



US 20160087329A1

(19) **United States**(12) **Patent Application Publication**
Rappoport et al.(10) **Pub. No.: US 2016/0087329 A1**(43) **Pub. Date: Mar. 24, 2016**(54) **EMBEDDED ANTENNA STRUCTURES**(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Benjamin M. Rappoport**, Los Gatos, CA (US); **Bruce E. Berg**, Shanghai (CN); **John Raff**, Menlo Park, CA (US); **Stephen R. McClure**, San Francisco, CA (US)(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **B29C 45/14655** (2013.01); **B29C 45/14819** (2013.01); **B29L 2031/3456** (2013.01)

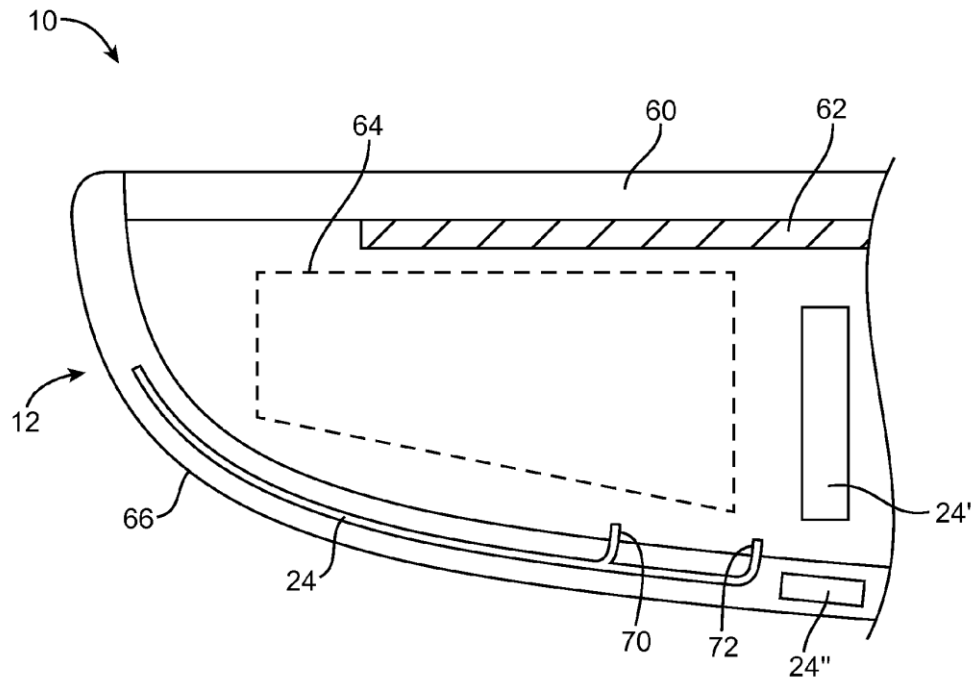
(57)

ABSTRACT(21) Appl. No.: **14/862,032**(22) Filed: **Sep. 22, 2015****Related U.S. Application Data**

(63) Continuation of application No. 13/243,549, filed on Sep. 23, 2011, now Pat. No. 9,153,856.

Publication Classification(51) **Int. Cl.****H01Q 1/24** (2006.01)
B29C 45/14 (2006.01)
H01Q 1/48 (2006.01)

An electronic device may be provided with antenna structures that are embedded in a dielectric such as plastic. The plastic may be molded over the antenna structures using molding equipment. Antenna structures may be embedded in molded plastic structures such as plastic electronic device housing structures. The plastic electronic device housing structures may form housing structures such as housing wall structures. The antenna structures may be embedded within the housing wall structures in the vicinity of an exterior surface of the housing wall structures. Embedded antenna structures may also be mounted under other dielectric structures such portions of a display cover layer.





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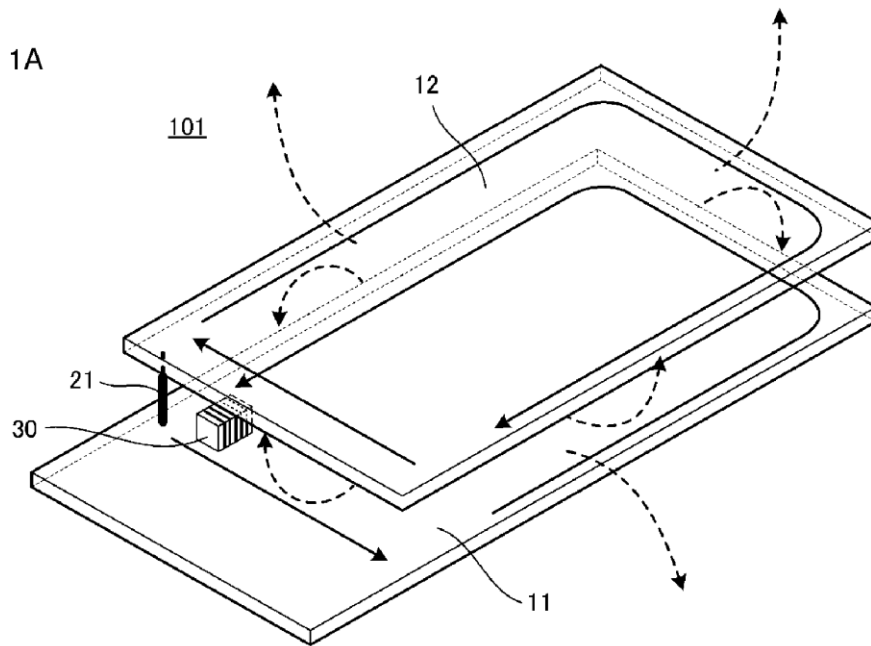
(19) **United States**(12) **Patent Application Publication**
KATO(10) **Pub. No.: US 2016/0087330 A1**(43) **Pub. Date: Mar. 24, 2016**(54) **ANTENNA DEVICE AND COMMUNICATION
TERMINAL DEVICE**(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01); **H01Q 7/08**
(2013.01); **H01Q 7/00** (2013.01)(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi (JP)(72) Inventor: **Noboru KATO**, Nagaokakyo-shi (JP)(21) Appl. No.: **14/959,142**(22) Filed: **Dec. 4, 2015****Related U.S. Application Data**(63) Continuation of application No. PCT/JP2014/064666,
filed on Jun. 3, 2014.(30) **Foreign Application Priority Data**

Jun. 14, 2013 (JP) 2013-125186

Publication Classification(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)
H01Q 7/08 (2006.01)(57) **ABSTRACT**

An antenna device includes two conductor surfaces at opposing positions with a space interposed between the conductor surfaces, a first connection conductor connecting the two conductor surfaces galvanically at one location, and an antenna coil arranged in proximity to the first connection conductor. The antenna coil is arranged at a position at which the antenna coil causes an induced current to flow through the first connection conductor by electromagnetic induction. Currents in the opposite directions flow through peripheral edge portions of the two conductor surfaces, so that a magnetic field is radiated from A space across which the two conductor surfaces oppose each other. This enables a conductor surface defined by a metal plate or the like to be used as a radiation element without providing a slit or an opening in the metal plate so as to avoid problems of a decrease in mechanical strength, design restrictions, and a decrease in an electric field shielding effect.

FIG. 1A



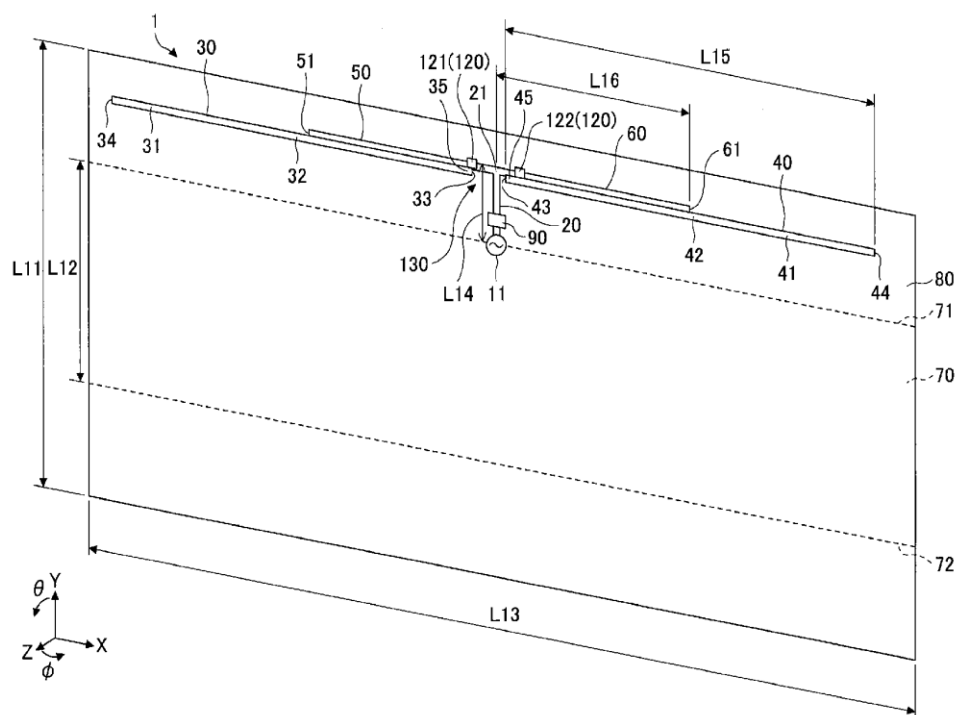


US 20160087334A1

(19) **United States**(12) **Patent Application Publication**
SAYAMA et al.(10) **Pub. No.: US 2016/0087334 A1**(43) **Pub. Date: Mar. 24, 2016**(54) **ANTENNA, ANTENNA DEVICE, AND
WIRELESS DEVICE****Publication Classification**(71) Applicant: **Asahi Glass Company, Limited,**
Chiyoda-ku (JP)(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 9/06 (2006.01)(72) Inventors: **Toshiki SAYAMA**, Chiyoda-ku (JP);
Ryuta SONODA, Chiyoda-ku (JP); **Koji
IKAWA**, Chiyoda-ku (JP)(52) **U.S. Cl.**
CPC . **H01Q 1/50** (2013.01); **H01Q 9/065** (2013.01)(73) Assignee: **Asahi Glass Company, Limited,**
Chiyoda-ku (JP)(57) **ABSTRACT**(21) Appl. No.: **14/960,967**(22) Filed: **Dec. 7, 2015****Related U.S. Application Data**(63) Continuation of application No. PCT/JP2014/066334,
filed on Jun. 19, 2014.(30) **Foreign Application Priority Data**

Jun. 21, 2013 (JP) 2013-131195

An antenna includes a feeding element connected to a feeding point, a first radiating element that is spaced apart from the feeding element and is coupled to the feeding element through electromagnetic field coupling, a second radiating element that is spaced apart from the feeding element and is coupled to the feeding element through electromagnetic field coupling, a first control element that is connected to the feeding element via a first impedance variable unit, and a second control element that is connected to the feeding element via a second impedance variable unit, and a control unit that controls the first impedance variable unit to adjust the connection between the feeding element and the first control element and controls the second impedance variable unit to adjust the connection between the feeding element and the second control element.





US 20160087340A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0087340 A1**

(43) **Pub. Date: Mar. 24, 2016**

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

Publication Classification

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

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

(72) Inventors: **Yen-Jung TSENG**, New Taipei (TW);
Yi-Ting CHEN, New Taipei (TW);
Cho-Kang HSU, New Taipei (TW)

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

(21) Appl. No.: **14/584,900**

(22) Filed: **Dec. 29, 2014**

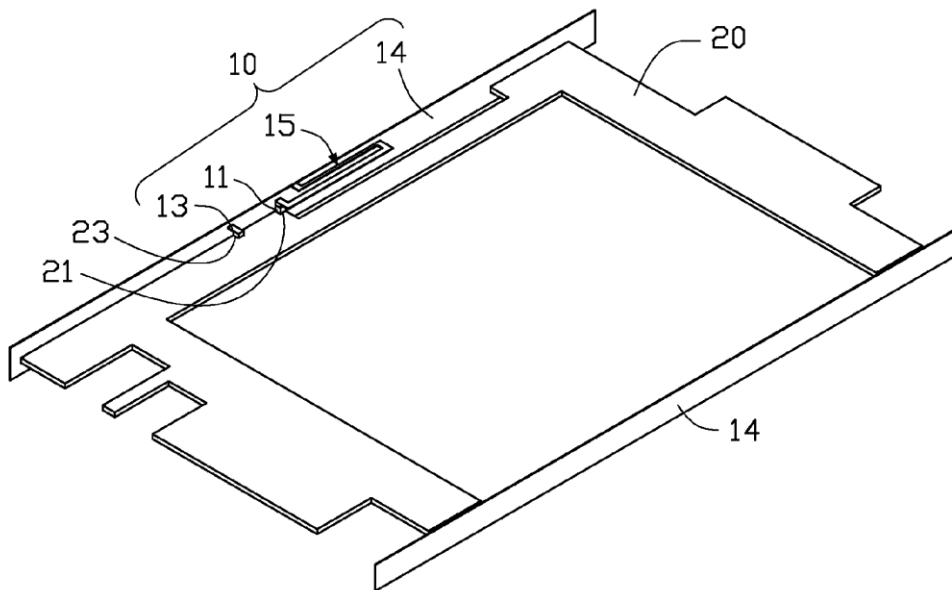
(30) **Foreign Application Priority Data**

Sep. 19, 2014 (CN) 201410480631.8

(57) **ABSTRACT**

An antenna structure includes a feed portion, a ground portion, at least one metallic portion, and a radiating portion. The ground portion is spaced apart from the feed portion. The least one metallic portion is electrically connected to the ground portion. The radiating portion has a first end electrically connected to the feed portion and a second end electrically connected to the at least one metallic portion.

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US 20160087667A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0087667 A1**

(43) **Pub. Date: Mar. 24, 2016**

(54) **WIRELESS COMMUNICATIONS DEVICE**

Publication Classification

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

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

(72) Inventors: **Yuanpeng Li**, Beijing (CN); **Yafang Yu**, Beijing (CN); **Meng Hou**, Shanghai (CN)

(52) **U.S. Cl.**
CPC **H04B 1/3838** (2013.01)

(21) Appl. No.: **14/961,397**

(22) Filed: **Dec. 7, 2015**

Related U.S. Application Data

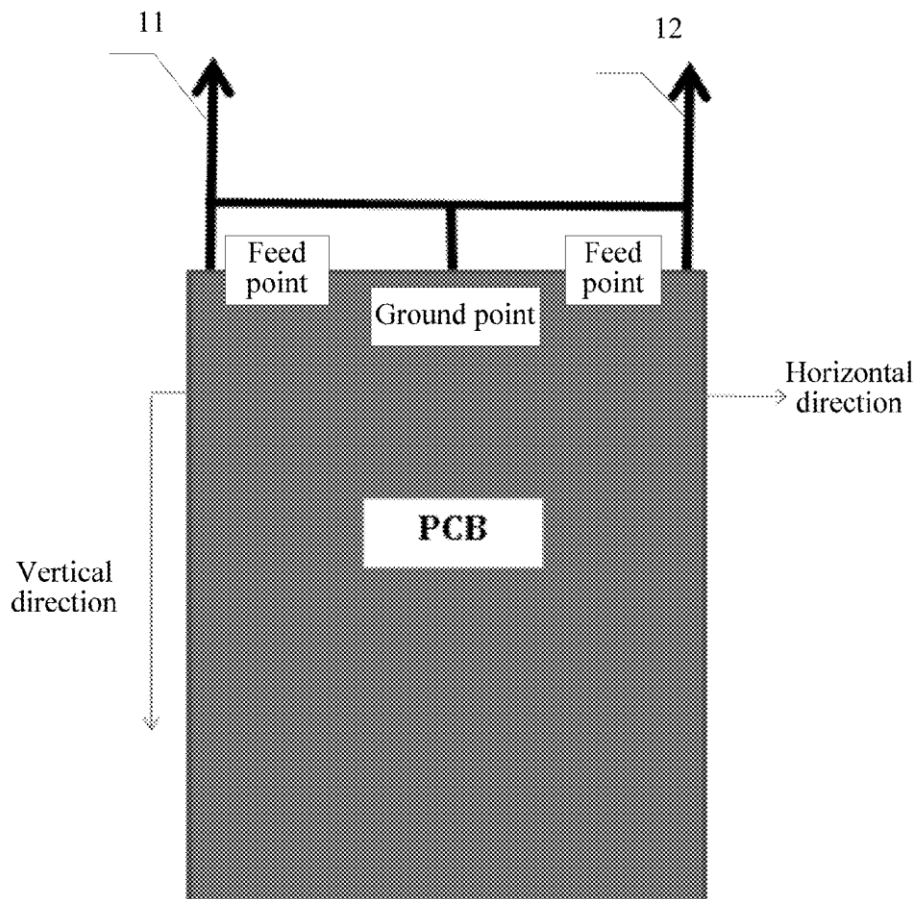
(63) Continuation of application No. PCT/CN2014/083788, filed on Aug. 6, 2014.

(30) **Foreign Application Priority Data**

Aug. 6, 2013 (CN) 201310339216.6

(57) **ABSTRACT**

A wireless communications device is provided. A first antenna and a second antenna are disposed on the wireless communications device, where an electrical length of the first antenna is N times an electrical length of the second antenna, where N is an integer greater than or equal to 1. The first antenna and the second antenna are disposed on a printed circuit board by means of common ground connection, that is, ground points of the first antenna and the second antenna are a same ground point, which reduces input impedance at the ground point of the first antenna and the second antenna, so that energy fed from the antennas is evenly distributed in a horizontal direction and a vertical direction of the printed circuit board.





US 20160088130A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0088130 A1**

(43) **Pub. Date: Mar. 24, 2016**

(54) **MOBILE TERMINAL EQUIPPED WITH AN
ANTENNA TRANSMITTING AND
RECEIVING WIRELESS COMMUNICATION**

Publication Classification

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

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

(72) Inventors: **Byungwoon JUNG**, Seoul (KR);
Jaewoo LEE, Seoul (KR); **Sungjung
RHO**, Seoul (KR); **Changwon YUN**,
Seoul (KR); **Dacyong KWAK**, Seoul
(KR); **Sungjoon HONG**, Seoul (KR)

(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01)

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

(57) **ABSTRACT**

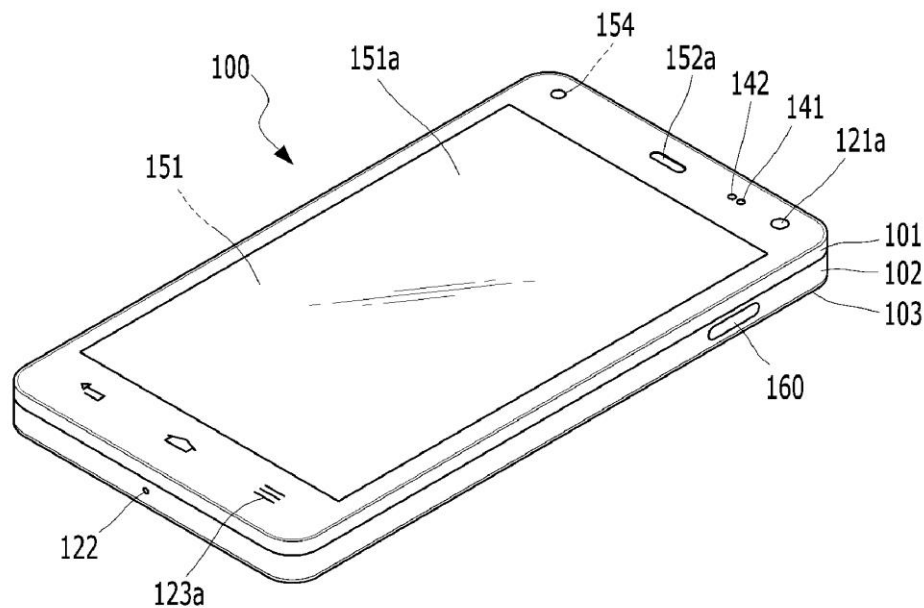
(21) Appl. No.: **14/693,539**

According to the present invention, a mobile terminal includes a main body including a front side with which a display unit is combined, a first antenna mounted on the main body, extended in a first direction and including a first slot of which one end is closed and another end is opened, a second antenna mounted on the main body, extended in a second direction corresponding to a direction opposite to the direction to which the first slot is extended and including a second slot of which one end is closed and another end is opened, a power supply unit mounted in the inside of the main body, a first feeder configured to supply power to the first antenna from the power supply unit and a second feeder configured to supply power to the second antenna from the power supply unit.

(22) Filed: **Apr. 22, 2015**

(30) **Foreign Application Priority Data**

Sep. 19, 2014 (KR) 10-2014-0125062





US 20160093943A1

(19) **United States**

(12) **Patent Application Publication**

Yang et al.

(10) **Pub. No.: US 2016/0093943 A1**

(43) **Pub. Date: Mar. 31, 2016**

(54) **ANTENNA INTEGRATED INTO A TOUCH SENSOR OF A TOUCHSCREEN DISPLAY**

(71) Applicant: **Intel Corporation**, Santa Clara, CA (US)

(72) Inventors: **Songnan Yang**, San Jose, CA (US);
Xintian E. Lin, Palo Alto, CA (US);
Quanjie Forest Zhuang, Shanghai (CN);
Ulun Karacaoglu, San Diego, CA (US)

(21) Appl. No.: **14/877,231**

(22) Filed: **Oct. 7, 2015**

Related U.S. Application Data

(63) Continuation of application No. 12/975,952, filed on Dec. 22, 2010, now Pat. No. 9,184,502.

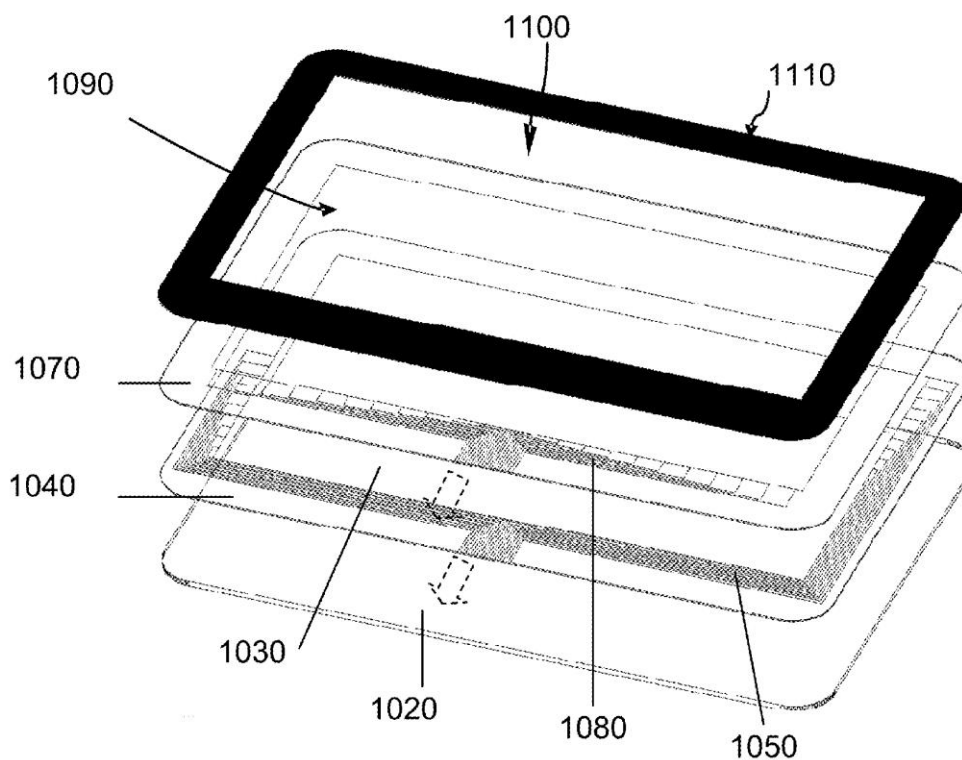
Publication Classification

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

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

(57) **ABSTRACT**

A touch sensor with a transparent conductive layer and a metalized border area at least partially bordering the transparent conductive layer and forming a far-field antenna.





US 2016009394A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0093949 A1**

(43) **Pub. Date: Mar. 31, 2016**

(54) **ANTENNA SYSTEM**

Publication Classification

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

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

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

(52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 1/526** (2013.01)

(21) Appl. No.: **14/574,677**

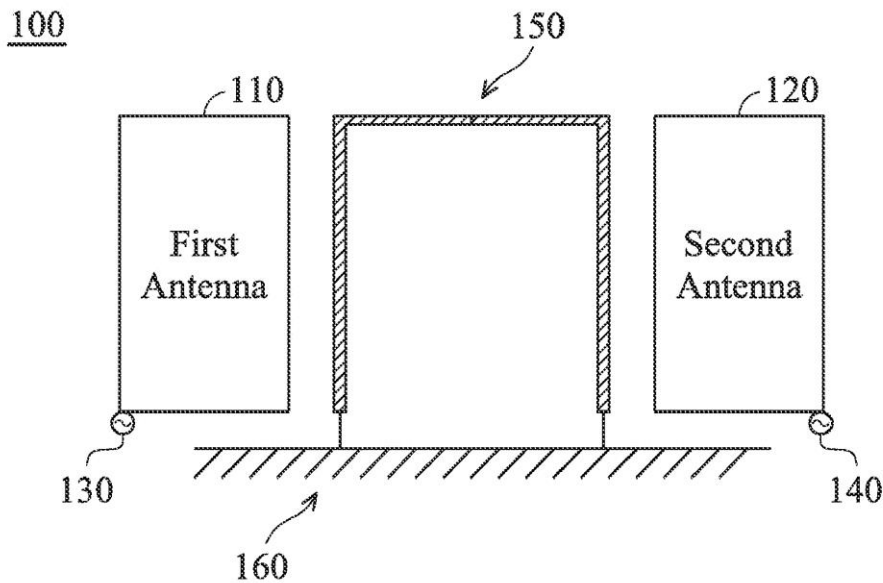
(22) Filed: **Dec. 18, 2014**

(30) **Foreign Application Priority Data**

Sep. 26, 2014 (TW) 103133446

(57) **ABSTRACT**

An antenna system includes a first antenna, a second antenna, and a bridge element. The first antenna is excited by a first signal source. The second antenna is excited by a second signal source. The bridge element is disposed between the first antenna and the second antenna. Both ends of the bridge element are coupled to a ground region.

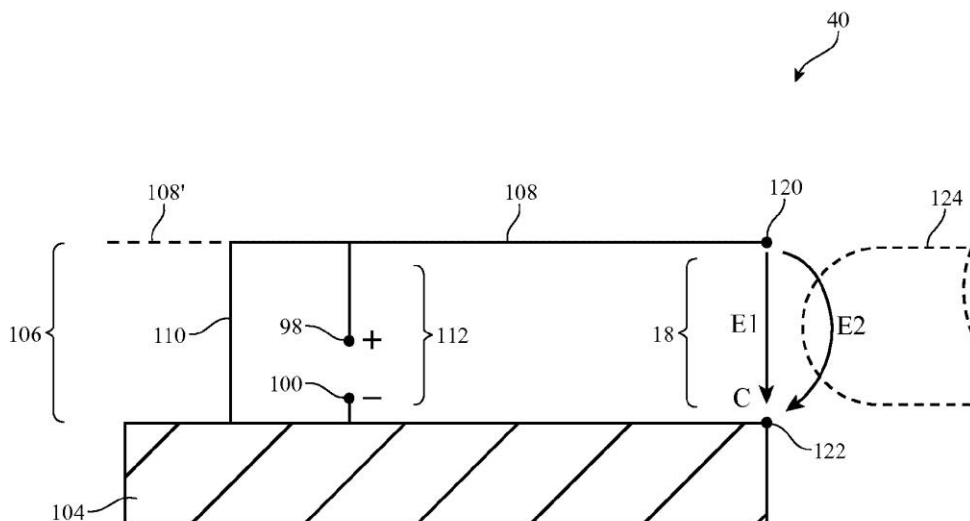




US 20160093955A1

(19) **United States**(12) **Patent Application Publication****Ayala Vazquez et al.**(10) **Pub. No.: US 2016/0093955 A1**(43) **Pub. Date: Mar. 31, 2016**(54) **ELECTRONIC DEVICE WITH PASSIVE
ANTENNA RETUNING CIRCUITRY****Publication Classification**(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)(72) Inventors: **Enrique Ayala Vazquez**, Watsonville, CA (US); **Mattia Pascolini**, San Francisco, CA (US); **Hongfei Hu**, Santa Clara, CA (US); **Erdinc Irci**, Santa Clara, CA (US); **Yuehui Ouyang**, Sunnyvale, CA (US); **Jennifer M. Edwards**, San Francisco, CA (US); **Jayesh Nath**, Milpitas, CA (US); **Salih Yarga**, Sunnyvale, CA (US); **Yijun Zhou**, Sunnyvale, CA (US); **Hao Xu**, Cupertino, CA (US)(52) **U.S. Cl.**
CPC **H01Q 9/0442** (2013.01); **H01Q 1/243** (2013.01)(57) **ABSTRACT**

An electronic device may have wireless circuitry with antennas. An antenna may have an inverted-F antenna resonating element, an antenna ground, and other resonating element structures. A tip of the antenna resonating element and the antenna ground may be separated by a peripheral housing gap filled with plastic. The antenna may be sensitive to capacitance changes induced by the presence of a user's hand overlapping the gap or other portions of the antenna. A hand capacitance sensing electrode may be mounted in the plastic of the gap or elsewhere in the vicinity of the antenna. A transmission line may couple the hand capacitance sensing electrode to the antenna to retune the antenna in the event that the user's hand overlaps the antenna.

(21) Appl. No.: **14/500,819**(22) Filed: **Sep. 29, 2014**



US 20160094695A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0094695 A1**

(43) **Pub. Date: Mar. 31, 2016**

(54) **WIRELESS COMMUNICATION DEVICE**

H04M 1/60 (2006.01)

H04L 25/08 (2006.01)

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

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

CPC **H04M 1/0277** (2013.01); **H04L 25/08** (2013.01); **H04W 88/06** (2013.01); **H04M 1/6058** (2013.01)

(72) Inventors: **WEI-CHENG SU**, New Taipei (TW);
YEN-HUI LIN, Tu-Cheng (TW)

(21) Appl. No.: **14/573,938**

(22) Filed: **Dec. 17, 2014**

(30) **Foreign Application Priority Data**

Sep. 30, 2014 (CN) 201410517885.2

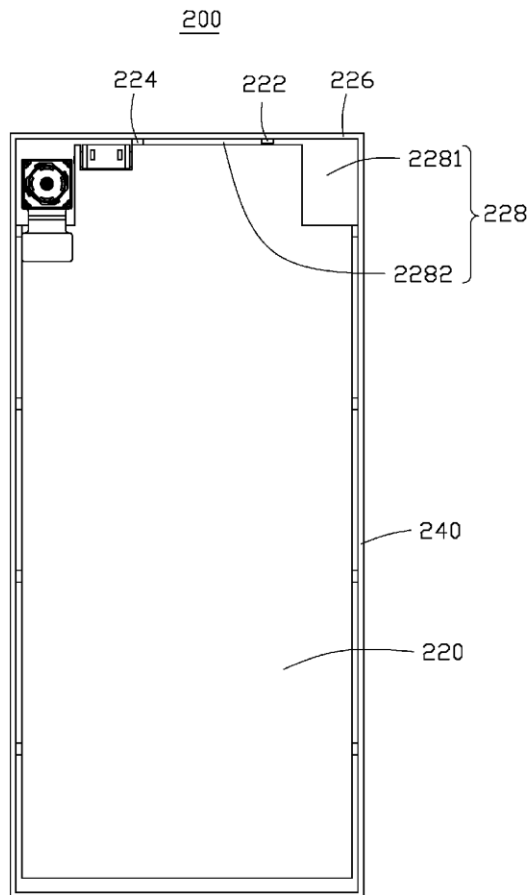
Publication Classification

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H04W 88/06 (2006.01)

(57)

ABSTRACT

A wireless communication device includes a circuit board, a metal frame, and a slot antenna. The circuit board includes a multiple bandpass filter, a plurality of matching circuits, and a plurality of Radio Frequency (RF) modules. The metal frame surrounds the circuit board. The slot antenna includes a feeding portion, at least one grounding portion, and a radiating portion. The feeding portion and the at least one grounding portion are connected between the circuit board and the metal frame, the radiating portion and the circuit board enclose a slot. The radiating portion is formed on a portion of the metal frame. The slot antenna, the multiple bandpass filter, the plurality of matching circuits, and the plurality of RF modules are electrically connected in that order.





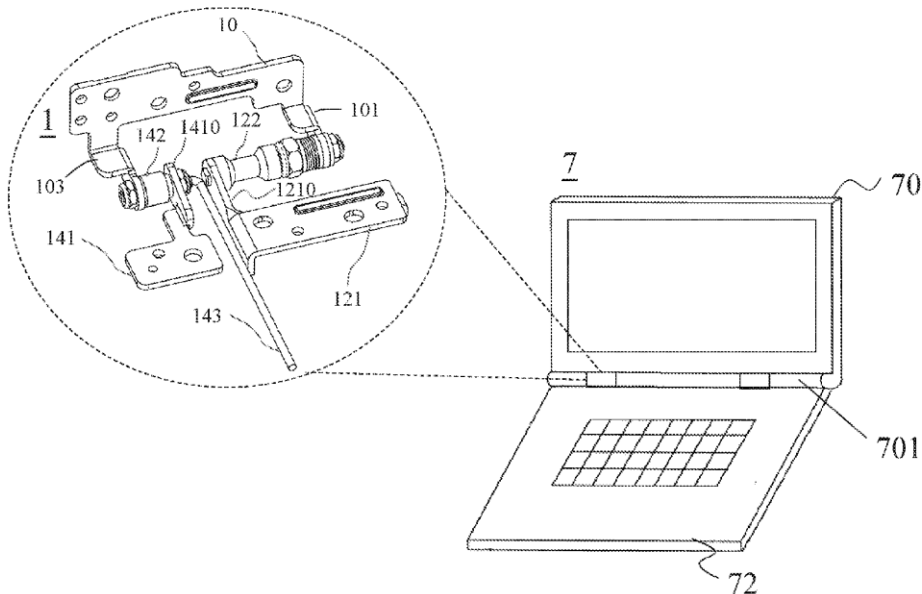
US 20160099495A1

(19) **United States**(12) **Patent Application Publication**
Chiu et al.(10) **Pub. No.: US 2016/0099495 A1**(43) **Pub. Date: Apr. 7, 2016**(54) **INTEGRATED ANTENNA WITH THE DEVICE
HOUSING****Publication Classification**(71) Applicant: **ADVANCED-CONNTEK INC.**, New
Taipei City (TW)(51) **Int. Cl.**
H01Q 1/24 (2006.01)(72) Inventors: **Tsung-Wen Chiu**, New Taipei City
(TW); **Fu-Ren Hsiao**, New Taipei City
(TW); **Chih-Fan Chen**, New Taipei City
(TW); **Pei-Feng Wu**, New Taipei City
(TW)(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01)(57) **ABSTRACT**

A hinge antenna comprises a major conductor, a first rotating element and a second rotating element. The stretching arms on both sides of the major conductor are assembled to the first rotating element and the second rotating element, respectively. The first rotating element further comprises a torque device and a first vice conductor, and the second rotating element further comprises a signal feeding line, a connection device, and a second vice conductor. The signal feeding line is electrically connected to the connection device and the second vice conductor, by which a high frequency signal can be passed to the major conductor, and then passed to the torque device on the other side and the first vice conductor. The aforementioned configuration is utilized to form an antenna loop. In addition, the configuration of this antenna can be applied to a foldable electronic device.

(21) Appl. No.: **14/965,013**(22) Filed: **Dec. 10, 2015****Related U.S. Application Data**(62) Division of application No. 14/143,731, filed on Dec.
30, 2013, now Pat. No. 9,252,480.(30) **Foreign Application Priority Data**

Oct. 14, 2013 (TW) 102137034

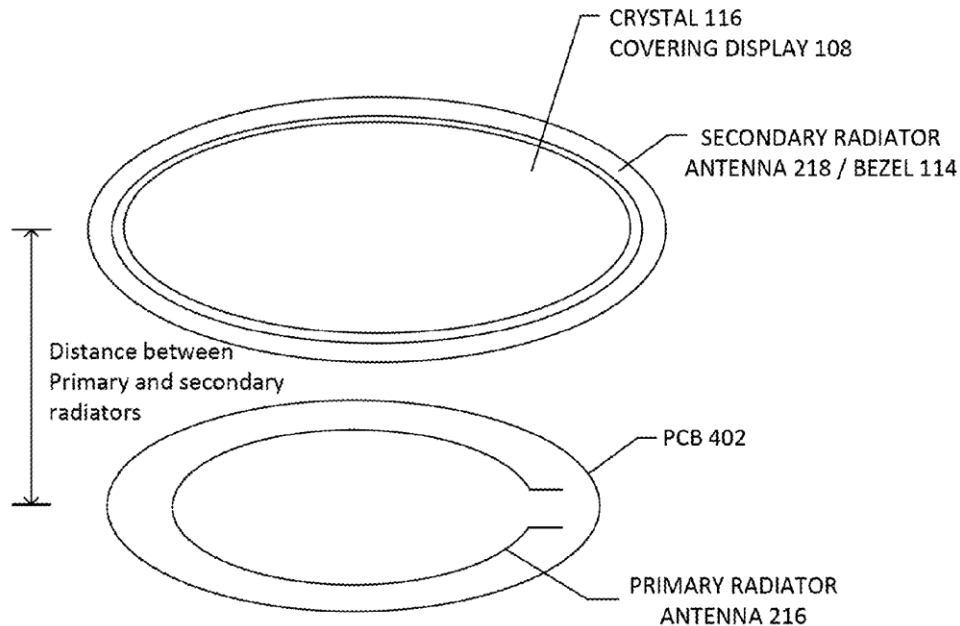




US 20160099497A1

(19) **United States**(12) **Patent Application Publication**
Lee(10) **Pub. No.: US 2016/0099497 A1**(43) **Pub. Date: Apr. 7, 2016**(54) **USER-WEARABLE DEVICES WITH
PRIMARY AND SECONDARY RADIATOR
ANTENNAS**(52) **U.S. Cl.**
CPC *H01Q 1/273* (2013.01); *H01Q 1/243*
(2013.01); *H01Q 25/00* (2013.01)(71) Applicant: **Salutron, Inc.**, Fremont, CA (US)(72) Inventor: **Yong Jin Lee**, Seoul (KR)(73) Assignee: **Salutron, Inc.**, Fremont, CA (US)(21) Appl. No.: **14/661,758**(22) Filed: **Mar. 18, 2015****Related U.S. Application Data**(60) Provisional application No. 62/058,489, filed on Oct.
1, 2014.**Publication Classification**(51) **Int. Cl.**
H01Q 1/27 (2006.01)
H01Q 25/00 (2006.01)
H01Q 1/24 (2006.01)(57) **ABSTRACT**

A user-wearable device include a wireless transceiver, a primary radiator antenna and a secondary radiator antenna. The primary radiator antenna produces a first radio frequency (RF) radiation pattern when driven by the wireless transceiver, wherein the first RF radiation pattern is at least partially circularly polarized. The secondary radiator antenna, which is spaced apart from the primary radiator antenna, is configured to modify the first RF radiation pattern produced by the primary radiator antenna to thereby produce a second RF radiation pattern having increased RF radiation in a specific direction (e.g., away from the user's/wearer's skin) compared to the first RF radiation pattern. Inclusion of both the primary radiator antenna and the secondary radiator antenna increases an overall antenna efficiency (e.g., by about 3 dB) in the specific direction compared to if only the primary radiator antenna was included.





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(19) **United States**

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

(10) **Pub. No.: US 2016/0099501 A1**

(43) **Pub. Date: Apr. 7, 2016**

(54) **ANTENNA AND METHOD FOR STEERING
ANTENNA BEAM DIRECTION FOR WIFI
APPLICATIONS**

continuation of application No. 13/029,564, filed on
Feb. 17, 2011, now Pat. No. 8,362,962, which is a
continuation of application No. 12/043,090, filed on
Mar. 5, 2008, now Pat. No. 7,911,402.

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

Publication Classification

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

(51) **Int. Cl.**
H01Q 3/34 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 3/34** (2013.01)

(73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)

(21) Appl. No.: **14/965,881**

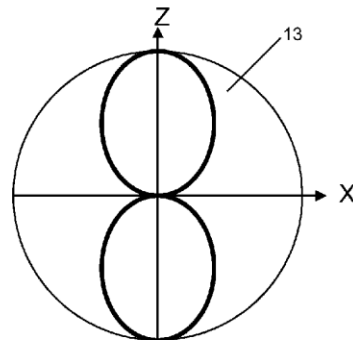
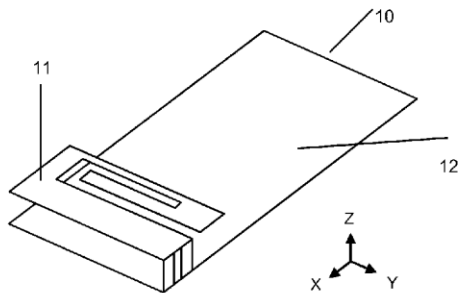
(57) **ABSTRACT**

(22) Filed: **Dec. 10, 2015**

An antenna comprising an IMD element and one or more
parasitic and active tuning elements is disclosed. The IMD
element, when used in combination with the active tuning and
parasitic elements, allows antenna operation at multiple reso-
nant frequencies. In addition, the direction of antenna radia-
tion pattern may be arbitrarily rotated in accordance with the
parasitic and active tuning elements. Unique antenna archi-
tectures for beam steering in Wi-Fi band applications is fur-
ther described.

Related U.S. Application Data

(63) Continuation-in-part of application No. 14/144,461,
filed on Dec. 30, 2013, now Pat. No. 9,240,634, which
is a continuation of application No. 13/726,477, filed
on Dec. 24, 2012, now Pat. No. 8,648,755, which is a





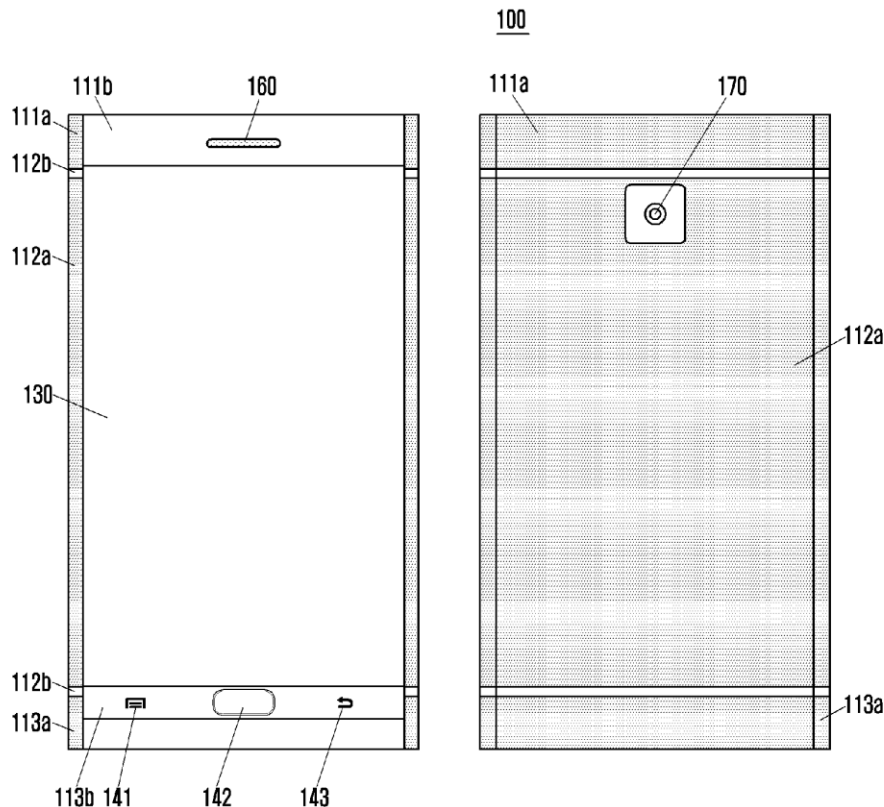
US 20160104930A1

(19) **United States**(12) **Patent Application Publication****LEE et al.**(10) **Pub. No.: US 2016/0104930 A1**(43) **Pub. Date: Apr. 14, 2016**(54) **ELECTRONIC DEVICE AND ANTENNA
DEVICE THEREOF****Publication Classification**(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)(51) **Int. Cl.**
H01Q 1/24 (2006.01)(72) Inventors: **Woosup LEE**, Gyeonggi-do (KR);
Yeonwoo KIM, Gyeonggi-do (KR);
Jungsik PARK, Gyeonggi-do (KR);
Seunggil JEON, Gyeonggi-do (KR);
Juseok NOH, Gyeonggi-do (KR);
Jaebong CHUN, Gyeonggi-do (KR);
Hyunju HONG, Gyeonggi-do (KR)(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01)(57) **ABSTRACT**

An electronic device having a housing formed of a conductive material, and an antenna device thereof. The electronic device includes a housing provided with a plurality of housing modules, and a printed circuit board positioned inside the housing, and having an antenna power feeding unit electrically connected to the printed circuit board. The plurality of housing modules may be at least partially formed of a conductive material. At least one of the conductive materials of the plurality of housing modules may be electrically connected to the antenna power feeding unit of the printed circuit board so as to function as an antenna of the electronic device. Various embodiments may be made based on the technical idea of the present disclosure.

(21) Appl. No.: **14/873,595**(22) Filed: **Oct. 2, 2015**(30) **Foreign Application Priority Data**

Oct. 8, 2014 (KR) 10-2014-0135898





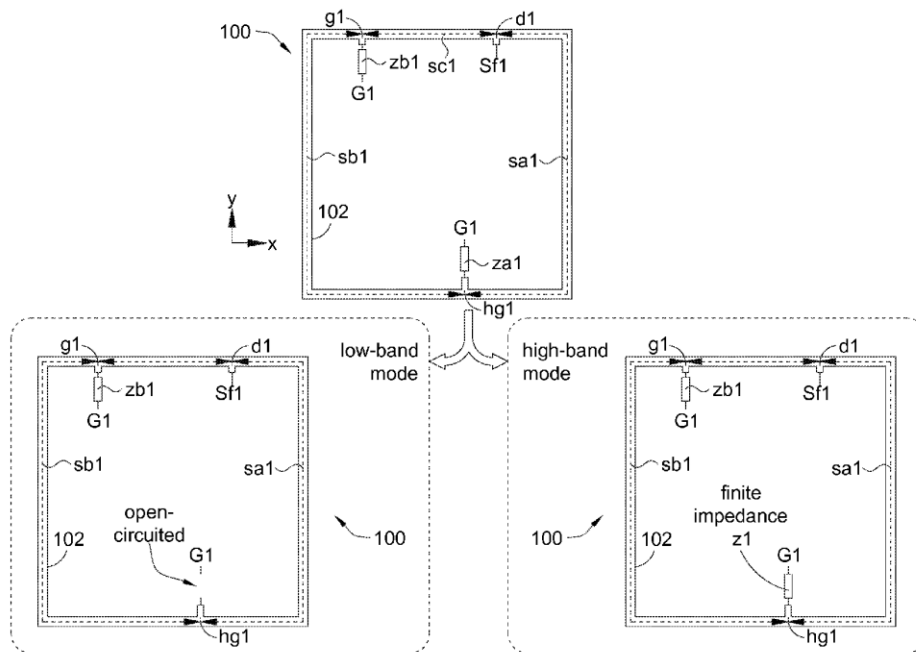
US 20160104935A1

(19) **United States**(12) **Patent Application Publication**
HUNG(10) **Pub. No.: US 2016/0104935 A1**(43) **Pub. Date: Apr. 14, 2016**(54) **ANTENNA STRUCTURE**(71) Applicant: **MEDIATEK Inc.**, Hsin-Chu (TW)(72) Inventor: **CHUNG-YU HUNG**, Taipei City (TW)(21) Appl. No.: **14/705,151**(22) Filed: **May 6, 2015****Related U.S. Application Data**

(60) Provisional application No. 62/063,499, filed on Oct. 14, 2014.

Publication Classification(51) **Int. Cl.**
H01Q 5/371 (2006.01)
H01Q 7/00 (2006.01)
H01Q 1/48 (2006.01)(52) **U.S. Cl.**CPC **H01Q 5/371** (2015.01); **H01Q 1/48**
(2013.01); **H01Q 7/00** (2013.01)(57) **ABSTRACT**

The present disclosure provides an antenna structure, including a feed terminal, an intermediate grounding terminal, a tail grounding terminal, a conductive head section and a conductive intermediate section. The feed terminal is for connecting a feed signal. The intermediate grounding terminal is responsible for conducting to a ground plane via an intermediate impedance during a second operation mode, and ceasing conducting via the intermediate impedance during a first operation mode. The tail grounding terminal is for connecting the ground plane. The head section extends from the feed terminal to the intermediate grounding terminal along a loop. The intermediate section extends from the intermediate grounding terminal to the tail grounding terminal along the loop.





US 20160104938A1

(19) **United States**(12) **Patent Application Publication**
HSU(10) **Pub. No.: US 2016/0104938 A1**(43) **Pub. Date: Apr. 14, 2016**(54) **SLOT ANTENNA**(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)(72) Inventor: **CHO-KANG HSU**, New Taipei (TW)(21) Appl. No.: **14/585,375**(22) Filed: **Dec. 30, 2014**(30) **Foreign Application Priority Data**

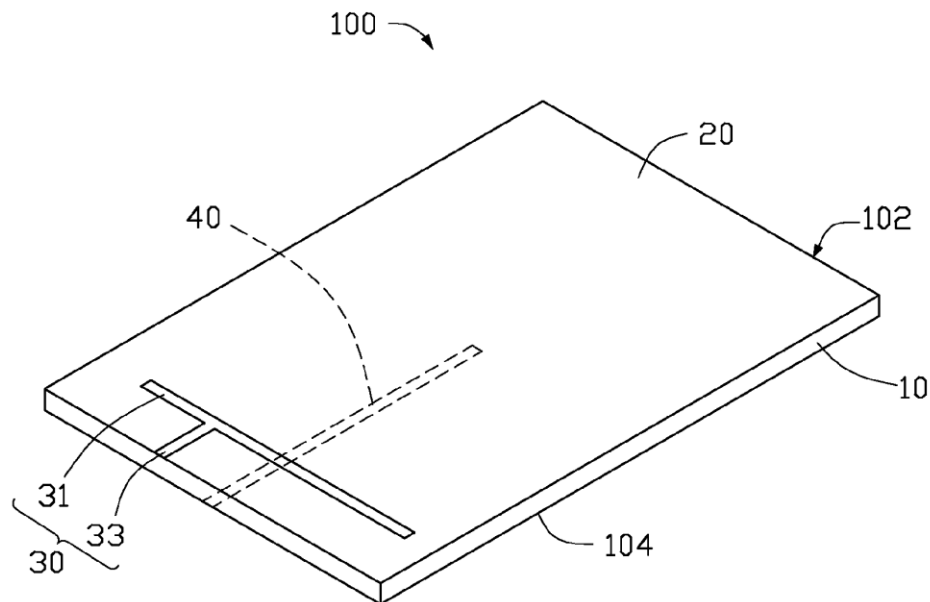
Oct. 13, 2014 (CN) 201410537600.1

Publication Classification(51) **Int. Cl.**
H01Q 13/10 (2006.01)(52) **U.S. Cl.**CPC **H01Q 13/106** (2013.01)

(57)

ABSTRACT

A slot antenna includes a dielectric substrate, a conductive layer, a slot and a feeding strip. The dielectric substrate includes a first surface and a second surface opposite the first surface. The conductive layer is positioned on the first surface of the dielectric substrate, and is configured to electronically couple to ground. The slot is defined in the conductive layer and terminates on an edge of the conductive layer. The feeding strip is positioned on the second surface of the dielectric substrate and extends across the slot. The feeding strip is configured to feed current signal and resonate with the conductive layer.

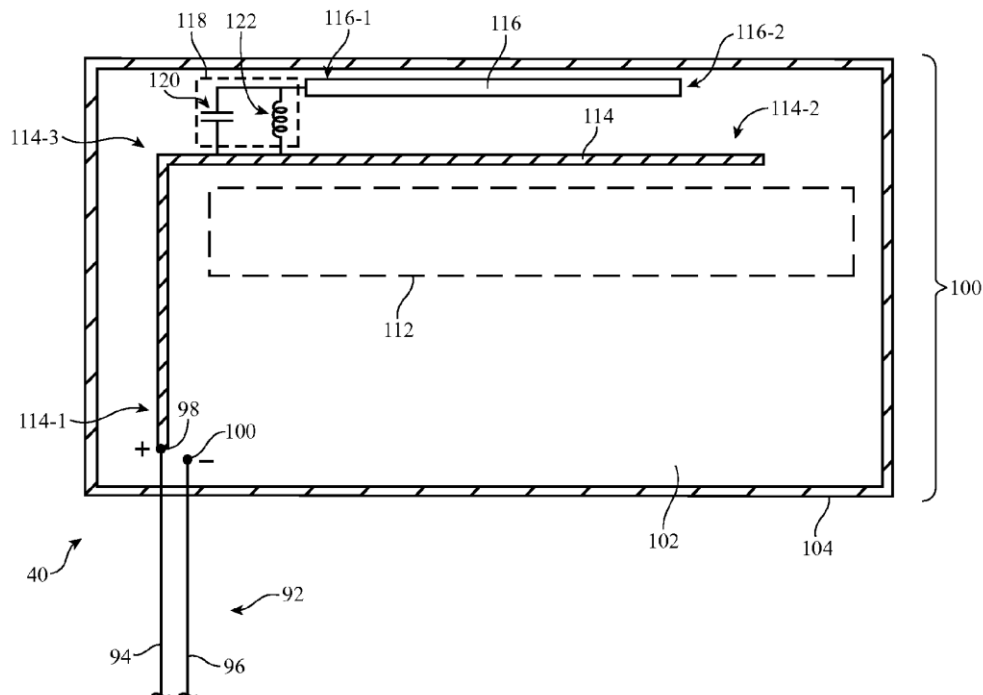




US 20160104944A1

(19) **United States**(12) **Patent Application Publication**
Rajagopalan et al.(10) **Pub. No.: US 2016/0104944 A1**(43) **Pub. Date: Apr. 14, 2016**(54) **ELECTRONIC DEVICE CAVITY ANTENNAS
WITH SLOTS AND MONOPOLES**(52) **U.S. Cl.**CPC **H01Q 21/005** (2013.01); **H01Q 13/18**
(2013.01); **H01Q 9/045** (2013.01)(71) Applicant: **Apple Inc.**, Cupertino, CA (US)(72) Inventors: **Harish Rajagopalan**, San Jose, CA
(US); **Huan-Chu Huang**, Taoyuan
County (TW); **Ke Sun**, Beijing (CN);
Qingxiang Li, Mountain View, CA (US);
Robert W. Schlub, Cupertino, CA (US);
Rodney A. Gomez Angulo, Sunnyvale,
CA (US); **Umar Azad**, San Jose, CA
(US)(57) **ABSTRACT**

An electronic device may be provided with wireless circuitry. The wireless circuitry may include cavity antennas. A cavity antenna may be formed from a metal antenna cavity and resonating element structures. The metal antenna cavity may be formed from metal traces on a dielectric carrier. The resonating element structures may include directly fed and indirectly fed slot antenna resonating elements and monopole antenna resonating elements. The metal antenna cavity may exhibit a resonance that is tuned using a transmission line tuning stub. Filters and duplexer circuits may be used in routing signals at different frequency bands among the antenna resonating elements.

(21) Appl. No.: **14/510,724**(22) Filed: **Oct. 9, 2014****Publication Classification**(51) **Int. Cl.****H01Q 21/00** (2006.01)**H01Q 9/04** (2006.01)**H01Q 13/18** (2006.01)



US 20160104945A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0104945 A1**

(43) **Pub. Date: Apr. 14, 2016**

(54) **ANTENNA SYSTEM AND TERMINAL**

Publication Classification

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

(51) **Int. Cl.**
H01Q 21/00 (2006.01)

(72) Inventors: **Hongyu Wang**, Shenzhen (CN);
Shuwen Lv, Shanghai (CN); **Huimin Zhang**, Shenzhen (CN); **Bin Wu**, Shenzhen (CN)

(52) **U.S. Cl.**
CPC **H01Q 21/0006** (2013.01)

(57) **ABSTRACT**

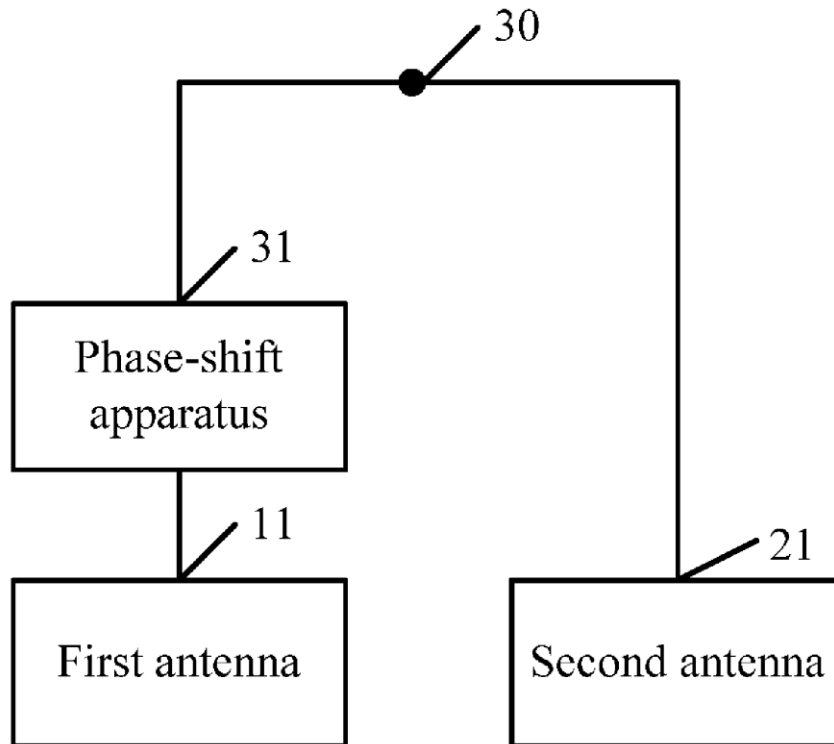
(21) Appl. No.: **14/973,016**

(22) Filed: **Dec. 17, 2015**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2014/075941, filed on Apr. 22, 2014.

An antenna system includes a first antenna and a second antenna, where the first antenna and the second antenna are connected in parallel to an antenna feeding point, and a phase-shift apparatus is connected in series between the first antenna or the second antenna and the antenna feeding point, so that an imaginary part of impedance at the antenna feeding point is canceled out near a central frequency channel number. The antenna system provides an expansion in radio frequency bandwidth in free space and an increase in average efficiency.

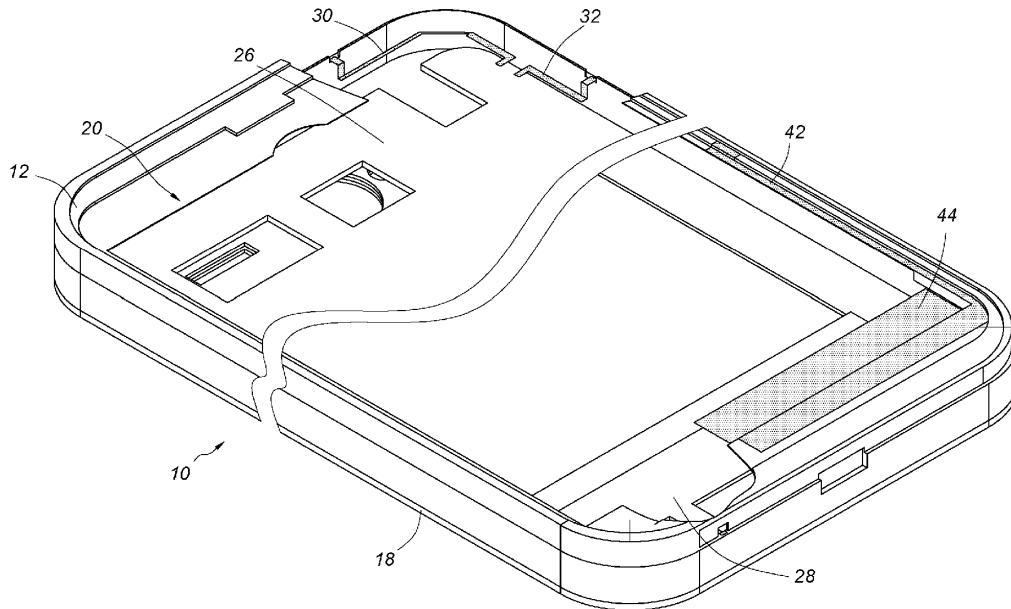




US 20160111771A1

(19) **United States**(12) **Patent Application Publication**
Su et al.(10) **Pub. No.: US 2016/0111771 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **COMMUNICATION DEVICE AND ANTENNA
THEREOF**(52) **U.S. Cl.**CPC **H01Q 1/243** (2013.01)(71) Applicant: **KING SLIDE TECHNOLOGY CO.,
LTD.**, Kaohsiung City (TW)(57) **ABSTRACT**(72) Inventors: **Hsin-Cheng Su**, Kaohsiung City (TW);
Chun-Ta Liu, Kaohsiung City (TW);
Shu-Chen Lin, Kaohsiung City (TW)

An antenna of a communication device includes a metal frame, a metal back cover and a printed circuit board. The printed circuit board includes a first circuit block and a second circuit block electrically connected to the first circuit block. A first conductor is connected between a first part of the metal frame and a signal terminal of the first circuit block. A second conductor is connected between a second part of the metal frame and a ground terminal of the first circuit block. A third conductor is connected to a third part of the metal frame. A fourth conductor is connected to a ground terminal of the second circuit block, and at least one coupling gap is defined between the third conductor and the fourth conductor. A signal terminal of the second circuit block is electrically connected to a fourth part of the metal frame.

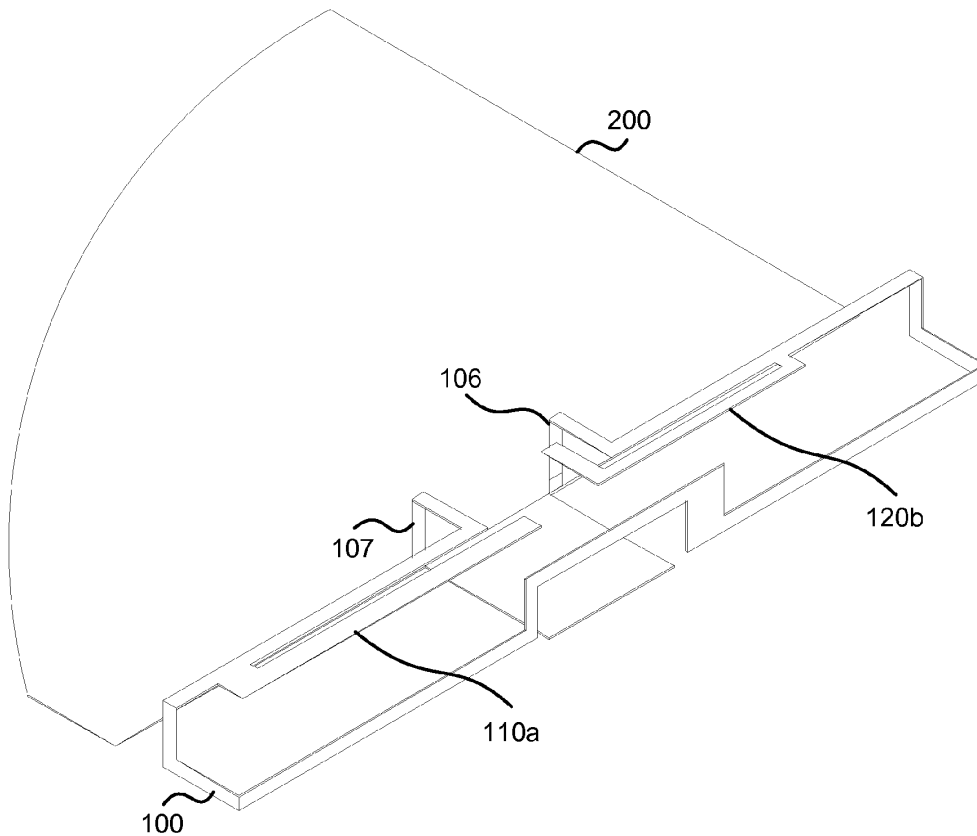
(21) Appl. No.: **14/515,494**(22) Filed: **Oct. 15, 2014****Publication Classification**(51) **Int. Cl.**
H01Q 1/24 (2006.01)



US 2016011772A1

(19) **United States**(12) **Patent Application Publication**
Lilja(10) **Pub. No.: US 2016/011772 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **LOOP ANTENNA WITH A PARASITIC
ELEMENT INSIDE**(52) **U.S. CL.**
CPC . **H01Q 1/243** (2013.01); **H01Q 7/00** (2013.01)(71) Applicant: **Microsoft Corporation**, Redmond, WA
(US)(57) **ABSTRACT**(72) Inventor: **Juha Lilja**, Tampere (FI)(21) Appl. No.: **14/516,356**(22) Filed: **Oct. 16, 2014****Publication Classification**(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 7/00 (2006.01)

A loop antenna with a parasitic element inside is described. In an embodiment, the loop antenna comprises a loop element that has a feed contact and a ground contact. The loop antenna further comprises a first parasitic element that is arranged inside the loop element and that acts as a first slot radiator. A first end of the first parasitic element is physically connected to the loop element thereby forming a closed end of the first slot radiator. The first slot radiator further has an open end that is closer to the feed contact and the ground contact than its closed end.





US 2016011777A1

(19) **United States**(12) **Patent Application Publication**
YANG(10) **Pub. No.: US 2016/011777 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **MOBILE DEVICE**(71) Applicant: **Acer Incorporated**, New Taipei City
(TW)(72) Inventor: **Chung-Wen YANG**, New Taipei City
(TW)(21) Appl. No.: **14/614,433**(22) Filed: **Feb. 5, 2015**(30) **Foreign Application Priority Data**

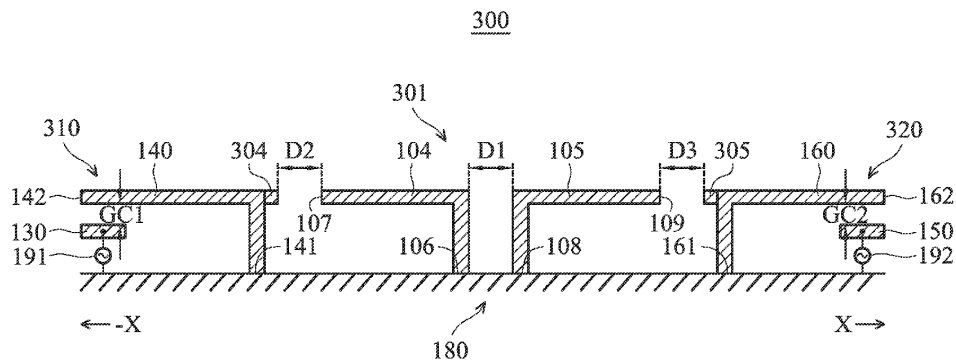
Oct. 15, 2014 (TW) 103135623

Publication Classification(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/50 (2006.01)**H01Q 9/04** (2006.01)**H01Q 21/28** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/521** (2013.01); **H01Q 21/28**
(2013.01); **H01Q 1/50** (2013.01); **H01Q 9/04**
(2013.01)

(57)

ABSTRACT

A mobile device at least includes an antenna system. The antenna system includes a first antenna, a second antenna, a first isolation element, and a second isolation element. The first antenna is excited by a first signal source. The second antenna is excited by a second signal source. A first end of the first isolation element is coupled to a ground region, and a second end of the first isolation element is open. A first end of the second isolation element is coupled to the ground region, and a second end of the second isolation element is open. The first isolation element and the second isolation element are both disposed between the first antenna and the second antenna, and are configured to enhance the isolation of the antenna system.





US 20160111778A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0111778 A1**

(43) **Pub. Date: Apr. 21, 2016**

(54) **MULTIPLE-INPUT MULTIPLE-OUTPUT
ANTENNA SYSTEM AND APPARATUS**

H01Q 21/28 (2006.01)

H01Q 1/12 (2006.01)

(71) Applicant: **VERTU CORPORATION LIMITED**,
Fleet, Hampshire (GB)

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

CPC *H01Q 1/521* (2013.01); *H01Q 1/12*
(2013.01); *H01Q 1/526* (2013.01); *H01Q 21/30*
(2013.01); *H01Q 21/28* (2013.01)

(72) Inventors: **Dawei Zhou**, Woking (GB); **Andy
Hannigan**, Thatcham (GB); **Zidong Liu**,
Poole (GB)

(57)

ABSTRACT

(21) Appl. No.: **14/781,679**

(22) PCT Filed: **Apr. 2, 2013**

(86) PCT No.: **PCT/EP2013/056866**

§ 371 (c)(1),

(2) Date: **Dec. 2, 2015**

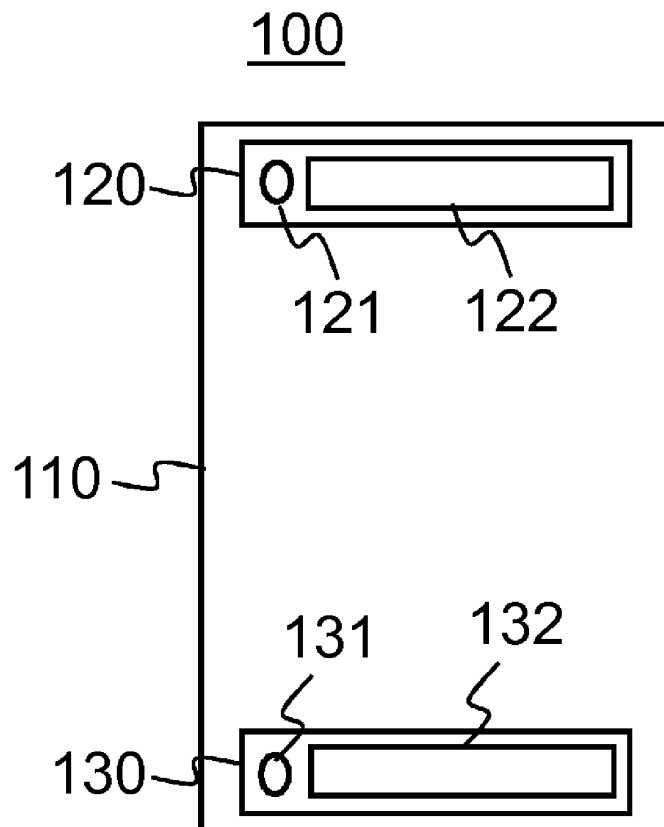
Publication Classification

(51) **Int. Cl.**

H01Q 1/52 (2006.01)

H01Q 21/30 (2006.01)

A multiple-input multiple-output (MIMO) antenna system includes a first elongated antenna connected to a first feed point, comprising a radiator configured to resonate in at least one frequency band; a second elongated antenna connected to a second feed point, comprising a radiator configured to resonate in at least one frequency band; a support element, where to the first and the second elongated antenna being attached parallel with a first distance. The antenna system further includes an elongated conductive element connected to a ground and attached to the support element, the elongated conductive element configured to reduce coupling between the first and the second radiator.





US 20160111784A1

(19) **United States**

(12) **Patent Application Publication**
Caporal Del Barrio et al.

(10) **Pub. No.: US 2016/0111784 A1**

(43) **Pub. Date: Apr. 21, 2016**

(54) **TUNABLE MULTIPLE-RESONANCE
ANTENNA SYSTEMS, DEVICES, AND
METHODS FOR HANDSETS OPERATING IN
LOW LTE BANDS WITH WIDE DUPLEX
SPACING**

Publication Classification

(51) **Int. Cl.**
H01Q 5/314 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 5/314** (2015.01); **H01Q 9/0414**
(2013.01)

(71) Applicant: **WISPRY, INC.**, Irvine, CA (US)

(72) Inventors: **Samantha Caporal Del Barrio**, Aalborg
(DK); **Gert Frølund Pedersen**,
Storvorde (DK); **Arthur S. Morris, III**,
Raleigh, NC (US)

(21) Appl. No.: **14/885,779**

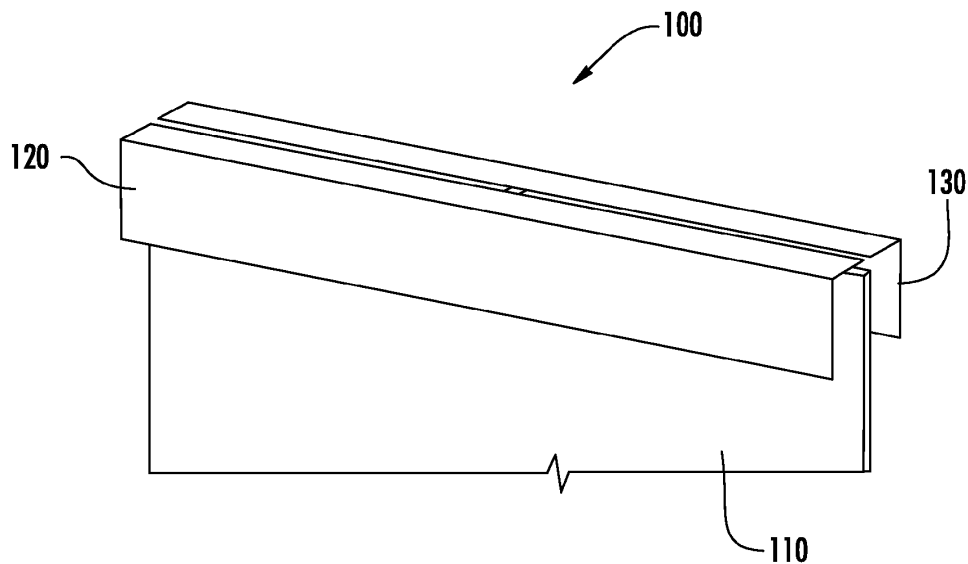
(22) Filed: **Oct. 16, 2015**

Related U.S. Application Data

(60) Provisional application No. 62/065,106, filed on Oct.
17, 2014.

ABSTRACT

The present subject matter relates to antenna systems, devices, and methods that provide efficient coverage of low frequency bands (e.g., 700 MHz-bands and 600 MHz-bands) for the new generations of mobile communication. For example, a dual-resonant radiating system can include a ground plane, a radiating coupler spaced apart from but in communication with the ground plane, and a ground plane extension in communication with the ground plane. In this arrangement, one or both of the radiating coupler and the ground plane extension are tunable to tune a dual-resonance frequency response.





US 20160111786A1

(19) **United States**

(12) **Patent Application Publication**
Lilja

(10) **Pub. No.: US 2016/0111786 A1**

(43) **Pub. Date: Apr. 21, 2016**

(54) **LOOP ANTENNA WITH A MAGNETICALLY
COUPLED ELEMENT**

Publication Classification

(71) Applicant: **Microsoft Corporation**, Redmond, WA
(US)

(51) **Int. Cl.**
H01Q 7/06 (2006.01)
H01Q 1/24 (2006.01)

(72) Inventor: **Juha Lilja**, Tampere (FI)

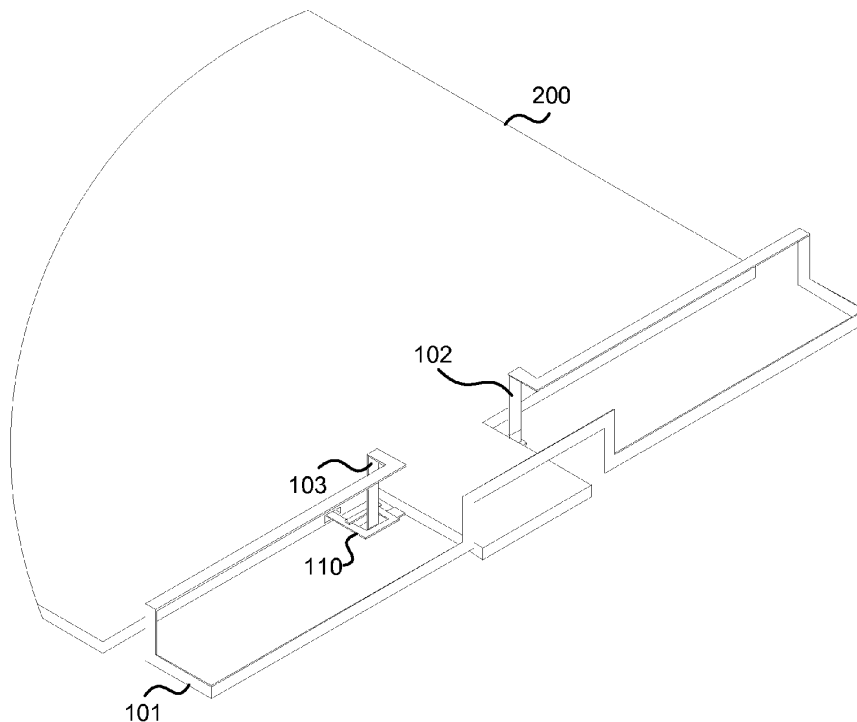
(52) **U.S. Cl.**
CPC . **H01Q 7/06** (2013.01); **H01Q 1/243** (2013.01)

(21) Appl. No.: **14/516,431**

(57) **ABSTRACT**

(22) Filed: **Oct. 16, 2014**

A loop antenna with a magnetically coupled element is described. In an embodiment, the loop antenna comprises a loop element that has a feed contact and a ground contact. The loop antenna further comprises an open ended conductor that is magnetically coupled around the ground contact.





US 20160111789A1

(19) **United States**(12) **Patent Application Publication**
CHANG et al.(10) **Pub. No.: US 2016/0111789 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **ANTENNA STRUCTURE AND ELECTRONIC
DEVICE HAVING SAME**(52) **U.S. Cl.**CPC **H01Q 9/0407** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 9/0442** (2013.01); **H01Q 1/48**
(2013.01)(71) Applicant: **Chiun Mai Communication Systems,
Inc., New Taipei (TW)**(72) Inventors: **TZE-HSUAN CHANG, New Taipei
(TW); CHO-KANG HSU, New Taipei
(TW)**

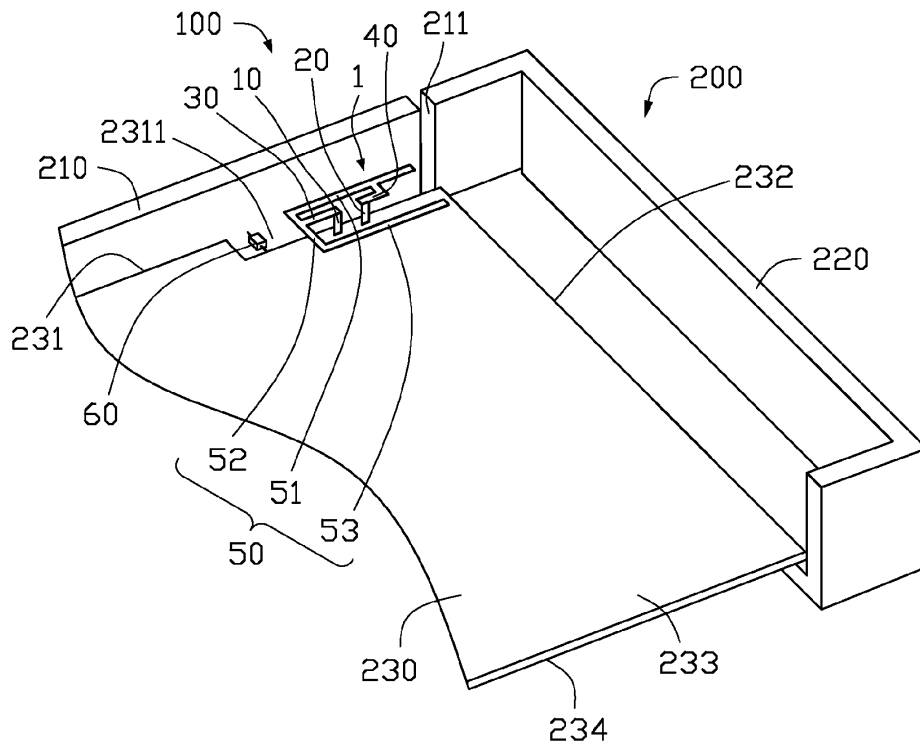
(57)

ABSTRACT

A dual-band Wi-Fi antenna structure includes a metallic middle frame of a casing of a handheld electronic device, a grounding plane received in the middle frame, an antenna body connected to the grounding plane, and an adjusting element. The grounding plane defines a rectangular recess in a corner thereof. The antenna body has a radiation patch having a part located over the recess. The adjusting element is located in the recess. An effective length of the recess is adjustable by adjusting a parameter of the adjusting element, which is a coefficient of self-inductance when the adjusting element is an adjustable inductor. By adjusting the effective length of the recess, a resonant frequency of the antenna structure at a low frequency band is adjustable, while a resonant frequency thereof at a high frequency band is not altered.

(21) Appl. No.: **14/527,127**(22) Filed: **Oct. 29, 2014**(30) **Foreign Application Priority Data**

Oct. 15, 2014 (CN) 201410544108.7

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



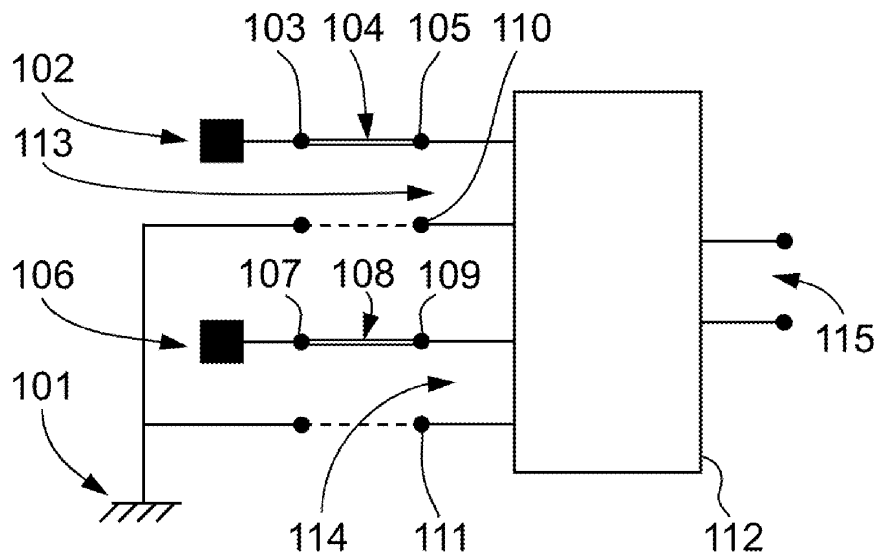
US 20160111790A1

(19) **United States**(12) **Patent Application Publication**
ANGUERA PROS et al.(10) **Pub. No.: US 2016/0111790 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **COUPLED ANTENNA SYSTEM FOR
MULTIBAND OPERATION****Publication Classification**(71) Applicant: **Fractus Antennas, S.L.**, Barcelona (ES)(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)(72) Inventors: **Jaume ANGUERA PROS**, Vinaros
(ES); **Aurora ANDUJAR LINARES**,
Barcelona (ES)(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/38**
(2013.01)(21) Appl. No.: **14/878,520**(57) **ABSTRACT**(22) Filed: **Oct. 8, 2015****Related U.S. Application Data**(60) Provisional application No. 62/159,998, filed on May
12, 2015, provisional application No. 62/064,716,
filed on Oct. 16, 2014, provisional application No.
62/072,671, filed on Oct. 30, 2014, provisional appli-
cation No. 62/152,991, filed on Apr. 27, 2015.

A radiating system configured to operate electromagnetic wave signals from first and second frequency regions, wherein the lowest frequency of the second frequency region is above the highest frequency of the first frequency region: the radiating system comprising a radiating structure, a radiofrequency system, and an external port. The radiating structure comprises a first boosting element electrically connected to a first conductive element, a second boosting element electrically connected to a second conductive element, and a ground plane layer. The radiofrequency system comprises a first matching network connected to the first conductive element and the external port, and a second matching network connected to the second conductive element and a ground port. The first and second matching networks are configured to modify the impedance of the radiating structure providing impedance matching to the radiating system, at the external port, in the first and second frequency regions.

(30) **Foreign Application Priority Data**

Oct. 16, 2014	(EP)	14189253.9
Oct. 30, 2014	(EP)	14191145.3
Apr. 27, 2015	(EP)	15165167.6
May 12, 2015	(EP)	15167298.7





US 20160111794A1

(19) **United States**(12) **Patent Application Publication**
YANG(10) **Pub. No.: US 2016/0111794 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **ANTENNA SYSTEM**(71) Applicant: **Acer Incorporated**, New Taipei City
(TW)(72) Inventor: **Chung-Wen YANG**, New Taipei City
(TW)(21) Appl. No.: **14/603,621**(22) Filed: **Jan. 23, 2015**(30) **Foreign Application Priority Data**

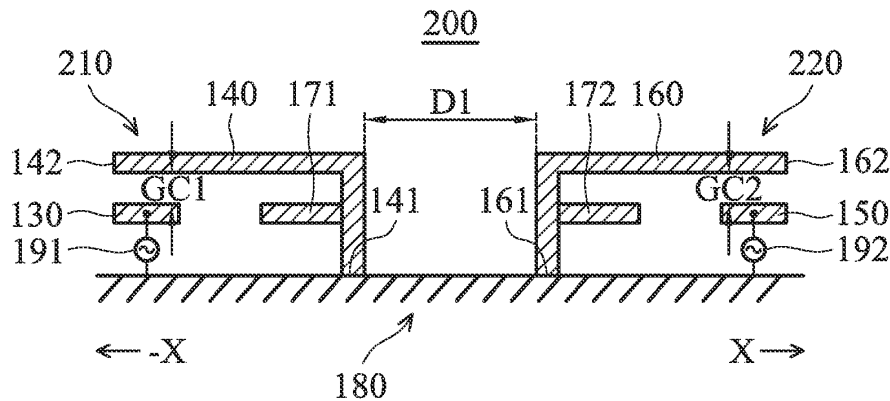
Oct. 15, 2014 (TW) 103135622

Publication Classification(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 9/04 (2006.01)**H01Q 5/20** (2006.01)**H01Q 1/50** (2006.01)(52) **U.S. Cl.**CPC **H01Q 21/28** (2013.01); **H01Q 1/50**
(2013.01); **H01Q 9/04** (2013.01); **H01Q 5/20**
(2015.01)

(57)

ABSTRACT

An antenna system includes a first antenna and a second antenna. The first antenna includes a first feeding element and a first radiation element. The first feeding element is coupled to a first signal source. A first end of the first radiation element is coupled to a ground region, and a second end of the first radiation element is open and adjacent to the first feeding element. The second antenna includes a second feeding element and a second radiation element. The second feeding element is coupled to a second signal source. A first end of the second radiation element is coupled to the ground region, and a second end of the second radiation element is open and adjacent to the second feeding element.





US 20160111797A1

(19) **United States**

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

(10) **Pub. No.: US 2016/0111797 A1**

(43) **Pub. Date: Apr. 21, 2016**

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

Publication Classification

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

(51) **Int. Cl.**
H01Q 21/30 (2006.01)
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)

(72) Inventors: **Dong-Ryul SHIN**, Daegu (KR); **Min
SAKONG**, Gumi-si (KR); **Joon-Bo
PARK**, Busan (KR); **Byung-Chan
JANG**, Gumi-si (KR); **Soo-Young
JANG**, Daegu (KR); **Jin-Woo JUNG**,
Seoul (KR)

(52) **U.S. Cl.**
CPC **H01Q 21/30** (2013.01); **H01Q 13/10**
(2013.01); **H01Q 1/38** (2013.01)

(57) **ABSTRACT**

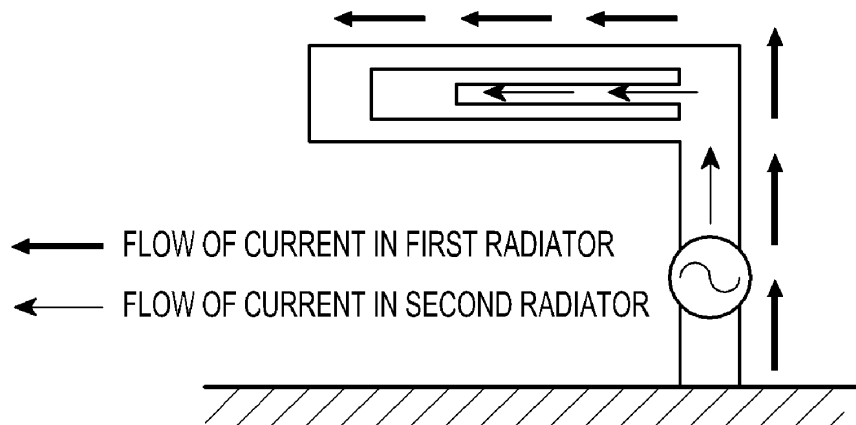
An antenna device and an electronic device including the same are provided. The antenna device includes a first radiator in which a slot is formed, a second radiator, at least a portion of which is disposed in the slot, and a feeder configured to feed the same electricity to the first radiator and the second radiator. The antenna device may have many resonance frequencies in the same installation space, allowing efficient use of the internal space of the electronic device. Moreover, the antenna device and the electronic device including the same may be implemented variously according to various embodiments.

(21) Appl. No.: **14/878,468**

(22) Filed: **Oct. 8, 2015**

(30) **Foreign Application Priority Data**

Oct. 17, 2014 (KR) 10-2014-0140649





US 20160112113A1

(19) **United States**(12) **Patent Application Publication**
LIOU et al.(10) **Pub. No.: US 2016/0112113 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **ANTENNA STRUCTURE AND WIRELESS
COMMUNICATION DEVICE USING THE
SAME**(52) **U.S. Cl.**CPC **H04B 7/10** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 5/335** (2015.01)(71) Applicant: **Chiun Mai Communication Systems,
Inc.**, New Taipei (TW)

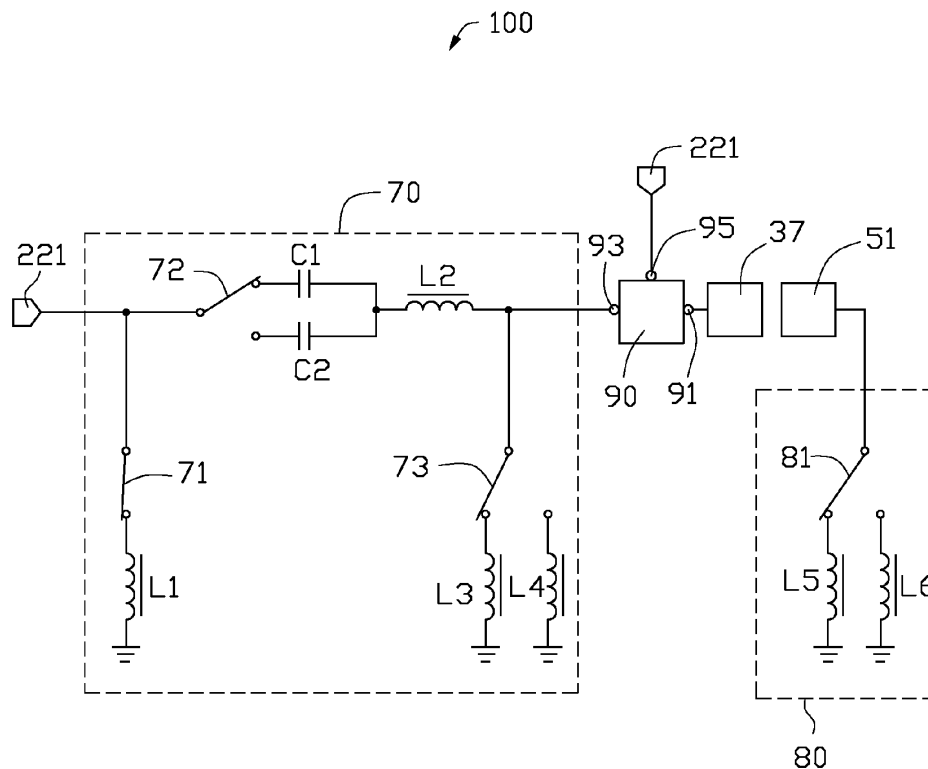
(57)

ABSTRACT(72) Inventors: **GENG-HONG LIOU**, Tu-Cheng (TW);
YEN-HUI LIN, Tu-Cheng (TW)(21) Appl. No.: **14/642,091**(22) Filed: **Mar. 9, 2015**(30) **Foreign Application Priority Data**

Oct. 21, 2014 (CN) 201410560732.6

Publication Classification(51) **Int. Cl.****H04B 7/10** (2006.01)**H01Q 5/335** (2006.01)**H01Q 1/24** (2006.01)

An antenna structure includes a feed end, a ground end, a main radiator, a coupling portion, a matching circuit, a switching circuit, and a diplexer. The main radiator is coupled to the feed end. The coupling portion is coupled to the ground end and is spaced apart from the main radiator to allow current to flow from the main radiator to the coupling portion. The switching circuit is coupled to the ground end. The diplexer includes a first port, a second port, and a third port, the first port is coupled to the feed end, the second port is coupled to a transceiver via the matching circuit, and the third port is coupled to the transceiver. The diplexer separates high frequency current from low frequency current output from the feed end, the matching circuit and the switching circuit adjust the high frequency current and the low frequency current.





US 20160112551A1

(19) **United States**(12) **Patent Application Publication**
Hung et al.(10) **Pub. No.: US 2016/0112551 A1**(43) **Pub. Date: Apr. 21, 2016**(54) **METAL-FRAME SLOT ANTENNA WITH
MATCHING CIRCUIT AND APPARATUS
THEREOF**(71) Applicant: **MediaTek Inc.**, Hsinchu (TW)(72) Inventors: **Kuo-Fong Hung**, Changhua (TW);
Chia-Wei Chi, Taipei (TW);
Shih-Huang Yeh, Hsinchu (TW)(21) Appl. No.: **14/979,398**(22) Filed: **Dec. 27, 2015****Related U.S. Application Data**(60) Provisional application No. 62/100,156, filed on Jan.
6, 2015.**Publication Classification**(51) **Int. Cl.**
H04M 1/02 (2006.01)
H04B 1/3827 (2006.01)(52) **U.S. Cl.**
CPC **H04M 1/026** (2013.01); **H04B 1/3827**
(2013.01)(57) **ABSTRACT**

Examples of a metal-frame slot antenna with one or more matching circuits and apparatus thereof are described. A slot antenna may include a metallic frame, which may include a primary sheet with plural peripheral sides surrounding the primary sheet. The metallic frame may also include at least one slot. Each slot of the at least one slot may extend along one or more peripheral sides of the plural peripheral sides of the metallic frame such that the plural peripheral sides of the metallic frame are continuous without an opening. The at least one slot may include a first slot which may be generally U-shaped or contiguous along at least three peripheral sides of the plural peripheral sides.

