



US 20190157746A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0157746 A1**  
(43) **Pub. Date: May 23, 2019**

(54) **ELECTRONIC DEVICE**

**H01Q 1/48** (2006.01)

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

**H01Q 7/00** (2006.01)

**H04M 1/02** (2006.01)

**H05K 7/20** (2006.01)

(72) Inventors: **Kenichi ISHIZUKA**, Nagaokakyo-shi (JP); **Takeaki TAMAYAMA**,  
Nagaokakyo-shi (JP)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 13/10**  
(2013.01); **H05K 7/20509** (2013.01); **H01Q**  
**7/00** (2013.01); **H04M 1/02** (2013.01); **H01Q**  
**1/48** (2013.01)

(21) Appl. No.: **16/258,869**

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

**Related U.S. Application Data**

(63) Continuation of application No. PCT/JP2018/  
020746, filed on May 30, 2018.

**Foreign Application Priority Data**

Jul. 6, 2017 (JP) ..... 2017-132442

**Publication Classification**

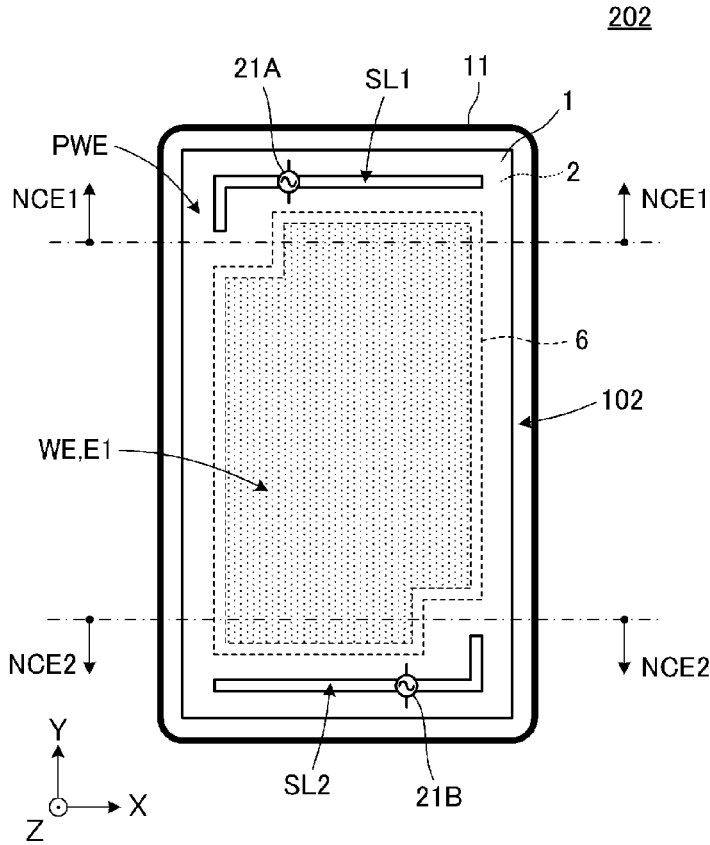
(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 13/10** (2006.01)

(57) **ABSTRACT**

An electronic device includes an antenna, and a plate-shaped heat spreader including first and second metal layers that are stacked, a working fluid in an enclosed space interposed between the first and second metal layers, and a joint along which outer peripheral portions around the enclosed space are joined. The heat spreader includes an operational region in which the enclosed space is located and a quasi-operational region other than the enclosed space. The antenna is provided in the quasi-operational region in a plan view of the heat spreader.





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(19) **United States**

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

(10) **Pub. No.: US 2019/0157751 A1**

(43) **Pub. Date: May 23, 2019**

(54) **ANTENNA AND MOBILE TERMINAL**

**Publication Classification**

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

(51) **Int. Cl.**  
*H01Q 1/52* (2006.01)  
*H01Q 1/24* (2006.01)  
*H01Q 5/307* (2006.01)

(72) Inventors: **Ming ZHANG**, Hangzhou (CN);  
**Daqing LIU**, Hangzhou (CN); **Huailin WEN**, Ottawa (CA)

(52) **U.S. Cl.**  
CPC ..... *H01Q 1/52* (2013.01); *H01Q 5/307* (2015.01); *H01Q 1/243* (2013.01)

(21) Appl. No.: **16/250,784**

(57) **ABSTRACT**

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

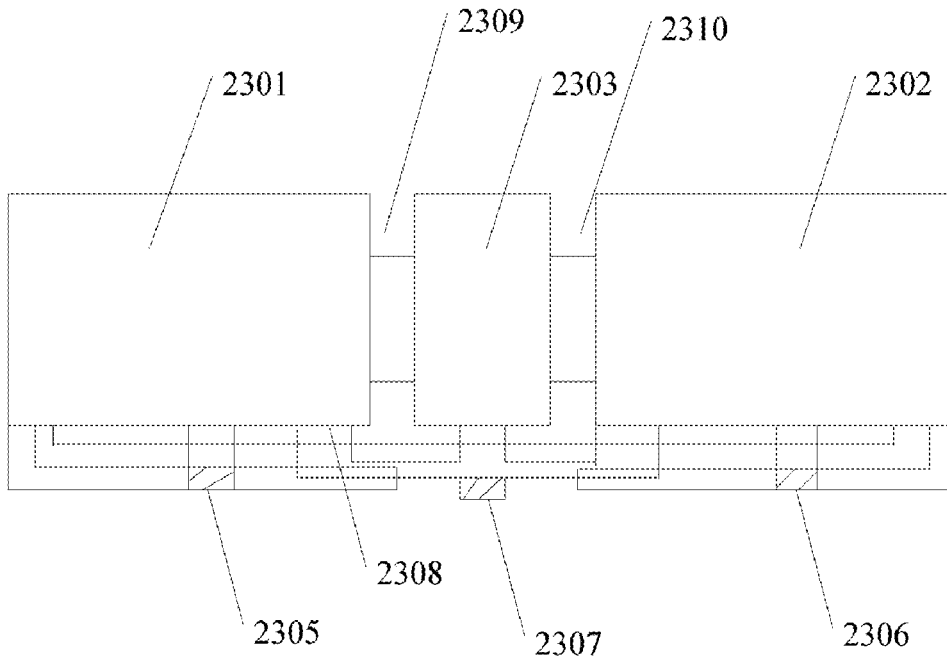
The application disclose an antenna. The antenna includes a first radiating element, a second radiating element, a third radiating element, and a closed ring, where the first radiating element is connected to a first feed point, the second radiating element is connected to a second feed point, and the third radiating element is connected to a third feed point; the closed ring is configured to be disposed in a clearance area of a ground plate, and configured to connect to the ground plate; the first radiating element, the second radiating element, and the third radiating element are connected by using a microstrip, to form a radiator; the third radiating element is disposed between the first radiating element and the second radiating element.

**Related U.S. Application Data**

(63) Continuation of application No. PCT/CN2017/090324, filed on Jun. 27, 2017.

**Foreign Application Priority Data**

(30) Jul. 20, 2016 (CN) ..... 201610578153.3





US 20190157762A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0157762 A1**

(43) **Pub. Date: May 23, 2019**

(54) **DUAL BAND PATCH ANTENNA**

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

(71) Applicant: **TDK Corporation, TOKYO (JP)**

CPC ..... **H01Q 5/307 (2015.01); H01Q 9/0407 (2013.01)**

(72) Inventors: **Tetsuya SHIBATA, TOKYO (JP); Naoki SOTOMA, TOKYO (JP)**

(57) **ABSTRACT**

(73) Assignee: **TDK Corporation, TOKYO (JP)**

(21) Appl. No.: **16/191,060**

(22) Filed: **Nov. 14, 2018**

(30) **Foreign Application Priority Data**

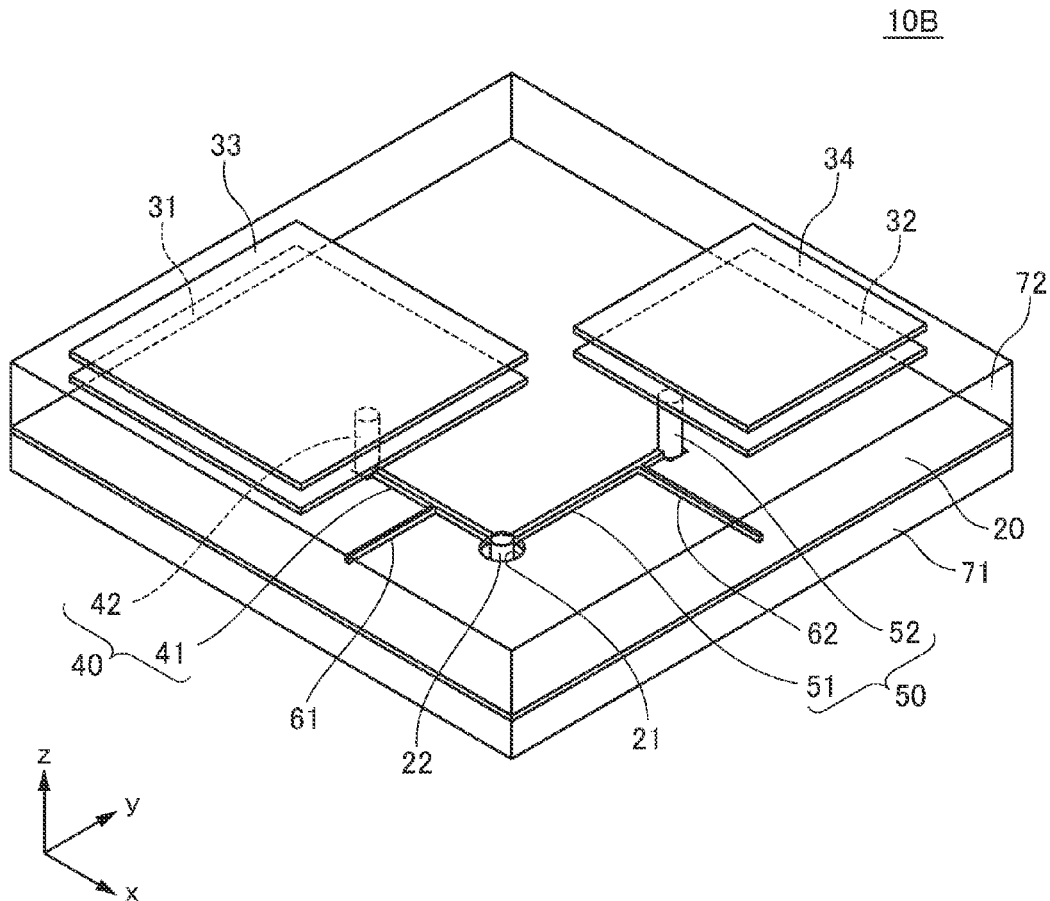
Nov. 17, 2017 (JP) ..... 2017-221423

Disclosed herein is a dual band patch antenna that includes a first feeding part, first and second radiation conductors, a first feeding conductor having one end connected to the first feeding part and other end connected to the first radiation conductor, a second feeding conductor having one end connected to the first feeding part and other end connected to the second radiation conductor, a first open stub having one end connected to the first feeding conductor and other end opened, and a second open stub having one end connected to the second feeding conductor and other end opened.

**Publication Classification**

(51) **Int. Cl.**

**H01Q 5/307 (2006.01)**  
**H01Q 9/04 (2006.01)**





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(19) **United States**

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

(10) **Pub. No.: US 2019/0165453 A1**

(43) **Pub. Date: May 30, 2019**

(54) **MOBILE DEVICE AND ANTENNA STRUCTURE**

(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);  
**Chao-Chiang KUO**, Taoyuan City (TW)

(73) Assignee: **HTC Corporation**, Taoyuan City (TW)

(21) Appl. No.: **16/265,430**

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

**Related U.S. Application Data**

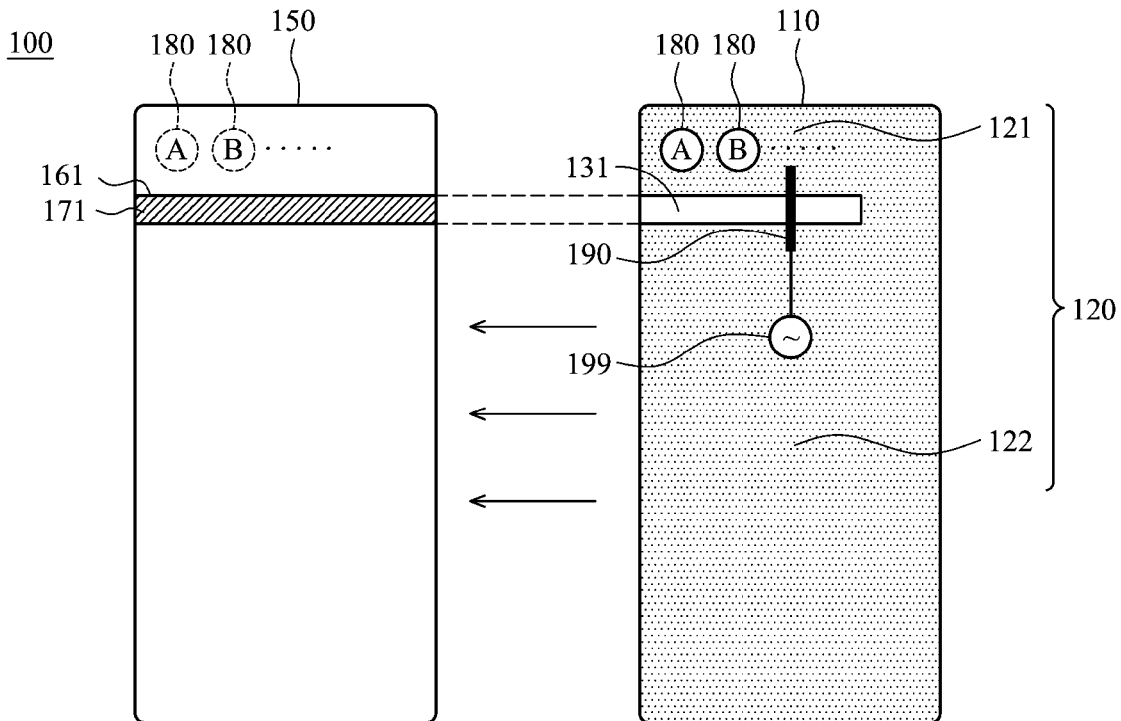
(60) Division of application No. 15/599,255, filed on May 18, 2017, which is a continuation of application No. 13/672,464, filed on Nov. 8, 2012, now Pat. No. 9,716,307.

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 13/10* (2006.01)  
(52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 13/106* (2013.01)

(57) **ABSTRACT**

A mobile device includes a dielectric substrate, a metal layer, a metal housing, a first nonconductive partition, a second nonconductive partition, a first connection element, and a second connection element. The dielectric substrate includes a first protruded portion. The metal layer lies on the dielectric substrate, and includes an upper element and a main element, wherein the upper element is separated from the main element by a first region. The metal housing is substantially a hollow structure, and has a first slit and a second slit, wherein a first projection of the first slit with respect to the dielectric substrate at least partially overlaps the first region, and a second projection of the second slit with respect to the dielectric substrate at least partially overlaps the first protruded portion. The mobile device is capable of operating in multiple bands.





(19) **United States**

(12) **Patent Application Publication**

**YUN et al.**

(10) **Pub. No.: US 2019/0165472 A1**

(43) **Pub. Date: May 30, 2019**

(54) **DUAL-BAND ANTENNA USING COUPLING FEEDING AND ELECTRONIC DEVICE INCLUDING THE SAME**

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

(72) Inventors: **Sumin YUN**, Gyeonggi-do (KR); **Sehyun PARK**, Gyeonggi-do (KR); **Myunghun JEONG**, Gyeonggi-do (KR); **Jehun JONG**, Gyeonggi-do (KR); **Jae Hoon JO**, Gyeonggi-do (KR); **Jinwoo JUNG**, Gyeonggi-do (KR); **Jae-Bong CHUN**, Gyeonggi-do (KR)

(21) Appl. No.: **16/200,816**

(22) Filed: **Nov. 27, 2018**

(30) **Foreign Application Priority Data**

Nov. 28, 2017 (KR) ..... 10-2017-0161064

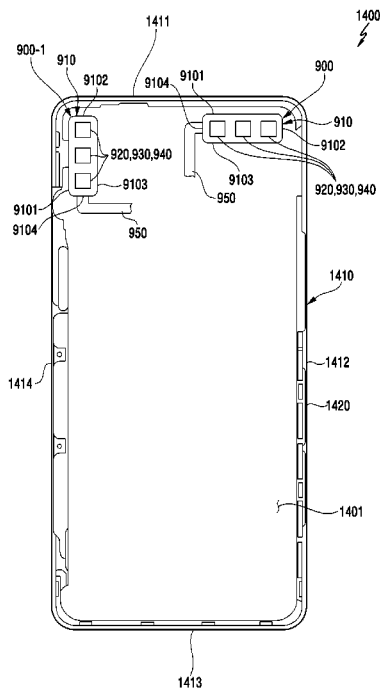
**Publication Classification**

(51) **Int. Cl.**  
**H01Q 5/10** (2006.01)  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/48** (2006.01)  
**H05K 1/11** (2006.01)  
**H05K 1/02** (2006.01)  
**H01Q 21/10** (2006.01)  
**H04B 1/40** (2006.01)  
**H04B 1/00** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 5/10** (2015.01); **H01Q 9/0407** (2013.01); **H01Q 1/242** (2013.01); **H01Q 1/48** (2013.01); **H05K 1/115** (2013.01); **H05K 2201/10098** (2013.01); **H01Q 21/10** (2013.01); **H04B 1/40** (2013.01); **H04B 1/0053** (2013.01); **H04B 1/0067** (2013.01); **H05K 1/0243** (2013.01)

(57) **ABSTRACT**

According to an embodiment, an electronic device comprises a housing comprising a first plate and a second plate facing away from the first plate; and a substrate disposed between the first plate and the second plate and comprising a first side facing the first plate and a second side facing the second plate, wherein the substrate comprises, a first conductive plate disposed on a first insulating layers and facing the second side; a conductive pattern disposed on a second insulating layer, wherein the second conductive layer is between the first conductive layer and the first side; a second conductive plate disposed on a third insulating layer between the second insulating layer and the first side, and when the second plate is viewed from above the second side, the second plate at least partially overlaps with the first conductive plate; a ground plate disposed on a fourth insulating layer, wherein the fourth insulating layer is between the third insulating layer and the first side; a conductive via constructed through the third and fourth insulating layers, and electrically connected with the conductive pattern; and a wireless communication circuit electrically connected with the conductive via, and configured to transmit/receive at least one signal having a frequency band in the range of 20 GHz to 100 GHz.





(19) **United States**

(12) **Patent Application Publication**

Irci et al.

(10) **Pub. No.: US 2019/0165836 A1**

(43) **Pub. Date: May 30, 2019**

(54) **ELECTRONIC DEVICE HAVING MULTIPLE ANTENNAS WITH SHARED STRUCTURES FOR NEAR-FIELD COMMUNICATIONS AND NON-NEAR-FIELD COMMUNICATIONS**

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

(72) Inventors: **Erdinc Irci**, Sunnyvale, CA (US); **Han Wang**, San Jose, CA (US); **Georgios Atmatzakis**, Cupertino, CA (US); **Enrique Ayala Vazquez**, Watsonville, CA (US); **Erica J. Tong**, Pacifica, CA (US); **Xu Gao**, Santa Clara, CA (US); **Hongfei Hu**, Cupertino, CA (US); **Nanbo Jin**, San Jose, CA (US); **Mattia Pascolini**, San Francisco, CA (US)

(21) Appl. No.: **16/265,462**

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

**Related U.S. Application Data**

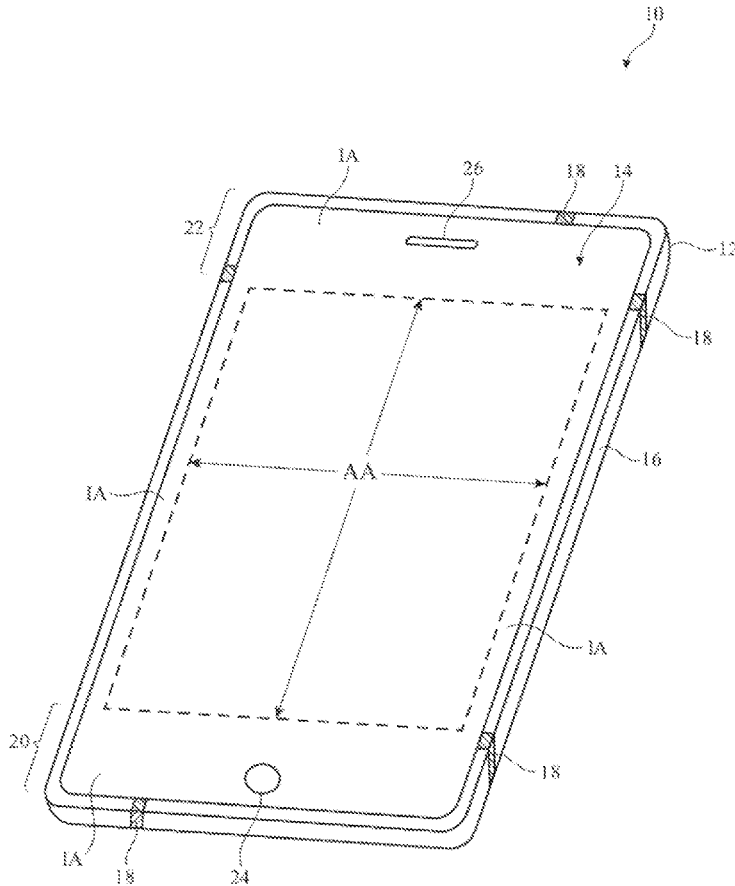
(62) Division of application No. 15/719,317, filed on Sep. 28, 2017, now Pat. No. 10,200,092.

**Publication Classification**

(51) **Int. Cl.**  
*H04B 5/02* (2006.01)  
*H04B 5/00* (2006.01)  
*H04B 7/0413* (2006.01)  
(52) **U.S. Cl.**  
CPC ..... *H04B 5/02* (2013.01); *H04B 7/0413* (2013.01); *H04B 5/0031* (2013.01)

(57) **ABSTRACT**

An electronic device may include a peripheral conductive wall. A gap in the wall may divide the wall into first and second segments. The device may include a first antenna having a first resonating element arm formed from the first segment and a second antenna having a second resonating element arm formed from the second segment. A non-near-field communications transceiver may perform multiple-input and multiple-output (MIMO) operations using the first and second antennas. The gap may provide satisfactory isolation between the first and second antennas while the first and second antennas perform MIMO operations. Near-field communications circuitry may convey near-field communications signals over a conductive loop path that includes portions of the first and second segments and the antenna ground. The volume of the conductive loop path may extend across substantially all of a width of the electronic device.





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(19) **United States**

(12) **Patent Application Publication**

**Azad et al.**

(10) **Pub. No.: US 2019/0173158 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **ELECTRONIC DEVICE WITH HOUSING SLOTS FOR ANTENNAS**

*H01Q 7/00* (2006.01)

*H01Q 9/42* (2006.01)

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

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

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

(2013.01); *H01Q 9/42* (2013.01); *H01Q 7/00*

(2013.01); *H01Q 1/48* (2013.01)

(72) Inventors: **Umar Azad**, San Jose, CA (US);  
**Harish Rajagopalan**, San Jose, CA (US);  
**Mattia Pascolini**, San Francisco, CA (US);  
**Rodney A. Gomez Angulo**, Sunnyvale, CA (US)

(57)

**ABSTRACT**

An electronic device housing may have a rear housing wall that forms a metal ground plane. A slot may be formed in the metal ground plane. The slot may have one or more open ends along an edge of the ground plane. A near-field communications loop antenna may overlap the slot. The near-field communications loop antenna may have one or more turns. A current path through the metal ground plane may form one of the turns in the near-field communications loop antenna. The slot may form portions of non-near-field-communications antennas in addition to the near-field communications loop antenna. The slot in the non-near-field-communications antennas may be fed using an indirect antenna feed structure. Components such as a capacitor and inductor may help allow non-near-field communications antenna and the near-field communications antenna to be formed from common portions of the metal ground plane.

(21) Appl. No.: **16/252,311**

(22) Filed: **Jan. 18, 2019**

**Related U.S. Application Data**

(63) Continuation of application No. 14/693,274, filed on Apr. 22, 2015, now Pat. No. 10,224,602.

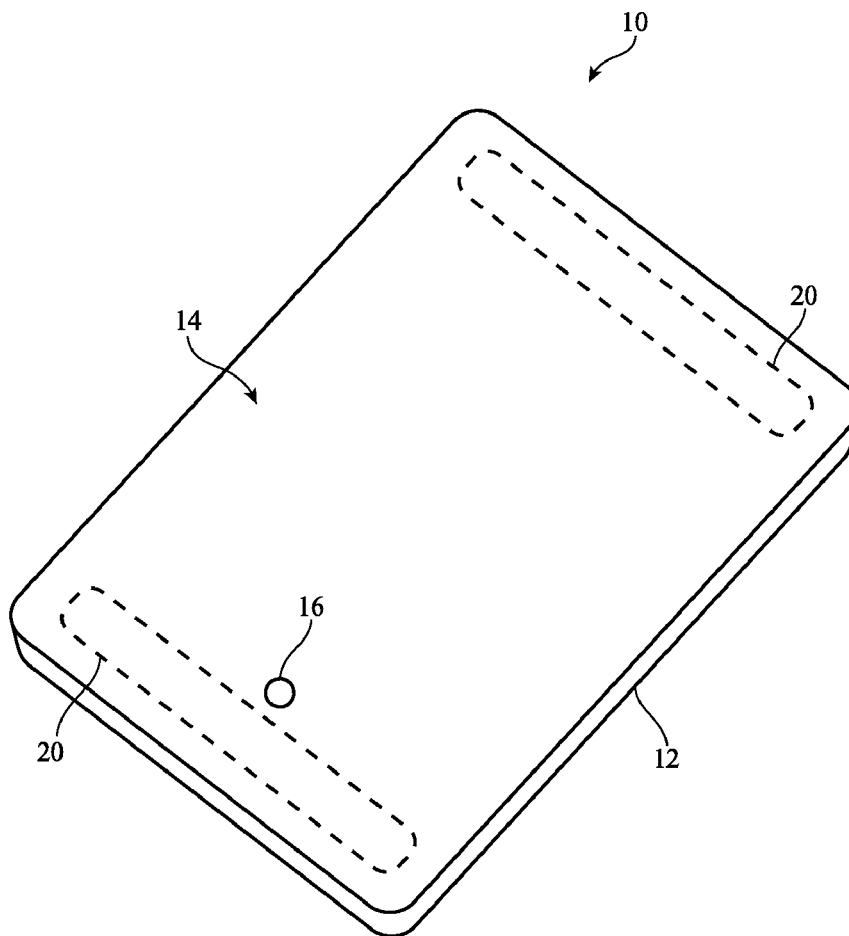
**Publication Classification**

(51) **Int. Cl.**

*H01Q 1/24* (2006.01)

*H01Q 13/10* (2006.01)

*H01Q 1/48* (2006.01)





(19) **United States**

(12) **Patent Application Publication**  
**WOO**

(10) **Pub. No.: US 2019/0173159 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **MOBILE TERMINAL**

**H03H 1/00** (2006.01)

**H03H 7/38** (2006.01)

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

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/35** (2015.01); **H01Q 1/52** (2013.01); **H03H 1/00** (2013.01); **H03H 7/38** (2013.01); **H01Q 5/335** (2015.01)

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

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

(57) **ABSTRACT**

(21) Appl. No.: **16/268,298**

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

(22) Filed: **Feb. 5, 2019**

**Related U.S. Application Data**

(63) Continuation of application No. 15/461,412, filed on Mar. 16, 2017, now Pat. No. 10,243,258.

**Foreign Application Priority Data**

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

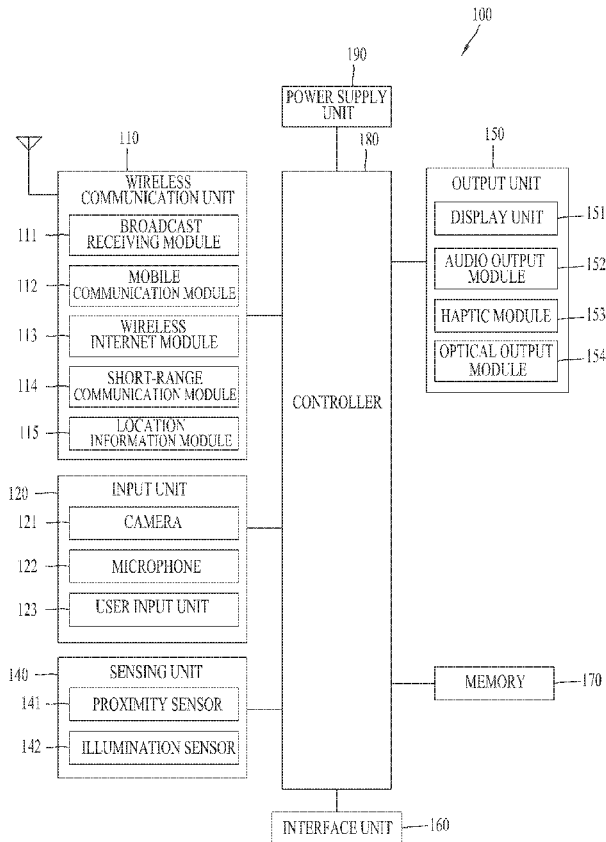
**Publication Classification**

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 5/35** (2006.01)

**H01Q 5/335** (2006.01)







(19) **United States**

(12) **Patent Application Publication**

**Mow et al.**

(10) **Pub. No.: US 2019/0173160 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **ELECTRONIC DEVICE WITH MILLIMETER WAVE ANTENNA ARRAYS**

**H01Q 9/04** (2006.01)

**H01Q 1/48** (2006.01)

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 21/28** (2013.01); **H01Q 21/062** (2013.01); **H01Q 1/22** (2013.01); **H01Q 1/2283** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/242** (2013.01); **H01Q 21/065** (2013.01)

(72) Inventors: **Matthew A. Mow**, Los Altos, CA (US); **Basim H. Noori**, San Jose, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Xu Han**, San Jose, CA (US); **Victor C. Lee**, Sunnyvale, CA (US); **Ming-Ju Tsai**, Cupertino, CA (US); **Simone Paulotto**, Redwood City, CA (US)

(57) **ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include one or more antennas. The antennas may include millimeter wave antenna arrays formed from arrays of patch antennas, dipole antennas or other millimeter wave antennas on millimeter wave antenna array substrates. Circuitry such as upconverter and downconverter circuitry may be mounted on the substrates. The upconverter and downconverter may be coupled to wireless communications circuitry such as a baseband processor circuit using an intermediate frequency signal path. The electronic device may have opposing front and rear faces. A display may cover the front face. A rear housing wall may cover the rear face. A metal midplate may be interposed between the display and rear housing wall. Millimeter wave antenna arrays may transmit and receive antenna signals through the rear housing wall.

(21) Appl. No.: **16/272,932**

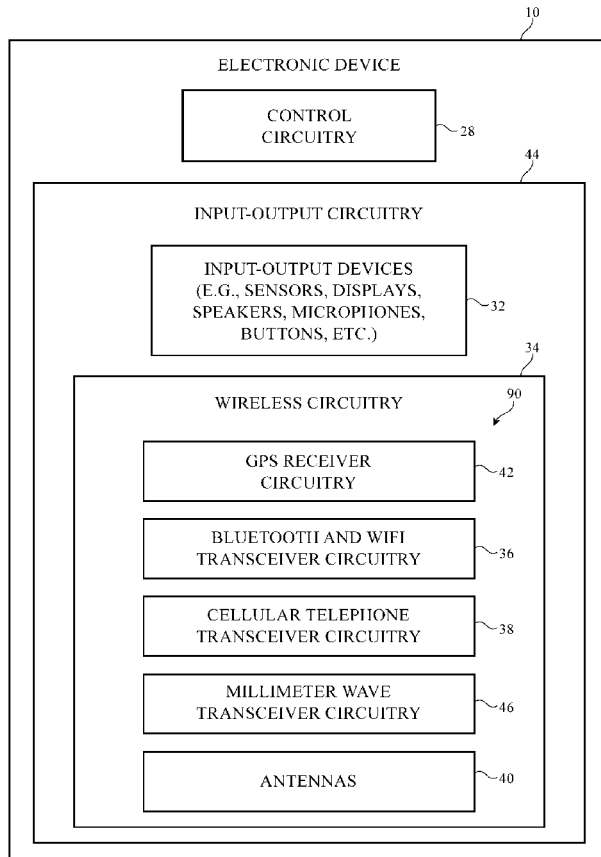
(22) Filed: **Feb. 11, 2019**

**Related U.S. Application Data**

(63) Continuation of application No. 15/275,183, filed on Sep. 23, 2016, now Pat. No. 10,205,224.

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 21/28** (2006.01)  
**H01Q 21/06** (2006.01)  
**H01Q 1/22** (2006.01)





US 20190173166A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0173166 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **ANTENNA SYSTEM COUPLED TO AN EXTERNAL DEVICE**

**Publication Classification**

(71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)

(51) **Int. Cl.**  
*H01Q 1/40* (2006.01)  
*H01Q 1/24* (2006.01)  
*H01Q 1/52* (2006.01)

(52) **U.S. Cl.**  
 CPC ..... *H01Q 1/40* (2013.01); *H01Q 1/521* (2013.01); *H01Q 1/243* (2013.01)

(72) Inventors: **Laurent Desclos**, San Diego, CA (US);  
**Sebastian Rowson**, San Diego, CA (US);  
**Jeffrey Shamblin**, San Marcos, CA (US)

(57) **ABSTRACT**

(21) Appl. No.: **16/270,695**

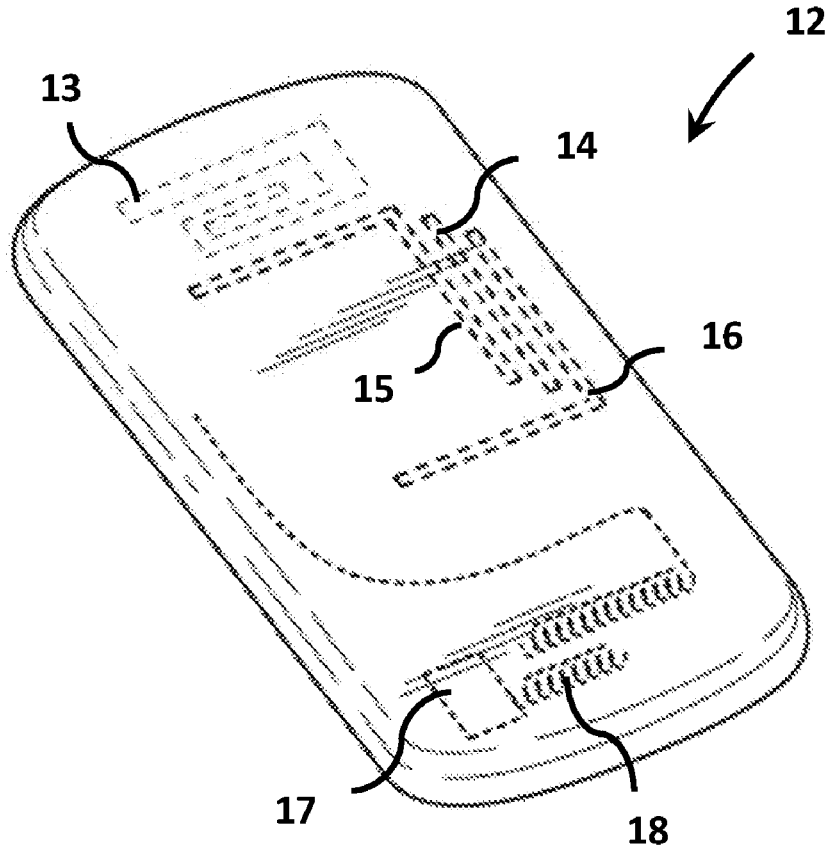
An antenna system is integrated into a cover or accessory and adapted to couple to an antenna in a host device to improve transmission and reception of signals. The antenna system can be passive or active, with the active antenna system designed to amplify coupled signals on the integrated antenna elements in the cover or accessory. Single or multiple frequency bands can be improved with the integrated antenna system, and multiple antennas in the host device can be coupled to and improved. The antenna system can couple to the existing antennas in the host device by capacitive coupling, i.e. no physical contact required, or a connector can be designed into the cover or accessory containing the integrated antenna system that makes contact to electrical ground of the host device or power supply signals or other control signals.

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

**Related U.S. Application Data**

(63) Continuation of application No. 15/677,996, filed on Aug. 15, 2017, now Pat. No. 10,205,230, which is a continuation of application No. 13/295,979, filed on Nov. 14, 2011, now abandoned.

(60) Provisional application No. 61/412,473, filed on Nov. 11, 2010.





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(19) **United States**

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

(10) **Pub. No.: US 2019/0173175 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **MAGNETIC FIELD COUPLING ELEMENT,  
ANTENNA DEVICE, AND ELECTRONIC  
EQUIPMENT**

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

(72) Inventors: **Kentaro MIKAWA**, Nagaokakyo-shi  
(JP); **Kenichi ISHIZUKA**,  
Nagaokakyo-shi (JP); **Takafumi NASU**,  
Nagaokakyo-shi (JP)

(21) Appl. No.: **16/269,642**

(22) Filed: **Feb. 7, 2019**

**Related U.S. Application Data**

(63) Continuation of application No. PCT/JP2017/  
042707, filed on Nov. 29, 2017.

(30) **Foreign Application Priority Data**

Nov. 29, 2016	(JP)	2016-231025
Dec. 28, 2016	(JP)	2016-255730
Apr. 18, 2017	(JP)	2017-082044
May 26, 2017	(JP)	2017-104651
Aug. 18, 2017	(JP)	2017-158219

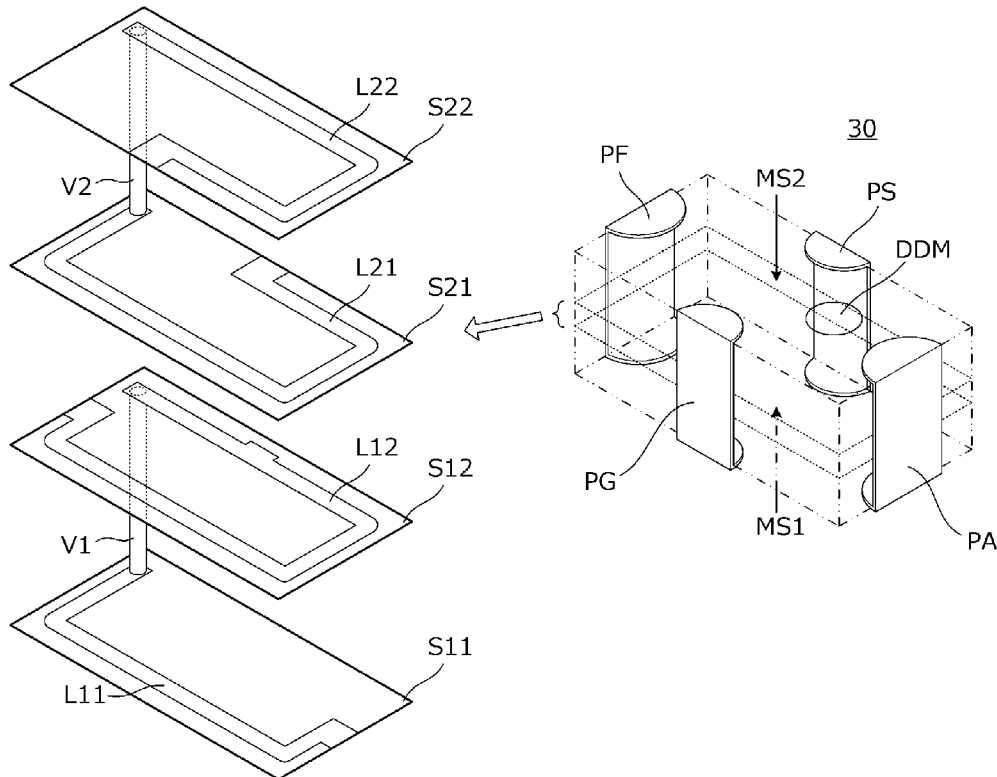
**Publication Classification**

(51) **Int. Cl.**  
*H01Q 5/335* (2006.01)  
*H01Q 5/378* (2006.01)  
*H01Q 9/30* (2006.01)  
*H01Q 1/36* (2006.01)  
*H01Q 21/00* (2006.01)

(52) **U.S. Cl.**  
 CPC ..... *H01Q 5/335* (2015.01); *H01Q 5/378*  
 (2015.01); *H01Q 21/0006* (2013.01); *H01Q*  
*1/36* (2013.01); *H01Q 9/30* (2013.01)

(57) **ABSTRACT**

A magnetic field coupling element includes conductor patterns stacked with insulating layers interposed therebetween, and interlayer connection conductors that inter-connect the conductor patterns at predetermined positions. The conductor patterns include first, second, third, and fourth conductor patterns, and the interlayer connection conductors include first and second interlayer connection conductors. The first conductor pattern, the second conductor pattern, and the first interlayer connection conductor define a first coil, and the third conductor pattern, the fourth conductor pattern, and the second interlayer connection conductor define a second coil. The first coil and the second coil are disposed in a region of less than about 1/3 of a stacking height of a multi-layer body including the insulating layers.





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(19) **United States**

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

(10) **Pub. No.: US 2019/0173176 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **ANTENNA APPARATUS AND ANTENNA MODULE**

*H01Q 1/52* (2006.01)

*H01Q 5/49* (2006.01)

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

*H01Q 13/18* (2006.01)

*H01Q 1/22* (2006.01)

(72) Inventors: **Nam Ki KIM**, Suwon-si (KR); **Jeong Ki RYOO**, Suwon-si (KR); **Sang Hyun KIM**, Suwon-si (KR)

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

CPC ..... *H01Q 5/371* (2015.01); *H01Q 11/14* (2013.01); *H01Q 1/2283* (2013.01); *H01Q 5/49* (2015.01); *H01Q 13/18* (2013.01); *H01Q 1/526* (2013.01)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**,  
Suwon-si (KR)

(21) Appl. No.: **16/171,844**

(57) **ABSTRACT**

(22) Filed: **Oct. 26, 2018**

(30) **Foreign Application Priority Data**

Dec. 1, 2017 (KR) ..... 10-2017-0164105

Jun. 4, 2018 (KR) ..... 10-2018-0064244

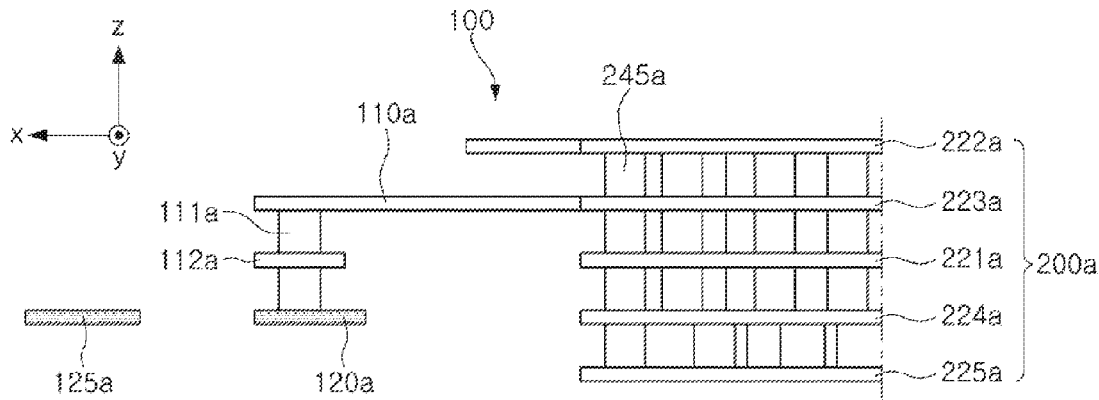
**Publication Classification**

(51) **Int. Cl.**

*H01Q 5/371* (2006.01)

*H01Q 11/14* (2006.01)

An antenna apparatus includes: a first ground layer; a second ground layer disposed on a surface of the first ground layer; an antenna pattern spaced apart from the first and second ground layers in a direction of the surface, and configured to transmit and/or receive a radio frequency (RF) signal; and a feed line electrically connected to the antenna pattern and extending from the antenna pattern toward the first ground layer in the direction of the surface, wherein the first ground layer includes a first region recessed, relative to the second ground layer, in the direction of the surface.





US 20190173184A1

(19) **United States**

(12) **Patent Application Publication**

**KIM et al.**

(10) **Pub. No.: US 2019/0173184 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **ANTENNA MODULE AND MANUFACTURING METHOD THEREOF**

*G06K 19/077* (2006.01)

*H01Q 23/00* (2006.01)

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

(52) **U.S. Cl.**  
CPC ..... *H01Q 9/0407* (2013.01); *H01Q 23/00* (2013.01); *G06K 19/07775* (2013.01); *H01Q 1/38* (2013.01)

(72) Inventors: **Doo Il KIM**, Suwon-si (KR); **Young Sik HUR**, Suwon-si (KR); **Yong Ho BAEK**, Suwon-si (KR); **Jin Seon PARK**, Suwon-si (KR)

(57) **ABSTRACT**

An antenna module includes a connection member, an integrated circuit (IC), a dielectric layer, antenna members, feed vias, and a plating member. The connection member includes one or more wiring layer(s) and insulating layer(s). The IC is disposed on one surface of the connection member and is electrically connected to the wiring layer(s). The dielectric layer is disposed on another surface of the connection member. The antenna members are disposed in the dielectric layer, and the feed vias are disposed in the dielectric layer so that each has one end electrically connected to a corresponding antenna member and the other end electrically connected to a corresponding one of the wiring layer(s). The plating member is disposed in the dielectric layer to surround side surfaces of the feed vias. The dielectric layer has a dielectric constant Dk greater than that of at least one insulating layer.

(21) Appl. No.: **15/949,386**

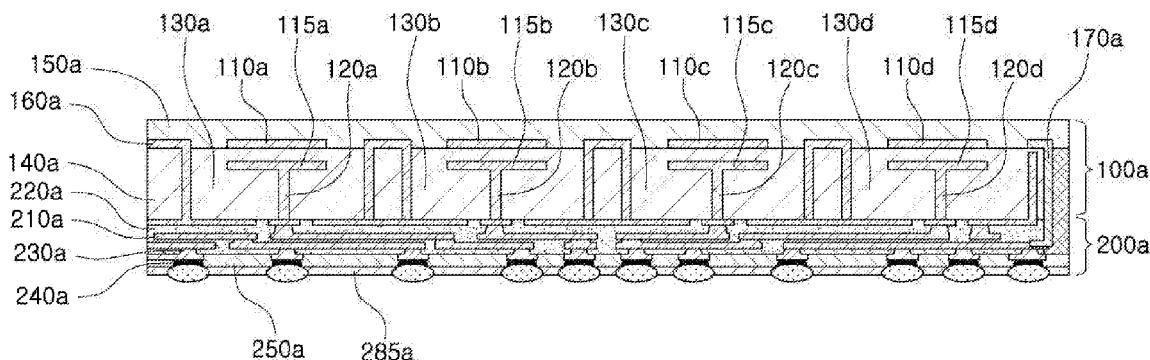
(22) Filed: **Apr. 10, 2018**

(30) **Foreign Application Priority Data**

Dec. 6, 2017 (KR) ..... 10-2017-0166855

**Publication Classification**

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





(19) **United States**

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

(10) **Pub. No.: US 2019/0173188 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **WIRELESS ELECTRONIC DEVICE**

*H01Q 21/28* (2006.01)

*H01Q 1/50* (2006.01)

*H01Q 5/335* (2006.01)

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

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

CPC ..... *H01Q 11/14* (2013.01); *H01Q 9/30* (2013.01); *H01Q 5/335* (2015.01); *H01Q 1/50* (2013.01); *H01Q 21/28* (2013.01)

(72) Inventors: **Yung-Sheng Tseng**, New Taipei City (TW); **Huei-Chun Yang**, New Taipei City (TW); **Chung-Hsuan Tsai**, New Taipei City (TW)

(73) Assignee: **Acer Incorporated**, New Taipei City (TW)

(57) **ABSTRACT**

A wireless electronic device includes a ground plane, a first antenna element, a first extension element, a first switching element and a plurality of impedance elements. The ground plane includes a first edge and a second edge opposite to each other. The first antenna element is adjacent to the first edge. The first extension element is adjacent to the second edge. The first switching element is electrically connected to the first extension element. The plurality of impedance elements are electrically connected between the first switching element and a ground. The first switching element connects the first extension element to one of the plurality of impedance elements in response to an operation frequency band of the first antenna element.

(21) Appl. No.: **16/203,630**

(22) Filed: **Nov. 29, 2018**

(30) **Foreign Application Priority Data**

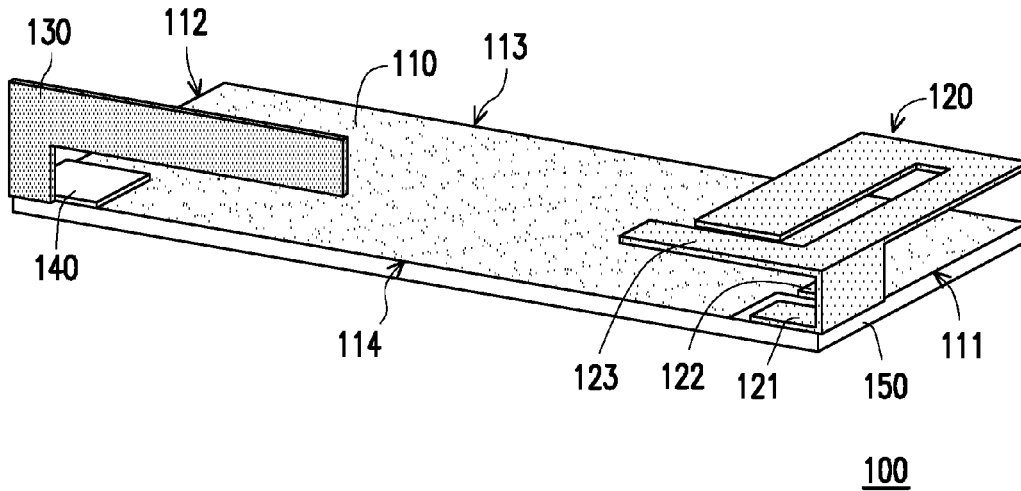
Dec. 6, 2017 (TW) ..... 106142766

**Publication Classification**

(51) **Int. Cl.**

*H01Q 11/14* (2006.01)

*H01Q 9/30* (2006.01)





US 20190173984A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0173984 A1**

(43) **Pub. Date: Jun. 6, 2019**

(54) **MOBILE TERMINAL**

**H05K 5/00** (2006.01)

**H05K 7/20** (2006.01)

(71) Applicant: **LG Electronics Inc.**, Seoul (KR)

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

(72) Inventors: **Jaehyuk KANG**, Seoul (KR); **Jinho JANG**, Seoul (KR); **Hyunseok KIM**, Seoul (KR)

CPC ..... **H04M 1/026** (2013.01); **H05K 5/04** (2013.01); **H05K 5/03** (2013.01); **H05K 5/0239** (2013.01); **H04M 2001/0204** (2013.01); **H05K 5/069** (2013.01); **H05K 5/0008** (2013.01); **H05K 7/20436** (2013.01); **G06F 1/1658** (2013.01)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(21) Appl. No.: **16/260,800**

(57) **ABSTRACT**

(22) Filed: **Jan. 29, 2019**

A bar-type mobile terminal can include a wireless communication unit including one or more components which permit wireless communications between the bar type mobile terminal and a wireless communication system; a plurality of antennas configured to transmit or receive radio signals; a metallic frame having a front side and a rear side, the metallic frame including a base portion, an edge portion forming an appearance of the bar-type mobile terminal, an upper through hole disposed in an upper portion of the metallic frame, and a lower through hole disposed in a lower portion of the metallic frame; an upper non-metallic coupling disposed in the upper through hole of the metallic frame; a lower non-metallic coupling disposed in the lower through hole of the metallic frame; a window disposed on the front side of the metallic frame; a display module disposed between the window and the front side of the metallic frame; a first waterproof layer disposed between the window and a front side of the edge portion of the metallic frame; a cover disposed on the rear side of the metallic frame; a first printed circuit board (PCB) disposed between the cover and the rear side of the metallic frame, wherein the wireless communication unit is mounted on the first PCB; and a second waterproof layer disposed between the cover and a rear side of the edge portion of the metallic frame.

**Related U.S. Application Data**

(63) Continuation of application No. 16/046,661, filed on Jul. 26, 2018, now Pat. No. 10,230,415, which is a continuation of application No. 15/632,012, filed on Jun. 23, 2017, now Pat. No. 10,097,227, which is a continuation of application No. 14/464,167, filed on Aug. 20, 2014, now Pat. No. 9,720,458.

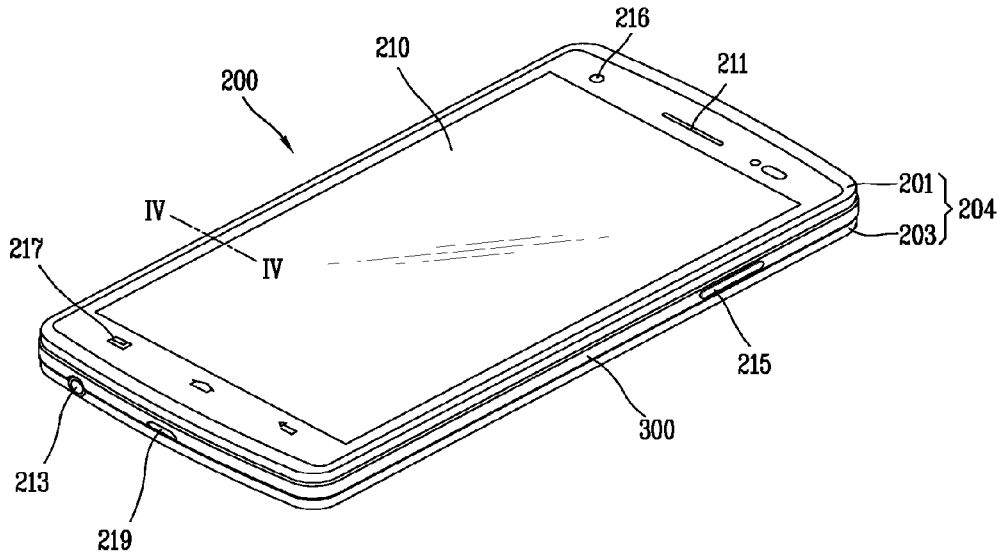
**Foreign Application Priority Data**

(30) Oct. 17, 2013 (KR) ..... 10-2013-0124166

**Publication Classification**

(51) **Int. Cl.**

**H04M 1/02** (2006.01)  
**H05K 5/04** (2006.01)  
**H05K 5/03** (2006.01)  
**H05K 5/02** (2006.01)  
**G06F 1/16** (2006.01)  
**H05K 5/06** (2006.01)





US 20190179378A1

(19) **United States**

(12) **Patent Application Publication**

**Xia et al.**

(10) **Pub. No.: US 2019/0179378 A1**

(43) **Pub. Date: Jun. 13, 2019**

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

(52) **U.S. Cl.**  
CPC ..... **G06F 1/1698** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 1/44** (2013.01); **H01Q 1/241** (2013.01)

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

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

(21) Appl. No.: **16/055,945**

(22) Filed: **Aug. 6, 2018**

(30) **Foreign Application Priority Data**

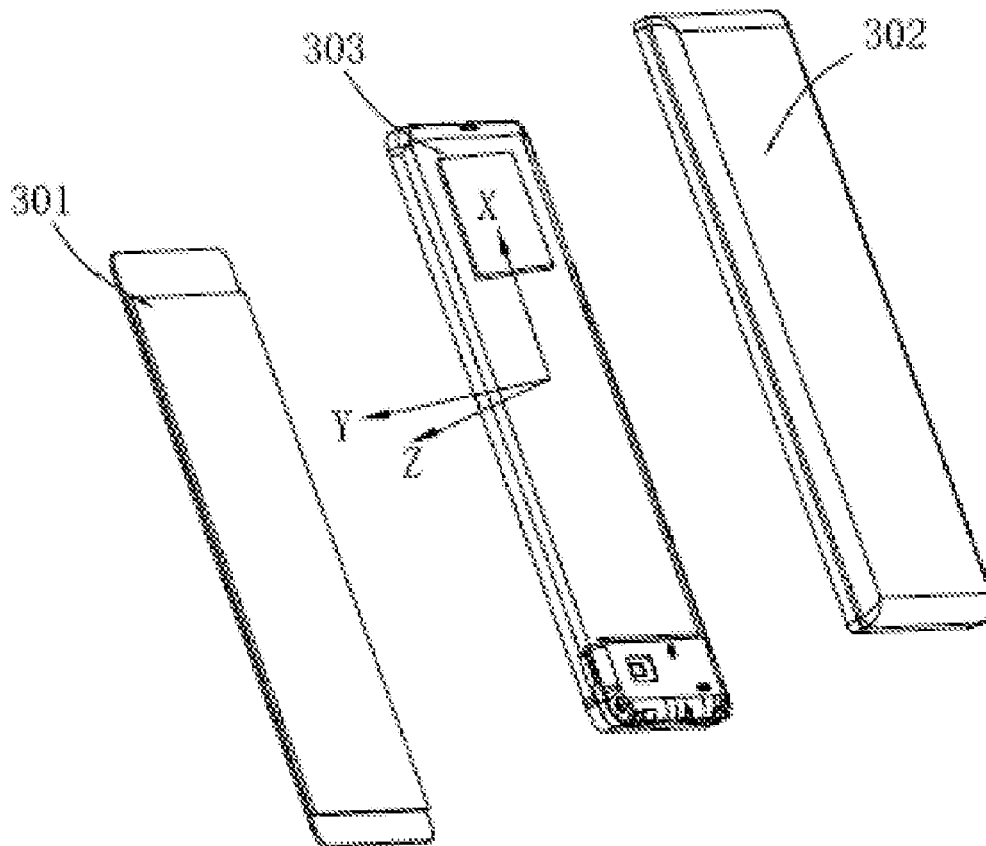
Dec. 13, 2017 (CN) ..... 201711326062.1

**Publication Classification**

(51) **Int. Cl.**  
**G06F 1/16** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/44** (2006.01)  
**H01Q 21/00** (2006.01)

(57) **ABSTRACT**

The present disclosure discloses an antenna system and a mobile terminal. The antenna system is applied to the mobile terminal and includes a first feeding point, a first millimeter-wave array antenna electrically connected to the first feeding point, a second feeding point, a second millimeter-wave array antenna electrically connected to the second feeding point, a third feeding point, a third millimeter-wave array antenna electrically connected to the third feeding point, a fourth feeding point and a fourth millimeter-wave array antenna electrically connected to the fourth feeding point, which are all arranged on a circuit board. Beams of the first millimeter-wave array antenna cover a space of  $Z>0$ ; beams of the second millimeter-wave array antenna cover a space of  $Z<0$ ; beams of the third millimeter-wave array antenna cover a space of  $X>0$ ; and beams of the fourth millimeter-wave array antenna cover a space of  $X<0$ .







US 20190181537A1

(19) **United States**

(12) **Patent Application Publication**  
**Vanjani**

(10) **Pub. No.: US 2019/0181537 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **BIFURCATED MULTI-MODE RING ANTENNA FOR A WIRELESS COMMUNICATION DEVICE**

**Publication Classification**

(51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 7/00* (2006.01)  
*H01Q 13/10* (2006.01)  
*H01Q 5/30* (2006.01)

(52) **U.S. Cl.**  
 CPC ..... *H01Q 1/243* (2013.01); *H01Q 5/30* (2015.01); *H01Q 13/10* (2013.01); *H01Q 7/00* (2013.01)

(71) Applicant: **Futurewei Technologies, Inc.**, Plano, TX (US)

(72) Inventor: **Kiran Vanjani**, San Diego, CA (US)

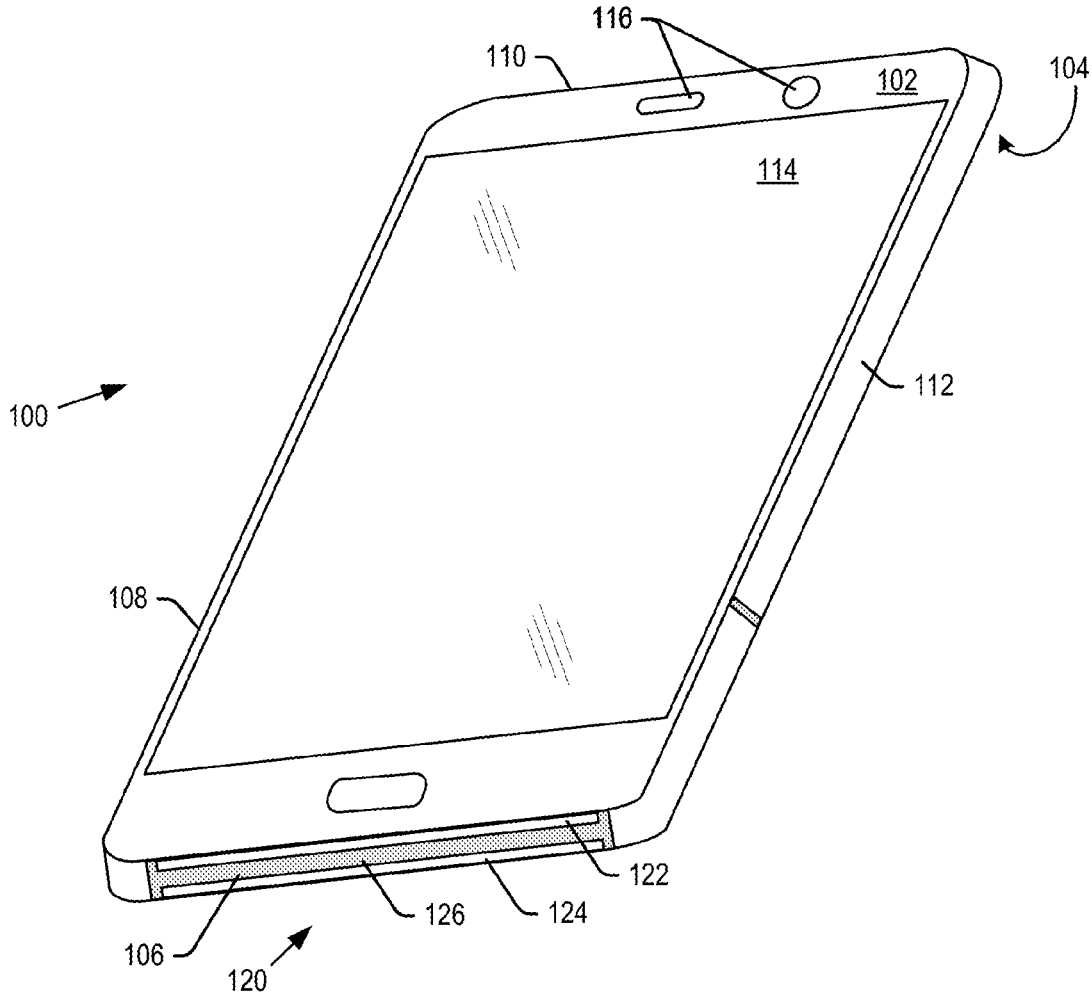
(73) Assignee: **Futurewei Technologies, Inc.**, Plano, TX (US)

(21) Appl. No.: **15/835,150**

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

(57) **ABSTRACT**

A multiband antenna is disclosed for wireless mobile communication devices such as cellular telephones. The antenna may include a bifurcated ring structure along one, two, three or all four edges of the device. The ring structure may include bifurcated metal conductors, or bars, extending along the length of the one or more edges.





(19) **United States**

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

(10) **Pub. No.: US 2019/0181549 A1**

(43) **Pub. Date: Jun. 13, 2019**

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 5/30** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/10** (2015.01)

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

(57) **ABSTRACT**

(72) Inventors: **WEI-EN HSIEH**, New Taipei (TW);  
**CHIEN-HUA LI**, New Taipei (TW);  
**YIH-SHYANG HER**, New Taipei (TW)

An antenna structure includes a radiating portion and a coupling portion. The radiating portion is electrically connected to a feed point for feeding current. The coupling portion is electrically connected to a ground point to be grounded. The coupling portion is spaced apart from the radiating portion. The radiating portion excites a first resonant mode for generating radiation signals in a first frequency band. The current flowing through the radiating portion is coupled to the coupling portion, and the coupling portion excites a second resonant mode and a third resonant mode for generating radiation signals in a second frequency band and a third frequency band. Frequencies of the first frequency band are higher than frequencies of the second frequency band. Frequencies of the third frequency band are higher than frequencies of the first frequency band.

(21) Appl. No.: **16/183,721**

(22) Filed: **Nov. 7, 2018**

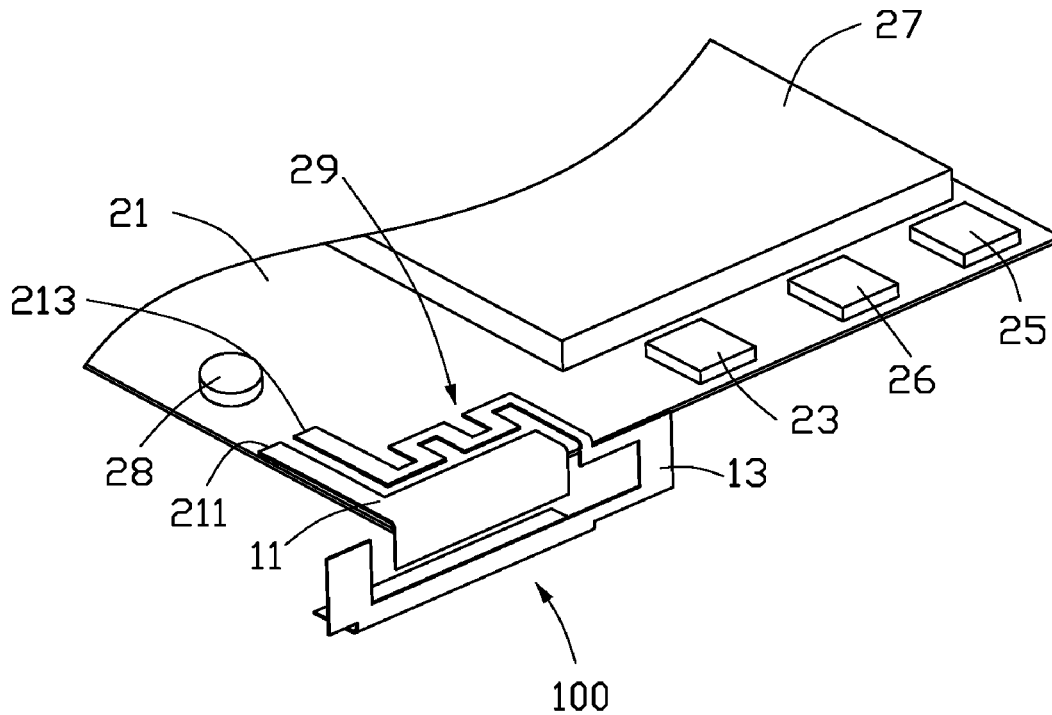
(30) **Foreign Application Priority Data**

Nov. 22, 2017 (CN) ..... 201711175305.6

**Publication Classification**

(51) **Int. Cl.**  
**H01Q 5/30** (2006.01)  
**H01Q 5/10** (2006.01)  
**H01Q 1/24** (2006.01)

200





US 20190181551A1

(19) **United States**

(12) **Patent Application Publication**  
**CHIA**

(10) **Pub. No.: US 2019/0181551 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **MULTIBAND ANTENNA AND ELECTRONIC DEVICE WITH MULTIBAND ANTENNA**

*H01Q 5/328* (2006.01)

*H01Q 21/00* (2006.01)

*H01Q 5/50* (2006.01)

(71) Applicant: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

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

CPC ..... *H01Q 5/35* (2015.01); *H01Q 9/0435*

(2013.01); *H01Q 5/50* (2015.01); *H01Q*

*21/0031* (2013.01); *H01Q 5/328* (2015.01)

(72) Inventor: **KAI-WEI CHIA**, New Taipei (TW)

(21) Appl. No.: **15/869,117**

(57) **ABSTRACT**

(22) Filed: **Jan. 12, 2018**

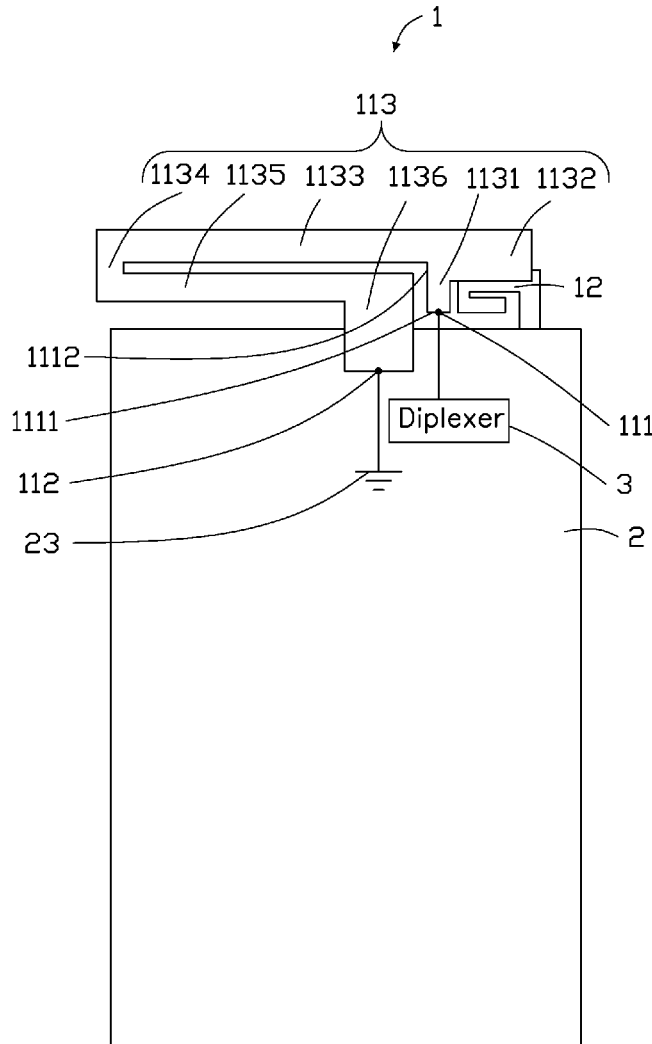
An electronic device includes a base plate and a miniaturized multiband antenna. The multiband antenna is set on the base plate. The base plate includes a first side and a second side relative to the first side. The multiband antenna includes a first radiating part and a second radiating part. The first radiating part is set on the first side. The second radiating part is set on the second side. A gap is formed between the first radiating part and the second radiating part which facilitates a coupling oscillation between the first radiating part and the second radiating part, which enables the multiband antenna to work in at least one working band.

(30) **Foreign Application Priority Data**

Dec. 7, 2017 (CN) ..... 201711286617.4

**Publication Classification**

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





(19) **United States**

(12) **Patent Application Publication**

LEE et al.

(10) **Pub. No.: US 2019/0181552 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **ANTENNA STRUCTURE**

**Publication Classification**

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

(51) **Int. Cl.**  
*H01Q 5/35* (2006.01)  
*H01Q 3/24* (2006.01)  
*H01Q 5/335* (2006.01)  
*H01Q 9/30* (2006.01)

(72) Inventors: **CHENG-HAN LEE**, New Taipei (TW);  
**HUO-YING CHANG**, New Taipei (TW)

(52) **U.S. Cl.**  
CPC ..... *H01Q 5/35* (2015.01); *H01Q 9/30* (2013.01); *H01Q 5/335* (2015.01); *H01Q 3/247* (2013.01)

(21) Appl. No.: **16/217,063**

(22) Filed: **Dec. 12, 2018**

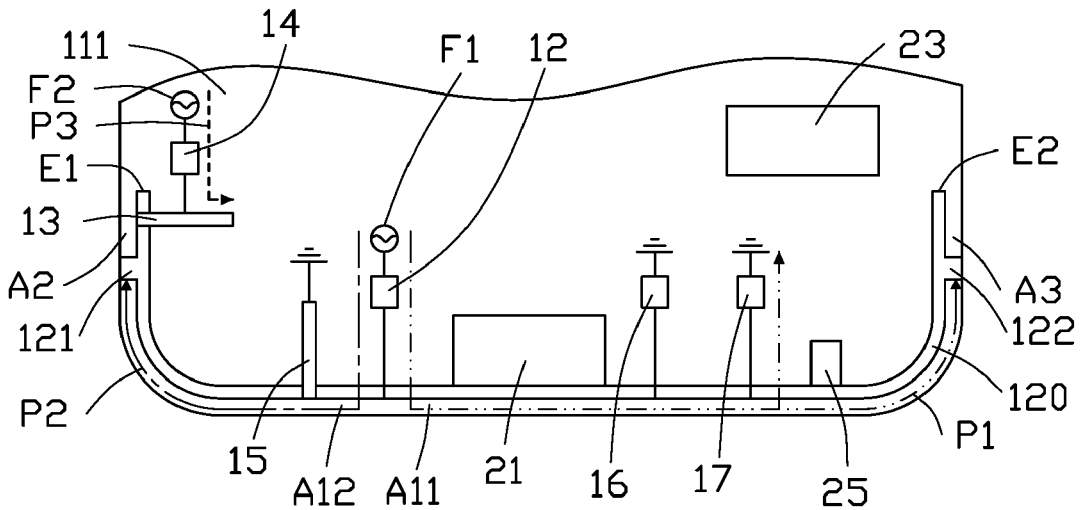
**Related U.S. Application Data**

(60) Provisional application No. 62/597,442, filed on Dec. 12, 2017, provisional application No. 62/614,364, filed on Jan. 6, 2018.

(57) **ABSTRACT**

An antenna structure includes a housing and a first feed source. The first feed source is electrically coupled to a first radiating portion of the housing and adapted to provide an electric current to the first radiating portion.

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(19) **United States**

(12) **Patent Application Publication**

**LEE et al.**

(10) **Pub. No.: US 2019/0181553 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **ANTENNA STRUCTURE**

*H01Q 5/335* (2006.01)

*H01Q 9/42* (2006.01)

*H01Q 3/24* (2006.01)

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

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

(72) Inventors: **CHENG-HAN LEE**, New Taipei (TW);  
**MIN-HUI HO**, New Taipei (TW)

CPC ..... *H01Q 5/35* (2015.01); *H01Q 9/285* (2013.01); *H01Q 3/247* (2013.01); *H01Q 9/42* (2013.01); *H01Q 5/335* (2015.01)

(21) Appl. No.: **16/217,065**

(57)

**ABSTRACT**

(22) Filed: **Dec. 12, 2018**

**Related U.S. Application Data**

(60) Provisional application No. 62/597,442, filed on Dec. 12, 2017, provisional application No. 62/614,364, filed on Jan. 6, 2018.

An antenna structure includes a housing, a first feed source, a second feed source, a third feed source, and a radiating body. The first feed source is electrically coupled to a first radiating portion of the housing and adapted to provide an electric current to the first radiating portion. The second feed source is electrically coupled to the second radiating portion and adapted to provide an electric current to the second radiating portion. The radiating body is mounted within the housing and electrically coupled to the third feed source. The third feed source provides an electric current to the radiating body.

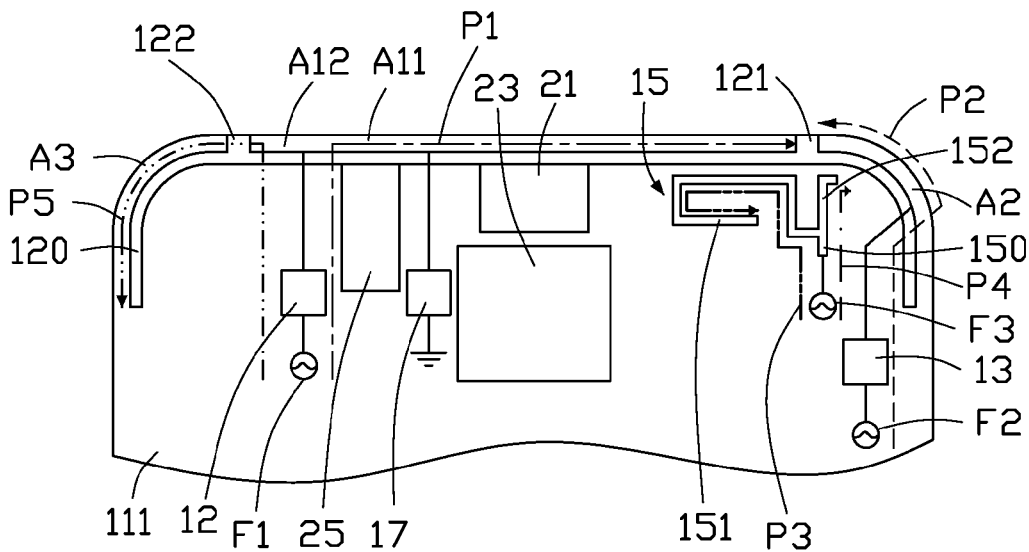
**Publication Classification**

(51) **Int. Cl.**

*H01Q 5/35* (2006.01)

*H01Q 9/28* (2006.01)

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(19) **United States**

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

(10) **Pub. No.: US 2019/0181554 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **ANTENNA STRUCTURE**

**Publication Classification**

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

(51) **Int. Cl.**  
*H01Q 5/35* (2006.01)  
*H01Q 9/28* (2006.01)  
*H01Q 5/335* (2006.01)  
*H01Q 9/42* (2006.01)  
*H01Q 3/24* (2006.01)

(72) Inventors: **CHENG-HAN LEE**, New Taipei (TW);  
**TE-CHANG LIN**, New Taipei (TW);  
**HUO-YING CHANG**, New Taipei (TW);  
**MIN-HUI HO**, New Taipei (TW)

(52) **U.S. Cl.**  
CPC ..... *H01Q 5/35* (2015.01); *H01Q 9/285* (2013.01); *H01Q 3/247* (2013.01); *H01Q 9/42* (2013.01); *H01Q 5/335* (2015.01)

(21) Appl. No.: **16/217,066**

(57) **ABSTRACT**

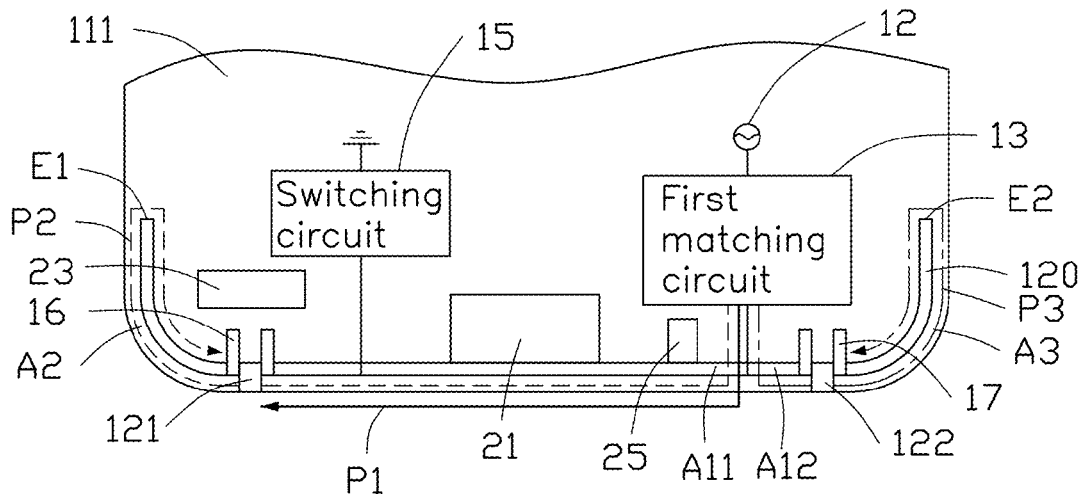
(22) Filed: **Dec. 12, 2018**

An antenna structure includes a housing, a first feed source, and a second feed source. The first feed source is electrically coupled to a first radiating portion of the housing and adapted to provide an electric current to the first radiating portion. The second feed source is electrically coupled to one of a second radiating portion or a third radiating portion of the housing. The other one of the second radiating portion or the third radiating portion is electrically coupled to the first radiating portion.

**Related U.S. Application Data**

(60) Provisional application No. 62/597,442, filed on Dec. 12, 2017, provisional application No. 62/614,364, filed on Jan. 6, 2018.

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US 20190181564A1

(19) **United States**

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

(10) **Pub. No.: US 2019/0181564 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **ANTENNA DEVICE AND MOBILE TERMINAL HAVING THE SAME**

**Publication Classification**

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

(51) **Int. Cl.**  
*H01Q 21/28* (2006.01)  
*H01Q 1/24* (2006.01)  
*H01Q 1/16* (2006.01)

(72) Inventors: **Youngbae KWON**, Seoul (KR);  
**Byungeun JEON**, Seoul (KR);  
**Byungwoon JUNG**, Seoul (KR);  
**Sungjoon HONG**, Seoul (KR)

(52) **U.S. Cl.**  
CPC ..... *H01Q 21/28* (2013.01); *H01Q 1/16* (2013.01); *H01Q 1/243* (2013.01)

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

(57) **ABSTRACT**

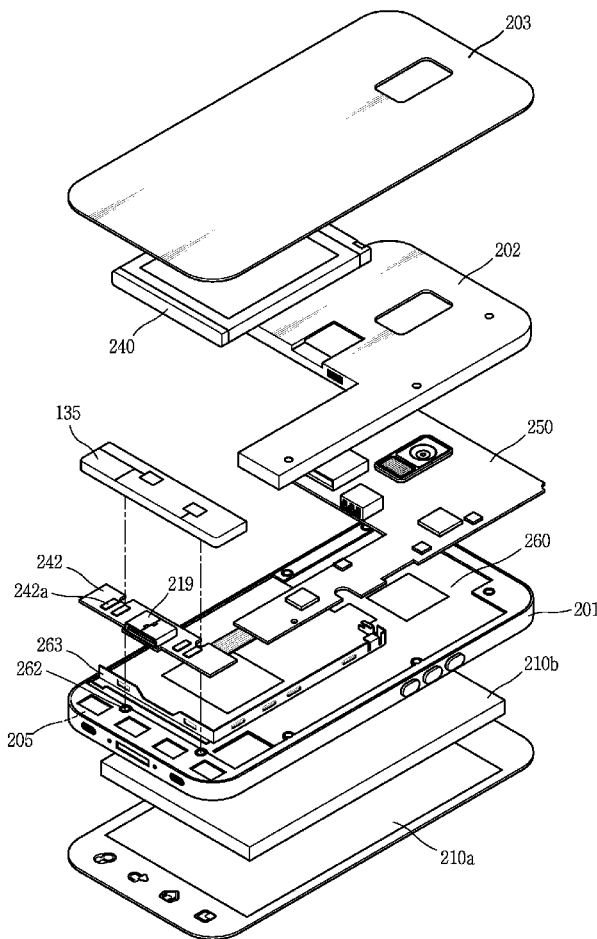
(21) Appl. No.: **16/218,088**

A mobile terminal according to the present invention includes a first conductive member forming a part of a lower end of an outer metal frame, and a second conductive member spaced apart from the first conductive member to form parts of the lower end and a side surface of the outer metal frame. The terminal may further include a conductive line connected to one point of each of the first conductive member and the second conductive member and interconnected inside the mobile terminal. At this time, an antenna device, in which the second conductive member is connected adjacent to a ground at a predetermined position from the one point of the second conductive member, so as to fully cover a low frequency band including an LTE, and which has a hand-effect compensation function, and a mobile terminal can be provided.

(22) Filed: **Dec. 12, 2018**

(30) **Foreign Application Priority Data**

Dec. 12, 2017 (KR) ..... PCT/KR2017/014557







(19) **United States**

(12) **Patent Application Publication**  
**HARPER**

(10) **Pub. No.: US 2019/0181891 A1**

(43) **Pub. Date: Jun. 13, 2019**

(54) **MONOPOLE AND SLOT ANTENNA ASSEMBLY**

(52) **U.S. Cl.**  
CPC ..... **H04B 1/0064** (2013.01); **H04L 27/0002** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/2258** (2013.01); **H01Q 5/378** (2015.01); **H01Q 13/10** (2013.01)

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

(72) Inventor: **Marc HARPER**, Snohomish, WA (US)

(21) Appl. No.: **15/838,150**

(22) Filed: **Dec. 11, 2017**

**Publication Classification**

(51) **Int. Cl.**  
**H04B 1/00** (2006.01)  
**H04L 27/00** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 1/22** (2006.01)  
**H01Q 5/378** (2006.01)

(57) **ABSTRACT**  
The herein described technology provides a hybrid monopole and slot antenna assembly including an electrically-driven monopole antenna and a parasitic slot antenna. The electrically-driven monopole antenna is fed by a feed line coupled to a first metal portion of a device case exterior, and the parasitic slot antenna is capacitively-driven by a radiating feed element embedded in a dielectric material that resonates a second metal portion of the device case exterior. The hybrid monopole and slot antenna assembly further includes a dielectric gap insert electrically separating the first metal portion of the device case exterior from the second metal portion of the device case exterior, and a modem that drives the electrically-driven monopole antenna at a first frequency and the parasitic slot antenna at a second different frequency.

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