US 20200403300A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0403300 A1**

KIM et al. (43) **Pub. Date: Dec. 24, 2020**

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

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

(72) Inventors: **Jong Min KIM**, Gyeonggi-do (KR); **Dong Pil PARK**, Incheon (KR); **Yun Seok OH**, Gyeonggi-do (KR); **Won Bin HONG**, Seoul (KR)

(21) Appl. No.: **17/012,863**

(22) Filed: **Sep. 4, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2019/002566, filed on Mar. 6, 2019.

(30) **Foreign Application Priority Data**

Mar. 6, 2018 (KR) 10-2018-0026382

Publication Classification

(51) **Int. Cl.**

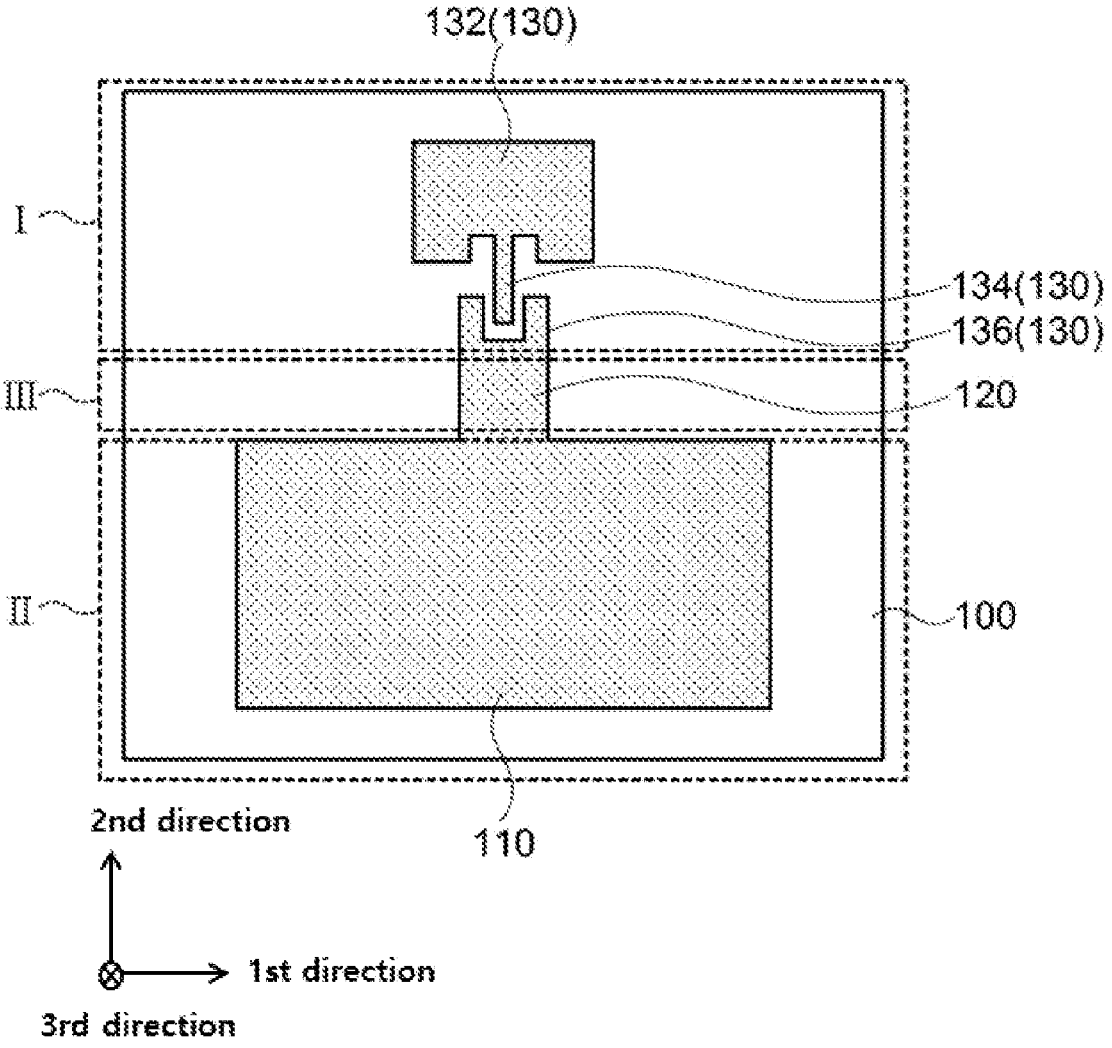
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)

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

CPC ***H01Q 1/38*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 1/243*** (2013.01)

(57) **ABSTRACT**

An antenna device according to an embodiment of the present invention includes a dielectric layer, an upper electrode layer disposed on the dielectric layer and including a radiation pattern, a lower electrode layer disposed on the dielectric layer, and a bending connection portion integrally connected to the upper electrode layer and the lower electrode layer on the dielectric layer. An interconnection of a ground layer is implemented with high reliability by the bending connection portion.



US 20200403318A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0403318 A1**

LIU (43) **Pub. Date: Dec. 24, 2020**

(54) **ANTENNA STRUCTURE AND INTELLIGENT HOUSEHOLD APPLIANCE USING THE SAME**

(71) Applicant: **AMBIT MICROSYSTEMS (SHANGHAI) LTD.**, Shanghai (CN)

(72) Inventor: **YEN-YU LIU**, New Taipei (TW)

(21) Appl. No.: **16/445,346**

(22) Filed: **Jun. 19, 2019**

Publication Classification

(51) **Int. Cl.**

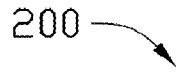
H01Q 9/06	(2006.01)
H01Q 9/04	(2006.01)
H01Q 1/22	(2006.01)
H01Q 1/00	(2006.01)
H01Q 13/10	(2006.01)

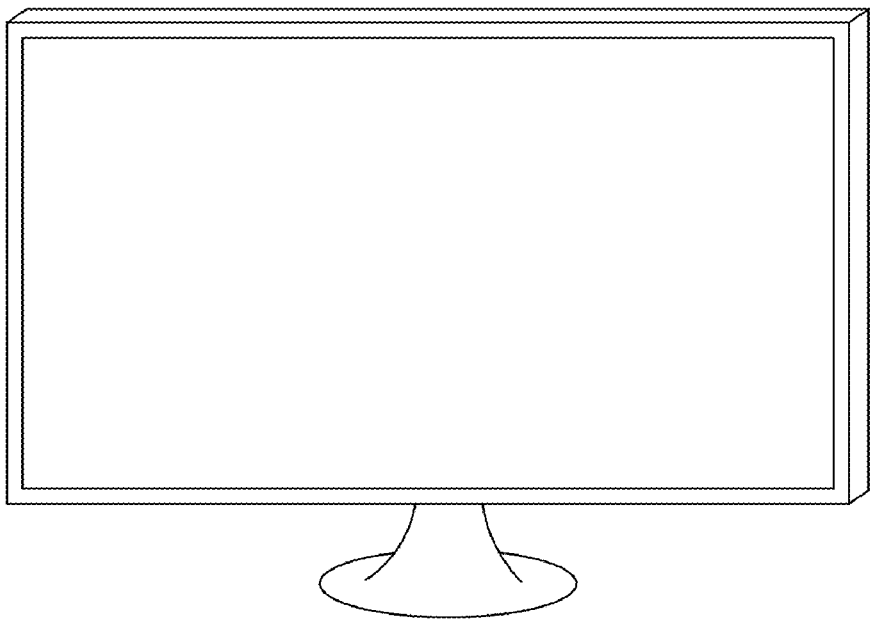
(52) **U.S. Cl.**

CPC ***H01Q 9/065*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 13/106*** (2013.01); ***H01Q 1/007*** (2013.01); ***H01Q 1/2208*** (2013.01)

(57) **ABSTRACT**

An antenna structure capable of operating in several modes includes first and second metal patches and a substrate (which can be an air-filled void) positioned between them. The second patch is substantially an isosceles trapezoidal patch. The second patch includes a first bottom edge, a second bottom edge parallel to and spaced from the first bottom edge, a first side edge, a second side edge, a first shorting wall, and a second short circuit patch. The first side edge and the second side edge are connected to the first bottom edge and the second bottom edge. The first shorting wall and the second shorting wall are formed between the first patch and the second patch. The second patch further defines a V-shaped slot.





US 20200411946A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411946 A1**

Shen (43) **Pub. Date: Dec. 31, 2020**

(54) **ANTENNA DEVICE AND ON-BOARD EQUIPMENT**

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

(72) Inventor: **Yachuan Shen**, Shenzhen (CN)

(21) Appl. No.: **16/993,293**

(22) Filed: **Aug. 14, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094081, filed on Jun. 30, 2019.

Publication Classification

(51) **Int. Cl.**

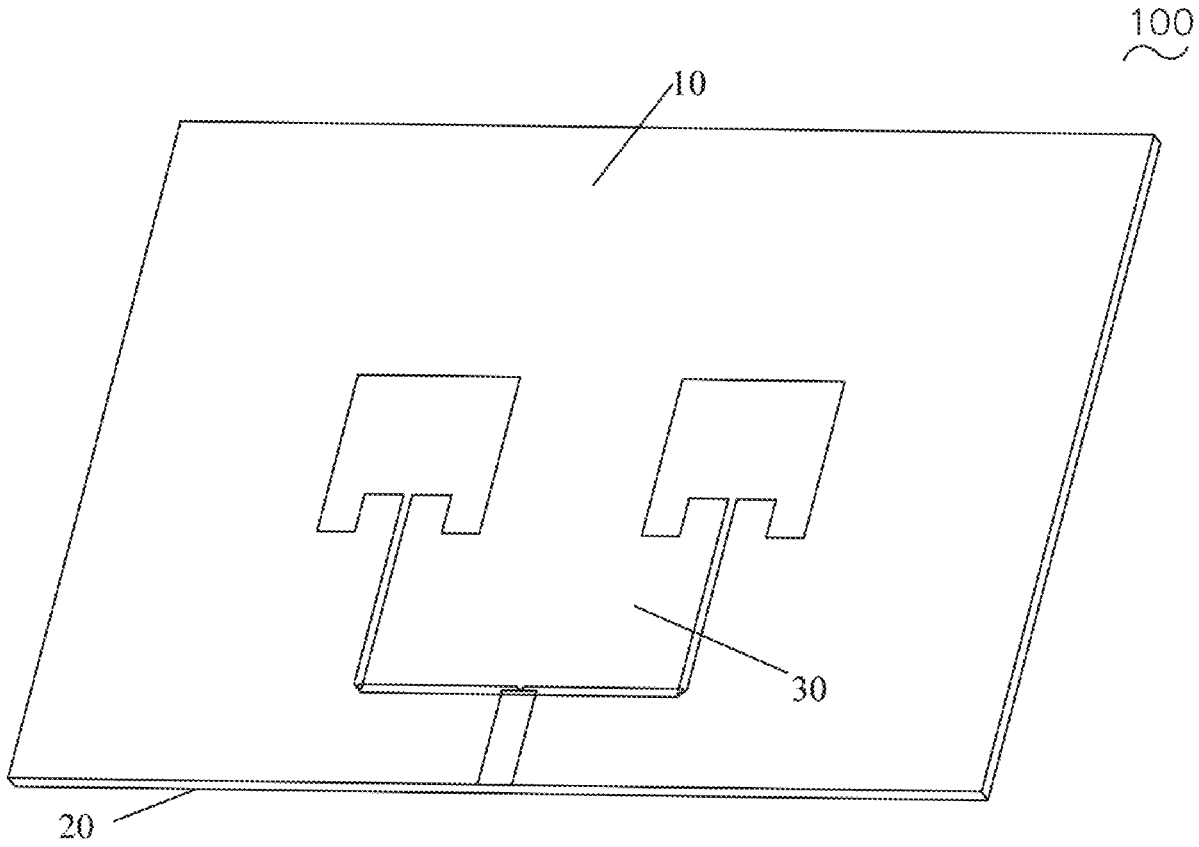
H01Q 1/12	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/04	(2006.01)
H05K 1/02	(2006.01)

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

CPC ***H01Q 1/12*** (2013.01); ***H01Q 1/48*** (2013.01); *H05K 2201/09036* (2013.01); ***H05K 1/0243*** (2013.01); *H05K 2201/10098* (2013.01); ***H01Q 9/0407*** (2013.01)

(57) **ABSTRACT**

An antenna device, including: a substrate, a ground and an antenna provided on two surfaces of the substrate; the antenna includes a first radiating portion, a second radiating portion, a one-to-two power divider and a feeding portion; the first radiating portion is provided with a first impedance adjusting groove, the other end of the first transmission wire is inserted into the first impedance adjusting groove and connected to the first radiating portion, to form two symmetrically distributed first impedance adjusting sub-grooves; the second radiating portion is provided with a second impedance adjusting groove, the other end of the second transmission wire is inserted into the second impedance adjusting groove and connected to the second radiating portion, to form two symmetrically distributed second impedance adjusting sub-grooves. The above antenna device has a simple structure, can realize directional radiation of the antenna, and also has a relatively wide radiation range.



US 20200411949A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411949 A1**

Wu et al. (43) **Pub. Date: Dec. 31, 2020**

(54) **ANTENNA-IN-PACKAGE MODULE AND ELECTRONIC DEVICE**

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

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

(21) Appl. No.: **16/991,001**

(22) Filed: **Aug. 11, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094046, filed on Jun. 30, 2019.

Publication Classification

(51) **Int. Cl.**

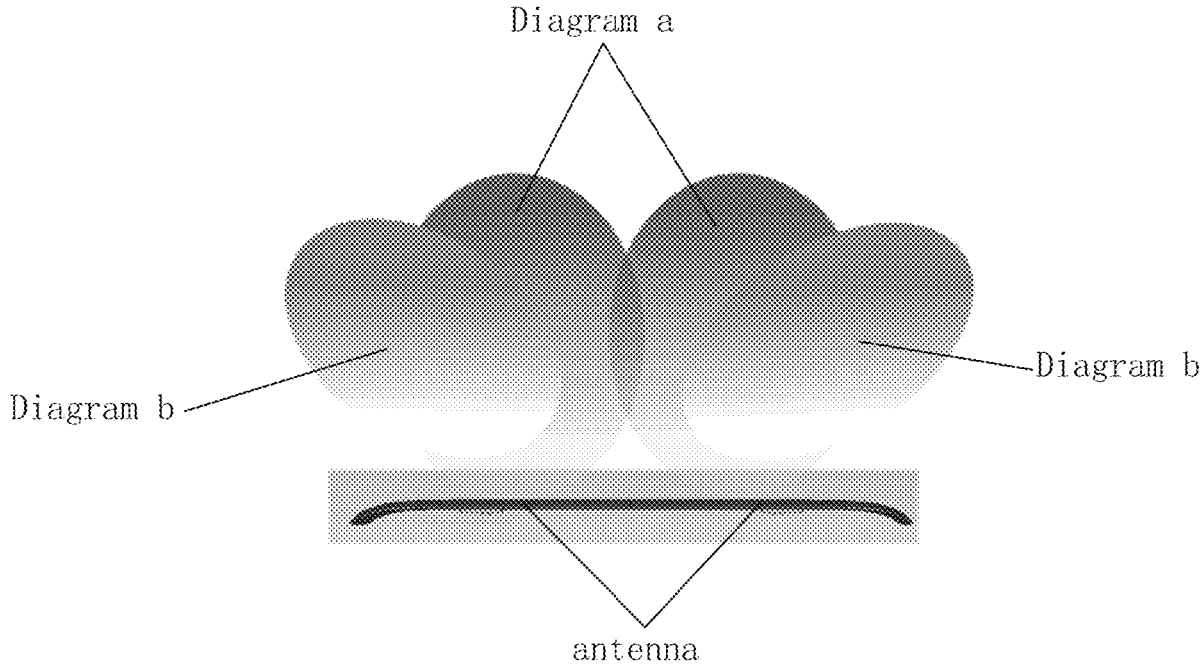
H01Q 1/22	(2006.01)
H04M 1/02	(2006.01)
H01Q 21/00	(2006.01)
H01Q 21/06	(2006.01)
H01Q 21/22	(2006.01)
H01Q 1/24	(2006.01)
H01Q 19/00	(2006.01)

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

CPC ***H01Q 1/2283*** (2013.01); ***H04M 1/0283*** (2013.01); ***H01Q 21/0025*** (2013.01); ***H01Q 19/005*** (2013.01); ***H01Q 21/22*** (2013.01); ***H01Q 1/243*** (2013.01); ***H01Q 21/065*** (2013.01)

(57) **ABSTRACT**

The invention provides an antenna-in-package module and an electronic device. The antenna-in-package module comprises a substrate, an antenna module and an integrated circuit chip arranged on opposite two sides of the substrate and a circuit arranged in the substrate to connect the antenna module and the integrated circuit chip. The antenna module comprises a plurality of antenna units connected to the circuit and a plurality of guiding directors arranged separated from each antenna unit, separately. The antenna-in-package module provided by the invention can increase spatial coverage of the antenna-in-package module.



US 20200411951A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411951 A1**

Shen et al. (43) **Pub. Date: Dec. 31, 2020**

(54) **WIFI ANTENNA AND WIRELESS COMMUNICATION DEVICE**

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

(72) Inventors: **Yachuan Shen**, Shenzhen (CN); **Lei Zheng**, Shenzhen (CN); **Yongsheng Peng**, Shenzhen (CN); **Hongjun Wang**, Shenzhen (CN)

(21) Appl. No.: **16/996,932**

(22) Filed: **Aug. 19, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094080, filed on Jun. 30, 2019.

Publication Classification

(51) **Int. Cl.**

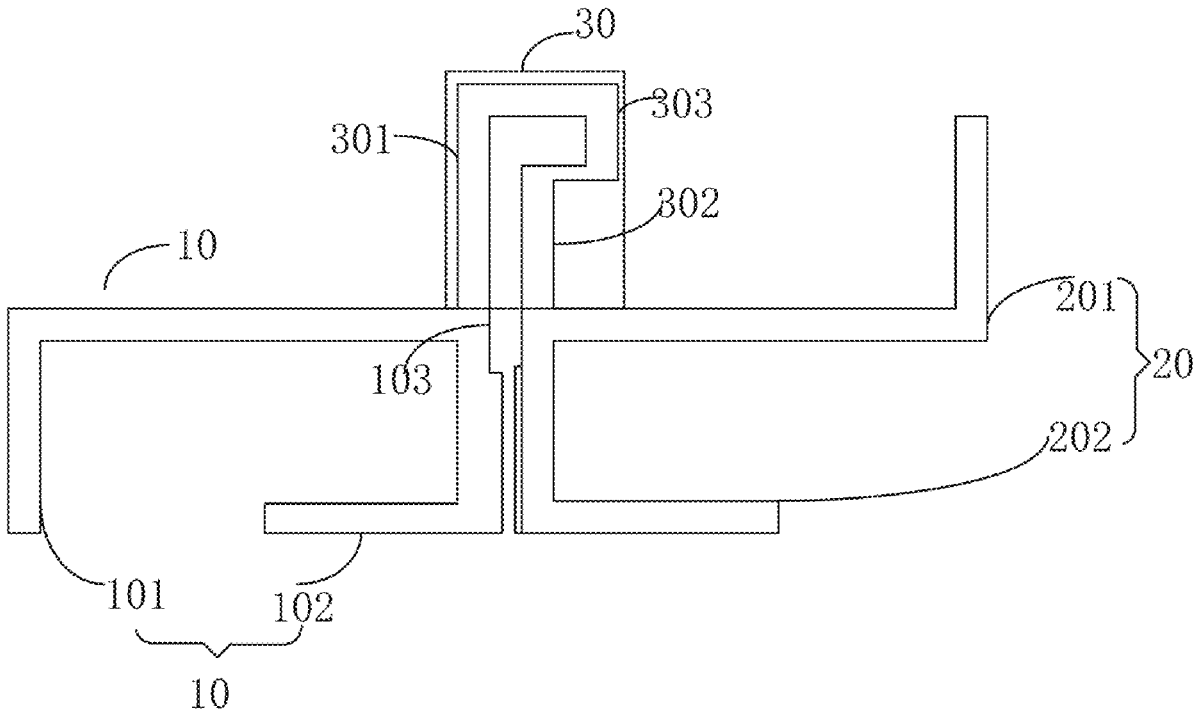
H01Q 1/22	(2006.01)
H01Q 9/26	(2006.01)
H01Q 5/20	(2006.01)
H01Q 5/307	(2006.01)

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

CPC ***H01Q 1/2291*** (2013.01); ***H01Q 5/307*** (2015.01); ***H01Q 5/20*** (2015.01); ***H01Q 9/26*** (2013.01)

(57) **ABSTRACT**

A WIFI antenna, including: a dipole including a first radiator and a second radiator that are arranged opposite to and spaced apart from each other; a feeding port provided at adjacent ends of the first radiator and the second radiator; a balun structure including a first access portion, a second access portion provided opposite to the first access portion, and an intermediate portion connecting the first access portion with the second access portion, and the intermediate portion having an annular structure; the first access portion of the balun structure is connected to the first radiator at the feeding port, and the second access portion is connected to the second radiator at the feeding port. Setting of the WIFI antenna provides characteristics of omnidirectional radiation, high gain and high physical stability, which not only improves the gain, but also fully covers the WIFI frequency band.



US 20200411955A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411955 A1**

Liu (43) **Pub. Date: Dec. 31, 2020**

(54) **ANTENNA ASSEMBLY AND ELECTRONIC DEVICE USING SAME**

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

(72) Inventor: **Feng Liu**, Shenzhen (CN)

(21) Appl. No.: **16/936,412**

(22) Filed: **Jul. 22, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/093346, filed on Jun. 27, 2019.

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

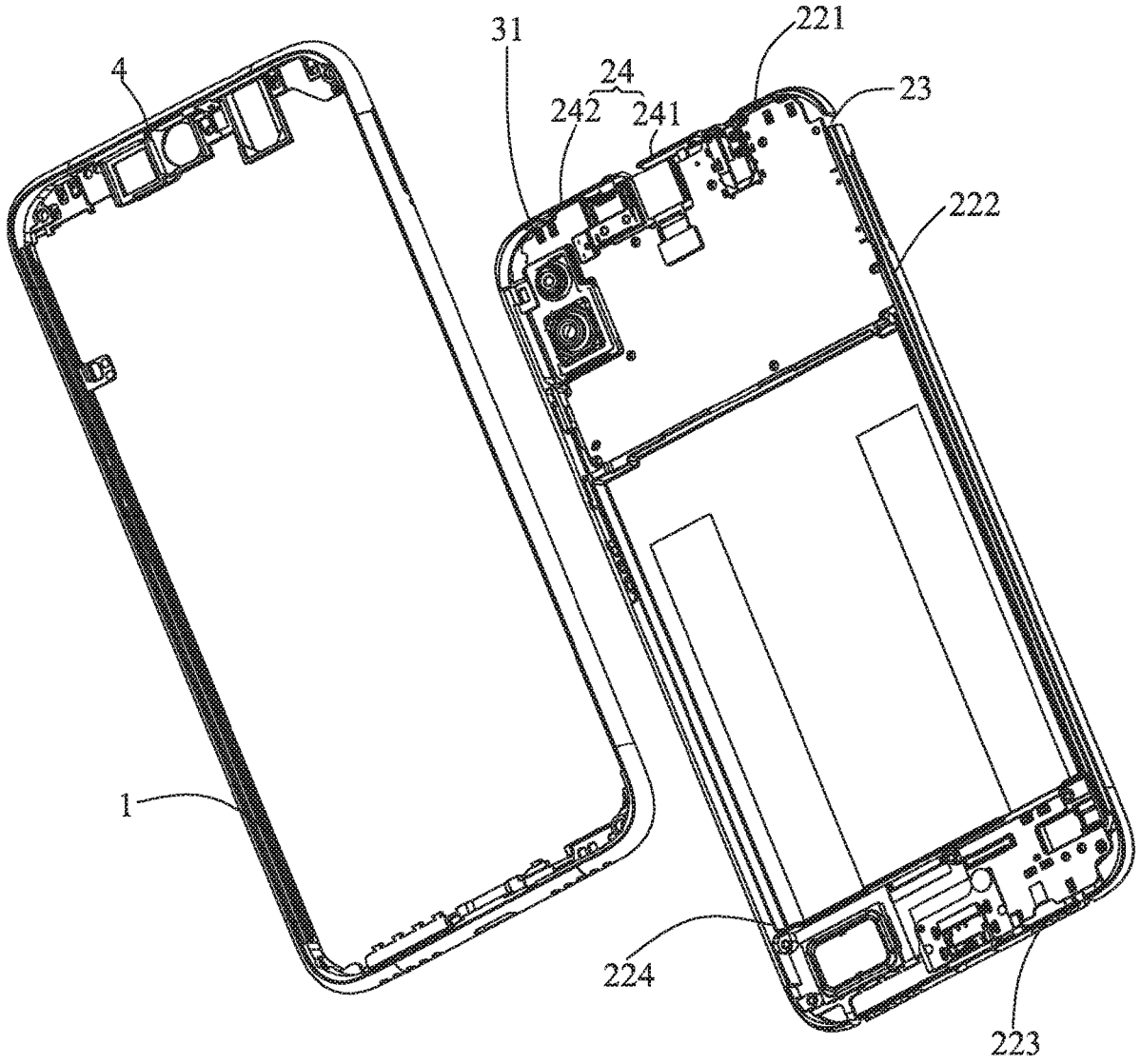
H04M 1/02 (2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H04M 1/026*** (2013.01)

(57) **ABSTRACT**

The present application provides an antenna assembly and an electronic device. The antenna assembly includes a plastic housing, a frame body and a circuit board arranged in the frame body, wherein the frame body includes a middle frame and an outer metal frame surrounding the edge of the middle frame and connected with the middle frame. The plastic housing covers the outer side of the outer metal frame. A number of gaps are arranged on the outer metal frame. The present application can randomly set the positions of the gaps as described in requirements of an antenna structure, then the performance of the antennas can be ensured, and the attractiveness is not affected.



US 20200411956A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2020/0411956 A1

Peng et al. (43) Pub. Date: Dec. 31, 2020

(54) **FULL SCREEN ELECTRONIC DEVICE AND ANTENNA THEREOF**

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

(72) Inventors: **Yongsheng Peng**, Shenzhen (CN); **Lei Zheng**, Shenzhen (CN)

(21) Appl. No.: **16/936,449**

(22) Filed: **Jul. 23, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094070, filed on Jun. 30, 2019.

Publication Classification

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

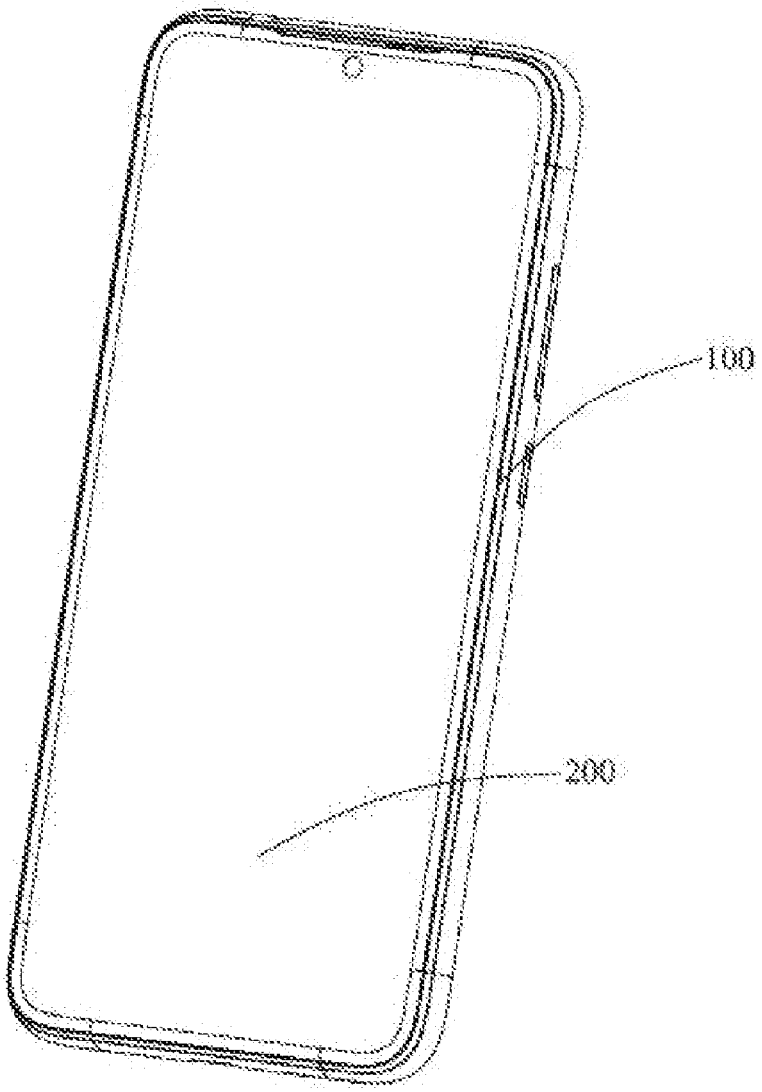
H04M 1/02 (2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H04M 1/0266*** (2013.01)

(57) **ABSTRACT**

The present invention discloses an antenna including a frame body and a circuit board arranged in the frame body. The frame body includes a middle frame and an outer metal frame surrounding the edge of the middle frame and connected to the middle frame. The outer metal frame includes a first side frame, a second side frame, a third side frame and a fourth side frame. The circuit board is provided with a feeding part and a switch circuit which are electrically connected with the third side frame. The third side frame and the middle frame are arranged at an interval to form a first gap; a second gap is arranged between one end of the second side frame near the third side frame and the middle frame. BY virtue of this configuration the radiation efficiency of the antenna is accordingly improved.



US 20200411957A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411957 A1**

Zhu et al. (43) **Pub. Date: Dec. 31, 2020**

(54) **ANTENNA ASSEMBLY FOR TERMINAL WITH FOLDABLE SCREEN AND TERMINAL**

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

(72) Inventors: **Yufei Zhu**, Shenzhen (CN); **Kai Dong**, Shenzhen (CN); **Shengjun Liu**, Shenzhen (CN)

(21) Appl. No.: **16/994,645**

(22) Filed: **Aug. 16, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094096, filed on Jun. 30, 2019.

Publication Classification

(51) **Int. Cl.**

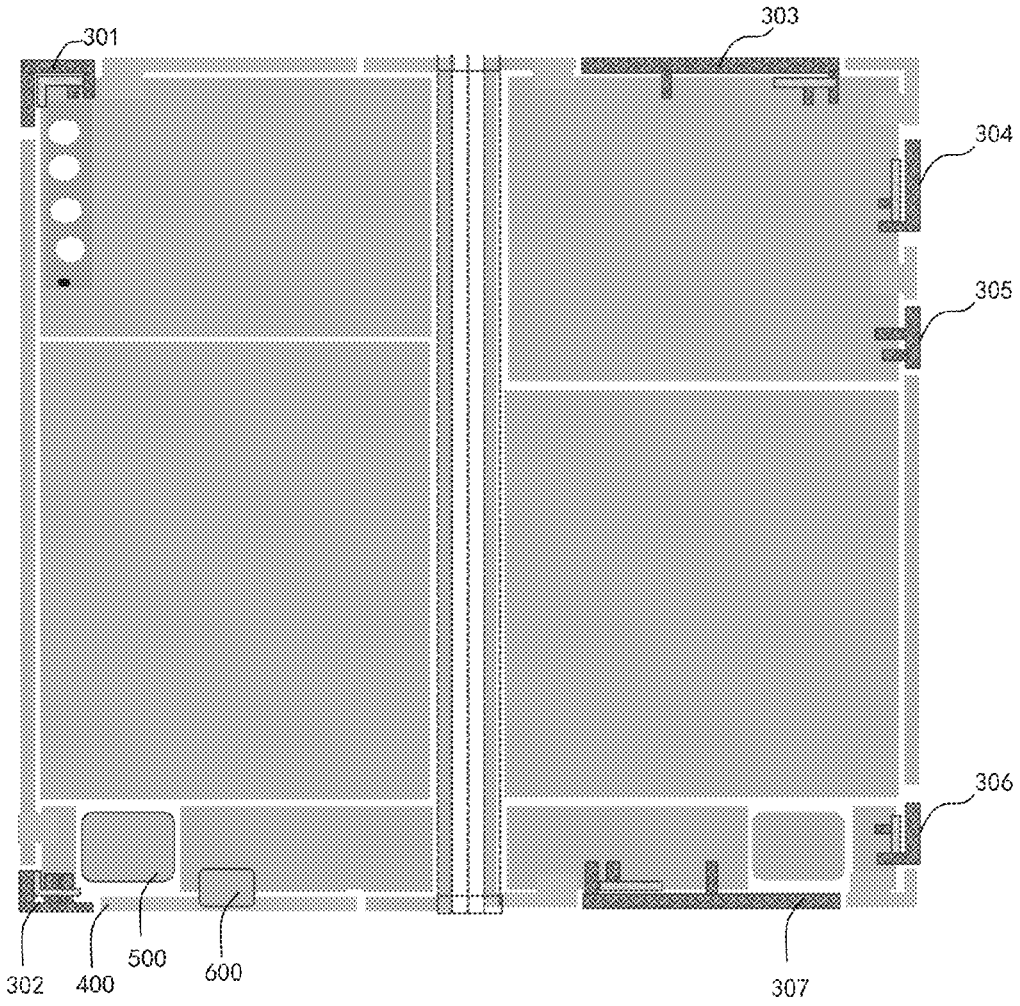
H01Q 1/24	(2006.01)
H01Q 5/307	(2006.01)
H04B 7/0413	(2006.01)
H04M 1/02	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H04M 1/0268*** (2013.01); ***H04B 7/0413*** (2013.01); ***H01Q 5/307*** (2015.01)

(57) **ABSTRACT**

A terminal with a foldable screen and an antenna assembly thereof are disclosed. The antenna assembly includes a foldable frame and seven antenna modules. The frame includes a first side frame; a second side frame opposite to the first side frame, a third side frame, and a fourth side frame. A first antenna portion is disposed at a corner connecting the first side frame to the third side frame. A second antenna portion is disposed at a corner connecting the second side frame and the third side frame. A third antenna portion is disposed on the second sub-frame. Fourth, fifth, and sixth antenna portions are sequentially arranged on the fourth side frame. A seventh antenna portion is disposed on the fourth sub-frame. At least 2*2 MIMO configuration of WIFI frequency band and 4*4 MIMO configuration of 5G NR frequency band below Sub-6G frequency band are formed by the antenna modules.



US 20200411958A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411958 A1**

Yan (43) **Pub. Date: Dec. 31, 2020**

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

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

(72) Inventor: **Wei Yan**, Shenzhen (CN)

(21) Appl. No.: **16/995,730**

(22) Filed: **Aug. 17, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/093965, filed on Jun. 29, 2019.

Publication Classification

(51) **Int. Cl.**

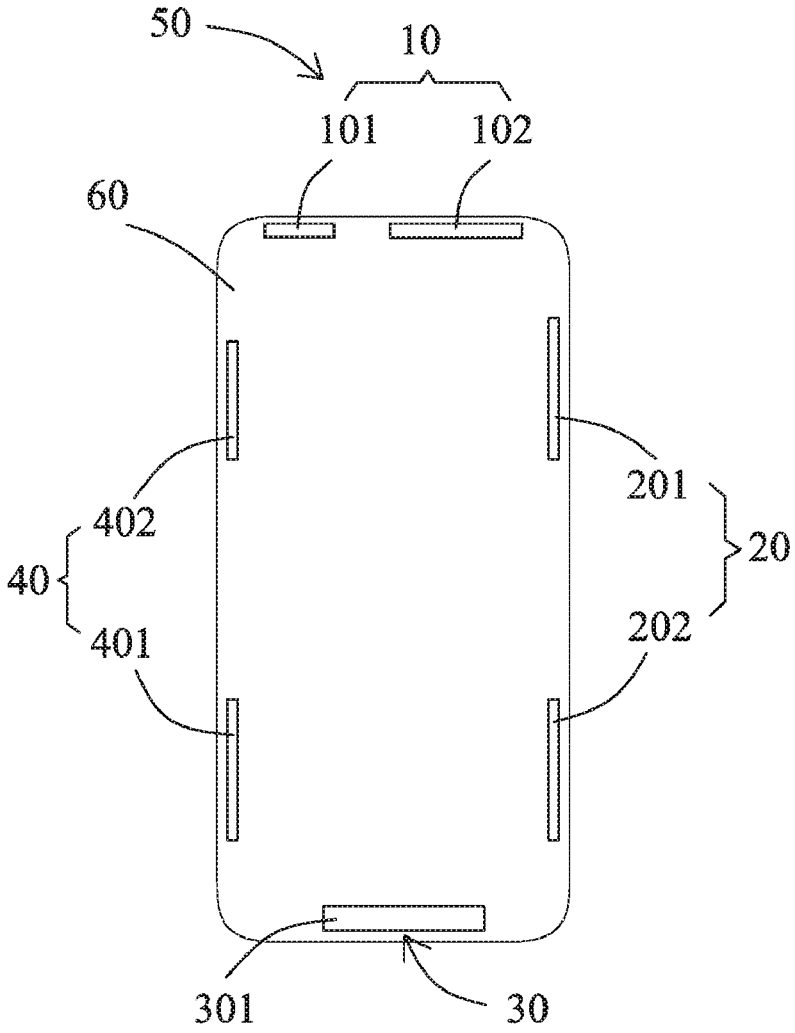
H01Q 1/24	(2006.01)
H01Q 5/307	(2006.01)
H01Q 5/20	(2006.01)
H04B 7/0413	(2006.01)
H04M 1/02	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 5/307*** (2015.01); ***H04M 1/026*** (2013.01); ***H04B 7/0413*** (2013.01); ***H01Q 5/20*** (2015.01)

(57) **ABSTRACT**

An antenna module and a mobile terminal are provided. The mobile terminal is provided with a housing. The antenna module includes a first antenna group, a second antenna group, a third antenna group and a fourth antenna group. The first antenna group includes a first antenna and a second antenna, where both the first antenna and the second antenna operate in a 4G frequency band. The second antenna group includes a third antenna and a fourth antenna, where both the third antenna and the fourth antenna operate in a 5G frequency band. The third antenna group includes a fifth antenna, and the fifth antenna operates in the 4G frequency band. The fourth antenna group includes a sixth antenna and a seventh antenna, where both the sixth antenna and the seventh antenna operate in the 5G frequency band. The third, fourth, sixth and seventh antenna form a 4*4MIMO antenna group.



US 20200411959A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411959 A1**

RYU et al. (43) **Pub. Date: Dec. 31, 2020**

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

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

(72) Inventors: **Han Sub RYU**, Gyeongsangbuk-do (KR); **Yun Seok OH**, Gyeonggi-do (KR); **Yoon Ho HUH**, Seoul (KR); **Won Bin HONG**, Seoul (KR)

(21) Appl. No.: **17/019,527**

(22) Filed: **Sep. 14, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2019/002929, filed on Mar. 14, 2019.

(30) **Foreign Application Priority Data**

Mar. 14, 2018 (KR) 10-2018-0029804
Sep. 21, 2018 (KR) 10-2018-0113445

Publication Classification

(51) **Int. Cl.**

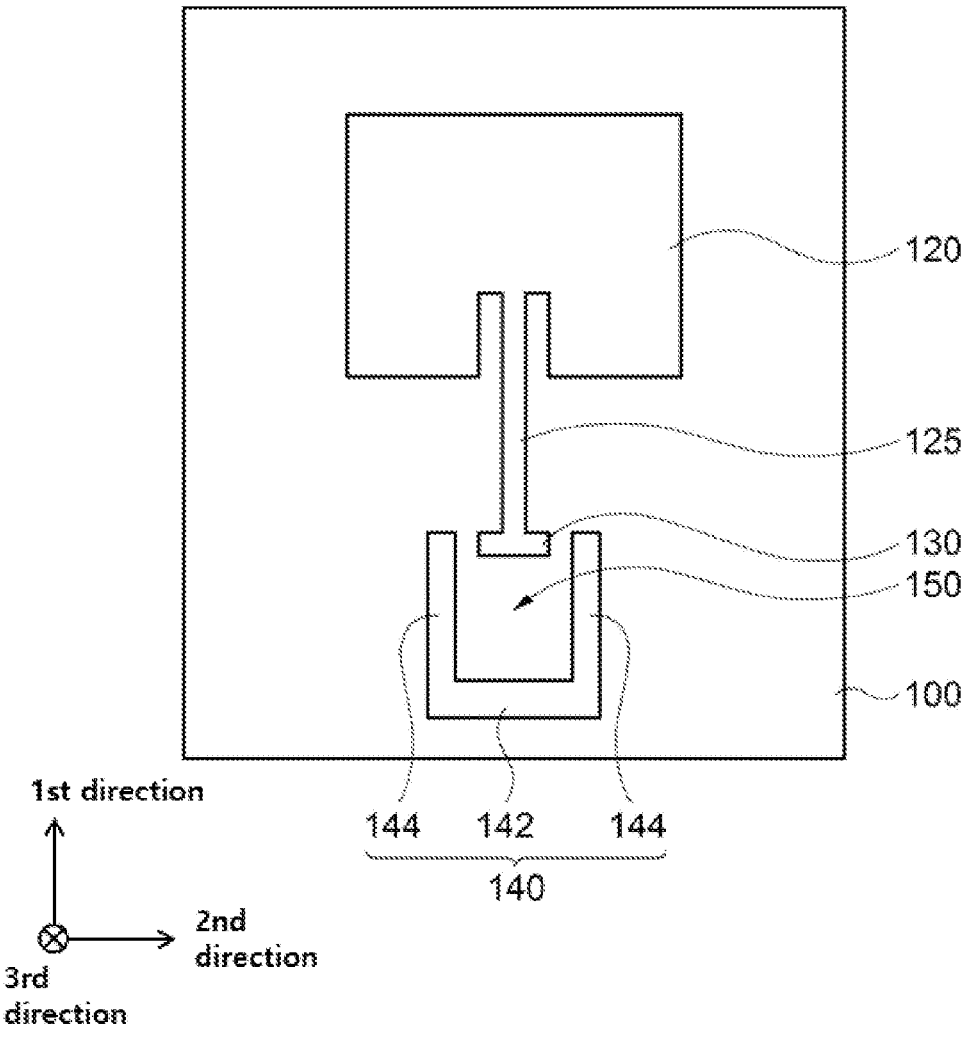
H01Q 1/24	(2006.01)
H01Q 1/48	(2006.01)
H01Q 1/36	(2006.01)
H01Q 9/04	(2006.01)

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

CPC ***H01Q 1/243*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H01Q 1/36*** (2013.01); ***H01Q 1/48*** (2013.01)

(57) **ABSTRACT**

An antenna device according to an embodiment of the present invention includes a dielectric layer, a radiation pattern disposed on a top surface of the dielectric layer, a signal pad electrically connected to the radiation pattern, and a ground pad spaced apart from the signal pad and having an isolation space. A length of the isolation space is greater than a length of the signal pad.



US 20200411987A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0411987 A1**

LO et al. (43) **Pub. Date: Dec. 31, 2020**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **Quanta Computer Inc.**, Taoyuan City (TW)

(72) Inventors: **Chung-Hung LO**, Taoyuan City (TW); **Yi-Ling TSENG**, Taoyuan City (TW); **Chin-Lung TSAI**, Taoyuan City (TW); **Ching-Hai CHIANG**, Taoyuan City (TW); **Kuan-Hsien LEE**, Taoyuan City (TW); **Ying-Cong DENG**, Taoyuan City (TW); **Chung-Ting HUNG**, Taoyuan City (TW)

(21) Appl. No.: **16/661,319**

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

(30) **Foreign Application Priority Data**

Jun. 28, 2019 (TW) 108122731

Publication Classification

(51) **Int. Cl.**

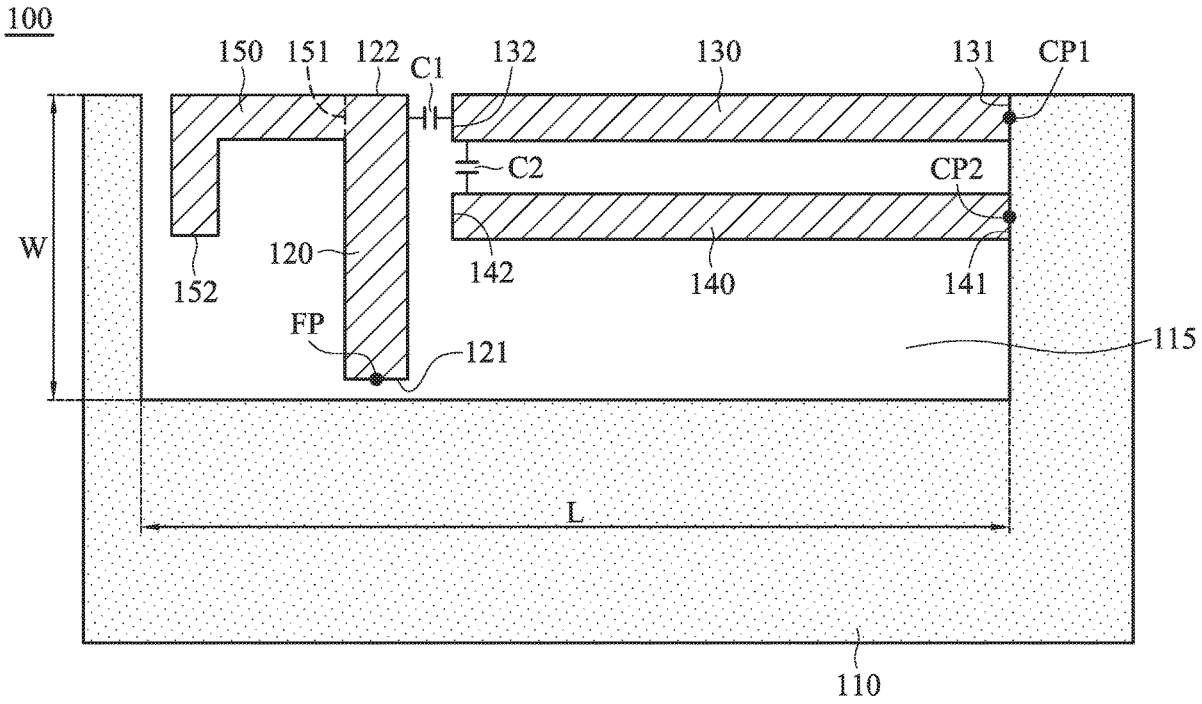
H01Q 5/307	(2006.01)
H01Q 1/48	(2006.01)
H01Q 9/42	(2006.01)

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

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

(57) **ABSTRACT**

An antenna structure includes a ground element, a feeding radiation element, a first radiation element, a second radiation element, a third radiation element, a first capacitor, and a second capacitor. The ground element has a notch region. The feeding radiation element has a feeding point. The first radiation element is coupled to the ground element. The first capacitor is coupled between the feeding radiation element and the first radiation element. The second radiation element is coupled to the ground element. The second capacitor is coupled between the first radiation element and the second radiation element. The third radiation element is coupled to the feeding radiation element. The feeding radiation element, the first radiation element, the second radiation element, the third radiation element, the first capacitor, and the second capacitor are all disposed inside the notch region of the ground element.



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(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0412001 A1**

Ayala Vazquez et al. (43) **Pub. Date: Dec. 31, 2020**

(54) **ELECTRONIC DEVICES HAVING INDIRECTLY-FED SLOT ANTENNA ELEMENTS**

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

(72) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Erdinc Irci**, Sunnyvale, CA (US); **Georgios Atmatzakis**, Cupertino, CA (US); **Hongfei Hu**, Cupertino, CA (US)

(21) Appl. No.: **16/457,515**

(22) Filed: **Jun. 28, 2019**

Publication Classification

(51) **Int. Cl.**

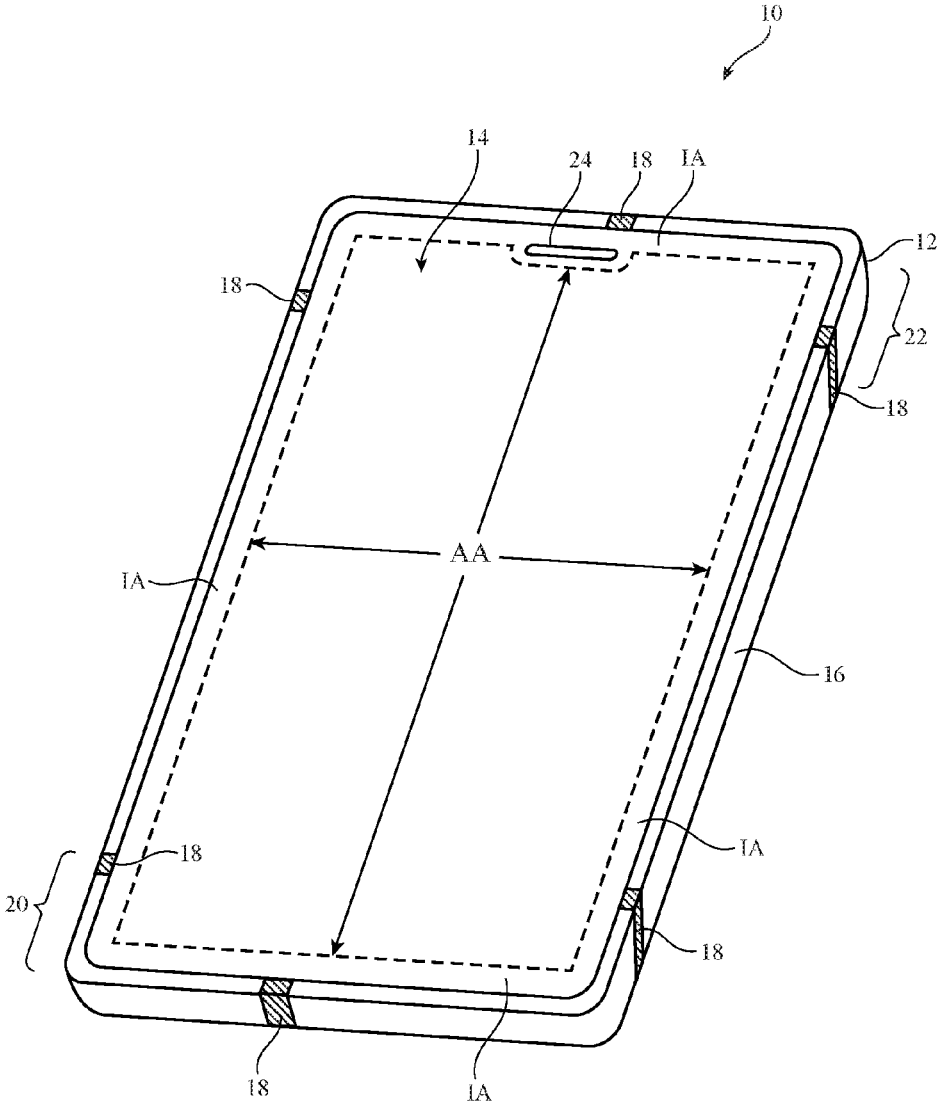
H01Q 13/10	(2006.01)
H01Q 1/24	(2006.01)
H01Q 9/14	(2006.01)

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

CPC ***H01Q 13/103*** (2013.01); ***H01Q 9/145*** (2013.01); ***H01Q 1/243*** (2013.01)

(57) **ABSTRACT**

An electronic device may include ground structures and peripheral conductive housing structures defining opposing edges of a slot element. A monopole element may overlap the slot element. The monopole element may be directly fed radio-frequency signals by an antenna feed coupled to the monopole element. The monopole element may radiate the radio-frequency signals in a first frequency band while indirectly feeding the radio-frequency signals to the slot element via near-field electromagnetic coupling. The slot element may radiate the radio-frequency signals in a second frequency band that is lower than the first frequency band. The monopole element and the slot element may collectively form a multi-band antenna that exhibits a relatively wide bandwidth.



US 20200412015A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2020/0412015 A1

Zhang et al. (43) Pub. Date: Dec. 31, 2020

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

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

(72) Inventors: **Xuanbo Zhang**, Shenzhen (CN); **Yongli Chen**, Shenzhen (CN); **Xinqian Liu**, Shenzhen (CN); **Jiangyan Yang**, Shenzhen (CN)

(21) Appl. No.: **16/996,918**

(22) Filed: **Aug. 19, 2020**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2019/094083, filed on Jun. 30, 2019.

Publication Classification

(51) **Int. Cl.**

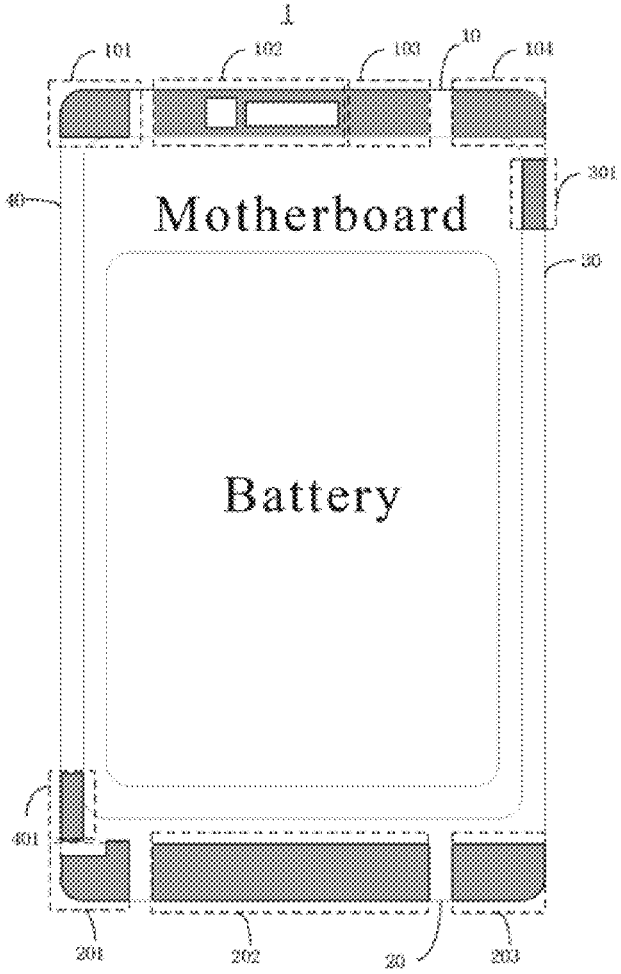
H01Q 21/06	(2006.01)
H04B 7/0413	(2006.01)
H01Q 1/24	(2006.01)
H01Q 1/22	(2006.01)
H01Q 5/307	(2006.01)
H01Q 5/20	(2006.01)

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

CPC ***H01Q 21/061*** (2013.01); ***H04B 7/0413*** (2013.01); ***H01Q 1/243*** (2013.01); *H04W 84/12* (2013.01); ***H01Q 5/307*** (2015.01); ***H01Q 5/20*** (2015.01); ***H01Q 1/2291*** (2013.01)

(57) **ABSTRACT**

An antenna module and a mobile terminal are provided. The mobile terminal includes a shell including opposite upper and lower edges and opposite first and second side edges. First to fourth antennas are sequentially provided on the upper edge, and the first side edge is provided with a fifth antenna close to the upper edge. Sixth to eighth antennas are sequentially provided on the lower edge, and the second side edge is provided with a ninth antenna close to the lower edge. The first to ninth antennas form antenna groups respectively operating in communication frequency bands of 2G to 4G, GPS, WIFI2.4G, and WIFI5G, and an 8*8 MIMO antenna group operating in a 5G communication frequency band. The antenna module can operate in the 2G to 4G, GPS, and WIFI frequency bands, and have the 8*8 MIMO antenna and the antenna respectively operating in the 5G and WIFI5G frequency bands.



US 20200413530A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0413530 A1**

LEE et al. (43) **Pub. Date: Dec. 31, 2020**

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

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

(72) Inventors: **Junho LEE**, Gyeonggi-do (KR); **Antonio CICCOMANCINI SCOGNA**, Gyeonggi-do (KR)

(21) Appl. No.: **16/962,600**

(22) PCT Filed: **Jan. 25, 2019**

(86) PCT No.: **PCT/KR2019/001097**

§ 371 (c)(1),
(2) Date: **Jul. 16, 2020**

(30) **Foreign Application Priority Data**

Jan. 26, 2018 (KR) 10-2018-0009876

Publication Classification

(51) **Int. Cl.**

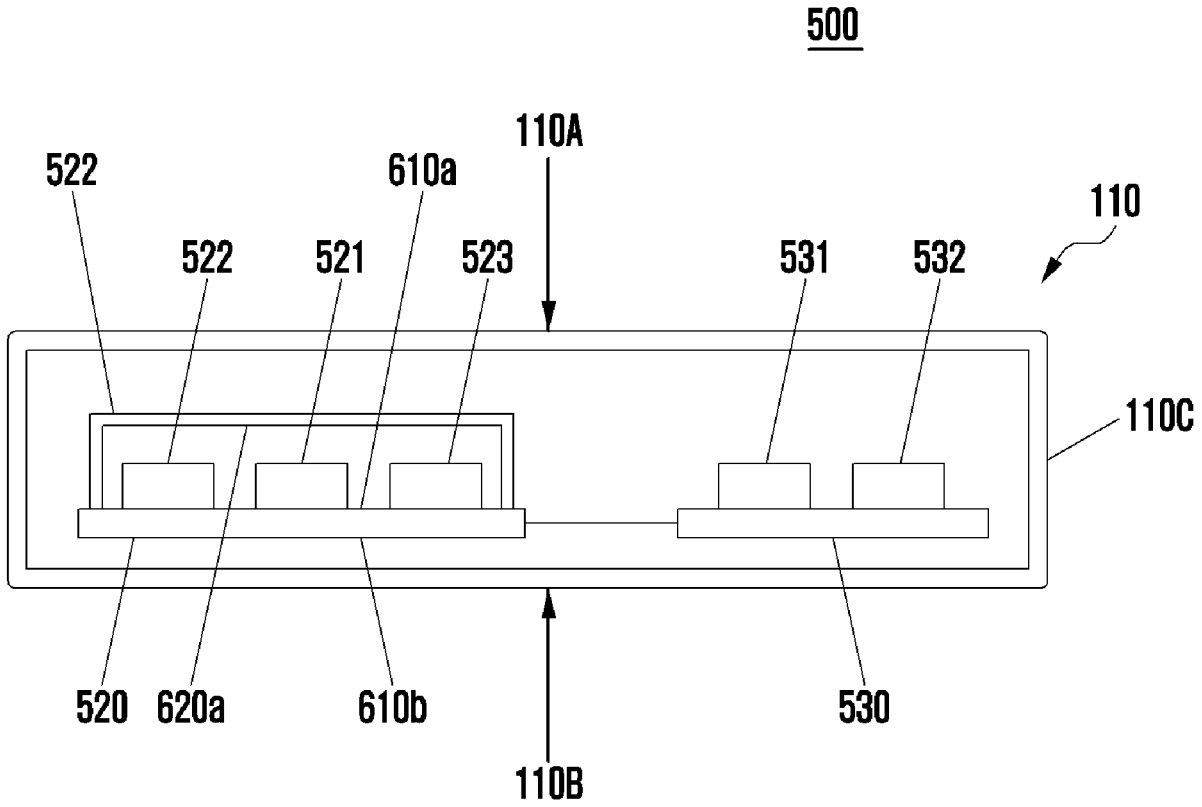
H05K 1/02	(2006.01)
H01Q 9/04	(2006.01)
H05K 9/00	(2006.01)
H01Q 21/06	(2006.01)
H01Q 1/52	(2006.01)

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

CPC ***H05K 1/0236*** (2013.01); ***H01Q 9/0407*** (2013.01); ***H05K 1/0243*** (2013.01); *H05K 2201/10098* (2013.01); ***H01Q 21/06*** (2013.01); ***H01Q 1/526*** (2013.01); ***H05K 9/0024*** (2013.01)

(57) **ABSTRACT**

An antenna device comprises: a printed circuit board formed with both sides in a plate shape including a first surface and a second surface and including at least one conductive layer between the first surface and the second surface; an array of conductive plates formed parallel to the first surface on or in the printed circuit board; a wireless communication circuit electrically connected to the array of conductive plates, coupled to the first surface, and capable of transmitting or receiving frequencies between 3 GHz and 300 GHz; and a conductive shielding structure mounted on the first surface of the printed circuit board and electrically connected to the at least one conductive layer when covering the wireless communication circuit, wherein the conductive shielding structure may include: a third surface facing the first surface when seen from the top of the first surface; and an electromagnetic bandgap (EBG) structure formed on the third surface.



US 20210005952A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0005952 A1**

CHANG et al. (43) **Pub. Date: Jan. 7, 2021**

(54) **MOBILE DEVICE**

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

(72) Inventors: **Kun-Sheng CHANG**, New Taipei City (TW); **Ching-Chi LIN**, New Taipei City (TW)

(21) Appl. No.: **16/550,681**

(22) Filed: **Aug. 26, 2019**

(30) **Foreign Application Priority Data**

Jul. 5, 2019 (TW) 108123737

Publication Classification

(51) **Int. Cl.**

H01Q 1/22 (2006.01)

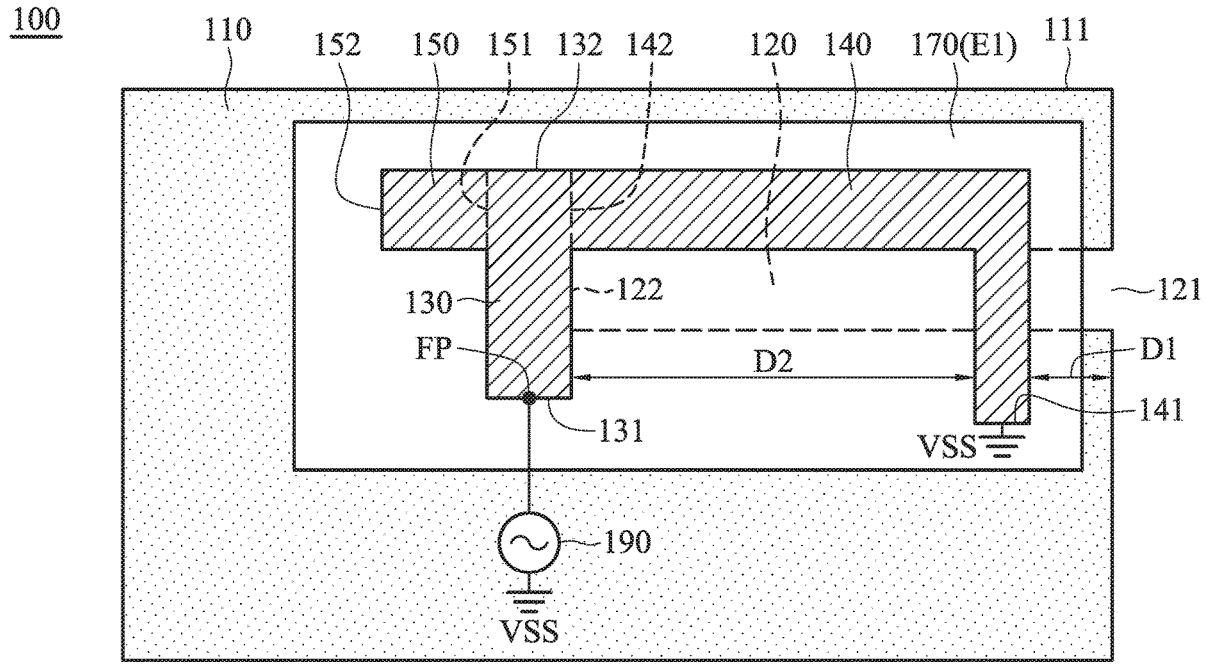
H01Q 9/42 (2006.01)

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

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

(57) **ABSTRACT**

A mobile device includes a metal mechanism element, a feeding radiation element, a first radiation element, a second radiation element, and a dielectric substrate. The metal mechanism element has a slot. The slot has an open end and a closed end. The feeding radiation element has a feeding point. The first radiation element extends across the slot of the metal mechanism element. The feeding radiation element is coupled through the first radiation element to a ground voltage. The second radiation element is coupled to the feeding radiation element. The dielectric substrate is adjacent to the metal mechanism element. The feeding radiation element, the first radiation element, and the second radiation element are disposed on the dielectric substrate. An antenna structure is formed by the feeding radiation element, the first radiation element, the second radiation element, and the slot of the metal mechanism element.



US 20210005968A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2021/0005968 A1**

(43) **Pub. Date: Jan. 7, 2021**

PARK et al.

(54) **ANTENNA APPARATUS**

(71) Applicants: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR); **Seoul National University R&DB Foundation**, Seoul (KR)

(72) Inventors: **Ju Hyoung PARK**, Suwon-si (KR); **Won Cheol LEE**, Suwon-si (KR); **In Seop YOON**, Incheon (KR); **Jung Woo SEO**, Seoul (KR); **Jung Suek OH**, Seoul (KR)

(73) Assignees: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR); **Seoul National University R&DB Foundation**, Seoul (KR)

(21) Appl. No.: **16/675,889**

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

(30) **Foreign Application Priority Data**

Jul. 3, 2019 (KR) 10-2019-0079870

Publication Classification

(51) **Int. Cl.**

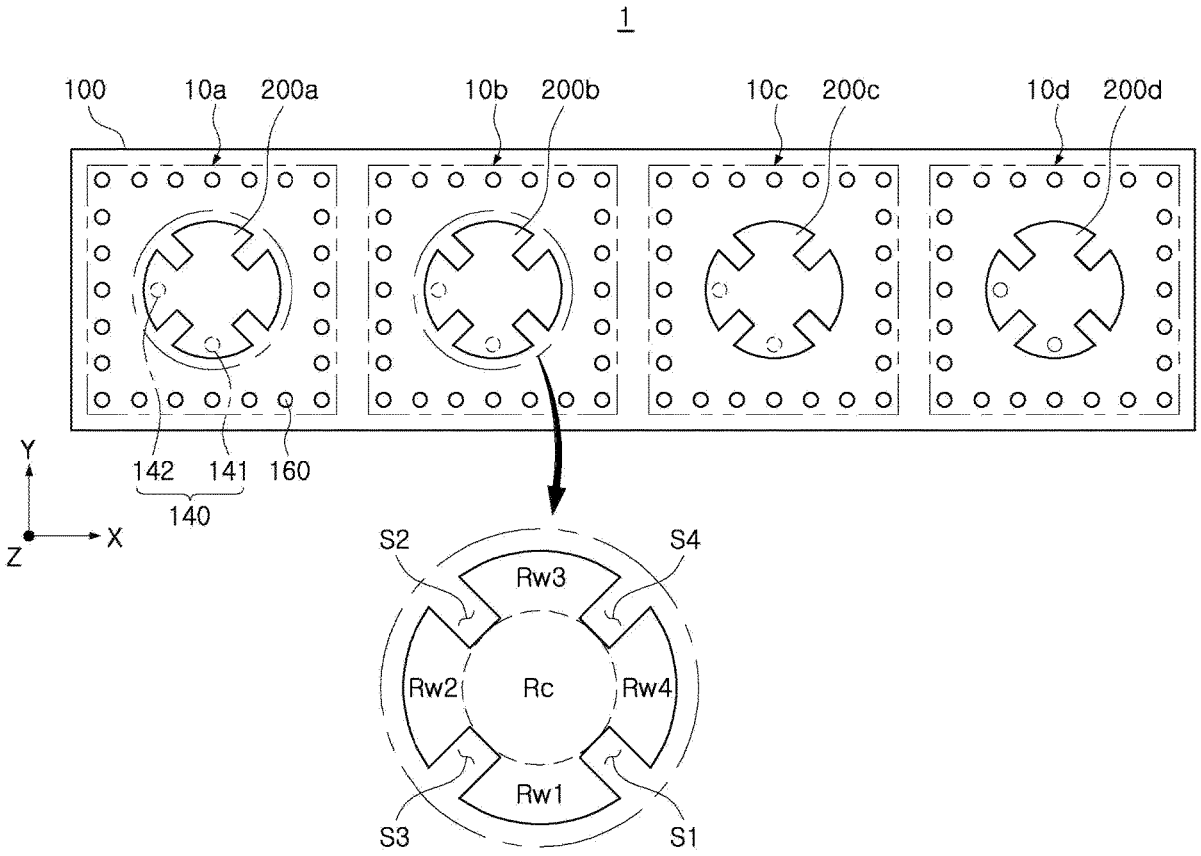
H01Q 5/50	(2006.01)
H01Q 1/22	(2006.01)
H01Q 5/10	(2006.01)
H01Q 13/10	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/24	(2006.01)
H01Q 9/30	(2006.01)
H01Q 21/00	(2006.01)

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

CPC ***H01Q 5/50*** (2015.01); ***H01Q 1/2208*** (2013.01); ***H01Q 5/10*** (2015.01); ***H01Q 21/0006*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 1/241*** (2013.01); ***H01Q 9/30*** (2013.01); ***H01Q 13/10*** (2013.01)

(57) **ABSTRACT**

An antenna apparatus may include: a substrate; two feed vias disposed in the substrate; and an antenna pattern disposed on one surface of the substrate, and including a central portion and wing portions protruding from the central portion. A first wing portion and a second wing portion adjacent to the first wing portion, among the wing portions, may be disposed over the two feed vias. The antenna apparatus may be configured to selectively provide a feed signal to either one or both of the two feed vias.



US 20210005972A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2021/0005972 A1

Wang et al. (43) Pub. Date: Jan. 7, 2021

(54) SLOT ANTENNA AND ELECTRONIC DEVICE

(71) Applicant: **HUAWEI TECHNOLOGIES CO., LTD.**, Shenzhen (CN)

(72) Inventors: **Hanyang Wang**, Reading (GB); **Jianming Li**, Shenzhen (CN); **Xuefei Zhang**, Shenzhen (CN); **Chi Liu**, Shenzhen (CN)

(21) Appl. No.: **17/027,650**

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

Related U.S. Application Data

(63) Continuation of application No. 15/576,723, filed on Nov. 24, 2017, now Pat. No. 10,811,780, filed as application No. PCT/CN2015/080123 on May 28, 2015.

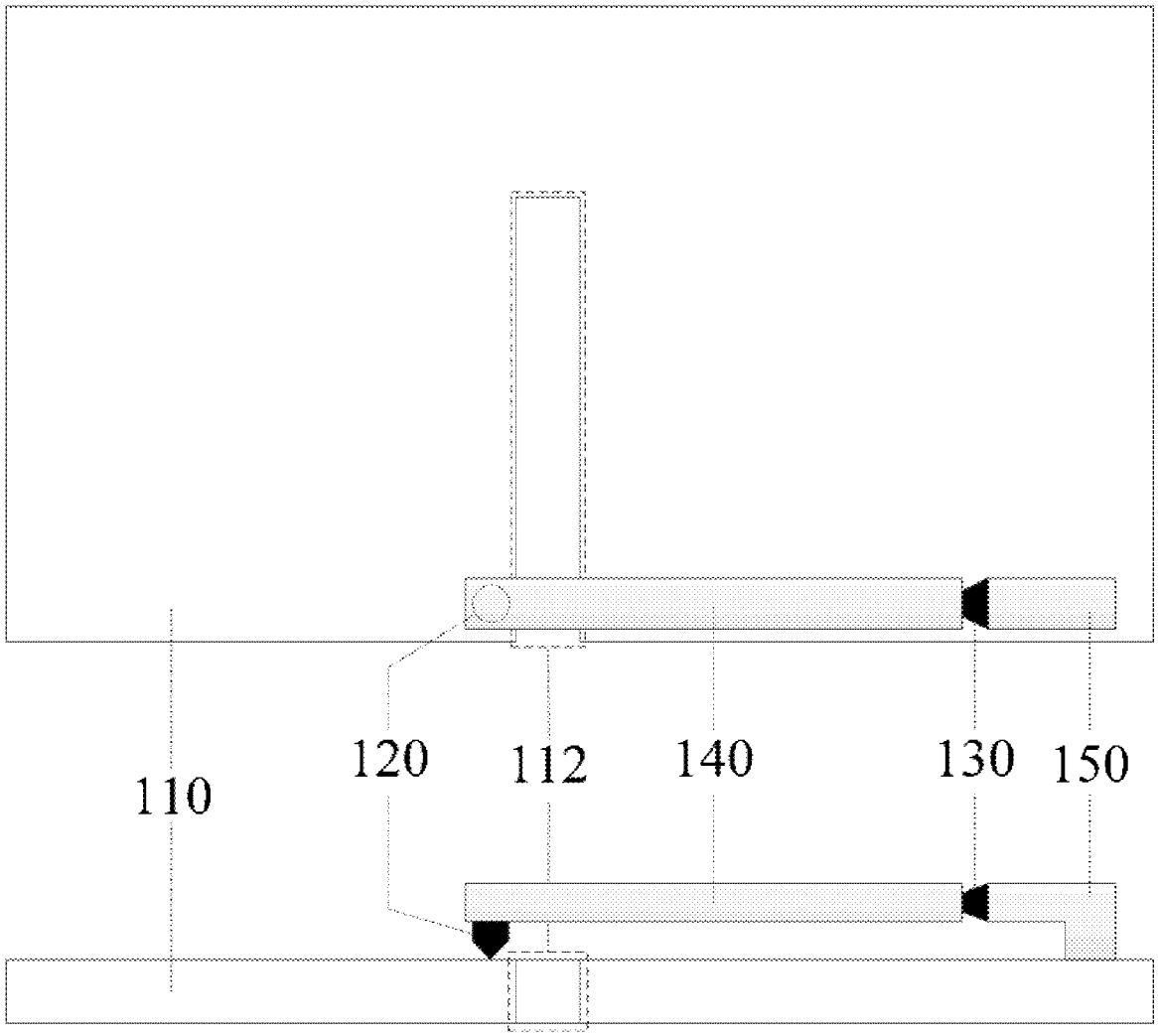
Publication Classification

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

(52) **U.S. Cl.**
CPC ***H01Q 13/10*** (2013.01); ***H01Q 13/106*** (2013.01); ***H01Q 13/103*** (2013.01)

(57) **ABSTRACT**

A slot antenna comprises a printed circuit board, wherein the printed circuit board has a slot, a first capacitor, a radio frequency signal source, a transmission line, and a ground cable, wherein one end of the slot is open, and the other end is closed; the first capacitor and the ground cable are disposed on the printed circuit board, wherein the first capacitor is located on the open end of the slot; the transmission line connects the first capacitor to the radio frequency signal source; and the radio frequency signal source is configured to stimulate a feeding signal, and feed the feeding signal to the open end of the slot, wherein the radio frequency signal source connects the transmission line to the ground cable, and wherein a feed point from the radio frequency signal source to the transmission line is located outside the slot.



US 20210005975A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2021/0005975 A1

Hussain et al. (43) Pub. Date: Jan. 7, 2021

(54) PENTAGONAL SLOT BASED MIMO ANTENNA SYSTEM

(71) Applicant: **King Fahd University of Petroleum and Minerals**, Dhahran (SA)

(72) Inventors: **Rifaqat Hussain**, Dhahran (SA); **Muhammad Umar Khan**, Dhahran (SA); **Mohammad Said Sharawi**, Dhahran (SA)

(73) Assignee: **King Fahd University of Petroleum and Minerals**, Dhahran (SA)

(21) Appl. No.: **16/460,797**

(22) Filed: **Jul. 2, 2019**

Publication Classification

(51) **Int. Cl.**

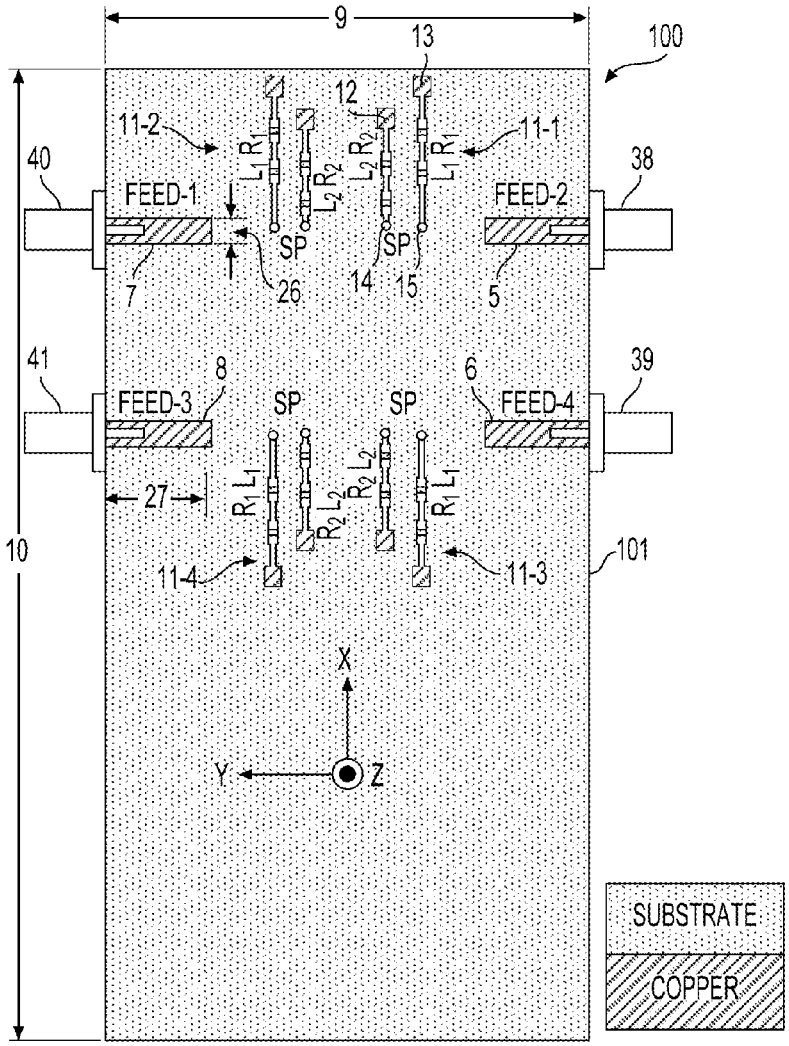
H01Q 21/00	(2006.01)
H01Q 21/06	(2006.01)
H01Q 1/38	(2006.01)
H04B 7/0413	(2006.01)

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

CPC ***H01Q 21/005*** (2013.01); ***H04B 7/0413*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 21/061*** (2013.01)

(57) **ABSTRACT**

An antenna system can include a dielectric substrate having a top surface and a bottom surface that is covered by a ground plane. Four identical antenna elements can be disposed on the bottom surface. Each antenna element can be formed by a pentagonal slot that is etched out of the ground plane. The four antenna elements are positioned symmetrically such that a layout of the four antenna elements has left-right symmetry and top-bottom symmetry. The dielectric substrate can be rectangular, and each pentagonal slot can have a side that is parallel with a longer edge of the dielectric substrate without a center of the pentagonal slots positioned between the side and the longer edge. The antenna system can further include a varactor diode for each of the four antenna elements. A capacitance of the varactor diode is loaded across the respective pentagonal slot.



US 20210005980A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0005980 A1**

Luk et al. (43) **Pub. Date: Jan. 7, 2021**

(54) **PLANAR COMPLEMENTARY ANTENNA AND RELATED ANTENNA ARRAY**

(71) Applicant: **City University of Hong Kong**, Kowloon (HK)

(72) Inventors: **Kwai Man Luk**, Kowloon (HK); **Jingtao Zeng**, RongGui (CN)

(21) Appl. No.: **16/502,131**

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

Publication Classification

(51) **Int. Cl.**

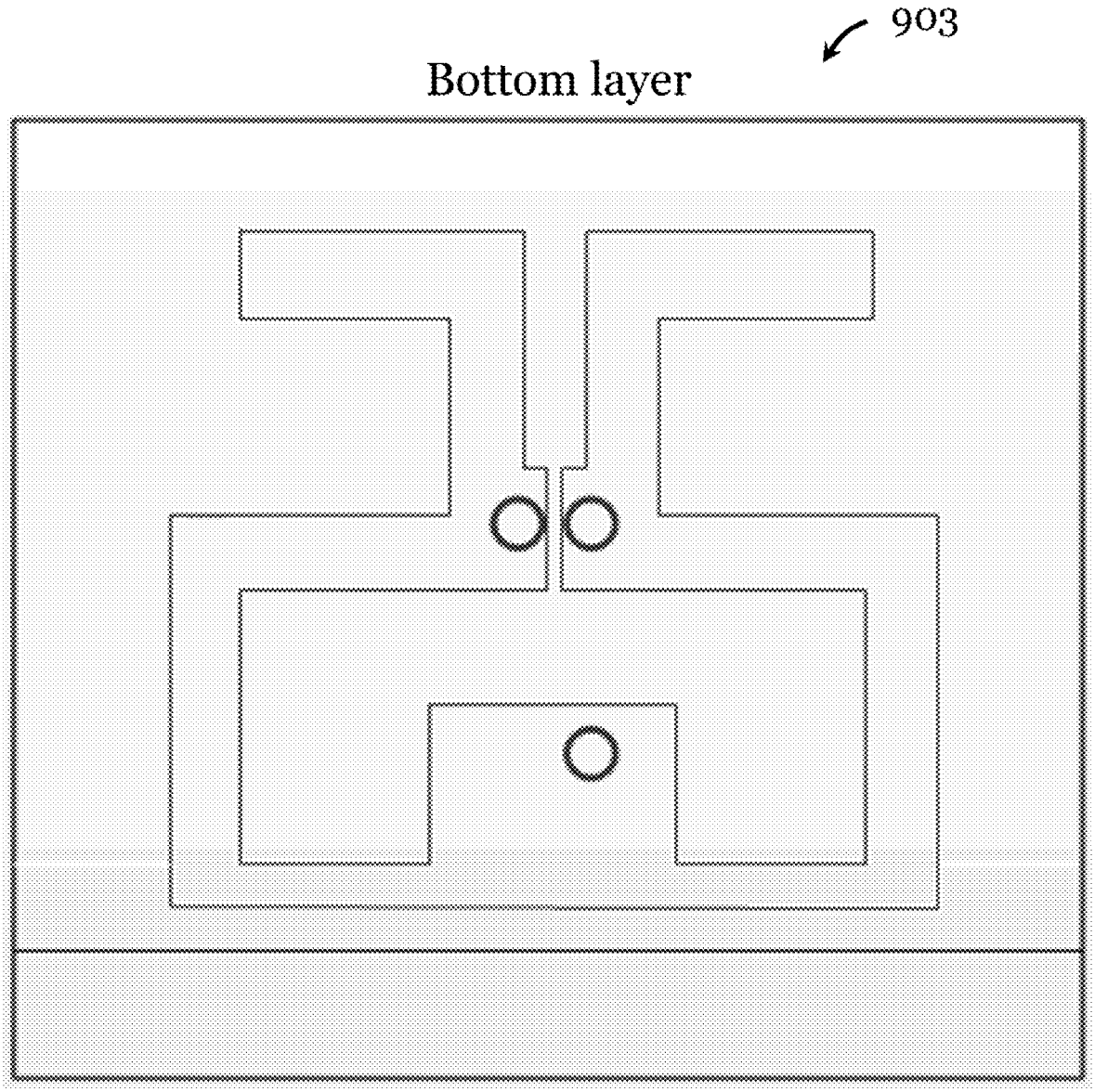
H01Q 21/06	(2006.01)
H01Q 7/00	(2006.01)
H01Q 1/38	(2006.01)

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

CPC ***H01Q 21/062*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 7/00*** (2013.01)

(57) **ABSTRACT**

A planar complementary antenna and an antenna array with multiple planar complementary antennas. The planar complementary antenna has a substrate, a planar dipole antenna arranged on the substrate, a loop antenna arranged on the substrate and operably connected with the planar dipole antenna, and a feed network for connection with a feed source. The feed network is operably connected with the planar dipole antenna and the loop antenna for feeding an electrical signal from the feed source to the planar dipole antenna and the loop antenna so as to form an electric dipole at the planar dipole antenna and a magnetic dipole at the loop antenna.



US 20210005982A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0005982 A1**

HAN et al. (43) **Pub. Date: Jan. 7, 2021**

(54) **ANTENNA APPARATUS**

(71) Applicants: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Suwon-si (KR); **Research & Business Foundation Sungkyunkwan University**, Suwon-si (KR)

(72) Inventors: **Myeong Woo HAN**, Suwon-si (KR); **Dae Ki LIM**, Suwon-si (KR); **Keum Cheol HWANG**, Seoul (KR); **Sung Woo LEE**, Suwon-si (KR); **Jeong Ki RYOO**, Suwon-si (KR)

(73) Assignees: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Suwon-si (KR); **Research & Business Foundation Sungkyunkwan University**, Suwon-si (KR)

(21) Appl. No.: **16/662,508**

(22) Filed: **Oct. 24, 2019**

(30) **Foreign Application Priority Data**

Jul. 3, 2019 (KR) 10-2019-0079869

Publication Classification

(51) **Int. Cl.**

H01Q 21/06 (2006.01)

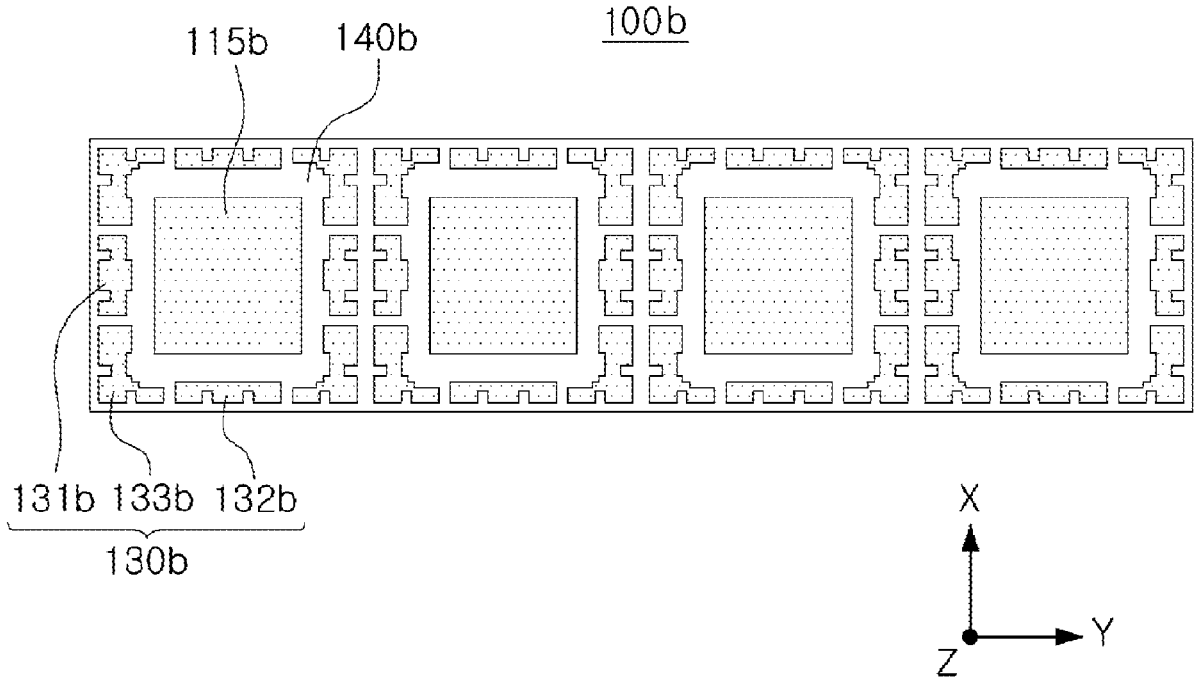
H01Q 1/24 (2006.01)

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

CPC ***H01Q 21/065*** (2013.01); ***H01Q 1/241*** (2013.01)

(57) **ABSTRACT**

An antenna apparatus may include: a feed via; a patch antenna pattern electrically connected to the feed via; and coupling patterns spaced apart from the patch antenna pattern and spaced apart from each other. At least one of the coupling patterns may protrude in a direction in which the at least one of the coupling patterns is spaced apart from the patch antenna pattern.



US 20210013588A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2021/0013588 A1

YOO et al. (43) Pub. Date: Jan. 14, 2021

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

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

(72) Inventors: **Sungcheol YOO**, Suwon-si (KR); **Chihwei LEE**, Suwon-si (KR); **Jungmin PARK**, Suwon-si (KR); **Chonghwa SEO**, Suwon-si (KR); **Jongwon LEE**, Suwon-si (KR)

(21) Appl. No.: **16/924,863**

(22) Filed: **Jul. 9, 2020**

(30) **Foreign Application Priority Data**

Jul. 9, 2019 (KR) 10-2019-0082719
Mar. 4, 2020 (KR) 10-2020-0027269

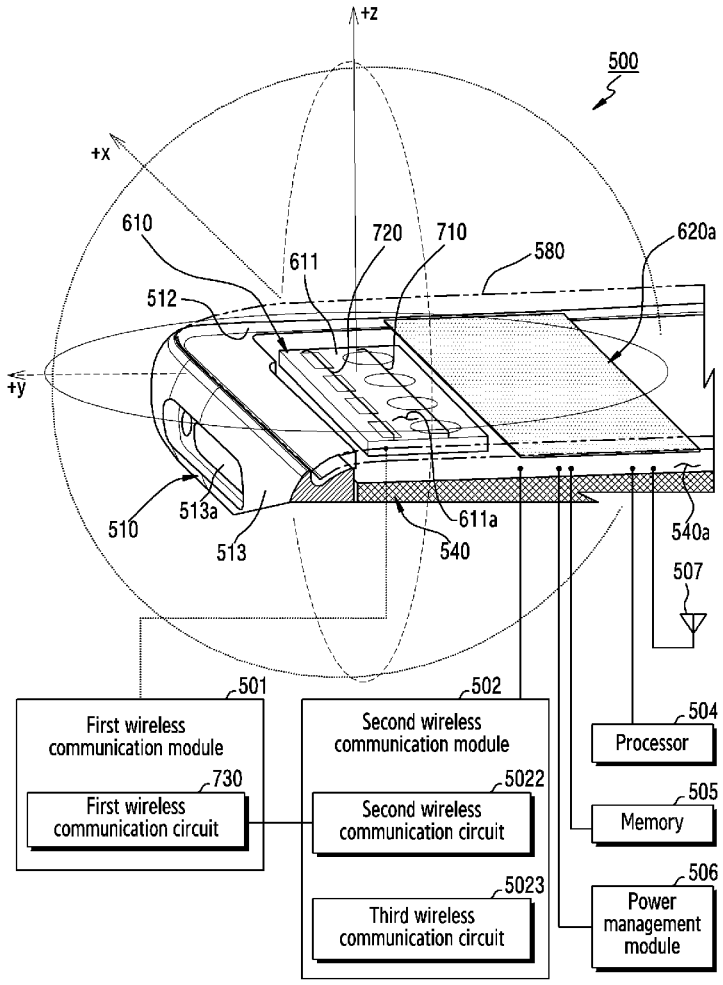
Publication Classification

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 7/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 7/00*** (2013.01); ***H01Q 1/38*** (2013.01)

(57) **ABSTRACT**

A portable communication device is provided. The portable communication device includes a display defining a front surface of the portable communication device, a plate defining a rear surface of the portable communication device and including a nonconductive material, the plate including a first surface facing an outside of the portable communication device and a second surface facing an inside of the portable communication device, a first antenna module attached to a first area of the second surface or disposed adjacent to the first area, a second antenna module attached to a second area of the second surface or disposed adjacent to the second area, and a conductive member disposed in or attached to a third area between the first area and the second area, wherein the conductive member at least partially interrupts some electric waves, among electric waves radiated from the first antenna module, that travel towards the second antenna module through the plate.



US 20210013607A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0013607 A1**

TAI et al. (43) **Pub. Date: Jan. 14, 2021**

(54) **ANTENNA STRUCTURE**

(71) Applicant: **WISTRON NEWEB CORPORATION**, Hsinchu (TW)

(72) Inventors: **CHIH-FENG TAI**, HSINCHU (TW); **KUAN-HSUN LAI**, HSINCHU (TW); **KUEI-CHENG WANG**, HSINCHU (TW)

(21) Appl. No.: **16/853,794**

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

(30) **Foreign Application Priority Data**

Jul. 12, 2019 (TW) 108124731

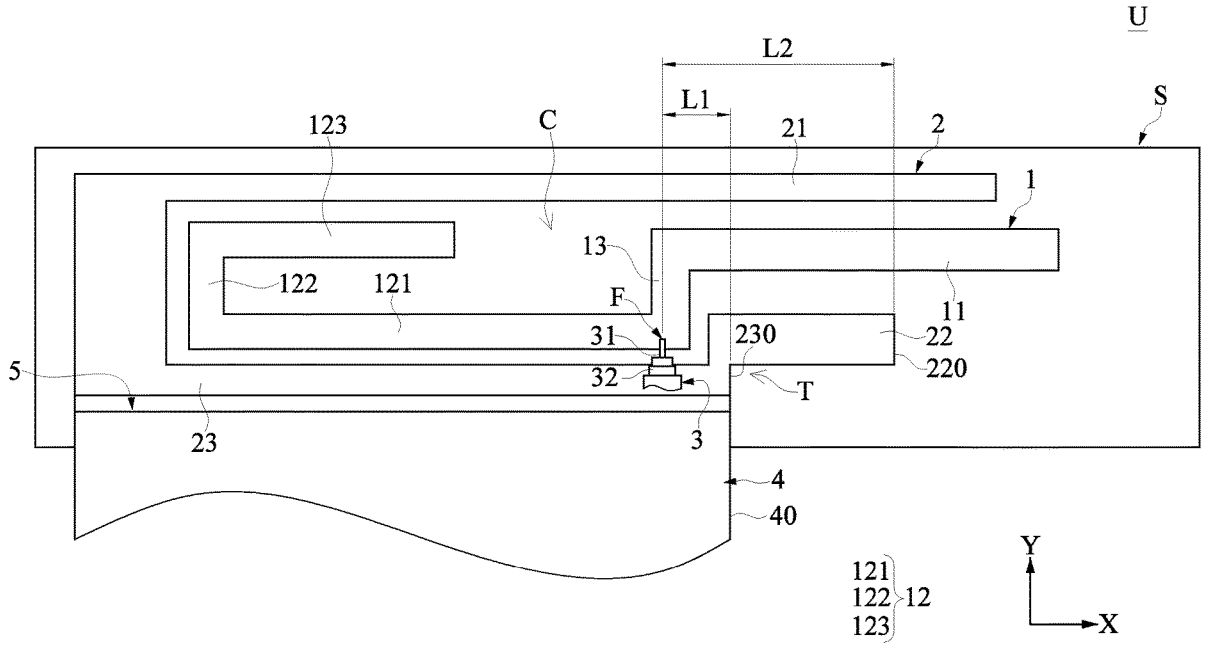
Publication Classification

(51) **Int. Cl.**
H01Q 5/30 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 5/30*** (2015.01)

(57) **ABSTRACT**

An antenna structure is provided. The antenna structure includes a first radiation member, a second radiation member, and a feeding member. The first radiation member includes a first radiation portion, a second radiation portion, and a feeding portion electrically connected between the first radiation portion and the second radiation portion. The second radiation member includes a third radiation portion, a fourth radiation portion, and a grounding portion electrically connected between the third radiation portion and the fourth radiation portion. The third radiation portion and the first radiation portion are separate from and coupled to each other, the third radiation portion and the second radiation portion are separate from and coupled to each other, and the fourth radiation portion and the first radiation portion are separate from and coupled to each other. The feeding member is electrically connected between the feeding portion and the grounding portion.



US 20210013611A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2021/0013611 A1**

Yang (43) **Pub. Date: Jan. 14, 2021**

(54) **TEN-FREQUENCY BAND ANTENNA**

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

(72) Inventor: **Tsai-Yi Yang**, Tainan (TW)

(21) Appl. No.: **16/827,404**

(22) Filed: **Mar. 23, 2020**

Related U.S. Application Data

(63) Continuation of application No. 15/689,292, filed on Aug. 29, 2017, now Pat. No. 10,601,135, which is a continuation of application No. 14/948,226, filed on Nov. 20, 2015, now Pat. No. 9,755,310.

Publication Classification

(51) **Int. Cl.**

H01Q 9/04	(2006.01)
H01Q 1/38	(2006.01)
H01Q 1/24	(2006.01)
H01Q 5/371	(2006.01)

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

CPC ***H01Q 9/04*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01)

(57) **ABSTRACT**

A ten-frequency band antenna includes a carrier, a high-frequency segment, a low-frequency segment, a printed circuit board (PCB) and an inductor. The high-frequency segment is arranged on left side of the carrier and the low-frequency segment is arranged on right side of the carrier. The radiator on the bottom face of the carrier electrically connects with the micro strip of the PCB and the ground line of the ground metal when the carrier is fixed to the PCB. The low-frequency segment is located at an opened area and corresponding to a metal face with smaller area such that the low-frequency segment is at a free space to enhance the frequency response of the low-frequency segment and the bandwidth of the high-frequency segment. The area and the volume of blind hole on the carrier can adjust the effective dielectric constant to adjust the resonant frequency and bandwidth of the antenna.