



US009196948B2

(12) **United States Patent**
Yamamoto et al.

(10) **Patent No.:** **US 9,196,948 B2**
(45) **Date of Patent:** **Nov. 24, 2015**

- (54) **ANTENNA SYSTEM FOR WIRELESS TERMINAL DEVICES**
- (71) Applicant: **LENOVO (SINGAPORE) PTE. LTD.,**
Singapore (SG)
- (72) Inventors: **Osamu Yamamoto, Kanagawa-ken (JP);**
Takaai Okada, Kanagawa-ken (JP)
- (73) Assignee: **LENOVO (SINGAPORE) PTE LTD,**
Singapore (SG)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 205 days.

- (21) Appl. No.: **13/749,172**
- (22) Filed: **Jan. 24, 2013**

- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
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- (51) **Int. Cl.**
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H01Q 1/00 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/50 (2006.01)
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/002** (2013.01); **H01Q 1/2266**
(2013.01); **H01Q 1/241** (2013.01); **H01Q 1/50**
(2013.01); **H01Q 1/526** (2013.01); **H01Q 9/42**
(2013.01)

- (58) **Field of Classification Search**
USPC 343/700 MS, 702, 833, 841
See application file for complete search history.

- (56) **References Cited**
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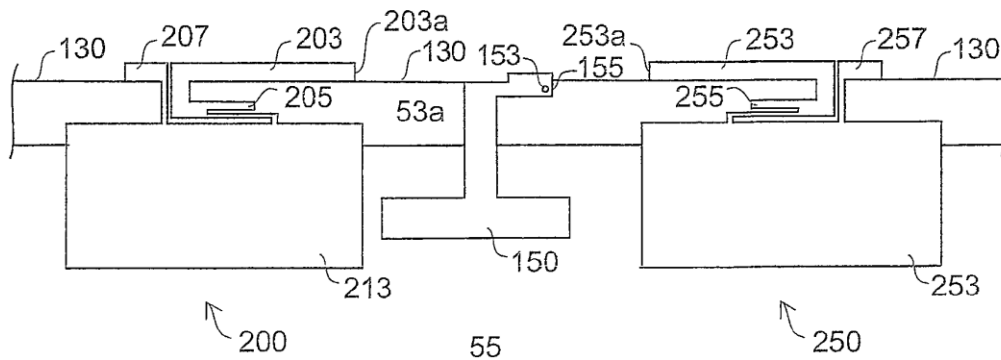
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Primary Examiner — Tan Ho
(74) *Attorney, Agent, or Firm* — Antony P. Ng; Russell Ng PLLC

- (57) **ABSTRACT**
An antenna system suitable for a mobile device is disclosed. The mobile device includes a display casing with a conductive region and a non-conductive region. The antenna system includes a driven element having an inverted-F antenna arranged in the non-conductive region of the display casing. The display casing is also provided with an electrostatic discharge (ESD) conductor as a countermeasure against ESD. The ESD conductor is connected to the conductive region of the casing. The ESD conductor causes static charges in the air to be discharged to the conductive region of the casing. The ESD conductor also produces harmonic resonance and exchanges electromagnetic energy with the driven element to improve the gain of the driven element.

9 Claims, 4 Drawing Sheets





US009196957B2

(12) **United States Patent**
Kim et al.

(10) **Patent No.:** **US 9,196,957 B2**
(45) **Date of Patent:** **Nov. 24, 2015**

(54) **MIMO ANTENNA FOR IMPROVED ISOLATION**

(75) Inventors: **Jin-Myung Kim**, Incheon (KR); **Chang-Won Jung**, Seoul (KR); **In-Su Yeom**, Seoul (KR)

(73) Assignees: **MOBITECH CORP**, Seoul (KR); **Seoul National University of Technology Center for Industry Collaboration**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 124 days.

(21) Appl. No.: **13/643,987**

(22) PCT Filed: **Apr. 28, 2011**

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(2), (4) Date: **Jan. 14, 2013**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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

(52) **U.S. Cl.**
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(58) **Field of Classification Search**

CPC H01Q 1/521; H01Q 1/243; H01Q 1/2266
USPC 343/841, 702, 893
See application file for complete search history.

(56) **References Cited**

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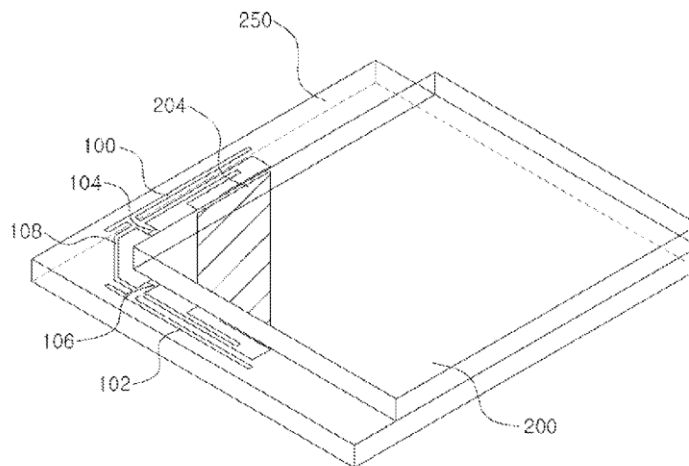
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — TechLaw LLP

(57) **ABSTRACT**

A MIMO antenna for improving isolation is disclosed. The disclosed antenna includes a dielectric feature; a ground plane included in a first layer of the dielectric feature; a first radiator, which is electromagnetically joined with a first feed point, configured to radiate a first RF signal, and joined with the ground plane; a second radiator, which is electromagnetically joined with a second feed point, configured to radiate a second RF signal, and joined with the ground plane; and a connector line, which is joined with a particular point of the first radiator and with a particular point of the second radiator to connect the first radiator with the second radiator. The disclosed antenna can improve isolation properties between multiple antennas and can ensure adequate isolation properties even when the distances between multiple antennas are set to be relatively small.

4 Claims, 3 Drawing Sheets





US009196952B2

(12) **United States Patent**
Tran et al.

(10) **Patent No.:** **US 9,196,952 B2**
(45) **Date of Patent:** **Nov. 24, 2015**

(54) **MULTIPURPOSE ANTENNA**

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)
(72) Inventors: **Allen M. Tran**, San Diego, CA (US); **Jatupum Jenwatanavet**, San Diego, CA (US)

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 253 days.

(21) Appl. No.: **13/831,714**

(22) Filed: **Mar. 15, 2013**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
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H01Q 7/00 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/27 (2006.01)
H01Q 5/357 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 7/00** (2013.01); **H01Q 13/10** (2013.01); **H01Q 1/273** (2013.01); **H01Q 5/357** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/273; H01Q 1/243; H01Q 1/242; H01Q 1/241; H01Q 13/10; H01Q 13/18
USPC 343/718, 702
See application file for complete search history.

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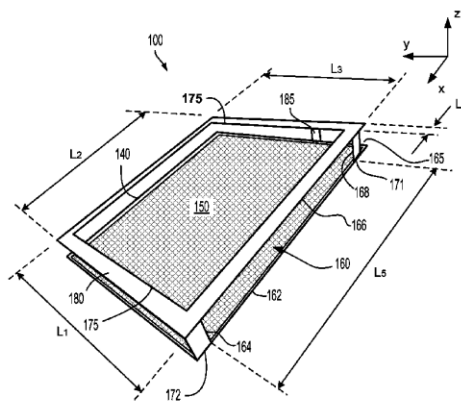
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — The Marbury Law Group, PLLC

(57) **ABSTRACT**

A multiband antenna for a wireless device includes a housing base portion, housing antenna portion and a feed contact. The housing base portion configured to receive radio circuitry thereon and include a first peripheral edge and a first conductive material. The housing antenna portion spaced away from and substantially opposed to the housing base portion, including a second peripheral edge and a second conductive material. The housing base and antenna portions together forming an outermost housing of the mobile wireless device, enclosing the radio circuitry there between. The first and second peripheral edges forming opposed lengthwise edges of a slot having a width formed by a distance between the first and second peripheral edges. The feed contact coupling the housing base portion, the housing antenna portion and the radio circuitry for providing at least one driving frequency to at least the housing antenna portion from the radio circuitry.

58 Claims, 12 Drawing Sheets





US009196966B1

(12) **United States Patent**
Obeidat

(10) **Patent No.:** **US 9,196,966 B1**
(45) **Date of Patent:** ***Nov. 24, 2015**

(54) **QUAD-SLOT ANTENNA FOR DUAL BAND OPERATION**

(71) Applicant: **AMAZON TECHNOLOGIES, INC.**,
Reno, NV (US)

(72) Inventor: **Khaled Ahmad Obeidat**, Santa Clara,
CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Reno, NV
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **13/714,117**

(22) Filed: **Dec. 13, 2012**

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/621,647,
filed on Sep. 17, 2012.

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

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

(58) **Field of Classification Search**

CPC H01Q 13/10

USPC 343/770, 767, 776

See application file for complete search history.

(56) **References Cited**

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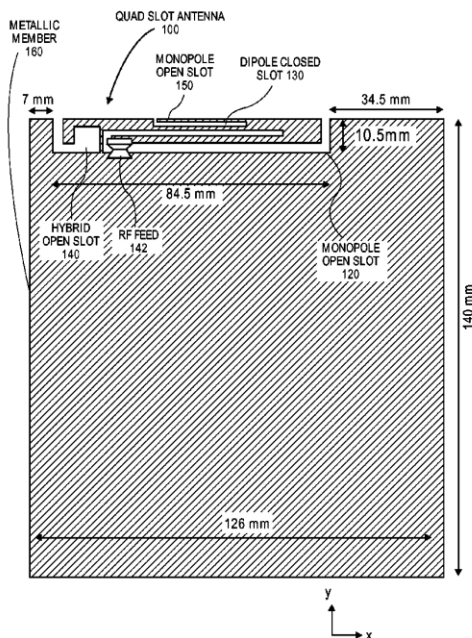
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(57) **ABSTRACT**

Quad-slot antenna structures of user devices and methods of operating the user devices with the quad-slot antenna structures are described. One apparatus includes a RF feed coupled to a quad-slot antenna, including a first slot and a second slot and a third slot and a fourth slot. The first slot and the second slot are driven elements and the third slot and the fourth slot are parasitic elements.

20 Claims, 10 Drawing Sheets





US009197270B2

(12) **United States Patent**
Ying et al.

(10) **Patent No.:** **US 9,197,270 B2**
(45) **Date of Patent:** **Nov. 24, 2015**

(54) **DOUBLE RING ANTENNA WITH INTEGRATED NON-CELLULAR ANTENNAS**

(71) Applicant: **Sony Corporation**, Tokyo (JP)

(72) Inventors: **Zhinong Ying**, Lund (SE); **Kun Zhao**, Stockholm (SE); **Shuai Zhang**, Solna (SE); **Sailing He**, Stockholm (SE)

(73) Assignee: **Sony Corporation**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 97 days.

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Primary Examiner — David Bilodeau

(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec, P.A.

(57) ABSTRACT

Wireless electronic devices may include a ground plane, a double ring antenna and non-cellular antennas integrated within the double ring antenna. The double ring antenna may comprise first and second metal rings around the perimeter of a ground plane to operate as MIMO cellular antennas. At least one non-cellular antenna, such as a MIMO Wi-Fi antenna, may be integrated between the first and second metal rings on one or more sides of the wireless electronic device.

17 Claims, 13 Drawing Sheets

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(65) Prior Publication Data

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H01Q 13/10 (2006.01)
H01Q 5/35 (2015.01)

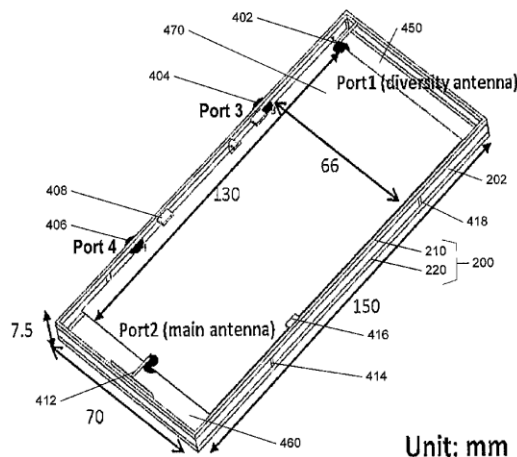
(52) **U.S. Cl.**
CPC **H04B 1/3827** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/35** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243
See application file for complete search history.

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Unit: mm



US009203137B1

(12) **United States Patent**
Guterman et al.

(10) **Patent No.:** **US 9,203,137 B1**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **ELECTRONIC DEVICE WITH ISOLATED CAVITY ANTENNAS**

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

(72) Inventors: **Jerzy Guterman**, Mountain View, CA (US); **Edward T. Sweet**, San Francisco, CA (US); **Huan-Chu Huang**, Luzhu (TW); **Daniel K. Boothe**, San Francisco, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/733,855**

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

Related U.S. Application Data

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H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 5/20 (2015.01)
H01Q 5/10 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 5/10** (2015.01); **H01Q 5/20** (2015.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 702
See application file for complete search history.

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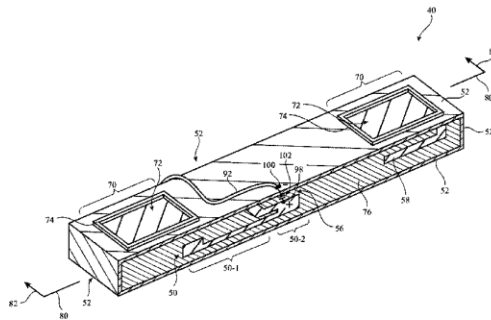
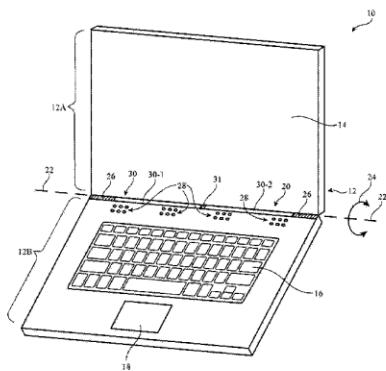
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

An electronic device may have a metal housing. The metal housing may have an upper housing in which a component such as a display is mounted and a lower housing in which a component such as a keyboard is mounted. Hinges may be used to mount the upper housing to the lower housing for rotation about a rotational axis. A slot-shaped opening may separate the upper and lower housing. A flexible printed circuit with ground traces may bisect the slot-shaped opening to form first and second slots. Cavity antennas may be aligned with the slots. Each cavity antenna may include a hollow carrier with a pair of speakers. The speakers may have ports that emit sound through aligned openings in the lower housing. Conductive gaskets surrounding the ports may acoustically seal the speaker ports while shorting the cavity antenna to the lower housing.

20 Claims, 16 Drawing Sheets





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(12) **United States Patent**
Zhu et al.

(10) **Patent No.:** **US 9,203,139 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **ANTENNA STRUCTURES HAVING
SLOT-BASED PARASITIC ELEMENTS**

(75) Inventors: **Jiang Zhu**, Sunnyvale, CA (US); **Jerzy
Guterman**, Mountain View, CA (US);
Mattia Pascolini, Campbell, CA (US);
Hongfei Hu, Santa Clara, CA (US)

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(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

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patent is extended or adjusted under 35
U.S.C. 154(b) by 186 days.

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(21) Appl. No.: **13/464,789**

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(65) **Prior Publication Data**

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(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)
H01Q 13/10 (2006.01)
H01Q 21/28 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/521**
(2013.01); **H01Q 9/42** (2013.01); **H01Q 13/10**
(2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/521; H01Q 21/28;
H01Q 13/10; H01Q 9/42

See application file for complete search history.

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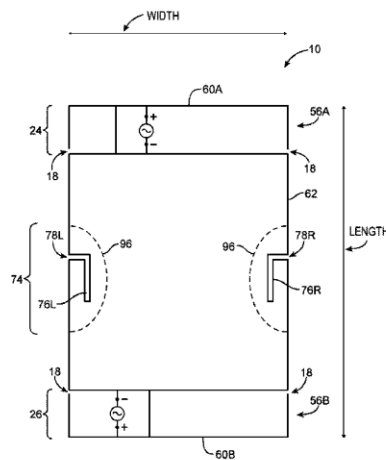
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(57) **ABSTRACT**

Electronic devices may include radio-frequency transceiver
circuitry and antenna structures. The antenna structures may
include antenna resonating elements and antenna ground
plane structures. An electronic device may have antennas
formed from the antenna resonating elements and an antenna
ground plane. The antenna ground plane may have slot struc-
tures. The slot structures may be configured to form a slot-
based parasitic antenna element to minimize coupling
between the antennas in a device. The slot-based parasitic
antenna element may be located between the antennas in a
device. The slots structures from which a parasitic antenna
element is formed may include open slots and closed slots.
Slots may have one or more arms and one or more bends.
Slots may be formed in internal housing members, traces on
dielectric carriers, and other conductive structures.

11 Claims, 20 Drawing Sheets





US009203140B2

(12) **United States Patent**
Yong et al.

(10) **Patent No.:** **US 9,203,140 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **MULTI-BAND FRAME ANTENNA**

(71) Applicant: **SONY MOBILE COMMUNICATIONS JAPAN, INC.**, Tokyo (JP)

(72) Inventors: **Check Chin Yong**, Tokyo (JP); **Minh-Chau Huynh**, Tokyo (JP)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **SONY MOBILE COMMUNICATIONS INC.**, Tokyo (JP)

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(22) Filed: **Aug. 8, 2013**

(65) **Prior Publication Data**

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H01Q 1/42 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/42 (2006.01)
H01Q 13/16 (2006.01)
H01Q 5/30 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/42** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/30** (2015.01); **H01Q 9/0464** (2013.01); **H01Q 9/42** (2013.01); **H01Q 13/16** (2013.01)

(58) **Field of Classification Search**

USPC 343/700 MS, 702, 866
See application file for complete search history.

(56) **References Cited**

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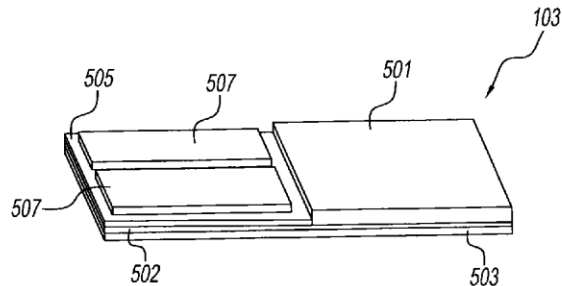
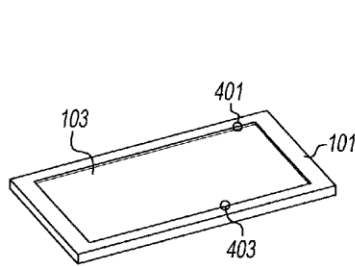
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A multi-band frame antenna to be used for LTE, MIMO, and other frequency bands. The frame antenna includes two main parts: a metallic frame with no gaps or discontinuities, and a conductive block. The outer perimeter of the metallic frame surrounds the conductive block, and there is a gap between the metallic frame and the conductive block. The conductive block is connected to a system ground. One or more antenna feeds are routed across the gap, between the metallic frame and the conductive block. One or more electrically shorted connections may also be made across the gap, between the metallic frame and the conductive block.

19 Claims, 35 Drawing Sheets





US009203141B1

(12) **United States Patent**
Su et al.

(10) **Patent No.:** **US 9,203,141 B1**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **COMMUNICATION DEVICE AND ANTENNA THEREOF**

(56) **References Cited**

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(71) Applicant: **KING SLIDE TECHNOLOGY CO., LTD.**, Kaohsiung (TW)

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(72) Inventors: **Hsin-Cheng Su**, Kaohsiung (TW);
Chun-Ta Liu, Kaohsiung (TW);
Shu-Chen Lin, Kaohsiung (TW)

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(73) Assignee: **KING SLIDE TECHNOLOGY CO., LTD.**, Kaohsiung Science Park, Lu Zhu Dist., Kaohsiung (TW)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 55 days.

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Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(21) Appl. No.: **14/302,418**

(57) **ABSTRACT**

(22) Filed: **Jun. 11, 2014**

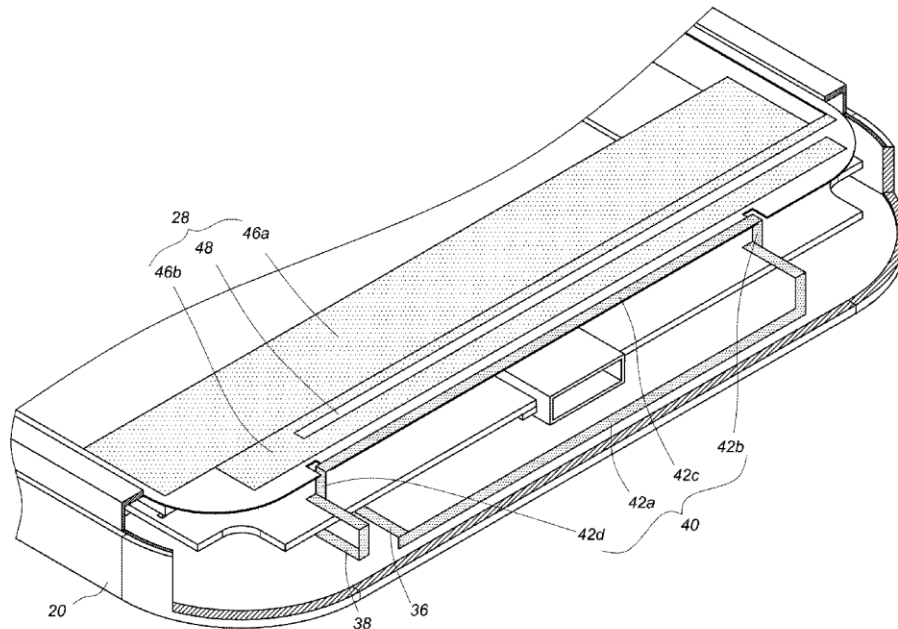
A communication device comprises a front housing, a back cover, a main body, a display panel, a signal feed point, a ground point, an antenna and a conductor. The main body is located between the front housing and the back cover. The antenna is installed on the main body and corresponding to an adjacent edge of the display panel. The antenna comprises a first metal part and a second metal part. The first metal part is coupled to the signal feed point, and the second metal part is coupled to the ground point. A coupling gap is defined between the conductor and the antenna, and at least one part of the conductor corresponds to the display panel.

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

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

(58) **Field of Classification Search**
USPC 343/702
See application file for complete search history.

12 Claims, 7 Drawing Sheets





US009203142B2

(12) **United States Patent
Zhu**

(10) **Patent No.:** **US 9,203,142 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **MOBILE COMMUNICATION ANTENNA
DEVICE AND MOBILE COMMUNICATION
TERMINAL DEVICE**

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

(72) Inventor: **Dejin Zhu**, Wuhan (CN)

(73) Assignee: **HUAWEI DEVICE CO., LTD.**,
Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 191 days.

(21) Appl. No.: **13/627,250**

(22) Filed: **Sep. 26, 2012**

(65) **Prior Publication Data**

US 2013/0082881 A1 Apr. 4, 2013

Related U.S. Application Data

(63) Continuation of application No.
PCT/CN2011/072197, filed on Mar. 28, 2011.

(30) **Foreign Application Priority Data**

Mar. 26, 2010 (CN) 2010 2 0144966 U

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

(52) **U.S. Cl.**
CPC **H01Q 1/38** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/36** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 5/357** (2015.01); **H01Q 5/378**
(2015.01); **H01Q 9/40** (2013.01); **H01Q 9/42**
(2013.01)

(58) **Field of Classification Search**
CPC ... H01Q 1/243; H01Q 5/0051; H01Q 5/0062;
H01Q 9/42
USPC 343/702, 700 MS
See application file for complete search history.

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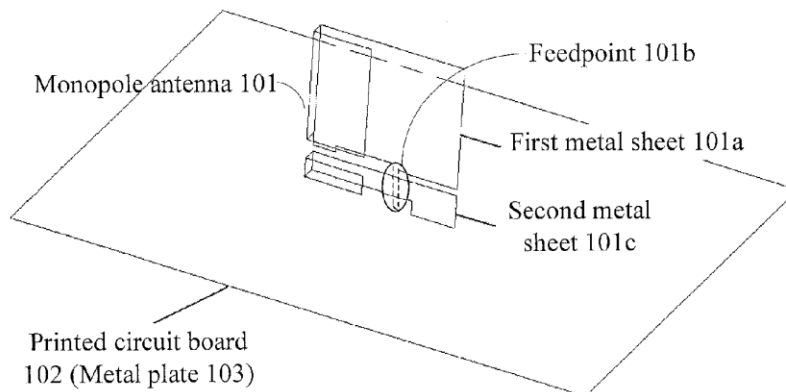
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Staas & Halsey LLP

(57) **ABSTRACT**

The present invention discloses a mobile communication antenna device. The device includes: a monopole antenna, placed on one side of a printed circuit board, where a distance between the monopole antenna and a central position of the printed circuit board is less than a threshold, and the monopole antenna includes a first metal sheet which is vertical to the printed circuit board, and is conducted with a circuit of the printed circuit board through a feedpoint. The present invention also discloses a mobile communication terminal device. By adopting the present invention, an ultra wideband antenna may be achieved, thereby making it possible that a mobile communication terminal device product, such as a fixed station, supports more frequency bands.

10 Claims, 2 Drawing Sheets





US009203152B2

(12) **United States Patent**
Chou

(10) **Patent No.:** **US 9,203,152 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **MULTI-BAND ANTENNA AND PORTABLE ELECTRONIC DEVICE THEREOF**

USPC 343/702, 700 MS, 826, 828, 829, 830, 343/846

See application file for complete search history.

(71) Applicant: **Wistron Corporation**, New Taipei (TW)

(56) **References Cited**

(72) Inventor: **Chen-Yu Chou**, New Taipei (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **Wistron Corporation**, Hsichih, New Taipei (TW)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 168 days.

* cited by examiner

(21) Appl. No.: **14/061,768**

Primary Examiner — Michael C Wimer

(22) Filed: **Oct. 24, 2013**

(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(65) **Prior Publication Data**

US 2015/0061939 A1 Mar. 5, 2015

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Sep. 3, 2013 (TW) 102216565 U

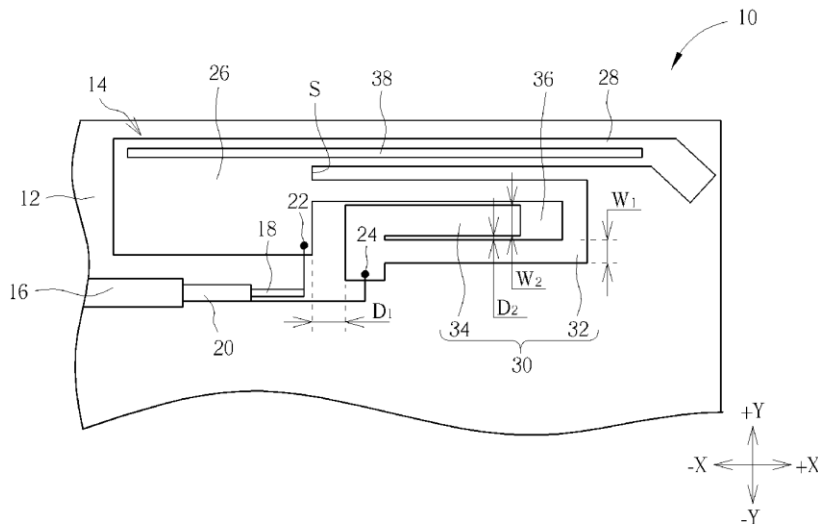
A multi-band antenna is disposed on a circuit board having a feeding line. The feeding line has a signal-transmitting end and a ground end. The multi-band antenna includes a feeding portion coupled to the signal-transmitting end, a ground portion coupled to the ground end, an intermediate-frequency sheet section extending from the feeding portion toward a first direction, a low-frequency arm, and a high-frequency arm. The low-frequency arm extends from a side of the intermediate-frequency sheet section toward a second direction opposite to the first direction. The high-frequency arm includes first and second bending portions. The first bending portion extends from the side of the intermediate-frequency sheet section toward the second direction so as to connect to the ground portion. The first bending portion has a recess. The second bending portion extends into the recess for transceiving signals within a first frequency band cooperatively with the first bending portion.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/371 (2015.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/371** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 5/371; H01Q 5/378; H01Q 9/0421

14 Claims, 2 Drawing Sheets





US009203164B2

(12) **United States Patent**
Lo Hine Tong et al.

(10) **Patent No.:** **US 9,203,164 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **ISOLATION OF ANTENNAS MOUNTED ON A PRINTED CIRCUIT BOARD**

(58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 1/526; H01Q 1/521
USPC 343/841
See application file for complete search history.

(71) Applicant: **Thomson Licensing**, Issy de Moulinaux (FR)

(56) **References Cited**

(72) Inventors: **Dominique Lo Hine Tong**, Cesson Sevigne (FR); **Philippe Minard**, Cesson Sevigne (FR); **Jean-Luc Robert**, Cesson Sevigne (FR)

U.S. PATENT DOCUMENTS

(73) Assignee: **Thomson Licensing**, Issy-les-Moulineaux (FR)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 13 days.

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(21) Appl. No.: **13/744,495**

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EP	1950834	7/2008
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JP	2005244317	9/2005
JP	2006121630	5/2006

(22) Filed: **Jan. 18, 2013**

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(65) **Prior Publication Data**
US 2013/0187823 A1 Jul. 25, 2013

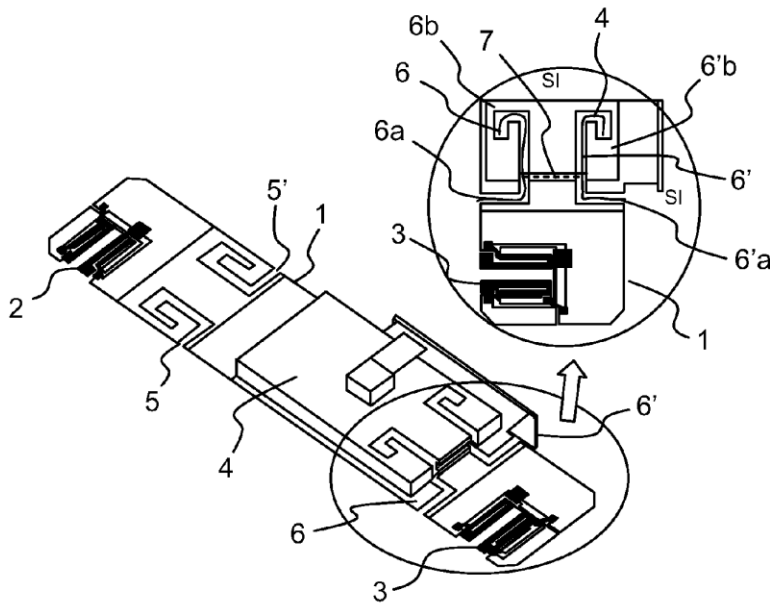
Primary Examiner — Hoang V Nguyen
Assistant Examiner — Michael Bouizza
(74) *Attorney, Agent, or Firm* — Robert D. Shedd; Brian J. Cromarty

(30) **Foreign Application Priority Data**
Jan. 20, 2012 (FR) 12 50571

(51) **Int. Cl.**
H01Q 21/28 (2006.01)
H01Q 1/52 (2006.01)
H01Q 1/22 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/22** (2013.01); **H01Q 1/521** (2013.01); **H01Q 1/526** (2013.01)

(57) **ABSTRACT**
The present invention relates to a circuit comprising on a same board at least one antenna, a processing circuit and a cover covering the processing circuit. Said circuit comprises between the antenna and the cover at least one isolation element realized partly on the board and partly on the cover.

5 Claims, 1 Drawing Sheet





US009203370B2

(12) **United States Patent**
Ryu et al.

(10) **Patent No.:** **US 9,203,370 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **BROADBAND CIRCUIT AND COMMUNICATION APPARATUS INCLUDING SAME**

(71) Applicant: **EMW CO., LTD.**, Incheon (KR)
(72) Inventors: **Byung Hoon Ryu**, Seoul (KR); **Won Mo Sung**, Gyeonggi-do (KR); **Yeon Sik Yu**, Gyeonggi-do (KR); **Ui Sheon Kim**, Gyeonggi-do (KR)
(73) Assignee: **EMW CO., LTD.**, Incheon (KR)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/009,514**
(22) PCT Filed: **Dec. 18, 2012**
(86) PCT No.: **PCT/KR2012/011037**
§ 371 (c)(1),
(2) Date: **Oct. 2, 2013**
(87) PCT Pub. No.: **WO2013/105744**
PCT Pub. Date: **Jul. 18, 2013**

(65) **Prior Publication Data**
US 2014/0327498 A1 Nov. 6, 2014

(30) **Foreign Application Priority Data**
Jan. 9, 2012 (KR) 10-2012-0002276

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H03H 7/01 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H03H 7/0115** (2013.01); **H01P 5/028** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/335** (2015.01); **H03H 7/0138** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 5/335; H01Q 5/371; H01Q 1/243; H03H 7/0115; H03H 7/0138

USPC 343/850; 333/174, 167
See application file for complete search history.

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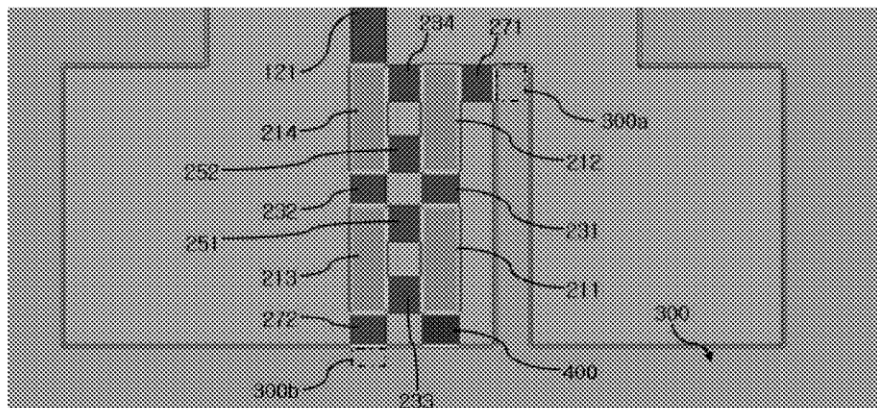
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — The PL Law Group, PLLC

(57) **ABSTRACT**

A broadband circuit between an antenna operating in a first service band and a power feeding unit and allowing the antenna to operate in a second service band wider than the first service band, includes a first line connected to the power feeding unit, a second line connected to a ground surface, a first capacitor between the first and second lines, a third line connected to the ground surface and parallel to the first line, a fourth line connected to the antenna and parallel to the second line, a second capacitor between the first and third lines, a first inductor between the first and third lines and closer to the first and third lines than the third capacitor, a fourth capacitor between the second and fourth lines, and a second inductor between the second and fourth lines and closer to the second and fourth lines than the fourth capacitor.

10 Claims, 6 Drawing Sheets





US009203463B2

(12) **United States Patent**
Asrani et al.

(10) **Patent No.:** **US 9,203,463 B2**
(45) **Date of Patent:** **Dec. 1, 2015**

(54) **MOBILE DEVICE WITH ANTENNA AND CAPACITANCE SENSING SYSTEM WITH SLOTTED METAL BEZEL**

(56) **References Cited**

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(71) Applicant: **Google Technology Holdings LLC**,
Mountain View, CA (US)
(72) Inventors: **Vijay L. Asrani**, Round Lake, IL (US);
Khan Mohammed Shams, Lindenhurst,
IL (US); **Timothy J. Sutherland**,
Gurnee, IL (US)
(73) Assignee: **Google Technology Holdings LLC**,
Mountain View, CA (US)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 26 days.

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(21) Appl. No.: **14/293,013**

(22) Filed: **Jun. 2, 2014**

(65) **Prior Publication Data**

US 2015/0171916 A1 Jun. 18, 2015

Related U.S. Application Data

(60) Provisional application No. 61/915,554, filed on Dec. 13, 2013.

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04B 1/68 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC . **H04B 1/68** (2013.01); **H01Q 1/245** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/245; H01Q 1/24; H01Q 9/0442;
H01Q 5/00; H01Q 5/335; H01Q 5/314;
H04B 1/68; H04B 1/0064; H04B 7/08;
H04W 40/06

See application file for complete search history.

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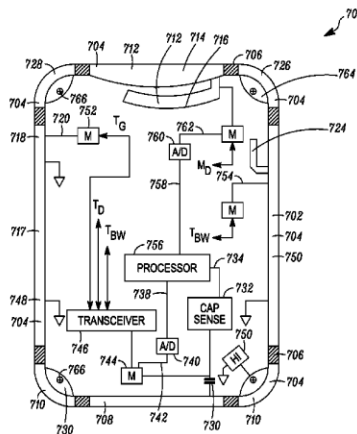
Primary Examiner — Meless Zewdu

(74) *Attorney, Agent, or Firm* — Faegre Baker Daniels LLP

(57) **ABSTRACT**

A mobile communication device is provided having a peripheral metal bezel made up of a plurality of metal segments. At least one of the metal segments on the bezel is configured to be a main antenna that is connected to a transceiver circuit via an antenna matching circuit. Proximate to the main antenna is another metal segment on the metal bezel that is configured to be a capacitance proximity sensor. The capacitance proximity sensor, in conjunction with a capacitance sensing circuit provide information to the circuitry within the mobile communication device to tune the antenna matching circuit to impedance match the transceiver with the antenna.

18 Claims, 5 Drawing Sheets





US009209512B2

(12) **United States Patent**
Cheng et al.

(10) **Patent No.:** **US 9,209,512 B2**
(45) **Date of Patent:** **Dec. 8, 2015**

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

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 1/2266
USPC 343/702, 841
See application file for complete search history.

(71) Applicant: **Wistron NeWeb Corporation**, Hsinchu (TW)

(56) **References Cited**

(72) Inventors: **Kai-Yang Cheng**, Hsinchu (TW);
Ming-Feng Chang, Hsinchu (TW);
Chih-Ming Wang, Hsinchu (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **Wistron NeWeb Corporation**, Hsinchu Science Park, Hsinchu (TW)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 354 days.

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(21) Appl. No.: **13/772,361**

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TW	201212384		3/2012

(22) Filed: **Feb. 21, 2013**

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(65) **Prior Publication Data**

US 2014/0097992 A1 Apr. 10, 2014

Primary Examiner — Tho G Phan

(30) **Foreign Application Priority Data**

Oct. 9, 2012 (TW) 101137317 A

(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
H01Q 13/10 (2006.01)

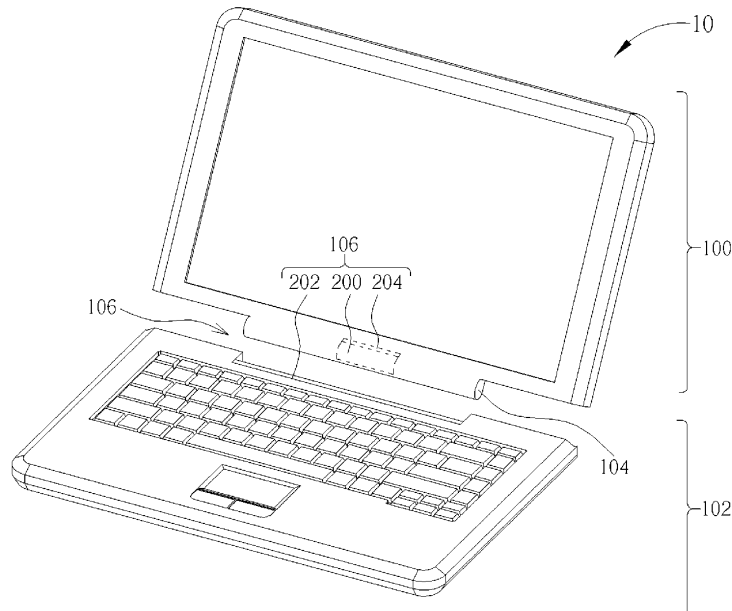
(57) **ABSTRACT**

An antenna device utilized in a wireless communication device having a lid, a chassis and a hinge is disclosed. The antenna device includes a radiating module disposed in the lid or the hinge and moving in response to movement of the lid, for transmitting or receiving radio-frequency signals; and a metal barricade disposed in an area apart from the radiating module by a specified distance on the chassis.

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 13/10** (2013.01)

16 Claims, 12 Drawing Sheets





US009209513B2

(12) **United States Patent**
Ely et al.

(10) **Patent No.:** **US 9,209,513 B2**
(45) **Date of Patent:** **Dec. 8, 2015**

(54) **ANTENNA WINDOW AND ANTENNA PATTERN FOR ELECTRONIC DEVICES AND METHODS OF MANUFACTURING THE SAME**

16/06 (2013.01); *C23C 28/322* (2013.01); *C23C 28/345* (2013.01); *H01Q 1/42* (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24
USPC 343/702
See application file for complete search history.

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

(72) Inventors: **Colin M. Ely**, Cupertino, CA (US); **Christopher D. Prest**, San Francisco, CA (US); **Lucy E. Browning**, San Francisco, CA (US); **Stephen B. Lynch**, Portola Valley, CA (US); **Eric S. Laakmann**, Cupertino, CA (US); **Paul L. Nangeroni**, Cupertino, CA (US)

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Primary Examiner — Dameon E Levi
Assistant Examiner — Andrea Lindgren Baltzell

(74) *Attorney, Agent, or Firm* — Downey Brand LLP

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 197 days.

(21) Appl. No.: **13/973,939**

(22) Filed: **Aug. 22, 2013**

(65) **Prior Publication Data**

US 2014/0361934 A1 Dec. 11, 2014

Related U.S. Application Data

(60) Provisional application No. 61/832,760, filed on Jun. 7, 2013.

(51) **Int. Cl.**

<i>H01Q 1/24</i>	(2006.01)
<i>C23C 14/16</i>	(2006.01)
<i>C23C 14/58</i>	(2006.01)
<i>C23C 16/06</i>	(2006.01)
<i>C23C 28/00</i>	(2006.01)
<i>H01Q 1/42</i>	(2006.01)

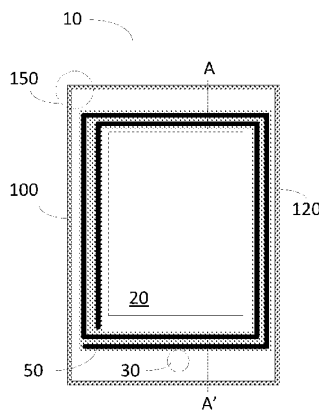
(52) **U.S. Cl.**

CPC *H01Q 1/243* (2013.01); *C23C 14/16* (2013.01); *C23C 14/5853* (2013.01); *C23C*

(57) **ABSTRACT**

A housing for an electronic device, including an aluminum layer enclosing a volume that includes a radio-frequency (RF) antenna is provided. The housing includes a window aligned with the RF antenna; the window including a non-conductive material filling a cavity in the aluminum layer; and a thin aluminum oxide layer adjacent to the aluminum layer and to the non-conductive material; wherein the non-conductive material and the thin aluminum oxide layer form an RF-transparent path through the window. A housing for an electronic device including an integrated RF-antenna is also provided. A method of manufacturing a housing for an electronic device as described above is provided.

20 Claims, 15 Drawing Sheets





US009209515B2

(12) **United States Patent**
Lin et al.

(10) **Patent No.:** **US 9,209,515 B2**
(45) **Date of Patent:** **Dec. 8, 2015**

(54) **THREE-DIMENSIONAL ANTENNA AND A WIRELESS COMMUNICATION APPARATUS PROVIDED WITH THE SAME**

(58) **Field of Classification Search**
CPC H01Q 1/36; H01Q 1/48; H01Q 1/243
USPC 343/702, 848
See application file for complete search history.

(71) Applicant: **C/O WISTRON NeWEB CORP.**, New Taipei (TW)

(56) **References Cited**

(72) Inventors: **Chia-Hong Lin**, New Taipei (TW);
Jui-Hsiang Chou, New Taipei (TW);
Chang-Hsiu Huang, New Taipei (TW);
Shih-Hong Chen, New Taipei (TW);
Yi-Cheng Wu, New Taipei (TW)

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(73) Assignee: **Wistron NeWeb Corporation**, New Taipei (TW)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 446 days.

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(21) Appl. No.: **13/677,356**

Primary Examiner — Dameon E Levi
Assistant Examiner — Collin Dawkins

(22) Filed: **Nov. 15, 2012**

(74) *Attorney, Agent, or Firm* — LeClairRyan

(65) **Prior Publication Data**

US 2013/0201062 A1 Aug. 8, 2013

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

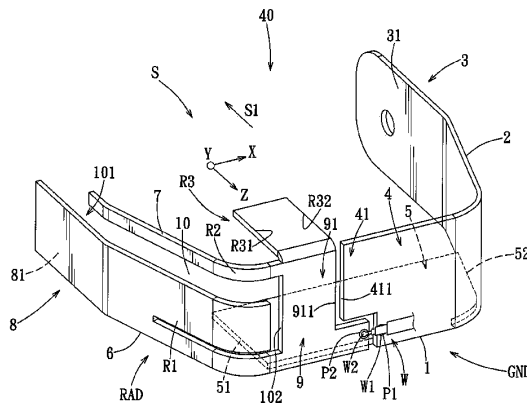
Feb. 8, 2012 (TW) 101104059 A

A three-dimensional antenna includes an L-shaped grounding element and an L-shaped radiating element. The grounding and radiating elements are arranged in a U shape. The grounding element includes a first grounding segment, a second grounding segment extending from the first grounding segment, and a short-circuit point disposed at the second grounding segment. The radiating element includes a first radiating segment opposite to the first grounding segment, a second radiating segment extending from the first radiating segment and adjacent to the second grounding segment, a feeding point disposed at the second radiating segment, and two radiator arms being able to generate respective resonant frequencies.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/08 (2006.01)
H01Q 9/26 (2006.01)

17 Claims, 6 Drawing Sheets

(52) **U.S. Cl.**
CPC **H01Q 1/36** (2013.01); **H01Q 1/084** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/26** (2013.01)





US009209517B2

(12) **United States Patent**
Choi et al.

(10) **Patent No.:** **US 9,209,517 B2**
(45) **Date of Patent:** **Dec. 8, 2015**

- (54) **MIMO/DIVERSITY ANTENNA FOR IMPROVING THE ISOLATION OF A SPECIFIC FREQUENCY BAND**
- (75) Inventors: **Sang-Hoon Choi**, Anyang-shi (KR); **Young-Sang Kim**, Seoul (KR); **Bu-Seok Shim**, Seoul (KR)
- (73) Assignee: **MOBITECH CORP.**, Seoul (KR)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 196 days.

USPC 343/700 MS, 846
See application file for complete search history.

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Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — LRK Patent Law Firm

- (21) Appl. No.: **13/983,568**
- (22) PCT Filed: **Feb. 8, 2012**
- (86) PCT No.: **PCT/KR2012/000912**
§ 371 (c)(1),
(2), (4) Date: **Aug. 4, 2013**
- (87) PCT Pub. No.: **WO2012/108682**
PCT Pub. Date: **Aug. 16, 2012**

- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
Feb. 9, 2011 (KR) 10-2011-0011420

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

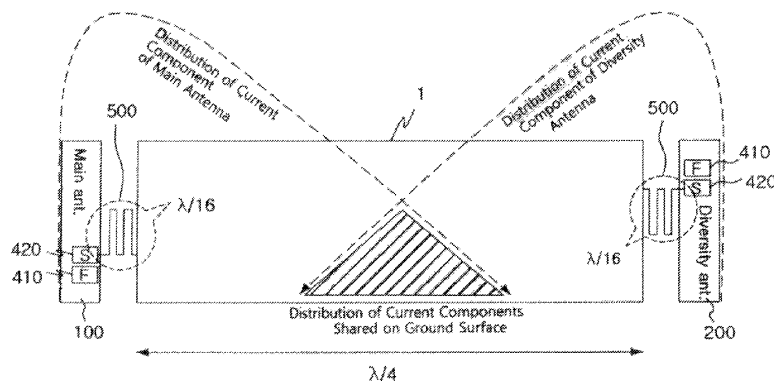
- (52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 1/241** (2013.01); **H01Q 1/521** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 21/28** (2013.01)

- (58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/241; H01Q 1/523;
H01Q 21/28; H01Q 9/0421

(57) **ABSTRACT**

A MIMO/diversity antenna for improving isolation of a frequency band includes: a ground surface formed on a printed circuit board; planar inverted F antennas having the ground surface therebetween and disposed on the printed circuit board having no ground surface formed, each F antenna having an antenna pattern that includes a radiation unit, a power supply unit, and a ground unit; power supply pads and ground pads formed on the printed circuit board having no ground surface formed corresponding to the power supply unit and the ground unit of the antenna pattern in the planar inverted F antennas; and connection patterns connecting the ground surface with each ground pad to electrically connect the ground surface to each ground unit of the antenna pattern in the planar inverted F antennas. At least one of the connection patterns is formed with a strip line of a meandering shape.

5 Claims, 5 Drawing Sheets





US009209520B2

(12) **United States Patent**
Oon et al.

(10) **Patent No.:** **US 9,209,520 B2**
(45) **Date of Patent:** **Dec. 8, 2015**

(54) **HYBRID ANTENNA FOR PORTABLE COMMUNICATION DEVICES**

(58) **Field of Classification Search**
CPC H01Q 9/06; H01Q 1/088; H01Q 21/28; H01Q 1/362; H01Q 9/42; H01Q 1/242
USPC 343/702, 729, 745, 749, 895, 806
See application file for complete search history.

(71) Applicant: **Motorola Solutions, Inc.**, Schaumburg, IL (US)

(56) **References Cited**

(72) Inventors: **Chin Keong Alexander Oon**, Penang (MY); **Sin Keng Lee**, Kedah (MY)

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(73) Assignee: **Motorola Solutions, Inc.**, Schaumburg, IL (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 311 days.

(21) Appl. No.: **13/767,520**

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(22) Filed: **Feb. 14, 2013**

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(65) **Prior Publication Data**
US 2013/0207856 A1 Aug. 15, 2013

Corresponding Chinese Patent Application No. 201301022316.3—
Office Action dated Oct. 24, 2014.
Corresponding Malaysian Patent Application No. PI2012000651—
Office Action dated Jun. 15, 2015.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/06 (2006.01)
H01Q 1/08 (2006.01)
H01Q 1/36 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

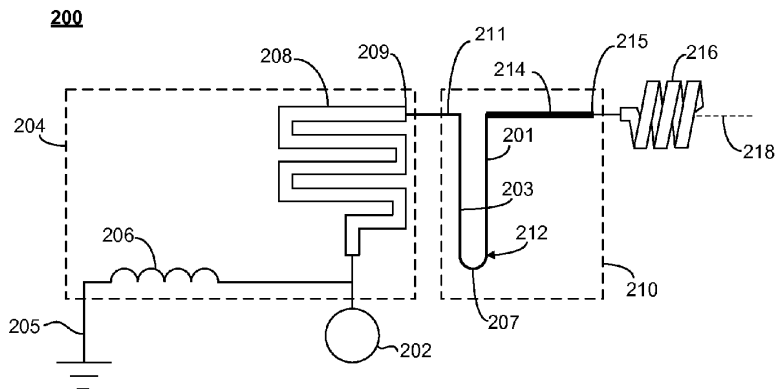
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Primary Examiner — Michael C Wimer
(74) *Attorney, Agent, or Firm* — Barbara R. Dautre

(52) **U.S. Cl.**
CPC **H01Q 9/06** (2013.01); **H01Q 1/088** (2013.01); **H01Q 1/242** (2013.01); **H01Q 1/362** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(57) **ABSTRACT**
An antenna structure (111) commences at a feed point (202) that is coupled to an inverted F antenna section (204). The inverted F antenna section is coupled to a monopole section (210) that is further coupled to a helical section (216). The inverted F section, monopole section, and helical section are coupled in series together.

12 Claims, 6 Drawing Sheets





US009209851B1

(12) **United States Patent**
Wilmhoff et al.

(10) **Patent No.:** **US 9,209,851 B1**
(45) **Date of Patent:** ***Dec. 8, 2015**

- (54) **ELECTRONIC DEVICE CASE WITH ANTENNA**
- (71) Applicant: **BluFlux RF Technologies, LLC**,
Louisville, CO (US)
- (72) Inventors: **Benjamin Russell Wilmhoff**, Boulder,
CO (US); **Andrew David Rowser**,
Boulder, CO (US)
- (73) Assignee: **BLUFLUX RF TECHNOLOGIES,
LLC**, Louisville, CO (US)
- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

This patent is subject to a terminal dis-
claimer.
- (21) Appl. No.: **14/574,675**
- (22) Filed: **Dec. 18, 2014**

Related U.S. Application Data

- (63) Continuation of application No. 14/322,027, filed on
Jul. 2, 2014, now Pat. No. 8,954,122.

- (51) **Int. Cl.**
H04M 1/00 (2006.01)
H04B 1/3888 (2015.01)
H04B 5/00 (2006.01)
H04B 1/3827 (2015.01)
- (52) **U.S. Cl.**
CPC **H04B 1/3888** (2013.01); **H04B 1/3838**
(2013.01); **H04B 5/0031** (2013.01); **H04B**
5/0081 (2013.01)

- (58) **Field of Classification Search**
CPC H04W 4/02; H04Q 1/245; H04Q 1/243;
H04M 1/00; H04B 1/3888; H04B 5/0081;
H04B 5/0031; H04B 1/3838
USPC 455/83, 575.7, 575.1; 340/572.5, 572.1,
340/572.7; 342/375, 368, 372
See application file for complete search history.

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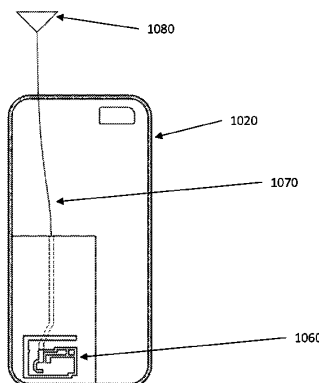
Primary Examiner — Mahendra Patel

(74) *Attorney, Agent, or Firm* — pklousek.ip

(57) **ABSTRACT**

A method for improving signal quality for a mobile electronic device and an apparatus embodying the method, comprising a protective case comprising a shell that encases at least a portion of the mobile electronic device; an external antenna assembly position-ably attached to the shell; a transmission line attached to the shell and electrically interconnected to the case antenna; and a near-field coupling device attached to the shell and having a feed port electrically interconnected to the transmission line, the near-field coupling device configured to near-field couple to a native antenna of the encased mobile electronic device to capture an electromagnetic signal generated by the native antenna of the mobile electronic device.

15 Claims, 16 Drawing Sheets





US009214721B2

(12) **United States Patent**
Israel et al.

(10) **Patent No.:** **US 9,214,721 B2**
(45) **Date of Patent:** **Dec. 15, 2015**

(54) **ANTENNA DESIGNS AND SYSTEM FOR REDUCING ENERGY EMISSIONS FROM WEARABLE MOBILE DEVICE**

(71) Applicant: **GPS Tracking and Security IP, LLC**, Henderson, NV (US)

(72) Inventors: **David Israel**, Emek Hayarden (IL); **Refael Israel**, Rison Ltzion (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 423 days.

(21) Appl. No.: **13/711,539**

(22) Filed: **Dec. 11, 2012**

(65) **Prior Publication Data**
US 2014/0159969 A1 Jun. 12, 2014

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/27 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/273** (2013.01); **H01Q 1/38** (2013.01); **H01Q 13/106** (2013.01); **Y02B 60/50** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/273; H01Q 13/106; Y02B 60/50
See application file for complete search history.

(56) **References Cited**

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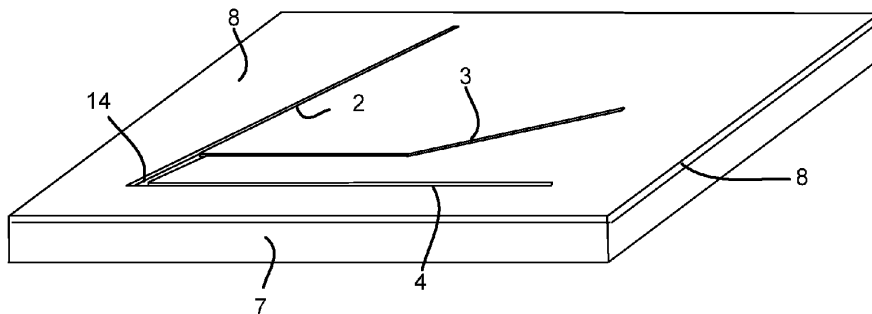
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Kunzler Law Group

(57) **ABSTRACT**

The present invention relates to design of antennas for efficient communication over the radio-frequency airwaves in applications such as cellular phones and more particularly, wearable wireless devices, and to a system for reducing the overall electromagnetic energy radiated from a cellular phone designed to be worn on the body. The invention includes a series of antenna designs with a configuration of materials that can transmit wireless signals efficiently without excess power being emitted, enabling regulatory approval of a wearable wireless communications device, enhancing consumer safety, and increasing battery life. The design further enables a single antenna, with extraordinarily small physical dimensions, to be used across many of the most popular wireless communication spectra in the United State and worldwide. The accompanying system further reduces the electromagnetic emissions from a cellular or mobile communications device designed to be worn on the body, further enabling such devices to meet relevant regulatory approval standards in the United States and elsewhere.

24 Claims, 8 Drawing Sheets





US009214727B2

(12) **United States Patent**
Huang et al.

(10) **Patent No.:** **US 9,214,727 B2**
(45) **Date of Patent:** **Dec. 15, 2015**

- (54) **MULTI-BAND ANTENNA**
- (71) Applicant: **AUDEN TECHNO CORP.**, Taoyuan County (TW)
- (72) Inventors: **Yu-Tsung Huang**, Kaohsiung (TW); **Pin-Tang Chiu**, Kaohsiung (TW); **Yen-Chao Li**, Taoyuan County (TW)
- (73) Assignee: **AUDEN TECHNO CORP.**, Taoyuan County (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 80 days.

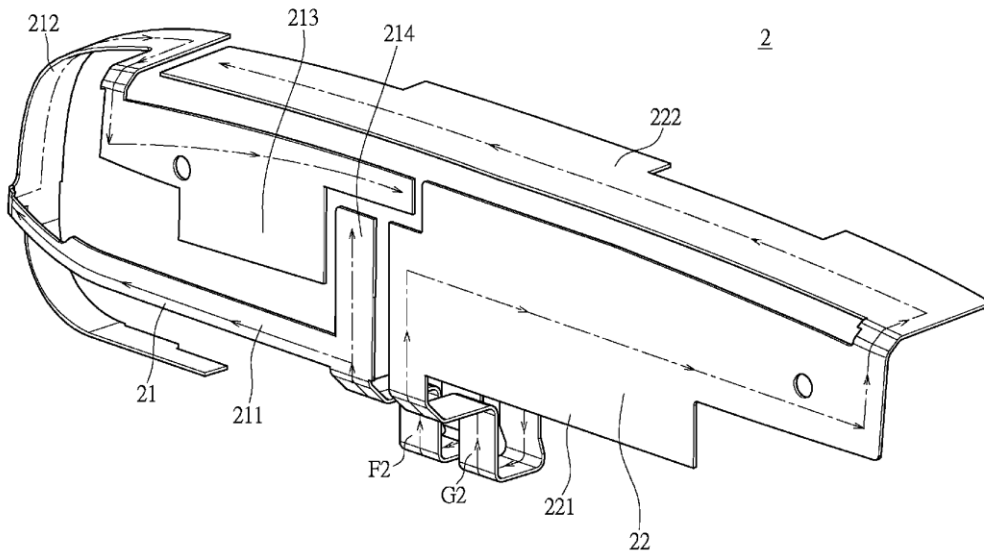
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- Primary Examiner* — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

- (21) Appl. No.: **14/276,950**
- (22) Filed: **May 13, 2014**
- (65) **Prior Publication Data**
US 2015/0333400 A1 Nov. 19, 2015
- (51) **Int. Cl.**
H01Q 5/307 (2015.01)
H01Q 5/20 (2015.01)
H01Q 5/30 (2015.01)
- (52) **U.S. Cl.**
CPC **H01Q 5/307** (2015.01); **H01Q 5/20** (2015.01); **H01Q 5/30** (2015.01)
- (58) **Field of Classification Search**
CPC H01Q 5/20; H01Q 5/30; H01Q 5/307; H01Q 1/243
USPC 343/700 MS, 702
See application file for complete search history.

(57) **ABSTRACT**

A multi-band antenna comprises a single-pole radiating portion and a coupling radiating portion coupled to a grounding terminal. The single-pole radiating portion has a first radiating unit and a fourth radiating unit coupled to a feeding terminal. The single-pole radiating portion is bent to form a second radiating unit and a third radiating unit. The coupling radiating portion has a fifth radiating unit, and the coupling radiating portion is bent to form a sixth radiating unit. The sixth radiating unit of the coupling radiating portion and the third radiating unit of the single-pole radiating portion are coupled to each other to generate a LTE technology band near 700 MHz. The fifth radiating unit of the coupling radiating portion, the third radiating unit and the fourth radiating unit of the single-pole radiating portion are coupled to each other to generate a high frequency band.

10 Claims, 7 Drawing Sheets





US009214731B2

(12) **United States Patent**
Grange et al.

(10) **Patent No.:** **US 9,214,731 B2**
(45) **Date of Patent:** **Dec. 15, 2015**

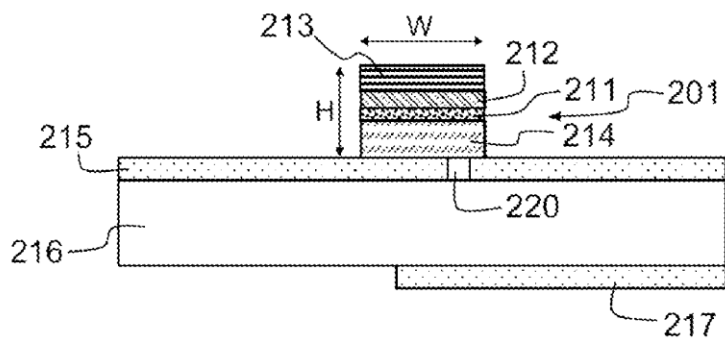
- (54) **PLANAR ANTENNA HAVING A WIDENED BANDWIDTH**
- (75) Inventors: **François Grange**, Moirans (FR); **Christophe Delaveaud**, St. Jean de Moirans (FR); **Bernard Viala**, Sassenage (FR)
- (73) Assignee: **COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES**, Paris (FR)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 406 days.
- (21) Appl. No.: **13/988,750**
- (22) PCT Filed: **Nov. 22, 2011**
- (86) PCT No.: **PCT/EP2011/070712**
§ 371 (c)(1),
(2), (4) Date: **Jul. 23, 2013**
- (87) PCT Pub. No.: **WO2012/069492**
PCT Pub. Date: **May 31, 2012**
- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
Nov. 22, 2010 (FR) 10 59611
- (51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 9/0428** (2013.01); **H01Q 9/0457** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/04
USPC 343/843, 700 MS, 905
See application file for complete search history.

- (56) **References Cited**
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- Primary Examiner — Huedung Mancuso
- (74) Attorney, Agent, or Firm — Baker & Hostetler LLP

(57) **ABSTRACT**
A planar antenna with widened bandwidth comprises at least one first conducting element disposed above an earth plane and separated from the latter, and means for exciting said at least first conducting element, configured to excite two distinct orthogonal resonant modes, wherein said at least first conducting element is embodied by a substrate comprising at least one thin layer of an anisotropic material with relative permeability of greater than 10 for 2 GHz. The antenna applies notably to mobile communications terminals.

13 Claims, 10 Drawing Sheets





US009214732B2

(12) **United States Patent**
Huang et al.

(10) **Patent No.:** **US 9,214,732 B2**
(45) **Date of Patent:** **Dec. 15, 2015**

(54) **FLEXIBLE PIFA ANTENNA WITH TUNABLE COUPLING ELEMENT**

(71) Applicants: **Chen Hung Huang**, Zhongli (TW);
Ronan Quinlan, Wexford (IE)

(72) Inventors: **Chen Hung Huang**, Zhongli (TW);
Ronan Quinlan, Wexford (IE)

(73) Assignee: **TAOGIAS GROUP HOLDINGS LIMITED**, Wexford (IE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 172 days.

(21) Appl. No.: **14/091,182**

(22) Filed: **Nov. 26, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/729,728, filed on Nov. 26, 2012.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0421** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 861
See application file for complete search history.

(56) **References Cited**

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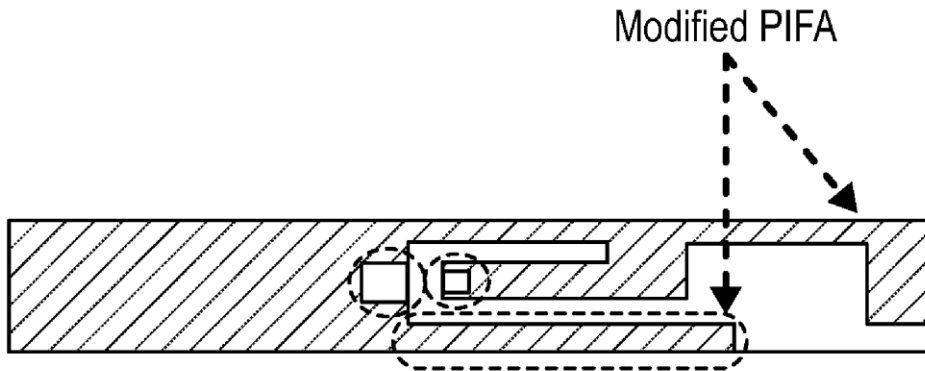
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(57) **ABSTRACT**

A modified PIFA antenna is designed for wireless local area network (WLAN) applications. The modified PIFA antenna is configured to resist detuning effects caused by use of various cable lengths and is adapted for use in the 2.4 GHz operation band. A slot extends between the ground and feed portions of the antenna for slightly increasing frequency bandwidth of the antenna.

6 Claims, 4 Drawing Sheets





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Qi et al.

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(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE INCLUDING AN ELECTRICALLY CONDUCTIVE DIRECTOR ELEMENT AND RELATED METHODS**

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H01Q 1/24 (2006.01)
H01Q 19/00 (2006.01)

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CPC **H01Q 19/00** (2013.01); **H01Q 1/243** (2013.01); **Y10T 29/49002** (2015.01)

(58) **Field of Classification Search**
USPC 343/818, 833-834, 702, 700 MS
See application file for complete search history.

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(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing, a printed circuit board (PCB) carried by the portable housing, a wireless transceiver carried by the PCB, and an antenna connected to the transceiver and carried by the PCB. The mobile wireless communications device may further include at least one director element for directing a beam pattern of the antenna. More particularly, the at least one director element may include an electrically conductive main branch carried by the portable housing, and an electrically conductive connector portion extending between the main branch and the PCB.

20 Claims, 7 Drawing Sheets

