



US009293806B2

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

(10) **Patent No.:** **US 9,293,806 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **ELECTRONIC DEVICE WITH DISPLAY FRAME ANTENNA**

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

(72) Inventors: **Kelvin Kwong**, Cupertino, CA (US);
Lee E. Hooton, Cupertino, CA (US)

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

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(21) Appl. No.: **14/201,501**

(22) Filed: **Mar. 7, 2014**

(65) **Prior Publication Data**

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H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01); **H01Q 1/2258**
(2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2258; H01Q 1/2283;
H01Q 1/2291; H01Q 1/241-1/243
USPC 343/702
See application file for complete search history.

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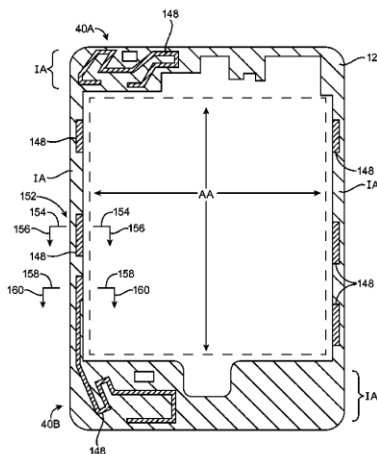
Primary Examiner — Howard Williams

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

(57) **ABSTRACT**

An electronic device has a display mounted in a housing using a plastic display frame. The display has an active area and an inactive area. A display cover layer may have polymer coating layers in the inactive area. The display frame may lie under the inactive area. A patterned metal coating layer may be formed on the display frame. The patterned metal coating layer may have portions that form adhesion promotion structures for promoting adhesion between the frame and the adhesive. The patterned metal coating layer may also have portions that form antenna structures. The antenna structures may be used to transmit and receive radio-frequency signals and may be used as adhesion promotion structures. Adhesive may be interposed between the polymer coating layers and the metal coating layer on the display frame to attach the display cover layer and the display to the display frame.

20 Claims, 13 Drawing Sheets





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

(10) **Patent No.:** **US 9,293,807 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE WITH ELECTRICALLY CONDUCTIVE CONTINUOUS RING AND RELATED METHODS**

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

(72) Inventors: **Joshua Kwan Ho Wong**, Waterloo (CA); **John Alfred Whitmore**, Heidelberg (CA); **Adrian Matthew Cooke**, Kitchener (CA); **Steven Eugene Downs**, Irving, TX (US); **Jari Kristian Van Wonerghem**, Tampere (FI)

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

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(21) Appl. No.: **14/260,363**

(22) Filed: **Apr. 24, 2014**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 13/099,025, filed on May 2, 2011, now Pat. No. 8,774,880, which is a continuation-in-part of application No. 13/005,311, filed on Jan. 12, 2011, now Pat. No. 8,615,279.

(60) Provisional application No. 61/367,113, filed on Jul. 23, 2010.

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

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(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 9/0442** (2013.01); **H01Q 9/0464** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC ... H04W 88/02; H04M 1/026; H04M 1/0202; H04M 1/0277
USPC 455/575.1, 575.7
See application file for complete search history.

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Primary Examiner — Charles Appiah

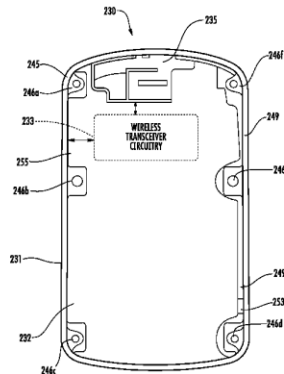
Assistant Examiner — Jaime Holliday

(74) *Attorney, Agent, or Firm* — Guntin & Gust, PLC; Jay H. Anderson

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing that may include an electrically conductive continuous ring defining a perimeter of the portable housing. The electrically conductive continuous ring may be configured to function as an antenna. The mobile wireless communications device may further include a printed circuit board (PCB) carried by the portable housing and may include an electrically conductive layer defining a ground plane. The mobile wireless communications device may further include wireless transceiver circuitry carried by the PCB and coupled to the antenna. The mobile wireless communications device may also include an electrically conductive shorting member coupled between the electrically conductive continuous ring and the ground plane.

23 Claims, 14 Drawing Sheets





US009293816B2

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

(10) **Patent No.:** **US 9,293,816 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **ELECTRONIC DEVICE PLATE ANTENNA**

(75) Inventors: **Miroslav Samardzija**, Mountain View, CA (US); **Rodney A. Gomez Angulo**, Sunnyvale, CA (US); **Qingxiang Li**, Mountain View, CA (US); **Robert W. Schlub**, Cupertino, CA (US); **Ruben Caballero**, San Jose, 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 372 days.

(21) Appl. No.: **13/543,054**

(22) Filed: **Jul. 6, 2012**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
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H01Q 1/42 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 13/16 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/0407** (2013.01); **H01Q 13/16** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 13/16
USPC 343/702, 872
See application file for complete search history.

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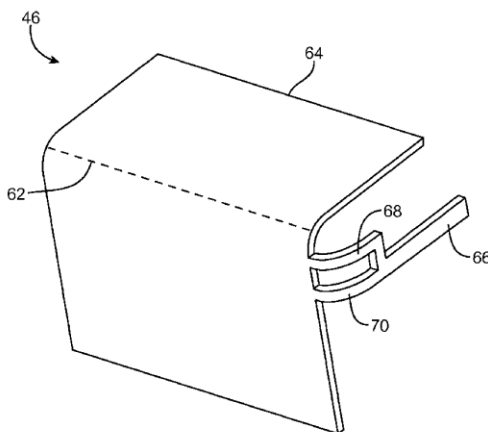
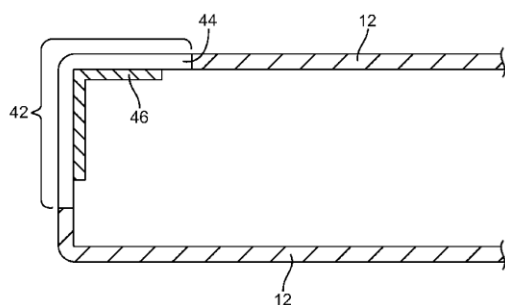
Primary Examiner — Dieu H Duong

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

(57) **ABSTRACT**

An electronic device may be provided with antenna structures. The antenna structures may include a plate antenna. The electronic device may have a conductive housing such as a metal housing with an opening. A dielectric antenna window may be formed within the opening. A dielectric support structure such as a flexible printed circuit may overlap the opening. A conductive trace on the dielectric support structure may form an antenna resonating element plate for the plate antenna. The plate may have a periphery that is separated from adjacent portions of the metal housing by a gap. The antenna resonating element plate may have a rectangular shape with a bend that lies along an edge of the conductive housing. The dielectric antenna window may have a bend that also lies along the edge of the conductive housing.

17 Claims, 9 Drawing Sheets





US009293819B2

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

(10) **Patent No.:** **US 9,293,819 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

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

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

(72) Inventors: **Jaegon Lee**, Seoul (KR); **Chisang You**, Seoul (KR); **Changil Kim**, Seoul (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 333 days.

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(22) Filed: **May 8, 2013**

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(30) **Foreign Application Priority Data**
May 9, 2012 (KR) 10-2012-0049340

(51) **Int. Cl.**
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H01Q 1/50 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/378 (2015.01)

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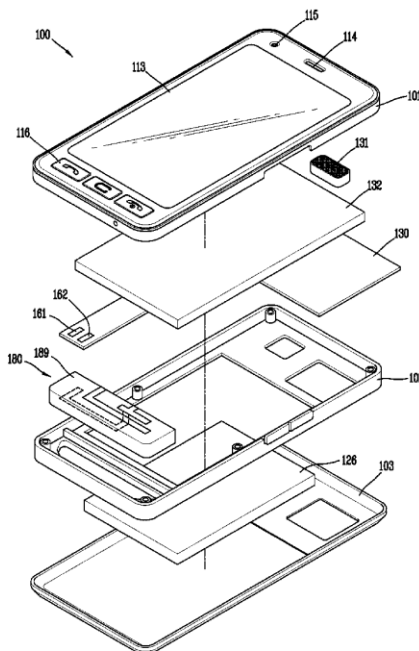
(58) **Field of Classification Search**
USPC 343/700 MS, 702
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Tan Ho
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**
An antenna apparatus includes: a first member ground-connected to a ground of a printed circuit board (PCB); a second member spaced from the first member in parallel, and configured to capacitive coupling-feed the first member so as to transmit and receive signals of a first frequency band; and a third member extending from the second member by a prescribed length, so as to have a bandwidth extending up to a second frequency band adjacent to the first frequency band.

20 Claims, 12 Drawing Sheets





US009293826B2

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

(10) **Patent No.:** **US 9,293,826 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **PLANAR INVERTED F ANTENNA WITH IMPROVED FEEDING LINE CONNECTION**

USPC 343/700 MS, 845, 848, 718, 702
See application file for complete search history.

(75) Inventors: **Yoshiyuki Yonei**, Chiba (JP); **Masahiro Sobu**, Chiba (JP); **Akinori Matsui**, Fukaya (JP); **Misao Haneishi**, Saitama (JP)

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Primary Examiner — Lam T Mai

(74) *Attorney, Agent, or Firm* — Adams & Wilks

(73) Assignees: **SEIKO SOLUTIONS INC.** (JP); **CHIKOUJI GAKUEN EDUCATIONAL FOUNDATION** (JP); **Misao Haneishi** (JP)

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(21) Appl. No.: **14/240,127**

(22) PCT Filed: **Aug. 10, 2012**

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§ 371 (c)(1),

(2), (4) Date: **Feb. 21, 2014**

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(30) **Foreign Application Priority Data**

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H01Q 9/04 (2006.01)

H01Q 5/371 (2015.01)

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

CPC **H01Q 9/0407** (2013.01); **H01Q 5/371**

(2015.01); **H01Q 9/045** (2013.01); **H01Q**

9/0421 (2013.01); **H01Q 9/0471** (2013.01)

(58) **Field of Classification Search**

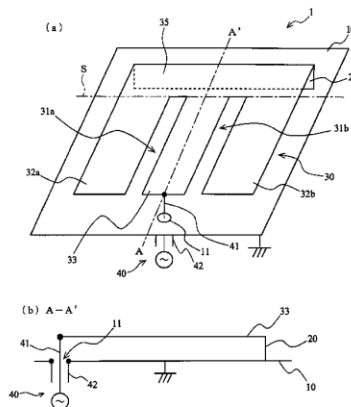
CPC ... H01Q 9/0421; H01Q 9/0407; H01Q 9/045;

H01Q 9/0471; H01Q 9/42; H01Q 1/243;

H01Q 1/273; H01Q 1/38; H01Q 1/40; H01Q

5/364; H01Q 5/371

20 Claims, 25 Drawing Sheets





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

(10) **Patent No.:** **US 9,293,827 B2**
(45) **Date of Patent:** **Mar. 22, 2016**

(54) **COMMUNICATION TERMINAL AND ANTENNA APPARATUS THEREOF**

(75) Inventors: **Hoon Park**, Seoul (KR); **Jin Kyu Bang**, Suwon-si (KR); **Sang Min Han**, Suwon-si (KR); **Sang Ha Lee**, Anyang-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1032 days.

(21) Appl. No.: **13/099,747**

(22) Filed: **May 3, 2011**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
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H01Q 1/38 (2006.01)
H01Q 1/40 (2006.01)
H01Q 1/42 (2006.01)
H01Q 19/00 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/245; H01Q 9/0421; H04B 1/3833
USPC 343/700 MS, 702, 833, 844, 872, 873
See application file for complete search history.

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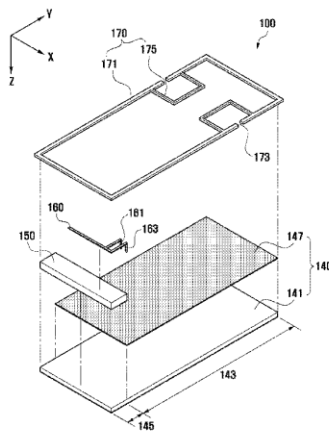
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Primary Examiner — Laura Gudorf
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

A communication terminal and an antenna apparatus of the communication terminal are provided. The communication terminal includes a body having a circuit board, an antenna element which is mounted inside the body and connected electrically to the circuit board and, when electric current is supplied via a main plate, resonant in a resonant frequency band for transmitting and receiving signals, and a metal case having an antenna pattern which is coupled to an edge of the body to be resonant and, when the antenna element is resonant, in the resonant frequency band for supporting operation of the antenna element.

5 Claims, 15 Drawing Sheets





US009293828B2

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

(10) **Patent No.:** **US 9,293,828 B2**
(45) **Date of Patent:** ***Mar. 22, 2016**

(54) **ANTENNA SYSTEM WITH TUNING FROM COUPLED ANTENNA**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)
(72) Inventors: **Peter Bevelacqua**, San Jose, CA (US); **Hao Xu**, Cupertino, CA (US); **Jayesh Nath**, Milpitas, CA (US); **Jennifer M. Edwards**, San Francisco, CA (US); **Mattia Pascolini**, Campbell, 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 380 days.
This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/851,471**

(22) Filed: **Mar. 27, 2013**

(65) **Prior Publication Data**

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H01Q 9/04 (2006.01)
H01Q 5/378 (2015.01)
H01Q 5/392 (2015.01)
H01Q 1/22 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
CPC H01Q 5/392; H01Q 5/378
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

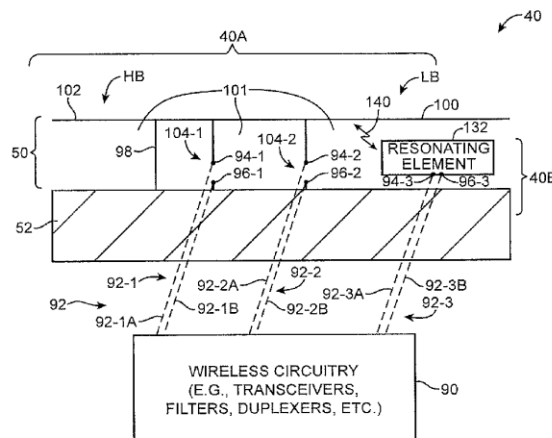
Assistant Examiner — Michael Bouizza

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

(57) **ABSTRACT**

Electronic devices may include radio-frequency transceiver circuitry and antenna structures. The antenna structures may form a dual arm inverted-F antenna and an additional antenna such as a monopole antenna sharing a common antenna ground. The antenna structures may have three ports. A first antenna port may be coupled to an inverted-F antenna resonating element at a first location and a second antenna port may be coupled to the inverted-F antenna resonating element at a second location. A third antenna port may be coupled to the additional antenna. An adjustable component may be coupled to the first antenna port to tune the inverted-F antenna. The inverted-F antenna may be near-field coupled to the additional antenna so that the inverted-F antenna may serve as a tunable parasitic antenna resonating element that tunes the additional antenna.

22 Claims, 7 Drawing Sheets





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

(10) **Patent No.:** **US 9,300,033 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **WIRELESS COMMUNICATION DEVICE WITH AN ANTENNA ADJACENT TO AN EDGE OF THE DEVICE**

(75) Inventors: **Chul Min Han**, San Diego, CA (US);
Jorge Fabrega Sanchez, San Diego, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 327 days.

(21) Appl. No.: **13/278,836**

(22) Filed: **Oct. 21, 2011**

(65) **Prior Publication Data**
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(51) **Int. Cl.**
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H01Q 13/10 (2006.01)
H01Q 21/29 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 13/10** (2013.01); **H01Q 21/293** (2013.01)

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

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Primary Examiner — Hoang V Nguyen

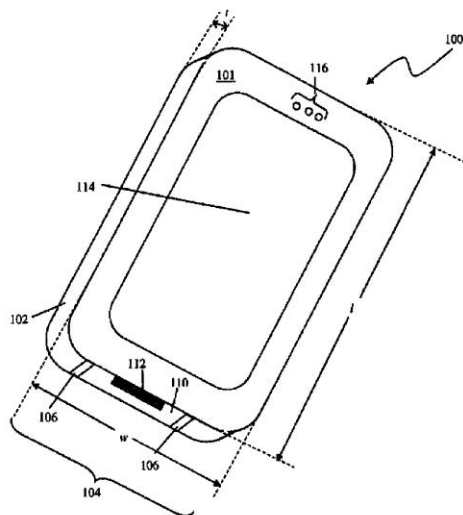
Assistant Examiner — Hai Tran

(74) *Attorney, Agent, or Firm* — Futurewei Technologies, Inc.

(57) **ABSTRACT**

A wireless communication device comprising a housing comprising a plurality of edges and configured to serve as an external surface for the wireless communication device, and an antenna adjacent to at least a first edge of the housing, wherein the antenna comprises at least a conductive strip and at least one slot and wherein the antenna is configured to receive and transmit wireless signals, wherein the first edge of the housing is one of an edge of the housing nearest an ear piece and an edge of the housing that is opposite the edge of the housing nearest the ear piece, and wherein the conductive strip and the slot are adjacent to at least the first edge of the housing.

21 Claims, 10 Drawing Sheets





US009300034B2

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

(10) **Patent No.:** **US 9,300,034 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MULTI-ANTENNA STRUCTURE**
(71) Applicant: **Auden Techno.Corp.**, Taoyuan Hsien (TW)
(72) Inventors: **Chun-Hua Chen**, Taoyuan Hsien (TW); **Hsien-Wen Liu**, Taoyuan Hsien (TW)
(73) Assignee: **AUDEN TECHNO. CORP.**, Pa-Te, Taoyuan Hsien (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 327 days.

(21) Appl. No.: **13/936,035**
(22) Filed: **Jul. 5, 2013**
(65) **Prior Publication Data**
US 2015/0009092 A1 Jan. 8, 2015

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/371 (2015.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

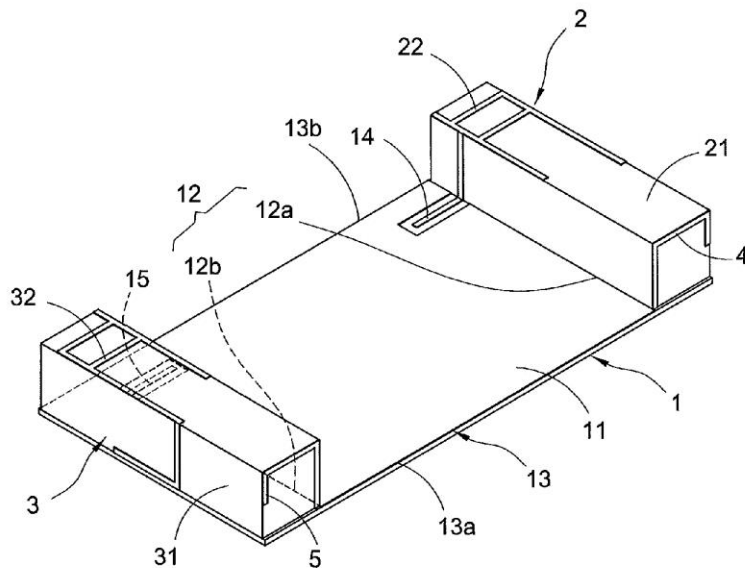
(58) **Field of Classification Search**
USPC 343/893, 700 MS, 702
See application file for complete search history.

(56) **References Cited**
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Primary Examiner — Hoang V Nguyen
Assistant Examiner — Hai Tran
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**
A multi-antenna structure includes a base plate, a first antenna, a second antenna, a first metal line, and a second metal line. The base plate includes a grounded metal surface. The grounded metal surface includes two short sides and two long sides. The first antenna and the second antenna are arranged on the base plate. The first metal line and the second metal line are electrically connected to the two short sides of the grounded metal surface. A current path of the two short sides is prolonged because of the first metal line and the second metal line. A longitudinal current is equal to a transverse current at a low frequency. A current of the first antenna and a current of the second antenna does not interfere each other. Isolation between the first antenna and the second antenna is improved.

5 Claims, 5 Drawing Sheets





US009300035B2

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

(10) **Patent No.:** **US 9,300,035 B2**
(45) **Date of Patent:** ***Mar. 29, 2016**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE ANTENNA ASSEMBLY WITH ANTENNA ELEMENT AND FLOATING DIRECTOR ELEMENT ON FLEXIBLE SUBSTRATE AND RELATED METHODS**

(2013.01); **H01Q 1/245** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 19/005** (2013.01); **Y10T 29/49002** (2015.01); **Y10T 29/49016** (2015.01); **Y10T 29/49018** (2015.01)

(71) Applicant: **BlackBerry Limited**, Waterloo (CA)

(58) **Field of Classification Search**

CPC **H01Q 1/38**; **H01Q 1/243**; **H01Q 1/145**; **H01Q 9/0421**; **H01Q 19/005**
USPC **343/702**, **700 M**, **701**
See application file for complete search history.

(72) Inventors: **Yihong Qi**, Waterloo (CA); **Ying Tong Man**, Waterloo (CA); **Adrian Matthew Cooke**, Kitchener (CA)

(56) **References Cited**

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(Continued)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 333 days.

This patent is subject to a terminal disclaimer.

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(Continued)

(21) Appl. No.: **13/927,691**

Primary Examiner — Dylan White

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

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

(65) **Prior Publication Data**

US 2013/0285868 A1 Oct. 31, 2013

Related U.S. Application Data

(63) Continuation of application No. 12/901,641, filed on Oct. 11, 2010, now Pat. No. 8,487,815, which is a continuation of application No. 11/863,324, filed on Sep. 28, 2007, now Pat. No. 7,812,773.

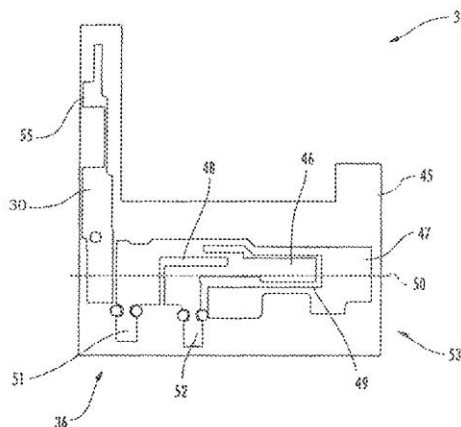
(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing, a circuit board carried by the portable housing and having a ground plane thereon, wireless communications circuitry carried by the circuit board, and an antenna assembly carried by the housing. More particularly, the antenna assembly may include a flexible substrate, an electrically conductive antenna element on the flexible substrate and connected to the wireless communications circuitry and the ground plane, and a floating, electrically conductive director element on the flexible substrate for directing a beam pattern of the antenna element.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 19/00 (2006.01)

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

20 Claims, 7 Drawing Sheets





US009300041B2

(12) **United States Patent**
Xu

(10) **Patent No.:** **US 9,300,041 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MULTIMODE BROADBAND ANTENNA
MODULE AND WIRELESS TERMINAL**

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

(72) Inventor: **Huiliang Xu**, Shenzhen (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 200 days.

(21) Appl. No.: **14/145,441**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No.
PCT/CN2012/083096, filed on Oct. 17, 2012.

(51) **Int. Cl.**
H01Q 9/42 (2006.01)
H01Q 5/01 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 5/01** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 5/371** (2015.01); **H01Q 5/392**
(2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 9/42; H01Q 5/392;
H01Q 5/371
USPC 343/702, 825-829, 833, 834, 846;
455/575.7

See application file for complete search history.

(56) **References Cited**

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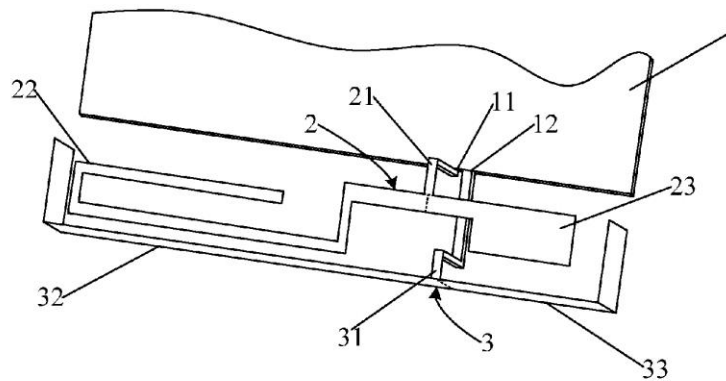
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.; Grant
Rodolph; Nicholas K. Beaulieu

(57) **ABSTRACT**

A multimode broadband antenna module and a wireless terminal are provided. The multimode broadband antenna module includes a printed circuit board and an antenna body, where the antenna body includes a first radiator and a second radiator that are electrically connected to the printed circuit board, where the first radiator includes a connection portion, a low frequency portion, and a high frequency portion, the second radiator includes a grounding portion, a low frequency portion, and a high frequency portion, and a first predetermined distance exists between the low frequency portion of the first radiator and the low frequency portion of the second radiator, and a second predetermined distance exists between the high frequency portion of the first radiator and the high frequency portion of the second radiator, so as to form a coupling capacitance effect between the first radiator and the second radiator.

4 Claims, 12 Drawing Sheets





US009300045B2

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

(10) **Patent No.:** **US 9,300,045 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **COMMUNICATION DEVICE WITH ANTENNA ELEMENT**

(71) Applicant: **Acер Incorporated**, New Taipei (TW)

(72) Inventors: **Kin-Lu Wong**, New Taipei (TW);
Zih-Guang Liao, New Taipei (TW)

(73) Assignee: **ACER INCORPORATED**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 15 days.

(21) Appl. No.: **14/338,691**

(22) Filed: **Jul. 23, 2014**

(65) **Prior Publication Data**
US 2015/0333403 A1 Nov. 19, 2015

(30) **Foreign Application Priority Data**
May 16, 2014 (TW) 103117263 A

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 5/50 (2015.01)
H01Q 5/20 (2015.01)
H01Q 5/335 (2015.01)
H01Q 5/30 (2015.01)

(52) **U.S. Cl.**
CPC . **H01Q 5/50** (2015.01); **H01Q 5/20** (2015.01);
H01Q 5/30 (2015.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 5/50; H01Q 5/20; H01Q 5/30;
H01Q 5/335
USPC 343/857, 858, 860
See application file for complete search history.

(56) **References Cited**

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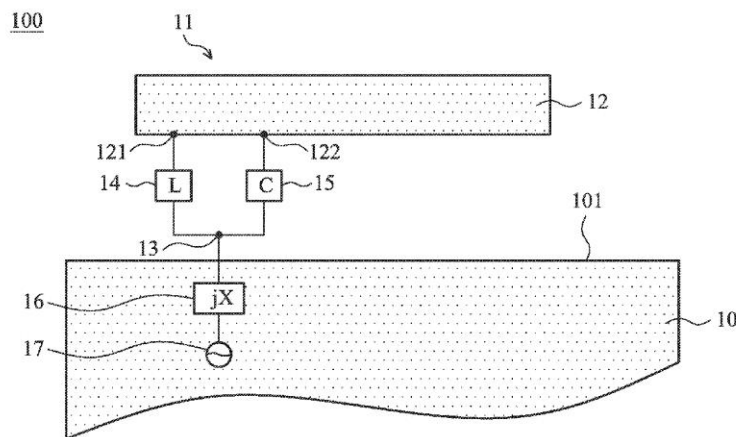
Primary Examiner — Brian Young

(74) *Attorney, Agent, or Firm* — McClure, Qualey & Rodack, LLP

(57) **ABSTRACT**

A communication device including a ground element and an antenna element is provided. The antenna element includes a metal element. The metal element is disposed adjacent to an edge of the ground element. The metal element has a first connection point and a second connection point. A feeding point of the antenna element is coupled through an inductive element to the first connection point. A first feeding path is formed from the feeding point through the inductive element to the first connection point. The feeding point of the antenna element is further coupled through a capacitive element to the second connection point. A second feeding path is formed from the feeding point through the capacitive element to the second connection point. The feeding point of the antenna element is further coupled through a matching circuit to a signal source.

14 Claims, 5 Drawing Sheets





US009300049B2

(12) **United States Patent**
Jo

(10) **Patent No.:** **US 9,300,049 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **ANTENNA AND PORTABLE DEVICE HAVING THE SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)
(72) Inventor: **Myungjae Jo**, Gyeongsangbuk-do (KR)
(73) Assignee: **Samsung Electronics Co., Ltd.**,
Yeongtong-gu, Suwon-si, 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 231 days.

(21) Appl. No.: **14/012,197**

(22) Filed: **Aug. 28, 2013**

(65) **Prior Publication Data**
US 2014/0062816 A1 Mar. 6, 2014

(30) **Foreign Application Priority Data**
Aug. 29, 2012 (KR) 10-2012-0094974

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

(52) **U.S. Cl.**
CPC . **H01Q 9/04** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/22; H01Q 1/24;
H01Q 1/241; H01Q 1/242; H01Q 1/243;
H01Q 1/42; H01Q 1/422; H01Q 1/52; H01Q
3/44; H01Q 9/0485; H01Q 15/08
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Robert Karacsony

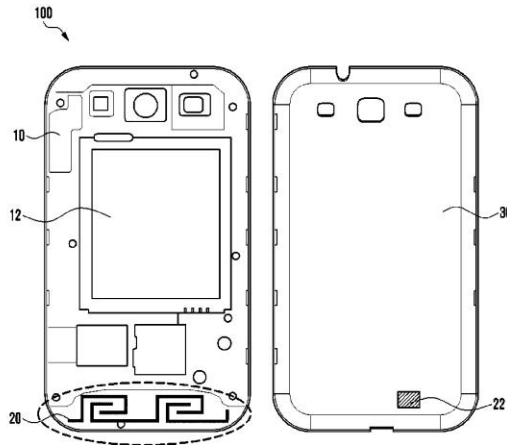
Assistant Examiner — Patrick Holecek

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**

An antenna and a portable device having the same are provided. The antenna provided in a portable device includes: a radiator unit housed at one surface of the portable device; and a resonant frequency compensation unit housed at another surface of the portable device facing the one surface and adjusting a resonant frequency of the radiator unit changed by an environment change to a preset resonant frequency. Examples of the environment change include a device color change, and a battery size change.

21 Claims, 9 Drawing Sheets





US009300050B2

(12) **United States Patent**
Laurent

(10) **Patent No.:** **US 9,300,050 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **MULTIBAND RF ANTENNA**

(56) **References Cited**

(71) Applicant: **BANG & OLUFSEN A/S**, Struer (DK)

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(72) Inventor: **Claude Laurent**, Aalborg (DK)

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(73) Assignee: **BANG & OLUFSEN A/S**, Struer (DK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 108 days.

(21) Appl. No.: **14/187,948**

(22) Filed: **Feb. 24, 2014**

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(65) **Prior Publication Data**
US 2014/0240185 A1 Aug. 28, 2014

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(30) **Foreign Application Priority Data**

Feb. 22, 2013 (DK) 2013 00105

Search Report prepared by the Danish Patent and Trademark Office on Oct. 8, 2013, for Danish Patent Application No. PA 2013 00105.

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(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)
H01Q 5/357 (2015.01)

Primary Examiner — Khai M Nguyen
(74) *Attorney, Agent, or Firm* — Sheridan Ross P.C.

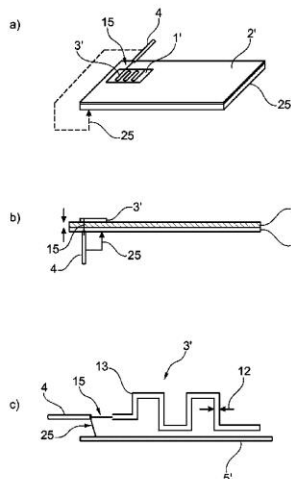
(52) **U.S. Cl.**
CPC **H01Q 9/0407** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/357** (2013.01)

(57) **ABSTRACT**

(58) **Field of Classification Search**
CPC H01Q 5/357; H01Q 1/48; H01Q 1/38; H01Q 9/0407
USPC 343/767, 700 MS, 905
See application file for complete search history.

This invention relates to a miniature multiband antenna, in which a substrate being the carrier of a conductive element, and the conductive element configured as a layer onto the substrate and being the radiator in form of a slot, and a conductive layer configured onto the substrate and being the antenna feed line in form of a polygon patch area. Alternative embodiments illustrate use of slot type—and meander type antennas. The invention may be applied in any kind of electronic equipment, where a high capacity wireless system is required and within a very small physical embodiment.

10 Claims, 6 Drawing Sheets





US009300051B2

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

(10) **Patent No.:** **US 9,300,051 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

(54) **COMMUNICATION DEVICE WITH COUPLED-FED MULTIBAND ANTENNA ELEMENT**

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

(72) Inventors: **Kin-Lu Wong**, New Taipei (TW);
Shan-Ni Hsu, New Taipei (TW)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **14/165,509**

(22) Filed: **Jan. 27, 2014**

(65) **Prior Publication Data**

US 2015/0145738 A1 May 28, 2015

(30) **Foreign Application Priority Data**

Nov. 22, 2013 (TW) 102142678 A

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 5/335 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0457** (2013.01); **H01Q 5/335** (2015.01)

(58) **Field of Classification Search**
CPC ... H01Q 5/0041; H01Q 9/0457; H01Q 5/328;
H01Q 5/50; H01Q 13/08
USPC 343/702, 893, 768, 770, 767, 700 MS,
343/745, 749
See application file for complete search history.

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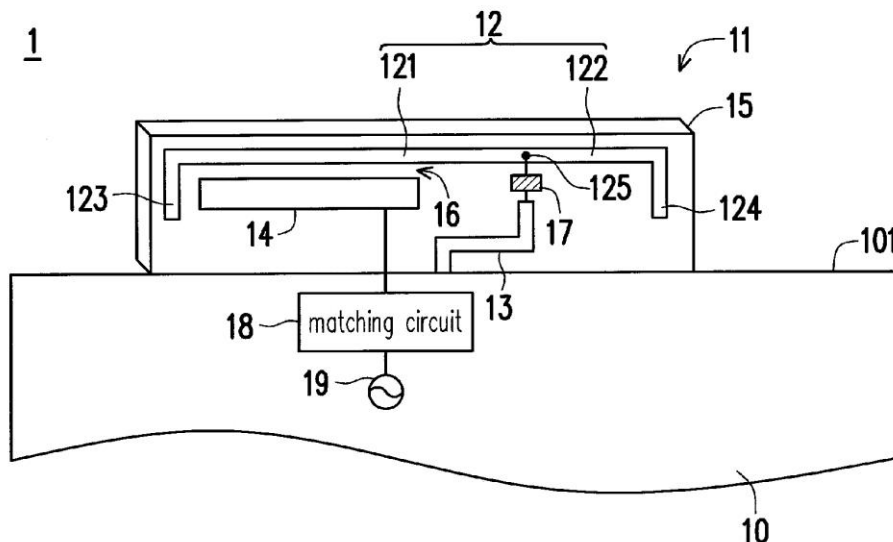
Primary Examiner — Jean B Jeanglaude

(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A communication device includes a ground element and an antenna element. The antenna element is disposed on a dielectric substrate which is adjacent to an edge of the ground element. The antenna element includes a radiating element, a shorting element and a feeding element. The radiating element has a first open end, a second open end and a shorting point. The radiating element is divided into a first element and a second element by the shorting point. The first element includes the first open end, and the second element includes the second open end. One end of the shorting element is coupled to the shorting point through a first inductive element, and another end is electrically connected to the ground element. The feeding element and the first element are spaced by a coupling gap, and the feeding element is coupled to a signal source through a matching circuit.

11 Claims, 4 Drawing Sheets





US009300055B2

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

(10) **Patent No.:** **US 9,300,055 B2**
(45) **Date of Patent:** **Mar. 29, 2016**

- (54) **MOBILE DEVICE WITH TWO ANTENNAS AND ANTENNA SWITCH MODULES**
- (71) Applicant: **Acer Incorporated**, New Taipei (TW)
- (72) Inventors: **Kuo-Hua Tseng**, New Taipei (TW);
Chih-Hua Chang, New Taipei (TW);
Shao-Yu Huang, New Taipei (TW)
- (73) Assignee: **ACER INCORPORATED**, New Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 358 days.

- (21) Appl. No.: **13/951,380**
- (22) Filed: **Jul. 25, 2013**

- (65) **Prior Publication Data**
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- (30) **Foreign Application Priority Data**
Jan. 14, 2013 (TW) 102101301 A

- (51) **Int. Cl.**
H01Q 3/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/30 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/30** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 21/28; H01Q 21/30; H01Q 29/42; H01Q 1/243
See application file for complete search history.

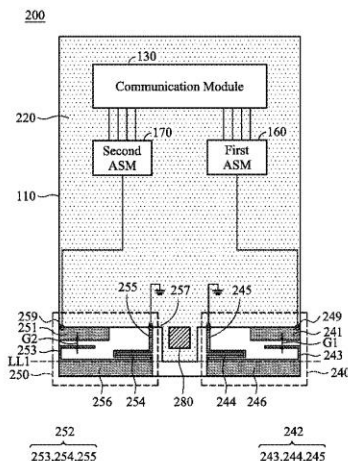
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Primary Examiner — Trinh Dinh
(74) Attorney, Agent, or Firm — McClure, Qualey & Rodack, LLP

- (57) **ABSTRACT**
A mobile device includes a system circuit board, a ground element, a communication module, a first antenna, a second antenna, a first ASM (Antenna Switch Module), and a second ASM. The first antenna is configured to receive or transmit a first signal in a first frequency band. The second antenna is configured to receive or transmit a second signal in a second frequency band. The second frequency band is different from the first frequency band. The first ASM is coupled between the first antenna and the communication module, and is configured to separate frequencies of the first signal. The second ASM is coupled between the second antenna and the communication module, and is configured to separate frequencies of the second signal.

14 Claims, 8 Drawing Sheets





US009306266B2

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

(10) **Patent No.:** **US 9,306,266 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **MULTI-BAND ANTENNA FOR WIRELESS COMMUNICATION**

USPC 343/860, 700 MS, 702
See application file for complete search history.

(71) Applicant: **Aalto University Foundation**, Aalto (FI)

(56) **References Cited**

(72) Inventors: **Risto Valkonen**, Espoo (FI); **Janne Ilvonen**, Lohja (FI)

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(73) Assignee: **AALTO UNIVERSITY FOUNDATION**, Aalto (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 488 days.

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(21) Appl. No.: **13/624,202**

Primary Examiner — Huedung Mancuso

(22) Filed: **Sep. 21, 2012**

(74) *Attorney, Agent, or Firm* — Young & Thompson

(65) **Prior Publication Data**

US 2014/0085160 A1 Mar. 27, 2014

(57) **ABSTRACT**

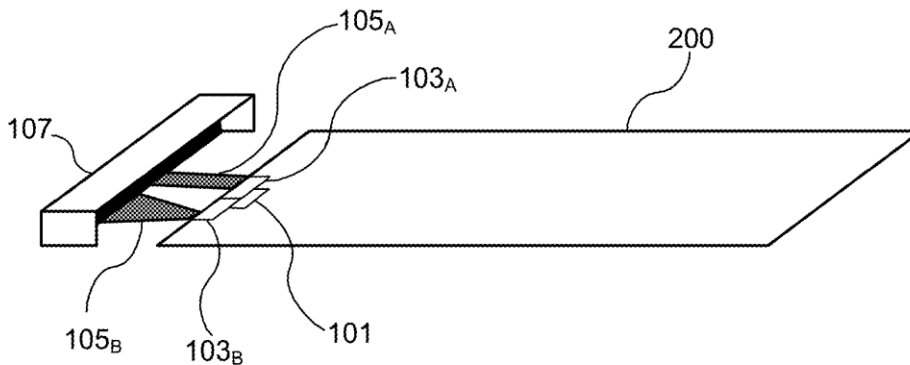
(51) **Int. Cl.**
H01Q 1/50 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/335 (2015.01)
H01Q 5/35 (2015.01)

A multi-band antenna includes a ground plane, a single antenna element, a frequency multiplexing circuit and at least two feeding strips coupled between the frequency multiplexing circuit and the single antenna element. Furthermore, the feeding of the antenna is arranged by one or more feeding points arranged between the ground plane and the frequency multiplexing circuit. According to first implementation one feeding point is arranged for at least two antenna branches. The signal fed into the feeding point is multiplexed by the multiplexing circuit to the antenna branches. According to at least one other implementation a dedicated feeding point is arranged for each of the antenna branches. At the same time the isolation of the frequencies between the different branches is arranged. This can be achieved e.g. by a multiplexing circuit. Moreover, impedance of the antenna branches can be matched with matching circuitry.

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 9/42; H01Q 5/0003; H01Q 1/243; H03H 7/38

22 Claims, 5 Drawing Sheets





US009306267B2

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

(10) **Patent No.:** **US 9,306,267 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA ASSEMBLY INTEGRAL WITH METAL HOUSING AND ELECTRONIC DEVICE USING THE ANTENNA ASSEMBLY**

- (71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)
- (72) Inventors: **Chia-Ming Liang**, New Taipei (TW); **Cho-Kang Hsu**, New Taipei (TW)
- (73) Assignee: **Chiun Mai Communications Systems, Inc.**, New Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 380 days.

(21) Appl. No.: **14/014,641**
(22) Filed: **Aug. 30, 2013**

(65) **Prior Publication Data**
US 2014/0354487 A1 Dec. 4, 2014

(30) **Foreign Application Priority Data**
May 31, 2013 (TW) 102119263 A

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/385 (2015.01)
- (52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/385** (2015.01); **H01Q 9/42** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 5/385; H01Q 9/42
USPC 343/700 MS, 702, 829, 846
See application file for complete search history.

(56) **References Cited**
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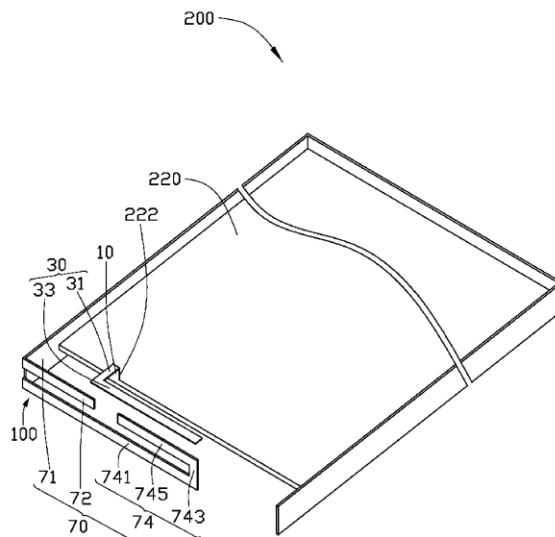
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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

The metal housing of a miniaturized electronic device is shaped to function as a multiband antenna assembly. The antenna assembly includes a feeding terminal, a radiator connecting to the feeding terminal, and a metal element. The metal element is part of a housing of the electronic device. The metal element includes two antenna units, both of which are adjacent to and spaced from the radiator. An electronic device using the antenna assembly is also described.

16 Claims, 2 Drawing Sheets





US009306274B2

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

(10) **Patent No.:** **US 9,306,274 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

- (54) **ANTENNA DEVICE AND ANTENNA MOUNTING METHOD**
- (71) Applicant: **FUJIKURA LTD.**, Tokyo (JP)
- (72) Inventors: **Hiroiku Tayama**, Sakura (JP); **Ning Guan**, Sakura (JP)
- (73) Assignee: **FUJIKURA LTD.**, Tokyo (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 182 days.

(21) Appl. No.: **14/158,312**

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

(65) **Prior Publication Data**
US 2014/0132471 A1 May 15, 2014

Related U.S. Application Data
(63) Continuation of application No. PCT/JP2012/071366, filed on Aug. 23, 2012.

(30) **Foreign Application Priority Data**
Sep. 26, 2011 (JP) 2011-209640

(51) **Int. Cl.**
H01Q 1/48 (2006.01)
H01Q 1/38 (2006.01)
H01Q 9/42 (2006.01)
H01Q 1/22 (2006.01)

(52) **U.S. Cl.**
CPC . **H01Q 1/48** (2013.01); **H01Q 1/22** (2013.01);
H01Q 1/38 (2013.01); **H01Q 9/42** (2013.01);
Y10T 29/49018 (2015.01)

(58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/22; H01Q 1/38;
H01Q 1/42; Y10T 29/49018
See application file for complete search history.

(56) **References Cited**

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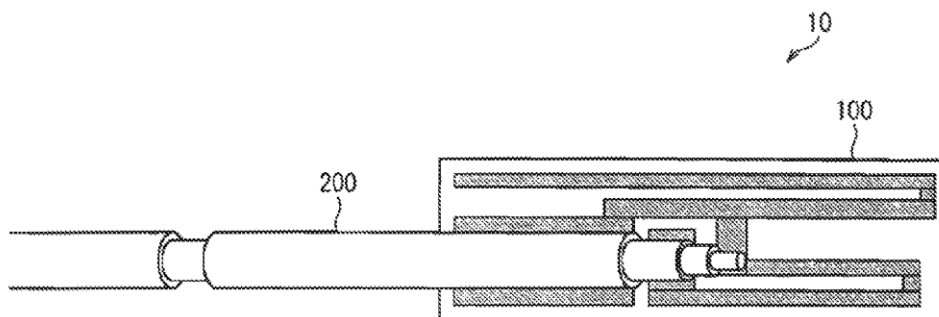
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Chinese Office Action dated Oct. 17, 2014, issued in corresponding CN application No. 201280036512.2 with English translation (32 pages).

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Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(57) **ABSTRACT**
An antenna device (10) includes: an antenna (100) including a radiating element (101) and an internal ground (103); a coaxial cable (200) whose internal conductor (204) is connected with the radiating element (101) and whose external conductor (203) is connected with the internal ground (103); and an external ground (500) connected with the external conductor (203) of the coaxial cable (200).

7 Claims, 8 Drawing Sheets





US009306275B2

(12) **United States Patent**
Mikata

(10) **Patent No.:** **US 9,306,275 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **MULTI-ANTENNA AND ELECTRONIC DEVICE**

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

(72) Inventor: **Jin Mikata**, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 210 days.

(21) Appl. No.: **13/849,241**

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

(65) **Prior Publication Data**
US 2013/0271339 A1 Oct. 17, 2013

(30) **Foreign Application Priority Data**
Apr. 17, 2012 (JP) 2012-093974

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/50 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/50** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 833, 834, 835
See application file for complete search history.

(56) **References Cited**
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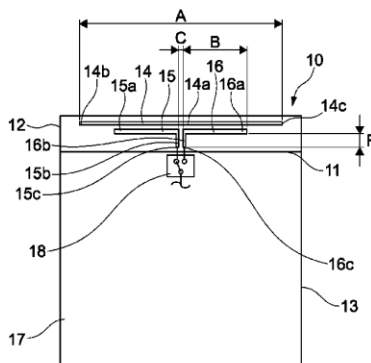
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Chen Yoshimura LLP

(57) **ABSTRACT**

A passive element has an electrical length such that a resonance mode thereof is in a target frequency band, and first and second feed elements, each of which has an electrical length such that a resonance mode thereof is not in the target frequency band. The first feed element has a first coupling conductive part, and a first connecting conductive part, which has a continuous shape with the first coupling conductive part. The second feed element has a second coupling conductive part, and a second connecting conductive part, which has a continuous shape with the second coupling conductive part. The first coupling conductive part is disposed parallel and adjacent to the passive element. The second coupling conductive part is disposed parallel and adjacent to the passive element. The first connecting conductive part and the second connecting conductive part are disposed adjacent and parallel to each other.

8 Claims, 37 Drawing Sheets





US009306277B2

(12) **United States Patent**
Miyake

(10) **Patent No.:** **US 9,306,277 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **MULTI-ANTENNA DEVICE AND COMMUNICATION DEVICE**

(71) Applicant: **Funai Electric Co., Ltd.**, Daito, Osaka (JP)

(72) Inventor: **Yasunari Miyake**, Osaka (JP)

(73) Assignee: **FUNAI ELECTRIC CO., LTD.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 141 days.

(21) Appl. No.: **14/077,755**

(22) Filed: **Nov. 12, 2013**

(65) **Prior Publication Data**
US 2014/0139399 A1 May 22, 2014

(30) **Foreign Application Priority Data**
Nov. 20, 2012 (JP) 2012-254225

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 1/52 (2006.01)

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

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/243
USPC 343/702, 893, 846
See application file for complete search history.

(56) **References Cited**

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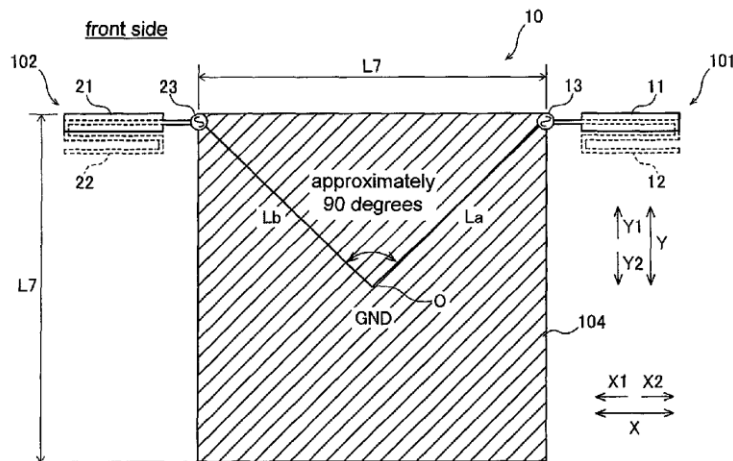
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Primary Examiner — Hoanganh Le
(74) *Attorney, Agent, or Firm* — Global IP Counselors, LLP

(57) **ABSTRACT**

A multi-antenna device includes a grounding plate, a first antenna and a second antenna. The first antenna includes a first feed element that is grounded to the grounding plate via a first feed point. The second antenna includes a second feed element that is grounded to the grounding plate via a second feed point. The first feed point and the second feed point are disposed such that a straight line connecting the first feed point and a center of the grounding plate and a straight line connecting the second feed point and the center of the grounding plate are substantially perpendicular to each other in a plan view.

14 Claims, 9 Drawing Sheets





US009306280B2

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

(10) **Patent No.:** **US 9,306,280 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

- (54) **MOBILE TERMINAL**
- (71) Applicant: **SONY MOBILE COMMUNICATIONS, INC.**, Tokyo (JP)
- (72) Inventors: **Kenichiro Kodama**, Tokyo (JP); **Aiko Yoshida**, Tokyo (JP); **Akihiro Bungo**, Tokyo (JP)
- (73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony Mobile Communications Inc.**, Tokyo (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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

- (56) **References Cited**
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- (21) Appl. No.: **14/594,594**
- (22) Filed: **Jan. 12, 2015**
- (65) **Prior Publication Data**
US 2015/0207225 A1 Jul. 23, 2015

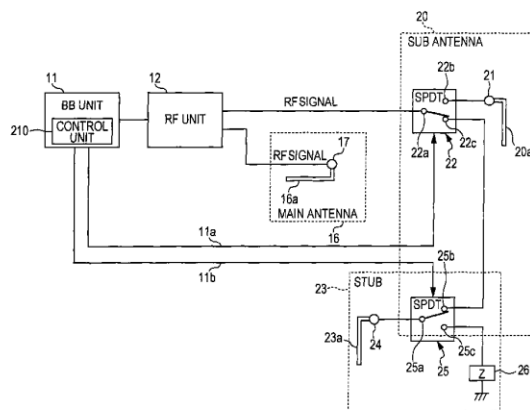
Primary Examiner — Dieu H Duong
(74) *Attorney, Agent, or Firm* — Oblon, McClelland, Maier & Neustadt, L.L.P.

- Related U.S. Application Data**
- (62) Division of application No. 13/544,418, filed on Jul. 9, 2012.
- (60) Provisional application No. 61/524,916, filed on Aug. 18, 2011.

- (57) **ABSTRACT**
A mobile terminal that includes a first antenna element disposed in proximity to a first side of the mobile terminal, a second antenna element disposed in proximity to a second side of the mobile terminal, and a third antenna element disposed in proximity to a third side of the mobile terminal. The mobile terminal further including a switching mechanism that switches between a first connection mode in which the first and second antenna elements are feed elements and the third antenna element is a parasitic element, and a second connection mode in which the first and third antenna elements are feed elements, and a control unit that controls the switching mechanism to switch between the first connection mode and the second connection mode in accordance with a predetermined condition.

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 3/24 (2006.01)
(Continued)
- (52) **U.S. Cl.**
CPC **H01Q 3/24** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/521** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 21/28** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 3/24

5 Claims, 12 Drawing Sheets





US009306281B2

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

(10) **Patent No.:** **US 9,306,281 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

- (54) **WIRELESS COMMUNICATION DEVICE**
- (71) Applicant: **Acer Incorporated**, New Taipei (TW)
- (72) Inventors: **Kun-Sheng Chang**, New Taipei (TW);
Ming-Yu Chou, New Taipei (TW);
Ching-Chi Lin, New Taipei (TW)
- (73) Assignee: **Acer Incorporated**, New Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 89 days.
- (21) Appl. No.: **14/195,861**
- (22) Filed: **Mar. 4, 2014**
- (65) **Prior Publication Data**
US 2015/0188223 A1 Jul. 2, 2015
- (30) **Foreign Application Priority Data**
Dec. 31, 2013 (TW) 102149314 A
- (51) **Int. Cl.**
H01Q 5/314 (2015.01)
H01Q 5/00 (2015.01)
- (52) **U.S. Cl.**
CPC **H01Q 5/0034** (2013.01); **H01Q 5/314** (2015.01)
- (58) **Field of Classification Search**
USPC 343/702, 722
See application file for complete search history.

- (56) **References Cited**
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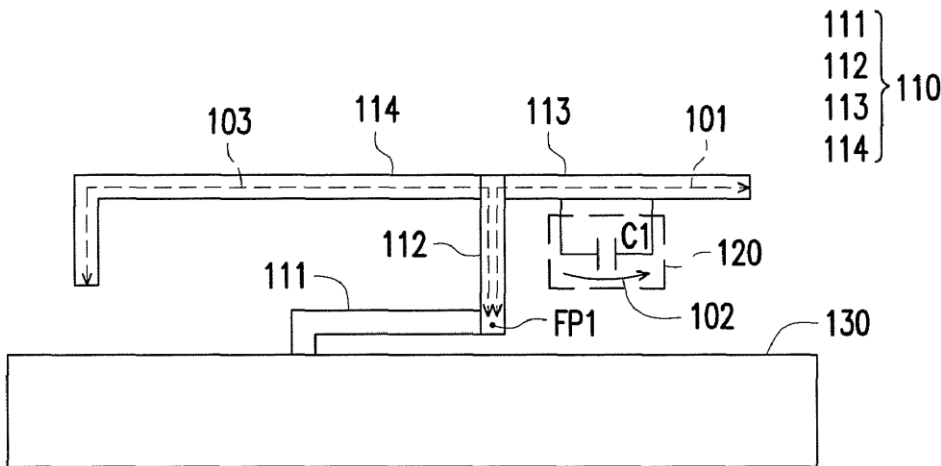
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Primary Examiner — Howard Williams
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A wireless communication device including an antenna element and a resonant divider is provided. The antenna element has a resonant path so that an operation frequency of the antenna element covers a first band and a second band. The resonant divider is electrically connected to the antenna element and provides a current path connected in parallel with a part of the resonant path. The resonant divider delays a current flowing through the current path so that the antenna element is incapable of covering an interval band between the first band and the second band.

8 Claims, 2 Drawing Sheets





US009306282B2

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

(10) **Patent No.:** **US 9,306,282 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

- (54) **ANTENNA ARRANGEMENT** 6,850,196 B2 * 2/2005 Wong H01Q 1/243
343/702
- (71) Applicant: **Nokia Technologies Oy**, Espoo (FI) 6,914,565 B2 * 7/2005 Shikata H01Q 9/0421
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- (72) Inventors: **Mikko S. Komulainen**, Oulu (FI); **Sami Hienonen**, Oulu (FI); **Tommi Lepisto**, Kempele (FI) 6,977,616 B2 * 12/2005 Yuanzhu H01Q 5/378
343/700 MS
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- (73) Assignee: **Nokia Technologies Oy**, Espoo (FI)
- (*) 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.: **14/714,528**

(22) Filed: **May 18, 2015**

(65) **Prior Publication Data**
US 2015/0380819 A1 Dec. 31, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/630,018, filed on Sep. 28, 2012, now Pat. No. 9,035,830.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 5/20 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ... **H01Q 5/20** (2015.01); **H01Q 9/04** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/521; H01Q 21/28;
H01Q 5/371; H01Q 9/42
See application file for complete search history.

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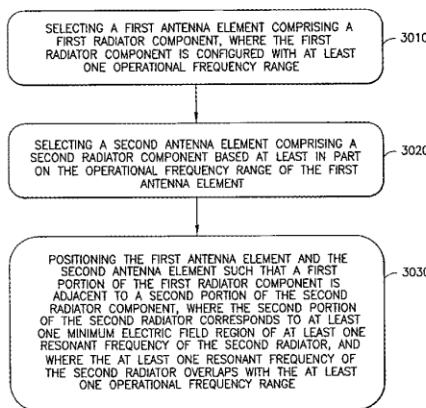
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Primary Examiner — Tho G Phan
(74) *Attorney, Agent, or Firm* — Harrington & Smith

(57) **ABSTRACT**

An apparatus for antenna arrangement isolation is described. The apparatus includes a first antenna element (for example, a CMMB TV antenna) having a first radiator component and a second antenna element (for example, a cellular antenna) having a second radiator component. A first portion of the first radiator component is adjacent to a second portion of the second radiator component. The second radiator component is configured with at least one operational frequency range. The first portion of the first radiator corresponds to at least one minimum electric field region of at least one resonant frequency of the first radiator. The at least one resonant frequency of the first radiator overlaps with the at least one operational frequency range. Methods, Apparatus and Computer readable media for providing the antenna arrangement are also described.

16 Claims, 29 Drawing Sheets





US009306285B2

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

(10) **Patent No.:** **US 9,306,285 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA HAVING THREE OPERATING FREQUENCY BANDS AND METHOD FOR MANUFACTURING THE SAME**

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

(71) Applicant: **Arcadyan Technology Corporation**,
Hsinchu (TW)

(56) **References Cited**

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(72) Inventors: **Chih-Yung Huang**, Taichung (TW);
Kuo-Chang Lo, Miaoli County (TW);
Jen-Hsiang Fang, Hsinchu (TW)

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(73) Assignee: **ARCADYAN TECHNOLOGY CORPORATION**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 255 days.

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(21) Appl. No.: **14/017,361**

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(22) Filed: **Sep. 4, 2013**

(Continued)

(65) **Prior Publication Data**

US 2014/0062795 A1 Mar. 6, 2014

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(30) **Foreign Application Priority Data**

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Search report issued on Feb. 5, 2014 from European Patent Office in a counterpart European patent.
Office Action was issued on Sep. 2, 2015 from the TW patent Office.

Primary Examiner — Dameon E Levi

Assistant Examiner — Ab Salam Alkassim, Jr.

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

- (51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/40 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/371 (2015.01)

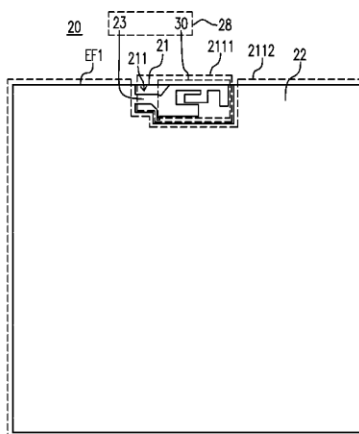
(57) **ABSTRACT**

An antenna including a radiation portion is provided. The radiation portion includes a feed terminal and three conductor branch paths directly extending from the feed terminal. The three conductor branch paths are located on the same side of the feed terminal, and each has an initial direction, and any two of the three initial directions have an acute angle therebetween. A method for manufacturing an antenna having three operating frequency bands is also provided.

- (52) **U.S. Cl.**
CPC **H01Q 9/04** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 9/40** (2013.01); **H01Q 9/42** (2013.01); **Y10T 29/49016** (2015.01)

- (58) **Field of Classification Search**
CPC H01Q 5/371; H01Q 5/30; H01Q 5/20; H01Q 1/243; H01Q 9/0421

20 Claims, 4 Drawing Sheets





US009306287B2

(12) **United States Patent**
Chiang

(10) **Patent No.:** **US 9,306,287 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **ANTENNA STRUCTURE WITH AN EFFECTIVE SERIAL CONNECTING CAPACITANCE**

(71) Applicant: **Auden Techno Corp.**, Pa-Te, Tao-Yuan Hsien (TW)
(72) Inventor: **Chi-Ming Chiang**, Pa-Te (TW)
(73) Assignee: **AUDEN TECHNO CORP.**, Pa-Te (TW)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 314 days.

(21) Appl. No.: **14/074,818**

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

(65) **Prior Publication Data**
US 2014/0091975 A1 Apr. 3, 2014

Related U.S. Application Data

(60) Division of application No. 12/510,380, filed on Jul. 28, 2009, now abandoned, which is a continuation-in-part of application No. 12/364,681, filed on Feb. 3, 2009, now abandoned.

(51) **Int. Cl.**
H01Q 9/16 (2006.01)
H01Q 9/06 (2006.01)
H01Q 1/22 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/06** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 9/0421** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 9/042; H01Q 9/06; H01Q 1/2266
See application file for complete search history.

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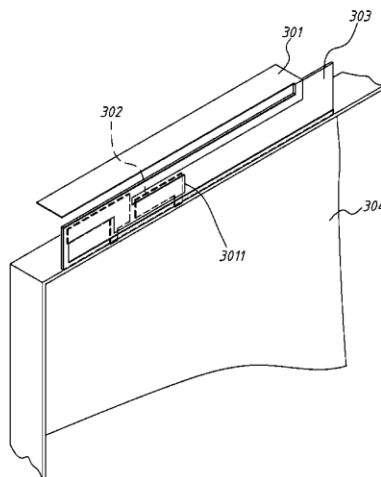
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Primary Examiner — Trinh Dinh
(74) *Attorney, Agent, or Firm* — Guice Patents PLLC

(57) **ABSTRACT**

In an antenna structure having a serial connected capacitance effect, mainly a metallic planar antenna is provided thereon at least with a first metallic plane board, and a second metallic plane board being close to but not connected to the first metallic plane board to form the effect of capacitance in serial connecting. And more, the antenna structure further has an extension arm made from a microstrip extended from the antenna or the second metallic plane board, and can be optionally grounded or not grounded, for the purpose of adjusting the impedance value of the antenna structure.

5 Claims, 11 Drawing Sheets





US009306288B2

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

(10) **Patent No.:** **US 9,306,288 B2**
(45) **Date of Patent:** **Apr. 5, 2016**

(54) **SMALL ANTENNA APPARATUS AND METHOD FOR CONTROLLING THE SAME**

- (71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si, Gyeonggi-do (KR)
- (72) Inventors: **Jungsik Park**, Bucheon-si (KR);
Sooung Chun, Suwon-si (KR)
- (73) Assignee: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 371 days.

(21) Appl. No.: **13/727,205**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jan. 13, 2012 (KR) 10-2012-0004448

(51) **Int. Cl.**

- H01Q 11/12** (2006.01)
- H04B 1/04** (2006.01)
- H04B 1/18** (2006.01)
- H01Q 9/16** (2006.01)
- H01Q 1/24** (2006.01)
- H01Q 9/14** (2006.01)
- H01Q 9/42** (2006.01)
- H04W 88/02** (2009.01)

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

CPC **H01Q 9/16** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/145** (2013.01); **H01Q 9/42** (2013.01); **H04W 88/02** (2013.01); **H04B 1/0458** (2013.01); **H04B 1/18** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 9/145; H01Q 1/243; H01Q 9/42
USPC 455/129, 193.1, 193.2, 193.3, 121, 269
See application file for complete search history.

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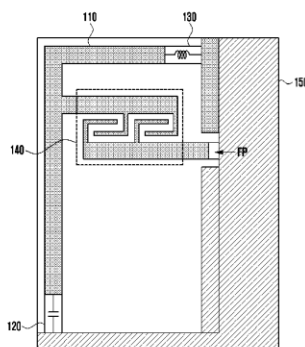
Primary Examiner — Nguyen Vo

(74) Attorney, Agent, or Firm — Jefferson IP Law, LLP

(57) **ABSTRACT**

An antenna apparatus for a mobile terminal is provided. The antenna apparatus includes an antenna pattern, a first electric circuit and a second electric circuit respectively connected between both ends of the antenna pattern and a system ground, and a third electric circuit disposed between the antenna pattern and a feeding line, wherein the first electric circuit and the second electric circuit extend electrical wavelengths of the antenna pattern and the third electric circuit increases input impedance matching.

15 Claims, 13 Drawing Sheets





US009306292B2

(12) **United States Patent**
Ryu

(10) **Patent No.:** **US 9,306,292 B2**

(45) **Date of Patent:** **Apr. 5, 2016**

(54) **PORTABLE TERMINAL**
(71) Applicant: **LG ELECTRONICS INC.**, Seoul (KR)
(72) Inventor: **Seungwoo Ryu**, Uijeongbu (KR)
(73) Assignee: **LG ELECTRONICS INC.**, Seoul (KR)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 289 days.

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(21) Appl. No.: **13/757,292**
(22) Filed: **Feb. 1, 2013**
(65) **Prior Publication Data**
US 2013/0207854 A1 Aug. 15, 2013

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(30) **Foreign Application Priority Data**
Feb. 15, 2012 (KR) 10-2012-0015448

Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Islam
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/52 (2006.01)
H01Q 5/35 (2015.01)

(57) **ABSTRACT**

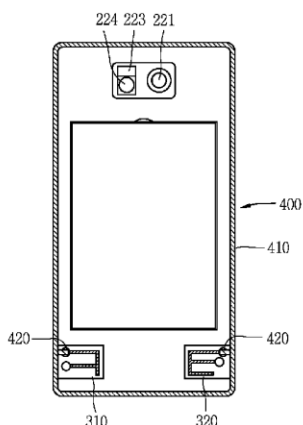
(52) **U.S. Cl.**
CPC **H01Q 21/28** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 5/35** (2015.01)

The present disclosure relates to a portable terminal having antennas for transmitting or receiving wireless signals. The portable terminal includes a terminal body, a first antenna mounted in the terminal body to transmit or receive a wireless signal, a second antenna disposed with being spaced apart from the first antenna and set to transmit or receive a wireless signal at a frequency band different from the first antenna, and a connection unit configured to electrically connect the first and second antennas to reduce a frequency interference between the first and second antennas, at least part of the connection unit being formed along an edge of the terminal body.

(58) **Field of Classification Search**
CPC H01Q 5/0048; H01Q 1/521; H01Q 1/243
USPC 343/702, 841, 893, 853
See application file for complete search history.

(56) **References Cited**
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11 Claims, 15 Drawing Sheets





US009312608B2

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

(10) **Patent No.:** **US 9,312,608 B2**
(45) **Date of Patent:** **Apr. 12, 2016**

(54) **MULTIPLE-INPUT MULTIPLE-OUTPUT ANTENNA DEVICE**

USPC 343/702, 893, 841; 29/600
See application file for complete search history.

(71) Applicant: **TAI-SAW TECHNOLOGY CO., LTD.**,
Taoyuan County (TW)

(56) **References Cited**

(72) Inventors: **Tzu-Chun Tang**, Taoyuan County (TW);
Ken-Huang Lin, Taoyuan County (TW)

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(73) Assignee: **TAI-SAW TECHNOLOGY CO, LTD.**,
Taoyuan (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 324 days.

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(21) Appl. No.: **13/863,900**

Office Action from TW application No. 101113674 dated Mar. 27,
2014.

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

Office Action from TW application No. 101113674 dated Oct. 14,
2014.

(65) **Prior Publication Data**

US 2013/0271345 A1 Oct. 17, 2013

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(30) **Foreign Application Priority Data**

Apr. 17, 2012 (TW) 101113674 A

Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Haverstock & Owens LLP

(51) **Int. Cl.**

H01Q 21/00 (2006.01)

H01Q 1/52 (2006.01)

H01Q 5/48 (2015.01)

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

CPC **H01Q 21/0075** (2013.01); **H01Q 1/521**
(2013.01); **H01Q 5/48** (2015.01); **H01Q**
21/0093 (2013.01); **Y10T 29/49016** (2015.01)

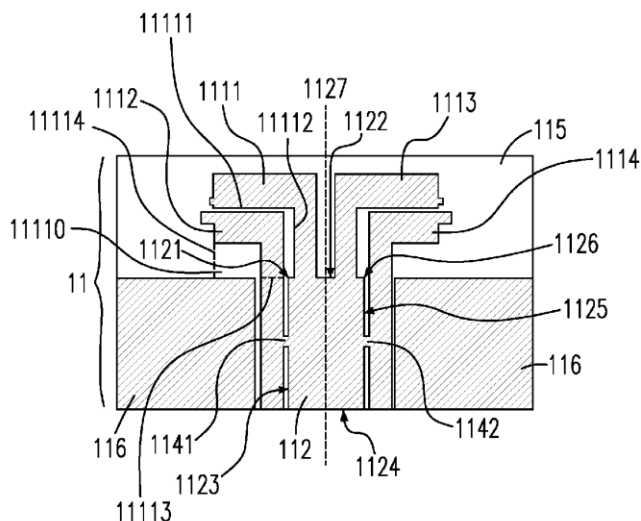
(58) **Field of Classification Search**

CPC ... H01Q 1/521; H01Q 1/526; H01Q 21/0075;
H01Q 21/0093; Y10T 29/49016

(57) **ABSTRACT**

A coplanar waveguide fed multiple-input multiple-output (MIMO) antenna device is provided in the present invention. The coplanar waveguide fed multiple-input multiple-output (MIMO) antenna device includes a grounding metal piece; a grounding plane; a first radiation element connected to the grounding plane; and a second radiation element connected to the grounding plane through the grounding metal piece.

20 Claims, 15 Drawing Sheets





US009317074B2

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

(10) **Patent No.:** **US 9,317,074 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

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

(75) Inventors: **Gang Ji**, Kawakaki (JP); **Tetsuya Ohtani**, Yokohama (JP); **Takayuki Morino**, Yamato (JP); **Akinori Uchino**, Yamato (JP)

(73) Assignee: **Lenova (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 1380 days.

(21) Appl. No.: **12/351,533**

(22) Filed: **Jan. 9, 2009**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Jan. 11, 2008 (JP) 2008-004103

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

(52) **U.S. Cl.**
CPC **G06F 1/1698** (2013.01); **G06F 1/1616** (2013.01); **G06F 1/1637** (2013.01); **G06F 1/1656** (2013.01)

(58) **Field of Classification Search**
USPC 361/679.21, 679.26-679.27, 697.55
See application file for complete search history.

(56) **References Cited**

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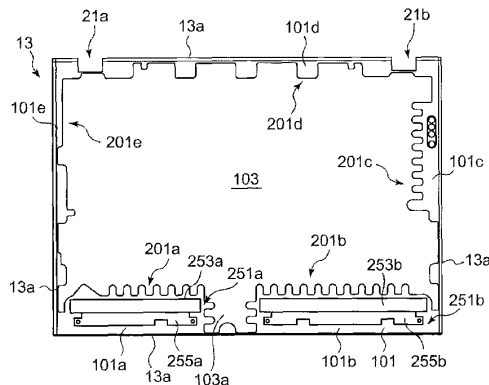
English translation of Koike, JP 3-20492 U, dated Feb. 28, 1991, translated in Jun. 2012.*

Primary Examiner — Robert J Hoffberg
(74) *Attorney, Agent, or Firm* — Ference & Associates LLC

(57) **ABSTRACT**

The invention broadly contemplates an electronic apparatus that provides improved antenna characteristics, while maintaining a thin size and light weight. The electronic apparatus of the present invention includes a display casing having a nonconductive resin region and a conductive resin region in a bottom surface thereof; a display module accommodated in the display casing; an antenna disposed in the nonconductive resin region; and a system casing accommodating a wireless module connected to the antenna. By disposing the antenna in the nonconductive resin region formed in the bottom surface of the display casing, it is possible to secure high radio wave sensitivity while preventing an antenna mounting portion from being exposed to the outside of the display casing. The casing structure of the electronic apparatus does not become thick because of butt joining even when the joint portions are in a projection area of an LCD module.

19 Claims, 6 Drawing Sheets





US009318791B2

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

(10) **Patent No.:** **US 9,318,791 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **CARBON FIBER-BASED CHASSIS COMPONENTS FOR PORTABLE INFORMATION HANDLING SYSTEMS**

(71) Applicants: **Brian H. Leonard**, Austin, TX (US);
David J. Hernandez, Round Rock, TX (US); **Chuan Beng Sim**, Shanghai (CN)

(72) Inventors: **Brian H. Leonard**, Austin, TX (US);
David J. Hernandez, Round Rock, TX (US); **Chuan Beng Sim**, Shanghai (CN)

(73) Assignee: **Dell Products L.P.**, Round Rock, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 121 days.

(21) Appl. No.: **14/169,376**

(22) Filed: **Jan. 31, 2014**

(65) **Prior Publication Data**
US 2015/0222007 A1 Aug. 6, 2015

(51) **Int. Cl.**
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H01Q 1/22 (2006.01)
H01Q 9/30 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2266** (2013.01); **H01Q 9/30** (2013.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**
CPC H01Q 9/14; H01Q 1/50; H01Q 9/30
USPC 343/700, 702; 361/679.01
See application file for complete search history.

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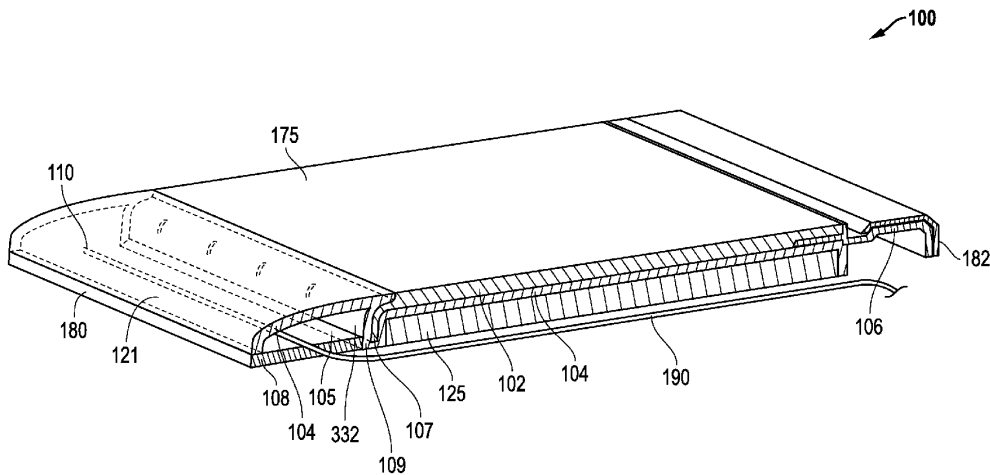
Primary Examiner — Peguy Jean Pierre

(74) *Attorney, Agent, or Firm* — Egan, Peterman, Enders & Huston LLP

(57) **ABSTRACT**

A chassis component of an information handling system may include a chassis main lid component constructed of carbon fiber composite material that supports a lid chassis antenna housing that includes an internal antenna cavity defined therein to create an antenna window for the system. The carbon fiber composite material may be attached to the chassis antenna housing by an interlocking rib that provides sufficient joint strength to allow for a substantially larger and extended chassis antenna housing with larger antenna window that may be spaced further away from the carbon fiber composite material of the chassis main lid component than would otherwise be possible for the same form factor size so as to minimize or substantially eliminate shielding or blocking of wireless signals by the carbon fiber composite material lid component that would result in reduced system wireless performance.

27 Claims, 8 Drawing Sheets





US009318792B2

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

(10) **Patent No.:** **US 9,318,792 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **METHOD FOR CONTROLLING ANTENNAS OF MOBILE TERMINAL DEVICE AND SUCH A MOBILE TERMINAL DEVICE**

(75) Inventors: **Kozo Matsunaga**, Yokohama (JP); **Takeshi Asano**, Atsugi (JP); **Masaharu Itoh**, Yamato (JP); **Kazuo Fujii**, Yokohama (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 584 days.

(21) Appl. No.: **12/509,125**

(22) Filed: **Jul. 24, 2009**

(65) **Prior Publication Data**
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Related U.S. Application Data
(62) Division of application No. 11/445,942, filed on Jun. 3, 2006, now abandoned.

(30) **Foreign Application Priority Data**
Jun. 3, 2005 (JP) 2005-164280

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04B 1/38 (2015.01)
H01Q 1/22 (2006.01)
H01Q 1/24 (2006.01)
H01Q 3/24 (2006.01)
H04B 1/3827 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/2291** (2013.01); **H01Q 1/243** (2013.01); **H01Q 3/24** (2013.01); **H04B 1/3838** (2013.01)

(58) **Field of Classification Search**
CPC H04B 1/3838; H01Q 1/243
USPC 455/550.1, 575.7, 103, 272, 277.1, 566
See application file for complete search history.

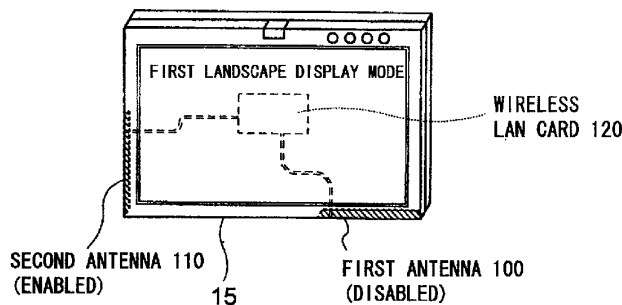
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Primary Examiner — Nguyen Vo
(74) *Attorney, Agent, or Firm* — Ference & Associates LLC

(57) **ABSTRACT**
A method for controlling antennas of a mobile terminal device such as a laptop PC and a handheld PC without degrading communication speed or quality and a mobile terminal device having such control are provided. The method comprises determining the usage of the mobile terminal device, determining an antenna to be disabled among the plurality of antennas according to the usage that is determined by the determining of usage, and disabling the antenna which is determined by determining of an antenna to be disabled, wherein the determining of usage determines usage based on the display orientation of the display unit of the mobile terminal device.

20 Claims, 10 Drawing Sheets





US009318793B2

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

(10) **Patent No.:** **US 9,318,793 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **CORNER BRACKET SLOT ANTENNAS**

(56) **References Cited**

(75) Inventors: **Jiang Zhu**, Sunnyvale, CA (US); **Qingxiang Li**, Mountain View, CA (US); **Robert W. Schlub**, Cupertino, CA (US); **Miroslav Samardzija**, Mountain View, CA (US); **Gordon Coutts**, Sunnyvale, CA (US); **Rodney A. Gomez Angulo**, Sunnyvale, CA (US); **Yi Jiang**, Sunnyvale, CA (US); **Boon W. Shiu**, San Jose, CA (US); **Salih Yarga**, Sunnyvale, CA (US); **Emily B. McMilin**, Mountain View, CA (US); **Ruben Caballero**, San Jose, CA (US)

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Primary Examiner — Trinh Dinh

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

(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 413 days.

(21) Appl. No.: **13/462,268**

(22) Filed: **May 2, 2012**

(65) **Prior Publication Data**

US 2013/0293424 A1 Nov. 7, 2013

(51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)

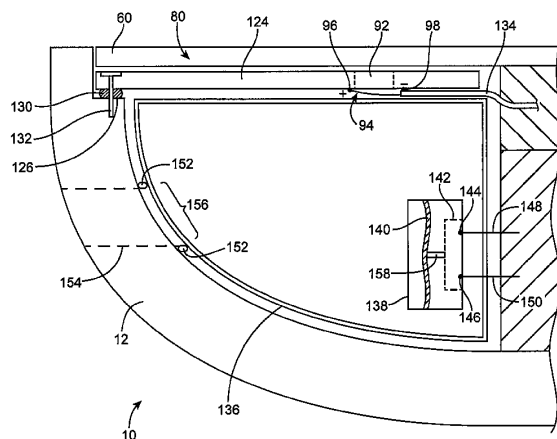
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/44; H01Q 13/10
See application file for complete search history.

(57) **ABSTRACT**

A display cover layer may be mounted in an electronic device housing using housing structures such as corner brackets. A slot antenna may be formed from a corner bracket opening, metal traces on a hollow plastic support structure, or other conductive structures. The slot antenna may have a main portion with opposing ends. An antenna feed may be located at one of the ends. The slot antenna may have a slot with one or more bends. The bends may provide the slot antenna with a C-shaped outline. A side branch slot may extend from the main portion of the slot at a location between the two bends. The presence of the side branch slot may enhance antenna bandwidth. A hollow enclosure may serve as an antenna support structure and as a speaker box enclosing a speaker driver. The antenna feed may be positioned so as to overlap the speaker driver.

8 Claims, 11 Drawing Sheets





US009318795B2

(12) **United States Patent**
Su

(10) **Patent No.:** **US 9,318,795 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **WIDEBAND ANTENNA AND RELATED RADIO-FREQUENCY DEVICE**

(75) Inventor: **Chi-Kang Su**, 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 269 days.

(21) Appl. No.: **13/585,841**

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

(65) **Prior Publication Data**

US 2013/0249765 A1 Sep. 26, 2013

(30) **Foreign Application Priority Data**

Mar. 22, 2012 (TW) 101109847 A

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)
H01Q 1/24 (2006.01)
H01Q 15/02 (2006.01)
H01Q 1/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/371 (2015.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC ... H01Q 21/24; H01Q 13/206; H01Q 5/0072; H01Q 1/38; H01Q 9/40; H01Q 1/48; H01Q 1/50
USPC 343/700 MS, 850, 702, 909, 722
See application file for complete search history.

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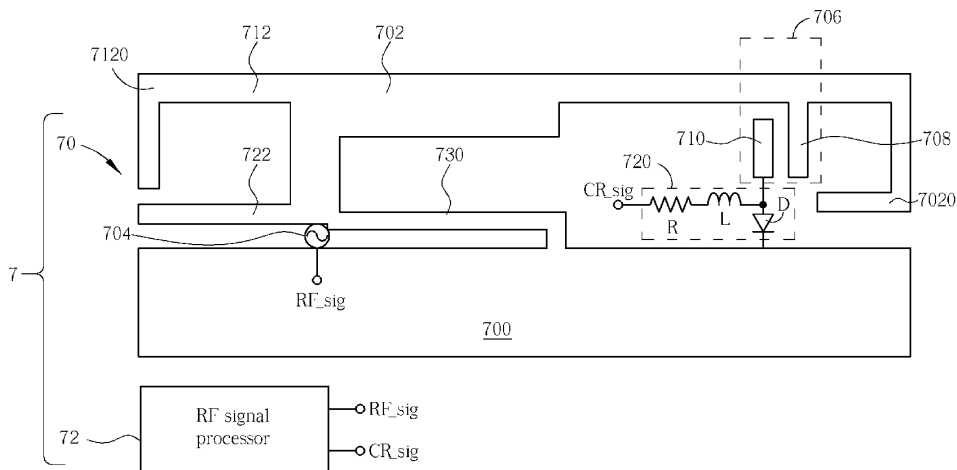
Primary Examiner — Graham Smith

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

(57) **ABSTRACT**

A wideband antenna is disclosed. The wideband antenna includes a ground element electrically connected to a ground, a feed element for feeding in a Radio-Frequency signal, a radiation element electrically connected to the feed element for radiating the Radio-Frequency signal, and at least one meta-material structure electrically connected between the radiation element and the ground element.

16 Claims, 22 Drawing Sheets





US009318796B2

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

(10) **Patent No.:** **US 9,318,796 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **MULTIBAND ANTENNA**

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

(72) Inventors: **Cho-Kang Hsu**, New Taipei (TW);
Che-Yen Lin, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 208 days.

(21) Appl. No.: **14/014,623**

(22) Filed: **Aug. 30, 2013**

(65) **Prior Publication Data**

US 2014/0313083 A1 Oct. 23, 2014

(30) **Foreign Application Priority Data**

Apr. 19, 2013 (TW) 102113874 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/28 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0421** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 5/371; H01Q 1/243; H01Q 21/28; H01Q 9/0421; H01Q 5/0062; H01Q 5/378; H01Q 5/385; H01Q 5/392; H01Q 5/00
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Michael C Wimer

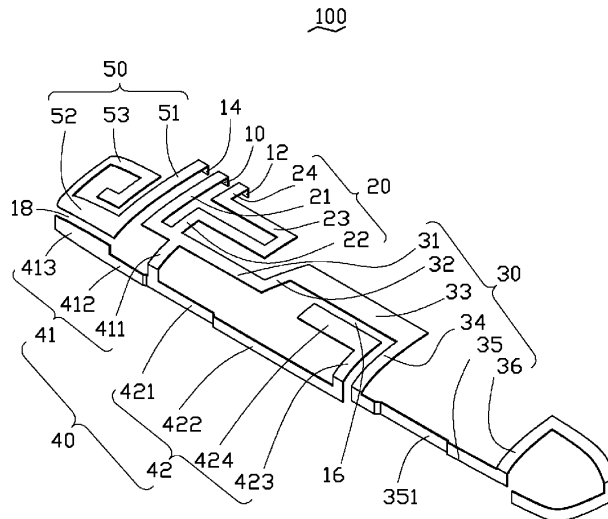
Assistant Examiner — Noel Maldonado

(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

(57) **ABSTRACT**

A multiband antenna includes a feed end, a first ground end, a second ground end, a ground path, parasitic member, a first resonating member, and a second resonating member. The ground path is connected between the feed end and the first ground end. The first resonating member operates at a low frequency resonating mode. The second resonating member operates at a high frequency resonating mode. The second resonating member includes a first bent portion and a second bent portion. The first bent portion is coupled with the parasitic member to widen a bandwidth of the second resonating member at the high frequency resonating mode. The second bent portion is coupled with the first resonating member to reduce an electrical length of the first resonating member.

15 Claims, 2 Drawing Sheets





US009318797B2

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

(10) **Patent No.:** **US 9,318,797 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **ELECTRONIC DEVICE**

(71) Applicants: **Bin-Chyi Tseng**, Taipei (TW);
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Chih-Chung Lin, Taipei (TW)

(72) Inventors: **Bin-Chyi Tseng**, Taipei (TW);
Tsung-Chieh Yen, Taipei (TW);
Chih-Chung Lin, Taipei (TW)

(73) Assignee: **ASUSTeK COMPUTER INC.**, Taipei (TW)

(*) 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.: **14/277,065**

(22) Filed: **May 14, 2014**

(65) **Prior Publication Data**
US 2014/0347228 A1 Nov. 27, 2014

Related U.S. Application Data
(60) Provisional application No. 61/826,988, filed on May 23, 2013.

(30) **Foreign Application Priority Data**
Feb. 12, 2014 (CN) 2014 1 0048864

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/245** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/241** (2013.01); **H01Q 1/242** (2013.01); **H01Q 1/44** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/24; H01Q 1/241; H01Q 1/242; H01Q 1/245; H01Q 1/44
USPC 343/702, 787
See application file for complete search history.

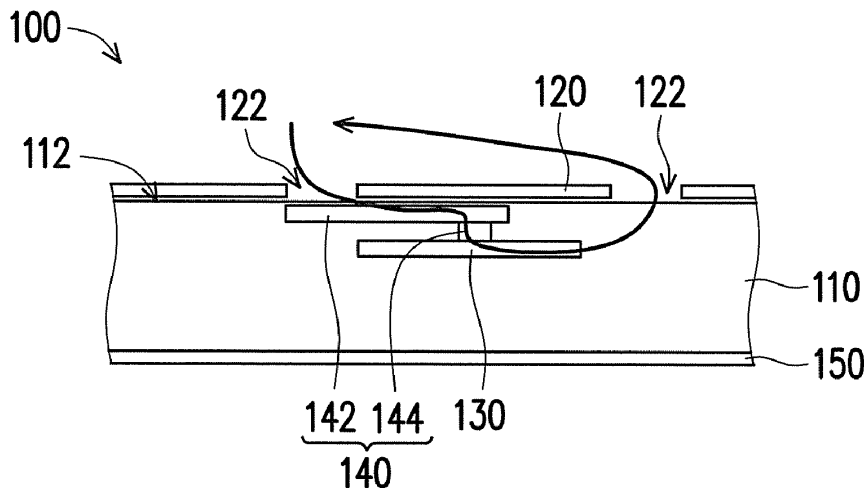
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Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**
An electronic device includes a main body, a metal cover, an antenna and a magnetic flux inducer unit. The metal cover is disposed at the main body and the main body includes a nonmetal covered portion. The antenna is disposed in the main body. The magnetic flux inducer unit is disposed in the main body and located between the nonmetal covered portion and the antenna. The permeability of the magnetic flux inducer unit is greater than 1.

9 Claims, 3 Drawing Sheets





US009318803B2

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

(10) **Patent No.:** **US 9,318,803 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **MULTIMODE ANTENNA STRUCTURE**

(56) **References Cited**

(71) Applicant: **Skycross, Inc.**, San Jose, CA (US)

U.S. PATENT DOCUMENTS

(72) Inventors: **Mark T. Montgomery**, Melbourne Beach, FL (US); **Frank M. Caimi**, Vero Beach, FL (US); **Mark W. Kishler**, Rockledge, FL (US)

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(73) Assignee: **Skycross, Inc.**, San Jose, CA (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 103 days.

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(21) Appl. No.: **14/319,882**

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(22) Filed: **Jun. 30, 2014**

(65) **Prior Publication Data**

US 2014/0340274 A1 Nov. 20, 2014

Primary Examiner — Tho G Phan

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

Related U.S. Application Data

(57) **ABSTRACT**

(63) Continuation of application No. 13/974,479, filed on Aug. 23, 2013, now Pat. No. 8,803,756, which is a continuation of application No. 13/454,738, filed on Apr. 24, 2012, now Pat. No. 8,547,289, which is a

One or more embodiments are directed to a multimode antenna structure for transmitting and receiving electromagnetic signals in a communications device. The communications device includes circuitry for processing signals communicated to and from the antenna structure. The antenna structure is configured for optimal operation in a given frequency range. The antenna structure includes a plurality of antenna ports operatively coupled to the circuitry, and a plurality of antenna elements, each operatively coupled to a different one of the antenna ports. Each of the plurality of antenna elements is configured to have an electrical length selected to provide optimal operation within the given frequency range. The antenna structure also includes one or more connecting elements electrically connecting the antenna elements such that electrical currents on one antenna element flow to a connected neighboring antenna element and generally bypass the antenna port coupled to the neighboring antenna element. The electrical currents flowing through the one antenna element and the neighboring antenna element are generally equal in magnitude, such that an antenna mode excited by one antenna port is generally electrically isolated from a mode excited by another antenna port at a given desired signal frequency range without the use of a decoupling network connected to the antenna ports, and the antenna structure generates diverse antenna patterns.

(Continued)

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/52 (2006.01)

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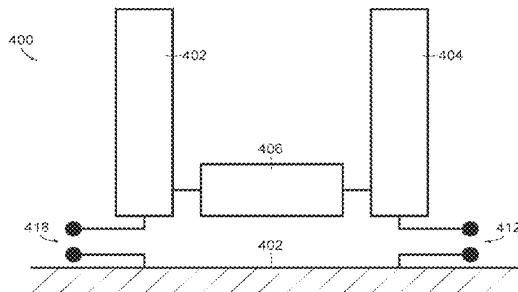
(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/521** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/521; H01Q 1/523; H01Q 21/20; H01Q 21/28; H01Q 21/30; H01Q 3/2617; H01Q 5/371; H01Q 9/145
USPC 343/700 MS, 742, 810, 820, 844, 853, 343/867

See application file for complete search history.

20 Claims, 67 Drawing Sheets





US009318806B2

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

(10) **Patent No.:** **US 9,318,806 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

(54) **ELECTRONIC DEVICE WITH
BALANCED-FED SATELLITE
COMMUNICATIONS ANTENNAS**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)
(72) Inventors: **Salih Yarga**, Sunnyvale, CA (US);
Miroslav Samardzija, Mountain View,
CA (US); **Enrique Ayala Vazquez**,
Watsonville, CA (US); **Harish**
Rajagopalan, San Jose, CA (US);
Qingxiang Li, Mountain View, CA (US);
Robert W. Schlub, Cupertino, CA (US)

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Primary Examiner — Tan Ho

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

(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 183 days.

(57) **ABSTRACT**

(21) Appl. No.: **14/058,024**

An electronic device may include balance-fed antenna structures that do not have direct paths to ground. The antenna structures may serve as a Global Positioning System (GPS) antenna and may have a dipole structure having a first and second antenna resonating element arms. The antenna structures may include a conductive path that conveys antenna signals between a first feed terminal on the first antenna resonating element arm and a transmission line. The conductive path may overlap with the second antenna resonating element arm such that current flow through the conductive path induces corresponding current flow in the second antenna resonating element arm. The antenna structures may include an impedance matching short-circuit stub path that couples the first antenna resonating element arm to the second antenna resonating element arm. Choke inductors may be used to help block indirect paths from the antenna structures to ground through adjacent circuitry.

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

(65) **Prior Publication Data**

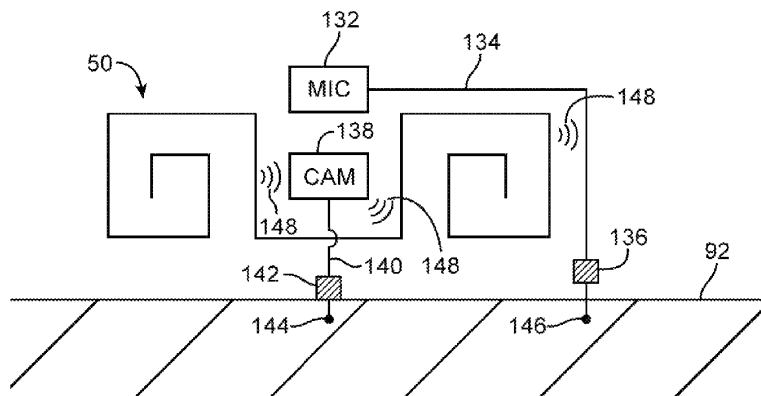
US 2015/0109167 A1 Apr. 23, 2015

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/16 (2006.01)
H01Q 5/328 (2015.01)
H01Q 1/24 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**
CPC **H01Q 5/328** (2015.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**
USPC 343/700 MS, 793, 795, 821
See application file for complete search history.

19 Claims, 12 Drawing Sheets





US009319987B2

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

(10) **Patent No.:** **US 9,319,987 B2**
(45) **Date of Patent:** **Apr. 19, 2016**

- (54) **MOBILE COMMUNICATION**
- (71) Applicant: **BROADCOM CORPORATION**, Irvine, CA (US)
- (72) Inventors: **Seppo Rousu**, Oulu (FI); **Samuel Vehkalahti**, Haukipudas (FI)
- (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 36 days.

- (56) **References Cited**
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- (21) Appl. No.: **14/101,773**
- (22) Filed: **Dec. 10, 2013**
- (65) **Prior Publication Data**
- US 2014/0162574 A1 Jun. 12, 2014
- (30) **Foreign Application Priority Data**
- Dec. 10, 2012 (GB) 1222189.1

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Primary Examiner — Ping Hsieh
(74) *Attorney, Agent, or Firm* — Foley & Lardner LLP; Christopher J. McKenna; Paul M. H. Pua

- (51) **Int. Cl.**
- H04B 1/44** (2006.01)
- H04W 52/04** (2009.01)
- H04W 52/42** (2009.01)
- H04B 7/06** (2006.01)
- H04B 7/08** (2006.01)
- H04B 7/04** (2006.01)
- (52) **U.S. Cl.**
- CPC **H04W 52/04** (2013.01); **H04B 7/0608** (2013.01); **H04B 7/0817** (2013.01); **H04W 52/42** (2013.01); **H04B 7/0413** (2013.01)
- (58) **Field of Classification Search**
- CPC .. H04B 7/0413; H04B 7/0817; H04B 7/0608; H04W 52/04; H04W 52/42; H04W 52/16
- USPC 455/78, 101, 277.1, 277.2, 67.11; 375/267, 299

- (57) **ABSTRACT**
- An apparatus for use in a mobile device includes a switch unit configured to switch a common connection of a transmitter and a first receiver from a first antenna to a second antenna and a connection of a respective second receiver from the second antenna to the first antenna; and a processing system configured to detect a switch condition that the transmitter needs to transmit via the second antenna, obtain power-related reception parameters of said first and said second receivers, cause the switch unit to switch the common connection of the transmitter and the first receiver so that the transmitter transmits via the second antenna, and adjust the power of the transmitter in dependence on the power-related reception parameters.

See application file for complete search history.

20 Claims, 5 Drawing Sheets

