



US009397388B2

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

(10) **Patent No.:** **US 9,397,388 B2**

(45) **Date of Patent:** ***Jul. 19, 2016**

(54) **DUAL FEED ANTENNA**

(71) Applicant: **SKYCROSS, INC.**, Fremont, CA (US)

(72) Inventors: **Mark T. Montgomery**, Melbourne Beach, FL (US); **Paul A. Tornatta, Jr.**, Melbourne, FL (US)

(73) Assignee: **Skycross, Inc.**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 249 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/107,568**

(22) Filed: **Dec. 16, 2013**

(65) **Prior Publication Data**

US 2014/0104119 A1 Apr. 17, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/757,192, filed on Feb. 1, 2013, now Pat. No. 8,633,860, which is a continuation of application No. 12/644,718, filed on Dec. 22, 2009, now Pat. No. 8,373,603.

(60) Provisional application No. 61/140,370, filed on Dec. 23, 2008.

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

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01); **H01Q 5/364** (2015.01); **H01Q 5/371** (2015.01); **H01Q 7/00** (2013.01); **H01Q 9/06** (2013.01); **H01Q 9/30** (2013.01); **H01Q 9/40** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/24; H01Q 5/364; H01Q 5/371; H01Q 9/40; H01Q 9/42
USPC 343/700 MS, 702, 853
See application file for complete search history.

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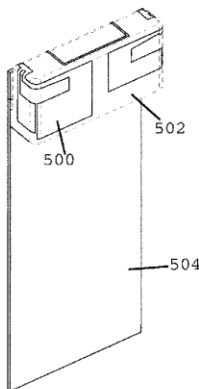
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLC; Robert Gingher

(57) **ABSTRACT**

The subject disclosure may include, for example, an antenna structure including an antenna having a first antenna port to transmit electromagnetic signals and a second antenna port to receive electromagnetic signals, where the antenna is coupled to a housing assembly of a communication device to transmit energy between the housing assembly and the first antenna port and second antenna port, and where first resonant modes of the housing assembly for the first antenna port or second resonant modes of the housing assembly for the second antenna port increases decoupling between the first antenna port and the second antenna port. Other embodiments are disclosed.

20 Claims, 9 Drawing Sheets





US009397390B2

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

(10) **Patent No.:** **US 9,397,390 B2**
(45) **Date of Patent:** **Jul. 19, 2016**

(54) **TERMINAL HAVING HF TRANSMISSION
LINE USING PRINTED CIRCUIT BOARD**

- (71) Applicant: **GIGALANE CO., LTD.**, Gyeonggi-do (KR)
- (72) Inventors: **Yong Goo Lee**, Seoul (KR); **Kyung Hun Jung**, Seoul (KR); **Kwang Seok Choi**, Gyeonggi-do (KR); **Hee Seok Jung**, Gyeonggi-do (KR)
- (73) Assignee: **GIGALANE CO., LTD.**, Gyeonggi-Do (KR)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 160 days.

(21) Appl. No.: **14/173,229**

(22) Filed: **Feb. 5, 2014**

(65) **Prior Publication Data**
US 2014/0225806 A1 Aug. 14, 2014

(30) **Foreign Application Priority Data**
Feb. 13, 2013 (KR) 10-2013-0015448

- (51) **Int. Cl.**
H01Q 1/00 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/243
USPC 343/905, 702
See application file for complete search history.

(56) **References Cited**

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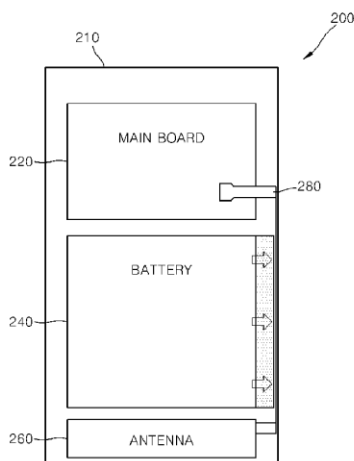
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Primary Examiner — Peguy Jean Pierre
(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

Provided is a terminal including a high frequency (HF) communication line using a flexible printed circuit board (FPCB). The terminal includes a base board, a main board, an antenna, a battery, and an FPCB connected between the main board and the antenna and formed with an HF communication line for radio frequency (RF) communication. The FPCB includes a first connection formed on one end thereof and electrically connected to the main board, a second connection formed on another end thereof and electrically connected to the antenna, and a connector connecting the first connection with the second connection and bent at the right angle with the first connection and the second connection to vertically stand between the battery and the wall plate of the base board, thereby maximizing an area for the battery.

16 Claims, 26 Drawing Sheets





US009397398B2

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

(10) **Patent No.:** **US 9,397,398 B2**

(45) **Date of Patent:** ***Jul. 19, 2016**

(54) **MULTIPLE-BAND ANTENNA WITH PATCH AND SLOT STRUCTURES**

(71) Applicant: **BLACKBERRY LIMITED**, Waterloo (CA)

(72) Inventors: **Geyi Wen**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA); **Adam D. Stevenson**, Waterloo (CA)

(73) Assignee: **BLACKBERRY LIMITED**, Waterloo (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 199 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/269,811**

(22) Filed: **May 5, 2014**

(65) **Prior Publication Data**

US 2014/0240180 A1 Aug. 28, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/933,251, filed on Jul. 2, 2013, now Pat. No. 8,878,731, which is a continuation of application No. 13/488,101, filed on Jun. 4, 2012, now Pat. No. 8,531,336, which is a

(Continued)

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/00 (2015.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/0027** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/10** (2015.01);

(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 13/10; H01Q 1/38; H01Q 5/307; H01Q 9/0407; H01Q 9/0421; H01Q 5/357

USPC 343/700 MS, 702, 770, 767; 29/600
See application file for complete search history.

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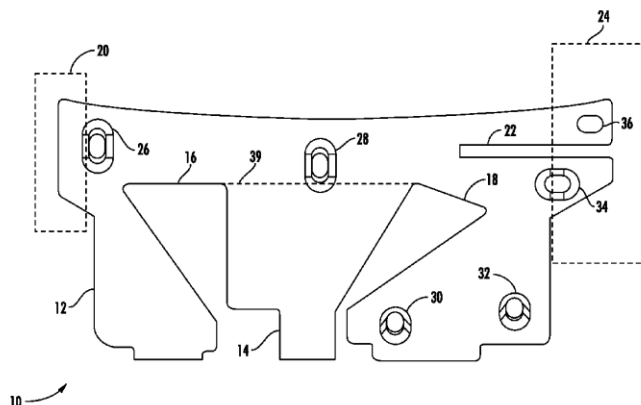
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLC; Robert Gingher

(57) **ABSTRACT**

A multiple-band antenna having first and second operating frequency bands is provided. The antenna includes a first patch structure associated primarily with the first operating frequency band, a second patch structure electrically coupled to the first patch structure and associated primarily with the second operating frequency band, a first slot structure disposed between a first portion of the first patch structure and the second patch structure and associated primarily with the first operating frequency band, and a second slot structure disposed between a second portion of the first patch structure and the second patch structure and associated primarily with the second operating frequency band. A mounting structure for the multiple-band antenna is also provided. The mounting structure includes a first surface and a second surface opposite to and overlapping the first surface.

23 Claims, 7 Drawing Sheets





US009397399B2

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

(10) **Patent No.:** **US 9,397,399 B2**
(45) **Date of Patent:** **Jul. 19, 2016**

(54) **LOOP ANTENNA WITH SWITCHABLE
FEEDING AND GROUNDING POINTS**

(71) Applicants: **Olivier Pajona**, San Diego, CA (US);
Laurent Desclos, San Diego, CA (US)

(72) Inventors: **Olivier Pajona**, San Diego, CA (US);
Laurent Desclos, San Diego, CA (US)

(73) Assignee: **ETHERTRONICS, INC.**, 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 456 days.

(21) Appl. No.: **13/868,093**

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

(65) **Prior Publication Data**

US 2013/0307740 A1 Nov. 21, 2013

Related U.S. Application Data

(60) Provisional application No. 61/636,553, filed on Apr.
20, 2012.

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 5/307 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 7/00** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 5/307** (2015.01); **H01Q 21/28**
(2013.01)

(58) **Field of Classification Search**

CPC H01Q 7/00; H01Q 1/243; H01Q 21/28
USPC 343/748, 866, 702
See application file for complete search history.

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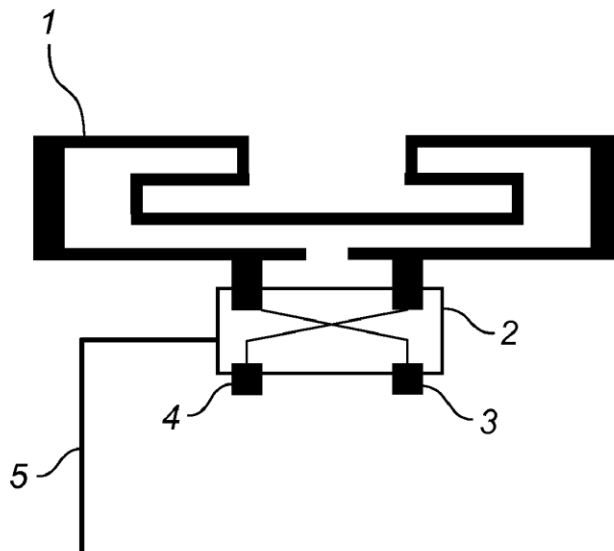
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Coastal Patent Law Group,
P.C.

(57) **ABSTRACT**

An active differential antenna is described that provides for improved performance for wireless communication systems across a wide set of use cases and environments. A balanced antenna structure along with switch assembly provides the differential mode radiation which results in minimal coupling to the components and items in the near field of the antenna. This results in an efficient antenna that is well isolated from the local environment of the antenna. The switch assembly is configured to switch the feed and ground connections of the differential design when needed to provide similar antenna performance for both “against head left” and “against head right” use cases for a cellular handset application for example. An active component or circuit can be integrated or coupled to the antenna design to provide the capability to dynamically balance the antenna to maintain pattern symmetry and efficiency.

11 Claims, 17 Drawing Sheets





US009397402B2

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

(10) **Patent No.:** **US 9,397,402 B2**

(45) **Date of Patent:** ***Jul. 19, 2016**

(54) **ANTENNA HAVING A PLANAR CONDUCTING ELEMENT WITH FIRST AND SECOND END PORTIONS SEPARATED BY A NON-CONDUCTIVE GAP**

(71) Applicant: **Airwire Technologies**, Reno, NV (US)

(72) Inventors: **Forrest D. Wolf**, Reno, NV (US);
Claude Jean Michel Laurent, Aalborg (DK)

(73) Assignee: **AirWire Technologies**, Reno, NV (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 disclaimer.

(21) Appl. No.: **14/546,736**

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

(65) **Prior Publication Data**

US 2015/0318615 A1 Nov. 5, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/434,594, filed on Mar. 29, 2012, now Pat. No. 8,890,751.

(60) Provisional application No. 61/599,932, filed on Feb. 17, 2012.

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

(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/243** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/045** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 7/00; H01Q 1/38; H01Q 9/045;
H01Q 9/42; H01Q 1/243

USPC 343/700 MS, 741, 866
See application file for complete search history.

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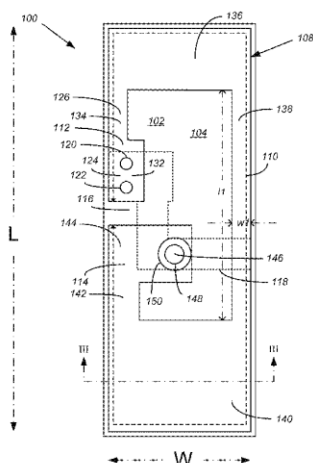
International Search Report and Written Opinion dated Jun. 26, 2013 in International Application No. PCT/US2013/026602. 12 pages.

Primary Examiner — Hoang V Nguyen

(57) **ABSTRACT**

In one embodiment, an antenna includes a dielectric material and a planar conducting element. The dielectric material has a first side opposite a second side, with the planar conducting element residing on the first side. The planar conducting element defines a conductive path between first and second end portions of the planar conducting element, which end portions are separated by a non-conductive gap. In another embodiment, an antenna has a planar conducting element defining a conductive path between first and second end portions of the planar conducting element. The planar conducting element has at least two different widths transverse to the conductive path. The first and second end portions of the planar conducting element are separated by a non-conductive gap.

18 Claims, 15 Drawing Sheets





US009397405B2

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

(10) **Patent No.:** **US 9,397,405 B2**
(45) **Date of Patent:** **Jul. 19, 2016**

(54) **ANTENNA DEVICE**

(56) **References Cited**

(75) Inventors: **Masahiro Yanagi**, Tokyo (JP); **Shigemi Kurashima**, Tokyo (JP); **Hideaki Yoda**, Tokyo (JP)

(73) Assignee: **FUJITSU COMPONENT LIMITED**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 156 days.

(21) Appl. No.: **13/329,452**

(22) Filed: **Dec. 19, 2011**

(65) **Prior Publication Data**

US 2012/0162036 A1 Jun. 28, 2012

(30) **Foreign Application Priority Data**

Dec. 28, 2010 (JP) 2010-294268

(51) **Int. Cl.**

H01Q 9/42 (2006.01)

H01Q 13/10 (2006.01)

H01Q 5/00 (2015.01)

H01Q 5/378 (2015.01)

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

CPC **H01Q 9/42** (2013.01); **H01Q 5/378** (2015.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 1/48; H01Q 1/243; H01Q 5/378; H01Q 19/005

USPC 343/702, 767, 833, 834, 846, 700 MS, 343/848

See application file for complete search history.

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Primary Examiner — Hoang V Nguyen

Assistant Examiner — Daniel J Munoz

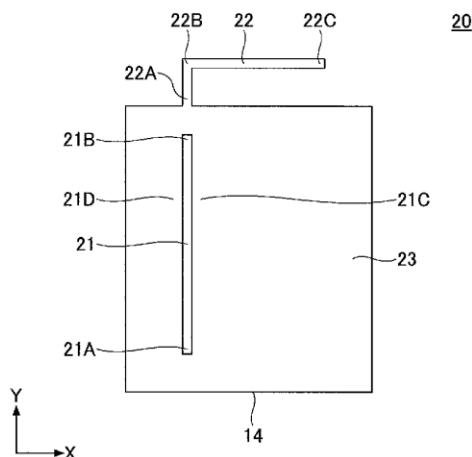
(74) *Attorney, Agent, or Firm* — IPUSA, PLLC

(57)

ABSTRACT

An antenna device includes a ground element configured to be grounded, a first antenna to be connected to a radio communication module, and a second antenna configured to be parasitic on the first antenna, the second antenna receiving no power feed.

5 Claims, 7 Drawing Sheets





US009397387B1

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

(10) **Patent No.:** **US 9,397,387 B1**
(45) **Date of Patent:** **Jul. 19, 2016**

(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.: **14/733,839**

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

Related U.S. Application Data

- (63) Continuation of application No. 14/640,787, filed on Mar. 6, 2015.
(51) **Int. Cl.**
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**
CPC H01Q 1/22; H01Q 1/24; H01Q 1/2258; H01Q 1/2266
USPC 343/700 MS, 702
See application file for complete search history.

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Primary Examiner — Sue A Purvis

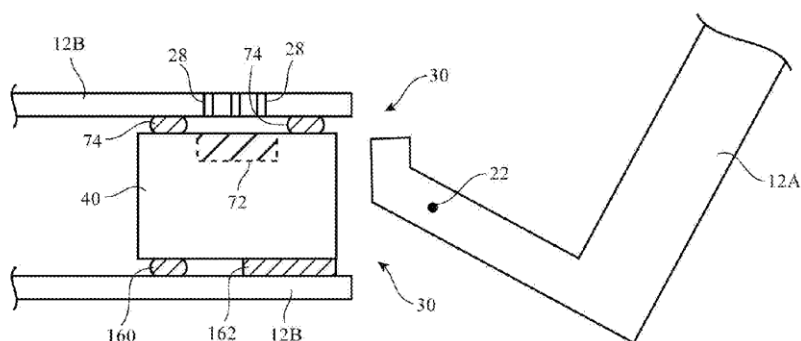
Assistant Examiner — Patrick Holecek

(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





US009400531B2

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

(10) **Patent No.:** **US 9,400,531 B2**

(45) **Date of Patent:** **Jul. 26, 2016**

(54) **NOTEBOOK COMPUTER**

(71) Applicant: **SHENZHEN ARBOO TECHNOLOGY CO., LTD.**, Baoan, Shenzhen, Guangdong (CN)

(72) Inventors: **David Chu**, Guangdong (CN); **Haihua Zhou**, Guangdong (CN)

(73) Assignee: **Shenzhen Arboo Technology Co., Ltd.**, Shenzhen, Guangdong province (CN)

(*) 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.: **14/374,017**

(22) PCT Filed: **Aug. 19, 2013**

(86) PCT No.: **PCT/CN2013/081754**

§ 371 (c)(1),

(2) Date: **Jul. 23, 2014**

(87) PCT Pub. No.: **WO2014/173048**

PCT Pub. Date: **Oct. 30, 2014**

(65) **Prior Publication Data**

US 2016/0041587 A1 Feb. 11, 2016

(30) **Foreign Application Priority Data**

Apr. 26, 2013 (CN) 2013 1 0149886

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

G06F 1/18 (2006.01)

G06F 1/16 (2006.01)

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

CPC **G06F 1/185** (2013.01); **G06F 1/1616** (2013.01); **G06F 1/1637** (2013.01); **G06F 1/1658** (2013.01); **G06F 1/1681** (2013.01); **H01Q 1/244** (2013.01)

(58) **Field of Classification Search**

CPC **G06F 1/183**; **G06F 1/185**; **G06F 1/186**; **G06F 1/1656**; **G06F 1/1658**; **H01Q 1/244**; **H01Q 1/2275**

USPC **361/801**

See application file for complete search history.

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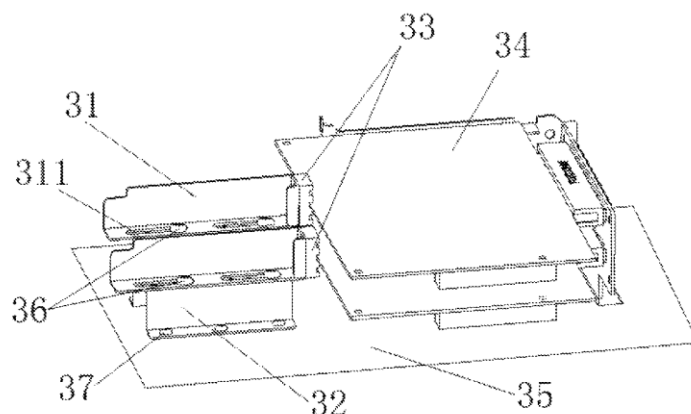
Primary Examiner — Adrian S Wilson

(74) Attorney, Agent, or Firm — PROI Intellectual Property
US
(57)

ABSTRACT

The present invention relates to a notebook computer, comprising a computer main body and a screen movably connected to the computer main body. A cavity and an expansion card press mechanism is provided inside the computer main body. A popup box is further provided on one side of the computer main body. The expansion card press mechanism comprises press blocks capable of moving forward and backward in an installation direction of an expansion card. The press blocks press the expansion card. The cavity is provided with an opening which is disposed at a position on an end face of the computer main body. The popup box is movably connected to the computer main body and provided with an antenna.

17 Claims, 4 Drawing Sheets





US009401543B2

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

(10) **Patent No.:** **US 9,401,543 B2**
(45) **Date of Patent:** **Jul. 26, 2016**

(54) **BROADBAND ANTENNA**

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

(72) Inventors: **Shang-Sian You**, Hsinchu (TW);
Chien-Ting Huang, Hsinchu (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 111 days.

(21) Appl. No.: **14/463,669**

(22) Filed: **Aug. 20, 2014**

(65) **Prior Publication Data**

US 2015/0200456 A1 Jul. 16, 2015

(30) **Foreign Application Priority Data**

Jan. 14, 2014 (TW) 103200771 U

(51) **Int. Cl.**

H01Q 1/00 (2006.01)

H01Q 5/321 (2015.01)

H01Q 9/42 (2006.01)

H01Q 5/371 (2015.01)

H01Q 5/378 (2015.01)

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

CPC **H01Q 5/321** (2015.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/38; H01Q 9/0421; H01Q 5/371

USPC 343/722, 876, 702
See application file for complete search history.

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Primary Examiner — Dameon E Levi

Assistant Examiner — Collin Dawkins

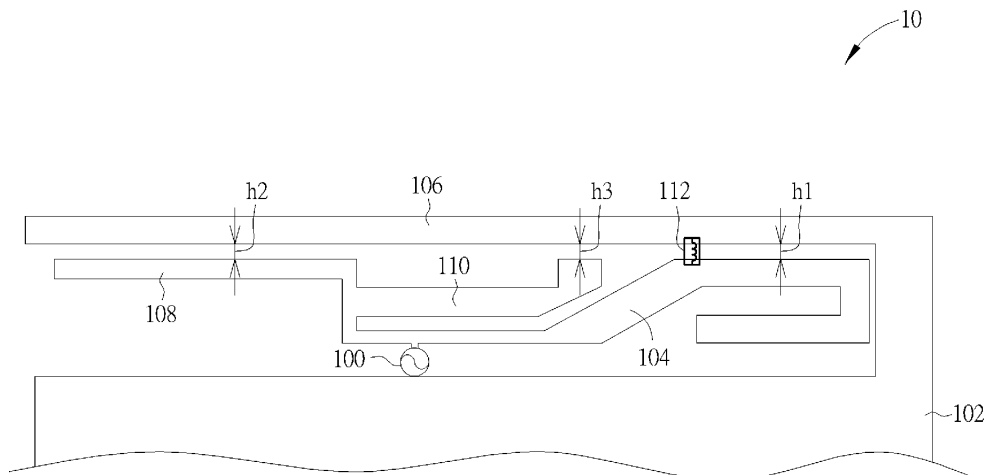
(74) *Attorney, Agent, or Firm* — Winston Hsu; Scott Margo

(57)

ABSTRACT

A broadband antenna for a wireless communication device includes a grounding unit for grounding; a first radiating element; a second radiating element electrically connected to the grounding unit; a signal feed-in element for transmitting a radio signal to the first radiating element in order to emit the radio signal via the first radiating element; and a passive component comprising an inductor, where the passive component is electrically connected between the first and the second radiating elements to work in conjunction with the first radiating element, the second radiating element and the grounding unit to form a loop antenna effect.

8 Claims, 11 Drawing Sheets





US009401544B2

(12) **United States Patent**
Zhang

(10) **Patent No.:** **US 9,401,544 B2**

(45) **Date of Patent:** **Jul. 26, 2016**

(54) **QUAD-BAND INTERNAL ANTENNA AND
MOBILE COMMUNICATION TERMINAL
THEREOF**

(75) Inventor: **Lian Zhang**, Guangdong (CN)

(73) Assignee: **HUIZHOU TCL MOBILE
COMMUNICATION CO., LTD.**,
Huizhou, Guangdong (CN)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 326 days.

(21) Appl. No.: **13/816,214**

(22) PCT Filed: **Nov. 4, 2011**

(86) PCT No.: **PCT/CN2011/081780**

§ 371 (c)(1),
(2), (4) Date: **Feb. 8, 2013**

(87) PCT Pub. No.: **WO2012/071966**

PCT Pub. Date: **Jun. 7, 2012**

(65) **Prior Publication Data**

US 2013/0135155 A1 May 30, 2013

(30) **Foreign Application Priority Data**

Dec. 1, 2010 (CN) 2010 1 0568426

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/48 (2006.01)
H01Q 3/26 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **H01Q 9/04** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/245** (2013.01); **H01Q 1/48**
(2013.01); **H01Q 3/26** (2013.01); **H01Q 5/364**
(2015.01); **H01Q 5/385** (2015.01); **H01Q**
9/0421 (2013.01)

(58) **Field of Classification Search**

CPC ... H01Q 1/243; H01Q 5/0065; H01Q 9/0421;
H01Q 5/0055

USPC 343/700 MS, 702, 767, 725, 770
See application file for complete search history.

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operation in the mobile phone. Microwave and Optical Technology
Letters., Jan. 31, 2008, p. 38-42, vol. 50, issue 1.

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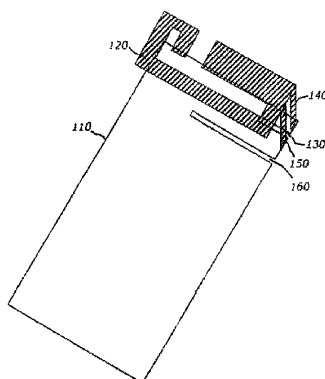
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Shimokaji IP

(57) **ABSTRACT**

A quad-band internal antenna may include an antenna radiating
element, a first slotted hole and a second slotted hole
arranged on a printed circuit board. The first slotted hole may
be arranged along a direction perpendicular to the current
flow direction of the printed circuit board, and the second
slotted hole may be arranged between a ground pin and a feed
pin of the antenna radiating element, such that the first slotted
hole and the second slotted hole are both open slotted holes.

16 Claims, 4 Drawing Sheets





US009401738B2

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

(10) **Patent No.:** **US 9,401,738 B2**

(45) **Date of Patent:** **Jul. 26, 2016**

(54) **METHOD FOR SIMPLIFIED CLOSED-LOOP ANTENNA TUNING**

USPC 455/67.11, 77, 78, 423, 425, 550.1;
343/787, 860, 861, 876

See application file for complete search history.

(71) Applicant: **MEDIATEK Singapore Pte. Ltd.**,
Singapore (SG)

(56) **References Cited**

(72) Inventors: **James June-Ming Wang**, San Marino,
CA (US); **Qiang Zhou**, San Jose, CA
(US); **YungPing Hsu**, Taipei (TW);
Bernard Mark Tenbroek, Kent (GB)

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343/767
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(73) Assignee: **MEDIATEK 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 0 days.

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(21) Appl. No.: **14/799,413**

International Search Report and Written Opinion of International
Search Authority for PCT/SG2015/050214 dated Oct. 23, 2015(9
pages).

(22) Filed: **Jul. 14, 2015**

Primary Examiner — Quochien B Vuong

(65) **Prior Publication Data**

US 2016/0020814 A1 Jan. 21, 2016

(74) *Attorney, Agent, or Firm* — Imperium Patent Works;
Zheng Jin

Related U.S. Application Data

(60) Provisional application No. 62/024,537, filed on Jul.
15, 2014, provisional application No. 62/045,088,
filed on Sep. 3, 2014, provisional application No.
62/080,623, filed on Nov. 17, 2014.

(57) **ABSTRACT**

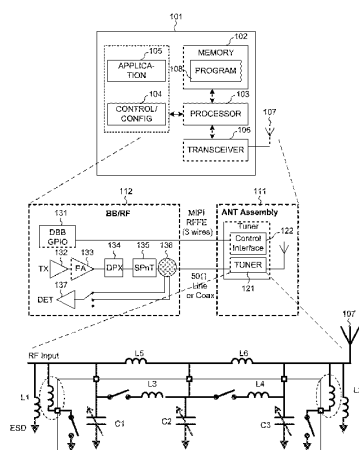
A method of closed-loop antenna tuning (CLAT) search strategy based on maximum Relative Transducer Gain (RTG) is proposed. A search region that account for TX input mismatch and forward voltage gain is pre-computed. The search region that is independent of antenna load can be pre-computed to reduce the computation complexity. The Maximum RTG is searched by estimating antenna S-parameters corresponding to a good load match. The search is conducted between the peak forward voltage gain and the best load match. Global optimal with reasonable RTG can be found with limited number of iterations. The transmitter search region can further be constrained by the receiver path mismatching.

(51) **Int. Cl.**
H04B 1/40 (2015.01)
H01Q 1/50 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC . **H04B 1/40** (2013.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**
CPC H04B 1/04; H04B 1/0458; H04B 1/0053;
H04B 1/40; H04B 1/48; H03H 7/38; H01Q
1/50; H01Q 1/241; H01Q 5/335; H01Q
13/103; H01Q 19/10

23 Claims, 7 Drawing Sheets





US009406998B2

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

(10) **Patent No.:** **US 9,406,998 B2**
(45) **Date of Patent:** **Aug. 2, 2016**

(54) **DISTRIBUTED MULTIBAND ANTENNA AND METHODS**

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(75) Inventors: **Heikki Korva**, Tupos (FI); **Petteri Annamaa**, Oulunsalo (FI); **Ari Raappana**, Kello (FI)

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(73) Assignee: **Pulse Finland OY** (FI)

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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 1199 days.

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(21) Appl. No.: **12/764,826**

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(22) Filed: **Apr. 21, 2010**

(Continued)

(65) **Prior Publication Data**

US 2011/0260939 A1 Oct. 27, 2011

Primary Examiner — Graham Smith

(51) **Int. Cl.**

H01Q 21/00 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/30 (2006.01)
H01Q 5/357 (2015.01)
H01Q 5/378 (2015.01)

(74) *Attorney, Agent, or Firm* — Gazdzinski & Associates PC

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/357** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/30** (2013.01)

(57) **ABSTRACT**

A distributed multiband antenna intended for radio devices, and methods for designing manufacturing the same. In one embodiment, a planar inverted-F antenna (PIFA) configured to operate in a high-frequency band, and a matched monopole configured to operate in a low-frequency band, are used within a handheld mobile device (e.g., cellular telephone). The two antennas are placed on substantially opposing regions of the portable device. The use of a separate low-frequency antenna element facilitates frequency-specific antenna matching, and therefore improves the overall performance of the multiband antenna. The use of high-band PIFA reduces antenna volume, and enables a smaller device housing structure while also reducing signal losses in the high frequency band. These attributes also advantageously facilitate compliance with specific absorption rate (SAR) tests; e.g., in the immediate proximity of hand and head "phantoms" as mandated under CTIA regulations. Matching of the low-frequency band monopole antenna is further described.

(58) **Field of Classification Search**

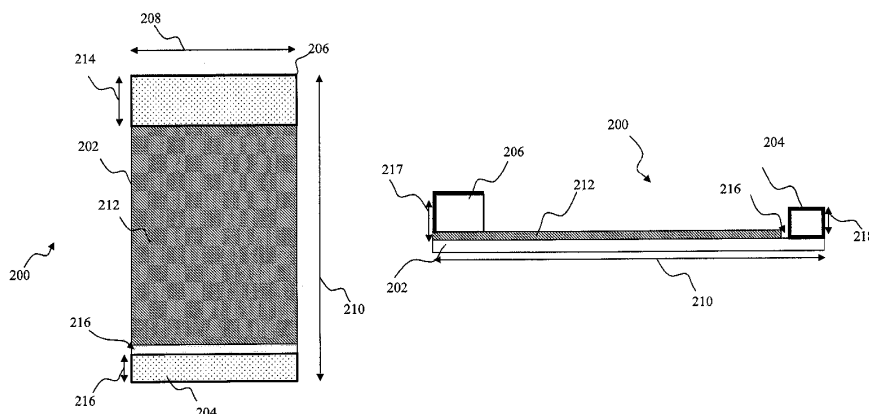
USPC 343/725
See application file for complete search history.

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24 Claims, 11 Drawing Sheets





US009406999B2

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

(10) **Patent No.:** **US 9,406,999 B2**
(45) **Date of Patent:** **Aug. 2, 2016**

(54) **METHODS FOR MANUFACTURING
CUSTOMIZED ANTENNA STRUCTURES**

FOREIGN PATENT DOCUMENTS

(75) Inventors: **Benjamin M. Rappoport**, Los Gatos,
CA (US); **Bruce E. Berg**, Santa Clara,
CA (US); **John Raff**, Menlo Park, CA
(US); **Stephen R. McClure**, San
Francisco, CA (US)

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

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Module for Battery Pack," ip.com Prior Art Database, Apr. 29, 2004
(6 pages).

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 856 days.

(Continued)

(21) Appl. No.: **13/243,722**

Primary Examiner — Minh Trinh

(22) Filed: **Sep. 23, 2011**

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; G.
Victor Treyz; Joseph F. Guihan

(65) **Prior Publication Data**

US 2013/0076574 A1 Mar. 28, 2013

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 9/42**
(2013.01); **Y10T 29/49004** (2015.01)

(58) **Field of Classification Search**

CPC H01P 11/00; H01Q 1/42; H01Q 1/44;
H01Q 1/12275; H01Q 1/243; H01Q 9/42;
Y10T 29/49004
USPC 29/600, 592.1, 601; 343/700 MS, 702,
343/720, 795, 872

See application file for complete search history.

Antenna structures may be customized to compensate for manufacturing variations in electronic device antennas. The antenna structures may include an antenna resonating element and a ground. Customizations may be made to the antenna structures by performing customization operations such as adding material, removing material, deforming material, and making electrical adjustments. Customizations may be performed to a conductive antenna resonating element structure, to a ground structure, or to associated antenna structures such as parasitic antenna elements. During manufacturing operations, antenna structures may be characterized by making radio-frequency antenna performance measurements. Antenna performance can be compared to desired performance levels and compensating customizations for the antenna structures can be identified. Customized antenna structures can be installed in electronic devices during manufacturing to produce devices that meet desired specifications.

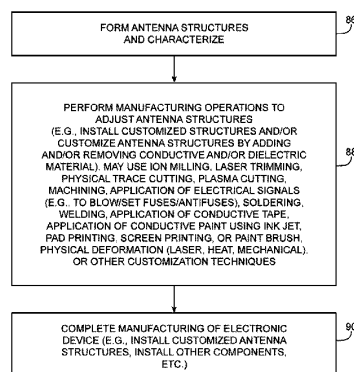
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18 Claims, 8 Drawing Sheets





US009407014B2

(12) **United States Patent**
Tanaka

(10) **Patent No.:** **US 9,407,014 B2**

(45) **Date of Patent:** **Aug. 2, 2016**

(54) **ANTENNA DEVICE**

(71) Applicant: **MURATA MANUFACTURING CO., LTD.**, Kyoto (JP)

(72) Inventor: **Hiroya Tanaka**, Kyoto (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**, Kyoto-fu (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 173 days.

(21) Appl. No.: **14/068,953**

(22) Filed: **Oct. 31, 2013**

(65) **Prior Publication Data**

US 2014/0118214 A1 May 1, 2014

(30) **Foreign Application Priority Data**

Oct. 31, 2012 (JP) 2012-240832
Oct. 22, 2013 (JP) 2013-218903

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/521** (2013.01); **H01Q 5/335** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 9/42; H01Q 21/28; H01Q 5/335
USPC 343/702, 852
See application file for complete search history.

(56) **References Cited**

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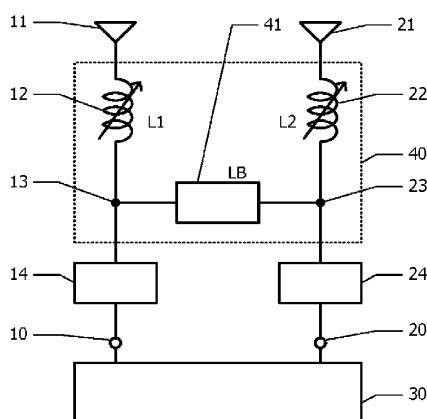
Primary Examiner — Dieu H Duong

(74) Attorney, Agent, or Firm — Studebaker & Brackett PC

(57) **ABSTRACT**

In an antenna device, power is fed from a first port to a first radiation element, and power is fed from a second port to a second radiation element. A decoupling circuit connects the first radiation element and the second radiation element, and includes a bridge element connecting a first point between the first port and the first radiation element and a second point between the second port and the second radiation element to each other. A first reactance element is provided in series with the first radiation element between the first point and the first radiation element, and a second reactance element is provided in series with the second radiation element between the second point and the second radiation element. At least one of the first reactance element and the second reactance element is configured so as to be capable of changing the value of reactance.

5 Claims, 5 Drawing Sheets





US009407739B2

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

(10) **Patent No.:** **US 9,407,739 B2**

(45) **Date of Patent:** **Aug. 2, 2016**

(54) **MOBILE TERMINAL**

(75) Inventors: **Yajun Chen**, Shenzhen (CN); **Shougang Cheng**, Shenzhen (CN); **Jun Shen**, Shenzhen (CN); **Yu Qin**, Shenzhen (CN)

(73) Assignee: **ZTE Corporation**, Shenzhen (CN)

(*) 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.: **14/396,602**

(22) PCT Filed: **Jun. 20, 2012**

(86) PCT No.: **PCT/CN2012/077258**

§ 371 (c)(1),

(2), (4) Date: **Oct. 23, 2014**

(87) PCT Pub. No.: **WO2013/159444**

PCT Pub. Date: **Oct. 31, 2013**

(65) **Prior Publication Data**

US 2015/0080066 A1 Mar. 19, 2015

(30) **Foreign Application Priority Data**

Apr. 23, 2012 (CN) 2012 2 0176420 U

(51) **Int. Cl.**

H01Q 9/42 (2006.01)

H01Q 5/378 (2015.01)

H04M 1/02 (2006.01)

H01Q 1/24 (2006.01)

H01Q 19/00 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H04M 1/026** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01); **H01Q 9/42** (2013.01); **H01Q 19/00** (2013.01); **H01Q 1/245** (2013.01)

(58) **Field of Classification Search**

CPC H04M 1/026; H01Q 1/243; H01Q 9/42;

H01Q 5/378; H04B 7/0469

See application file for complete search history.

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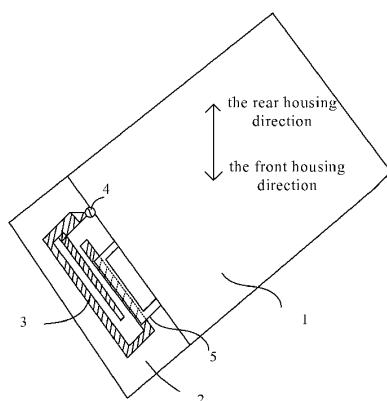
Primary Examiner — Andrew Wendell

(74) *Attorney, Agent, or Firm* — Jenkins, Wilson, Taylor & Hunt, P.A.

(57) **ABSTRACT**

Disclosed is a mobile terminal. The mobile terminal comprises an antenna body and a metal ring. The metal ring is provided on the mobile terminal without contacting the antenna body, and the vertical projection of the metal ring on a plane where the antenna body is located intersects the antenna body. By means of the disclosure, signal receiving performance of the mobile terminal is improved, and the loss caused by head and hand is reduced to a certain extent.

12 Claims, 4 Drawing Sheets





US009413058B1

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

(10) **Patent No.:** **US 9,413,058 B1**

(45) **Date of Patent:** **Aug. 9, 2016**

(54) **LOOP-FEEDING WIRELESS AREA NETWORK (WAN) ANTENNA FOR METAL BACK COVER**

(71) Applicant: **Amazon Technologies, Inc.**, Reno, NV (US)

(72) Inventors: **Jerry Weiming Kuo**, San Jose, CA (US); **Adrian Napoles**, Cupertino, CA (US); **Ming Zheng**, Cupertino, CA (US); **Khaled Ahmad Obeidat**, Santa Clara, CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Seattle, WA (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.: **14/796,040**

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

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/36; H01Q 5/00; H01Q 5/10; H01Q 5/20; H01Q 5/30; H01Q 5/314; H01Q 5/328; H01Q 5/357; H01Q 7/00
See application file for complete search history.

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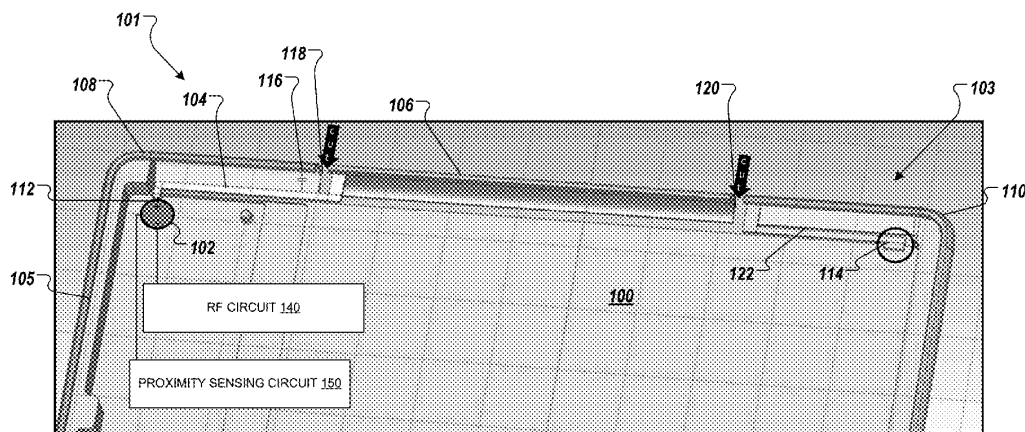
Primary Examiner — Nguyen Vo

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

(57) **ABSTRACT**

Antenna structures and methods of operating the same are described. One apparatus includes a metal cover having a first corner portion, a second corner portion, and an elongated portion. The elongated portion is physically separated from the first corner portion by a first cutout in the metal cover and the elongated portion is physically separated from the second corner portion by a second cutout in the metal cover. A radio frequency (RF) circuit is coupled to a feeding element that is coupled to the elongated portion. A capacitor is coupled between the feeding element and the first corner portion near the distal end of the feeding element. The RF circuit is operable to cause the feeding element, the elongated portion, and the first corner portion to radiate electromagnetic energy as a first radiator in a first frequency range with dual resonance.

20 Claims, 8 Drawing Sheets





US009413068B2

(12) **United States Patent**
Flores-Cuadras et al.

(10) **Patent No.:** **US 9,413,068 B2**

(45) **Date of Patent:** **Aug. 9, 2016**

(54) **SMALL DIGITAL TUNABLE ANTENNA
SYSTEMS FOR WIRELESS APPLICATIONS**

(71) Applicants: **Javier Ruben Flores-Cuadras**, Tijuana
(MX); **Carlos Francisco**
Montoya-Mejia, Tijuana (MX)

(72) Inventors: **Javier Ruben Flores-Cuadras**, Tijuana
(MX); **Carlos Francisco**
Montoya-Mejia, Tijuana (MX)

(73) Assignee: **TAOGLAS 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 93 days.

(21) Appl. No.: **14/534,021**

(22) Filed: **Nov. 5, 2014**

(65) **Prior Publication Data**

US 2015/0061950 A1 Mar. 5, 2015

Related U.S. Application Data

(63) Continuation-in-part of application No. 14/286,974,
filed on May 23, 2014, now abandoned.

(60) Provisional application No. 61/826,493, filed on May
23, 2013.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/335 (2015.01)
H01Q 1/48 (2006.01)

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

CPC **H01Q 5/335** (2015.01); **H01Q 1/243**
(2013.01); **H01Q 1/48** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/48; H01Q 1/50;
H01Q 5/335

USPC 343/700 MS, 722, 745, 772, 850, 852,
343/860

See application file for complete search history.

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343/700 MS
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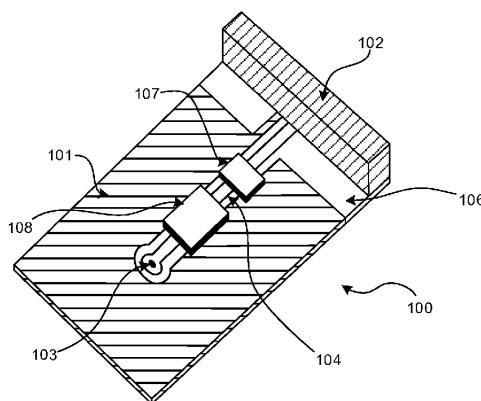
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Coastal Patent Law Group,
P.C.

(57) **ABSTRACT**

The instant disclosure provides an antenna system with a
generically small ground plane and a generic antenna radiat-
ing module, wherein the system further includes a matching
circuit and a tunable capacitor each bring integrated with the
ground plane and antenna in a novel configuration which
provides improved antenna performance across multiple
antenna resonances.

11 Claims, 4 Drawing Sheets





US009419328B2

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

(10) **Patent No.:** **US 9,419,328 B2**

(45) **Date of Patent:** **Aug. 16, 2016**

(54) **TERMINAL DEVICE**

USPC 343/702
See application file for complete search history.

(71) Applicants: **Lenovo (Beijing) Co., Ltd.**, Haidian District, Beijing (CN); **Beijing Lenovo Software Ltd.**, Haidian District, Beijing (CN)

(56)

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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 0 days.

(21) Appl. No.: **14/791,829**

(22) Filed: **Jul. 6, 2015**

(65) **Prior Publication Data**

US 2015/0311581 A1 Oct. 29, 2015

Related U.S. Application Data

(62) Division of application No. 13/647,602, filed on Oct. 9, 2012, now Pat. No. 9,112,271.

(30) **Foreign Application Priority Data**

Oct. 9, 2011 (CN) 2011 1 0303440
Oct. 24, 2011 (CN) 2011 1 0326512

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/44** (2013.01); **H01Q 19/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/36; H01Q 1/44; H01Q 19/10

Primary Examiner — Hoang V Nguyen

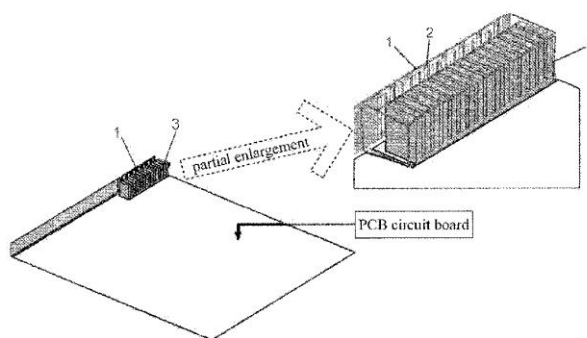
(74) *Attorney, Agent, or Firm* — Brinks Gilson & Lione; G. Peter Nichols

(57)

ABSTRACT

A terminal device includes a first house configured to at least accommodate a processing unit and a wireless communication unit. The wireless communication unit is configured to cause the terminal device to perform wireless communication with an external apparatus and exchange data. The wireless communication unit includes an antenna unit configured to receive and transmit a RF signal, a RF circuit connected with the antenna unit and configured to transmit the RF signal to or receive the RF signal from the antenna unit, wherein, an air vent is set on the first house, and the antenna unit is formed by the air vent.

14 Claims, 4 Drawing Sheets





US009419336B2

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

(10) **Patent No.:** **US 9,419,336 B2**

(45) **Date of Patent:** **Aug. 16, 2016**

(54) **COMPACT BROADBAND ANTENNA**

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

(71) Applicant: **Galtronics Corporation LTD.**, Tiberias (IL)

(56) **References Cited**

(72) Inventors: **Snir Azulay**, Tiberias (IL); **Steve Krupa**, Haifa (IL)

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(73) Assignee: **GALTRONICS CORPORATION, LTD**, Tiberias (IL)

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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 0 days.

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(21) Appl. No.: **14/475,815**

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(22) Filed: **Sep. 3, 2014**

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(65) **Prior Publication Data**

US 2014/0368403 A1 Dec. 18, 2014

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Related U.S. Application Data

Primary Examiner — Dieu H Duong

(63) Continuation of application No. 13/978,092, filed as application No. PCT/IL2012/000001 on Jan. 3, 2012.

(74) *Attorney, Agent, or Firm* — Ingrassia Fisher & Lorenz, P.C.

(60) Provisional application No. 61/429,240, filed on Jan. 3, 2011.

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/00 (2015.01)

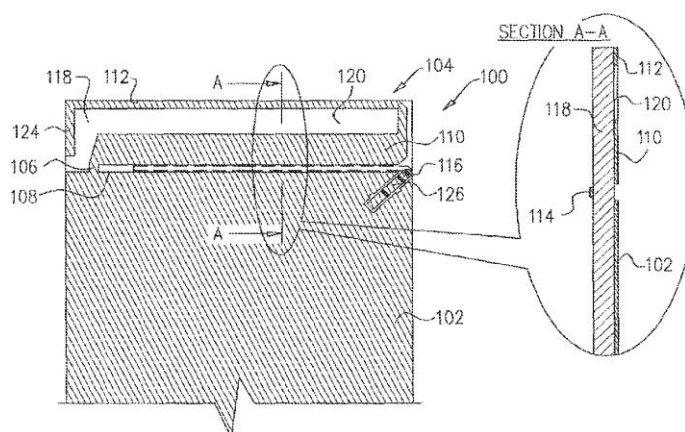
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An antenna including a substrate formed of a non-conductive material, a ground plane disposed on the substrate, a wideband element for coupling having one end connected to an edge of the ground plane and an elongate feed arm feeding the wideband element for coupling and having a maximum width of $1/100$ of a predetermined wavelength, the predetermined wavelength being defined by formula (I) wherein λ_p is the predetermined wavelength, f is a lowest operating frequency of the wideband element for coupling, μ is a permeability of the substrate, ϵ_r is a relative bulk permittivity of the substrate, W is a width of a conductive trace disposed above the substrate and H is a thickness of the substrate, wherein formula (II).

(52) **U.S. Cl.**
CPC **H01Q 5/0027** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/307** (2015.01); **H01Q 5/335** (2015.01); **H01Q 9/045** (2013.01); **H01Q 9/0457** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 9/045; H01Q 5/002

20 Claims, 4 Drawing Sheets





US009419340B2

(12) **United States Patent**
Pan

(10) **Patent No.:** **US 9,419,340 B2**

(45) **Date of Patent:** **Aug. 16, 2016**

(54) **ULTRA WIDE BAND ANTENNA**

(75) Inventor: **Sheng-gen Pan**, Kamp-Lintfort (DE)

(73) Assignee: **TE Connectivity Germany GmbH**,
Bensheim (DE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 115 days.

(21) Appl. No.: **13/251,956**

(22) Filed: **Oct. 3, 2011**

(65) **Prior Publication Data**

US 2012/0081252 A1 Apr. 5, 2012

(30) **Foreign Application Priority Data**

Oct. 4, 2010 (EP) 10013277

(51) **Int. Cl.**

H01Q 9/04 (2006.01)

H01Q 1/48 (2006.01)

H01Q 7/00 (2006.01)

B05D 5/12 (2006.01)

H01Q 9/42 (2006.01)

H01Q 5/371 (2015.01)

H01Q 1/36 (2006.01)

H01Q 21/30 (2006.01)

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

CPC . **H01Q 9/42** (2013.01); **H01Q 1/36** (2013.01);
H01Q 5/371 (2015.01); **H01Q 9/0414**
(2013.01); **H01Q 21/30** (2013.01)

(58) **Field of Classification Search**

CPC **H01Q 21/30**; **H01Q 5/371**; **H01Q 9/42**;
H01Q 9/0414

USPC **343/733**, **700 MS**
See application file for complete search history.

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Primary Examiner — Dameon E Levi

Assistant Examiner — Ricardo Magallanes

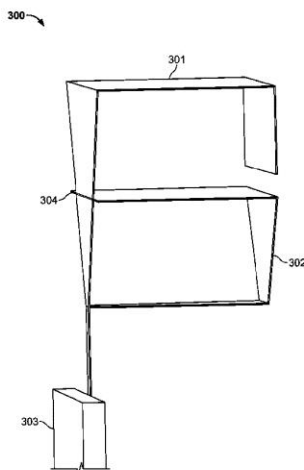
(74) *Attorney, Agent, or Firm* — Faegre Baker Daniels LLP

(57)

ABSTRACT

An ultrawideband antenna for use in communications equip-
ment, comprising a first folded branch antenna element with
an electrical connection at a first end and a second folded
branch antenna element with an electrical connection at a first
end. The folded branch antenna elements are of a triangular
shape, or a combination of polygonal shapes. By using the
present invention, the volume of an antenna is reduced and the
ultra wide bandwidth can be achieved.

14 Claims, 8 Drawing Sheets





US009419346B2

(12) **United States Patent**
Yoon

(10) **Patent No.:** **US 9,419,346 B2**

(45) **Date of Patent:** **Aug. 16, 2016**

(54) **HIGH ISOLATION ANTENNA STRUCTURE ON A GROUND PLANE**

(71) Applicant: **BROADCOM CORPORATION**,
Irvine, CA (US)

(72) Inventor: **Seunghwan Yoon**, Irvine, CA (US)

(73) Assignee: **BROADCOM CORPORATION**,
Irvine, 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.: **14/568,865**

(22) Filed: **Dec. 12, 2014**

(65) **Prior Publication Data**

US 2015/0200466 A1 Jul. 16, 2015

Related U.S. Application Data

(60) Provisional application No. 61/927,611, filed on Jan. 15, 2014, provisional application No. 62/087,069, filed on Dec. 3, 2014.

(51) **Int. Cl.**

H01Q 9/26 (2006.01)

H01Q 21/28 (2006.01)

H01Q 9/28 (2006.01)

H01Q 1/48 (2006.01)

H01Q 1/24 (2006.01)

H04B 1/40 (2015.01)

H01Q 9/42 (2006.01)

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

CPC **H01Q 21/28** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/26** (2013.01); **H01Q 9/28** (2013.01); **H01Q 9/42** (2013.01); **H04B 1/40** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 9/26; H01Q 9/28; H01Q 9/42

See application file for complete search history.

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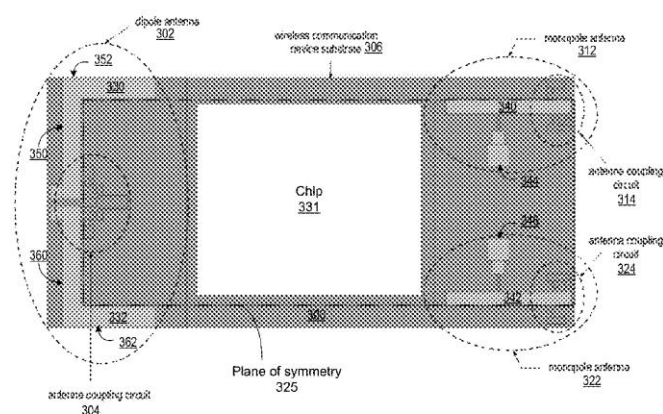
Primary Examiner — David Bilodeau

(74) *Attorney, Agent, or Firm* — Garlick & Markison; Bruce E. Stuckman

(57) **ABSTRACT**

In accordance with one example, an antenna structure includes a three-dimensional dipole antenna having a first arm and a second arm that are suspended above a ground plane. One or more three-dimensional monopole antennas have corresponding monopole elements positioned in a plane of symmetry between the arms of the dipole. Other examples are disclosed.

20 Claims, 9 Drawing Sheets





US00D763834S

(12) **United States Design Patent**
Zheng et al.

(10) **Patent No.:** **US D763,834 S**
(45) **Date of Patent:** **** Aug. 16, 2016**

(54) **ANTENNA**

(71) Applicant: **Airgain, Incorporated**, San Diego, CA
(US)

(72) Inventors: **Bei Zheng**, Zhang Jia Gang (CN);
Mengyi Tao, Zhang Jia Gang (CN);
Xiangjie Bian, Zhang Jia Gang (CN)

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

(**) Term: **14 Years**

(21) Appl. No.: **29/516,559**

(22) Filed: **Feb. 4, 2015**

(51) **LOC (10) Cl.** **14-03**

(52) **U.S. Cl.**
USPC **D14/230**

(58) **Field of Classification Search**
USPC D14/138, 230–238.1, 299, 358;
D13/182
CPC H01L 33/48; H01L 33/486; H01L 23/02;
H05K 5/00; H01Q 13/10
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Manpreet Matharu

Assistant Examiner — Mojtaba Tehrani

(74) *Attorney, Agent, or Firm* — Clause Eight IPS; Michael
Catania

(57) **CLAIM**

The ornamental design for an antenna, as shown and
described.

DESCRIPTION

FIG. 1 is a top plan view of an antenna, showing our new
design;

FIG. 2 is a side elevation view thereof;

FIG. 3 is a bottom plan view thereof;

FIG. 4 is a top perspective view thereof;

FIG. 5 is a bottom perspective view thereof;

FIG. 6 is a top plan view thereof, with unclaimed environment
not shown; and,

FIG. 7 is a bottom plan view thereof, with unclaimed envi-
ronment not shown.

The broken line in the figure drawings represents unclaimed
environment only and forms no part of the claimed design.

1 Claim, 2 Drawing Sheets

