



(19) **United States**

(12) **Patent Application Publication**

LEE et al.

(10) **Pub. No.: US 2020/0266519 A1**

(43) **Pub. Date: Aug. 20, 2020**

(54) **ANTENNA MODULE INCLUDING FLEXIBLE PRINTED CIRCUIT BOARD AND ELECTRONIC DEVICE INCLUDING THE ANTENNA MODULE**

H01Q 9/04 (2006.01)
H04B 7/06 (2006.01)
H05K 1/18 (2006.01)
H01Q 1/24 (2006.01)

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

(52) **U.S. Cl.**
CPC *H01Q 1/2283* (2013.01); *H01Q 9/42* (2013.01); *H01Q 1/243* (2013.01); *H04B 7/0617* (2013.01); *H05K 1/189* (2013.01); *H01Q 9/0435* (2013.01)

(72) Inventors: **Juneseok LEE**, Suwon-si (KR); **Junsig KUM**, Suwon-si (KR); **Kwanghyun BAEK**, Suwon-si (KR); **Dohyuk HA**, Suwon-si (KR); **Jinsu HEO**, Suwon-si (KR); **Youngju LEE**, Suwon-si (KR); **Jungyub LEE**, Suwon-si (KR)

(57) **ABSTRACT**

(21) Appl. No.: **16/793,360**

(22) Filed: **Feb. 18, 2020**

Related U.S. Application Data

(60) Provisional application No. 62/807,903, filed on Feb. 20, 2019.

Foreign Application Priority Data

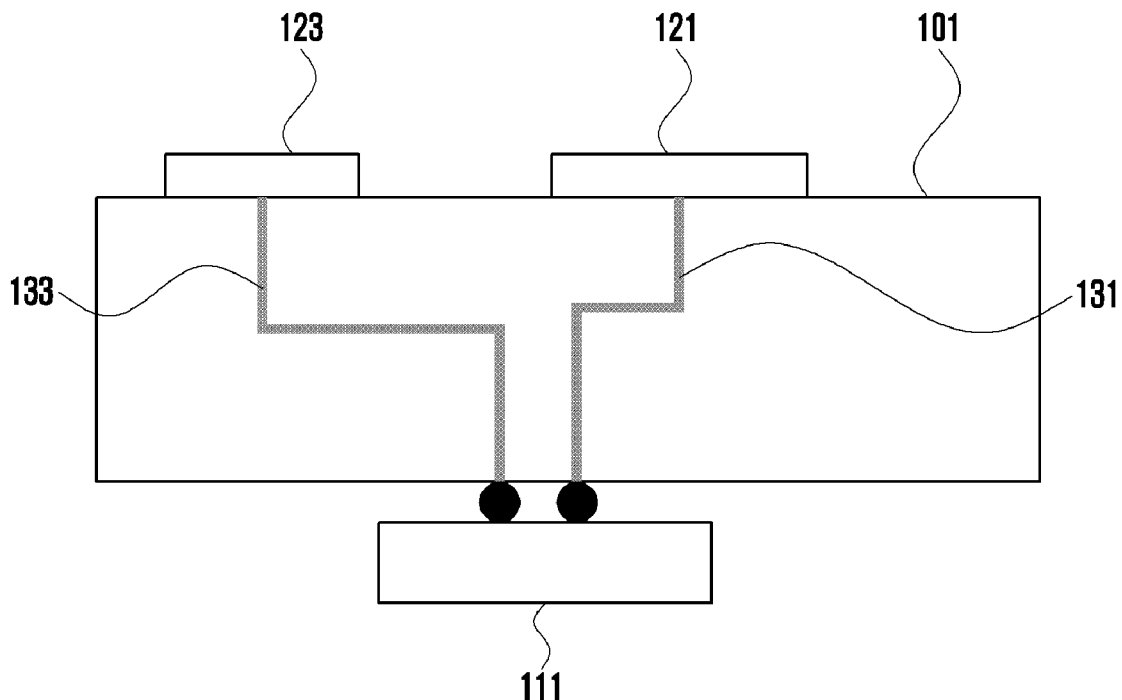
Mar. 29, 2019 (KR) 10-2019-0036901

Publication Classification

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 9/42 (2006.01)

The disclosure relates to a communication method and system for converging a 5th-Generation (5G) communication system for supporting higher data rates beyond a 4th-Generation (4G) system with a technology for Internet of Things (IoT). The disclosure may be applied to intelligent services based on the 5G communication technology and the IoT-related technology, such as smart home, smart building, smart city, smart car, connected car, health care, digital education, smart retail, security and safety services. An antenna module is provided. The antenna module includes a flexible printed circuit board (FPCB) including a first surface directed in a first direction and a second surface directed in a second direction that forms a predetermined first angle with respect to the first direction, a first antenna deployed on one surface of the first surface, and a second antenna deployed on one surface of the second surface.

100





(19) **United States**

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

(10) **Pub. No.: US 2020/0266524 A1**

(43) **Pub. Date: Aug. 20, 2020**

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

H04M 1/02 (2006.01)

H01Q 1/48 (2006.01)

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

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

CPC *H01Q 1/243* (2013.01); *H01Q 1/42* (2013.01); *H01Q 1/48* (2013.01); *H01Q 13/16* (2013.01); *H04M 1/0216* (2013.01); *G06F 1/1681* (2013.01)

(72) Inventors: **Shinho YOON**, Suwon-si (KR); **Dongjun OH**, Suwon-si (KR); **Jonghyuck LEE**, Suwon-si (KR); **Soonho HWANG**, Suwon-si (KR)

(57)

ABSTRACT

An electronic device is provided. The electronic device includes a first housing structure including a first side surface member, a second housing structure including a second side surface member, a hinge structure configured to rotatably connect the first housing structure and the second housing structure and configured to provide a folding axis on which the first housing structure and the second housing structure rotate, and at least one printed circuit board, wherein the first side surface member or the second side surface member includes a first side surface portion, a second side surface portion, a third side surface portion, a fourth side surface portion, a fifth side surface portion, a first slit, a second slit, a third slit, and a fourth slit, and wherein at least part of at least one of the second side surface portion, the third side surface portion, and the fourth side surface portion is formed of a radiation conductor and is electrically connected to the at least one printed circuit board.

(21) Appl. No.: **16/794,859**

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

(30) **Foreign Application Priority Data**

Feb. 19, 2019 (KR) 10-2019-0019551

Jul. 1, 2019 (KR) 10-2019-0078718

Publication Classification

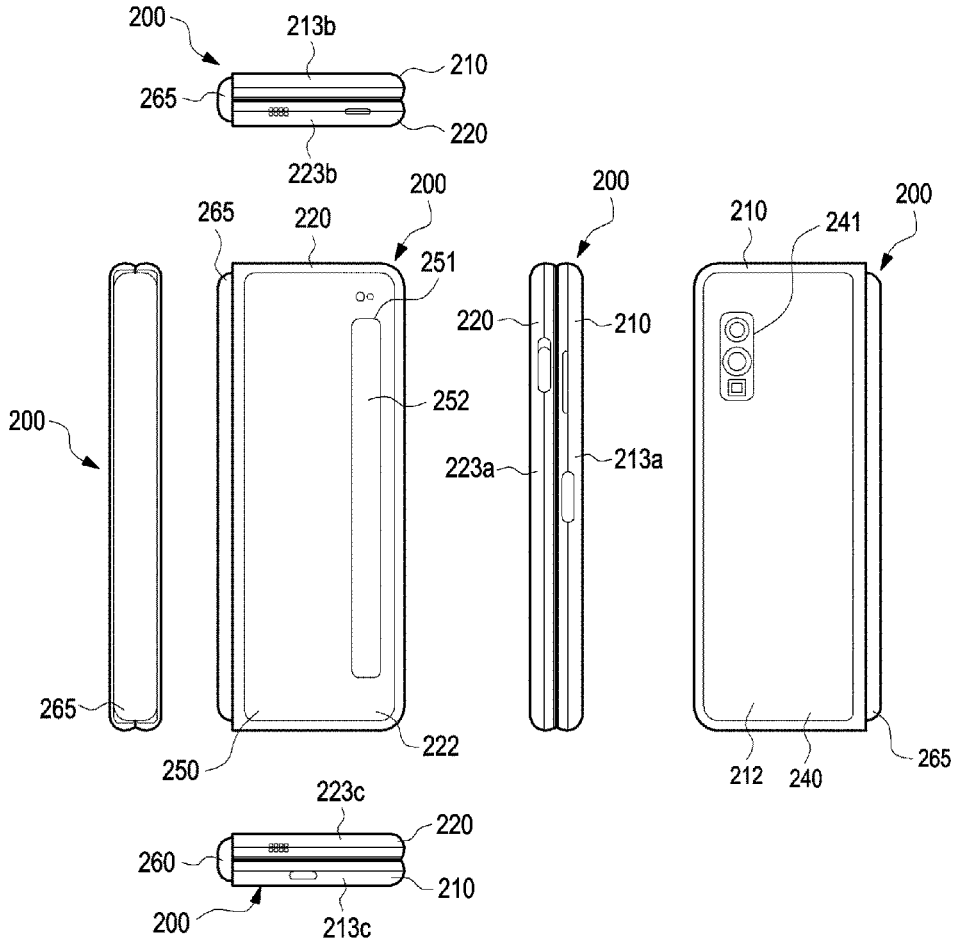
(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/42 (2006.01)

G06F 1/16 (2006.01)

H01Q 13/16 (2006.01)





US 20200266541A1

(19) **United States**

(12) **Patent Application Publication**
Yang

(10) **Pub. No.: US 2020/0266541 A1**

(43) **Pub. Date: Aug. 20, 2020**

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

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

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

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

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

(57) **ABSTRACT**

(21) Appl. No.: **16/685,843**

(22) Filed: **Nov. 15, 2019**

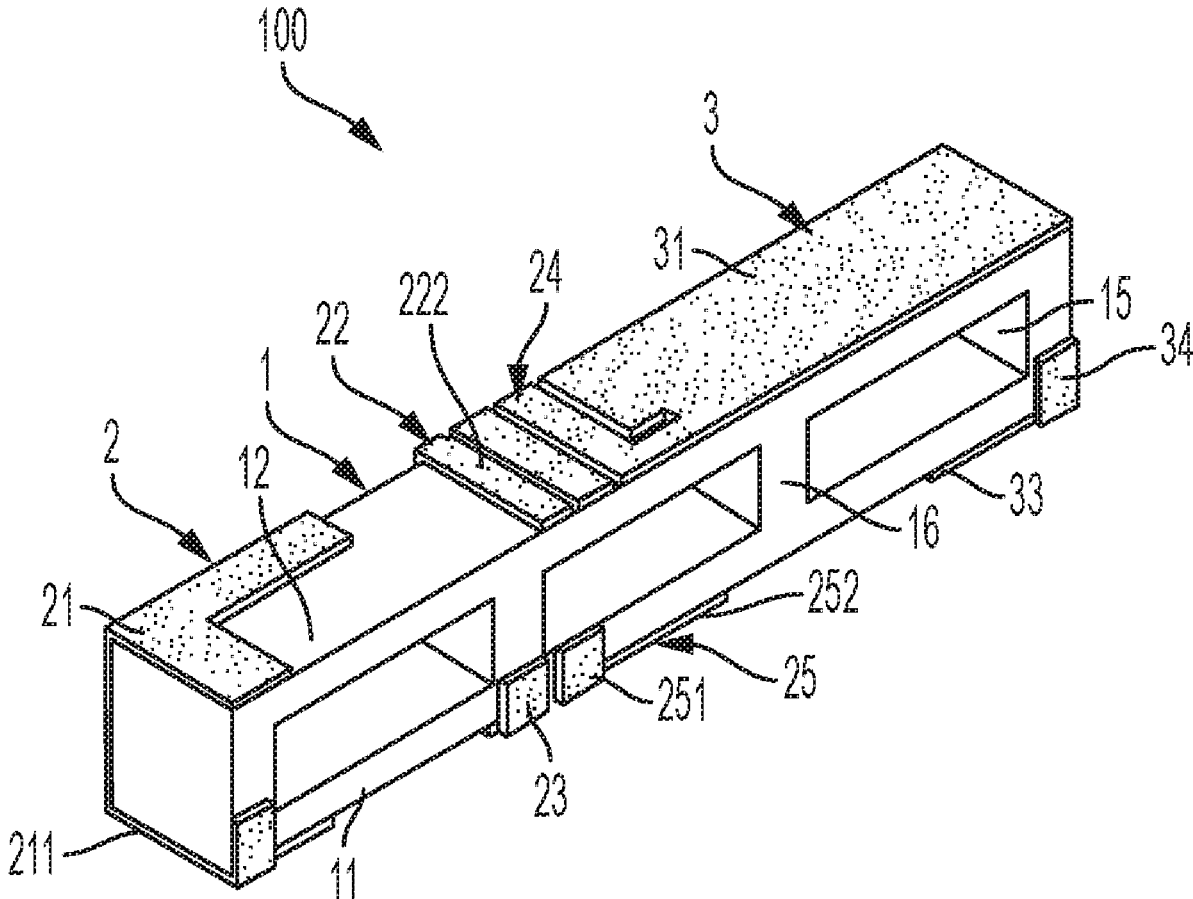
An eight-frequency band antenna includes a carrier, a high-frequency segment, a low-frequency segment, a printed circuit board (PCB) and an inductor. The high-frequency segment is arranged on left side of the carrier and the low-frequency segment is arranged on right side of the carrier. The radiator 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. Moreover, the low-frequency segment is 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.

Related U.S. Application Data

(63) Continuation of application No. 16/172,098, filed on Oct. 26, 2018, now Pat. No. 10,483,644, which is a continuation of application No. 14/948,237, filed on Nov. 20, 2015, now abandoned.

Publication Classification

(51) **Int. Cl.**
H01Q 5/371 (2006.01)
H01Q 1/24 (2006.01)





US 20200266553A1

(19) **United States**

(12) **Patent Application Publication**

CAO et al.

(10) **Pub. No.: US 2020/0266553 A1**

(43) **Pub. Date: Aug. 20, 2020**

(54) **PHASED-ARRAY ANTENNA, DISPLAY PANEL, AND DISPLAY DEVICE**

Publication Classification

(71) Applicants: **BEIJING BOE OPTOELECTRONICS TECHNOLOGY CO., LTD.**, Beijing (CN); **BOE TECHNOLOGY GROUP CO., LTD.**, Beijing (CN)

(51) **Int. Cl.**
H01Q 21/22 (2006.01)
H01Q 21/06 (2006.01)
H01Q 1/38 (2006.01)
G02F 1/1333 (2006.01)
(52) **U.S. Cl.**
CPC *H01Q 21/22* (2013.01); *G02F 1/1333* (2013.01); *H01Q 1/38* (2013.01); *H01Q 21/065* (2013.01)

(72) Inventors: **Xue CAO**, Beijing (CN); **Tien-Lun TING**, Beijing (CN); **Jie WU**, Beijing (CN); **Ying WANG**, Beijing (CN); **Chuncheng CHE**, Beijing (CN); **Hailin XUE**, Beijing (CN)

(57) **ABSTRACT**
Embodiments of the present disclosure relate to a phased-array antenna, a display panel, and a display device. The phased-array antenna includes a first substrate and a second substrate arranged oppositely, and a plurality of phased-array elements located between the first substrate and the second substrate. At least one of the phased-array elements includes a first electrode, a second electrode arranged opposite to the first electrode, a voltage-controlled phase shift material located between the first electrode and the second electrode, wherein the first electrode is configured to receive a bias signal for controlling the voltage-controlled phase shift material, and the second electrode serves as a ground electrode, and a microstrip line located at a side of the first electrode far away from the voltage-controlled phase shift material and electrically insulated from the first electrode, wherein the microstrip line is configured to receive or transmit a transmission signal.

(21) Appl. No.: **16/641,933**

(22) PCT Filed: **Dec. 13, 2018**

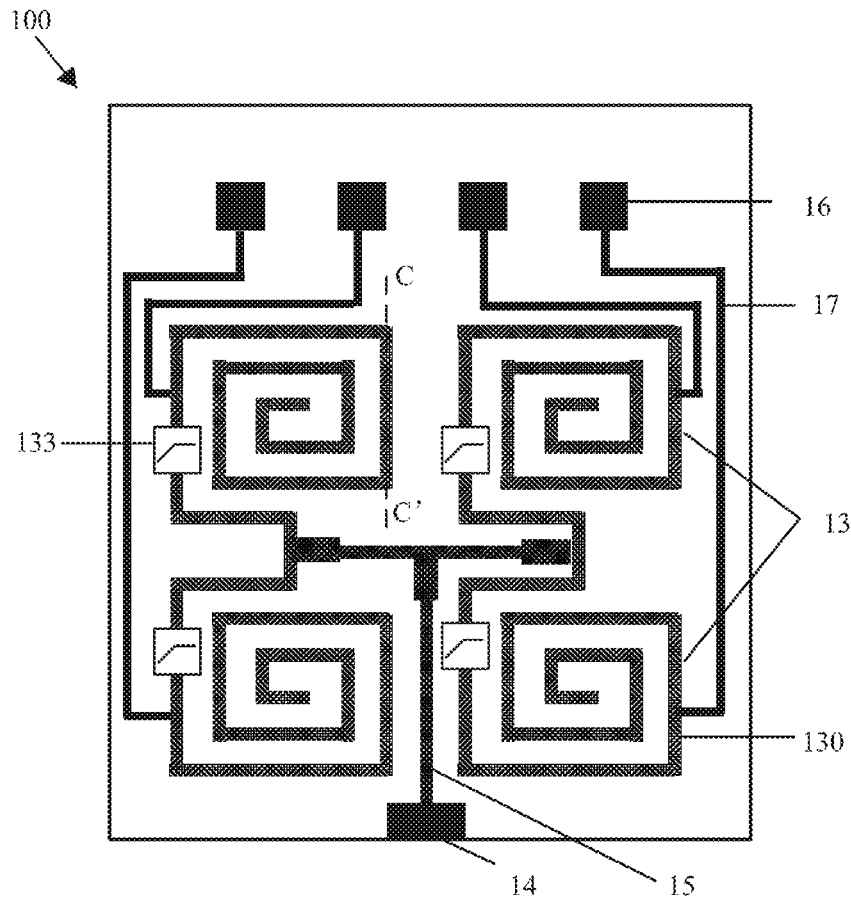
(86) PCT No.: **PCT/CN2018/120833**

§ 371 (c)(1),

(2) Date: **Feb. 25, 2020**

(30) **Foreign Application Priority Data**

Jan. 5, 2018 (CN) 201810009872.2





US 20200274227A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0274227 A1**

(43) **Pub. Date: Aug. 27, 2020**

(54) **COMMUNICATION DEVICE**

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

CPC *H01Q 1/24* (2013.01); *H01Q 1/38* (2013.01)

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

(72) Inventors: **Shu-Yang TU**, Taoyuan City (TW);
Chun-I LIN, Taoyuan City (TW); **Hui LIN**, Taoyuan City (TW)

(57) **ABSTRACT**

A communication device includes a ground element, a dielectric substrate, and an antenna element. The dielectric substrate is disposed adjacent to an edge of the ground element. The antenna element is disposed on the dielectric substrate. The antenna element includes a feeding metal element, a shorting metal element, a first radiation metal element, a second radiation metal element, and an inductive element. The feeding metal element has a feeding point. The shorting metal element is coupled to the ground element. The first radiation metal element is coupled to the shorting metal element, and is disposed adjacent to the feeding metal element. The second radiation metal element is coupled through the inductive element to the feeding metal element. The second radiation metal element is further coupled to the ground element.

(21) Appl. No.: **16/517,888**

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

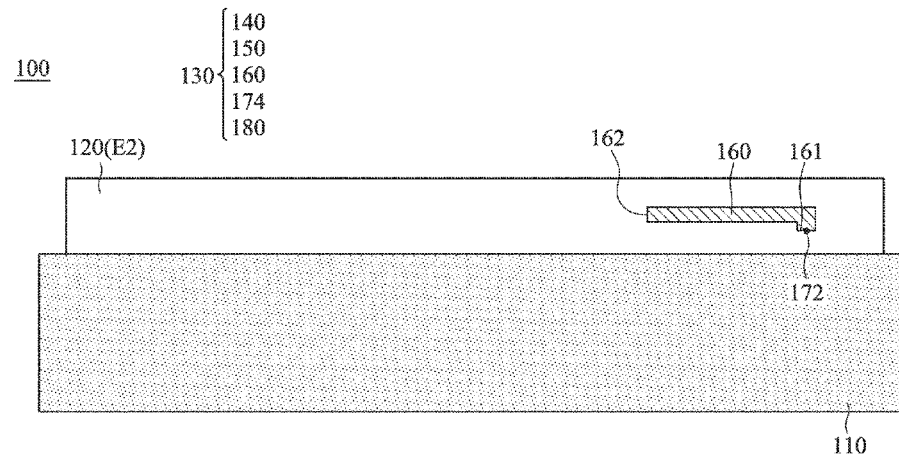
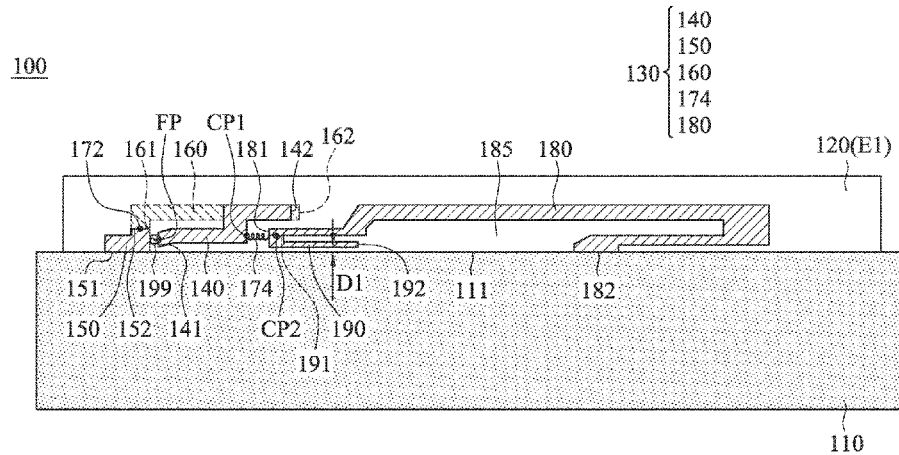
(30) **Foreign Application Priority Data**

Feb. 23, 2019 (TW) 108106135

Publication Classification

(51) **Int. Cl.**

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





US 20200274570A1

(19) **United States**

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

(10) **Pub. No.: US 2020/0274570 A1**

(43) **Pub. Date: Aug. 27, 2020**

(54) **ELECTRONIC DEVICE HAVING
ADJUSTABLE ANTENNA SETTINGS**

G06K 9/62 (2006.01)

G06T 7/521 (2006.01)

H04W 52/28 (2006.01)

G06T 7/55 (2006.01)

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

(72) Inventors: **Liang Han**, Sunnyvale, CA (US);
Matthew A. Mow, Los Altos, CA (US);
Mattia Pascolini, San Francisco, CA
(US); **Ruben Caballero**, San Jose, CA
(US); **Thomas E. Biedka**, San Jose,
CA (US); **Yuancheng Xu**, Melbourne,
FL (US); **Iyappan Ramachandran**,
Santa Clara, CA (US)

(52) **U.S. Cl.**
CPC *H04B 1/3838* (2013.01); *H04M 1/03*
(2013.01); *H04M 1/0264* (2013.01); *G06K*
9/2018 (2013.01); *G06T 7/55* (2017.01); *G06K*
9/6289 (2013.01); *G06T 7/521* (2017.01);
H04W 52/283 (2013.01); *H04M 1/72569*
(2013.01)

(21) Appl. No.: **15/930,298**

(22) Filed: **May 12, 2020**

Related U.S. Application Data

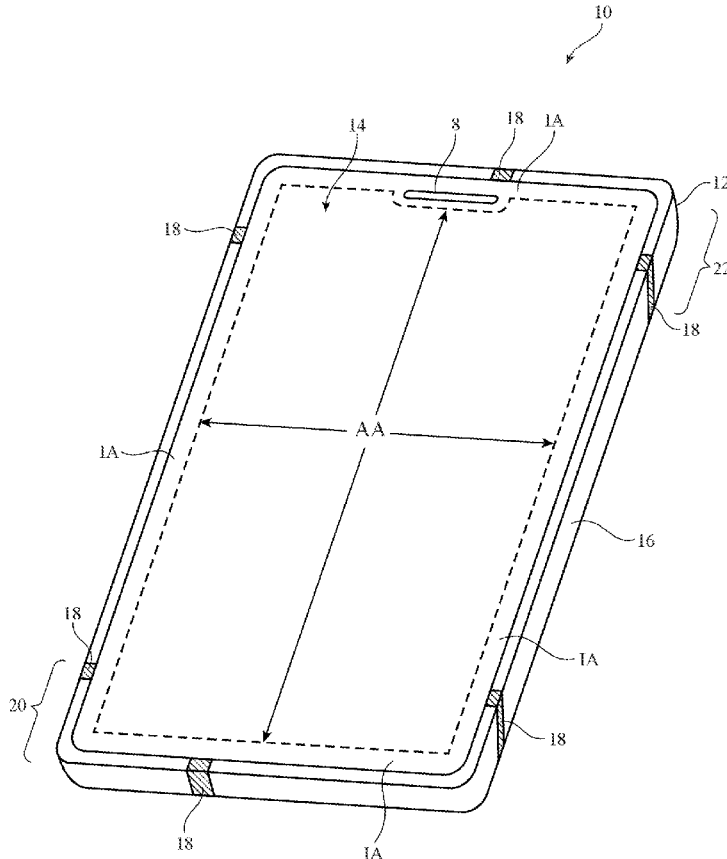
(62) Division of application No. 16/017,847, filed on Jun.
25, 2018, now Pat. No. 10,693,516.

Publication Classification

(51) **Int. Cl.**
H04B 1/3827 (2006.01)
H04M 1/03 (2006.01)
H04M 1/02 (2006.01)
G06K 9/20 (2006.01)
H04M 1/725 (2006.01)

(57) **ABSTRACT**

An electronic device may include control circuitry, sensors, and wireless circuitry having antennas. The sensors may generate sensor data that is used by the control circuitry to identify an operating environment for the device. The sensor data may include a grip map generated by a touch-sensitive display, infrared facial recognition image signals or other image signals, an angle of arrival of sound received by a set of microphones, impedance data from an impedance sensor, and any other desired sensor data. The control circuitry may use the sensor data, radio-frequency spatial ranging data, information about whether audio is being played over an ear speaker, and/or information about communications protocols in use to identify the operating environment. The control circuitry may adjust antenna settings for the wireless circuitry based on the identified operating environment to ensure that the antennas operate with satisfactory antenna efficiency regardless of operating conditions.





(19) **United States**

(12) **Patent Application Publication**

Liu et al.

(10) **Pub. No.: US 2020/0280132 A1**

(43) **Pub. Date: Sep. 3, 2020**

(54) **PATCH ANTENNA UNIT AND ANTENNA**

H01Q 21/06 (2006.01)

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

H01Q 23/00 (2006.01)

(72) Inventors: **Liangsheng Liu**, Shenzhen (CN);
Xinhong Li, Hsinchu (CN); **HuiLi Fu**,
Shenzhen (CN)

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

H01Q 21/00 (2006.01)

H01Q 1/48 (2006.01)

CPC *H01Q 9/0414* (2013.01); *H01Q 1/2283*
(2013.01); *H01Q 9/0457* (2013.01); *H01Q*
9/045 (2013.01); *H01Q 23/00* (2013.01);
H01Q 21/0075 (2013.01); *H01Q 1/48*
(2013.01); *H01Q 21/065* (2013.01)

(21) Appl. No.: **16/872,920**

(22) Filed: **May 12, 2020**

Related U.S. Application Data

(63) Continuation of application No. 16/049,104, filed on
Jul. 30, 2018, which is a continuation of application
No. PCT/CN2016/109322, filed on Dec. 9, 2016.

Foreign Application Priority Data

Jan. 30, 2016 (CN) 201610071196.2

Publication Classification

(51) **Int. Cl.**

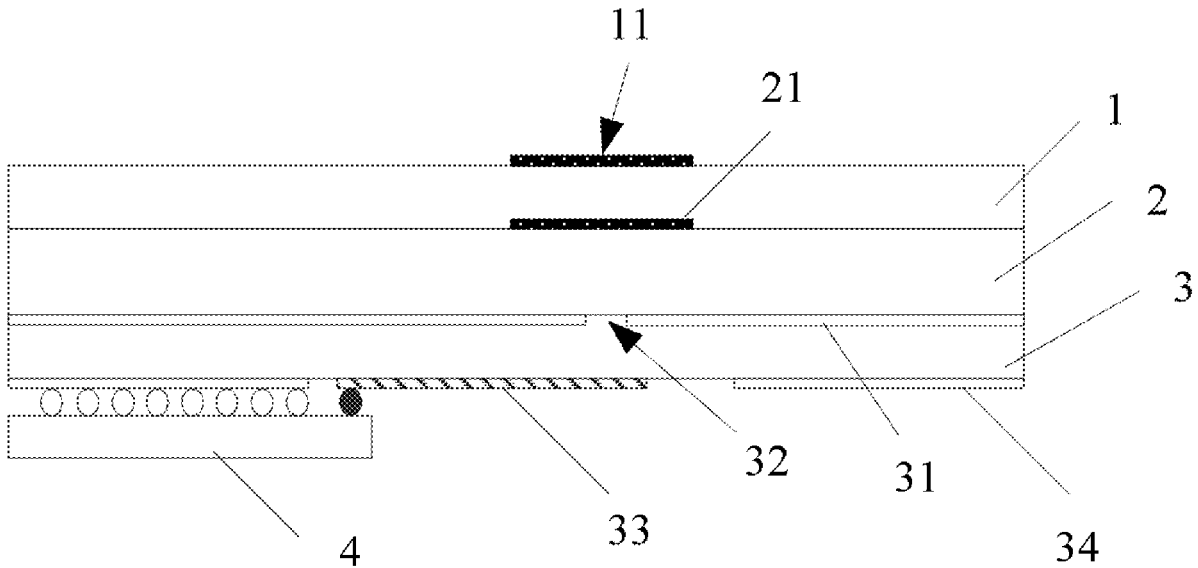
H01Q 9/04 (2006.01)

H01Q 1/22 (2006.01)

(57)

ABSTRACT

A patch antenna unit includes a first support layer, a substrate, a second support layer, and an integrated circuit that are stacked. One radiation patch is attached to the first support layer, and one radiation patch is attached to the second support layer. A ground layer is disposed on the second support layer, a coupling slot is disposed on the ground layer, and a feeder corresponding to the coupling slot is disposed on the second support layer. The integrated circuit is connected to the first ground layer and the feeder. In the foregoing specific technical solution, a four-layer substrate is used for fabrication.





(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2020/0280133 A1**

Avser et al.

(43) **Pub. Date: Sep. 3, 2020**

(54) **ELECTRONIC DEVICES WITH DIELECTRIC RESONATOR ANTENNAS**

(52) **U.S. Cl.**
CPC **H01Q 9/0485** (2013.01); **H01Q 1/243** (2013.01); **H01Q 21/0075** (2013.01)

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

(72) Inventors: **Bilgehan Avser**, Mountain View, CA (US); **Harish Rajagopalan**, San Jose, CA (US); **Simone Paulotto**, Redwood City, CA (US); **Jennifer M. Edwards**, San Francisco, CA (US); **Hao Xu**, Cupertino, CA (US); **Rodney A. Gomez Angulo**, Santa Clara, CA (US); **Matthew D. Hill**, Cupertino, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

(57) **ABSTRACT**

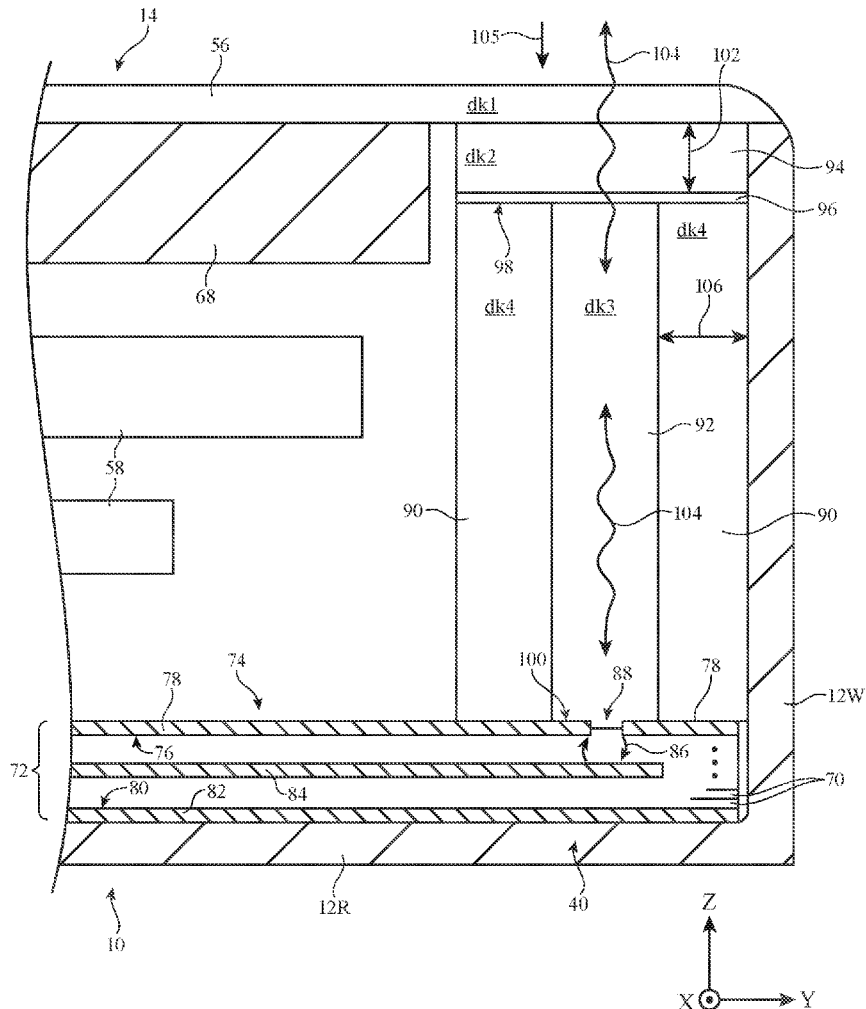
An electronic device may be provided with a phased antenna array and a display cover layer. The phased antenna array may include a dielectric resonator antenna. The dielectric resonator antenna may include a dielectric resonating element embedded in a lower permittivity dielectric substrate. The substrate and the resonating element may be mounted to a flexible printed circuit. A slot may be formed in ground traces on the flexible printed circuit and aligned with the resonating element. The slot may excite resonant modes of the resonating element. The resonating element may convey corresponding radio-frequency signals through the cover layer. A dielectric matching layer may be interposed between the resonating element and the cover layer. If desired, the slot may radiate additional radio-frequency signals and the matching layer may have a tapered shape. Dielectric resonator antennas for covering different polarizations and frequencies may be interleaved across the array.

(21) Appl. No.: **16/289,433**

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

Publication Classification

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/24 (2006.01)





US 20200287274A1

(19) **United States**

(12) **Patent Application Publication**
ZHANG

(10) **Pub. No.: US 2020/0287274 A1**

(43) **Pub. Date: Sep. 10, 2020**

(54) **ANTENNA FOR DEVICE AND FOLDABLE DEVICE**

Publication Classification

(71) Applicant: **ZTE CORPORATION**, Shenzhen, Guangdong (CN)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)
H01Q 1/50 (2006.01)
H04M 1/02 (2006.01)

(72) Inventor: **Yan ZHANG**, Shenzhen, Guangdong (CN)

(52) **U.S. Cl.**
CPC *H01Q 1/243* (2013.01); *H04M 1/0214* (2013.01); *H01Q 1/50* (2013.01); *H01Q 1/44* (2013.01)

(21) Appl. No.: **16/645,508**

(57) **ABSTRACT**

(22) PCT Filed: **Sep. 12, 2018**

The present disclosure provides an antenna for an electronic device, and a foldable device. The electronic device includes a body provided with a mainboard, and a first screen. The antenna includes: a feed point disposed at a side where the body is located; a first antenna connected to the feed point and extending from the side where the body is located to a side where the first screen is located; a second antenna disposed at the side where the body is located; a rotating shaft connected between the body and the first screen; and a switch provided between the rotating shaft and the first antenna.

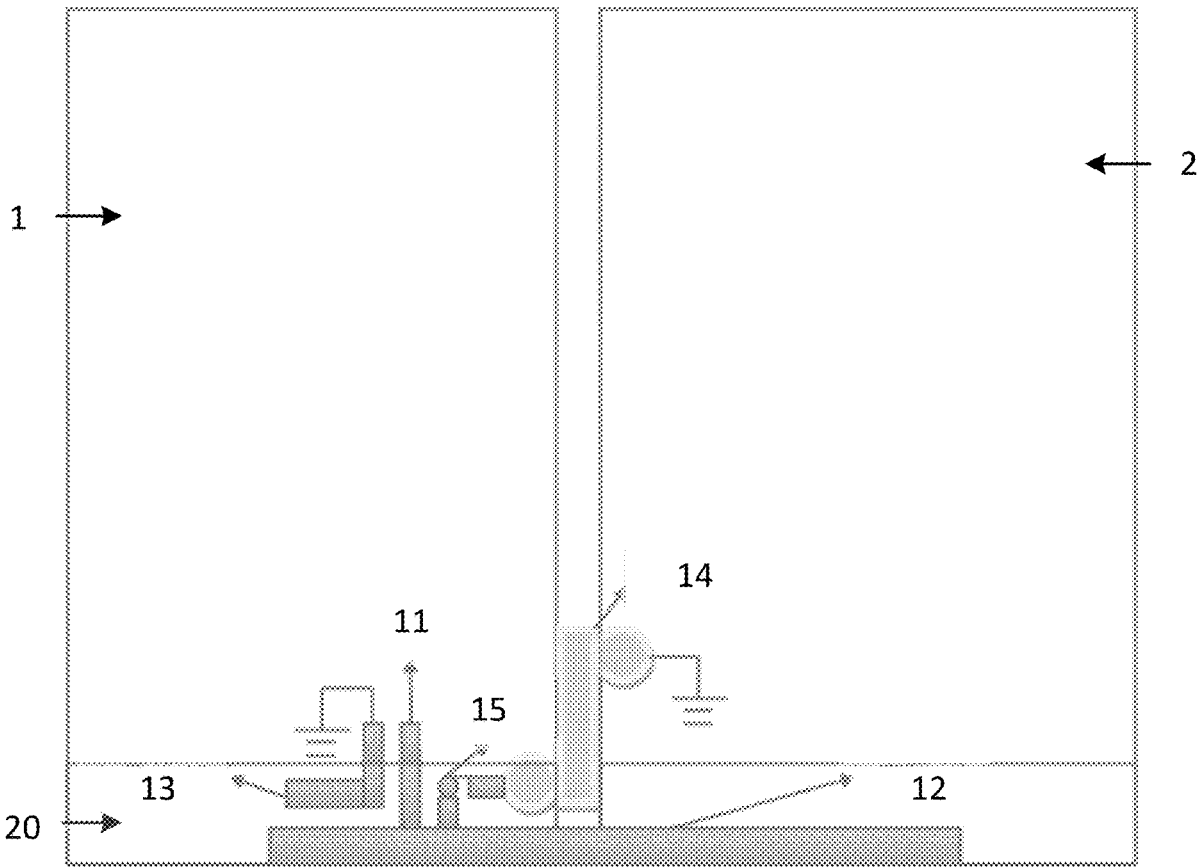
(86) PCT No.: **PCT/CN2018/105223**

§ 371 (c)(1),

(2) Date: **Mar. 9, 2020**

(30) **Foreign Application Priority Data**

Sep. 12, 2017 (CN) 201710817200.X





(19) **United States**

(12) **Patent Application Publication**
CHENG

(10) **Pub. No.: US 2020/0287288 A1**

(43) **Pub. Date: Sep. 10, 2020**

(54) **ANTENNA STRUCTURE**

H01Q 1/48 (2006.01)

H01Q 1/24 (2006.01)

(71) Applicant: **Wistron NeWeb Corp.**, Hsinchu (TW)

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

(72) Inventor: **Chia-Shang CHENG**, Hsinchu (TW)

CPC *H01Q 9/18* (2013.01); *H01Q 1/243*
(2013.01); *H01Q 1/48* (2013.01); *H01Q 1/38*
(2013.01)

(21) Appl. No.: **16/426,221**

(22) Filed: **May 30, 2019**

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Mar. 7, 2019 (TW) 108107545

An antenna structure includes a dipole antenna element and a floating metal element. The floating metal element is disposed adjacent to the dipole antenna element. The vertical projection of the dipole antenna element at least partially overlaps the floating metal element. The floating metal element is configured for fine-tuning the radiation pattern of the antenna structure and to increase the operation bandwidth of the antenna structure.

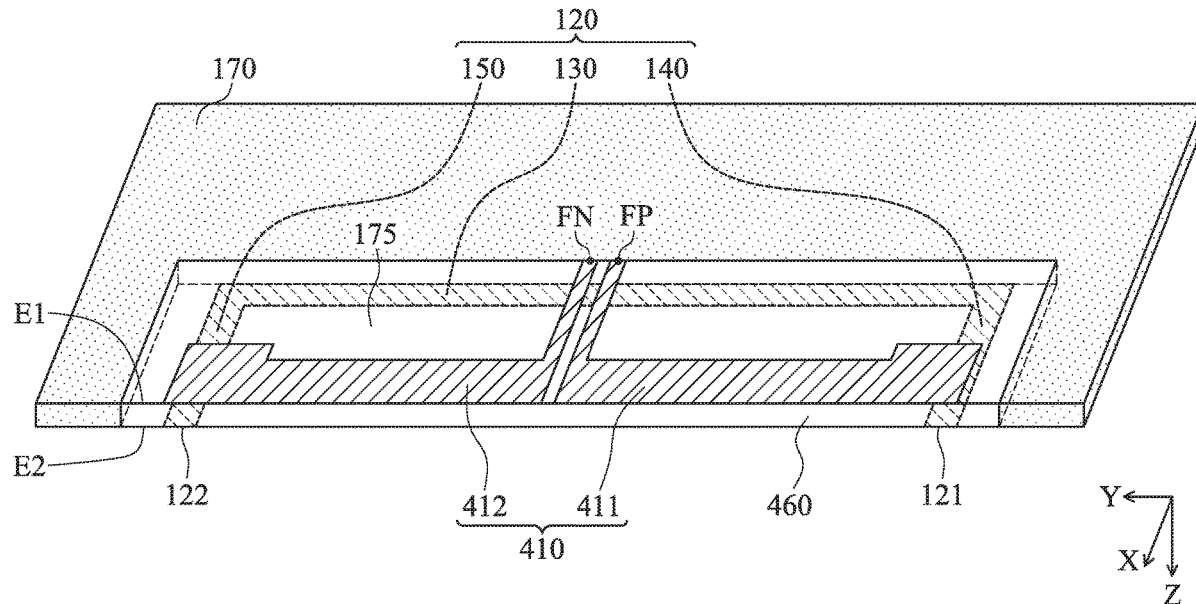
Publication Classification

(51) **Int. Cl.**

H01Q 9/18 (2006.01)

H01Q 1/38 (2006.01)

400





(19) **United States**

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

(10) **Pub. No.: US 2020/0287572 A1**

(43) **Pub. Date: Sep. 10, 2020**

(54) **WIRELESS COMMUNICATION DEVICE**

Publication Classification

(71) Applicant: **HTC CORPORATION**, TAOYUAN CITY (TW)

(72) Inventors: **Tiao-Hsing TSAI**, TAOYUAN CITY (TW); **Chien-Pin CHIU**, TAOYUAN CITY (TW); **Hsiao-Wei WU**, TAOYUAN CITY (TW); **Yi-Hsiang KUNG**, TAOYUAN CITY (TW); **Shen-Fu TZENG**, TAOYUAN CITY (TW); **Li-Yuan FANG**, TAOYUAN CITY (TW)

(51) **Int. Cl.**
H04B 1/00 (2006.01)
H01Q 5/328 (2006.01)
H01Q 5/371 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/35 (2006.01)
H04B 1/40 (2006.01)

(52) **U.S. Cl.**
CPC *H04B 1/006* (2013.01); *H01Q 5/328* (2015.01); *H01Q 5/371* (2015.01); *H04W 88/06* (2013.01); *H01Q 5/35* (2015.01); *H04B 1/40* (2013.01); *H01Q 1/243* (2013.01)

(21) Appl. No.: **16/880,036**

(57) **ABSTRACT**

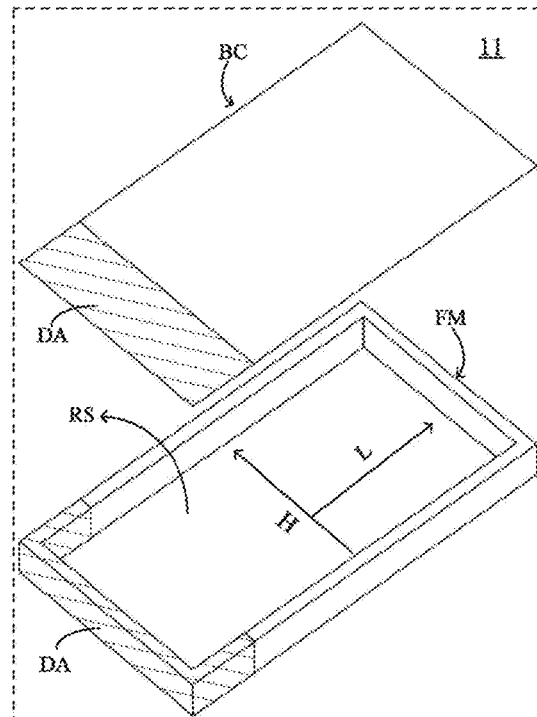
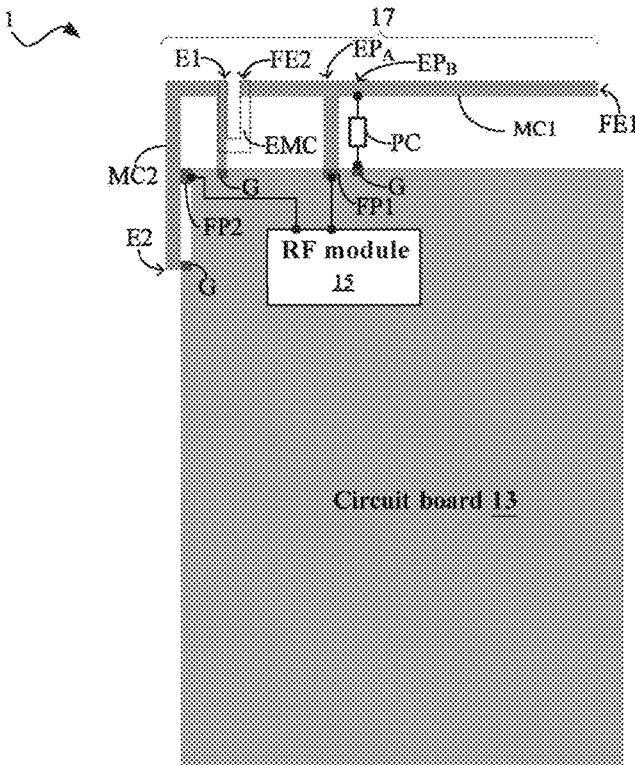
(22) Filed: **May 21, 2020**

A wireless communication device is provided. The wireless communication device includes a housing, a circuit board, a radio frequency module and an antenna. The housing has a frame and a back cover to define a receiving space. The circuit board is disposed in the receiving space, and defines a clearance area from the housing in the receiving space. The circuit board includes a ground terminal, a first feeding point, and a second feeding point. The antenna includes at least one metal conductor coupled to the first feeding point and the second feeding point, respectively, to provide a low frequency resonant path, a first middle frequency resonant path, a second middle frequency resonant path and a high frequency resonant path.

Related U.S. Application Data

(60) Continuation of application No. 16/239,710, filed on Jan. 4, 2019, now Pat. No. 10,700,716, which is a continuation of application No. 16/139,107, filed on Sep. 24, 2018, now Pat. No. 10,211,858, which is a division of application No. 15/821,777, filed on Nov. 23, 2017, now Pat. No. 10,158,381.

(60) Provisional application No. 62/428,183, filed on Nov. 30, 2016.





(19) **United States**

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

(10) **Pub. No.: US 2020/0287581 A1**

(43) **Pub. Date: Sep. 10, 2020**

(54) **SMALL ANTENNA APPARATUS AND METHOD FOR CONTROLLING THE SAME**

Publication Classification

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

(72) Inventors: **Jungsik PARK**, Bucheon-si (KR);
Sooung CHUN, Suwon-si (KR)

(21) Appl. No.: **16/884,487**

(22) Filed: **May 27, 2020**

- (51) **Int. Cl.**
H04B 1/18 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/14 (2006.01)
H01Q 9/42 (2006.01)
H01Q 9/16 (2006.01)
H04W 88/02 (2006.01)
H01Q 1/48 (2006.01)
- (52) **U.S. Cl.**
 CPC *H04B 1/18* (2013.01); *H01Q 1/243*
 (2013.01); *H01Q 9/145* (2013.01); *H04B*
1/0458 (2013.01); *H01Q 9/16* (2013.01);
H04W 88/02 (2013.01); *H01Q 1/48* (2013.01);
H01Q 9/42 (2013.01)

Related U.S. Application Data

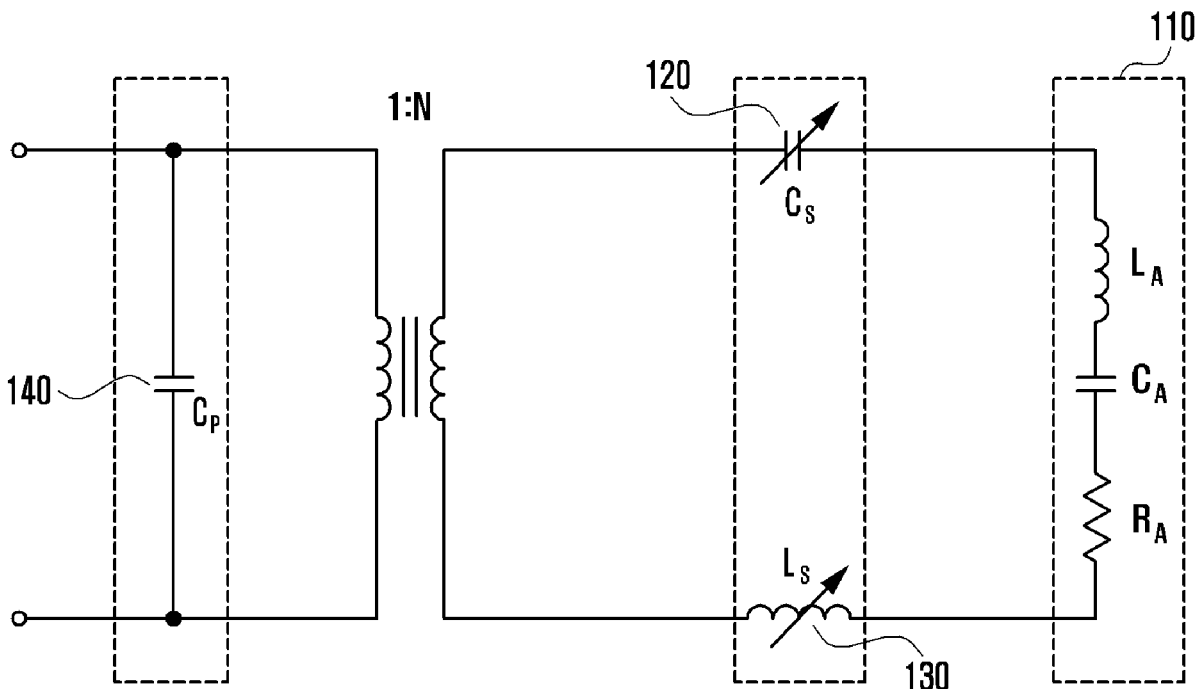
(63) Continuation of application No. 16/155,248, filed on Oct. 9, 2018, now Pat. No. 10,680,671, which is a continuation of application No. 15/082,280, filed on Mar. 28, 2016, now Pat. No. 10,128,883, which is a continuation of application No. 13/727,205, filed on Dec. 26, 2012, now Pat. No. 9,306,288.

Foreign Application Priority Data

Jan. 13, 2012 (KR) 10-2012-0004448

ABSTRACT

(57) An antenna apparatus for a mobile terminal is provided. The antenna apparatus includes an antenna pattern, a first electric circuit and a second electric circuit respectively connected between both ends of the antenna pattern and a system ground, and a third electric circuit disposed between the antenna pattern and a feeding line, wherein the first electric circuit and the second electric circuit extend electrical wavelengths of the antenna pattern and the third electric circuit increases input impedance matching.





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

(10) **Pub. No.: US 2020/0295445 A1**

(43) **Pub. Date: Sep. 17, 2020**

(54) **MOBILE DEVICE**

Publication Classification

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

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 9/28 (2006.01)
H01Q 1/22 (2006.01)

(72) Inventors: **Yi-Ling TSENG**, Taoyuan City (TW);
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Chung-Ting HUNG, Taoyuan City (TW)

(52) **U.S. Cl.**
CPC *H01Q 1/36* (2013.01); *H01Q 1/2283* (2013.01); *H01Q 9/285* (2013.01)

(57) **ABSTRACT**

A mobile device includes a metal mechanism element, a dielectric substrate, and a feeding radiation element. The metal mechanism element has an open slot. The open slot substantially has an L-shape. The dielectric substrate is adjacent to the metal mechanism element. The feeding radiation element has a feeding point. The feeding radiation element is disposed on the dielectric substrate. The feeding radiation element at least partially extends along the open slot. An antenna structure is formed by the feeding radiation element and the open slot of the metal mechanism element. The antenna structure covers a first frequency band, a second frequency band, and a third frequency band.

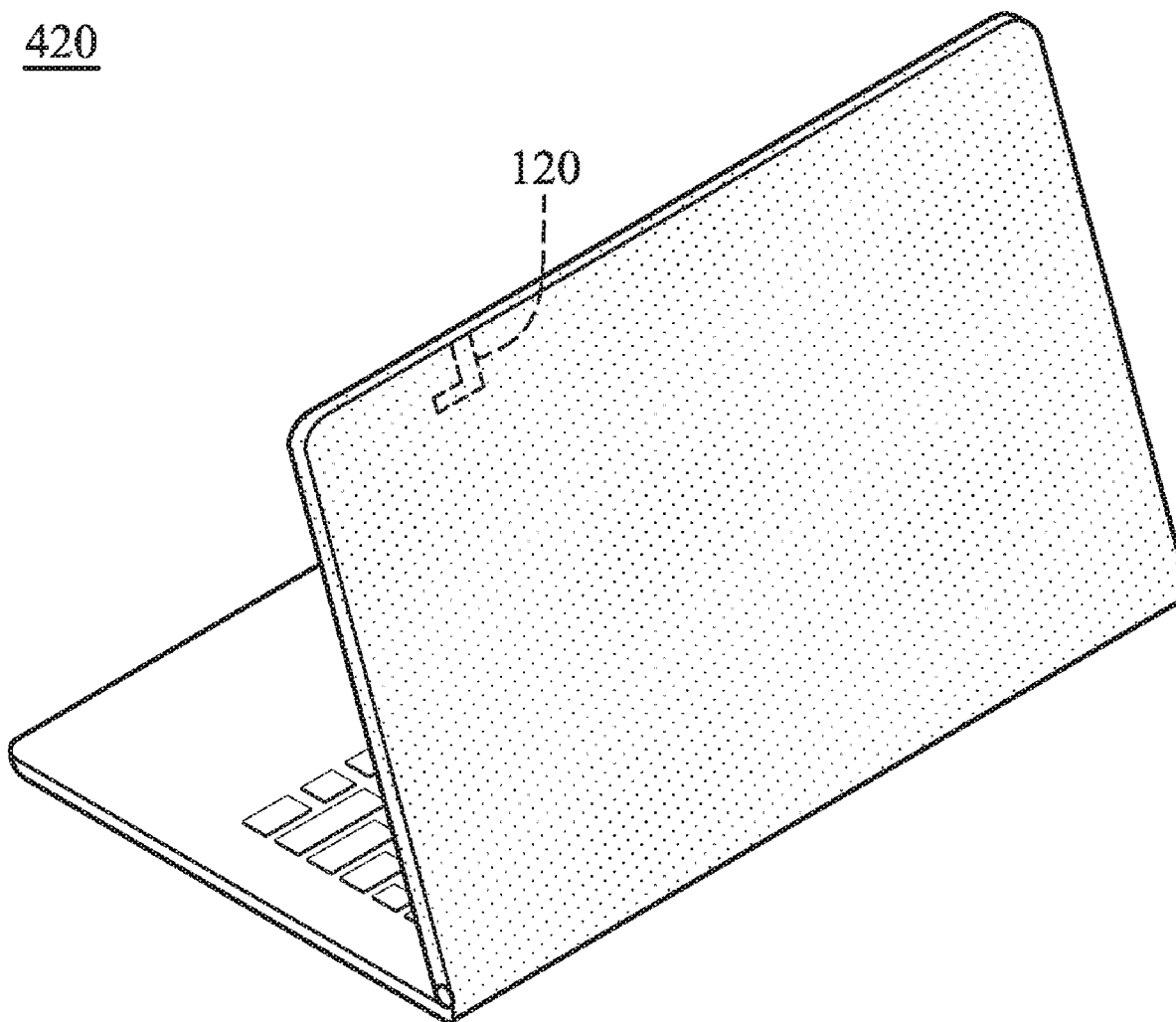
(21) Appl. No.: **16/550,755**

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

(30) **Foreign Application Priority Data**

Mar. 15, 2019 (TW) 108108755

420





US 20200295449A1

(19) **United States**

(12) **Patent Application Publication**
HAMABE

(10) **Pub. No.: US 2020/0295449 A1**

(43) **Pub. Date: Sep. 17, 2020**

(54) **ANTENNA DEVICE**

Publication Classification

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

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/24 (2006.01)
H01Q 5/378 (2006.01)
H01Q 9/04 (2006.01)

(72) Inventor: **Taichi HAMABE**, Kanagawa (JP)

(21) Appl. No.: **16/885,988**

(52) **U.S. Cl.**
CPC *H01Q 1/38* (2013.01); *H01Q 1/48* (2013.01); *H01Q 9/045* (2013.01); *H01Q 5/378* (2015.01); *H01Q 1/24* (2013.01)

(22) Filed: **May 28, 2020**

Related U.S. Application Data

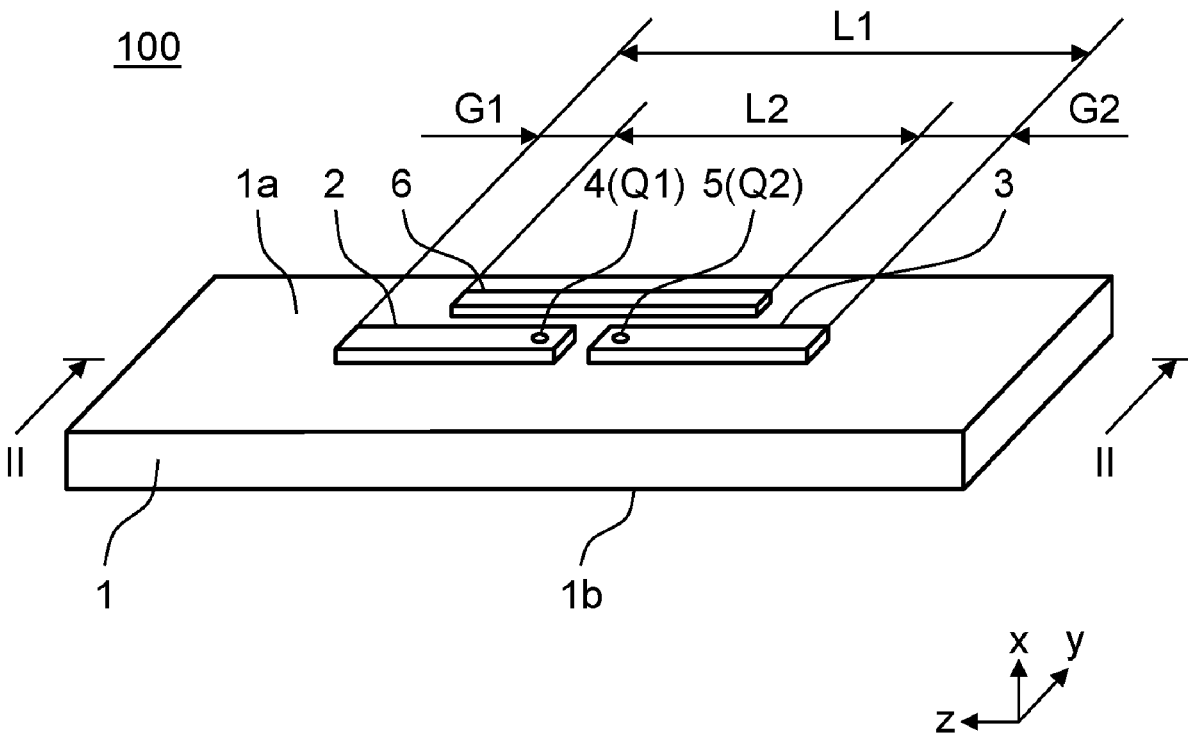
(63) Continuation of application No. PCT/JP2018/043676, filed on Nov. 28, 2018.

(57) **ABSTRACT**

An antenna device of the present disclosure includes a substrate having an artificial magnetic conductor, a plurality of antenna conductors disposed on the substrate, and a parasitic conductor disposed on the substrate. The parasitic conductor is apart from and adjacent to the plurality of antenna conductors.

(30) **Foreign Application Priority Data**

Nov. 30, 2017 (JP) 2017-231213





(19) **United States**

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

(10) **Pub. No.: US 2020/0295463 A1**

(43) **Pub. Date: Sep. 17, 2020**

(54) **ANTENNA ELEMENT, ANTENNA MODULE,
AND COMMUNICATION DEVICE**

Publication Classification

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

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/35 (2006.01)
H01Q 3/26 (2006.01)

(72) Inventors: **Yoshiki YAMADA**, Kyoto (JP); **Kaoru SUDO**, Kyoto (JP)

(52) **U.S. Cl.**
CPC *H01Q 9/0407* (2013.01); *H01Q 3/26* (2013.01); *H01Q 5/35* (2015.01)

(21) Appl. No.: **16/890,302**

(57) **ABSTRACT**

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

A patch antenna includes a ground conductor pattern, feeding conductor patterns (11, 12), and a feed line (15). The feeding conductor patterns (11, 12) are disposed on the same side with respect to the ground conductor pattern and are of different sizes. The feeding conductor pattern (11) has feed points (111, 112) for direct feeding through the feed line. The feeding conductor pattern (12) has a feed point (121) for direct feeding through the feed line and a feed point (122) for capacitive feeding through the feed line. The feed points (111, 112) are opposite to each other with respect to a center point of the feeding conductor pattern (11). The feed points (121, 122) are opposite to each other with respect to a center point of the feeding conductor pattern (12).

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2019/032248, filed on Aug. 19, 2019.

Foreign Application Priority Data

(30) Aug. 20, 2018 (JP) 2018-153806

