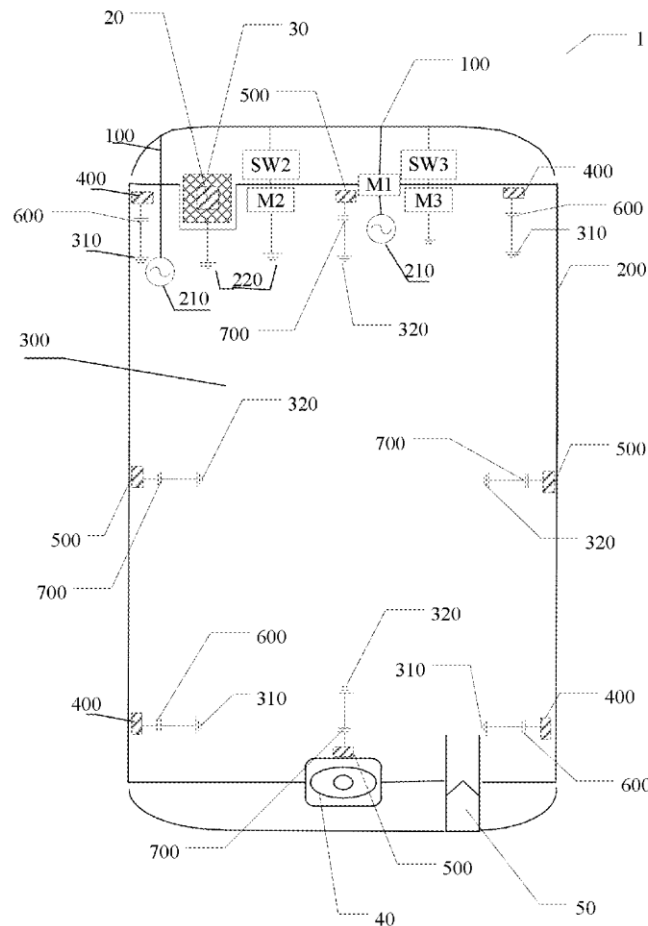




US 20180145405A1

(19) **United States**(12) **Patent Application Publication**
WU(10) **Pub. No.: US 2018/0145405 A1**(43) **Pub. Date: May 24, 2018**(54) **ANTENNA DEVICE FOR MOBILE
TERMINAL AND MOBILE TERMINAL**(71) Applicant: **GUANGDONG OPPO MOBILE
TELECOMMUNICATIONS CORP.,
LTD.**, Dongguan (CN)(72) Inventor: **Qing WU**, Dongguan (CN)(21) Appl. No.: **15/668,778**(22) Filed: **Aug. 4, 2017**(30) **Foreign Application Priority Data**Nov. 18, 2016 (CN) 201611036734.0
Nov. 18, 2016 (CN) 201621257004.9**Publication Classification**(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/528** (2013.01); **H01Q 9/0442**
(2013.01); **H01Q 1/24** (2013.01)(57) **ABSTRACT**

An antenna device for a mobile terminal as well as a mobile terminal is provided. The antenna device includes: a plurality of antennas; a mainboard comprising a plurality of feed sources that are connected with the plurality of antennas respectively; a metal battery cover comprising a plurality of first ground points; and a plurality of first connecting members configured to connect the plurality of first ground points with a plurality of second ground points of the mainboard respectively, in which the plurality of second ground points correspond to the plurality of feed sources respectively.





US 20180145410A1

(19) **United States**

(12) **Patent Application Publication**
BAN

(10) **Pub. No.: US 2018/0145410 A1**

(43) **Pub. Date: May 24, 2018**

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

Publication Classification

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

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

(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi
(JP)

(72) Inventor: **Yasumitsu BAN**, Yokohama (JP)

(73) Assignee: **FUJITSU LIMITED**, Kawasaki-shi
(JP)

(21) Appl. No.: **15/808,705**

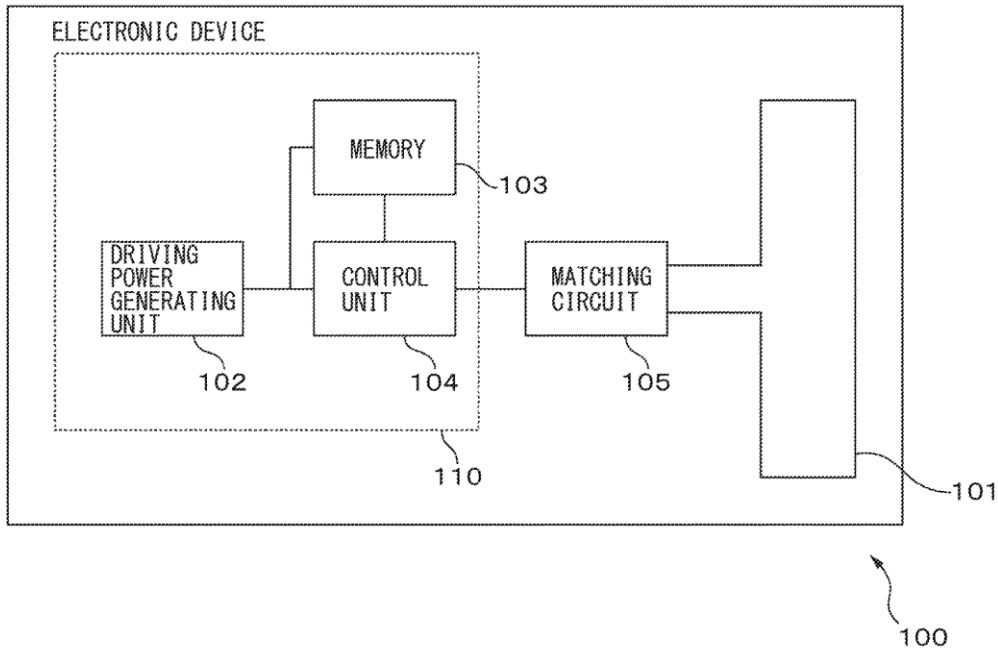
(22) Filed: **Nov. 9, 2017**

(30) **Foreign Application Priority Data**

Nov. 24, 2016 (JP) 2016-228120

(57) **ABSTRACT**

A loop antenna includes: a substrate; a first conductor which is provided on a first surface of the substrate, is conductive and is grounded; a second conductor which is formed as a loop to surround the substrate along a surface orthogonal to the first surface, is conductive, is fed on a second surface of the substrate, which is opposite to the first surface, and is electrically connected to the first conductor; and a third conductor which is provided on at least one side surface of the substrate, which intersects the surface on which the second conductor is formed as a loop, is conductive and is electrically connected to the first conductor.

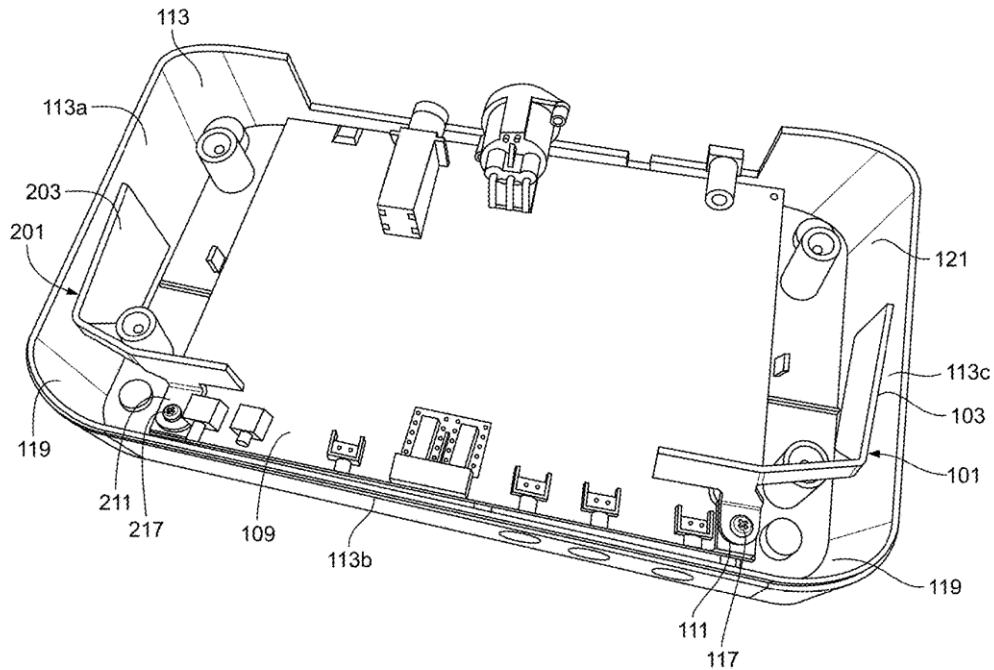




US 20180151944A1

(19) **United States**(12) **Patent Application Publication**
Lubin et al.(10) **Pub. No.: US 2018/0151944 A1**(43) **Pub. Date: May 31, 2018**(54) **WIRELESS ANTENNA**(52) **U.S. CL.**(71) Applicant: **Shure Acquisition Holdings, Inc.**,
Niles, IL (US)CPC **H01Q 1/2291** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 1/38** (2013.01)(72) Inventors: **Zachary Lubin**, Niles, IL (US);
Michael Le, Niles, IL (US); **Paul**
Mark Jacobs, Evanston, IL (US)(57) **ABSTRACT**(21) Appl. No.: **15/363,897**(22) Filed: **Nov. 29, 2016****Publication Classification**(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)

An antenna for supporting a wireless system, which can in one example, be operable in two industrial, scientific and medical ("ISM") bands, may include a first radiator and a second radiator, and a single feed transmission section coupled to the first radiator and the second radiator. The antenna can, for example, be formed of a unitary planar structure. The antenna may be configured to fit within a chassis, which in one example, can be a chassis for a wireless receiver in a microphone.





US 20180151955A1

(19) **United States**(12) **Patent Application Publication****Zhang et al.**(10) **Pub. No.: US 2018/0151955 A1**(43) **Pub. Date: May 31, 2018**(54) **LOW-PROFILE DUAL-BAND FILTERING
PATCH ANTENNA**(71) Applicant: **South China University of
Technology, Guangzhou (CN)**(72) Inventors: **Xiu Yin Zhang, Guangzhou (CN); Yao
Zhang, Guangzhou (CN); Yong-Mei
Pan, Guangzhou (CN); Wen Duan,
Guangzhou (CN)**(21) Appl. No.: **15/602,116**(22) Filed: **May 23, 2017**(30) **Foreign Application Priority Data**

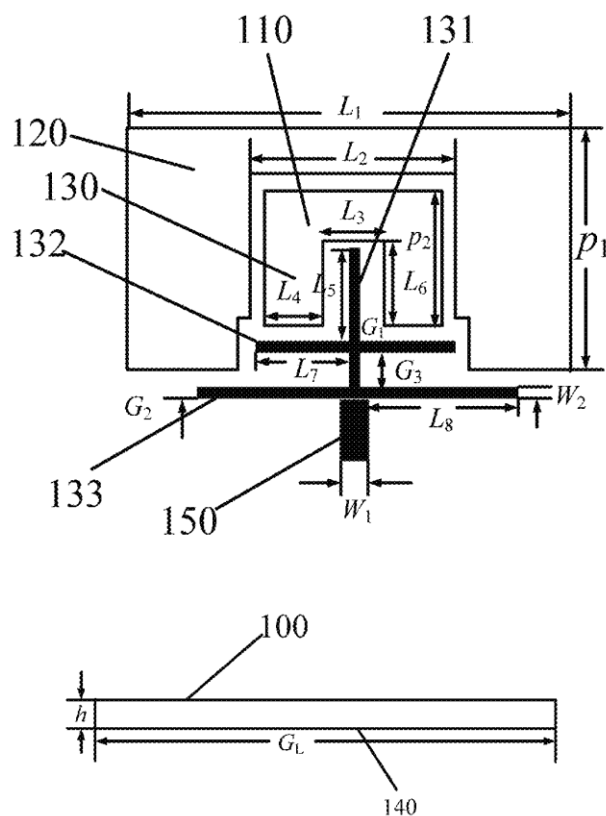
Nov. 25, 2016 (CN) 201611051345.5

Publication Classification(51) **Int. Cl.****H01Q 9/04** (2006.01)**H04B 7/0413** (2006.01)**H01Q 5/30** (2006.01)**H01Q 9/28** (2006.01)**H01Q 1/38** (2006.01)**H01Q 1/24** (2006.01)(52) **U.S. Cl.**CPC **H01Q 9/045** (2013.01); **H04B 7/0413**(2013.01); **H01Q 5/30** (2015.01); **H01Q****9/0414** (2013.01); **H01Q 1/38** (2013.01);**H01Q 1/243** (2013.01); **H01Q 9/28** (2013.01)

(57)

ABSTRACT

A low-profile dual-band filtering patch antenna and its application to LTE MIMO system are disclosed. By using two embedded U-shaped radiating patches and a multi-stub microstrip feed-line, two operating bands and four radiation nulls can be generated and individually controlled, the design is thus very simple and flexible. Based on the proposed low-profile dual-band filtering patch antenna, a MIMO antenna with a very low profile, low mutual coupling and low ECCs has been presented.





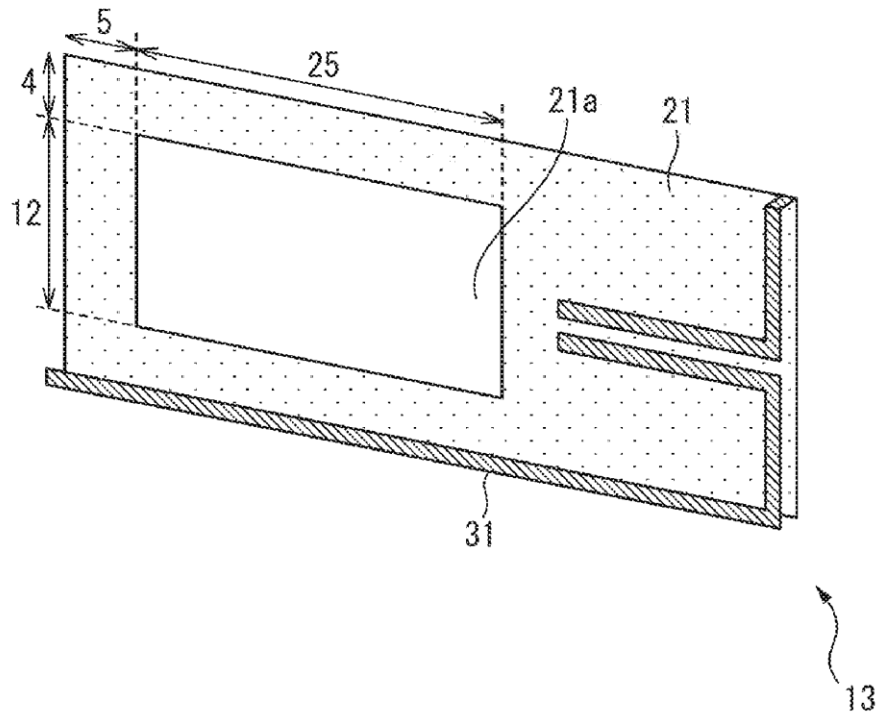
US 20180151956A1

(19) **United States**(12) **Patent Application Publication**
BAN(10) **Pub. No.: US 2018/0151956 A1**(43) **Pub. Date: May 31, 2018**(54) **LINEAR ANTENNA AND ELECTRONIC
DEVICE**(52) **U.S. CL.**CPC **H01Q 9/0414** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 9/045** (2013.01)(71) Applicant: **FUJITSU LIMITED**, Kawasaki-shi
(JP)(72) Inventor: **Yasumitsu BAN**, Yokohama (JP)(73) Assignee: **FUJITSU LIMITED**, Kawasaki-shi
(JP)(21) Appl. No.: **15/817,439**(22) Filed: **Nov. 20, 2017**(30) **Foreign Application Priority Data**

Nov. 25, 2016 (JP) 2016-229409

Publication Classification(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)(57) **ABSTRACT**

A linear antenna includes a first conductor which is formed as a plate and is grounded; and a second conductor which is connected at one end to the first conductor, includes an electrical length obtained by adding $\frac{1}{4}$ of a designed wavelength to an integer multiple of a half of the designed wavelength, and includes a first section from a folding point to an another end of which the second conductor is an open end along a surface parallel to a surface on which the first conductor is formed, wherein the second conductor is fed at a feed point in the first section, and at least a part of the first section including the feed point is formed to overlap with the first conductor when the first section is projected along a normal direction of the surface on which the first conductor is formed.





US 20180152208A1

(19) **United States**(12) **Patent Application Publication**
TSAI et al.(10) **Pub. No.: US 2018/0152208 A1**(43) **Pub. Date: May 31, 2018**(54) **WIRELESS COMMUNICATION DEVICE**(71) Applicant: **HTC CORPORATION**, Taoyuan City (TW)(72) Inventors: **Tiao-Hsing TSAI**, TAOYUAN CITY (TW); **Chien-Pin CHIU**, TAOYUAN CITY (TW); **Hsiao-Wei WU**, TAOYUAN CITY (TW); **Yi-Hsiang KUNG**, TAOYUAN CITY (TW); **Shen-Fu TZENG**, TAOYUAN CITY (TW); **Li-Yuan FANG**, TAOYUAN CITY (TW)(21) Appl. No.: **15/821,777**(22) Filed: **Nov. 23, 2017****Related U.S. Application Data**

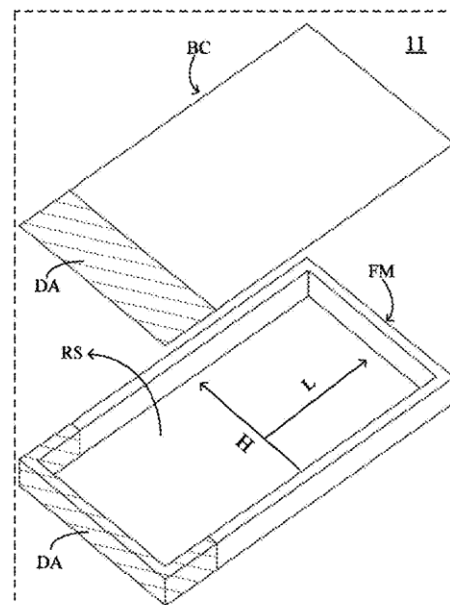
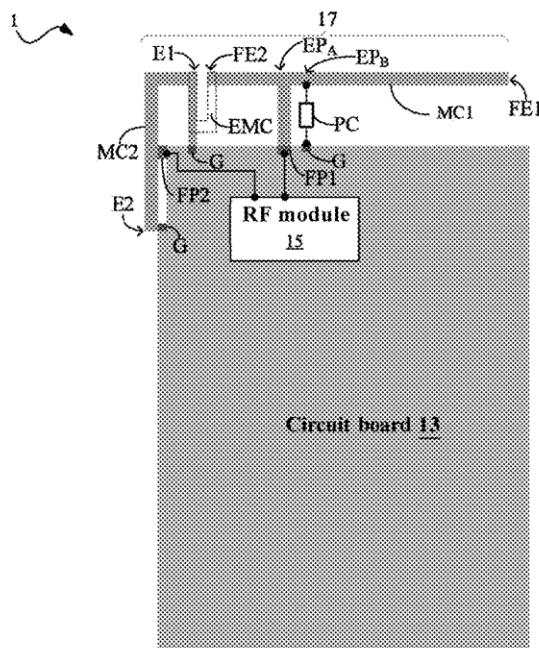
(60) Provisional application No. 62/428,183, filed on Nov. 30, 2016.

Publication Classification(51) **Int. Cl.****H04B 1/00** (2006.01)**H04B 1/40** (2006.01)(52) **U.S. Cl.**CPC **H04B 1/006** (2013.01); **H04W 88/06** (2013.01); **H04B 1/40** (2013.01)

(57)

ABSTRACT

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





US 20180152220A1

(19) **United States**

(12) **Patent Application Publication**

Mow et al.

(10) **Pub. No.: US 2018/0152220 A1**

(43) **Pub. Date: May 31, 2018**

(54) **TUNABLE ANTENNA SYSTEMS**

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

(72) Inventors: **Matthew A. Mow**, Los Altos, CA (US);
Robert W. Schlub, Cupertino, CA
(US); **Mattia Pascolini**, San Francisco,
CA (US); **Robert J. Hill**, Salinas, CA
(US); **Ruben Caballero**, San Jose, CA
(US)

H01Q 9/14 (2006.01)

H01Q 13/10 (2006.01)

H01Q 1/24 (2006.01)

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

CPC **H04B 1/40** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 7/005** (2013.01); **H01Q**
1/243 (2013.01); **H01Q 9/042** (2013.01);
H01Q 9/145 (2013.01); **H01Q 13/103**
(2013.01); **H01Q 9/0421** (2013.01)

(21) Appl. No.: **15/871,388**

(22) Filed: **Jan. 15, 2018**

Related U.S. Application Data

(63) Continuation of application No. 14/737,394, filed on
Jun. 11, 2015, now Pat. No. 9,893,755, which is a
continuation of application No. 12/831,180, filed on
Jul. 6, 2010, now Pat. No. 9,070,969.

Publication Classification

(51) **Int. Cl.**

H04B 1/40 (2006.01)

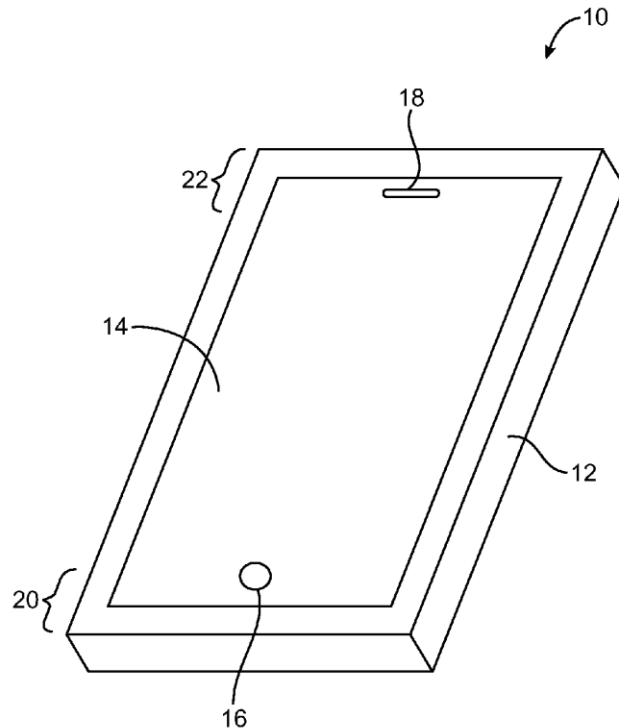
H01Q 1/48 (2006.01)

H01Q 7/00 (2006.01)

H01Q 9/04 (2006.01)

(57) **ABSTRACT**

An electronic device has wireless communications circuitry including an adjustable antenna system coupled to a radio-frequency transceiver. The adjustable antenna system may include one or more adjustable electrical components that are controlled by storage and processing circuitry in the electronic device. The adjustable electrical components may include switches and components that can be adjusted between numerous different states. The adjustable electrical components may be coupled between antenna system components such as transmission line elements, matching network elements, antenna elements and antenna feeds. By adjusting the adjustable electrical components, the storage and processing circuitry can tune the adjustable antenna system to ensure that the adjustable antenna system covers communications bands of interest.





US 20180152549A1

(19) **United States**(12) **Patent Application Publication**
Hobson et al.(10) **Pub. No.: US 2018/0152549 A1**(43) **Pub. Date: May 31, 2018**(54) **HANDHELD ELECTRONIC DEVICE WITH
CABLE GROUNDING**(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Phillip Michael Hobson**, Menlo Park, CA (US); **Erik L. Wang**, Redwood City, CA (US); **Kenneth A. Jenks**, Capitola, CA (US); **Robert J. Hill**, Ashland, OR (US); **Richard Hung Minh Dinh**, Saratoga, CA (US); **Tang Yew Tan**, Cupertino, CA (US); **Adam D. Mittleman**, Portola Valley, CA (US); **Bartley K. Andre**, Palo Alto, CA (US); **Daniel J. Coster**, San Francisco, CA (US); **Daniele G. De Iulius**, San Francisco, CA (US); **Richard P. Howarth**, San Francisco, CA (US); **Jonathan P. Ive**, San Francisco, CA (US); **Steve P. Jobs**, Palo Alto, CA (US); **Duncan Robert Kerr**, San Francisco, CA (US); **Shin Nishihori**, Kailua, HI (US); **Matthew Dean Rohrbach**, San Francisco, CA (US); **Douglas B. Satzger**, Menlo Park, CA (US); **Calvin Q. Seid**, Palo Alto, CA (US); **Christopher J. Stringer**, Woodside, CA (US); **Eugene Antony Whang**, San Francisco, CA (US); **Rico Zörkendörfer**, San Francisco, CA (US); **Robert W. Schlub**, Palo Alto, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)(21) Appl. No.: **15/882,010**(22) Filed: **Jan. 29, 2018****Related U.S. Application Data**

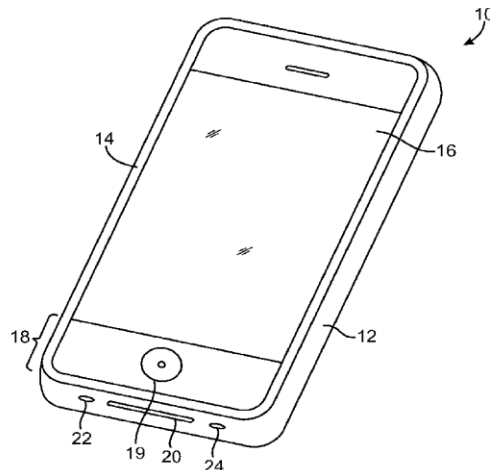
(63) Continuation of application No. 14/266,570, filed on Apr. 30, 2014, which is a continuation of application No. 14/158,403, filed on Jan. 17, 2014, which is a continuation of application No. 13/021,689, filed on Feb. 4, 2011, now Pat. No. 8,681,056, which is a continuation of application No. 11/821,329, filed on Jun. 21, 2007, now Pat. No. 7,889,139.

Publication Classification

(51) **Int. Cl.**
H04M 1/02 (2006.01)
H01Q 1/24 (2006.01)
H05K 5/02 (2006.01)
H01Q 9/04 (2006.01)
(52) **U.S. Cl.**
CPC **H04M 1/0202** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H04M 1/0266** (2013.01); **H05K 5/0247** (2013.01)

(57) **ABSTRACT**

A handheld electronic device may be provided that contains a conductive housing and other conductive elements. The conductive elements may form an antenna ground plane. One or more antennas for the handheld electronic device may be formed from the ground plane and one or more associated antenna resonating elements. Transceiver circuitry may be connected to the resonating elements by transmission lines such as coaxial cables. Ferrules may be crimped to the coaxial cables. A bracket with extending members may be crimped over the ferrules to ground the coaxial cables to the housing and other conductive elements in the ground plane. The ground plane may contain an antenna slot. A dock connector and flex circuit may overlap the slot in a way that does not affect the resonant frequency of the slot. Electrical components may be isolated from the antenna using isolation elements such as inductors and resistors.





US 20180159205A1

(19) **United States**
(12) **Patent Application Publication** (10) **Pub. No.: US 2018/0159205 A1**
Wu et al. (43) **Pub. Date: Jun. 7, 2018**

(54) **MOBILE TERMINAL**

Publication Classification

(71) Applicant: **Guangdong Oppo Mobile Telecommunications Corp., Ltd.**, Dongguan City (CN)
(72) Inventors: **Qing Wu**, Dongguan City (CN); **Yuanbin Xiang**, Dongguan City (CN)
(73) Assignee: **Guangdong Oppo Mobile Telecommunications Corp., Ltd.**, Dongguan City (CN)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H04M 1/02 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H04M 1/0281** (2013.01); **H04M 1/0274** (2013.01)

(21) Appl. No.: **15/787,858**

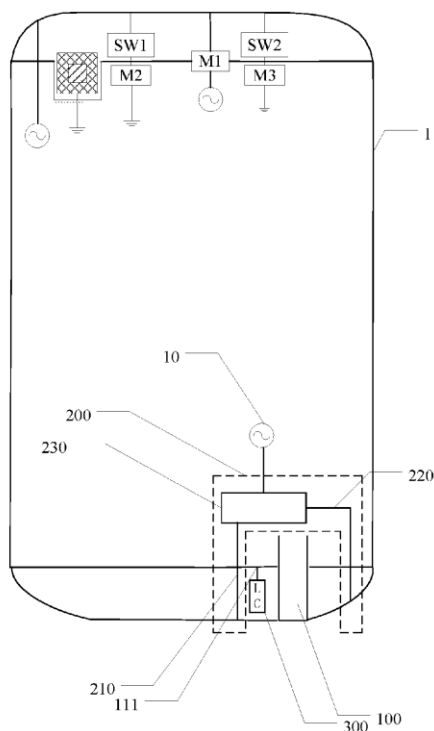
(22) Filed: **Oct. 19, 2017**

(30) **Foreign Application Priority Data**

Dec. 7, 2016 (CN) 20161118262.3
Dec. 7, 2016 (CN) 201621340998.0

(57) **ABSTRACT**

A mobile terminal includes an external interface body, an antenna assembly, and a first filter unit. The antenna assembly includes a first antenna, a second antenna, and a diplexer. The external interface body is disposed in an antenna clearance area defined by the first antenna and the second antenna. The diplexer is connected to the first antenna, the second antenna, and a feed of a board of the mobile terminal. The first filter unit is disposed between the first antenna and the external interface body and is connected to a first circuit board of the external interface body to reduce interference from the external interface body to the antenna assembly.





US 20180159209A1

(19) **United States**

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

(10) **Pub. No.: US 2018/0159209 A1**

(43) **Pub. Date: Jun. 7, 2018**

(54) **WIRELESS MODULE AND METHOD FOR
MANUFACTURING WIRELESS MODULE**

(71) Applicant: **TAIYO YUDEN CO., LTD.**, Tokyo
(JP)

(72) Inventors: **Jin MIKATA**, Tokyo (JP); **Masaya
SHIMAMURA**, Tokyo (JP); **Mikio
AOKI**, Tokyo (JP); **Takehiko KAI**,
Tokyo (JP); **Taiji ITO**, Tokyo (JP)

(73) Assignee: **TAIYO YUDEN CO., LTD.**, Tokyo
(JP)

(21) Appl. No.: **15/828,178**

(22) Filed: **Nov. 30, 2017**

(30) **Foreign Application Priority Data**

Dec. 1, 2016 (JP) 2016-233910

Publication Classification

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01L 23/31 (2006.01)

H01Q 1/22 (2006.01)

H01Q 9/04 (2006.01)

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

CPC **H01Q 1/38** (2013.01); **H01L 23/3121**

(2013.01); **H01Q 23/00** (2013.01); **H01Q**

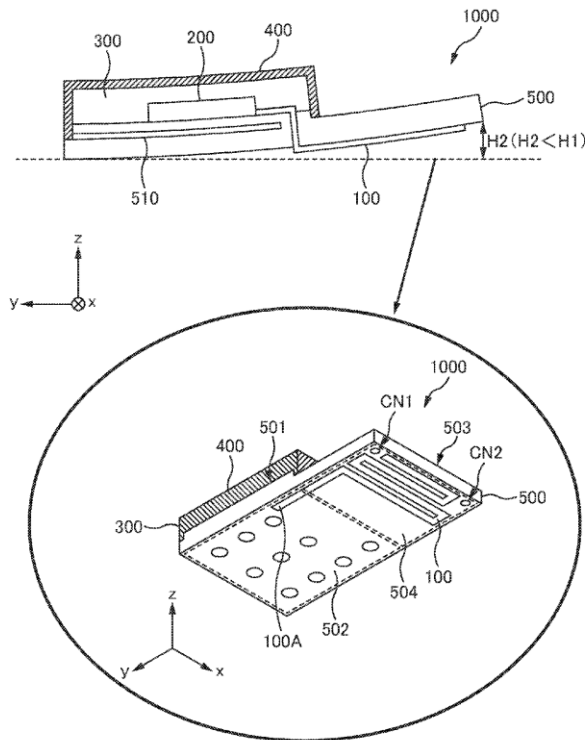
9/0407 (2013.01); **H01L 2223/6677** (2013.01);

H01Q 1/2283 (2013.01)

(57)

ABSTRACT

A wireless module, including: a substrate; an electronic circuit mounted in a first region on a one face of the substrate; a conductive pattern formed in a second region on another face of the substrate and serving as an antenna; a resin layer sealing the electronic circuit in the first region; and a shielding layer formed on a surface of the resin layer and having conductivity.





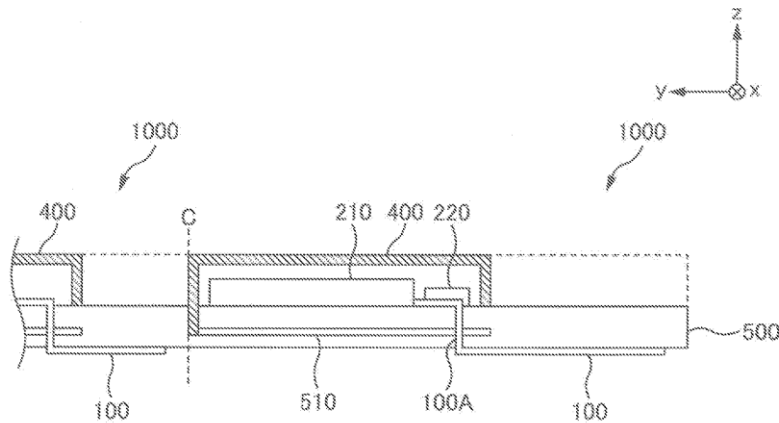
US 20180159216A1

(19) **United States**(12) **Patent Application Publication**
KAI et al.(10) **Pub. No.: US 2018/0159216 A1**(43) **Pub. Date: Jun. 7, 2018**(54) **WIRELESS MODULE AND METHOD FOR
MANUFACTURING THE SAME**(71) Applicant: **TAIYO YUDEN CO., LTD.**, Tokyo
(JP)(72) Inventors: **Takehiko KAI**, Tokyo (JP); **Masaya
SHIMAMURA**, Tokyo (JP); **Mikio
AOKI**, Tokyo (JP); **Jin MIKATA**,
Tokyo (JP); **Taiji ITO**, Tokyo (JP)(73) Assignee: **TAIYO YUDEN CO., LTD.**, Tokyo
(JP)(21) Appl. No.: **15/828,160**(22) Filed: **Nov. 30, 2017**(30) **Foreign Application Priority Data**

Dec. 1, 2016 (JP) 2016-233911

Publication Classification(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/22 (2006.01)**H01L 23/31** (2006.01)**H01L 23/552** (2006.01)**H01Q 9/04** (2006.01)**H01Q 1/38** (2006.01)(52) **U.S. Cl.**CPC **H01Q 1/526** (2013.01); **H01Q 1/2283**
(2013.01); **H01L 23/3121** (2013.01); **H01Q**
23/00 (2013.01); **H01Q 9/0407** (2013.01);
H01Q 1/38 (2013.01); **H01L 2223/6677**
(2013.01); **H01L 23/552** (2013.01)(57) **ABSTRACT**

Solution is preparing a substrate; covering an electronic component mounting region and an antenna mounting region of the substrate with a resin material having viscosity or fluidity; curing the resin material to form a resin layer, and thereafter performing grinding or polishing so as to substantially flatten a surface of the resin layer on the electronic component mounting region and the antenna mounting region; and covering the flattened resin layer with a shielding material having viscosity or fluidity.





US 20180159221A1

(19) **United States**(12) **Patent Application Publication**
LIOU et al.(10) **Pub. No.: US 2018/0159221 A1**(43) **Pub. Date: Jun. 7, 2018**(54) **ANTENNA STRUCTURE AND WIRELESS
COMMUNICATION DEVICE USING SAME**(52) **U.S. CL.**CPC **H01Q 5/371** (2015.01); **H01Q 1/243**
(2013.01); **H01Q 5/50** (2015.01)(71) Applicant: **Chiun Mai Communication Systems,
Inc.**, New Taipei (TW)(72) Inventors: **GENG-HONG LIOU**, New Taipei
(TW); **YUN-JIAN CHANG**, New
Taipei (TW)

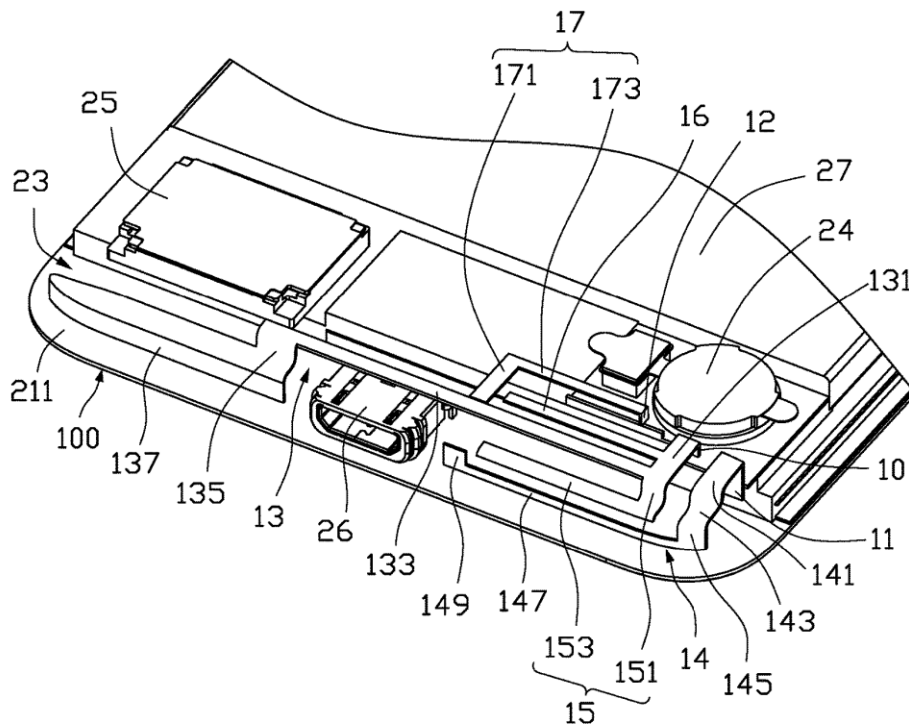
(57)

ABSTRACT(21) Appl. No.: **15/810,246**(22) Filed: **Nov. 13, 2017**(30) **Foreign Application Priority Data**

Dec. 7, 2016 (CN) 201611114590.6

Publication Classification(51) **Int. Cl.**
H01Q 5/371 (2006.01)
H01Q 5/50 (2006.01)
H01Q 1/24 (2006.01)

A multi-frequency antenna structure includes a feed portion, a first ground portion, a first radiating portion, a second radiating portion, and a third radiating portion. The feed portion supplies current to the antenna structure. The first ground portion is spaced apart from the feed portion and grounds the antenna structure. The first radiating portion is electrically connected to the feed portion. The second radiating portion is spaced apart from the first radiating portion and is electrically connected to the first ground portion. The third radiating portion is spaced apart from the second radiating portion and is electrically connected to the feed portion and the first radiating portion.

200



US 20180159575A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2018/0159575 A1**
(43) **Pub. Date: Jun. 7, 2018**

(54) **ANTENNA FOR WEARABLE ELECTRONIC DEVICES**

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

(72) Inventors: **AYCAN ERENTOK**, Sunnyvale, CA (US); **HUAN-SHENG HWANG**, San Diego, CA (US); **JOHN GROFF**, San Francisco, CA (US); **THOMAS H. LIU**, Fremont, CA (US)

(73) Assignee: **Intel Corporation**, Santa Clara, CA (US)

(21) Appl. No.: **15/645,511**

(22) Filed: **Jul. 10, 2017**

Related U.S. Application Data

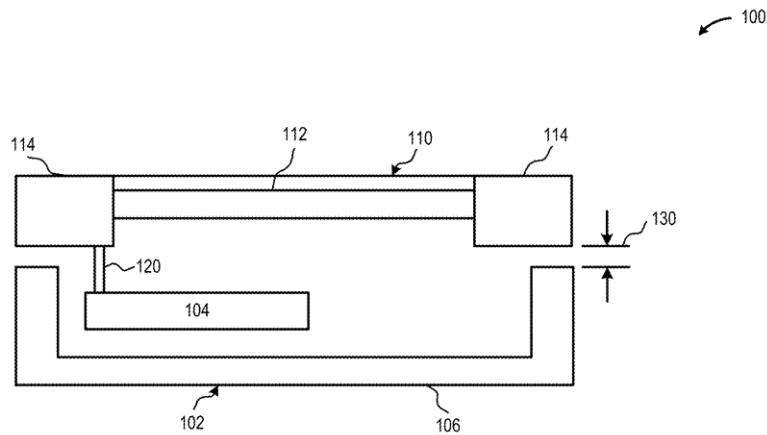
(63) Continuation of application No. 15/193,356, filed on Jun. 27, 2016, now Pat. No. 9,705,549.

Publication Classification

(51) **Int. Cl.**
H04B 1/3827 (2015.01)
H04W 4/20 (2018.01)
H04W 4/80 (2018.01)
(52) **U.S. Cl.**
CPC **H04B 1/385** (2013.01); **H04B 2001/3861** (2013.01); **H04W 4/80** (2018.02); **H04W 4/203** (2013.01)

(57) **ABSTRACT**

A wearable electronic device includes a first member and a second member. The second member includes a first, RF-attenuating, portion and a second, electrically conductive portion. A gap exists between the first member and at least the second portion of the second member. One or more transmitter/receivers, such as one or more BLUETOOTH®, BLUETOOTH® low energy, and/or IEEE 802.11 transceivers may be mounted in the first member. The one or more transmitter/receivers are conductively coupled to the second portion of the second member. RF signals generated by the one or more transceivers are emitted from the second portion of the second member.





US 20180166769A1

(19) **United States**(12) **Patent Application Publication**
CHANG et al.(10) **Pub. No.: US 2018/0166769 A1**(43) **Pub. Date: Jun. 14, 2018**(54) **ANTENNA STRUCTURE AND WIRELESS
COMMUNICATION DEVICE USING SAME**(71) Applicant: **Chiun Mai Communication Systems,
Inc.**, New Taipei (TW)(72) Inventors: **CHENG-I CHANG**, New Taipei (TW);
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ABSTRACT

An antenna structure includes a metallic member, a feed portion, and a coupling resistor. The metallic member defines a slot, a first gap, a second gap, and a third gap. The first gap and the second gap are connected with the slot and divide with the slot the metallic member into a first portion and a second portion. The second portion is grounded. The third gap is defined on the first portion and connected with the slot. The first portion is divided into a radiating portion and a coupling portion by the third gap. The coupling portion is spaced apart from the radiating portion. The feed portion is electrically connected to the radiating portion, and the coupling portion is grounded through the coupling resistor.

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