



US008638261B2

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

(10) **Patent No.:** **US 8,638,261 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

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

(56) **References Cited**

(75) Inventors: **Lung-Sheng Tai**, New Taipei (TW);
Wen-Fong Su, New Taipei (TW);
Chun-Ming Chiu, New Taipei (TW)

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(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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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 213 days.

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Primary Examiner — Trinh Dinh

(21) Appl. No.: **13/218,455**

(74) Attorney, Agent, or Firm — Wei Te Chung; Ming Chieh Chang

(22) Filed: **Aug. 26, 2011**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2012/0050111 A1 Mar. 1, 2012

(30) **Foreign Application Priority Data**

Aug. 26, 2010 (TW) 99128572 A

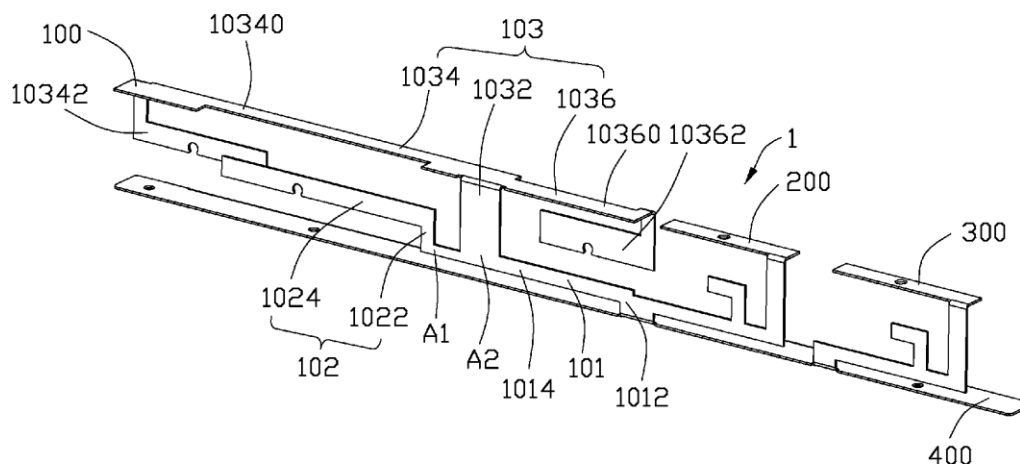
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/48 (2006.01)

A multi-band antenna includes a grounding element, a first antenna working on a wireless wide area network, a second antenna working on a wireless local area network, and a third antenna operating on a wireless local area network. The first antenna includes a first conductive piece, a first radiating element extending from the first conductive arm, a coupling radiating element and a feeding line. The second antenna includes a second conductive piece, a first resonant element extending from the second conductive piece, a second resonant element and a feeding line. The third antenna includes a third conductive element, a first conductive arm extending from the third conductive element and a second conductive arm and a feeding line. The first conductive piece is connected to the second conductive piece.

(52) **U.S. Cl.**
USPC **343/700 MS; 343/846**

(58) **Field of Classification Search**
None
See application file for complete search history.

18 Claims, 4 Drawing Sheets





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

(10) **Patent No.:** **US 8,638,262 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **APPARATUS FOR WIRELESS COMMUNICATION COMPRISING A LOOP LIKE ANTENNA**

(75) Inventors: **Aimo Arkko**, Ruutana (FI); **Jens Troelsen**, Copenhagen (DK); **Rune Skipper Soe**, Copenhagen (DK)

(73) Assignee: **Nokia Corporation**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 139 days.

(21) Appl. No.: **13/381,854**

(22) PCT Filed: **Jun. 30, 2009**

(86) PCT No.: **PCT/EP2009/058209**

§ 371 (c)(1),

(2), (4) Date: **Mar. 16, 2012**

(87) PCT Pub. No.: **WO2011/000416**

PCT Pub. Date: **Jan. 6, 2011**

(65) **Prior Publication Data**

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(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 7/00 (2006.01)

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

USPC **343/702**; 343/866; 343/846

(58) **Field of Classification Search**

USPC 343/702, 866, 846

See application file for complete search history.

(56) **References Cited**

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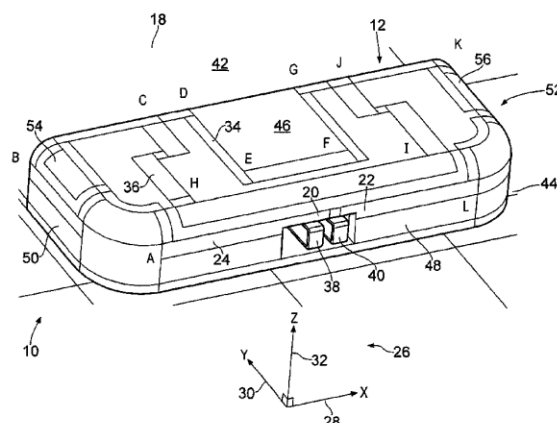
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Nokia Corporation

(57) **ABSTRACT**

Apparatus (20) comprising: an antenna (12) connectable to a first terminal (38) and to a second terminal (40) and comprising a first conductive part (34) and a second conductive part (36), the first conductive part being configured electrically in parallel with the second conductive part, the first conductive part (34) being configured to have a first electrical length and the second conductive part (36) being configured to have a second electrical length together providing a common resonant mode having a first operational frequency band, the second conductive part (36) substantially providing a common resonant mode having a second operational frequency band and the first conductive part (34) substantially providing a differential resonant mode having a third operational frequency band.

20 Claims, 8 Drawing Sheets





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(12) **United States Patent**
Mahanfar

(10) **Patent No.:** **US 8,638,265 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **SLOT ANTENNA**

(75) Inventor: **Alireza Mahanfar**, Bellevue, WA (US)

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 391 days.

(21) Appl. No.: **13/046,276**

(22) Filed: **Mar. 11, 2011**

(65) **Prior Publication Data**
US 2012/0231846 A1 Sep. 13, 2012

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

(52) **U.S. Cl.**
USPC **343/767**; 343/702; 343/846

(58) **Field of Classification Search**
USPC 343/767, 770, 702, 846
See application file for complete search history.

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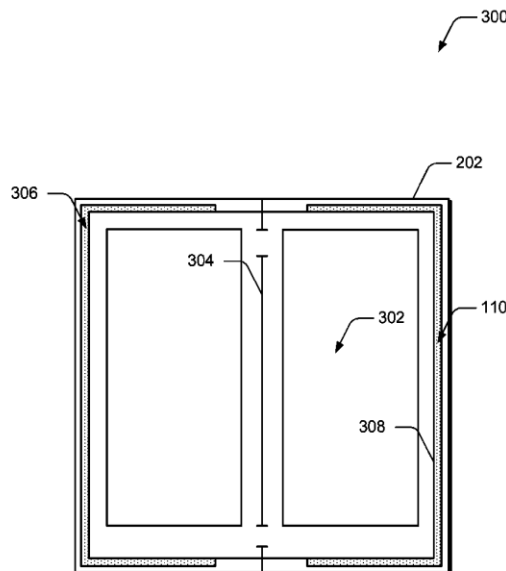
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Wolfe-SBMC

(57) **ABSTRACT**

Techniques involving a slot antenna and associated functionality are described. In one or more implementations, the techniques describe a slot antenna that is usable for wireless communication in a mobile communication device. The mobile communication device may include one or more modules communicatively coupled to the slot antenna and configured to employ the slot antenna to enable the wireless communication.

20 Claims, 6 Drawing Sheets





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

(10) **Patent No.:** **US 8,638,266 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **ANTENNA ARRANGEMENT AND A RADIO APPARATUS INCLUDING THE ANTENNA ARRANGEMENT**

(75) Inventors: **Zidong Liu**, Dorset (GB); **Kevin Boyle**, Horsham (GB)

(73) Assignee: **NXP, B.V.**, Eindhoven (NL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 340 days.

(21) Appl. No.: **13/055,173**

(22) PCT Filed: **Jul. 23, 2009**

(86) PCT No.: **PCT/IB2009/053210**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 24, 2008 (EP) 08104868

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

(52) **U.S. Cl.**
USPC **343/767**

(58) **Field of Classification Search**
USPC 343/767, 770, 700 MS
See application file for complete search history.

(56) **References Cited**

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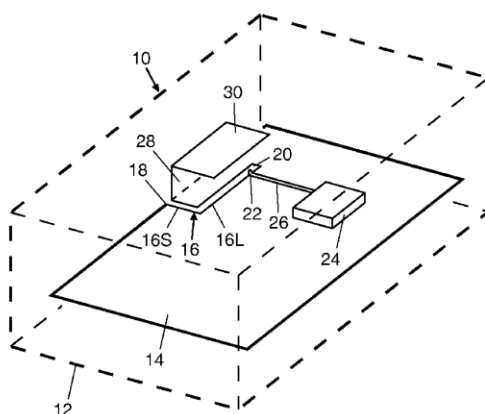
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Primary Examiner — Seung Lee

(57) **ABSTRACT**

An antenna arrangement comprises a ground plane (14) and a planar antenna element (30) mounted spaced from and parallel to the ground plane. An open-ended slot (16) is provided in the ground plane (14), the slot being coextensive with an edge portion of the ground plane and having a first end (18) opening into the edge portion of the ground plane and a second closed end (20). An antenna feed (22) is coupled to the slot at a location intermediate the first and second ends. The planar antenna element is connected by an electrically conductive wall (28) to the edge portion of the ground plane, the wall (28) being coextensive with the slot (16). The combination of the slot shape, slot location and the wall serves to increase the bandwidth of the antenna arrangement.

10 Claims, 6 Drawing Sheets





US008638267B2

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

(10) **Patent No.:** **US 8,638,267 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **PARABOLIC ANTENNA**

(75) Inventors: **Norihiko Omuro**, Tokyo (JP);
Nobuhiko Oguma, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 293 days.

(21) Appl. No.: **12/744,396**

(22) PCT Filed: **Dec. 5, 2008**

(86) PCT No.: **PCT/JP2008/072150**

§ 371 (c)(1),
(2), (4) Date: **May 25, 2010**

(87) PCT Pub. No.: **WO2009/072602**

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(65) **Prior Publication Data**

US 2010/0245187 A1 Sep. 30, 2010

(30) **Foreign Application Priority Data**

Dec. 7, 2007 (JP) 2007-317110

(51) **Int. Cl.**
H01Q 19/13 (2006.01)

(52) **U.S. Cl.**
USPC **343/781 R**; 343/840; 343/912

(58) **Field of Classification Search**
USPC 343/702, 781 R, 722, 840, 912
See application file for complete search history.

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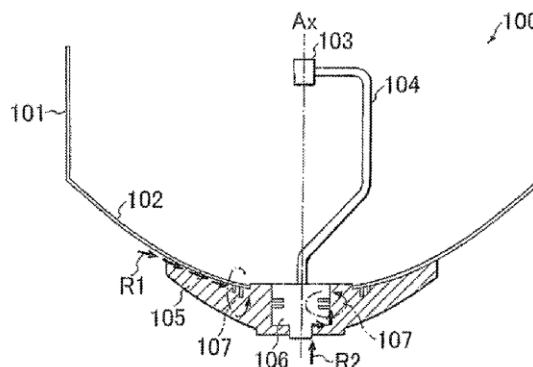
Primary Examiner — Douglas W Owens

Assistant Examiner — Collin Dawkins

(57) **ABSTRACT**

Provided is a parabolic antenna that suppresses leakage of radio waves with a simpler configuration. The parabolic antenna includes a horn that transmits and receives signals; a feed that supports the horn and relays the signals the horn transmits and receives; a reflector that reflects the received signals to focus the received signals on the horn and reflects the signals from the horn to transmit the signals; a reflecting mirror supporting member that supports the reflector; and a feed fitting adapter that enables the feed to be fitted into the reflecting mirror supporting member. A choke groove is formed in at least one of a joint area between the reflecting mirror supporting member and the reflector and a joint area between the reflecting mirror supporting member and the feed fitting adapter, which suppresses propagation of radio waves traveling through the gap of the joint area.

16 Claims, 11 Drawing Sheets





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

- (54) COIL ANTENNA AND ANTENNA STRUCTURE

- (75) Inventors: **Kuniaki Yosui**, Ishikawa-ken (JP);
Hiroyuki Kubo, Ishikawa-ken (JP);
Hiromitsu Ito, Ishikawa-ken (JP)

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

- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 503 days.

- (21) Appl. No.: 12/895,048

- (22) Filed: **Sep. 30, 2010**

- (65) **Prior Publication Data**
US 2012/0081258 A1 Apr. 5, 2012

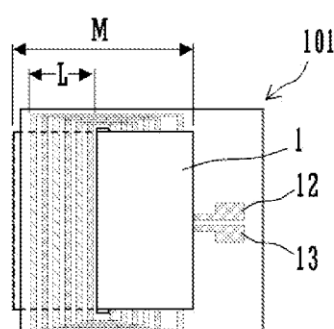
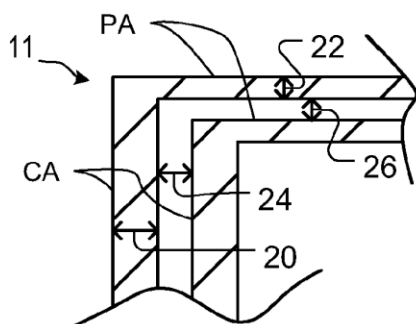
- (51) Int. Cl.
H01Q 1/00 (2006.01)
H01Q 7/08 (2006.01)
- (52) U.S. Cl.
USPC 343/787; 343/788; 343/866; 343/873;
343/893

- (58) **Field of Classification Search**
None
See application file for complete search history.

- (56)
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US008638271B2

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

(10) **Patent No.:** **US 8,638,271 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Chun-Yuan Wang**, Tainan (TW);
Chi-Yin Fang, Tao Yuan Shien (TW)

(73) Assignee: **Quanta Computer Inc.**, Tao Yuan Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 461 days.

(21) Appl. No.: **13/066,505**

(22) Filed: **Apr. 14, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
USPC **343/846**; 343/905; 343/700 MS

(58) **Field of Classification Search**
USPC 343/905, 846, 700 MS
See application file for complete search history.

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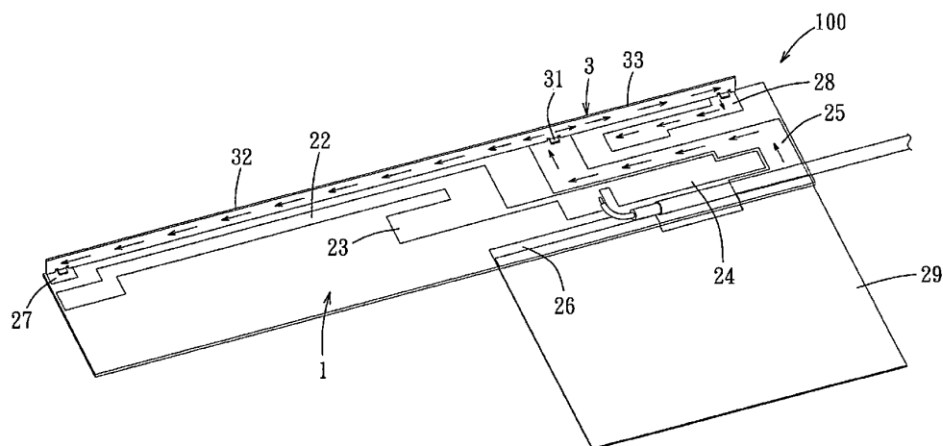
Primary Examiner — Kristy A Haupt

(74) *Attorney, Agent, or Firm* — Kramer Levin Naftalis & Frankel LLP

(57) **ABSTRACT**

A multi-band antenna includes a dielectric substrate, and a main antenna member and a metal piece disposed on the dielectric substrate. The main antenna member includes a feed-in portion for feeding with a radio frequency signal, a first conductor arm connected to the feed-in portion and adjacent to a first side edge of the dielectric substrate, a second conductor arm connected to the feed-in portion and having a length shorter than that of the first conductor arm, a third conductor arm connected to the feed-in portion, a fourth conductor arm extending along the third conductor arm, and a grounding portion adjacent to the feed-in portion. The metal piece is disposed at the first side edge and connected to the fourth conductor arm, resonates and couples with the first conductor arm to form a first radiator section, and cooperates with the fourth conductor arm to form a second radiator section.

10 Claims, 12 Drawing Sheets





US008639194B2

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

(10) **Patent No.:** **US 8,639,194 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **TUNABLE ANTENNA WITH A CONDUCTIVE, PHYSICAL COMPONENT CO-LOCATED WITH THE ANTENNA**

(75) Inventors: **Vijay L. Asrani**, Round Lake, IL (US);
Adrian Naples, Lake Villa, IL (US)

(73) Assignee: **Motorola Mobility LLC**, Libertyville, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 243 days.

(21) Appl. No.: **13/246,883**

(22) Filed: **Sep. 28, 2011**

(65) **Prior Publication Data**

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H04B 1/40 (2006.01)

(52) **U.S. Cl.**
USPC **455/77**; 455/575.7; 455/552.1; 455/73;
455/126; 455/127.4; 343/700 MS; 343/702;
343/713; 333/25; 333/103

(58) **Field of Classification Search**

USPC 455/77, 575.7, 93.1, 552.1, 73, 74, 126,
455/127.4; 343/700 MS, 702, 713, 753,
343/749, 846; 333/25, 103

See application file for complete search history.

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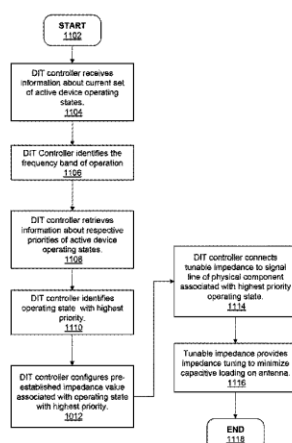
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Primary Examiner — Marceau Milord

(57) **ABSTRACT**

A method and device for providing impedance tuning to compensate for capacitive loading effects on an antenna which are associated with conductive or physical components in close proximity to the antenna is provided. A dynamic impedance tuning (DIT) controller periodically receives information that indicates that one or more functions of a physical component and/or a particular device operating state are currently active. In response to one or more functions of the physical component being activated, the DIT controller configures the tunable impedance to a pre-set impedance level to compensate for capacitive loading effects on the antenna. In addition, the controller triggers a switch to connect the tunable impedance to the ground signal line to provide antenna tuning corresponding to the preset impedance level. The tunable impedance adjusts the terminal impedance of the ground signal line to minimize capacitive loading effects associated with the signal line.

20 Claims, 11 Drawing Sheets





US008639302B2

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

(10) **Patent No.:** **US 8,639,302 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **ANTENNA SPACER FOR A HANDHELD COMMUNICATION DEVICE**

(56) **References Cited**

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(75) Inventors: **Ying Tong Man**, Waterloo (CA); **Yihong Qi**, St. Agatha (CA); **Perry Jarmuszewski**, Waterloo (CA); **Dietmar Wennemer**, Waterloo (CA)

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(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario (CA)

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(21) Appl. No.: **11/773,415**

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(22) Filed: **Jul. 4, 2007**

Primary Examiner — Marcos Torres

(74) Attorney, Agent, or Firm — McCarthy Tétrault LLP

(65) **Prior Publication Data**

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(57) **ABSTRACT**

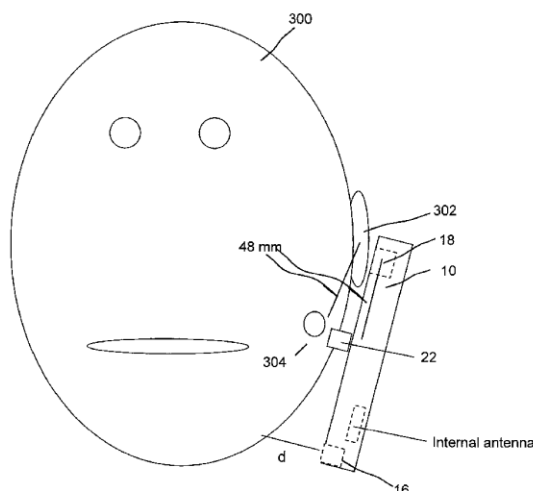
The invention provides a portable communication device and enclosure therefor where separation of its antenna from the user's head is facilitated. The device comprises: a case; a speaker port; an antenna located in the bottom of the case; and a spacer located on the front of the case for resting against a cheek of a user of the device. When the device is held against the head of a user of the device with the spacer resting against a cheek of the user, the spacer biases the bottom of the device away from the user's head. The spacer may be located at a distance from the speaker port on the front of the case to comply with a Cellular Telephone Information Association (CTIA) test plan for Mobile Station Over the Air Performance.

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

(52) **U.S. Cl.**
USPC **455/575.5**; 455/575.1; 455/575.6;
455/90.3

(58) **Field of Classification Search**
USPC 455/575.1–8, 90.3; 379/329, 429,
379/433.01, 437, 451; 343/702; 464/170
See application file for complete search history.

18 Claims, 8 Drawing Sheets





US008639303B2

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

(10) **Patent No.:** **US 8,639,303 B2**
(45) **Date of Patent:** **Jan. 28, 2014**

(54) **MOBILE ELECTRONIC DEVICE WITH AN
ENHANCED ANTENNA FARM**

(75) Inventors: **Joseph L. Allore**, Mundelien, IL (US);
Gary R. Weiss, Buffalo Grove, IL (US);
Jason P. Wojack, Libertyville, IL (US)

(73) Assignee: **Motorola Mobility LLC**, Libertyville,
IL (US)

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

(21) Appl. No.: **13/431,250**

(22) Filed: **Mar. 27, 2012**

(65) **Prior Publication Data**

US 2013/0017865 A1 Jan. 17, 2013

Related U.S. Application Data

(60) Provisional application No. 61/507,394, filed on Jul.
13, 2011.

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

(52) **U.S. Cl.**
USPC **455/575.7; 455/575.1**

(58) **Field of Classification Search**
USPC **455/550.1, 575.1, 575.5, 575.7, 575.8,**
455/562.1

See application file for complete search history.

(56) **References Cited**

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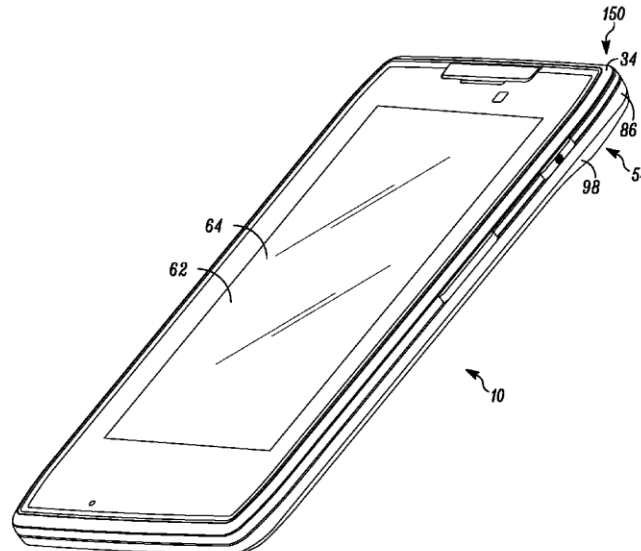
Primary Examiner — Sonny Trinh

(74) *Attorney, Agent, or Firm* — Gary J. Cunningham

(57) **ABSTRACT**

A mobile electronic device **10** with an enhanced antenna farm **180** is disclosed. The device **10** can include: a housing **150** including a front housing **34** and a rear housing **86**; and a user interface **62**, the rear housing **86** includes an antenna farm **180**. Advantageously, the antenna farm **180** allows wireless communication from or to multiple sources, is substantially isolated from EMI from electronic components in the device and can be made with a minimal Z dimension.

17 Claims, 18 Drawing Sheets





US008643547B2

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

(10) **Patent No.:** **US 8,643,547 B2**
(45) **Date of Patent:** **Feb. 4, 2014**

(54) **ANTENNA PATTERN FRAME, METHOD AND MOLD FOR MANUFACTURING THE SAME, ELECTRONIC DEVICE CASE HAVING ANTENNA PATTERN FRAME EMBEDDED THEREIN, AND METHOD FOR MANUFACTURING THE SAME**

(75) Inventors: **Ha Ryong Hong**, Gyeonggi-Do (KR); **Jae Suk Sung**, Gyeonggi-Do (KR); **Nam Il Seo**, Seoul (KR); **Dae Kyu Lee**, Gyeonggi-Do (KR); **Chan Gwang An**, Gyeonggi-Do (KR); **Chang Mok Han**, Chungcheongnam-Do (KR); **Tae Sung Kim**, Seoul (KR); **Kyong Keun Lee**, Gyeonggi-Do (KR); **Ki Won Chang**, Gyeonggi-Do (KR); **Sung Eun Cho**, Gyeonggi-Do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Suwon, 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 1055 days.

(21) Appl. No.: **12/646,381**

(22) Filed: **Dec. 23, 2009**

(65) **Prior Publication Data**
US 2011/0032153 A1 Feb. 10, 2011

(30) **Foreign Application Priority Data**
Aug. 10, 2009 (KR) 10-2009-0073353

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

(52) **U.S. Cl.**
USPC 343/700 MS; 343/702; 29/600

(58) **Field of Classification Search**
USPC 343/700 MS, 702; 29/600
See application file for complete search history.

(56) **References Cited**

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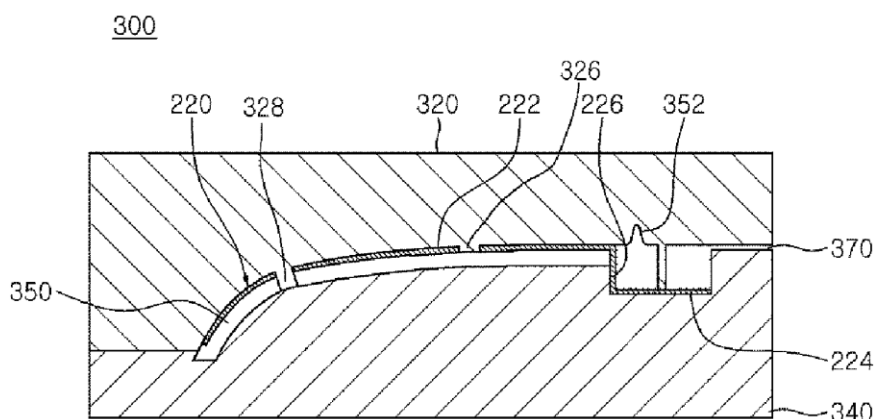
Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — McDermott Will & Emery LLP

(57) **ABSTRACT**

An antenna pattern frame includes an antenna radiator receiving an external signal and transmitting the received external signal to an electronic device, a radiator frame having the antenna radiator on a surface thereof, and a guide boss protruding from the radiator frame and preventing the radiator frame from moving vertically in a mold for manufacturing an electronic device case having an inner space having a shape corresponding to that of an electronic device case.

20 Claims, 7 Drawing Sheets





US008643549B2

(12) **United States Patent**
Yamaki

(10) **Patent No.:** **US 8,643,549 B2**
(45) **Date of Patent:** **Feb. 4, 2014**

(54) **MULTI-RESONANT ANTENNA**

(75) Inventor: **Kazuhiya Yamaki**, Ishikawa-ken (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 288 days.

(21) Appl. No.: **13/007,360**

(22) Filed: **Jan. 14, 2011**

(65) **Prior Publication Data**

US 2011/0109513 A1 May 12, 2011

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2009/057449, filed on Apr. 13, 2009.

(30) **Foreign Application Priority Data**

Jul. 17, 2008 (JP) 2008-185508

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

(52) **U.S. Cl.**
USPC **343/700 MS; 343/702**

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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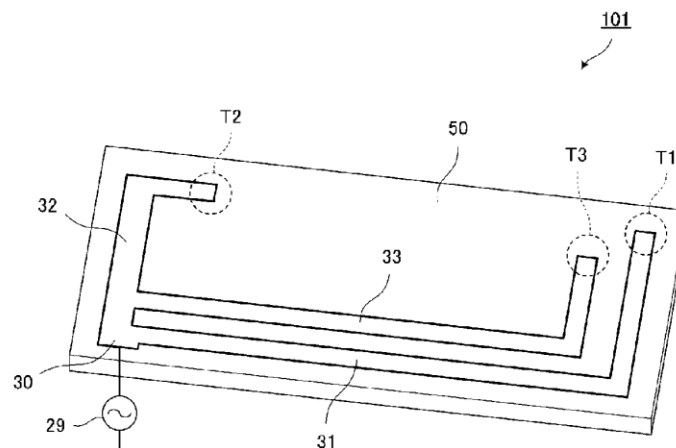
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A multi-resonant antenna having three independent resonance characteristics for three frequency bands includes a first electrode having an open end formed on the top surface of a dielectric substrate of a rectangular plate shape so as to extend from a feeding portion in a first direction (e.g., counterclockwise) along the periphery of the rectangular area; a second electrode having an open end and extending from the feeding portion in a second direction (e.g., clockwise) along the periphery of the rectangular area; and a third electrode positioned such that an open end of the third electrode is closer to the open end of the first electrode than to the open end of the second electrode, and such that the open end of the third electrode is closer to the open end of the first electrode than to a midsection (i.e., half the length) of the first electrode in the longitudinal direction thereof.

6 Claims, 5 Drawing Sheets





US008643550B2

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

(10) **Patent No.:** **US 8,643,550 B2**

(45) **Date of Patent:** **Feb. 4, 2014**

(54) **FLEXIBLE ANTENNA**

(75) Inventors: **Tsung-Wen Chiu**, Xin-Dian (TW);
Fu-Ren Hsiao, Taipei County (TW);
Chih-Fan Chen, Taipei County (TW);
Po-Sheng Chen, Taipei County (TW)

(73) Assignee: **Advanced Connectek Inc.**, Taipei
County (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 228 days.

(21) Appl. No.: **13/070,364**

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

(65) **Prior Publication Data**

US 2012/0068888 A1 Mar. 22, 2012

(30) **Foreign Application Priority Data**

Oct. 15, 2010 (TW) 99135181 A

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

(52) **U.S. Cl.**
USPC **343/700 MS**; 343/702; 343/850;
343/853

(58) **Field of Classification Search**
USPC 343/700, 702, 850, 853
See application file for complete search history.

(56) **References Cited**

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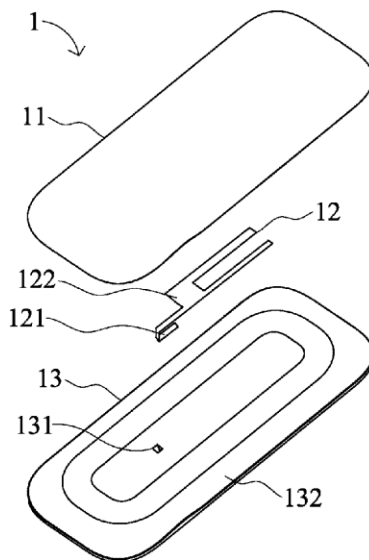
Primary Examiner — Allyson Trail

(74) *Attorney, Agent, or Firm* — Schmeiser Olsen & Watts
LLP

(57) **ABSTRACT**

A flexible antenna comprises a filmed layer, a flexible radiation conductor and a support member. The flexible radiation conductor has a crooked form and a feeder terminal. The filmed layer covers the upper surface of the flexible radiation conductor. The support member has a through-hole. The lower surface of the flexible radiation conductor is stuck to the upper surface of the support member. The feeder terminal is inserted through the through-hole to protrude from the lower surface of the support member. The flexible radiation conductor and the crooked feeder terminal thereof replace the conventional radiation conductor circuit layer and metallic contact terminal to overcome the problem that the conventional contact terminal damages the radiation conductor layer and protrudes the filmed layer. Further, the present invention integrates FPC and LDS technologies to enable the flexible radiation conductor to be arbitrarily stuck to complicated planes or complicated curved surfaces.

6 Claims, 2 Drawing Sheets





US008643552B2

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

(10) **Patent No.:** **US 8,643,552 B2**

(45) **Date of Patent:** **Feb. 4, 2014**

(54) **RECEIVER WITH PLURALITY OF ANTENNA**

(75) Inventors: **Kazuaki Suzuki**, Kyoto (JP); **Keisuke Kinoshita**, Osaka (JP)

(73) Assignee: **Panasonic Corporation**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 132 days.

(21) Appl. No.: **12/921,454**

(22) PCT Filed: **Dec. 3, 2009**

(86) PCT No.: **PCT/JP2009/006574**

§ 371 (c)(1),

(2), (4) Date: **Sep. 8, 2010**

(87) PCT Pub. No.: **WO2010/095200**

PCT Pub. Date: **Aug. 26, 2010**

(65) **Prior Publication Data**

US 2012/0019730 A1 Jan. 26, 2012

(30) **Foreign Application Priority Data**

Feb. 18, 2009 (JP) 2009-034953

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

(52) **U.S. Cl.**
USPC **343/702; 343/872**

(58) **Field of Classification Search**
USPC 343/702, 872
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

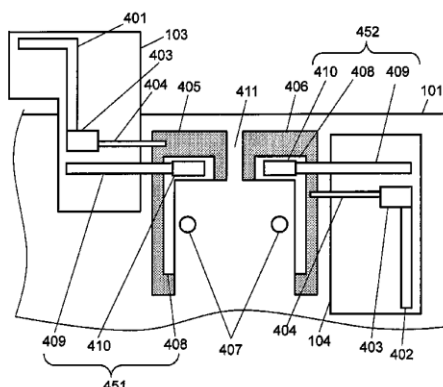
Assistant Examiner — Collin Dawkins

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

(57) **ABSTRACT**

The receiver diversity-receives radio wave with a plurality of antennas. The receiver includes a conductive case having a receiving section for executing diversity-receiving processing, a first through hole and a second through hole that are disposed on the surface of the same side of the case and penetrate the case from the outside to the inside, a first antenna and a second antenna for supplying a received signal to the receiving section, and a first hinge and a second hinge that are fixed to the inside of the case, pass the first through hole and the second through hole, directly or indirectly support the first antenna and the second antenna, and are movable, respectively. A partition is disposed between the first through hole and the second through hole.

13 Claims, 9 Drawing Sheets





US008643557B2

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

(10) **Patent No.:** **US 8,643,557 B2**

(45) **Date of Patent:** **Feb. 4, 2014**

(54) **ANTENNA APPARATUS AND RADIO COMMUNICATION APPARATUS**

(75) Inventors: **Shinichi Nakano**, Kanagawa-ken (JP); **Kazunari Kawahata**, Kanagawa-ken (JP); **Nobuhito Tsubaki**, Kanagawa-ken (JP); **Kenichi Ishizuka**, Kanagawa-ken (JP); **Shigeyuki Fujieda**, Ishikawa-ken (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 45 days.

(21) Appl. No.: **12/710,945**

(22) Filed: **Feb. 23, 2010**

(65) **Prior Publication Data**

US 2010/0149053 A1 Jun. 17, 2010

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2008/060962, filed on Jun. 16, 2008.

(30) **Foreign Application Priority Data**

Aug. 24, 2007 (JP) 2007-217968

(51) **Int. Cl.**
H01Q 11/12 (2006.01)

(52) **U.S. Cl.**
USPC **343/744**; 343/745; 343/748

(58) **Field of Classification Search**
USPC 343/702, 744, 745, 748, 750, 722
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

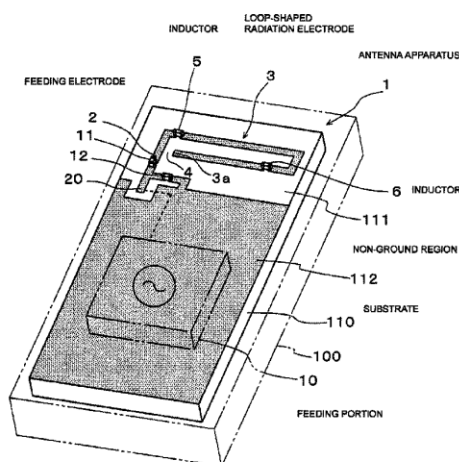
Assistant Examiner — Kyana R McCain

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

(57) **ABSTRACT**

An antenna apparatus and a radio communication apparatus are capable of separately controlling a resonance frequency in a basic mode and a resonance frequency in a higher mode and have a wide bandwidth in which the resonance frequency in the basic mode is variable. The antenna apparatus includes a feeding electrode 2, a loop-shaped radiation electrode 3, a capacitance portion 4, and inductors 5 and 6. The capacitance portion 4 is formed by a gap between an open end 3a of the loop-shaped radiation electrode 3 and the feeding electrode 2. The inductor 5 is disposed at a position where a large current is obtained in the basic mode and a small current is obtained in the higher mode. The inductor 6 is disposed at a position where a large current is obtained in the higher mode and a small current is obtained in the basic mode.

18 Claims, 9 Drawing Sheets





US008643558B2

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

(10) **Patent No.:** **US 8,643,558 B2**
(45) **Date of Patent:** **Feb. 4, 2014**

(54) **MULTI-FREQUENCY ANTENNA**

(75) Inventors: **Hsien-Sheng Tseng**, New Taipei (TW);
Chun-Ming Chiu, New Taipei (TW);
Wen-Fong Su, New Taipei (TW)

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
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.: **13/069,386**

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

(65) **Prior Publication Data**

US 2011/0267246 A1 Nov. 3, 2011

(30) **Foreign Application Priority Data**

Apr. 28, 2010 (TW) 99113420

(51) **Int. Cl.**
H01Q 9/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/750**; 343/749; 343/829; 343/830;
343/846

(58) **Field of Classification Search**
USPC 343/750, 749, 829, 830, 846
See application file for complete search history.

(56) **References Cited**

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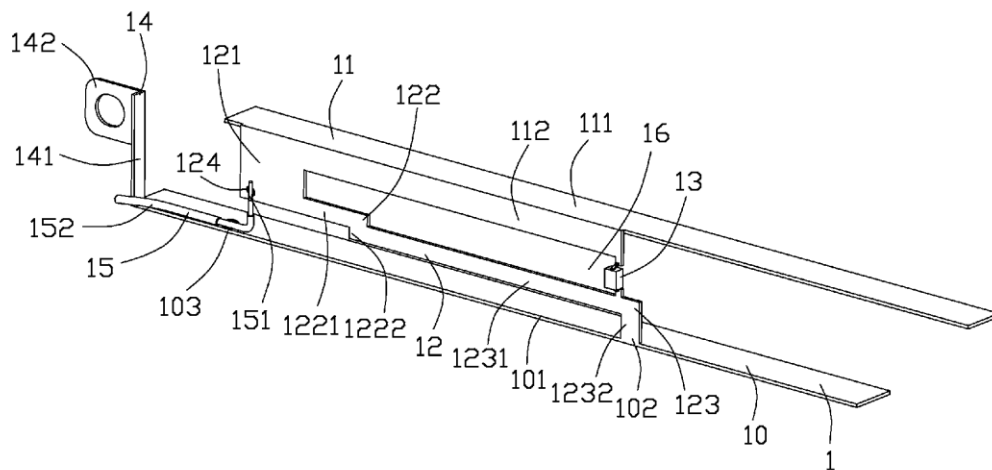
Primary Examiner — Kristy A Haupt

(74) *Attorney, Agent, or Firm* — Wei Te Chung; Ming Chieh
Chang

(57) **ABSTRACT**

A multi-frequency antenna (1) includes a grounding portion (1) extending along a transversal direction; a radiating arm (11) extending along a transversal direction and disposed above the grounding portion; a connecting arm (12) connected to the grounding portion and the radiating arm; a capacitor (13) connected to the radiating portion and the connecting arm; and a cable (15) having an inner conductor connected to the connecting arm and an outer conductor connected to the grounding portion.

20 Claims, 3 Drawing Sheets





US008643563B2

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

(10) **Patent No.:** **US 8,643,563 B2**

(45) **Date of Patent:** **Feb. 4, 2014**

(54) **ANTENNA WITH EMI SHELTER**

(75) Inventors: **Shih-Chieh Cheng**, Kaohsiung (TW);
Yong-Xiang Hsieh, Chiayi County
(TW); **Kuo-Chang Lo**, Miaoli County
(TW)

(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 203 days.

(21) Appl. No.: **13/276,402**

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

(65) **Prior Publication Data**

US 2013/0002506 A1 Jan. 3, 2013

(30) **Foreign Application Priority Data**

Jul. 1, 2011 (TW) 100123279 A

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

(52) **U.S. Cl.**
USPC **343/841**; 343/700 MS; 343/702;
343/846; 343/909

(58) **Field of Classification Search**
USPC 343/841
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jerome Jackson, Jr.

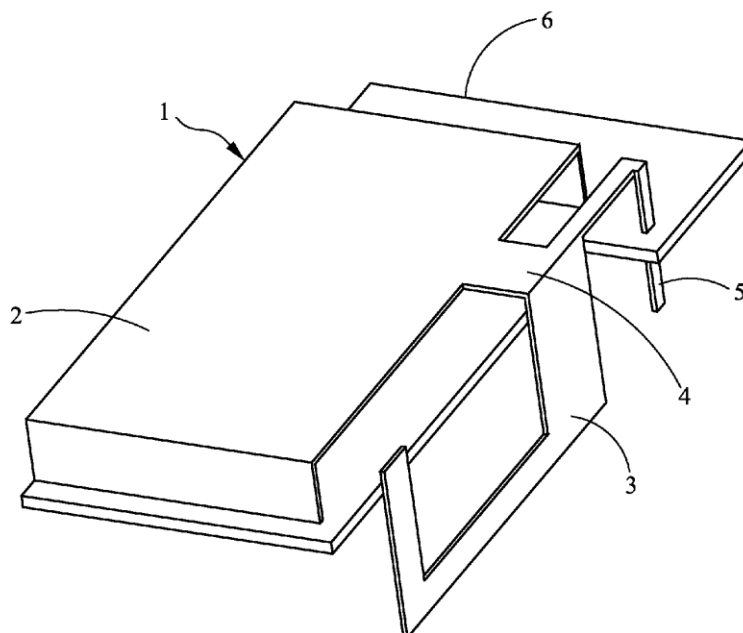
Assistant Examiner — Hai Tran

(74) *Attorney, Agent, or Firm* — WPAT, PC; Justin King

(57) **ABSTRACT**

An antenna with electromagnetic interference (EMI) shelter is disclosed, which comprises: an EMI shelter, mounted on a substrate while covering the same; a radiation unit; an induction current steering unit, disposed at a position between the EMI shelter and the radiation unit; and a signal feed-in unit, electrically connected with the radiation unit; wherein, the induction current generated by the radiation unit when it is activating is guided to the EMI shelter through the guidance of the induction current steering unit, and then to be feed into a ground connection (GND), thereby, preventing the operation of radio circuit elements that are mounted on the substrate from being interfered by the electric wave resulting from the induction current. With the aforesaid configuration, not only the EMI effect can be significantly suppressed and the overall manufacturing cost of the antenna can be effectively reduced, but also the signal transmission efficiency is improved.

10 Claims, 1 Drawing Sheet





US008644894B2

(12) **United States Patent**
Qiu

(10) **Patent No.:** **US 8,644,894 B2**

(45) **Date of Patent:** **Feb. 4, 2014**

(54) **MOBILE WIRELESS DEVICE WITH
MULTI-BAND ANTENNA AND RELATED
METHODS**

(75) Inventor: **Meide Qiu**, Ottawa (CA)

(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario
(CA)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 531 days.

(21) Appl. No.: **12/945,200**

(22) Filed: **Nov. 12, 2010**

(65) **Prior Publication Data**

US 2011/0223873 A1 Sep. 15, 2011

Related U.S. Application Data

(60) Provisional application No. 61/313,337, filed on Mar.
12, 2010.

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

(52) **U.S. Cl.**
USPC **455/575.7**; 455/90.3; 343/726; 343/702

(58) **Field of Classification Search**
USPC 455/90.2, 575.7, 575.1, 550.1;
29/600-601; 343/702, 726, 728
See application file for complete search history.

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Primary Examiner — Nay A Maung

Assistant Examiner — Angelica M Perez

(74) *Attorney, Agent, or Firm* — Allen, Dyers, Doppelt,
Milbrath & Gilchrist, P.A. Attorneys at Law

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing, and a printed circuit board (PCB) carried by the housing and having opposing upper and lower portions. The device may also include at least one wireless transceiver carried by the portable housing, and a satellite positioning signal receiver carried by the portable housing. An antenna assembly may be carried adjacent the upper portion of the PCB. The antenna assembly may include a horizontal conductor extending along the upper portion of the PCB in spaced relation therefrom. The horizontal conductor may be coupled to the satellite positioning receiver. The antenna assembly may also include a loop conductor extending from the horizontal conductor toward the lower portion of the PCB and in spaced relation from the PCB. The loop conductor may be coupled to the wireless transceiver.

21 Claims, 6 Drawing Sheets





US008648750B2

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

(10) **Patent No.:** **US 8,648,750 B2**

(45) **Date of Patent:** **Feb. 11, 2014**

(54) **ANTENNA WITH U-SHAPED PORTION AND
EXTENDING SECTION**

(75) Inventors: **Huang-Chih Chen**, Hsinchu (TW);
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(73) Assignee: **Wistron NeWeb Corp.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 435 days.

(21) Appl. No.: **12/983,096**

(22) Filed: **Dec. 31, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 1, 2010 (TW) 99210355 U

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

(52) **U.S. Cl.**
USPC 343/700 MS; 343/767

(58) **Field of Classification Search**

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

(56) **References Cited**

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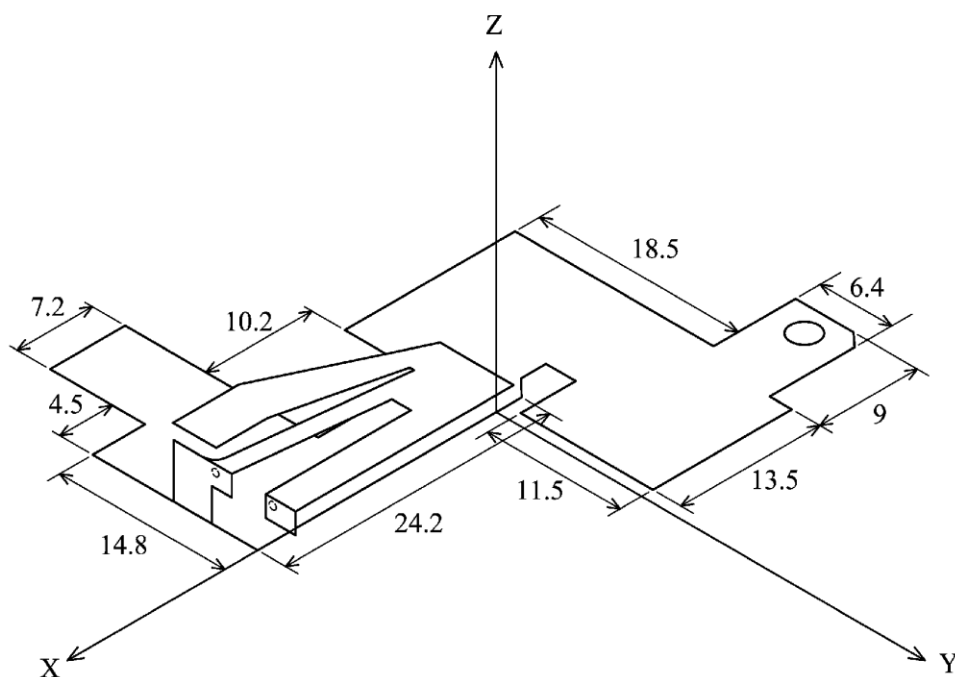
Primary Examiner — Douglas W Owens

Assistant Examiner — Jae Kim

(57) **ABSTRACT**

An antenna for transmitting a wireless signal is provided. The antenna includes a ground element, a short element and a transmitting element. The short element is connected to the ground element. The transmitting element is connected to the short element, wherein the transmitting element is a claw shaped structure, and the transmitting element includes a first section, a second section and an extending section, wherein an end of the first section is connected to the short element, and the other end of the first section is connected to ends of the second section and the extending section, and a first groove is formed between the first section and the second section, and a second groove is formed between the first section and the extending section.

14 Claims, 9 Drawing Sheets





US008648751B2

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

(10) **Patent No.:** **US 8,648,751 B2**

(45) **Date of Patent:** ***Feb. 11, 2014**

(54) **MOBILE WIRELESS DEVICE WITH
MULTI-BAND LOOP ANTENNA WITH ARMS
DEFINING A SLOTTED OPENING AND
RELATED METHODS**

(71) Applicant: **Research In Motion Limited**, Waterloo
(CA)

(72) Inventors: **Chun Kit Lai**, Coral Springs, FL (US);
Soo Liam Ooi, Plantation, FL (US);
Qiwu Tan, Plantation, FL (US)

(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario
(CA)

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

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **13/927,501**

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

(65) **Prior Publication Data**
US 2013/0285860 A1 Oct. 31, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/005,326, filed on
Jan. 12, 2011, now Pat. No. 8,497,806.

(60) Provisional application No. 61/367,083, filed on Jul.
23, 2010.

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

(52) **U.S. Cl.**
USPC **343/700 MS**; 343/702; 343/729

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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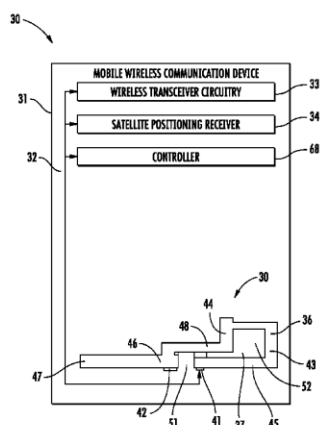
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt,
Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include a housing, a printed circuit board (PCB) carried by the housing. The device may also include an antenna coupled to wireless transceiver circuitry carried by the PCB. The antenna may include first and second feed legs extending upwardly from the PCB, a loop conductor spaced above the PCB and having a gap therein defining first and second ends, and a first conductor arm spaced above the PCB and extending between the first feed leg and the first end. The antenna may further include a second conductor arm spaced above the PCB and having a proximal portion between the second feed leg and the second end, and having a distal portion extending outwardly from the second feed leg. The first conductor arm and the proximal portion may define a slotted opening into an interior of the loop conductor.

21 Claims, 9 Drawing Sheets





US008648752B2

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

(10) **Patent No.:** **US 8,648,752 B2**

(45) **Date of Patent:** **Feb. 11, 2014**

(54) **CHASSIS-EXCITED ANTENNA APPARATUS
AND METHODS**

(75) Inventors: **Prasadh Ramachandran**, Kempele (FI);
Petteri Annamaa, Oulunsalo (FI)

(73) Assignee: **Pulse Finland Oy**, Kempele (FI)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 291 days.

(21) Appl. No.: **13/026,078**

(22) Filed: **Feb. 11, 2011**

(65) **Prior Publication Data**
US 2012/0206302 A1 Aug. 16, 2012

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

(52) **U.S. Cl.**
USPC **343/702; 343/700 MS**

(58) **Field of Classification Search**
USPC **343/702, 700 MS, 872, 878**
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jerome Jackson, Jr.

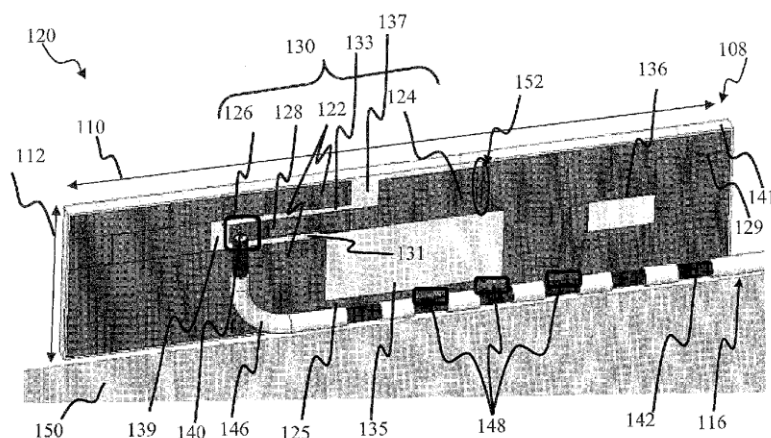
Assistant Examiner — Ricardo Magallanes

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

(57) **ABSTRACT**

A chassis-excited antenna apparatus, and methods of tuning and utilizing the same. In one embodiment, a distributed loop antenna configuration is used within a handheld mobile device (e.g., cellular telephone). The antenna comprises two radiating elements: one configured to operate in a high-frequency band, and the other in a low-frequency band. The two antenna elements are disposed on different side surfaces of the metal chassis of the portable device; e.g., on the opposing sides of the device enclosure. Each antenna component comprises a radiator and an insulating cover. The radiator is coupled to a device feed via a feed conductor and a ground point. A portion of the feed conductor is disposed with the radiator to facilitate forming of the coupled loop resonator structure.

27 Claims, 10 Drawing Sheets





US008648754B2

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

(10) **Patent No.:** **US 8,648,754 B2**

(45) **Date of Patent:** **Feb. 11, 2014**

(54) **MULTI-RESONANT BROADBAND ANTENNA**

(75) Inventors: **Hae-soo Kim**, Suwon-si (KR); **Il-kyu Kim**, Seongnam-si (KR); **Yong-jun Lim**, Seoul (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 593 days.

(21) Appl. No.: **12/533,122**

(22) Filed: **Jul. 31, 2009**

(65) **Prior Publication Data**

US 2010/0207821 A1 Aug. 19, 2010

(30) **Foreign Application Priority Data**

Feb. 18, 2009 (KR) 10-2009-0013502

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/01 (2006.01)
H01Q 21/30 (2006.01)

(52) **U.S. Cl.**
USPC **343/729**; 343/702; 343/806; 343/895

(58) **Field of Classification Search**

USPC 343/702, 806, 825-831, 700 MS, 729, 343/895

See application file for complete search history.

(56) **References Cited**

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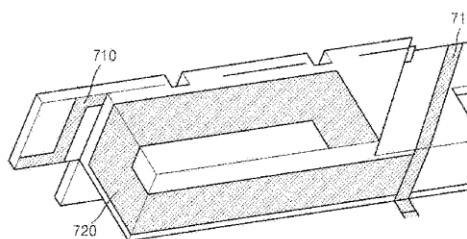
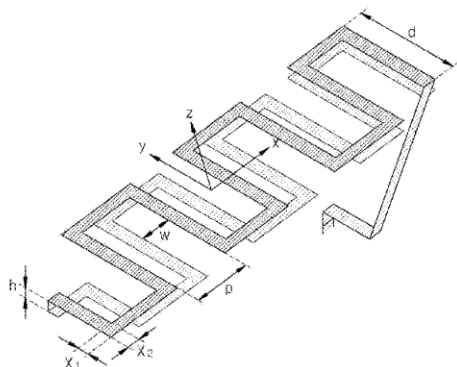
Primary Examiner — Michael C Wimer

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

(57) **ABSTRACT**

An antenna including: a conducting wire part which includes a first part extending in a first direction, a second part extending from an end of the first part in a direction crossing the first direction, and a third part extending from an end of the second part to face the first part, wherein lengths of the first and third parts are different from each other.

6 Claims, 6 Drawing Sheets





US008648755B2

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

(10) **Patent No.:** **US 8,648,755 B2**

(45) **Date of Patent:** **Feb. 11, 2014**

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

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

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

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

(21) Appl. No.: **13/726,477**

(22) Filed: **Dec. 24, 2012**

(65) **Prior Publication Data**

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Related U.S. Application Data

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

(51) **Int. Cl.**
H01Q 9/00 (2006.01)

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

USPC **343/745**; 343/700 MS; 343/795;
343/815

(58) **Field of Classification Search**

USPC 343/700, 745, 795, 815
See application file for complete search history.

(56) **References Cited**

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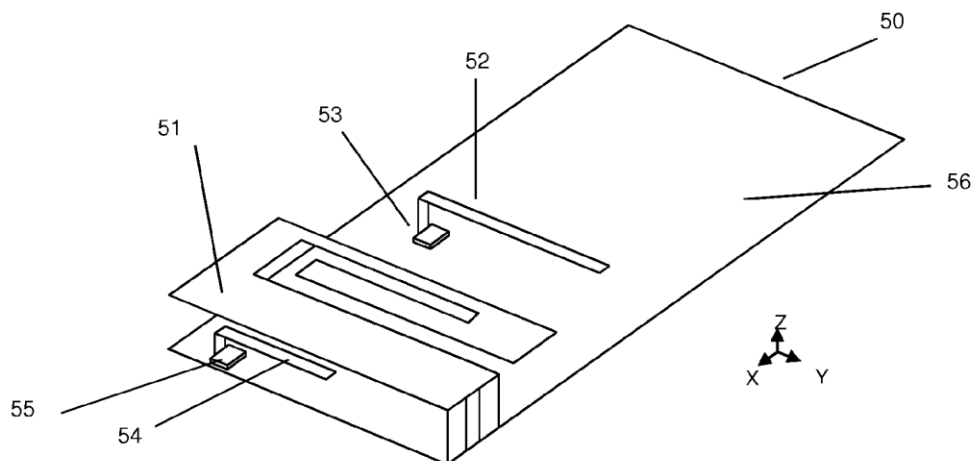
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna comprising an IMD element and one or more
parasitic and active tuning elements is disclosed. The IMD
element, when used in combination with the active tuning and
parasitic elements, allows antenna operation at multiple reso-
nant frequencies. In addition, the direction of antenna radia-
tion pattern may be arbitrarily rotated in accordance with the
parasitic and active tuning elements.

12 Claims, 13 Drawing Sheets





US008648756B1

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

(10) **Patent No.:** **US 8,648,756 B1**
(45) **Date of Patent:** **Feb. 11, 2014**

(54) **MULTI-FEED ANTENNA FOR PATH OPTIMIZATION**

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

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

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

(21) Appl. No.: **13/548,211**

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

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/289,901, filed on Nov. 4, 2011, and a continuation of application No. 12/894,052, filed on Sep. 29, 2010, now Pat. No. 8,077,116, and a continuation of application No. 11/841,207, filed on Aug. 20, 2007, now Pat. No. 7,830,320.

(51) **Int. Cl.**
H01Q 9/16 (2006.01)

(52) **U.S. Cl.**
USPC **343/747; 343/702**

(58) **Field of Classification Search**

USPC 343/747, 748, 795, 700 MS, 702
See application file for complete search history.

(56) **References Cited**

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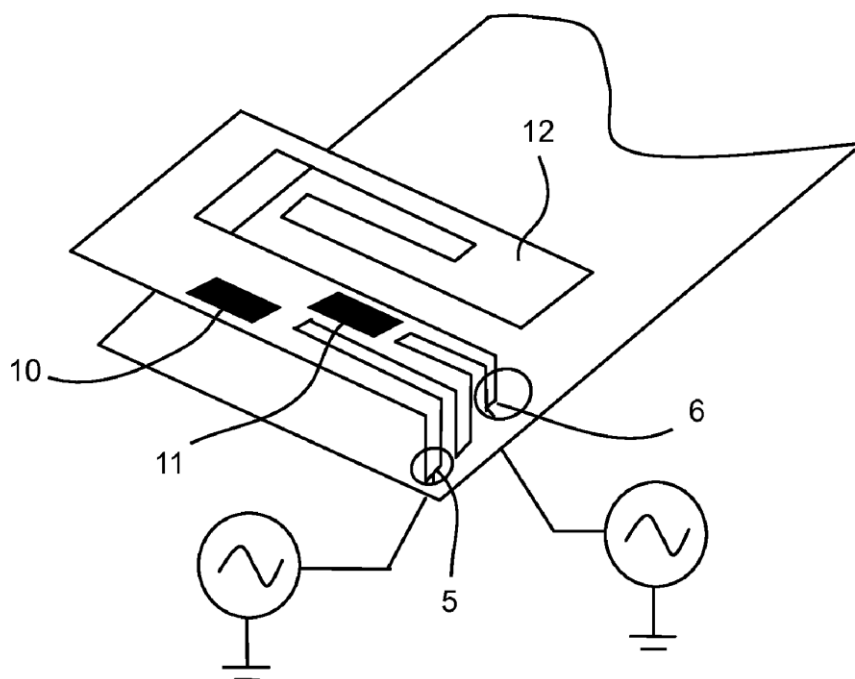
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

An antenna comprised of multiple feed ports with independent tuning of the antenna at each feed port to optimize the impedance match between the antenna and transceivers connected to the ports. Filters designed into one or several of the feed ports to provide isolation between the multiple ports and to adjust the frequency response at each port. One or multiple active components connected to the feed ports to provide dynamic tuning of the coupled or driven elements.

15 Claims, 13 Drawing Sheets





US008648761B2

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

(10) **Patent No.:** **US 8,648,761 B2**
(45) **Date of Patent:** **Feb. 11, 2014**

(54) **BEHIND-THE-EAR WIRELESS DEVICE**

(75) Inventors: **Kyouko Ishibana**, Tokyo (JP); **Naoki Matsubara**, Tokyo (JP); **Tomoaki Nishikido**, Ishikawa (JP); **Yoshio Koyanagi**, Kanagawa (JP)

(73) Assignee: **Panasonic Corporation**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 799 days.

(21) Appl. No.: **12/866,114**

(22) PCT Filed: **Feb. 2, 2009**

(86) PCT No.: **PCT/JP2009/000392**

§ 371 (c)(1),

(2), (4) Date: **Sep. 8, 2010**

(87) PCT Pub. No.: **WO2009/098858**

PCT Pub. Date: **Aug. 13, 2009**

(65) **Prior Publication Data**

US 2010/0321269 A1 Dec. 23, 2010

(30) **Foreign Application Priority Data**

Feb. 4, 2008 (JP) P2008-023607

(51) **Int. Cl.**

H01Q 19/26 (2006.01)

H04R 25/00 (2006.01)

H01Q 19/10 (2006.01)

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

USPC **343/834**; 343/833; 381/381

(58) **Field of Classification Search**

USPC 343/833, 834; 381/23.1, 381; 455/575.2

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

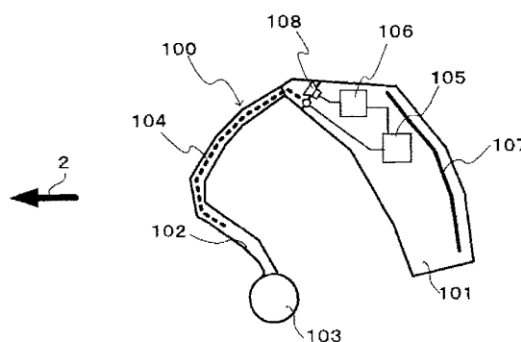
Assistant Examiner — Amal Patel

(74) Attorney, Agent, or Firm — Panasonic Patent Center

(57) **ABSTRACT**

A behind-the-ear wireless device includes a main body casing including a wireless circuit housed therein and an audio transmission unit having a function of transmitting sound to an ear. The main body casing and the audio transmission unit are integrally connected to each other, whereby the wireless device can be fitted to the ear. An antenna element having a length of about half wave length is disposed in a hollow of the sound tube. A parasitic element having a length of about a half wave length is disposed in the main body casing.

9 Claims, 4 Drawing Sheets





US008648762B2

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

(10) **Patent No.:** **US 8,648,762 B2**
(45) **Date of Patent:** **Feb. 11, 2014**

(54) **LOOP ARRAY ANTENNA SYSTEM AND ELECTRONIC APPARATUS HAVING THE SAME**

(75) Inventors: **Saou-Wen Su**, Taipei (TW); **Tzu-Chieh Hung**, Taipei (TW)

(73) Assignees: **Lite-On Electronics (Guangzhou) Limited**, Guangzhou (CN); **Lite-On Technology Corp.**, Taipei (TW)

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(21) Appl. No.: **13/083,969**

(22) Filed: **Apr. 11, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 13, 2010 (CN) 2010 1 0255303

(51) **Int. Cl.**
H01Q 9/16 (2006.01)

(52) **U.S. Cl.**
USPC **343/835**; 343/867

(58) **Field of Classification Search**
USPC 343/835, 867, 732, 742
See application file for complete search history.

(56) **References Cited**

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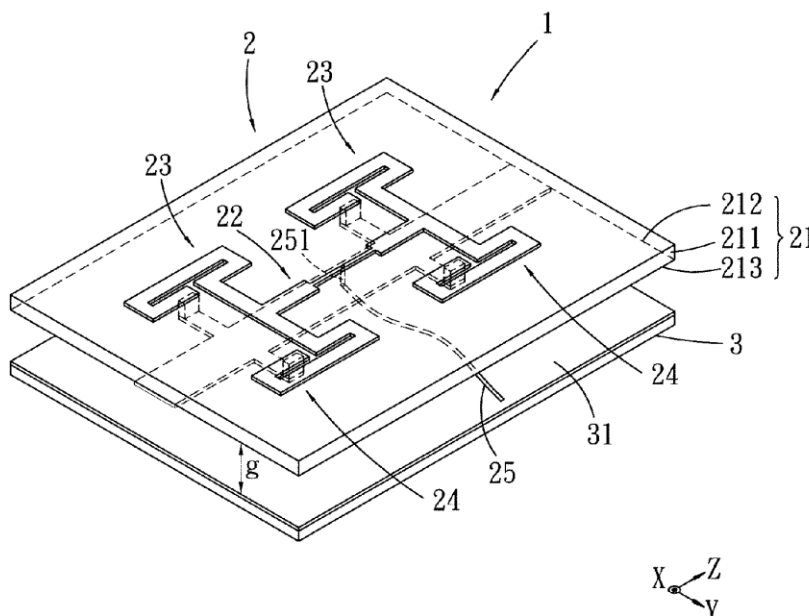
Primary Examiner — Ahshik Kim

(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

An antenna device includes: a substrate; micro-strip and grounding portions that are respectively disposed on opposite first and second surfaces of the substrate, the former including a signal-feed section for feeding of signals and a plurality of first connecting sections electrically connected to the signal-feed section; and a plurality of first loop antennas arranged along a peripheral edge of the grounding portion, each including a first radiator portion disposed on the first surface and electrically connected to a respective one of the first connecting sections, and a second radiator portion disposed on the second surface, electrically interconnecting the first radiator portion and the grounding portion, and cooperating with the first radiator portion to form a loop.

22 Claims, 12 Drawing Sheets





US008648763B2

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

(10) **Patent No.:** **US 8,648,763 B2**

(45) **Date of Patent:** ***Feb. 11, 2014**

(54) **GROUND RADIATOR USING CAPACITOR**

(56) **References Cited**

(75) Inventors: **Hyeng-cheul Choi**, Seoul (KR); **Yang Liu**, Seoul (KR); **Oul Cho**, Suwon-si (KR); **Hyun min Jang**, Jecheon-si (KR)

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(73) Assignee: **Radina Co., Ltd**, Seoul (KR)

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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 229 days.

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This patent is subject to a terminal disclaimer.

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(21) Appl. No.: **13/081,104**

(22) Filed: **Apr. 6, 2011**

(65) **Prior Publication Data**

US 2011/0193757 A1 Aug. 11, 2011

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2010/009340, filed on Dec. 24, 2010.

U.S. Office Action in U.S. Appl. No. 13/081,014 dated Mar. 29, 2013.
U.S. Office Action in U.S. Appl. No. 13/081,063 dated Mar. 28, 2013.
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International Search Report in International Application No. PCT/KR2010/009340, dated Aug. 16, 2011.
U.S. Office Action in U.S. Appl. No. 14/048,052 dated Nov. 15, 2013.

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(30) **Foreign Application Priority Data**

Feb. 11, 2010	(KR)	10-2010-0012775
Apr. 9, 2010	(KR)	10-2010-0032922
May 7, 2010	(KR)	10-2010-0043186
May 7, 2010	(KR)	10-2010-0043189
May 7, 2010	(KR)	20-2010-0043190
Jun. 14, 2010	(KR)	10-2010-0056207
Dec. 23, 2010	(KR)	10-2010-0133923

Primary Examiner — Kristy A Haupt

(74) *Attorney, Agent, or Firm* — Park, Kim & Suh, LLC

(57) **ABSTRACT**

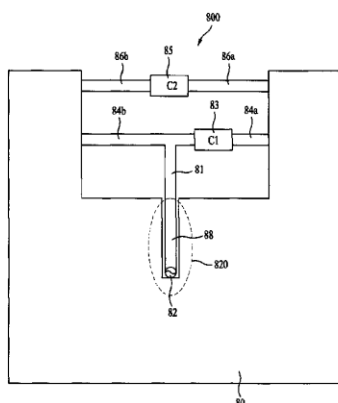
A ground radiation antenna is disclosed. Herein, the ground radiation antenna provides a ground radiator inducing resonance by using the inductance of a ground. Since the ground radiator efficiently uses the inductance of the ground, the ground radiator may operate as a radiator of the ground radiation antenna by using a simple structure of combining a capacitive element with the ground. As described above, by providing an antenna radiator having a remarkably simple structure, the fabrication cost for the antenna may be decreased, and the size of the antenna may also be largely reduced.

(51) **Int. Cl.**
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
USPC **343/845; 343/846; 343/847**

(58) **Field of Classification Search**
USPC **343/845-847**
See application file for complete search history.

12 Claims, 6 Drawing Sheets





US008648764B2

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

(10) **Patent No.:** **US 8,648,764 B2**

(45) **Date of Patent:** **Feb. 11, 2014**

(54) **COMPONENTS AND METHODS FOR
DESIGNING EFFICIENT ANTENNAE**

(75) Inventors: **Bryan McLaughlin**, Cambridge, MA
(US); **Douglas W. White**, Lexington,
MA (US)

(73) Assignee: **The Charles Stark Draper Laboratory,
Inc.**, Cambridge, MA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 385 days.

(21) Appl. No.: **13/116,618**

(22) Filed: **May 26, 2011**

(65) **Prior Publication Data**

US 2012/0299793 A1 Nov. 29, 2012

(51) **Int. Cl.**
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
USPC **343/848**

(58) **Field of Classification Search**
USPC 343/700 MS, 829, 846, 848
See application file for complete search history.

(56) **References Cited**

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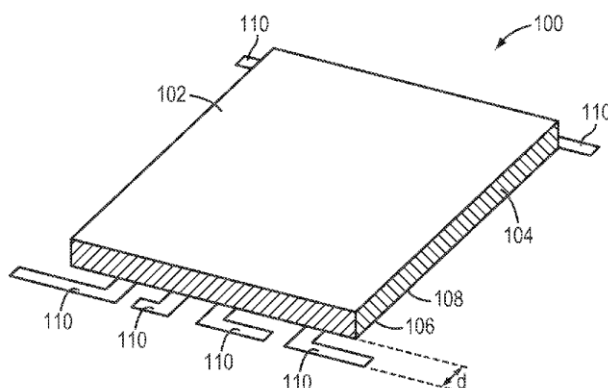
Primary Examiner — Seung Lee

(74) *Attorney, Agent, or Firm* — Goodwin Procter LLP

(57) **ABSTRACT**

An antenna features a ground plane having a continuous portion and one or more stubs extending therefrom.

15 Claims, 6 Drawing Sheets





US008648765B2

(12) **United States Patent**
Jeng

(10) **Patent No.:** **US 8,648,765 B2**
(45) **Date of Patent:** **Feb. 11, 2014**

(54) **COMPACT SIZE ANTENNA OPERATING IN
LTE FREQUENCY BANDS**

2007/0171130 A1 7/2007 Chung et al.
2009/0058735 A1 3/2009 Hill et al.
2009/0109098 A1 4/2009 Hung et al.

(75) Inventor: **Chang-Yueh Jeng**, Taipei Hsien (TW)

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

CN 201732860 2/2011

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 363 days.

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(21) Appl. No.: **13/150,779**

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Chinese language office action dated Dec. 2, 2013.
English language translation of abstract of CN 201732860 (published Feb. 2, 2011).

(22) Filed: **Jun. 1, 2011**

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(65) **Prior Publication Data**

US 2012/0218164 A1 Aug. 30, 2012

Primary Examiner — Seung Lee

(30) **Foreign Application Priority Data**

Feb. 24, 2011 (TW) 100106162 A

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

(51) **Int. Cl.**
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
USPC **343/848**

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 848
See application file for complete search history.

(57) **ABSTRACT**

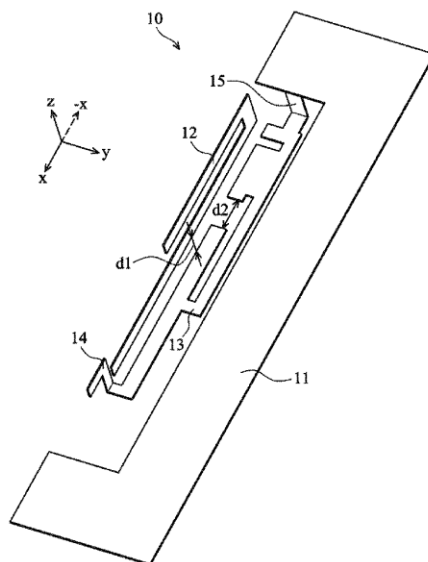
A compact size antenna operating in LTE frequency bands includes a radiation element, a ground plane, a connecting piece, and a ground extension element. The radiation element at least includes a first radiation branch extending toward a first direction, wherein a connection end of the radiation element has a signal feeding point. The connecting piece is coupled to the ground plane. The ground extension element includes: a metal arm, coupled to the ground plane through the connecting piece; a first ground branch, coupled to the metal arm, and extending toward the first direction; a second ground branch coupled to the metal arm, and extending toward a second direction opposite to the first direction; and a third ground branch, coupled to the metal arm, coupled to the second ground branch, and extending toward the first direction.

(56) **References Cited**

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7,518,555 B2 * 4/2009 Heng et al. 343/700 MS
2007/0103370 A1 5/2007 Hung et al.

18 Claims, 7 Drawing Sheets





US008649825B2

(12) **United States Patent**
van Wonterghem et al.

(10) **Patent No.:** **US 8,649,825 B2**

(45) **Date of Patent:** **Feb. 11, 2014**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE WITH SPATIAL DIVERSITY
ANTENNA AND RELATED METHODS**

(75) Inventors: **Jari Kristian van Wonterghem**, Ottawa
(CA); **Xiaoping Qin**, Ottawa (CA);
Subum Park, Ottawa (CA)

(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario
(CA)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 473 days.

(21) Appl. No.: **12/847,036**

(22) Filed: **Jul. 30, 2010**

(65) **Prior Publication Data**

US 2012/0028685 A1 Feb. 2, 2012

(51) **Int. Cl.**
H04B 1/38 (2006.01)

(52) **U.S. Cl.**
USPC **455/566**; 455/550.1; 455/552.1;
455/575.1; 455/575.3

(58) **Field of Classification Search**
USPC 455/550.1, 552.1, 575.1, 575.3, 575.7
See application file for complete search history.

(56) **References Cited**

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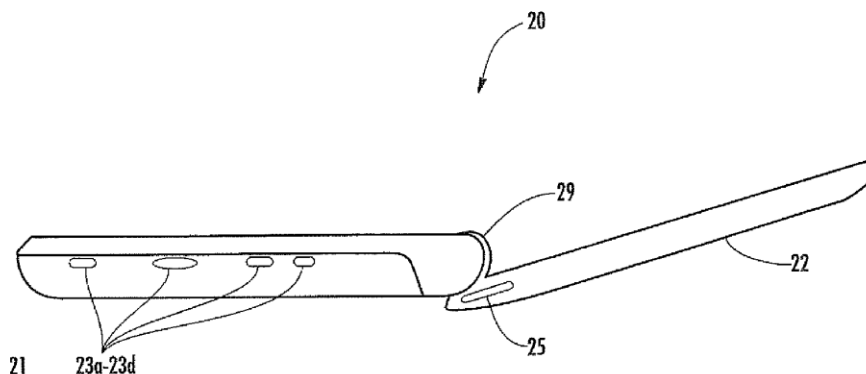
Primary Examiner — Fayyaz Alam

(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt,
Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include first and second housings, a hinge pivotally coupling the first and second housings, and a first antenna carried by the first housing. The mobile wireless communications device may include a second antenna carried by the second housing, wireless transceiver circuitry carried by the first housing and configured for spatial diversity operation with the first and second antennas, and a hinge connector carried by the hinge and coupling the second antenna to the wireless transceiver circuitry.

14 Claims, 8 Drawing Sheets





US008649832B2

(12) **United States Patent**
Takebe

(10) **Patent No.:** **US 8,649,832 B2**
(45) **Date of Patent:** ***Feb. 11, 2014**

(54) **CELLULAR WIRELESS UNIT**

(75) Inventor: **Hiroyuki Takebe**, Chiba (JP)

(73) Assignee: **Sharp Kabushiki Kaisha**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 256 days.
This patent is subject to a terminal disclaimer.

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(21) Appl. No.: **12/757,713**

(22) Filed: **Apr. 9, 2010**

(65) **Prior Publication Data**

US 2010/0197373 A1 Aug. 5, 2010

Related U.S. Application Data

(62) Division of application No. 10/580,270, filed as application No. PCT/JP2004/016633 on Nov. 10, 2004, now Pat. No. 7,725,123.

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

(52) **U.S. Cl.**
USPC **455/575.7**; 455/550.1; 455/562.1;
343/702

(58) **Field of Classification Search**
USPC 455/550.1, 562.1, 575.1, 575.3, 575.5,
455/575.7; 343/846, 848, 860, 702
See application file for complete search history.

(56) **References Cited**

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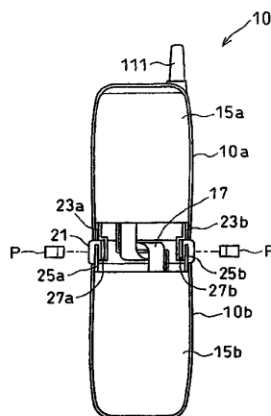
Primary Examiner — Ping Hsieh

(74) Attorney, Agent, or Firm — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

Antenna characteristics of a folding cellphone are adjusted to appropriate values. The cellphone includes a first casing **10a** containing a first circuit member **15a**, and a second casing **10b** containing a second circuit member **15b**. The first circuit member **15a** and the second circuit member **15b** are connected by a connection structure consisting of a first connecting conductor **23a** extending from each lateral end of the first circuit member **15a** downward (toward the second casing), and a second connecting conductor **25a** extending from each lateral end of the second circuit member **15b** upward (toward the first casing). The first circuit member **15a** and the second circuit member **15b** are each comprised of shields, substrates, and so on. Antenna **111** is disposed at an upper edge of the first casing **10a**. The effective casing length is affected by the length of the first casing **10a** and the second casing **10b**, which are both electrically conductive. The end of the first connecting conductor **23a** is formed by a first circular portion **31a** having a circular opening **31c**. The second connecting conductor **25a** has a second circular portion **31b** and an opening **31d** at the tip thereof, which are shaped similarly to those of the first connecting conductor **23a**. A spacer **27a** made of an insulator is inserted between the first and second connecting conductors.

8 Claims, 11 Drawing Sheets





US008649833B1

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

(10) **Patent No.:** **US 8,649,833 B1**

(45) **Date of Patent:** **Feb. 11, 2014**

(54) **CONDUCTIVE STRUCTURE FOR USE AS
SENSOR PAD AND ANTENNA**

(75) Inventors: **Cheng-Jung Lee**, Santa Clara, CA (US);
Michael M. Lee, San Jose, CA (US);
Mark Corbridge, Los Gatos, CA (US);
Nagendra Bage Jayaraj, Sunnyvale, CA
(US); **Khaled Ahmad Obeidat**, Santa
Clara, CA (US); **Joseph C. Modro**, Palo
Alto, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 26 days.

(21) Appl. No.: **13/429,132**

(22) Filed: **Mar. 23, 2012**

Related U.S. Application Data

(60) Provisional application No. 61/510,939, filed on Jul.
22, 2011.

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

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

USPC **455/575.7**; 455/82

(58) **Field of Classification Search**

USPC 340/572.7; 343/702, 720; 455/19, 82,
455/562.1, 575.7

See application file for complete search history.

(56) **References Cited**

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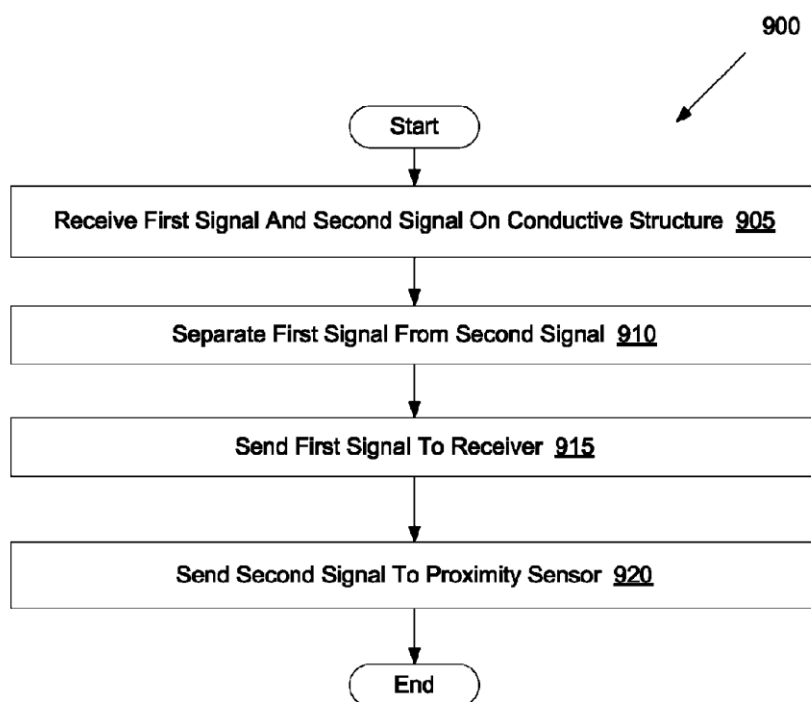
Primary Examiner — Sonny Trinh

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

(57) **ABSTRACT**

A user device includes a conductive structure coupled to a receiver and a sensor. The conductive structure is configured to operate as an antenna for the receiver and as a sensor pad for the sensor.

22 Claims, 9 Drawing Sheets





US008654012B2

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

(10) **Patent No.:** **US 8,654,012 B2**

(45) **Date of Patent:** **Feb. 18, 2014**

(54) **TAG ANTENNA USING MICROSTRIP LINE,
METHOD OF MANUFACTURING THE SAME
AND RADIO FREQUENCY IDENTIFICATION
TAG**

(75) Inventors: **Jeong-seok Kim**, Daejeon-si (KR);
Hae-won Son, Jeonju-si (KR); **Won-kyu
Choi**, Daejeon-si (KR); **Gil-young Choi**,
Daejeon-si (KR); **Jong-suk Chae**,
Daejeon-si (KR)

(73) Assignees: **Electronics and Telecommunications
Research Institute (KR); Industrial
Cooperation Foundation Chonbuk
National University (KR)**

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 854 days.

(21) Appl. No.: **12/688,753**

(22) Filed: **Jan. 15, 2010**

(65) **Prior Publication Data**

US 2010/0314453 A1 Dec. 16, 2010

(30) **Foreign Application Priority Data**

Jun. 16, 2009 (KR) 10-2009-0053591

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

(52) **U.S. Cl.**
USPC **343/700 MS; 343/702**

(58) **Field of Classification Search**
USPC **343/700 MS, 702, 718**
See application file for complete search history.

(56) **References Cited**

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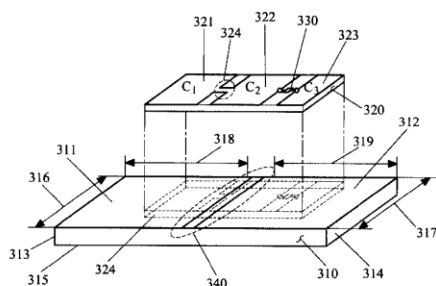
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Blakely Sokoloff Taylor &
Zafman

(57) **ABSTRACT**

Disclosed is a Radio Frequency Identification (RFID) tag antenna. The tag antenna includes a lower dielectric substrate and an upper dielectric substrate. The lower dielectric substrate is provided at a lower surface thereof with a ground plane and at an upper surface thereof with two microstrip lines. The microstrip lines each have an open-end, the open ends spaced apart from each other from a middle of the lower dielectric substrate while facing each other to form a radiating slot from which radiation of electromagnetic waves occurs. The upper dielectric substrate is provided at an upper surface thereof with at least one electric capacitive device and is stacked on the lower dielectric substrate. The RFID tag antenna enhances radiation efficiency while achieving miniaturization.

8 Claims, 6 Drawing Sheets





US008654013B2

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

(10) **Patent No.:** **US 8,654,013 B2**

(45) **Date of Patent:** **Feb. 18, 2014**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Munehisa Watanabe**, Shiga-ken (JP);
Kengo Onaka, Kanagawa-ken (JP);
Takashi Ishihara, Tokyo-to (JP);
Tsuyoshi Mukai, Kyoto-fu (JP); **Yuichi Kushihi**, Kanagawa-ken (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 125 days.

(21) Appl. No.: **12/835,476**

(22) Filed: **Jul. 13, 2010**

(65) **Prior Publication Data**

US 2011/0102268 A1 May 5, 2011

(30) **Foreign Application Priority Data**

Jul. 14, 2009 (JP) 2009-165395

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

(52) **U.S. Cl.**
USPC **343/700 MS; 343/702**

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

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Primary Examiner — Douglas W Owens

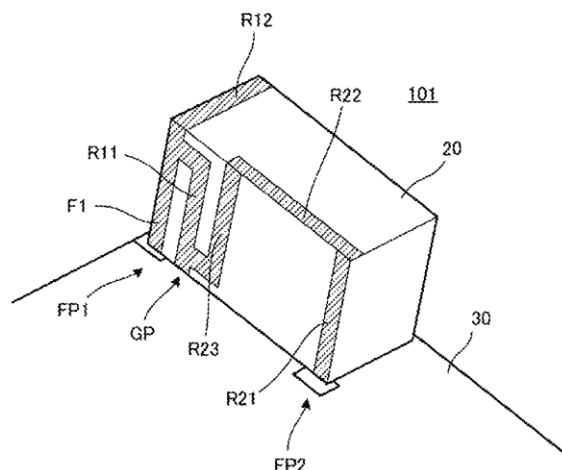
Assistant Examiner — Jae Kim

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

(57) **ABSTRACT**

An antenna includes a base, a first radiating element, and second radiating element. The first radiating element is open at a first end thereof, is connected to a ground point at a second end thereof, and resonates in a substantially $\frac{1}{4}$ wavelength mode in a first communication frequency band. A feed line is connected between a first feed point and a predetermined position between the first end and the second end of the first radiating element. The second radiating element has a first end that is a second feed point, a second end that is connected to the ground point, and resonates in a substantially $\frac{1}{2}$ wavelength mode in a second communication frequency band. A distance from the ground point to the second feed point is longer than a distance from the ground point to the first feed point.

6 Claims, 6 Drawing Sheets





US008654014B2

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

(10) **Patent No.:** **US 8,654,014 B2**
(45) **Date of Patent:** **Feb. 18, 2014**

(54) **INVERTED-F ANTENNA AND WIRELESS COMMUNICATION APPARATUS USING THE SAME**

(75) Inventors: **Ching-Wei Ling**, Tainan County (TW);
Chih-Pao Lin, Zhubei (TW)

(73) Assignee: **Realtek Semiconductor Corp.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 264 days.

(21) Appl. No.: **13/179,181**

(22) Filed: **Jul. 8, 2011**

(65) **Prior Publication Data**

US 2012/0007784 A1 Jan. 12, 2012

(30) **Foreign Application Priority Data**

Jul. 9, 2010 (TW) 99122701 A

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

(52) **U.S. Cl.**
USPC **343/702; 343/700 MS**

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

(56) **References Cited**

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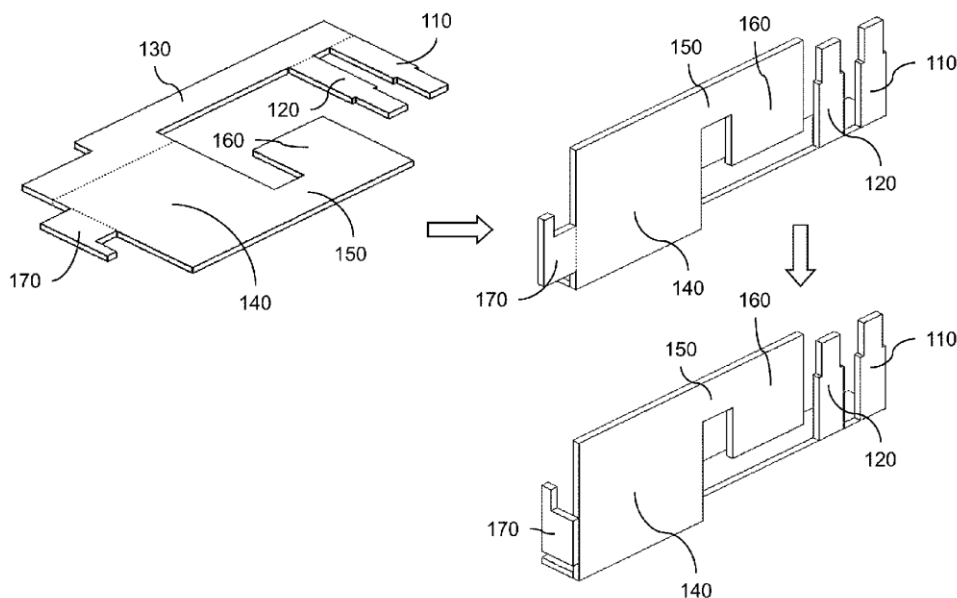
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

An inverted-F antenna is disclosed including: a radiating body including a plurality of radiating portions, and some of the radiating portions located on a same plane; a shorting element extending outward from the radiating body and forming a first predetermined included angle with one of the radiating portions; a feeding element extending outward from the radiating body and forming a second predetermined included angle with one of the radiating portions; and a protrusion extending outward from the radiating body and forming a third predetermined included angle with one of the radiating portions; wherein at least one of the first, second, and third predetermined included angles is substantially a right angle.

30 Claims, 9 Drawing Sheets





US008654015B2

(12) **United States Patent**
Saito

(10) **Patent No.:** **US 8,654,015 B2**
(45) **Date of Patent:** **Feb. 18, 2014**

(54) **ANTENNA, ADJUSTMENT METHOD THEREOF, AND ELECTRONIC DEVICE IN WHICH THE ANTENNA IS MOUNTED**

(75) Inventor: **Katsuo Saito**, Yokohama (JP)

(73) Assignee: **Canon Kabushiki Kaisha**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 282 days.

(21) Appl. No.: **13/287,438**

(22) Filed: **Nov. 2, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 3, 2010 (JP) 2010-270793
Oct. 12, 2011 (JP) 2011-225300

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

(52) **U.S. Cl.**
USPC 343/702; 343/700 MS

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 848
See application file for complete search history.

(56) **References Cited**

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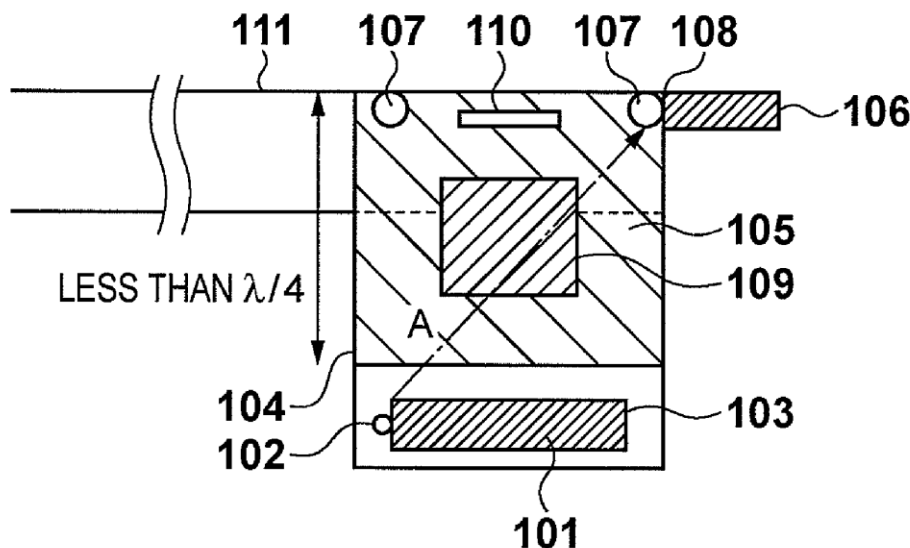
Primary Examiner — Tan Ho

(74) Attorney, Agent, or Firm — Carter, DeLuca, Farrell & Schmidt LLP

(57) **ABSTRACT**

An antenna used in wireless communication, provided with an antenna element and a GND portion on a dielectric board and mounted in an electronic device, includes an open conductor having a high-frequency connection to the GND portion at an end of the dielectric board in the opposing corner direction from a power supply point of the antenna element. The length of the GND portion in the vertical direction relative to the propagation direction of a high-frequency signal is less than $\frac{1}{4}$ the wavelength of the operating frequency of the antenna element.

7 Claims, 21 Drawing Sheets





US008654020B2

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

(10) **Patent No.:** **US 8,654,020 B2**

(45) **Date of Patent:** **Feb. 18, 2014**

(54) **ANTENNA HAVING CAPACITIVE ELEMENT**

(75) Inventors: **Hyeong-dong Kim**, Seoul (KR);
Sin-hyung Jeon, Seoul (KR);
Hyeng-cheul Choi, Seoul (KR)

(73) Assignee: **Radina Co., Ltd**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 530 days.

(21) Appl. No.: **12/997,992**

(22) PCT Filed: **Aug. 25, 2010**

(86) PCT No.: **PCT/KR2010/005675**

§ 371 (c)(1),
(2), (4) Date: **Dec. 14, 2010**

(87) PCT Pub. No.: **WO2012/026635**

PCT Pub. Date: **Mar. 1, 2012**

(65) **Prior Publication Data**

US 2012/0050121 A1 Mar. 1, 2012

(51) **Int. Cl.**
H01Q 9/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/745**; 343/700 MS

(58) **Field of Classification Search**
USPC 343/702, 700 MS, 846, 745
See application file for complete search history.

(56) **References Cited**

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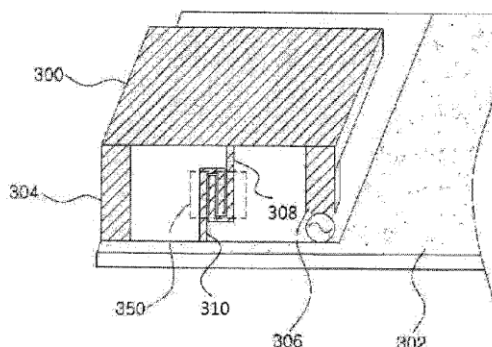
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Park, Kim & Suh, LLC

(57) **ABSTRACT**

An antenna having a capacitive element is disclosed. Herein, the antenna is configured of a radiator, a ground plane being spaced apart to a predetermined distance from the radiator, a ground pin electrically connected to the radiator and the ground plane, a capacitive element located between the radiator and the ground plane, a first branch arm electrically connecting the capacitive element and the radiator, and a second branch arm electrically connecting the capacitive element and the ground plane. Thus, multiple band and broad band characteristics can be realized by the simple structure of the antenna.

10 Claims, 4 Drawing Sheets





US008654021B2

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

(10) **Patent No.:** **US 8,654,021 B2**
(45) **Date of Patent:** **Feb. 18, 2014**

(54) **SINGLE-SIDED MULTI-BAND ANTENNA**

(75) Inventors: **Forrest James Brown**, Carson City, NV
(US); **Ryan James Orsi**, San Diego, CA
(US); **Matthew Robert Foster**, San
Diego, CA (US)

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(73) Assignee: **Dockon AG**, Zurich (CH)

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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 186 days.

EP 1672735 A1 6/2006
EP 1684379 A1 7/2006

(Continued)

(21) Appl. No.: **13/402,777**

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(22) Filed: **Feb. 22, 2012**

"Antenna Theory: A review," Balanis, Proc. IEEE, Jan. 1992, 80(1).

(65) **Prior Publication Data**

US 2013/0057440 A1 Mar. 7, 2013

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Related U.S. Application Data

(60) Provisional application No. 61/530,902, filed on Sep.
2, 2011.

Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

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

(52) **U.S. Cl.**
USPC 343/748; 343/726; 343/728

(58) **Field of Classification Search**
USPC 343/726, 728, 741, 745, 748, 866
See application file for complete search history.

(57) **ABSTRACT**

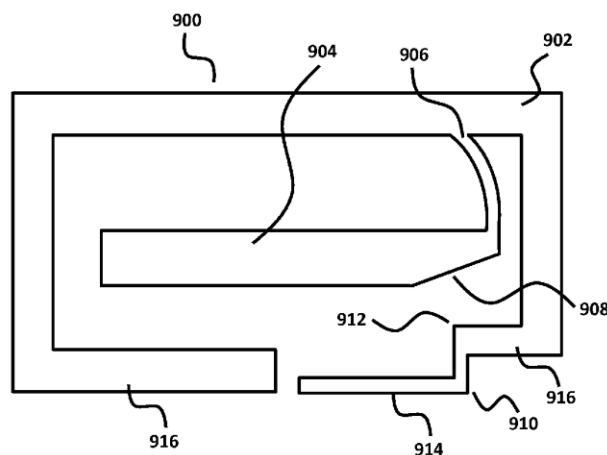
Embodiments provide multi-band, compound loop antennas (multi-band antennas). Embodiments of the multi-band antennas produce signals at two or more frequency bands, with the two or more frequency bands capable of being adjusted and tuned independently of each other. Embodiments of a multi-band antenna are comprised of at least one electric field radiator and at least one monopole formed out of the magnetic loop. At a particular frequency, the at least one electric field radiator in combination with various portions of the magnetic loop resonate and radiate an electric field at a first frequency band. At yet another particular frequency, the at least one monopole in combination with various portions of the magnetic loop resonate and radiate an electric field at a second frequency band. The shape of the magnetic loop can be tuned to increase the radiation efficiency at particular frequency bands and enable the multi-band operation of antenna embodiments.

(56) **References Cited**

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23 Claims, 18 Drawing Sheets





US008654022B2

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

(10) **Patent No.:** **US 8,654,022 B2**
(45) **Date of Patent:** **Feb. 18, 2014**

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

(75) Inventors: **Forrest James Brown**, Carson City, NV
(US); **Ryan James Orsi**, San Diego, CA
(US); **Matthew Robert Foster**, San
Diego, CA (US)

(73) Assignee: **Dockon AG**, Zurich (CH)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 198 days.

(21) Appl. No.: **13/402,806**

(22) Filed: **Feb. 22, 2012**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/530,902, filed on Sep.
2, 2011.

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

(52) **U.S. Cl.**
USPC **343/748; 343/726; 343/728**

(58) **Field of Classification Search**
USPC **343/726, 728, 741, 745, 748, 866**
See application file for complete search history.

(56) **References Cited**

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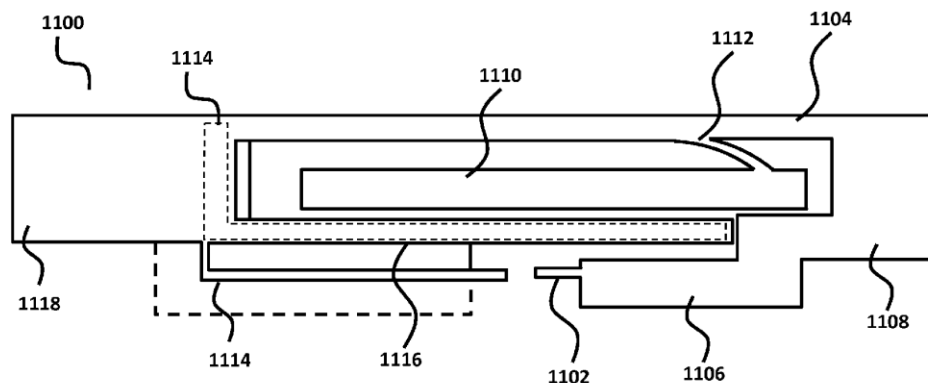
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

(57) **ABSTRACT**

Embodiments provide multi-band, compound loop antennas (multi-band antennas). Embodiments of the multi-band antennas produce signals at two or more frequency bands, with the two or more frequency bands capable of being adjusted and tuned independently of each other. Embodiments of a multi-band antenna are comprised of at least one electric field radiator and at least one monopole formed out of the magnetic loop. At a particular frequency, the at least one electric field radiator in combination with various portions of the magnetic loop resonate and radiate an electric field at a first frequency band. At yet another particular frequency, the at least one monopole in combination with various portions of the magnetic loop resonate and radiate an electric field at a second frequency band. The shape of the magnetic loop can be tuned to increase the radiation efficiency at particular frequency bands and enable the multi-band operation of antenna embodiments.

14 Claims, 18 Drawing Sheets





US008654023B2

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

(10) **Patent No.:** **US 8,654,023 B2**
(45) **Date of Patent:** **Feb. 18, 2014**

(54) **MULTI-LAYERED MULTI-BAND ANTENNA WITH PARASITIC RADIATOR**

(75) Inventors: **Forrest James Brown**, Carson City, NV (US); **Ryan James Orsi**, San Diego, CA (US); **Matthew Robert Foster**, San Diego, CA (US)

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(73) Assignee: **Dockon AG**, Zurich (CH)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 183 days.

EP 1672735 A1 6/2006
EP 1684379 A1 7/2006

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(21) Appl. No.: **13/402,817**

International Patent Application No. PCT/US12/53235; International Search Report and Written Opinion dated Nov. 2, 2012, 12 pages.

(22) Filed: **Feb. 22, 2012**

(Continued)

(65) **Prior Publication Data**
US 2013/0057441 A1 Mar. 7, 2013

Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Baker & Hostetler LLP

Related U.S. Application Data

(60) Provisional application No. 61/530,902, filed on Sep. 2, 2011.

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

(52) **U.S. Cl.**
USPC **343/748**; 343/749; 343/741; 343/866

(58) **Field of Classification Search**
USPC 343/741, 745, 748, 749, 866
See application file for complete search history.

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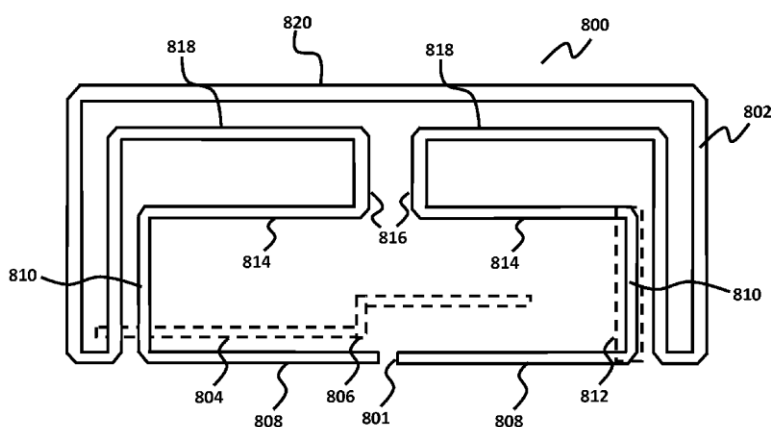
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5,198,826 A 3/1993 Ito
5,376,942 A 12/1994 Shiga
5,565,881 A 10/1996 Phillips

(57) **ABSTRACT**

Embodiments provide multi-band, compound loop antennas (multi-band antennas). Embodiments of the multi-band antennas produce signals at two or more frequency bands, with the two or more frequency bands capable of being adjusted and tuned independently of each other. Embodiments of a multi-band antenna are comprised of at least one electric field radiator and at least one monopole formed out of the magnetic loop. At a particular frequency, the at least one electric field radiator in combination with various portions of the magnetic loop resonate and radiate an electric field at a first frequency band. At yet another particular frequency, the at least one monopole in combination with various portions of the magnetic loop resonate and radiate an electric field at a second frequency band. The shape of the magnetic loop can be tuned to increase the radiation efficiency at particular frequency bands and enable the multi-band operation of antenna embodiments.

10 Claims, 18 Drawing Sheets





US008654024B2

(12) **United States Patent**
Chou

(10) **Patent No.:** **US 8,654,024 B2**

(45) **Date of Patent:** **Feb. 18, 2014**

(54) **ANTENNA MODULE**

(75) Inventor: **Ming-Yu Chou**, New Taipei (TW)

(73) Assignee: **Chi Mei 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 283 days.

(21) Appl. No.: **13/052,206**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 9/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/749**; 343/702; 343/700 MS;
343/846

(58) **Field of Classification Search**

USPC 343/702, 700, 846
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Daniel Hess

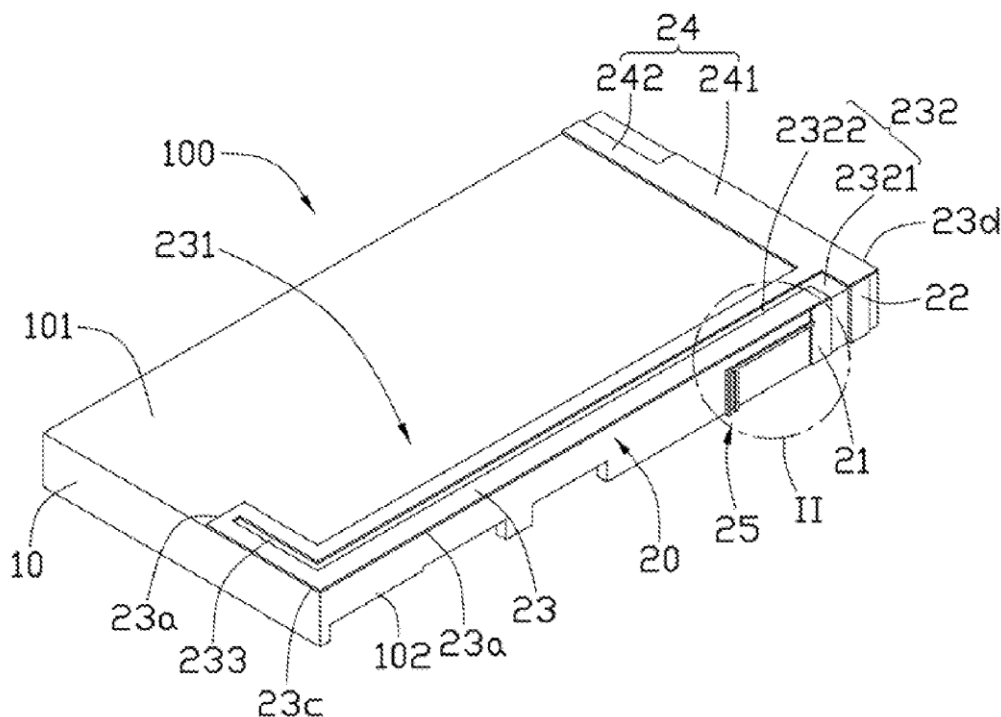
Assistant Examiner — Steven J Malone

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

An antenna includes a first antenna portion, a second antenna portion, a third antenna portion, a feed portion, and a ground portion. The first antenna portion perpendicularly connects to the feed portion and the ground portion. The second antenna portion connects to the first antenna portion. The third antenna portion connects to the feed portion. The first antenna portion and the second antenna portion are both located on a plane perpendicular to the feed portion. The feed portion, the ground portion, and the third antenna portion are coplanar.

4 Claims, 3 Drawing Sheets





US008654026B2

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

(10) **Patent No.:** **US 8,654,026 B2**
(45) **Date of Patent:** **Feb. 18, 2014**

(54) **ANTENNA MODULE**

(75) Inventors: **Wen-Yi Tsai**, New Taipei (TW);
Kuan-Jen Chung, New Taipei (TW);
Chia-Wei Su, New Taipei (TW)

(73) Assignee: **Wistron Corporation**, Hsichih, 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 190 days.

(21) Appl. No.: **13/364,294**

(22) Filed: **Feb. 1, 2012**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 25, 2011 (TW) 100222335 U

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

(52) **U.S. Cl.**
USPC **343/833**; 343/700 MS; 343/817

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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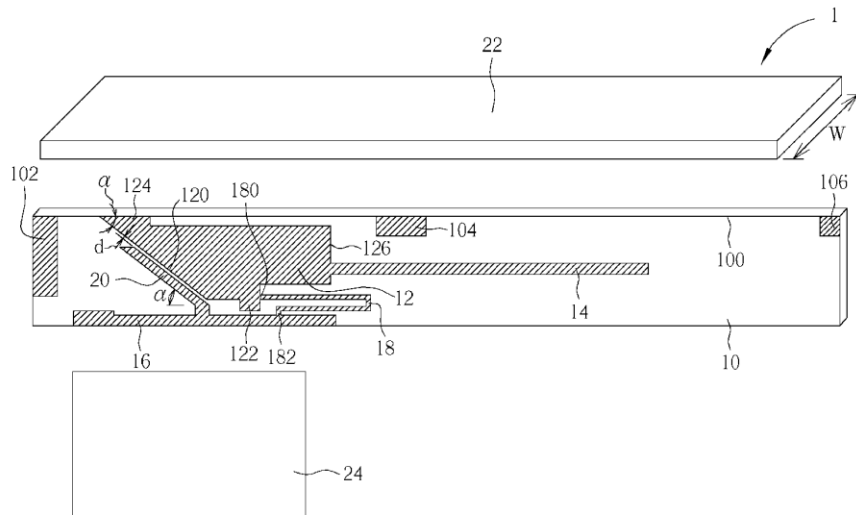
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

An antenna module includes a substrate, a main radiation structure, a strip-shaped radiation structure, a grounding structure, a shorting structure, a parasitic radiation structure and a metal radiation member. An acute angle is included between a first edge of the main radiation structure and a longitudinal edge of the substrate. The main radiation structure has a signal feeding portion and a connecting portion. The strip-shaped radiation structure is extended from a second edge of the main radiation structure. The shorting structure is U-shaped. A first end of the shorting structure is connected to the signal feeding portion and a second end of the shorting structure is connected to the grounding structure. The parasitic radiation structure is extended from the grounding structure and parallel to the first edge. A constant distance is between the parasitic radiation structure and the first edge. The metal radiation member is connected to the connecting portion.

8 Claims, 6 Drawing Sheets





US008654029B2

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

(10) **Patent No.:** **US 8,654,029 B2**

(45) **Date of Patent:** **Feb. 18, 2014**

(54) **HOUSING OF PORTABLE ELECTRONIC
DEVICE AND METHOD FOR MAKING THE
SAME**

(75) Inventors: **Yong-Fa Fan**, Shenzhen (CN); **Yong
Yan**, Shenzhen (CN); **Zhi-Guo Zhao**,
Shenzhen (CN); **Zhao-Yi Wu**, Shenzhen
(CN)

(73) Assignees: **Shenzhen Futaihong Precision
Industry Co., Ltd.**, Shenzhen (CN);
FIH (Hong Kong) Limited, Kowloon
(HK)

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

(21) Appl. No.: **12/967,150**

(22) Filed: **Dec. 14, 2010**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Jun. 28, 2010 (CN) 2010 1 0210968

(51) **Int. Cl.**
H01Q 1/40 (2006.01)

(52) **U.S. Cl.**
USPC **343/873; 343/702; 29/600**

(58) **Field of Classification Search**
USPC **343/702, 873; 29/600**
See application file for complete search history.

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Primary Examiner — Tan Ho

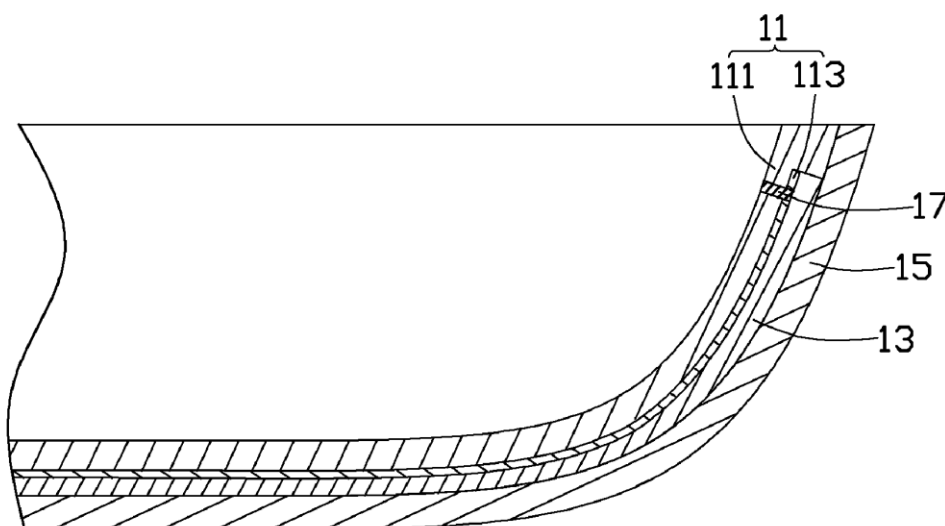
(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

A portable electronic device includes a base, an antenna radiator, an outer layer, and at least one conductive contact. The antenna radiator is formed on the activated base by plating. The antenna radiator is sandwiched between the base and the outer layer. One end of each conductive contact is electrically connected to the antenna radiator, and the other end of the each conductive contact is exposed.

14 Claims, 7 Drawing Sheets

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US008654030B1

(12) **United States Patent**
Mercer

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(54) **ANTENNA PLACEMENT**

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Related U.S. Application Data

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H01Q 3/24 (2006.01)

(52) **U.S. Cl.**
USPC **343/876**; 343/702; 343/893

(58) **Field of Classification Search**
USPC 343/725, 824, 872, 873, 893, 702, 876
See application file for complete search history.

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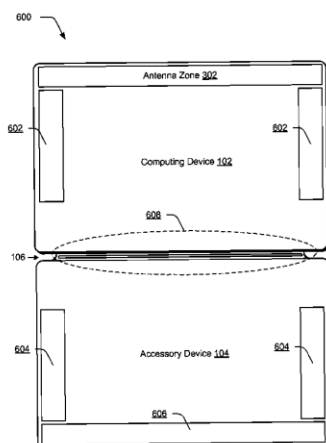
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(57) **ABSTRACT**

Antenna placement techniques are described. In one or more embodiments, a computing device includes an antenna suite having multiple different kinds of antennas. An antenna zone for the antenna suite may be established along a particular edge of the computing device. Non-interfering materials (e.g., RF transparent material) may be used within the antenna zone and other materials (e.g., metal) may be employed for other regions of the device. The multiple different kinds of antennas in the antenna suite may then be disposed within the established antenna zone. The antennas may be placed to minimize interference between antennas and/or achieve performance objective for the suite of antennas. In one approach, a suite of five antennas may be placed along a top edge of a computing device in a landscape orientation.

20 Claims, 13 Drawing Sheets





US008654032B2

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

(10) **Patent No.:** **US 8,654,032 B2**

(45) **Date of Patent:** **Feb. 18, 2014**

(54) **APPARATUS FOR MULTIPLE ANTENNAS IN WIRELESS COMMUNICATION SYSTEM**

(56) **References Cited**

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Jae-Hoon Jo, Seoul (KR); **Mi-Hyun Son**, Seoul (KR); **Se-Hyun Park**,
Suwon-si (KR); **Hee-Jun Lee**, Ansan-si
(KR)

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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 461 days.

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Primary Examiner — Trinh Dinh

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(21) Appl. No.: **13/008,149**

(22) Filed: **Jan. 18, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jan. 21, 2010 (KR) 10-2010-0005453

(51) **Int. Cl.**
H01Q 21/10 (2006.01)
H01Q 1/24 (2006.01)

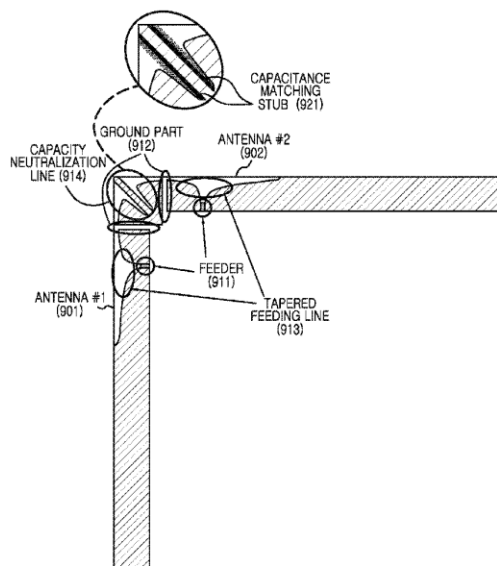
(52) **U.S. Cl.**
USPC **343/893**; 343/810; 343/853; 343/702

(58) **Field of Classification Search**
None
See application file for complete search history.

(57) **ABSTRACT**

An apparatus for multiple antennas having a low coupling coefficient in a wide frequency bandwidth in a wireless communication system is provided. To obtain the low coupling coefficient in the wide frequency bandwidth by minimizing interference between antennas which are close to each other, without an additional device, in the wireless communication system, the apparatus includes a transceiver and a line for decreasing a coupling coefficient. The transmitter includes a first antenna and a second antenna for transmitting and receiving signals over a radio channel and the line is indirectly connected the first antenna and the second antenna using a physically disconnected line.

8 Claims, 11 Drawing Sheets





US008655421B2

(12) **United States Patent**
Sakurai(10) **Patent No.:** **US 8,655,421 B2**(45) **Date of Patent:** **Feb. 18, 2014**(54) **PORTABLE WIRELESS DEVICE WITH
EXPANDABLE MECHANISM AND WIRELESS
COMMUNICATION METHOD**(75) Inventor: **Masanori Sakurai**, Tokyo (JP)(73) Assignee: **NEC Corporation**, Tokyo (JP)(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 227 days.(21) Appl. No.: **12/743,555**(22) PCT Filed: **Nov. 20, 2008**(86) PCT No.: **PCT/JP2008/071158**§ 371 (c)(1),
(2), (4) Date: **May 18, 2010**(87) PCT Pub. No.: **WO2009/072404**PCT Pub. Date: **Jun. 11, 2009**(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 3, 2007 (JP) 2007-312515

(51) **Int. Cl.**
H04M 1/00 (2006.01)(52) **U.S. Cl.**
USPC **455/575.4; 455/550.1; 455/575.7**(58) **Field of Classification Search**
None
See application file for complete search history.(56) **References Cited**

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Primary Examiner — Suhail Khan(57) **ABSTRACT**

A portable wireless device and a wireless communication method, which can transmit and receive wireless signal without affecting influence from metallic part that is included in an expandable mechanism, are provided. In the portable wireless device taking two statuses of an expanded status in which an upper housing 2 and a lower housing 7 are arranged approximately in series and a contracted status in which the upper housing 2 and the lower housing 7 are overlapped each other, at least a part of rotating mechanism 1 which makes the expanded status and the contracted status variable is formed of metal, and the metal part of rotating mechanism 1 operates as an antenna.

7 Claims, 6 Drawing Sheets