



US 20200194872A1

(19) **United States**

(12) **Patent Application Publication**

Han et al.

(10) **Pub. No.: US 2020/0194872 A1**

(43) **Pub. Date: Jun. 18, 2020**

(54) **THREE-SLOTTED ANTENNA APPARATUS AND METHOD**

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

(72) Inventors: **Chulmin Han**, San Diego, CA (US);
Wee Kian Toh, San Diego, CA (US);
Wei Huang, San Diego, CA (US);
Hongwei Liu, San Diego, CA (US)

(21) Appl. No.: **16/604,962**

(22) PCT Filed: **Apr. 10, 2018**

(86) PCT No.: **PCT/CN2018/082450**

§ 371 (c)(1),

(2) Date: **Oct. 11, 2019**

Related U.S. Application Data

(63) Continuation of application No. 15/488,308, filed on
Apr. 14, 2017, now Pat. No. 10,236,559.

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 5/371 (2006.01)

H01Q 5/35 (2006.01)

H01Q 13/10 (2006.01)

H01Q 5/50 (2006.01)

H01Q 1/48 (2006.01)

H01Q 13/18 (2006.01)

H04B 7/0404 (2006.01)

H04B 7/0413 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/371**
(2015.01); **H01Q 5/35** (2015.01); **H01Q 13/10**
(2013.01); **H01Q 21/28** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 13/18** (2013.01); **H04B**
7/0404 (2013.01); **H04B 7/0413** (2013.01);
H01Q 5/50 (2015.01)

(57) **ABSTRACT**

An apparatus and associated method are provided involving a housing having a periphery configured to operate as a second antenna, a third antenna, and a fourth antenna. The periphery includes a top wall having a first slot formed therein, a first side wall having a second slot formed therein, and a second side wall having a third slot formed therein. The top wall is arranged between the first side wall and the second side wall, and a top portion of the periphery is defined between the second slot and the third slot. The top portion is divided into a first top side portion and a second top side portion via the first slot. Further, the first top side portion operates as the second antenna, and the second top side portion operates as both the third antenna and the fourth antenna.



(19) **United States**

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

(10) **Pub. No.: US 2020/0194873 A1**

(43) **Pub. Date: Jun. 18, 2020**

(54) **MOBILE TERMINAL HAVING AN ANTENNA INCLUDING DIELECTRICS ON A CIRCUIT BOARD**

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

(72) Inventors: **Seungwoo RYU**, Seoul (KR); **Joohee LEE**, Seoul (KR); **Wonwoo LEE**, Seoul (KR); **Junyoung JUNG**, Seoul (KR)

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

(21) Appl. No.: **16/797,506**

(22) Filed: **Feb. 21, 2020**

Related U.S. Application Data

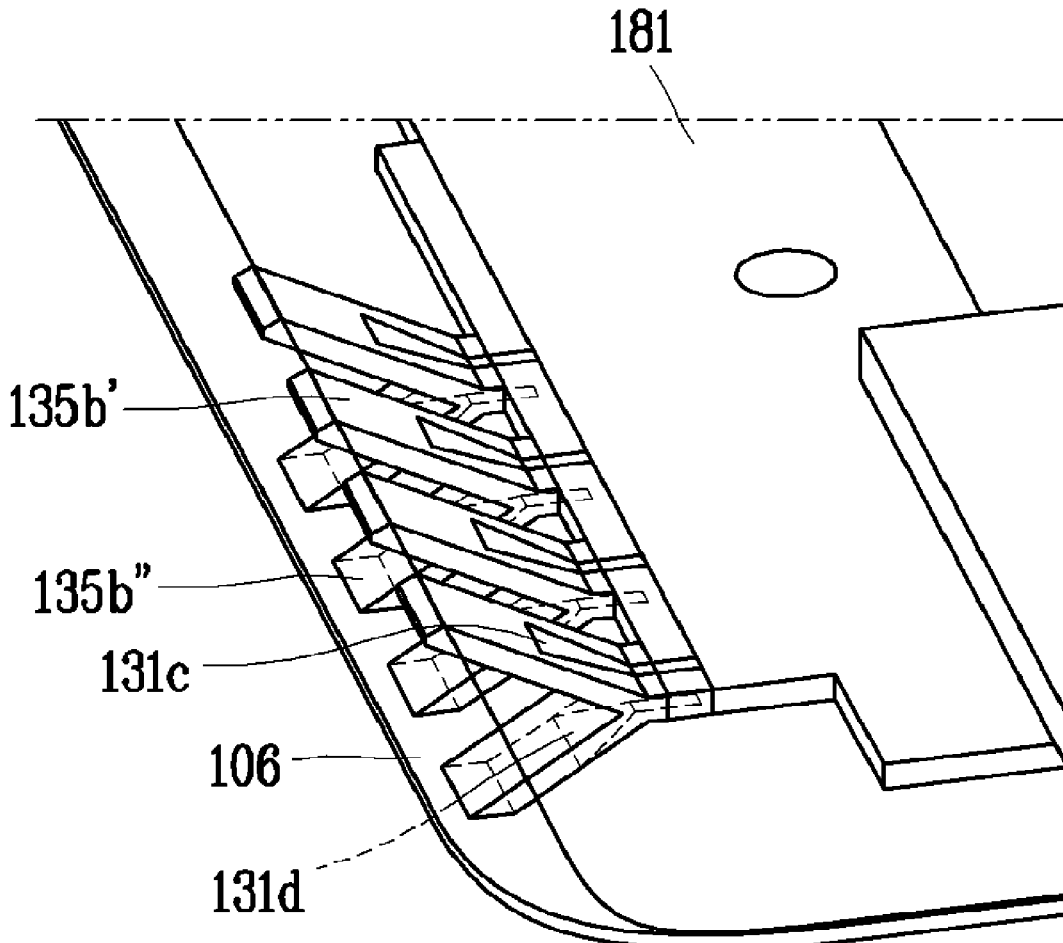
(63) Continuation of application No. 16/345,899, filed on Apr. 29, 2019, now Pat. No. 10,637,127, filed as application No. PCT/KR2016/012449 on Nov. 1, 2016.

Publication Classification

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
H01Q 5/30 (2006.01)
H01Q 1/38 (2006.01)
H01Q 21/20 (2006.01)
H01Q 9/04 (2006.01)
H01Q 3/26 (2006.01)
- (52) **U.S. Cl.**
 CPC *H01Q 1/243* (2013.01); *H04M 1/026* (2013.01); *H01Q 5/30* (2015.01); *H01Q 1/24* (2013.01); *H01Q 3/26* (2013.01); *H01Q 21/20* (2013.01); *H04M 1/02* (2013.01); *H01Q 9/04* (2013.01); *H01Q 1/38* (2013.01)

(57) **ABSTRACT**

A mobile terminal includes a terminal body and an antenna device configured to generate a resonant frequency of a frequency band for 5G communication system. Further, the antenna device is an antenna array including a plurality of dielectrics operating as a resonator. The mobile terminal also includes a circuit board including a feeding unit and a ground plane and configured to be inserted into each of the dielectrics such that a portion of the circuit board protrudes outward.





(19) **United States**

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

(10) **Pub. No.: US 2020/0194879 A1**

(43) **Pub. Date: Jun. 18, 2020**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA MODULE**

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/02** (2013.01); **H01Q 1/243** (2013.01)

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

(57) **ABSTRACT**

(72) Inventors: **Jinho LIM**, Suwon-si (KR); **Yonghwa KIM**, Suwon-si (KR); **Jungsik PARK**, Suwon-si (KR); **Hyunmi CHEONG**, Suwon-si (KR)

Disclosed is an electronic device. The electronic device includes a housing that includes a first plate facing a first direction, a second plate facing a second direction opposite the first direction, and a side housing surrounding a space between the first plate and the second plate, wherein the second plate includes an outer surface facing the second direction and being substantially flat and an inner surface facing the first direction and being substantially flat, an inner plate interposed between the first plate and the second plate, wherein the inner plate includes a surface facing the inner surface of the second plate and an opening, an antenna structure comprising a substrate including a first surface facing the inner surface of the second plate and a second surface facing away from the inner surface, at least one conductive pattern on the first surface and/or embedded in the substrate, a surrounding portion including a hole penetrating the second surface, the antenna structure being disposed in the opening, and a support coupler including a protrusion extending to an interior of the hole.

(21) Appl. No.: **16/716,063**

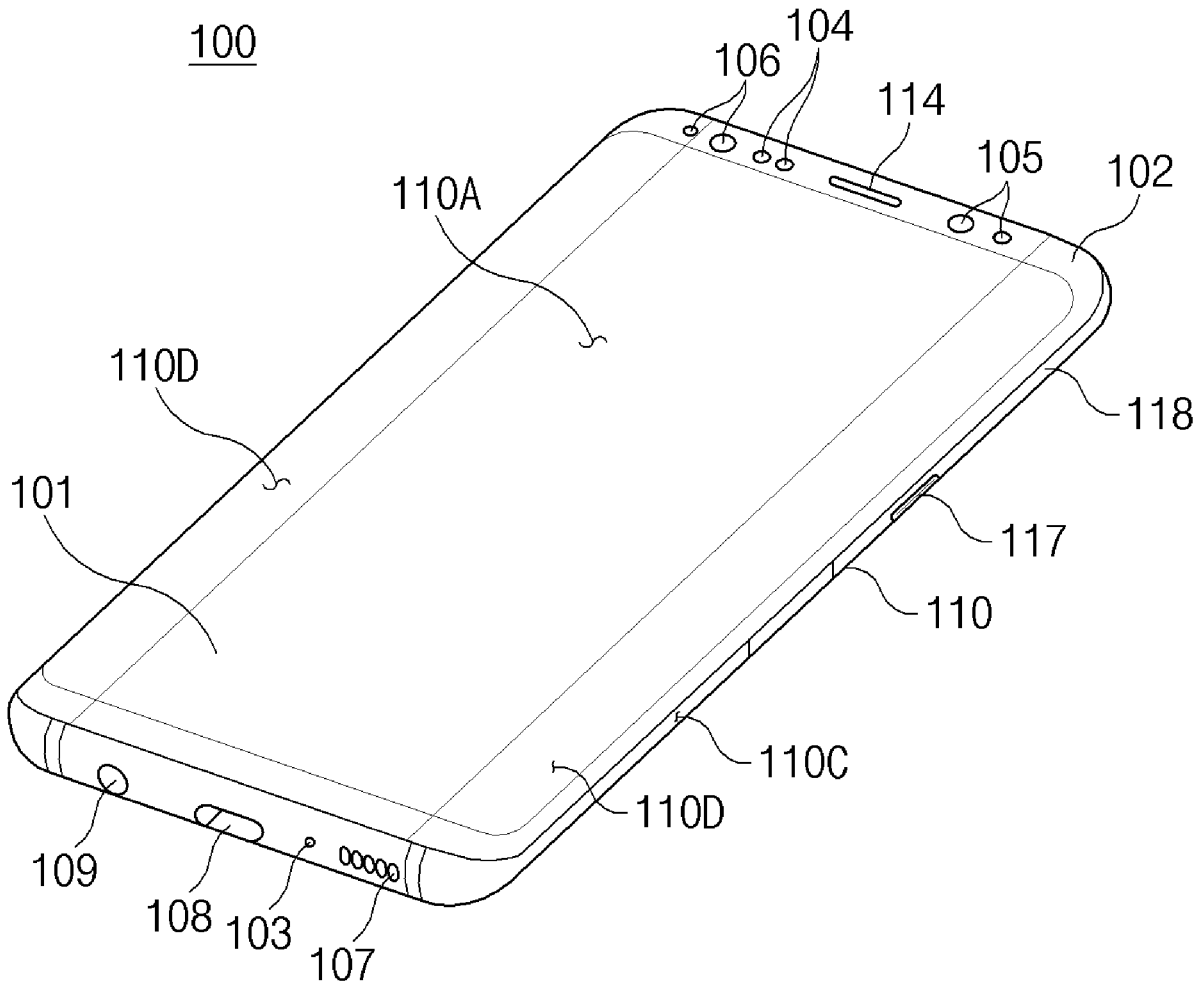
(22) Filed: **Dec. 16, 2019**

(30) **Foreign Application Priority Data**

Dec. 14, 2018 (KR) 10-2018-0162269

Publication Classification

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/02 (2006.01)





US 20200194891A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0194891 A1**

(43) **Pub. Date: Jun. 18, 2020**

(54) **ELECTRONIC APPARATUS**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd., Osaka (JP)**

(72) Inventors: **Yasuharu MATSUOKA, Osaka (JP); Kazuya NAKANO, Osaka (JP); Kenji NISHIKAWA, Hyogo (JP); Keita ENDO, Osaka (JP); Shintarou TANAKA, Osaka (JP); Ryo YONEZAWA, Kyoto (JP); Kazuki ZUSHO, Osaka (JP)**

(21) Appl. No.: **16/799,507**

(22) Filed: **Feb. 24, 2020**

H04B 1/00 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/36 (2006.01)
H01Q 5/10 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
 CPC *H01Q 5/35* (2015.01); *H01Q 5/378* (2015.01); *H04B 1/0064* (2013.01); *H01Q 1/2291* (2013.01); *H01Q 1/48* (2013.01); *H04B 1/3827* (2013.01); *H01Q 1/36* (2013.01); *H01Q 1/2266* (2013.01); *H01Q 5/10* (2015.01); *H01Q 1/24* (2013.01); *H01Q 21/28* (2013.01); *H01Q 1/38* (2013.01)

Related U.S. Application Data

(60) Division of application No. 15/820,228, filed on Nov. 21, 2017, which is a continuation of application No. PCT/JP2016/004512, filed on Oct. 7, 2016.

Foreign Application Priority Data

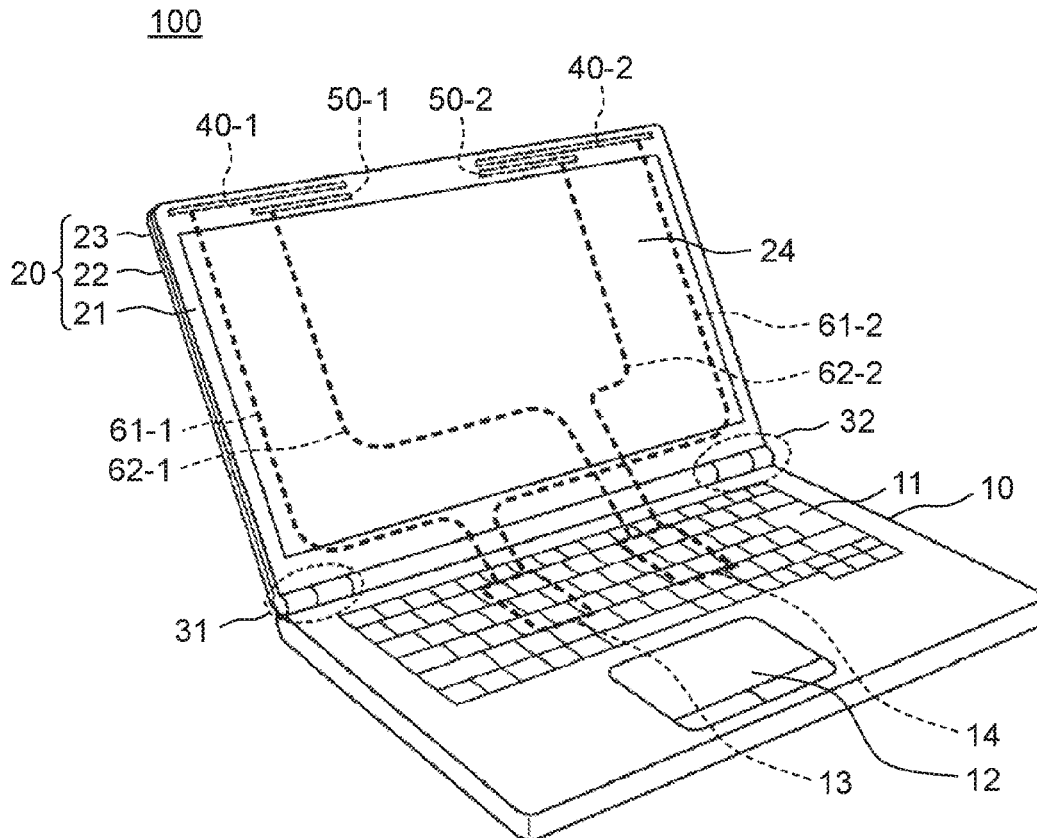
Oct. 30, 2015 (JP) 2015-214879

Publication Classification

(51) **Int. Cl.**
H01Q 5/35 (2006.01)
H01Q 5/378 (2006.01)

(57) **ABSTRACT**

An electronic apparatus includes: a first antenna board having a plate shape and extending with a first length; a second antenna board having a plate shape and extending with a second length; and a rectangular parallelepiped upper casing for accommodating the first antenna board and the second antenna board. The first antenna board and the second antenna board are arranged such that a longitudinal direction of the first antenna board and a longitudinal direction of the second antenna board are parallel to one side of one main surface of the rectangular parallelepiped upper casing. The first antenna board and the second antenna board are arranged parallel to each other.





US 20200194896A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0194896 A1**

(43) **Pub. Date: Jun. 18, 2020**

(54) **FILM ANTENNA AND DISPLAY DEVICE INCLUDING THE SAME**

(30) **Foreign Application Priority Data**

Aug. 24, 2017 (KR) 10-2017-0107145

(71) Applicants: **DONGWOO FINE-CHEM CO., LTD.**, Jeollabuk-do (KR); **POSTECH RESEARCH AND BUSINESS DEVELOPMENT FOUNDATION**, Gyeongsangbuk-do (KR)

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)

(72) Inventors: **Yoon Ho HUH**, Seoul (KR); **Jong Min KIM**, Gyeonggi-do (KR); **Han Sub RYU**, Gyeongsangbuk-do (KR); **Won Bin HONG**, Seoul (KR)

(52) **U.S. Cl.**
CPC *H01Q 9/0407* (2013.01); *H01Q 1/48* (2013.01); *H01Q 1/38* (2013.01)

(21) Appl. No.: **16/798,807**

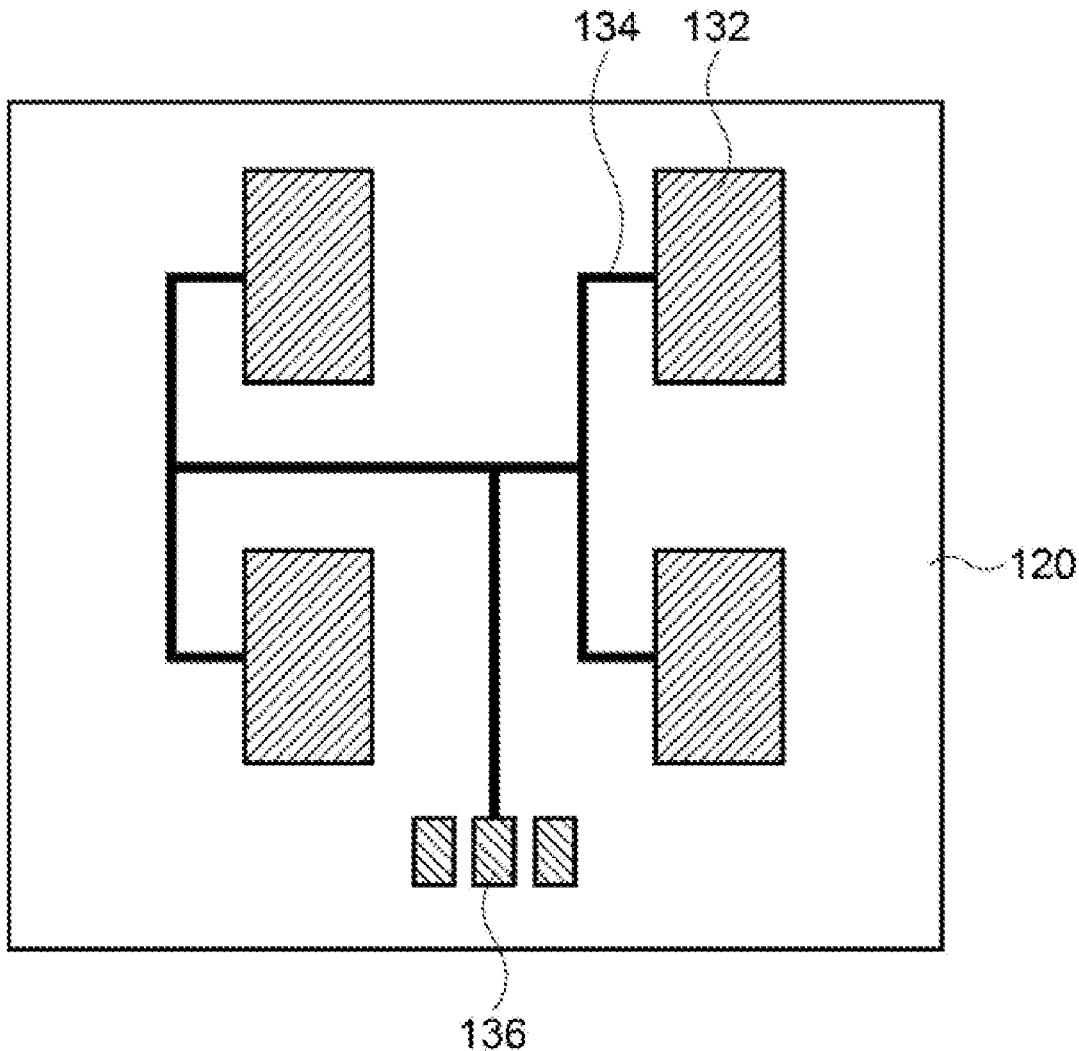
(57) **ABSTRACT**

(22) Filed: **Feb. 24, 2020**

A film antenna according to an embodiment of the present invention includes a first electrode layer, a dielectric layer having a thickness in a range from 50 μm to 1,000 μm and having a dielectric constant in a range from 2 to 10 on the first electrode layer, and a second electrode layer on the dielectric layer. The dielectric constant and the thickness of the dielectric layer are controlled to improve high-frequency driving property of the film antenna.

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2018/009692, filed on Aug. 23, 2018.





US 20200194898A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0194898 A1**

(43) **Pub. Date: Jun. 18, 2020**

(54) **ANTENNA SYSTEM AND COMMUNICATION TERMINAL**

(52) **U.S. Cl.**
CPC *H01Q 9/0457* (2013.01); *H04W 88/02* (2013.01); *H01Q 21/22* (2013.01); *H01Q 1/38* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore City (SG)

(72) Inventors: **Tan Yew Choon**, Singapore (SG); **Ng Guan Hong**, Singapore (SG); **Tay Yew Siow**, Singapore (SG)

(57) **ABSTRACT**

The invention provides an antenna system, includes a system ground unit and a dual polarized millimeter wave antenna unit. The dual polarization millimeter wave antenna unit includes a first substrate layer, a second substrate layer and a third substrate layer, a ground layer attached to a side of the first substrate layer away from the second substrate layer and electrically connected to the system ground unit, a feeder sandwiched between the first substrate layer and the second substrate layer and a radiator fixed on one side of the third substrate layer away from the second substrate layer. The feeder is provided with a horizontally polarized feed port and a vertically polarized feed port. The feeder is coupled to the radiator. Compared with the relevant technology, the communication signal of the antenna system is strong and stable.

(21) Appl. No.: **16/296,493**

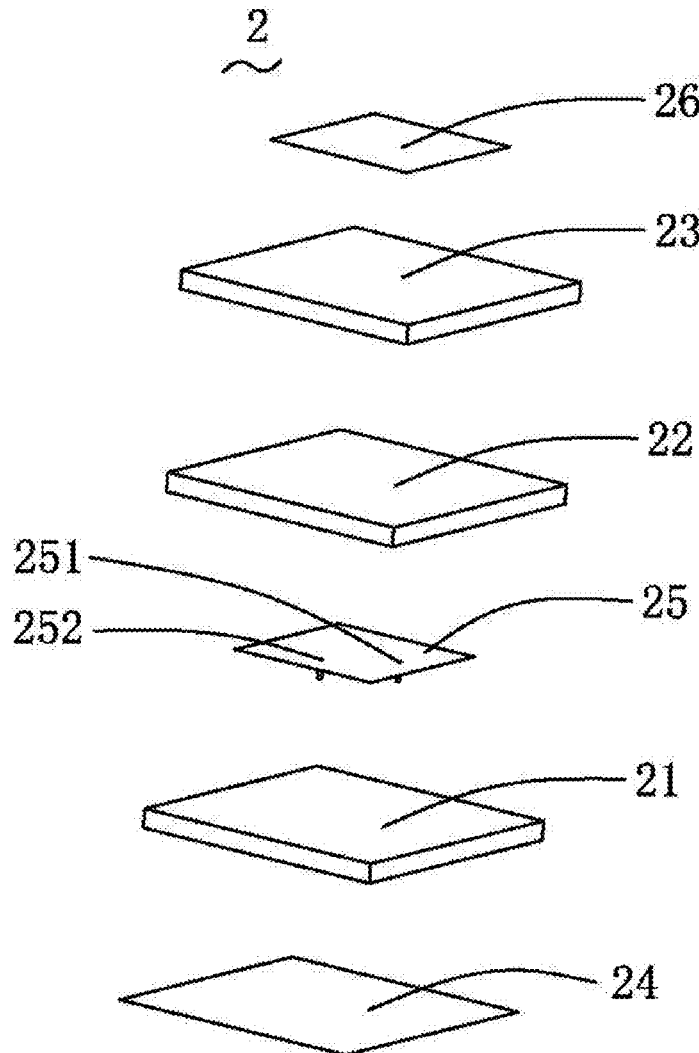
(22) Filed: **Mar. 8, 2019**

(30) **Foreign Application Priority Data**

Dec. 12, 2018 (CN) 201811514001.2

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
H01Q 21/22 (2006.01)





US 20200203806A1

(19) **United States**

(12) **Patent Application Publication**

Wu et al.

(10) **Pub. No.: US 2020/0203806 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **ANTENNASYSTEM AND MOBILE TERMINAL IMPLEMENTED WITH THE ANTENNA SYSTEM**

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 23/00* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore City (SG)

(57) **ABSTRACT**

(72) Inventors: **Jing Wu**, Shenzhen (CN); **Ke Hua**,
Shenzhen (CN); **Haibing Chen**,
Shenzhen (CN)

(21) Appl. No.: **16/699,702**

(22) Filed: **Dec. 1, 2019**

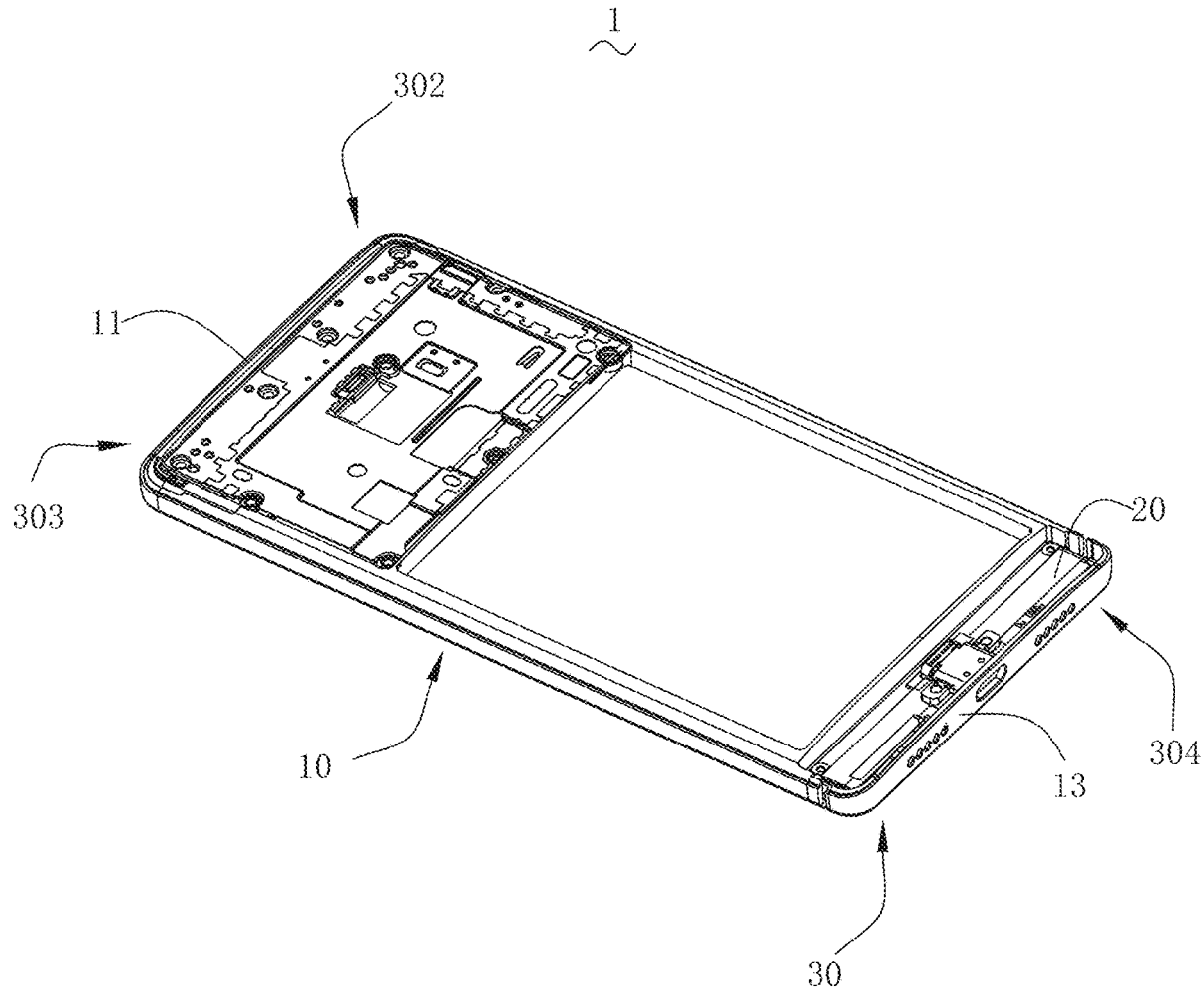
(30) **Foreign Application Priority Data**

Dec. 24, 2018 (CN) 201811581133.7

Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 23/00 (2006.01)

An antenna system and a mobile terminal implemented with the antenna system are provided. The mobile terminal has a metal frame and a system grounding. The antenna system has at least a first antenna module, a second antenna module, a third antenna module and a fourth antenna module. The first antenna module has a radiating body and a parasitic element coupled to the radiating body. The radiating body is configured to generate a main harmonic, and the parasitic element is configured to generate a parasitic harmonic. The first antenna module further has a first tuning circuit and a second tuning circuit. The antenna system has at least four operation modes. The antenna system of the present invention may achieve carrier aggregation of different LTE frequencies, and may be used as a MIMO antenna system.





US 20200203807A1

(19) **United States**

(12) **Patent Application Publication**

Wu et al.

(10) **Pub. No.: US 2020/0203807 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **ANTENNA MODULE AND MOBILE TERMINAL**

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 23/00* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore city (SG)

(57) **ABSTRACT**

(72) Inventors: **Jing Wu**, Shenzhen (CN); **Haibing Chen**, Shenzhen (CN); **Ke Hua**, Shenzhen (CN)

An antenna module and a mobile terminal are provided. The antenna module is used for a mobile terminal having a metal frame and a system grounding spaced apart from the metal frame. The antenna module has a radiating body formed on the metal frame and a parasitic element electrically connected to the system grounding and coupled to the radiating body. The antenna module supports carrier aggregation of the LTE low frequency harmonic, the LTE medium frequency harmonic and the LTE high frequency harmonic. The antenna module further includes a capacitor connected in series between the parasitic element and the system grounding, and a capacitance of the capacitor is less than 0.8 pF. The antenna module of the present invention covers all the LTE low, medium and high frequency bands as a single antenna, and has enhanced performance in low frequency.

(21) Appl. No.: **16/699,703**

(22) Filed: **Dec. 1, 2019**

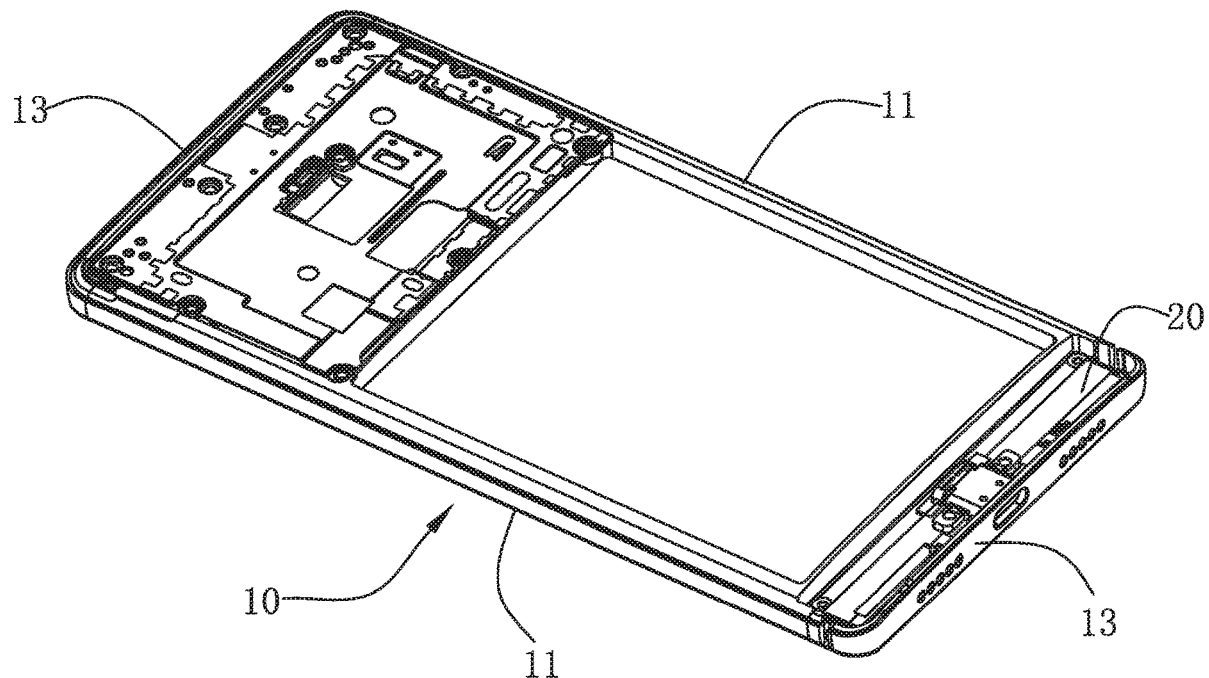
(30) **Foreign Application Priority Data**

Dec. 24, 2018 (CN) 201811580754.3

Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 23/00 (2006.01)

1
~





US 20200203808A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0203808 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **MULTI-ANTENNA SYSTEM AND ELECTRONIC DEVICE THEREOF**

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 9/0421* (2013.01); *H01Q 9/42* (2013.01); *H01Q 5/378* (2015.01); *H01Q 1/38* (2013.01)

(71) Applicant: **ASUSTeK COMPUTER INC.**, Taipei (TW)

(72) Inventors: **Saou-Wen SU**, Taipei (TW);
Wei-Hsuan CHANG, Taipei (TW)

(57) **ABSTRACT**

(21) Appl. No.: **16/708,593**

(22) Filed: **Dec. 10, 2019**

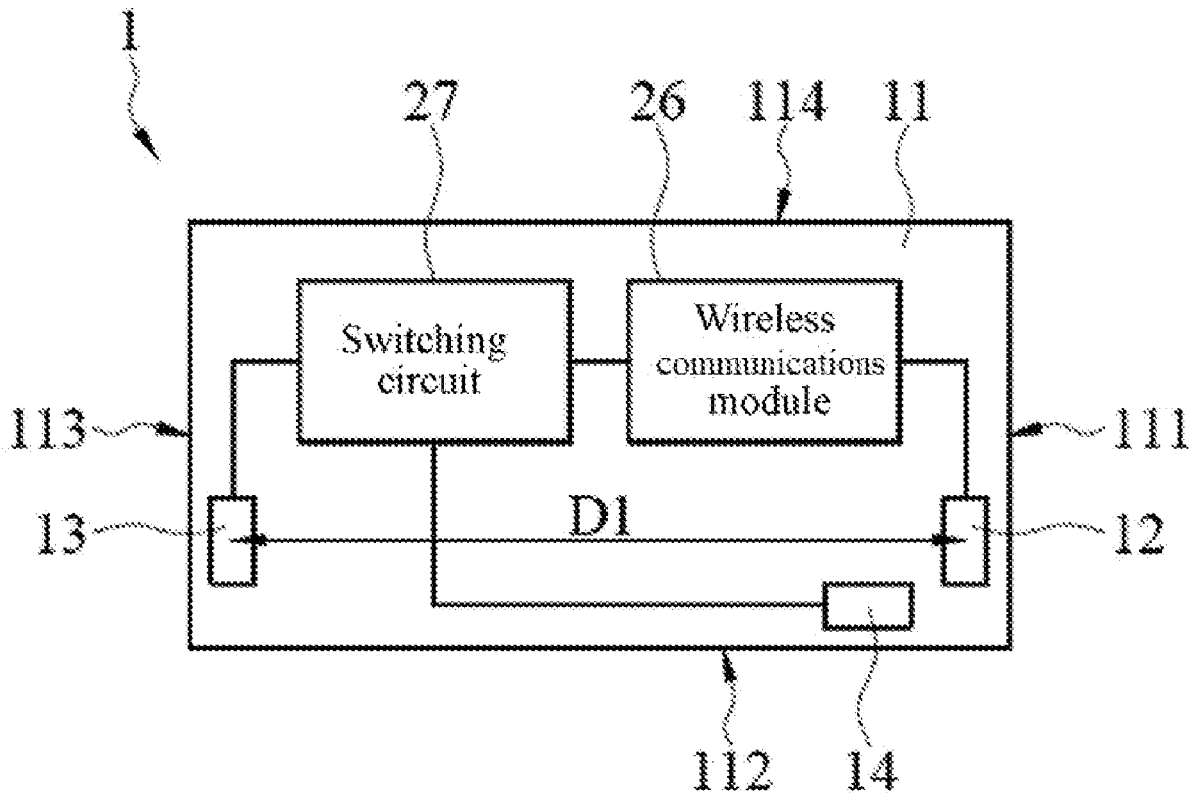
A multi-antenna system includes a conductive plane with four adjacent sides, a main antenna unit disposed on any one of the four sides, a first secondary antenna unit disposed on any one of the four side, a second secondary antenna unit disposed on any one of the four sides of the conductive plane except the side on which the main antenna unit is disposed, a switching circuit disposed on the conductive plane and is selectively electrically connected to the first secondary antenna unit or the second secondary antenna unit and a wireless communications module disposed on the conductive plane and electrically connected to the switching circuit and the main antenna unit. The first secondary antenna unit is spaced apart from the main antenna unit by a spacing, where the spacing is greater than 0.5 times a wavelength distance of a low-frequency operating frequency of the multi-antenna system.

(30) **Foreign Application Priority Data**

Dec. 19, 2018 (TW) 107146012

Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/378 (2006.01)
H01Q 9/42 (2006.01)





(19) **United States**

(12) **Patent Application Publication**
Tsai

(10) **Pub. No.: US 2020/0203810 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **TUNABLE CAPACITORS TO CONTROL ANTENNA RADIATION PATTERN**

Publication Classification

(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)

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

(72) Inventor: **Ming-Shien Tsai**, Taipei (TW)

(52) **U.S. Cl.**
CPC **H01Q 1/245** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 1/243** (2013.01)

(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)

(57) **ABSTRACT**

(21) Appl. No.: **16/608,822**

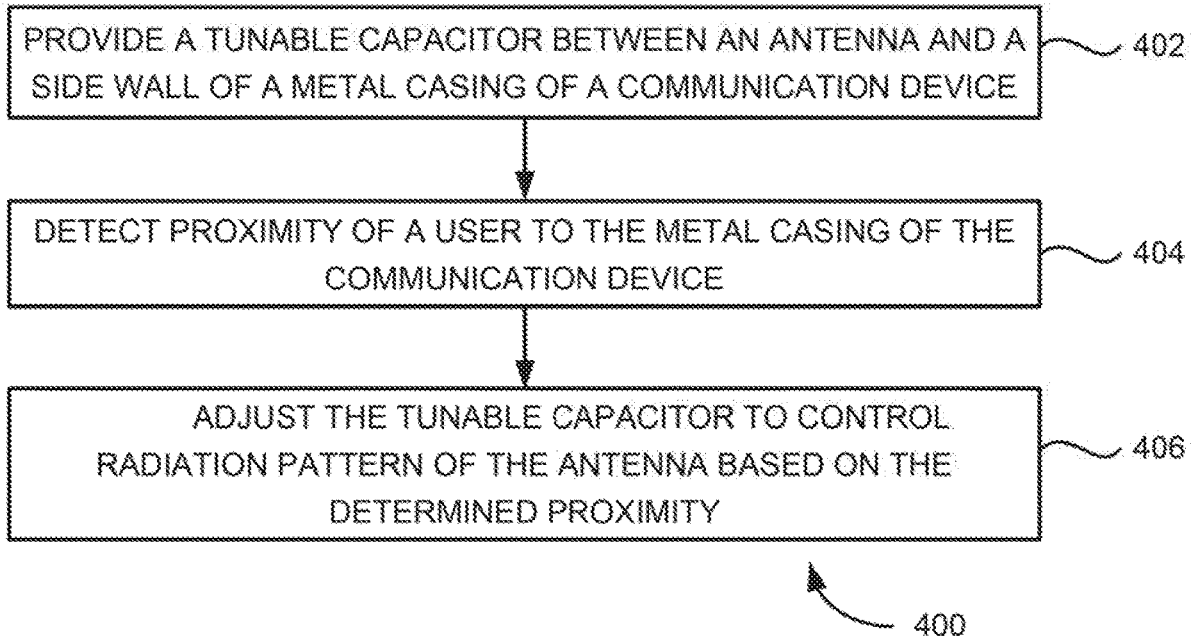
In one example, a communication device is disclosed, which includes a metal casing, an antenna, a tunable capacitor connected between the antenna and the metal casing, and a control unit. The control unit may determine proximity of a user to the communication device. Further, the control unit may adjust the tunable capacitor to control radiation pattern of the antenna based on the determined proximity.

(22) PCT Filed: **Apr. 24, 2017**

(86) PCT No.: **PCT/US2017/029043**

§ 371 (c)(1),

(2) Date: **Oct. 26, 2019**





US 20200203818A1

(19) **United States**

(12) **Patent Application Publication**
Zuniga-Juarez

(10) **Pub. No.: US 2020/0203818 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **ULTRA-WIDEBAND LTE ANTENNA SYSTEM**

Publication Classification

(71) Applicant: **Taoglas Group Holdings Limited**, San Diego, CA (US)

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/06 (2006.01)
H01Q 5/371 (2006.01)
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(72) Inventor: **Jose Eleazar Zuniga-Juarez**, Ensenada (MX)

(21) Appl. No.: **16/806,952**

(22) Filed: **Mar. 2, 2020**

(52) **U.S. Cl.**
CPC *H01Q 1/38* (2013.01); *H01Q 9/065* (2013.01); *H01Q 5/371* (2015.01); *H01Q 21/28* (2013.01); *H01Q 7/00* (2013.01); *H01Q 9/42* (2013.01); *H01Q 1/243* (2013.01)

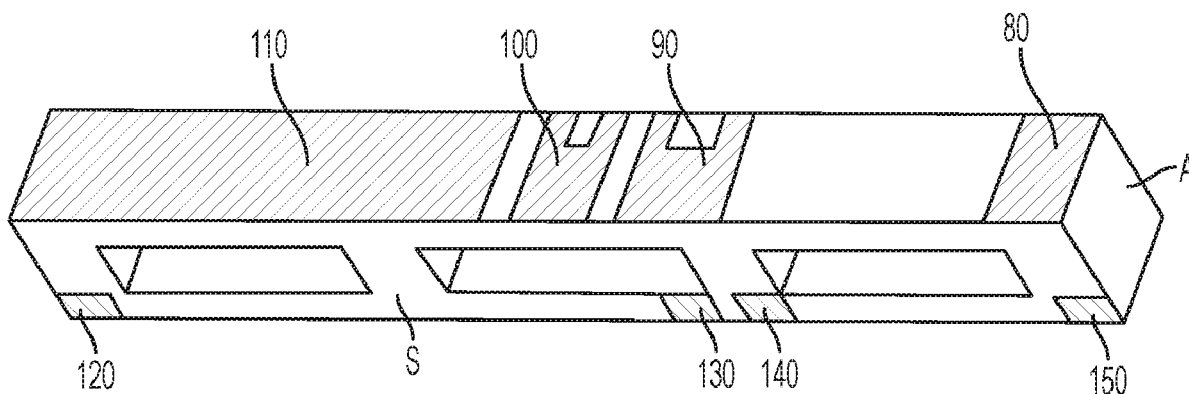
Related U.S. Application Data

(63) Continuation of application No. 16/291,318, filed on Mar. 4, 2019, which is a continuation of application No. 15/298,932, filed on Oct. 20, 2016, now Pat. No. 10,283,854, which is a continuation-in-part of application No. 14/438,611, filed on May 1, 2015, now Pat. No. 9,502,757, filed as application No. PCT/US2013/063947 on Oct. 8, 2013.

(60) Provisional application No. 61/711,196, filed on Oct. 8, 2012.

(57) **ABSTRACT**

An antenna system capable of operating among all LTE bands, and also capable of operation among all remote side cellular applications, such as GSM, AMPS, GPRS, CDMA, WCDMA, UMTS, and HSPA among others. The antenna system provides a low cost alternative to active-tunable antennas suggested in the prior art for the same multi-platform objective.





(19) **United States**

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

(10) **Pub. No.: US 2020/0203836 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **ANTENNA MODULE AND ELECTRONIC DEVICE COMPRISING THEREOF**

(52) **U.S. CL.**
CPC **H01Q 9/0414** (2013.01); **H01Q 1/242** (2013.01); **H01Q 1/2283** (2013.01); **H01Q 9/045** (2013.01)

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

(72) Inventors: **Jinwoo PARK**, Suwon-si (KR); **Kyujiin KWAK**, Suwon-si (KR); **Jinho LIM**, Suwon-si (KR); **Dongyeon KIM**, Suwon-si (KR); **Jungsik PARK**, Suwon-si (KR); **Sungjun KIM**, Suwon-si (KR)

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a housing, a plate attached to the housing to form an inner space together with the housing and includes a flat portion facing in a first direction and a curved portion extended from an edge of the flat portion and forming an obtuse angle with the first direction, and an antenna module positioned in the inner space. The antenna module includes a first partial layer, a second partial layer that includes a first antenna pattern, and is stacked on the first partial layer, and a third partial layer that includes a second antenna pattern, and is stacked on the second partial layer. When viewed from the first direction, the third partial layer overlaps at least a portion of the flat portion, and at least a portion of the second partial layer overlaps at least a portion of the curved portion.

(21) Appl. No.: **16/707,315**

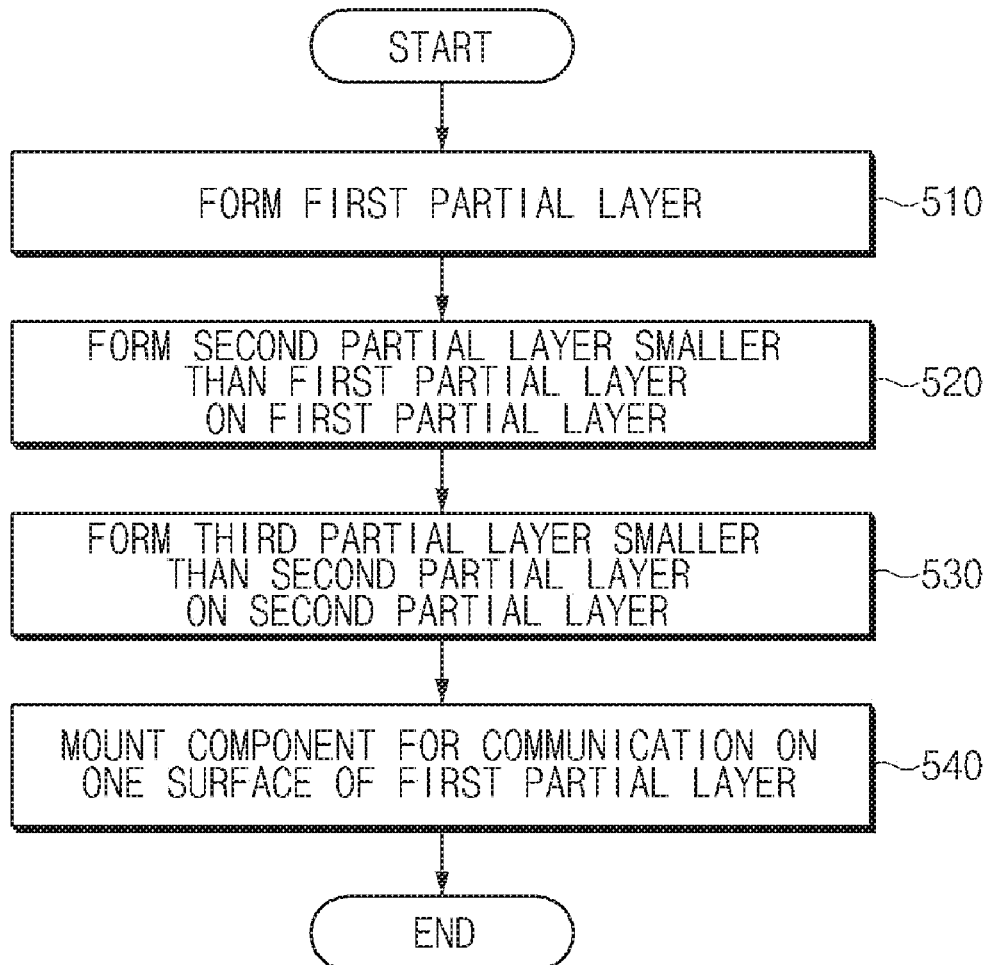
(22) Filed: **Dec. 9, 2019**

(30) **Foreign Application Priority Data**

Dec. 21, 2018 (KR) 10-2018-0166920

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)





US 20200203842A1

(19) **United States**

(12) **Patent Application Publication**

Chen et al.

(10) **Pub. No.: US 2020/0203842 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **INTEGRATED SLOT ANTENNA**

Publication Classification

(71) Applicant: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)

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

(72) Inventors: **Juhung Chen**, Taipei City (TW); **Leo Gerten**, Austin, TX (US); **Po Chao Chen**, Taipei City (TW); **Hung-Wen Cheng**, Taipei City (TW)

(52) **U.S. Cl.**
CPC *H01Q 13/10* (2013.01); *H01Q 1/241* (2013.01)

(73) Assignee: **Hewlett-Packard Development Company, L.P.**, Spring, TX (US)

(57) **ABSTRACT**

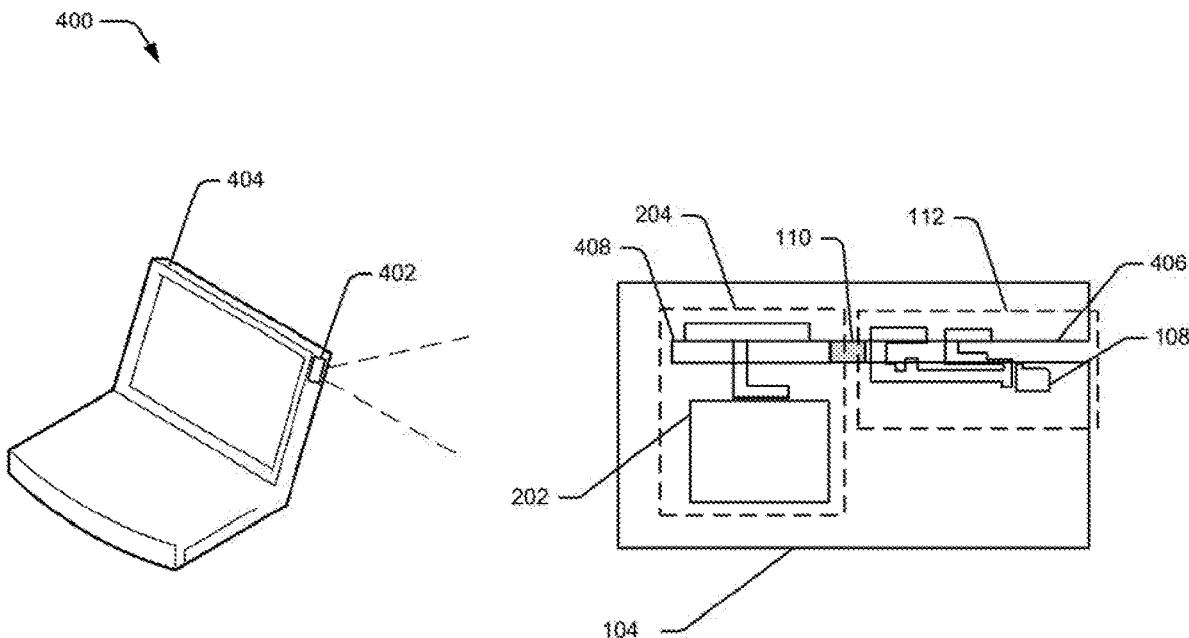
(21) Appl. No.: **16/608,821**

Examples of an integrated slot antenna are described. The integrated slot antenna comprises a first slot, a second slot and a separating member. The first slot is an open-ended slot and is coupled to a first antenna member to form a first slot antenna. The first slot antenna operates in a first predetermined range of frequencies. The second slot is a close-ended slot and is separated from the first slot by the separating member.

(22) PCT Filed: **Apr. 18, 2017**

(86) PCT No.: **PCT/US2017/028028**

§ 371 (c)(1),
(2) Date: **Oct. 26, 2019**





US 20200203851A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0203851 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **MULTIAXIAL ANTENNA, WIRELESS COMMUNICATION MODULE, AND WIRELESS COMMUNICATION DEVICE**

Publication Classification

(51) **Int. Cl.**
H01Q 21/08 (2006.01)
H01Q 9/42 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
 CPC *H01Q 21/08* (2013.01); *H01Q 1/48* (2013.01); *H01Q 9/42* (2013.01)

(71) Applicant: **HITACHI METALS, LTD.**,
Minato-ku, Tokyo (JP)

(72) Inventors: **Yasunori TAKAKI**, Minato-ku, Tokyo (JP); **Kenji HAYASHI**, Minato-ku, Tokyo (JP)

(21) Appl. No.: **16/620,985**

(22) PCT Filed: **Jul. 31, 2018**

(86) PCT No.: **PCT/JP2018/028687**

§ 371 (c)(1),

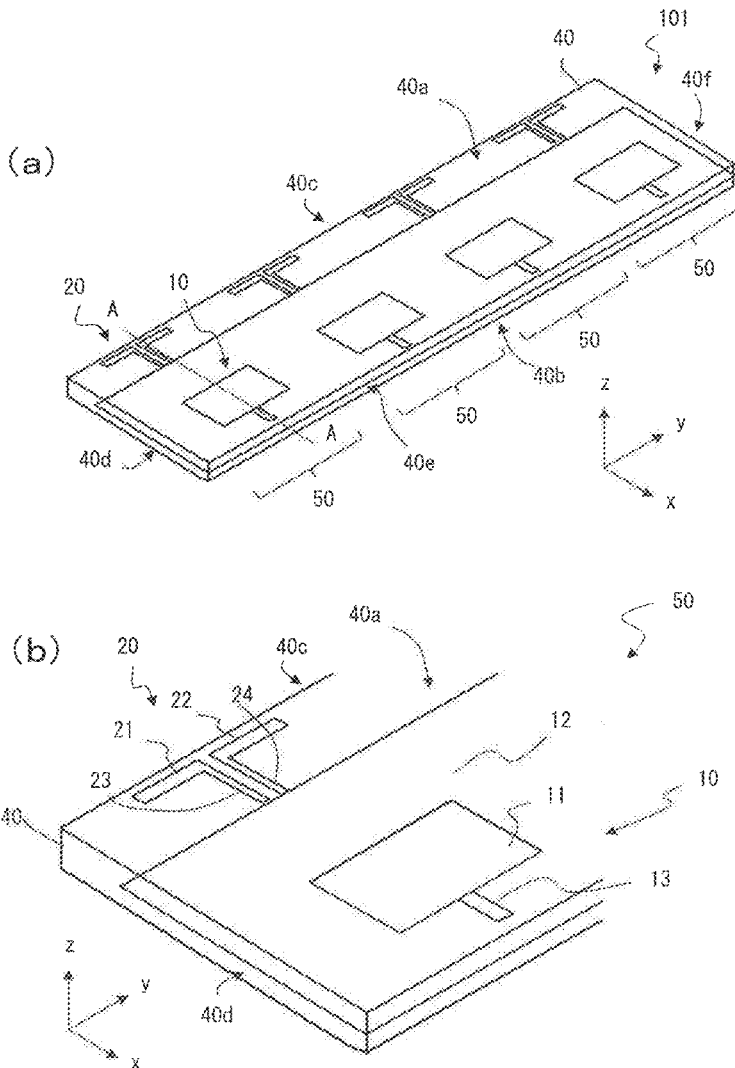
(2) Date: **Dec. 10, 2019**

(30) **Foreign Application Priority Data**

Aug. 1, 2017 (JP) 2017-149340

(57) **ABSTRACT**

A multiaxial antenna includes an antenna unit, the antenna unit including a planar antenna which includes a planar radiation conductor and a ground conductor, the planar radiation conductor and the ground conductor being spaced away from each other in a third axis direction in a first right-handed Cartesian coordinate system which has first, second and third axes, and at least one linear antenna which is spaced away from the planar antenna in a first axis direction, the linear antenna including one or two linear radiation conductors extending in a second axis direction.





US 20200212542A1

(19) **United States**

(12) **Patent Application Publication**

Yong et al.

(10) **Pub. No.: US 2020/0212542 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **ANTENNA SYSTEM AND MOBILE TERMINAL**

H04M 1/02 (2006.01)

H01Q 3/34 (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore City (SG)

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H01Q 9/0407*
(2013.01); *H01Q 3/34* (2013.01); *H01Q 9/045*
(2013.01); *H04M 1/0283* (2013.01)

(72) Inventors: **Zhengdong Yong**, Shenzhen (CN);
Zhimin Zhu, Shenzhen (CN); **Chao Wang**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/702,566**

(22) Filed: **Dec. 4, 2019**

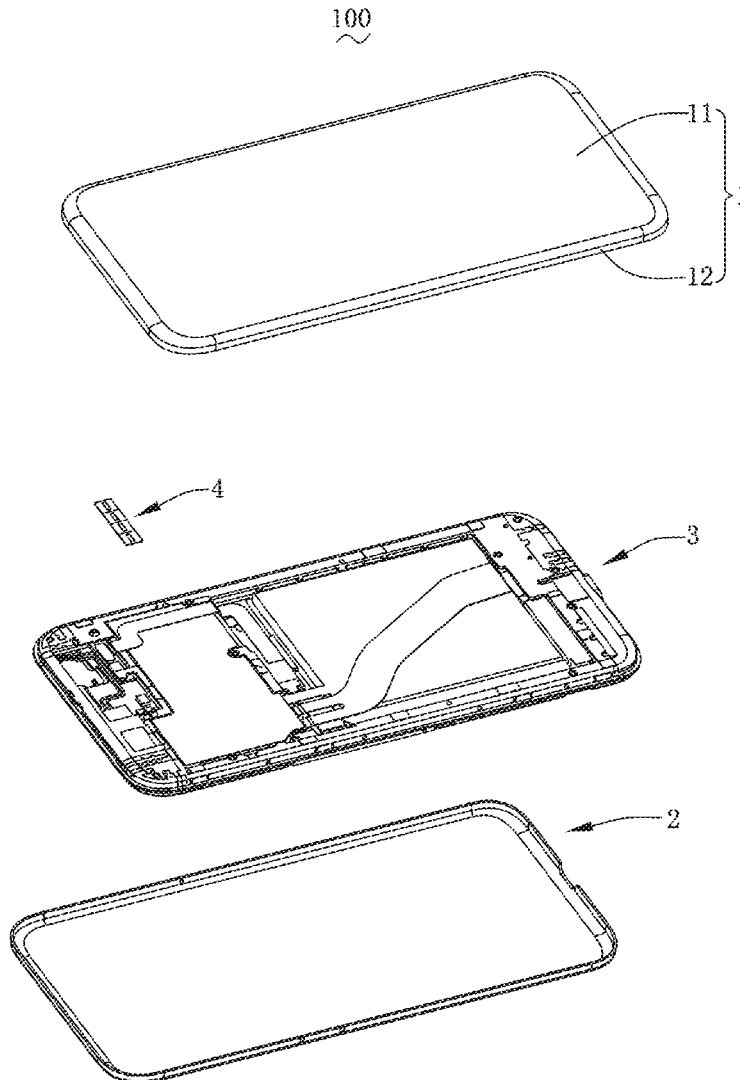
(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811653398.3

Publication Classification

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

The present disclosure provides an antenna system, which is applied to a mobile terminal. The mobile terminal includes a housing made of 3D glass or a ceramic material, and the housing includes a backplate and a sidewall connected to the backplate. The antenna system includes a LCP antenna attached to at least one of an inside surface of the backplate or an inside surface of the sidewall, and the LCP antenna includes antenna units arranged in an array sequentially in a same direction, and a phase shifter connected to the antenna units.





(19) **United States**

(12) **Patent Application Publication**
Wu

(10) **Pub. No.: US 2020/0212561 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **COMPACT DUAL-BAND MIMO ANTENNA AND MOBILE TERMINAL**

(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 9/0421** (2013.01); **H04B 7/0413** (2013.01); **H01Q 21/28** (2013.01); **H01Q 5/392** (2015.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore (SG)

(72) Inventor: **Jing Wu**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/709,952**

A compact dual-band MIMO antenna and a mobile terminal are provided, and the antenna includes a system ground unit, a radiation arm having an open-circuit end and a short-circuit end, a first antenna formed at the open-circuit end and a second antenna formed at the short-circuit end. The first antenna includes a grounding arm connecting the radiation arm with the system ground unit, and a first feeding arm located between the grounding arm and the open-circuit end. The second antenna includes a second feeding arm located between the short-circuit end and the grounding arm. Compared with the related art, the present invention has following beneficial effects: the antenna has compact structure and high isolation; it has dual-band, and it has excellent performance in the dual bands; it has a simple structure, a small volume and a light weight, and it is convenient to manufacture and thus for mass production.

(22) Filed: **Dec. 11, 2019**

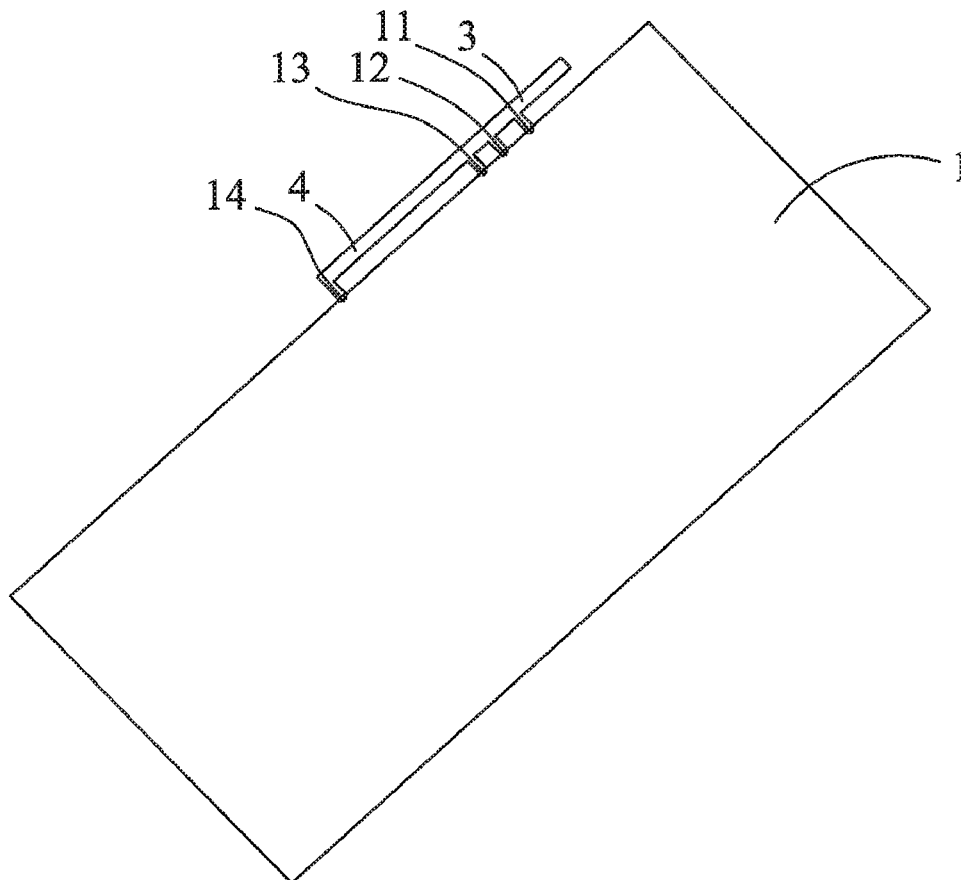
(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811650609.8

Publication Classification

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/392 (2006.01)
H01Q 21/28 (2006.01)
H04B 7/0413 (2006.01)

100





US 20200212568A1

(19) **United States**

(12) **Patent Application Publication**
Wu

(10) **Pub. No.: US 2020/0212568 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **COMPACT DUAL-BAND MIMO ANTENNA**

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

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore City (SG)

CPC **H01Q 5/307** (2015.01); **H04B 7/0413**
(2013.01); **H01Q 9/42** (2013.01); **H01Q 1/48**
(2013.01)

(72) Inventor: **Jing Wu**, Shenzhen (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/706,834**

A compact dual-band MIMO antenna is provided, including: a system ground unit, a radiation arm having an open-circuit end and a short-circuit end, a first antenna formed at the open-circuit end and a second antenna formed at the short-circuit end. The first antenna includes a grounding arm connecting the radiation arm with the system ground unit, a first feeding arm located between the grounding arm and the open-circuit end, and a first parasitic arm connected to the system ground unit. The second antenna includes a second feeding arm located between the short-circuit end and the grounding arm, and a second parasitic arm connected to the system ground unit. Compared with the related art, the present invention has following beneficial effects: the antenna has compact and simple structure, high isolation, excellent performance in dual bands, a small volume and a light weight, and it is convenient for mass production.

(22) Filed: **Dec. 9, 2019**

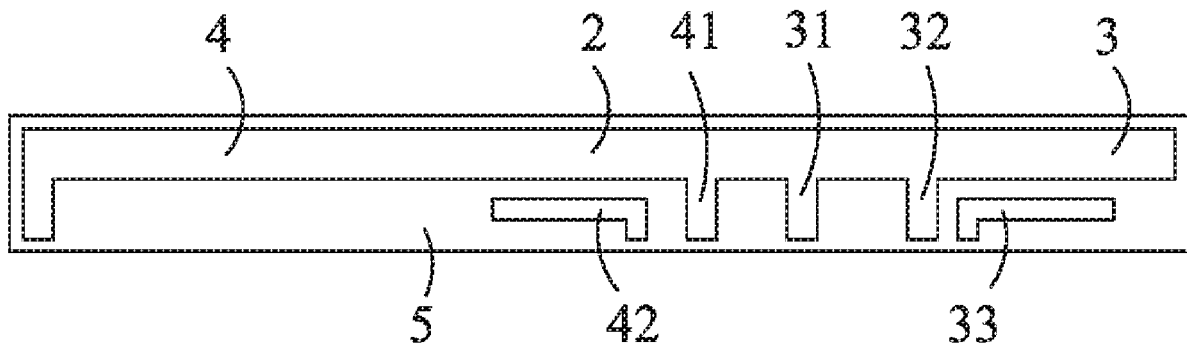
(30) **Foreign Application Priority Data**

Dec. 31, 2018 (CN) 201811650610.0

Publication Classification

(51) **Int. Cl.**

H01Q 5/307 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/42 (2006.01)





US 20200212570A1

(19) **United States**

(12) **Patent Application Publication**
IZAWA

(10) **Pub. No.: US 2020/0212570 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **DUAL BAND COMPATIBLE ANTENNA DEVICE**

H01Q 5/371 (2006.01)

H01Q 9/06 (2006.01)

H01Q 9/16 (2006.01)

(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Kyoto (JP)

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

CPC *H01Q 5/321* (2015.01); *H01Q 1/36*

(2013.01); *H01Q 9/16* (2013.01); *H01Q 9/065*

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

(72) Inventor: **Masahiro IZAWA**, Kyoto (JP)

(21) Appl. No.: **16/810,959**

(22) Filed: **Mar. 6, 2020**

(57)

ABSTRACT

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2018/028561, filed on Jul. 31, 2018.

Foreign Application Priority Data

Sep. 8, 2017 (JP) 2017-173244

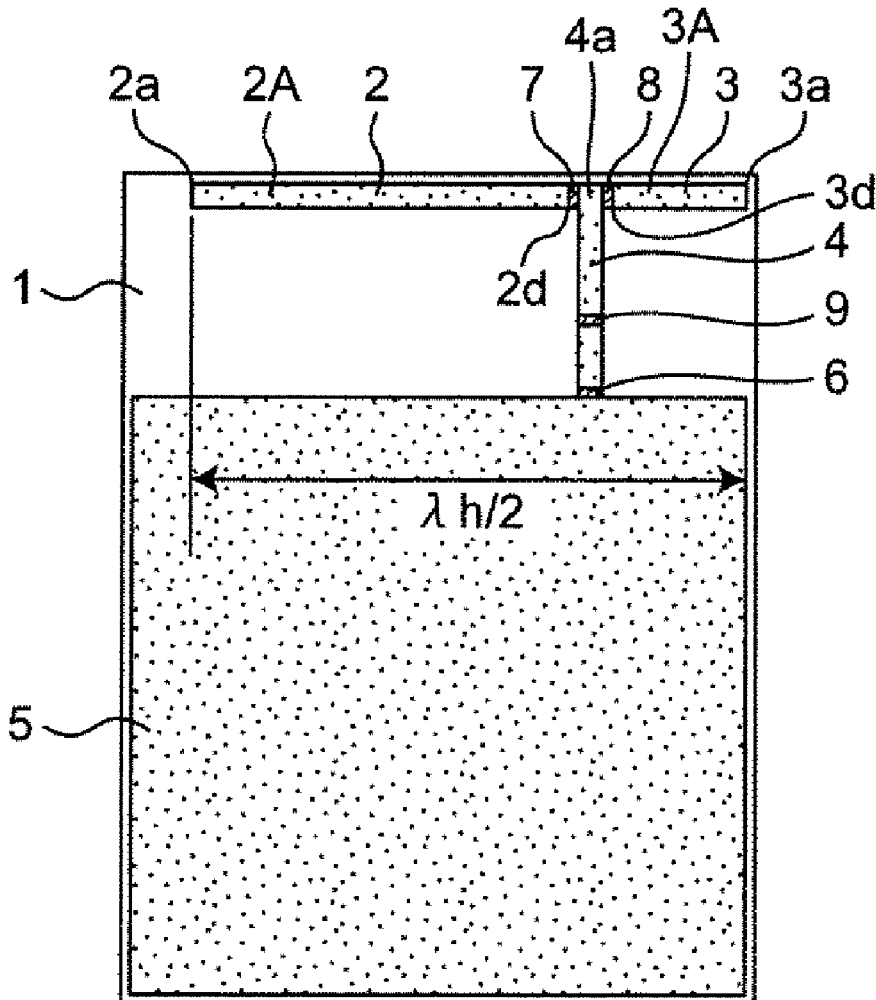
Publication Classification

(51) **Int. Cl.**

H01Q 5/321 (2006.01)

H01Q 1/36 (2006.01)

A dual band compatible antenna device includes a first branch electrode having a first electrode portion connected to a common electrode with a first adjustment element interposed between the first electrode portion and the common electrode and a second branch electrode having a second electrode portion connected to the common electrode with a second adjustment element interposed between the second electrode portion and the common electrode. The first electrode portion and the second electrode portion are provided on a line to have a length equal to or longer than $\frac{2}{3}$ of an electrical length of the first branch electrode and the second branch electrode.





(19) **United States**

(12) **Patent Application Publication**

Xia et al.

(10) **Pub. No.: US 2020/0212579 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **ANTENNA-IN-PACKAGE SYSTEM AND MOBILE TERMINAL**

(52) **U.S. Cl.**
CPC **H01Q 9/0435** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/065** (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore city (SG)

(57) **ABSTRACT**

(72) Inventors: **Xiaoyue Xia**, Shenzhen (CN); **Chao Wang**, Shenzhen (CN)

An antenna-in-package system and a mobile terminal are provided. The mobile terminal includes a main board. The antenna-in-package system includes a substrate, a metal antenna provided on a side of the substrate facing away from the main board, an integrated circuit chip provided on a side of the substrate close to the main board, and a circuit provided in the substrate and connecting the metal antenna to the integrated circuit chip. The circuit is connected to the main board. The metal antenna is a patch antenna simultaneously fed with power by two feeding points. The two feeding points are used to excite electromagnetic waves in different bands. The antenna-in-package system provided by the present disclosure achieves dual-band coverage of 28 GHz and 39 GHz, and a size is reduced to 18x5 mm, so that an occupied area is greatly reduced, and a gain reduction is small.

(21) Appl. No.: **16/705,227**

(22) Filed: **Dec. 6, 2019**

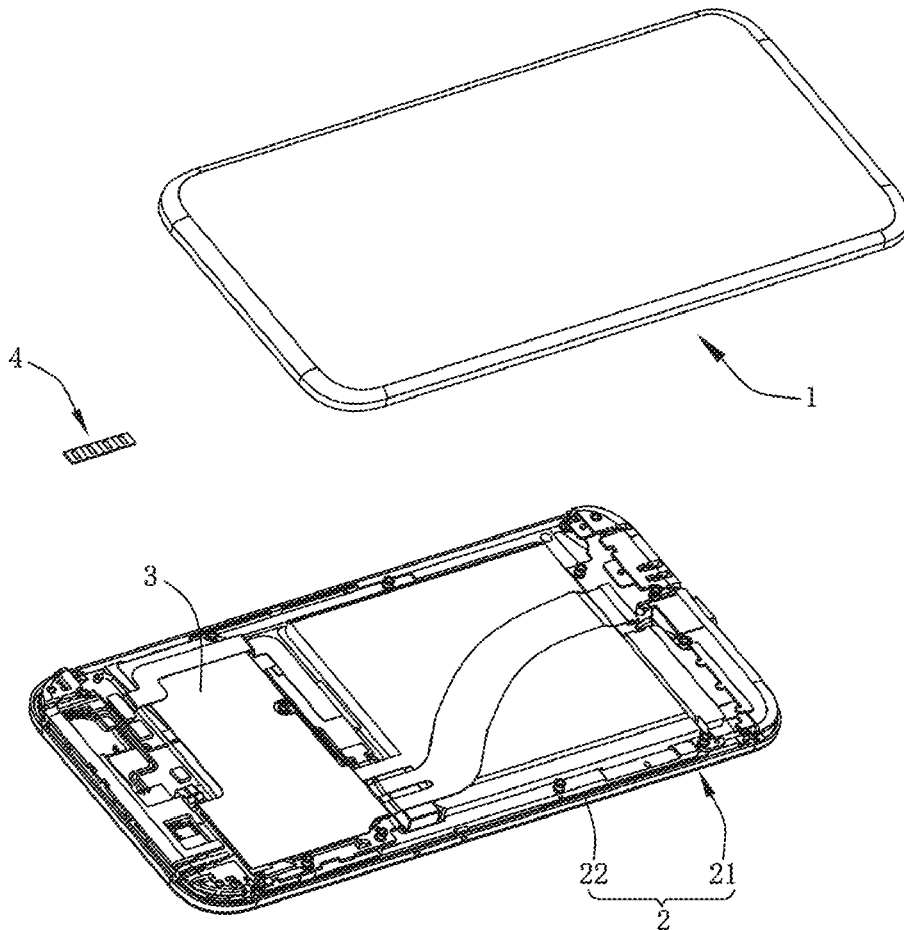
(30) **Foreign Application Priority Data**

Dec. 29, 2018 (CN) 201811645892.5

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 21/06 (2006.01)
H01Q 1/24 (2006.01)

100





(19) **United States**

(12) **Patent Application Publication**

Zhu et al.

(10) **Pub. No.: US 2020/0212581 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **DIELECTRIC RESONATOR ANTENNA-IN-PACKAGE SYSTEM AND MOBILE TERMINAL**

(71) Applicant: **AAC Technologies Pte. Ltd.**, Singapore City (SG)

(72) Inventors: **Zhimin Zhu**, Shenzhen (CN); **Xiaoyue Xia**, Shenzhen (CN); **Zhengdong Yong**, Shenzhen (CN); **Chao Wang**, Shenzhen (CN)

(21) Appl. No.: **16/702,586**

(22) Filed: **Dec. 4, 2019**

(30) **Foreign Application Priority Data**

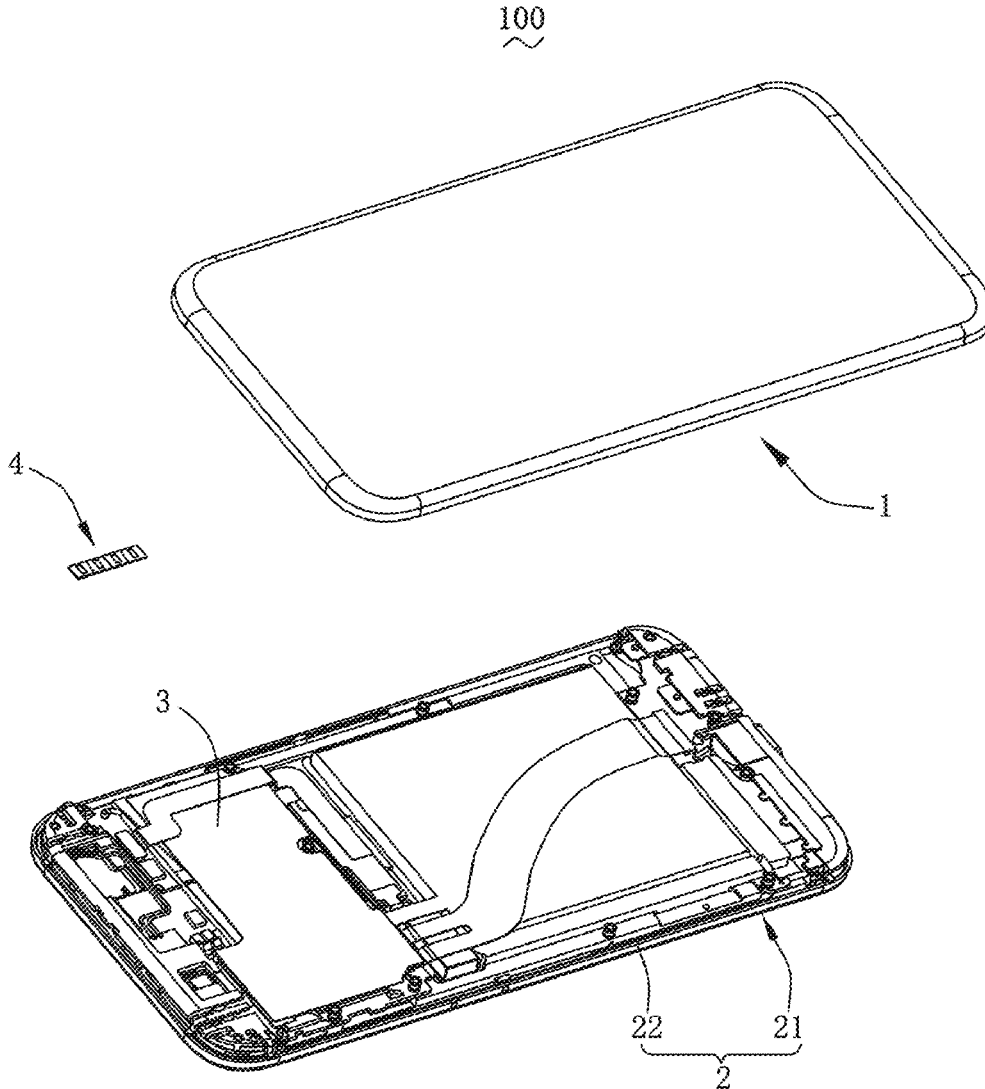
Dec. 29, 2018 (CN) 201811645984.3

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.**
CPC *H01Q 9/0485* (2013.01); *H01Q 1/243* (2013.01); *H01Q 1/38* (2013.01)

(57) **ABSTRACT**

The present disclosure provides a dielectric resonator antenna-in-package system applied to a mobile terminal. The mobile terminal includes a mainboard. The dielectric resonator antenna-in-package system includes a substrate, a dielectric resonator antenna provided on a side of the substrate facing away from the mainboard, an integrated circuit chip provided on a side of the substrate close to the mainboard, and a circuit provided in the substrate and connecting the dielectric resonator antenna with the integrated circuit chip. The circuit is connected to the mainboard.





(19) **United States**

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

(10) **Pub. No.: US 2020/0212583 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **MOBILE TERMINAL**

H01Q 1/42 (2006.01)

H01Q 9/04 (2006.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore city (SG)

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

CPC *H01Q 13/085* (2013.01); *H01Q 13/206*
(2013.01); *H01Q 9/0421* (2013.01); *H01Q*
1/243 (2013.01); *H01Q 1/422* (2013.01);
H04M 1/0266 (2013.01)

(72) Inventors: **Wei Zhao**, Shenzhen (CN); **Zhimin**
Zhu, Shenzhen (CN); **Zhengdong**
Yong, Shenzhen (CN); **Xiaoyue Xia**,
Shenzhen (CN); **Chao Wang**, Shenzhen
(CN)

(57)

ABSTRACT

The present invention provides a mobile terminal, which includes a Vivaldi antenna system arranged in the mobile terminal, wherein the Vivaldi antenna system includes two pairs of Vivaldi antenna arrays, opening directions of one pair of the Vivaldi antenna arrays are along a length direction of the mobile terminal, opening directions of the other pair of the Vivaldi antenna arrays are along a thickness direction of the mobile terminal, and each pair of the Vivaldi antenna arrays includes two Vivaldi antenna arrays with opposite opening directions, and the Vivaldi antenna arrays operate in a frequency band of 5G millimeter waves. Compared with the related art, the mobile terminal provided by the present disclosure has wide and uniform beam bandwidths in a non-scanning direction, thus achieving excellent spatial coverage efficiency.

(21) Appl. No.: **16/702,475**

(22) Filed: **Dec. 3, 2019**

(30) **Foreign Application Priority Data**

Dec. 28, 2018 (CN) 201811627448.0

Publication Classification

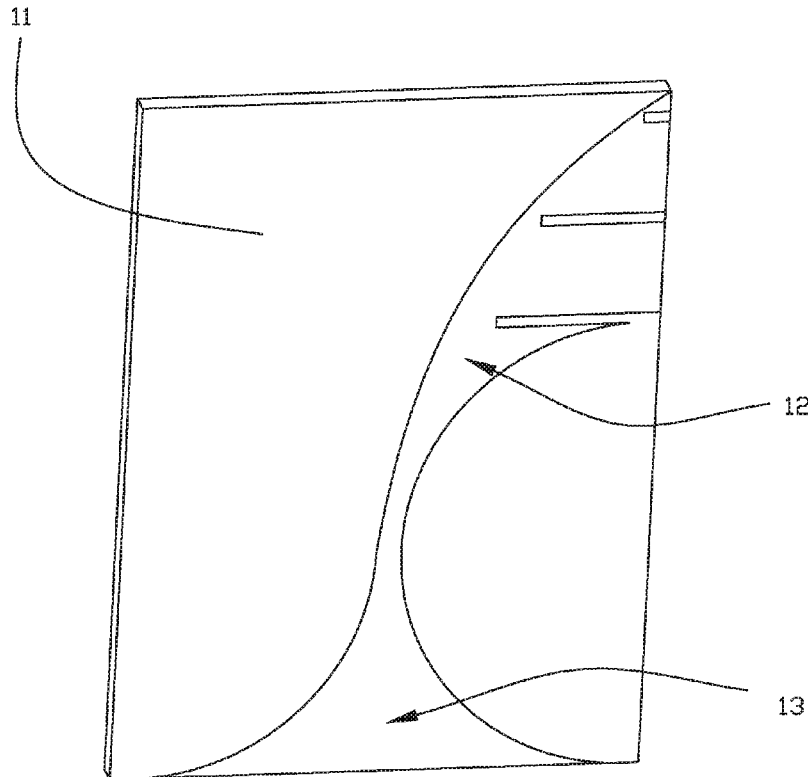
(51) **Int. Cl.**

H01Q 13/08 (2006.01)

H01Q 13/20 (2006.01)

H04M 1/02 (2006.01)

H01Q 1/24 (2006.01)





(19) **United States**

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

(10) **Pub. No.: US 2020/0212584 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **ANTENNA MODULE USING METAL BEZEL AND ELECTRONIC DEVICE INCLUDING THEREOF**

H01Q 21/06 (2006.01)

H01Q 5/35 (2006.01)

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

CPC *H01Q 13/18* (2013.01); *H01Q 5/35* (2015.01); *H01Q 21/064* (2013.01); *H01Q 1/243* (2013.01)

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

(72) Inventors: **Sungchul PARK**, Gyeonggi-do (KR);
Wonjoon CHOI, Gyeonggi-do (KR)

(57) **ABSTRACT**

Disclosed is an electronic device including a metal bezel including a bezel patch separated through a bezel slit, a printed circuit board including a first conductive pattern and a second conductive pattern, which are separated through a substrate slit and a communication module transmitting or receiving an antenna signal, using an antenna element including the bezel patch, the first conductive pattern, and the second conductive pattern. The first conductive pattern is connected to a part of the metal bezel. The bezel patch and the second conductive pattern is arranged to be aligned vertically. A bezel cavity is formed between the bezel patch and the second conductive pattern.

(21) Appl. No.: **16/724,920**

(22) Filed: **Dec. 23, 2019**

(30) **Foreign Application Priority Data**

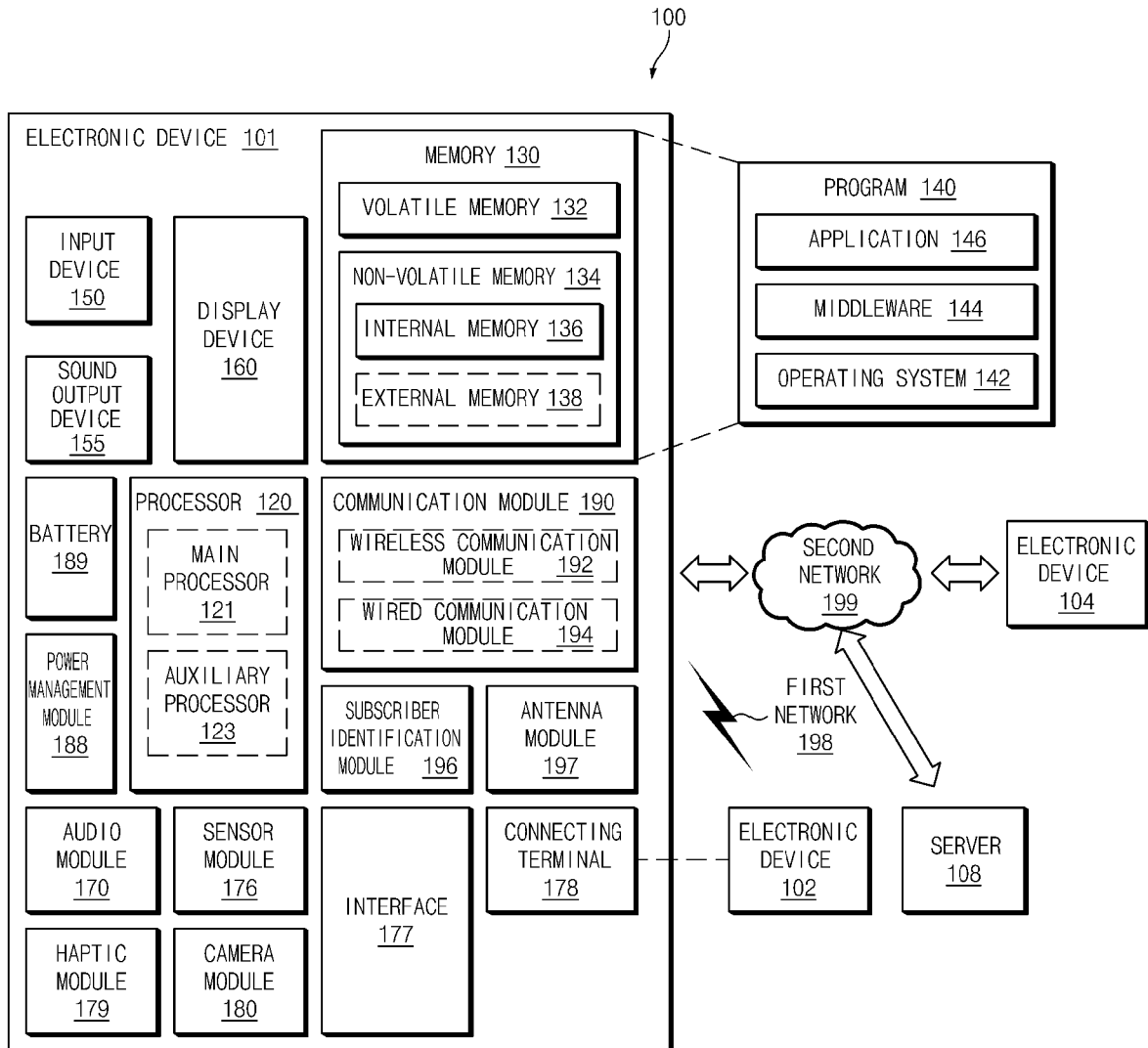
Dec. 28, 2018 (KR) 10-2018-0171607

Publication Classification

(51) **Int. Cl.**

H01Q 13/18 (2006.01)

H01Q 1/24 (2006.01)





US 20200212596A1

(19) **United States**

(12) **Patent Application Publication**

Chen et al.

(10) **Pub. No.: US 2020/0212596 A1**

(43) **Pub. Date: Jul. 2, 2020**

(54) **MILLIMETER WAVE ARRAY ANTENNA AND MOBILE TERMINAL**

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

CPC *H01Q 21/065* (2013.01); *H01Q 21/0006* (2013.01); *H01Q 1/24* (2013.01); *H01Q 5/10* (2015.01); *H01Q 5/50* (2015.01); *H01Q 1/48* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore city (SG)

(72) Inventors: **Yongli Chen**, Shenzhen (CN); **Xinying Xu**, Shenzhen (CN)

(57) **ABSTRACT**

The present invention provides a millimeter wave array antenna and mobile terminal. The millimeter wave array antenna includes several antenna elements arranged in an array, each antenna element includes a first radiation patch, a second radiation patch, a first grounding plate, a power divider layer and a second grounding plate sequentially stacked from top to bottom. The first radiating patch is spaced apart from and coupled to the second radiating patch. The second radiating patch is provided with two feeding ends, and each feeding end is provided with two feeding notches. The power divider layer includes two transmission lines, each includes one input port and two phase-inverted output ports electrically connected to the input port. The two phase-inverted output ports are respectively coupling-fed two feeding notches of one feeding end. Each antenna element generates orthogonal polarization and dual-band resonance under excitation of two input ports.

(21) Appl. No.: **16/703,798**

(22) Filed: **Dec. 4, 2019**

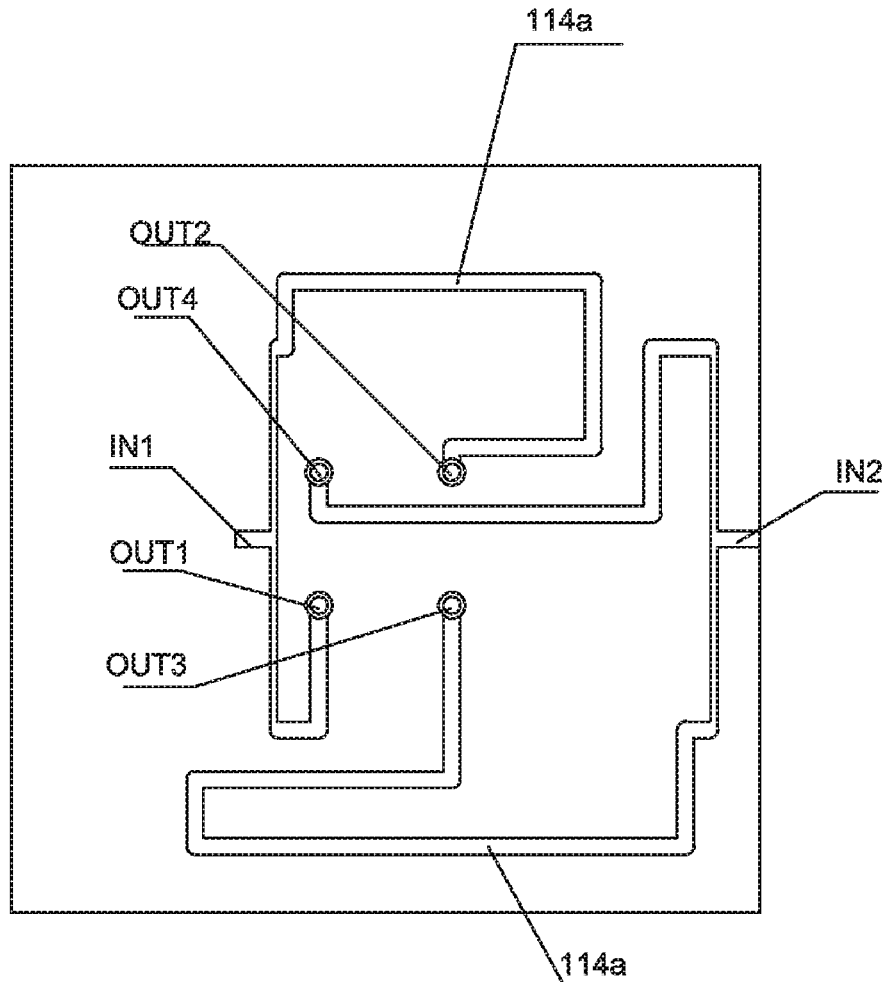
(30) **Foreign Application Priority Data**

Dec. 28, 2018 (CN) 201811628344.1

Publication Classification

(51) **Int. Cl.**

<i>H01Q 21/06</i>	(2006.01)
<i>H01Q 21/00</i>	(2006.01)
<i>H01Q 1/48</i>	(2006.01)
<i>H01Q 5/10</i>	(2006.01)
<i>H01Q 5/50</i>	(2006.01)
<i>H01Q 1/24</i>	(2006.01)





US 20200220269A1

(19) **United States**

(12) **Patent Application Publication**
MATSUURA

(10) **Pub. No.: US 2020/0220269 A1**

(43) **Pub. Date: Jul. 9, 2020**

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

Publication Classification

(71) Applicant: **NEC Platforms, Ltd.**, Kawasaki-shi (JP)

(51) **Int. Cl.**
H01Q 9/04 (2006.01)

(72) Inventor: **Tatsuya MATSUURA**, Kanagawa (JP)

(52) **U.S. Cl.**
CPC **H01Q 9/045** (2013.01); **H01Q 1/48** (2013.01)

(73) Assignee: **NEC Platforms, Ltd.**, Kawasaki-shi (JP)

(57) **ABSTRACT**

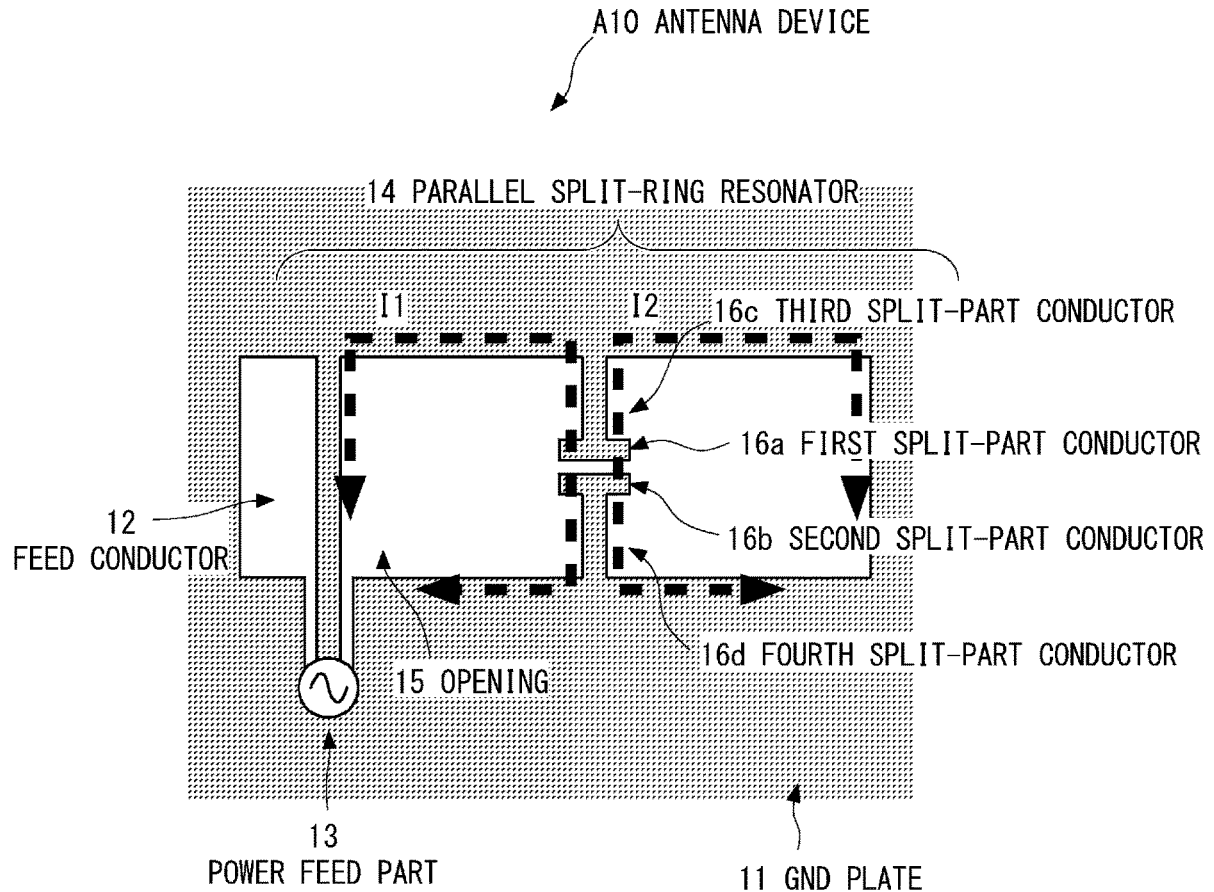
(21) Appl. No.: **16/717,505**

An antenna device includes first and second openings formed inside a GND plate, a first feed conductor formed from a first outer peripheral side, which is one of the outer peripheral sides of the first opening, to a second outer peripheral side, and supplied with AC power, a first split part formed in an opening region of the first opening, a first feed conductor formed from a third outer peripheral side, which is one of the outer peripheral sides of the second opening, to a fourth outer peripheral side, and supplied with the AC power common to the first feed conductor, and a second split part formed in an opening region of the second opening.

(22) Filed: **Dec. 17, 2019**

(30) **Foreign Application Priority Data**

Jan. 4, 2019 (JP) 2019-000192





US 20200227820A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0227820 A1**

(43) **Pub. Date: Jul. 16, 2020**

(54) **5G MIMO ANTENNA SYSTEM AND HANDHELD DEVICE**

Publication Classification

(71) Applicant: **SHENZHEN SUNWAY COMMUNICATION CO., LTD.**,
Shenzhen City, Guangdong (CN)

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H04B 7/0413 (2006.01)
H01Q 9/30 (2006.01)
H01Q 1/24 (2006.01)

(72) Inventors: **Anping ZHAO**, Shenzhen City (CN);
Zhouyou REN, Shenzhen City (CN)

(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 9/30** (2013.01); **H04B 7/0413** (2013.01)

(73) Assignee: **SHENZHEN SUNWAY COMMUNICATION CO., LTD.**,
Shenzhen City, Guangdong (CN)

(57) **ABSTRACT**

(21) Appl. No.: **16/462,030**

A 5G MIMO antenna system includes at least four antenna units which are arrayed at intervals. Each antenna unit includes a first branch and a second branch, wherein the first branch is of an inverted-U structure, and two ends of an opening of the first branch are grounded; the second branch is located in an area defined by the first branch and is a monopole branch, and a feed point is arranged at an end, close to the opening of the first branch, of the second branch. The first branches and the second branches generate two different resonances, so that the 5G antenna system has a broadband operation. Meanwhile, the 5G MIMO antenna system has the characteristics of being small in size, good in isolation and broad in frequency band.

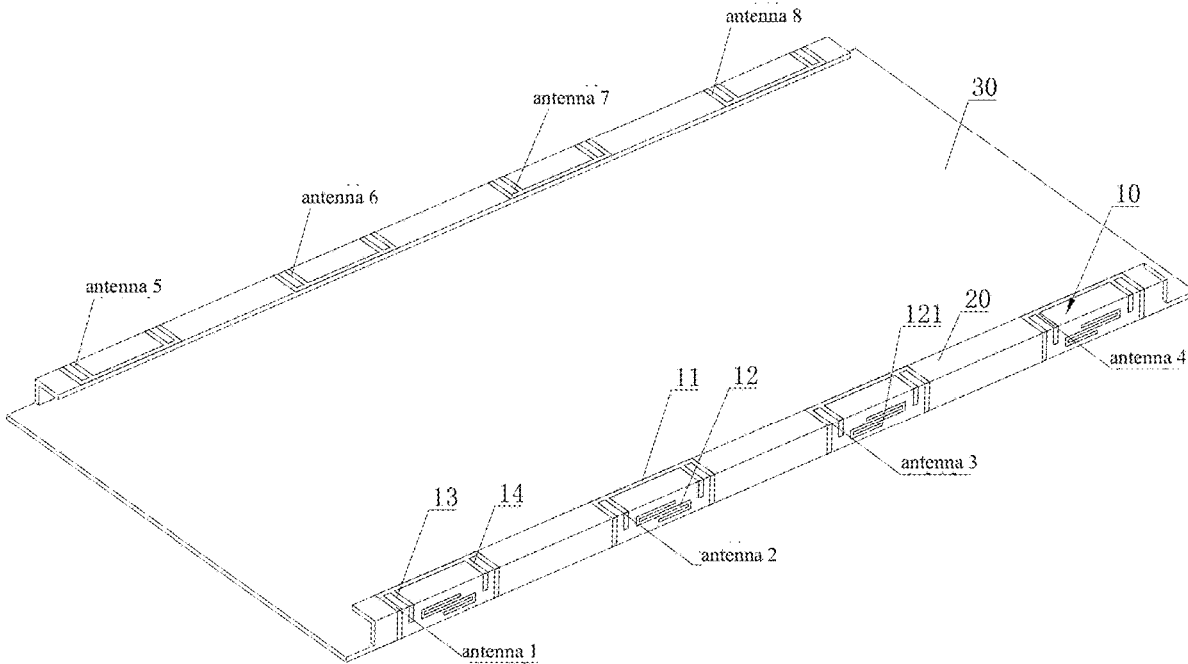
(22) PCT Filed: **Mar. 4, 2019**

(86) PCT No.: **PCT/CN2019/076806**

§ 371 (c)(1),
(2) Date: **May 17, 2019**

(30) **Foreign Application Priority Data**

Jan. 14, 2019 (CN) 201910030704.6





(19) **United States**

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

(10) **Pub. No.: US 2020/0227823 A1**

(43) **Pub. Date: Jul. 16, 2020**

- (54) **ANTENNA DEVICE AND ELECTRONIC DEVICE COMPRISING ANTENNA**
- (71) Applicant: **Samsung Electronics Co., Ltd.**, Gyeonggi-do (KR)
- (72) Inventors: **Kuo Cheng CHEN**, Gyeonggi-do (KR); **Se Hyun PARK**, Gyeonggi-do (KR); **Tae Young KIM**, Gyeonggi-do (KR); **Ahmed HUSSAIN**, Gyeonggi-do (KR); **Igor SHCHERBATKO**, Gyeonggi-do (KR); **Je Hun JONG**, Seoul (KR); **Jin Woo JUNG**, Seoul (KR); **Jae Hoon JO**, Gyeonggi-do (KR)

- H01Q 1/24* (2006.01)
- H01Q 25/02* (2006.01)
- H01Q 21/00* (2006.01)
- H01Q 21/06* (2006.01)
- H04B 7/10* (2006.01)
- H01Q 1/48* (2006.01)
- H01Q 25/00* (2006.01)
- H01Q 21/24* (2006.01)
- H01Q 21/28* (2006.01)
- (52) **U.S. Cl.**
- CPC *H01Q 3/247* (2013.01); *H01Q 3/36* (2013.01); *H01Q 1/246* (2013.01); *H01Q 25/02* (2013.01); *H01Q 21/005* (2013.01); *H01Q 21/065* (2013.01); *H01Q 1/243* (2013.01); *H01Q 1/48* (2013.01); *H01Q 25/001* (2013.01); *H01Q 21/062* (2013.01); *H01Q 21/24* (2013.01); *H01Q 21/28* (2013.01); *H04B 7/10* (2013.01)

- (21) Appl. No.: **16/833,964**
- (22) Filed: **Mar. 30, 2020**

Related U.S. Application Data

- (63) Continuation of application No. 16/022,023, filed on Jun. 28, 2018, now Pat. No. 10,608,336.

Foreign Application Priority Data

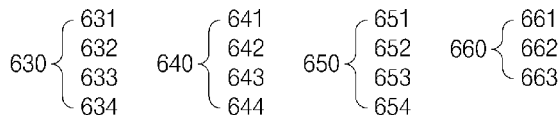
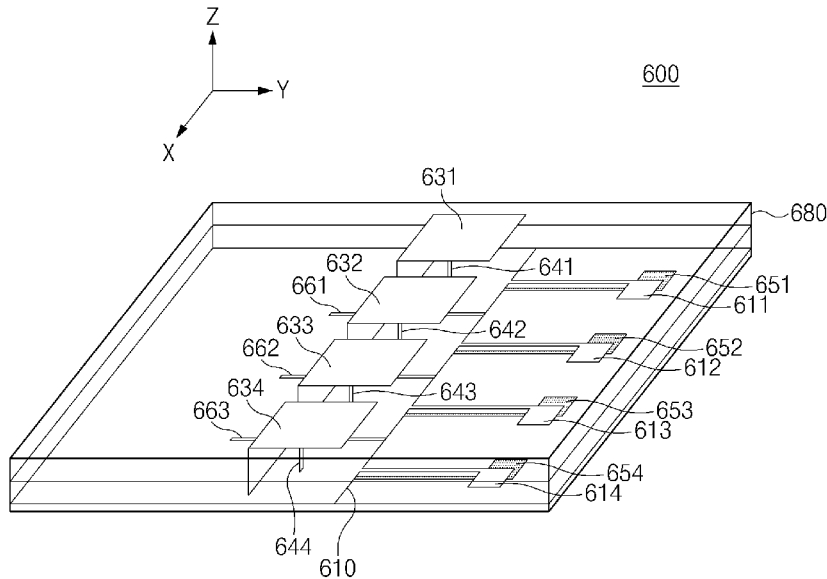
Jun. 28, 2017 (KR) 10-2017-0081751

Publication Classification

- (51) **Int. Cl.**
- H01Q 3/24* (2006.01)
- H01Q 3/36* (2006.01)

(57) **ABSTRACT**

An antenna device includes a ground member including a plane part and a plurality of extension parts extending from one end of the plane part in a first direction and arranged along a second direction, a plurality of patch-type radiators arranged on the plane part along the second direction and configured to radiate vertical polarization, and a plurality of straight radiators spaced apart from the ground member, respectively arranged to be adjacent to the plurality of extension parts, extending in the first direction, and configured to radiate horizontal polarization.





US 20200227829A1

(19) **United States**

(12) **Patent Application Publication**
JOUANLANNE

(10) **Pub. No.: US 2020/0227829 A1**

(43) **Pub. Date: Jul. 16, 2020**

(54) **PATCH ANTENNA HAVING TWO DIFFERENT RADIATION MODES WITH TWO SEPARATE WORKING FREQUENCIES, DEVICE USING SUCH AN ANTENNA**

Publication Classification

(51) **Int. Cl.**
H01Q 5/335 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/328 (2006.01)
(52) **U.S. Cl.**
CPC *H01Q 5/335* (2015.01); *H01Q 5/328* (2015.01); *H01Q 9/0407* (2013.01)

(71) Applicant: **SIGFOX**, Labege (FR)

(72) Inventor: **Cyril JOUANLANNE**, Toulouse (FR)

(21) Appl. No.: **16/635,831**

(22) PCT Filed: **Aug. 17, 2018**

(86) PCT No.: **PCT/EP2018/072288**

§ 371 (c)(1),

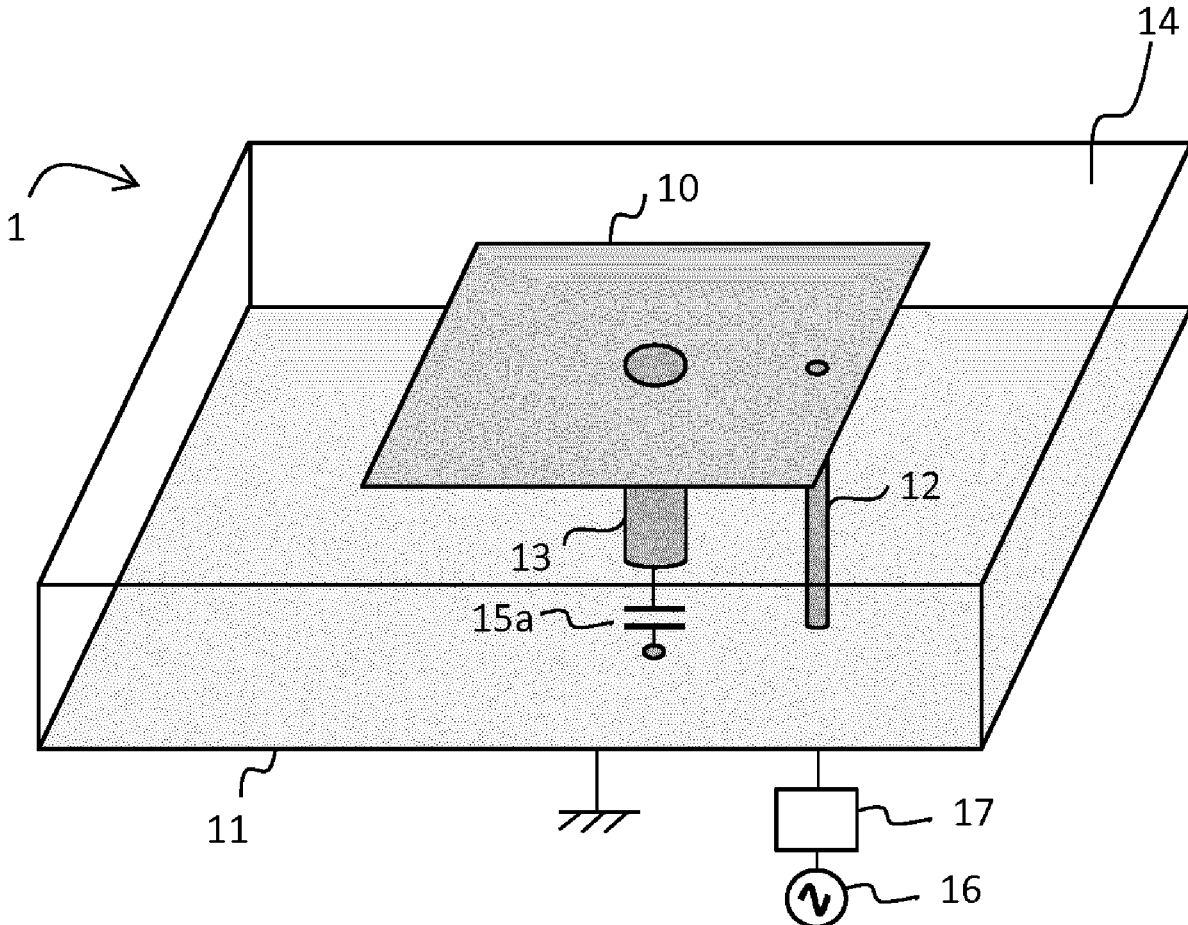
(2) Date: **Jan. 31, 2020**

(30) **Foreign Application Priority Data**

Aug. 18, 2017 (FR) 1757731

(57) **ABSTRACT**

An antenna including a ground plane, a metal plate arranged facing the ground plane, and a supply wire for connecting the plate to a generator or a receiver, such that the antenna has a first resonance frequency in a patch antenna mode. The antenna further includes a ground wire connecting the plate to the ground plane, and a capacitive element arranged in series with the ground wire between the supply wire and the ground plane, such that the antenna also has a second resonance frequency in a wire-plate antenna mode.





US 20200204199A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0204199 A1**

(43) **Pub. Date: Jun. 25, 2020**

(54) **ANTENNA MODULE, MOBILE TERMINAL AND METHOD FOR TUNING THE ANTENNA MODULE**

H01Q 1/48 (2006.01)
H01Q 5/328 (2006.01)

(52) **U.S. Cl.**
CPC *H04B 1/006* (2013.01); *H01Q 5/328* (2015.01); *H01Q 1/48* (2013.01); *H01Q 1/243* (2013.01)

(71) Applicant: **AAC Technologies Pte. Ltd.**,
Singapore City (SG)

(72) Inventors: **Jing Wu**, Shenzhen (CN); **Haibing Chen**, Shenzhen (CN); **Ke Hua**, Shenzhen (CN)

(57) **ABSTRACT**

An antenna module and a mobile terminal are provided. The mobile terminal has a metal frame and a system grounding spaced apart from the metal frame. The antenna module has a radiating body formed in the metal frame and a parasitic element coupled to the radiating body. The radiating body is configured for generating a main harmonic, and the parasitic element is configured for generating a parasitic harmonic. The antenna module further has a first tuning circuit connected in series between the radiating body and the system grounding, and a second tuning circuit connected in series between the parasitic element and the system grounding. The antenna system has at least four operation modes. The antenna system of the present invention may cover the LTE low, medium and high frequencies as a single antenna. A flexible and convenient method for tuning the antenna module is also provided.

(21) Appl. No.: **16/699,701**

(22) Filed: **Dec. 1, 2019**

(30) **Foreign Application Priority Data**

Dec. 24, 2018 (CN) 201811581064.X

Publication Classification

(51) **Int. Cl.**
H04B 1/00 (2006.01)
H01Q 1/24 (2006.01)

