(10) **Pub. No.: US 2018/0069616 A1**

(43) **Pub. Date: Mar. 8, 2018**

(54) **METHOD AND ELECTRONIC DEVICE FOR CONFIGURING RADIO FREQUENCY SETTING**

Publication Classification

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)

(51) **Int. Cl.**
H04B 7/08 (2006.01)
H04L 5/00 (2006.01)

(72) Inventors: **Sung Soo Kim**, Suwon-si (KR); **Min Chull Paik**, Suwon-si (KR); **Hyoungjoo Lee**, Suwon-si (KR); **Hyun Hoon Ha**, Suwon-si (KR); **Won Hyung Heo**, Suwon-si (KR)

(52) **U.S. Cl.**
CPC **H04B 7/0814** (2013.01); **H04L 5/001** (2013.01)

(21) Appl. No.: **15/699,575**

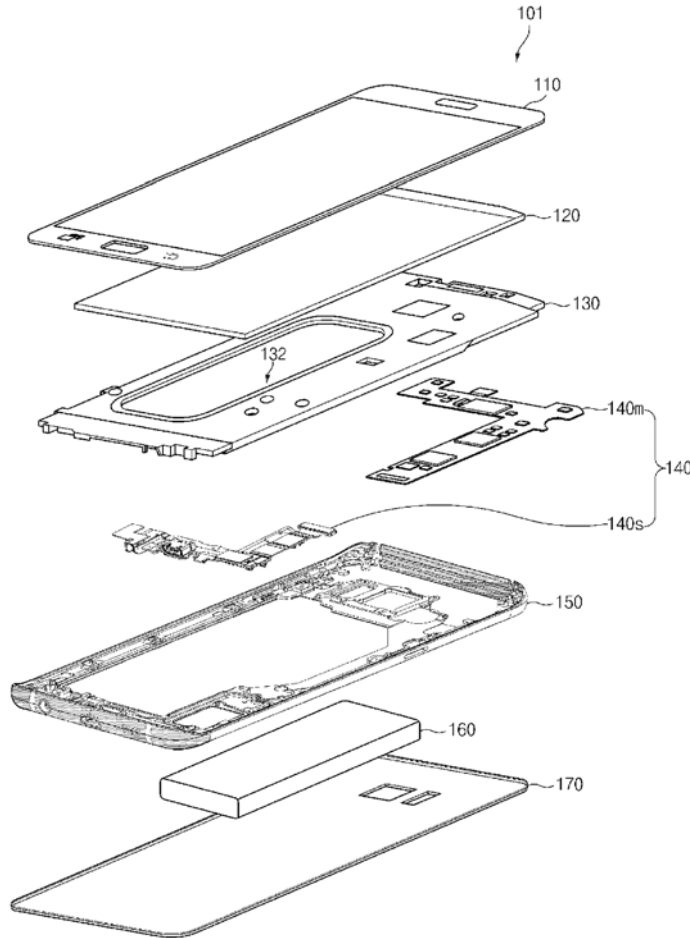
(57) **ABSTRACT**

(22) Filed: **Sep. 8, 2017**

An electronic device includes a communication circuit, a plurality of antennas that are fed with power from the communication circuit, and a processor that controls the communication circuit. The processor is configured to receive a first signal for indicating initiation of configuration for carrier aggregation. The processor is also configured to change the configuration of at least one of the antennas or the communication circuit to perform the carrier aggregation if a second signal for indicating operation initiation of the carrier aggregation is received from a base station.

(30) **Foreign Application Priority Data**

Sep. 8, 2016 (KR) 10-2016-0115903





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(19) **United States**

(12) **Patent Application Publication**
HEO

(10) **Pub. No.: US 2018/0076507 A1**

(43) **Pub. Date: Mar. 15, 2018**

(54) **ANTENNA AND ELECTRONIC DEVICE INCLUDING THE SAME**

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

CPC *H01Q 1/243* (2013.01); *H01Q 9/0421* (2013.01); *H01Q 5/321* (2015.01)

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

(72) Inventor: **Young HEO**, Gyeonggi-do (KR)

(57)

ABSTRACT

(21) Appl. No.: **15/694,261**

(22) Filed: **Sep. 1, 2017**

(30) **Foreign Application Priority Data**

Sep. 12, 2016 (KR) 10-2016-0117031

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 5/321 (2006.01)

An electronic device is provided, which includes a housing; a conductive member forming a part of the housing or disposed on an inside of the housing; a communication circuit electrically connected to a first region of the conductive member; a conductive pattern electrically connected to a second region of the conductive member; and a switching circuit disposed on an electric path between the conductive pattern and the conductive member that controls a switching operation to selectively, electrically connect and disconnect the conductive pattern to and from the conductive member.

