



US008922434B2

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

(10) **Patent No.:** **US 8,922,434 B2**

(45) **Date of Patent:** **Dec. 30, 2014**

(54) **FLAT SCREEN WITH INTEGRATED ANTENNA**

(75) Inventors: **Christophe Prat**, Coueron (FR); **Lionel Rudant**, Grenoble (FR)

(73) Assignee: **Commissariat a l'Energie Atomique et aux Energies Alternatives**, Paris (FR)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 695 days.

(21) Appl. No.: **13/143,589**

(22) PCT Filed: **Dec. 18, 2009**

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(2), (4) Date: **Oct. 6, 2011**

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PCT Pub. Date: **Jul. 15, 2010**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

**H01Q 5/00** (2006.01)

**H01Q 13/10** (2006.01)

**H01Q 1/22** (2006.01)

**H01Q 1/44** (2006.01)

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

CPC ..... **H01Q 13/106** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/44** (2013.01)

USPC ..... **343/700 MS**; **343/702**

(58) **Field of Classification Search**

USPC ..... 343/702, 700 MS, 720; 345/173, 107, 345/213, 76

See application file for complete search history.

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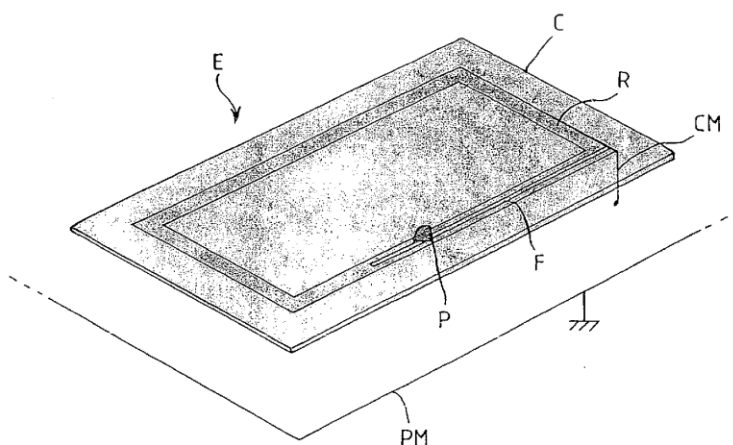
*Primary Examiner* — Thien M Le

(74) *Attorney, Agent, or Firm* — Alston & Bird LLP

(57) **ABSTRACT**

The invention relates to a flat screen (E) that comprises an active pixel matrix (M), an electrode that is common to said pixels (C), and a conductive strip (R) preferably in the form of a ring that is connected to said common electrode and at least partially surrounds said active matrix, characterized in that at least one slot (F) defining an antenna is formed in said conducting strip. The invention also relates to a portable apparatus that comprises: such a flat screen (E); an electronic board including a floorplan (PM) parallel to the flat screen and electrically connected to the conductive strip of the same; a means for generating and/or detecting electric radiofrequency signals; and an excitation port (P) for the slot antenna (F) installed in the flat screen, and connected to said means for generating and/or detecting electric radiofrequency signals.

**13 Claims, 3 Drawing Sheets**





US008922439B2

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

(10) **Patent No.:** **US 8,922,439 B2**  
(45) **Date of Patent:** **Dec. 30, 2014**

(54) **ELECTRONIC DEVICE CASE, METHOD AND MOLD FOR MANUFACTURING THE SAME, AND MOBILE COMMUNICATIONS TERMINAL**

(71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**, Gyeonggi-do (KR)

(72) Inventors: **Jae Suk Sung**, Gyeonggi-do (KR); **Sung Eun Cho**, Gyeonggi-do (KR); **Ha Ryong Hong**, Gyeonggi-so (KR); **Dae Kyu Lee**, Gyeonggi-do (KR); **Ki Won Chang**, Gyeonggi-do (KR); **Dae Seong Jeon**, Gyeonggi-do (KR); **Tae Sung Kim**, Seoul (KR); **Dae Ki Lim**, Gyeonggi-do (KR); **Hyun Do Park**, Gyeonggi-do (KR); **Nam Il Seo**, Seoul (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 0 days.

(21) Appl. No.: **13/973,936**

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

(65) **Prior Publication Data**

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**Related U.S. Application Data**

(62) Division of application No. 12/608,818, filed on Oct. 29, 2009, now Pat. No. 8,618,989.

(30) **Foreign Application Priority Data**

Apr. 23, 2009 (KR) ..... 10-2009-0035635

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

(Continued)

(52) **U.S. Cl.**  
CPC ..... **B29D 99/006** (2013.01); **H01Q 1/243** (2013.01); **B29C 45/14065** (2013.01);

(Continued)

(58) **Field of Classification Search**

USPC ..... 343/702, 873  
See application file for complete search history.

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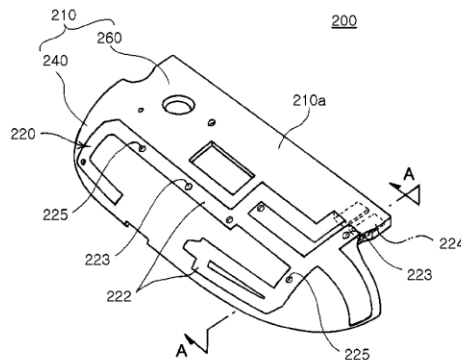
*Primary Examiner* — Tho G Phan

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

(57) **ABSTRACT**

An electronic device case having an antenna pattern embedded therein includes: a radiator having an antenna pattern portion transmitting and receiving a signal and a connection terminal portion allowing the signal to be transmitted to and received from a circuit board of an electronic device; a connection portion partially forming the radiator and connecting the antenna pattern portion and the connection terminal portion to be arranged in different planes; a radiator frame manufactured by injection molding on the radiator so that the antenna pattern portion of the radiator is provided on one side of the radiator frame and the connection terminal portion is provided on the other side thereof; and a case frame covering the one side of the radiator frame on which the antenna pattern portion is provided so that the antenna pattern portion is embedded between the case frame and the radiator frame.

**10 Claims, 19 Drawing Sheets**





US008922442B2

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

(10) **Patent No.:** **US 8,922,442 B2**  
(45) **Date of Patent:** **Dec. 30, 2014**

(54) **LOW-PROFILE MULTIBAND ANTENNA FOR A WIRELESS COMMUNICATION DEVICE**

(75) Inventors: **Guangli Yang**, San Diego, CA (US); **Xiaotao Liang**, East Northport, NY (US); **Mikhail Bruk**, Hicksville, NY (US); **Dean La Rosa**, Bohemia, NY (US)

(73) Assignee: **Symbol Technologies, Inc.**, Holtsville, NY (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 696 days.

(21) Appl. No.: **13/150,754**

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

(65) **Prior Publication Data**

US 2012/0306707 A1 Dec. 6, 2012

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

(52) **U.S. Cl.**  
USPC ..... **343/728; 343/702; 343/745**

(58) **Field of Classification Search**  
USPC ..... **343/728, 702, 745**  
See application file for complete search history.

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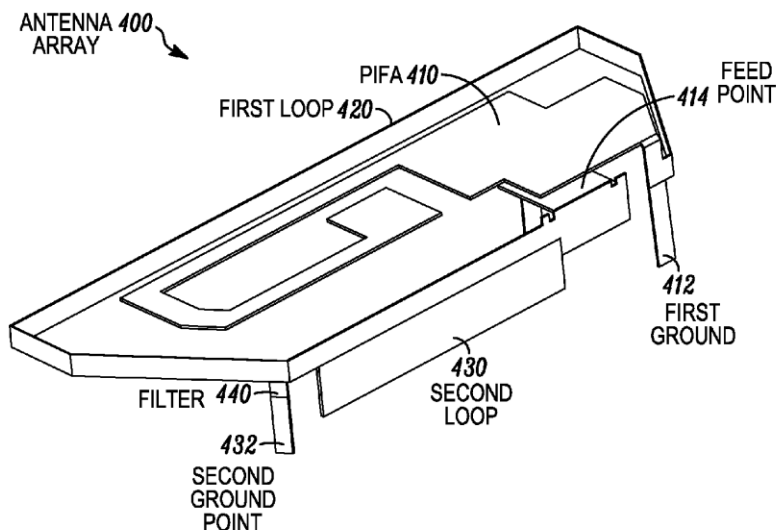
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Primary Examiner — Karl D Frech

(57) **ABSTRACT**

A device for wireless communication including a wireless transceiver, a printed circuit board (PCB) coupled to the wireless transceiver, a first antenna and a second antenna. The first antenna is coupled to the PCB at a feed point and grounded at a ground point. The first antenna is a quarter-wavelength antenna communicating signals with the wireless transceiver at a first frequency band. The second antenna is coupled to the first antenna at the feed point and grounded at a further ground point. The second antenna is a half-wavelength antenna communicating signals with the wireless transceiver at a second frequency band.

**20 Claims, 4 Drawing Sheets**





US008922443B2

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

(10) **Patent No.:** **US 8,922,443 B2**  
(45) **Date of Patent:** **Dec. 30, 2014**

- (54) **DISTRIBUTED LOOP ANTENNA WITH MULTIPLE SUBLOOPS**
- (71) Applicant: **Apple, Inc.**, Cupertino, CA (US)
- (72) Inventors: **Jiang Zhu**, Sunnyvale, CA (US);  
**Qingxiang Li**, Mountain View, CA (US);  
**Robert W. Schlub**, Cupertino, CA (US);  
**Ruben Caballero**, San Jose, CA (US)
- (73) Assignee: **Apple Inc.**, Cupertino, CA (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 163 days.

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Primary Examiner — Tho G Phan

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

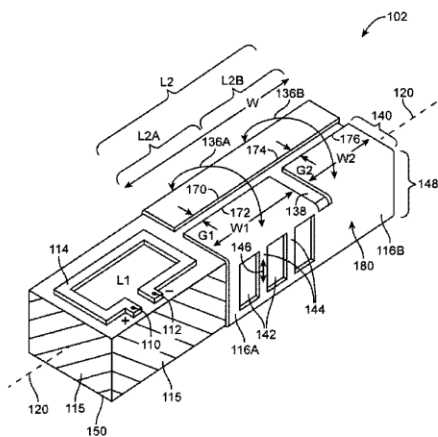
- (21) Appl. No.: **13/629,005**
- (22) Filed: **Sep. 27, 2012**
- (65) **Prior Publication Data**  
US 2014/0085161 A1 Mar. 27, 2014
- (51) **Int. Cl.**  
**H01Q 11/12** (2006.01)
- (52) **U.S. Cl.**  
USPC ..... **343/741**; 343/702; 343/866; 343/867
- (58) **Field of Classification Search**  
CPC ..... H01Q 21/00; H01Q 7/00  
USPC ..... 343/741, 742, 788, 866, 867, 702  
See application file for complete search history.

(57) **ABSTRACT**

An electronic device may be provided with antenna structures. The antenna structures may be formed using a dielectric carrier structure. The antenna structures may have first and second loop antenna resonating elements. The first loop antenna resonating element may indirectly feed the second loop antenna resonating element. The second loop antenna resonating element may be a distributed loop element formed from multiple antenna resonating element subloops. The second loop antenna resonating element may be formed from a strip of metal with a width that loops around the dielectric carrier. An opening in the metal may separate first and second subloop antenna resonating elements from each other in the second loop antenna resonating element. Openings in the metal may form metal segments that collectively form an inductance for the first subloop. Antenna currents may flow through metal traces on the carrier and portions of an electronic device housing wall.

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**21 Claims, 12 Drawing Sheets**





US008922444B2

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

(10) **Patent No.:** **US 8,922,444 B2**  
(45) **Date of Patent:** **Dec. 30, 2014**

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

USPC ..... 343/787, 788, 895, 866, 867  
See application file for complete search history.

(75) Inventors: **Kuniaki Yosui**, Kyoto (JP); **Hiromitsu Ito**, Kyoto (JP); **Hiroyuki Kubo**, Kyoto (JP)

(56) **References Cited**

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*Primary Examiner* — Dameon E Levi

*Assistant Examiner* — Hasan Islam

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

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

(21) Appl. No.: **13/428,552**

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

(65) **Prior Publication Data**

US 2012/0176283 A1 Jul. 12, 2012

**Related U.S. Application Data**

(63) Continuation of application No. PCT/JP2010/057946, filed on May 11, 2010.

(30) **Foreign Application Priority Data**

Sep. 25, 2009 (JP) ..... 2009-221627

(51) **Int. Cl.**  
**H01Q 7/08** (2006.01)  
**H01Q 1/24** (2006.01)  
**G06K 19/077** (2006.01)  
**H01Q 7/06** (2006.01)  
**H01Q 1/22** (2006.01)

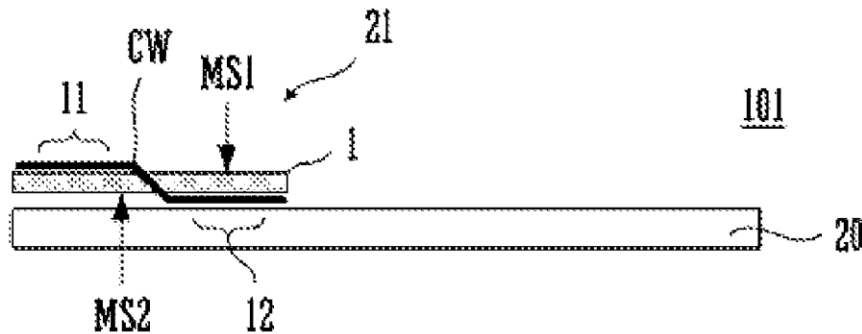
(52) **U.S. Cl.**  
CPC ..... **H01Q 7/06** (2013.01); **H01Q 1/241** (2013.01); **H01Q 7/08** (2013.01); **G06K 19/07779** (2013.01); **H01Q 1/2225** (2013.01)  
USPC ..... **343/788**; 343/702

(58) **Field of Classification Search**  
CPC . G06K 19/07779; H01Q 7/00; H01Q 1/2225; H01Q 1/2216; H01Q 1/38

(57) **ABSTRACT**

This disclosure provides an antenna device including an antenna coil having a plate-shaped magnetic core with first and second main surfaces and a coil conductor wound around the magnetic core, and a flat conductor adjacent to the antenna coil. For instance, the flat conductor can be a ground electrode formed on or within a circuit substrate. The coil conductor includes a first conductor portion adjacent to the first main surface of the magnetic core and a second conductor portion adjacent to a second main surface thereof. The first conductor portion of the antenna coil is closer to an end portion of the flat conductor than the second conductor portion, with the second main surface of the magnetic core facing the flat conductor.

**26 Claims, 5 Drawing Sheets**





US008922448B2

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

(10) **Patent No.:** **US 8,922,448 B2**

(45) **Date of Patent:** **Dec. 30, 2014**

(54) **COMMUNICATION DEVICE AND ANTENNAS WITH HIGH ISOLATION CHARACTERISTICS**

(71) Applicants: **MediaTek Singapore Pte. Ltd.**,  
Singapore (SG); **National Sun Yat-sen University**, Kaohsiung (TW)

(72) Inventors: **Kin-Lu Wong**, Kaohsiung (TW);  
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(73) Assignees: **MediaTek Singapore Pte. Ltd.**,  
Singapore (SG); **National Sun Yat-Sen University**, Kaohsiung (TW)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 192 days.

(21) Appl. No.: **13/627,311**

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

(65) **Prior Publication Data**  
US 2014/0085158 A1 Mar. 27, 2014

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**H01Q 1/52** (2006.01)  
**H01Q 1/24** (2006.01)

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USPC ..... **343/841**; 343/702

(58) **Field of Classification Search**  
CPC ..... H01Q 1/521; H01Q 1/243; H01Q 1/48  
USPC ..... 343/841, 702  
See application file for complete search history.

(56) **References Cited**

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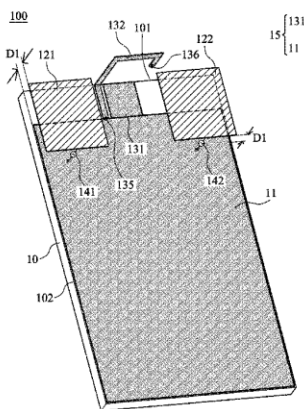
*Primary Examiner* — Hoang V Nguyen

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

(57) **ABSTRACT**

A communication device includes a system circuit board, a ground plane, a first antenna, a second antenna, a first metal element, and a second metal element. The ground plane is disposed on the system circuit board. The first metal element is substantially located between the first antenna and the second antenna. The first metal element is coupled to the ground plane such that a system ground plane is formed. The second metal element is adjacent to the first metal element and substantially located between the first antenna and the second antenna. The second metal element is coupled to the system ground plane. The first antenna, the second antenna, and the first metal element are substantially located at an edge of the system circuit board.

**20 Claims, 11 Drawing Sheets**





US008922449B2

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

(10) **Patent No.:** **US 8,922,449 B2**  
(45) **Date of Patent:** **Dec. 30, 2014**

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

(75) Inventors: **Kin-Lu Wong**, New Taipei (TW);  
**Tsung-Ju Wu**, New Taipei (TW)

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

(\* ) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
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(21) Appl. No.: **13/449,318**

(22) Filed: **Apr. 18, 2012**

(65) **Prior Publication Data**

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Dec. 27, 2011 (TW) ..... 100148862 A

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**H01Q 1/00** (2006.01)

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USPC ..... **343/843**

(58) **Field of Classification Search**  
USPC ..... 343/843, 846, 895, 817, 702, 700 MS,  
343/814-8  
See application file for complete search history.

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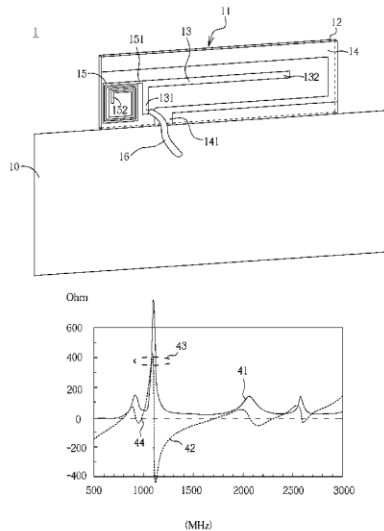
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

An antenna structure having a ground element and an antenna  
element is provided. The antenna element is disposed on a  
dielectric substrate, and includes a first radiation portion, a  
second radiation portion, and a spiral metal line. An end of the  
first radiation portion is a feeding point of the antenna ele-  
ment, and another end is open. An end of the second radiation  
portion is electrically coupled to the ground element, and the  
length of the second radiation portion is greater than that of  
the first radiation portion. The first radiation portion is sur-  
rounded by the second radiation portion. An end of the spiral  
metal line is coupled to the first radiation portion. The spiral  
metal line contributes a parallel resonance outside the anten-  
na's operating band, and results in a resonant mode generated  
within the antenna element's operating band such that the  
operating bandwidth of the antenna element is increased.

**16 Claims, 7 Drawing Sheets**





US008923914B2

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

(10) **Patent No.:** **US 8,923,914 B2**  
(45) **Date of Patent:** **Dec. 30, 2014**

(54) **RE-CONFIGURABLE BUILT-IN ANTENNA FOR PORTABLE TERMINAL**

USPC ..... 455/82, 550.1, 552.1, 553.1, 101, 455/127.4, 132, 133, 188.1; 343/714, 723, 343/823, 861, 868  
See application file for complete search history.

(75) Inventors: **Jin-U Kim**, Seoul (KR); **Austin Kim**, Seongnam-si (KR); **Dong-Hwan Kim**, Hwaseong-si (KR); **Jae-Ho Lee**, Yongin-si (KR); **Jung-Ho Park**, Hwaseong-si (KR)

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*Primary Examiner* — Andrew Wendell

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

(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 760 days.

(21) Appl. No.: **13/100,445**

(22) Filed: **May 4, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 10, 2010 (KR) ..... 10-2010-0043519

(51) **Int. Cl.**  
**H04M 1/00** (2006.01)  
**H01Q 11/12** (2006.01)  
**H01Q 9/16** (2006.01)  
**H01Q 7/00** (2006.01)  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)

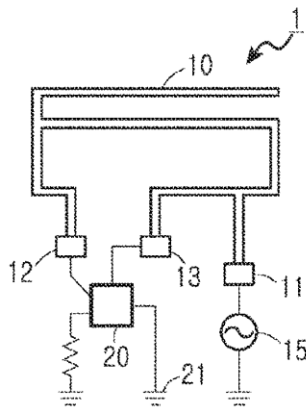
(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 9/0442** (2013.01)  
USPC ..... **455/550.1**; 343/723; 343/823; 343/868

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 9/0407; H01Q 1/245; H04B 1/0053; H04B 1/3838

(57) **ABSTRACT**

A re-reconfigurable built-in antenna of a portable terminal is provided. The antenna includes an antenna radiator having a feeding pad electrically connected to a feeding portion of a main board of the terminal and at least one ground pad disposed in a position different from that of the feeding pad for selectively establishing an electrical connection to a ground portion of the terminal, and a switching element, commonly connected to the at least one ground pad of the antenna radiator, for selectively establishing an electrical connection to the ground portion by a switching operation. The antenna radiator changes a shape of the antenna radiator by using the selective electrical connection of the ground portion so as to have various operational frequency bands and radiation properties.

**13 Claims, 5 Drawing Sheets**







US008928530B2

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

(10) **Patent No.:** **US 8,928,530 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

- (54) **ENHANCED METAMATERIAL ANTENNA STRUCTURES**
- (75) Inventors: **Maha Achour**, Encinitas, CA (US); **Ajay Gummalla**, Sunnyvale, CA (US); **Anders Mattsson**, Taipei (TW); **Vaneet Pathak**, Palo Alto, CA (US); **Gregory Poilasne**, El Cajon, CA (US); **Sunil Kumar Rajgopal**, San Diego, CA (US)
- (73) Assignee: **Tyco Electronics Services GmbH** (CH)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 295 days.

- (21) Appl. No.: **13/039,964**
- (22) Filed: **Mar. 3, 2011**
- (65) **Prior Publication Data**  
US 2012/0001826 A1 Jan. 5, 2012

- Related U.S. Application Data**
- (60) Provisional application No. 61/310,623, filed on Mar. 4, 2010, provisional application No. 61/332,620, filed on May 7, 2010, provisional application No. 61/366,520, filed on Jul. 21, 2010.

- (51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 15/00** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 5/00** (2006.01)

- (52) **U.S. Cl.**  
CPC ..... **H01Q 5/0024** (2013.01); **H01Q 9/0428** (2013.01); **H01Q 15/006** (2013.01); **H01Q 1/38** (2013.01)  
USPC ..... **343/700 MS**

- (58) **Field of Classification Search**  
USPC ..... 343/725, 893, 905  
See application file for complete search history.

- (56) **References Cited**  
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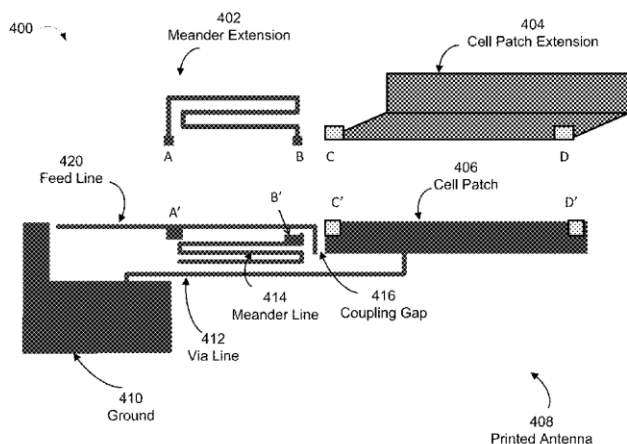
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*Primary Examiner* — Douglas W Owens  
*Assistant Examiner* — Patrick Holecek

- (57) **ABSTRACT**
- A wireless device having an antenna structure incorporates a conductive structure to extend an effective length of at least one component of the antenna structure. The enhanced 3-D conductive structure is applicable to a variety of antenna types, including, but not limited to, a CRLH structured antenna.

**20 Claims, 9 Drawing Sheets**





US008928531B2

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

(10) **Patent No.:** **US 8,928,531 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **ANTENNA MODULE**

(75) Inventors: **Pei-Cheng Hu**, New Taipei (TW);  
**Kuo-Chang Su**, New Taipei (TW);  
**Wen-Yi Tsai**, New Taipei (TW)

(73) Assignee: **Wistron Corp.**, 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 183 days.

(21) Appl. No.: **13/427,816**

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

(65) **Prior Publication Data**

US 2012/0242546 A1 Sep. 27, 2012

(30) **Foreign Application Priority Data**

Mar. 25, 2011 (TW) ..... 100110322 A

(51) **Int. Cl.**

**H01Q 1/38** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/00** (2006.01)  
**H01Q 9/04** (2006.01)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/0055** (2013.01); **H01Q 9/0421** (2013.01)  
USPC ..... **343/700 MS**; **343/702**

(58) **Field of Classification Search**

CPC ..... H01Q 1/38; H01Q 1/243; H01Q 9/0421  
USPC ..... **343/700 MS**, **702**, **846**  
See application file for complete search history.

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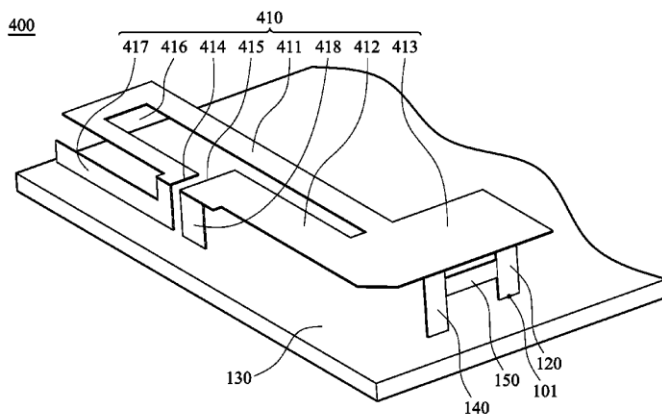
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Primary Examiner — Hoanganh Le

(57) **ABSTRACT**

An antenna module is provided. The antenna module includes a radiator, a feed conductor, a ground element, a ground conductor and a short conductor. The feed conductor is connected to the radiator. The ground conductor connects the radiator to the ground element. The short conductor connects the feed conductor to the ground conductor.

**7 Claims, 7 Drawing Sheets**





US008928535B2

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

(10) **Patent No.:** **US 8,928,535 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **ELECTRONIC APPARATUS**  
(75) Inventors: **Chang-Hsun Wu**, Taipei (TW);  
**Chien-Yi Wu**, Taipei (TW)  
(73) Assignee: **Pegatron Corporation**, Taipei (TW)  
(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 448 days.

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(21) Appl. No.: **13/350,593**  
(22) Filed: **Jan. 13, 2012**

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(65) **Prior Publication Data**  
US 2012/0182189 A1 Jul. 19, 2012

*Primary Examiner* — Tho G Phan  
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(30) **Foreign Application Priority Data**  
Jan. 14, 2011 (TW) ..... 100101475 A

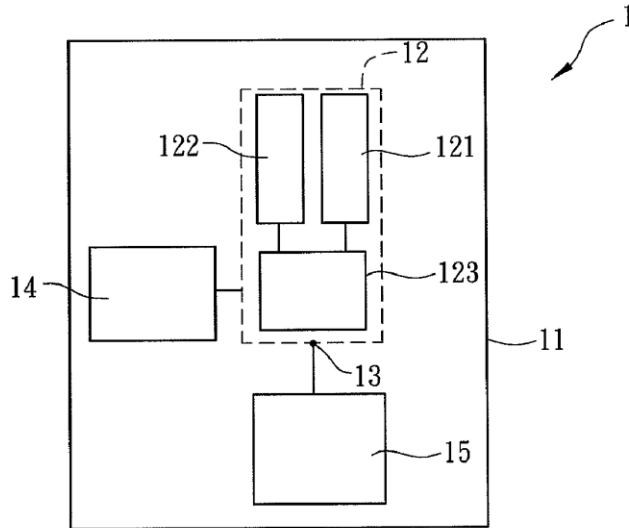
(57) **ABSTRACT**

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 3/24** (2006.01)  
(52) **U.S. Cl.**  
CPC **H01Q 3/24** (2013.01); **H01Q 1/243** (2013.01)  
USPC ..... **343/702**; 343/876  
(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 3/24  
USPC ..... 343/702, 876  
See application file for complete search history.

An electronic apparatus includes a casing, at least an antenna body, a feeding point and a control unit. The casing has a display portion. The antenna body is disposed at the casing and at least has two radiation paths and a switching element. Parts of the radiation paths are respectively disposed at two sides of the display portion. The switching element is electrically connected with the radiation paths. The feeding point is electrically connected with the switching element and operationally connected to one of the radiation paths. The control unit controls the switching element based on the rotation of the electronic apparatus. When one of the radiation paths is located between a user and the display portion, the control unit controls to selectively switch the switching element for connecting the other radiation path to the feeding point.

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**6 Claims, 8 Drawing Sheets**





US008928538B2

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

(10) **Patent No.:** **US 8,928,538 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **ANTENNA SYSTEM PROVIDING HIGH ISOLATION BETWEEN ANTENNAS ON ELECTRONICS DEVICE**

(75) Inventors: **Mark T. Montgomery**, Melbourne Beach, FL (US); **Frank M. Caimi**, Vero Beach, FL (US); **Paul A. Tornatta, Jr.**, Melbourne, FL (US)

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1127 days.

(21) Appl. No.: **12/899,900**

(22) Filed: **Oct. 7, 2010**

(65) **Prior Publication Data**

US 2011/0122035 A1 May 26, 2011

**Related U.S. Application Data**

(60) Provisional application No. 61/250,344, filed on Oct. 9, 2009, provisional application No. 61/363,085, filed on Jul. 9, 2010.

(51) **Int. Cl.**

**H01Q 21/28** (2006.01)  
**H01Q 1/52** (2006.01)  
**H01Q 1/22** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 9/22** (2006.01)  
**H01Q 9/26** (2006.01)  
**H01Q 9/28** (2006.01)  
**H01Q 9/42** (2006.01)

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

CPC ..... **H01Q 1/2291** (2013.01); **H01Q 1/52** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/521** (2013.01); **H01Q 9/22** (2013.01); **H01Q 9/26** (2013.01); **H01Q 9/28** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

USPC ..... **343/727**; 343/702

(58) **Field of Classification Search**

CPC ..... H01Q 21/28; H01Q 21/24; H01Q 21/30; H01Q 1/52; H01Q 25/00; H01Q 1/24; H01Q 1/241; H01Q 1/242

USPC ..... 343/727, 702  
See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Dameon E Levi

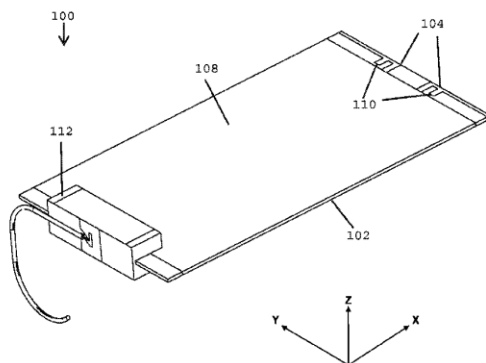
*Assistant Examiner* — Jennifer F Hu

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

(57) **ABSTRACT**

An antenna system is provided in a portable electronics device having a printed circuit board assembly. The antenna system includes a first antenna and a second balanced antenna provided on the printed circuit board assembly. The first antenna is fed from a portion of the printed circuit board assembly such that a ground plane of the printed circuit board assembly serves as a counterpoise for the first antenna. The second balanced antenna has dipole ends configured and oriented to generally minimize coupling to the ground plane of the printed circuit board assembly to increase isolation between the first antenna and the second balanced antenna.

**27 Claims, 22 Drawing Sheets**





US008928539B2

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

(10) **Patent No.:** **US 8,928,539 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **ANTENNA UNIT AND RADIO COMMUNICATION DEVICE**

USPC ..... 343/700 MS, 702, 725, 728, 729  
See application file for complete search history.

(71) Applicant: **Murata Manufacturing Co., Ltd.**,  
Kyoto-fu (JP)

(56) **References Cited**

(72) Inventors: **Kengo Onaka**, Kyoto-fu (JP); **Osamu Shibata**, Kyoto-fu (JP); **Yuichi Kushihi**,  
Kyoto-fu (JP)

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(Continued)

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

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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 169 days.

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(21) Appl. No.: **13/775,006**

The first Office Action issued by the State Intellectual Property Office of People's Republic of China on Mar. 19, 2014, which corresponds to Chinese Patent Application No. 201180041939.7 and is related to U.S. Appl. No. 13/775,006; with English language translation.

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

(65) **Prior Publication Data**

US 2013/0162488 A1 Jun. 27, 2013

(Continued)

**Related U.S. Application Data**

(63) Continuation of application No. PCT/JP2011/064596,  
filed on Jun. 25, 2011.

*Primary Examiner* — Tho G Phan

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

(30) **Foreign Application Priority Data**

Aug. 31, 2010 (JP) ..... 2010-194233

(57) **ABSTRACT**

An antenna unit and a radio communication device are provided. An antenna unit has a monopole antenna section and a loop antenna section. The monopole antenna section includes a linear radiating electrode that resonates at a first frequency and has an electrical length of one-quarter of the wave length corresponding to the first frequency. The loop antenna section includes a radiating electrode that resonates at a second frequency, is vertically erected on a non-ground region, and connected to a feed line. A proximal end of the radiating electrode of the loop antenna section is connected to an intermediate portion of the feed line, and a distal end thereof is connected to a ground region. The electrical length of the radiating electrode of the loop antenna section is one-half of the wave length of the second frequency.

(51) **Int. Cl.**

**H01Q 21/30** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 7/00** (2006.01)  
**H01Q 9/42** (2006.01)

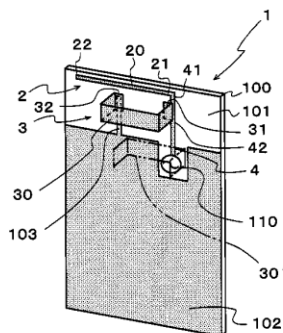
(52) **U.S. Cl.**

CPC . **H01Q 1/38** (2013.01); **H01Q 7/00** (2013.01);  
**H01Q 9/42** (2013.01); **H01Q 21/30** (2013.01)  
USPC ..... **343/728**; 343/700 MS; 343/702;  
343/725

(58) **Field of Classification Search**

CPC ..... H01Q 1/38; H01Q 21/30; H01Q 7/00

**19 Claims, 8 Drawing Sheets**





US008928540B2

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

(10) **Patent No.:** **US 8,928,540 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **MULTI-ANTENNA MODULE CONTAINING ACTIVE ELEMENTS AND CONTROL CIRCUITS FOR WIRELESS SYSTEMS**

(71) Applicant: **Ethertronics, Inc.**, San Diego, CA (US)

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

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

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

(21) Appl. No.: **13/674,078**

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

(65) **Prior Publication Data**

US 2013/0141292 A1 Jun. 6, 2013

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No. 8,362,962, which is a continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402, said application No. 13/674,078 is a continuation-in-part of application No. 13/289,901, filed on Nov. 4, 2011, which is a continuation of application No. 12/894,052, filed on Sep. 29, 2010, now Pat. No. 8,077,116, which is a continuation of application No. 11/841,207, filed on Aug. 20, 2007, now Pat. No. 7,830,320.

(51) **Int. Cl.**  
**H01Q 25/04** (2006.01)

(52) **U.S. Cl.**  
USPC ..... **343/745**; 343/702; 343/815; 343/833; 343/876

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 21/28; H01Q 25/04; H01Q 3/00; H01Q 9/0421  
USPC ..... 343/700 MS, 702, 745, 750, 813, 815, 343/833, 834, 876  
See application file for complete search history.

(56) **References Cited**

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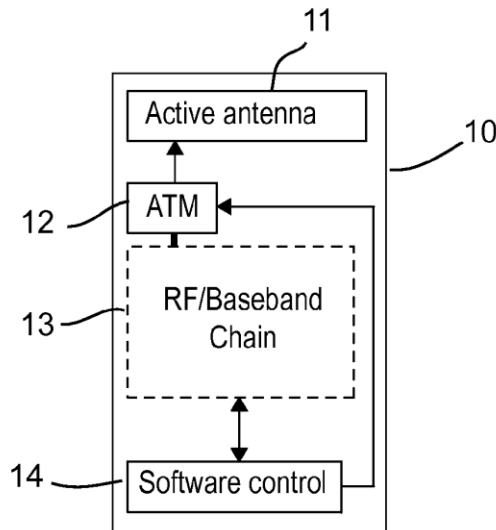
*Primary Examiner* — Tho G Phan

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

(57) **ABSTRACT**

An antenna system is provided for use in wireless communication, the antenna system is contained in a modular structure. The antenna system includes a plurality of co-located antennas, including at least one active modal antenna, each of the antennas being adapted for operation at a distinct frequency band. The antenna system further includes an active tuning module for tuning a frequency response of the co-located antennas.

**20 Claims, 4 Drawing Sheets**





US008928541B2

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

(10) **Patent No.:** **US 8,928,541 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **ACTIVE MIMO ANTENNA CONFIGURATION FOR MAXIMIZING THROUGHPUT IN MOBILE DEVICES**

(71) Applicant: **Ethertronic, Inc.**, San Diego, CA (US)

(72) Inventors: **Laurent Desclos**, San Diego, CA (US);  
**Barry Matsumori**, La Jolla, CA (US);  
**Sebastian Rowson**, San Diego, CA (US);  
**Abhishek Singh**, San Diego, CA (US)

(73) Assignee: **Ethertronic, 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 120 days.

(21) Appl. No.: **13/674,115**

(22) Filed: **Nov. 12, 2012**

(65) **Prior Publication Data**

US 2013/0135163 A1 May 30, 2013

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No. 8,362,962, which is a continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402, application No. 13/674,115, which is a continuation-in-part of application No. 13/227,361, filed on Sep. 7, 2011, now abandoned.

(51) **Int. Cl.**  
**H01Q 9/38** (2006.01)  
**H01Q 21/28** (2006.01)  
**H01Q 25/04** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 3/00** (2006.01)  
**H01Q 9/04** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 21/28** (2013.01); **H01Q 25/04** (2013.01); **H01Q 1/243** (2013.01); **H01Q 3/00** (2013.01); **H01Q 9/0421** (2013.01)  
USPC ..... **343/745**; 343/815; 343/853; 343/876

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 21/28; H01Q 25/04; H01Q 3/00; H01Q 9/0421  
USPC ..... 343/745, 750, 813, 815, 833, 834, 853, 343/876  
See application file for complete search history.

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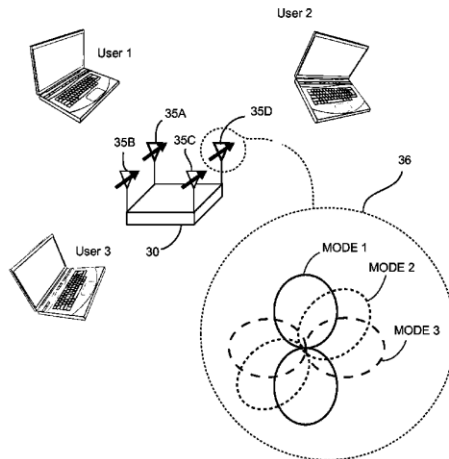
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An active antenna system and algorithm is proposed that provides for dynamic tuning and optimization of antenna system parameters for a MIMO system that will provide for greater throughput. As one or multiple antennas are loaded or de-tuned due to environmental changes, corrections to correlation and/or isolation are made by tuning the active antenna. A null-steering technique is implemented to alter the near-field and far-field characteristics to aid in modifying correlation and isolation in the multi-antenna system.

**8 Claims, 12 Drawing Sheets**





US008929946B2

(12) **United States Patent**  
**Yun**

(10) **Patent No.:** **US 8,929,946 B2**  
(45) **Date of Patent:** **Jan. 6, 2015**

(54) **ANTENNA APPARATUS OF MOBILE TERMINAL**

(75) Inventor: **Ju Hwan Yun**, Gyeongsangbuk-do (KR)

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

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 552 days.

(21) Appl. No.: **12/782,775**

(22) Filed: **May 19, 2010**

(65) **Prior Publication Data**  
US 2010/0298027 A1 Nov. 25, 2010

(30) **Foreign Application Priority Data**  
May 21, 2009 (KR) ..... 10-2009-0044377

(51) **Int. Cl.**  
**H04M 1/00** (2006.01)  
**H01Q 1/24** (2006.01)  
**H04M 1/02** (2006.01)  
(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H04M 1/0208** (2013.01); **H04M 1/0274** (2013.01)  
USPC ..... **455/553.1**; 455/575.1; 455/575.5; 455/575.6; 455/575.7; 455/575.8; 343/702

(58) **Field of Classification Search**  
USPC ..... 455/575.1, 575.5, 575.6, 552.1, 553.1, 455/575.7, 575.8; 343/906, 702  
See application file for complete search history.

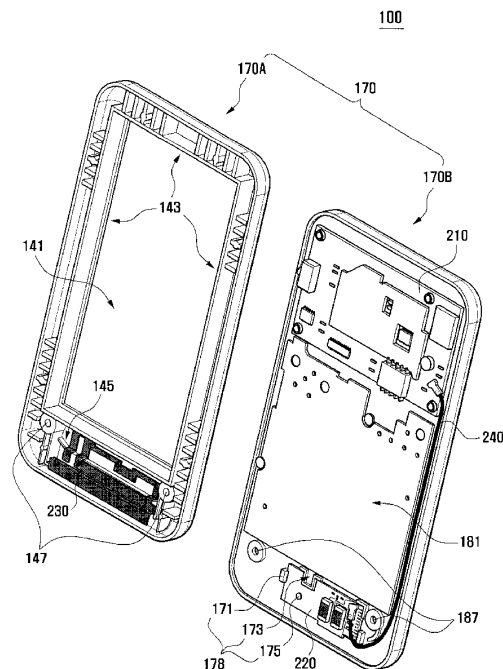
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*Primary Examiner* — Sharad Rampuria  
*Assistant Examiner* — Sayed T Zewari  
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**  
A mobile terminal and manufacture of same are provided. The mobile terminal includes: an antenna; a first case at which the antenna is disposed; a second case coupled to the first case; a main PCB disposed at one side of the second case; and a sub-PCB disposed at an opposite side of the second case, the sub-PCB being connected to the main PCB through a cable, wherein the sub-PCB is electrically coupled with the antenna when the first case and the second case are coupled together.

**20 Claims, 4 Drawing Sheets**







US008933842B2

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

(10) **Patent No.:** **US 8,933,842 B2**  
(45) **Date of Patent:** **\*Jan. 13, 2015**

(54) **WIDEBAND, HIGH ISOLATION TWO PORT ANTENNA ARRAY FOR MULTIPLE INPUT, MULTIPLE OUTPUT HANDHELD DEVICES**

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

(75) Inventors: **Mina Ayatollahi**, Waterloo (CA); **Qinjian Rao**, Waterloo (CA); **Dong Wang**, Waterloo (CA)

(56) **References Cited**

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*Primary Examiner* — Graham Smith

(74) *Attorney, Agent, or Firm* — Moffat & Co.

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 93 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/301,259**

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

(65) **Prior Publication Data**

US 2012/0068905 A1 Mar. 22, 2012

**Related U.S. Application Data**

(63) Continuation of application No. 12/405,955, filed on Mar. 17, 2009, now Pat. No. 8,085,202.

(51) **Int. Cl.**

**H01Q 1/38** (2006.01)  
**H01Q 21/28** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 1/52** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 13/10** (2006.01)

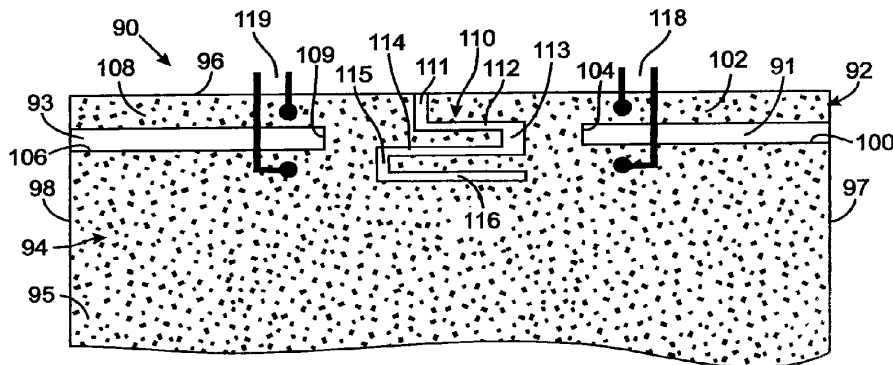
(52) **U.S. Cl.**

CPC ..... **H01Q 21/28** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/521** (2013.01); **H01Q 9/42** (2013.01); **H01Q 13/106** (2013.01)  
USPC ..... **343/700 MS**

(57) **ABSTRACT**

A multiple input-multiple output antenna assembly with high isolation between the antennas is disclosed. The antenna assembly includes a substrate with a ground layer at its surface. Two antennas are disposed opposing each other on the substrate. An isolation element in a form of a patterned slot is interposed between the first and second antennas on the ground plane. A first signal port is provided for applying a first signal to excite the first antenna and a second signal port is provided for applying a second signal to excite the second antenna. The isolation element provides isolation that inhibits electromagnetic propagation between the two antennas.

**12 Claims, 4 Drawing Sheets**





US008933843B2

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

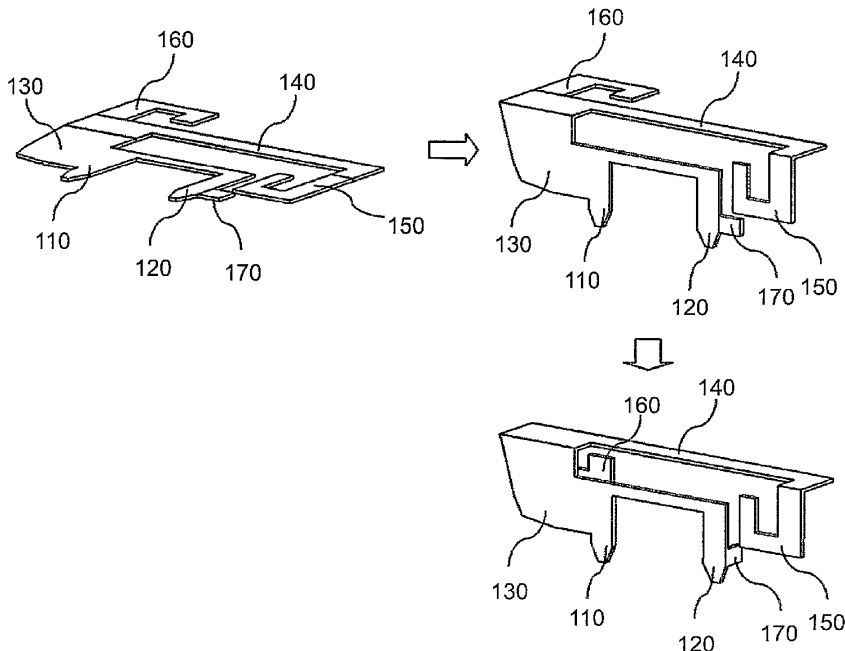
(10) **Patent No.:** **US 8,933,843 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

- (54) **DUAL-BAND ANTENNA AND COMMUNICATION DEVICE USING THE SAME**
- (75) Inventors: **Bo Pan**, Irvine, CA (US); **Ching-Wei Ling**, Xinhua Township (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 809 days.
- (21) Appl. No.: **12/957,702**
- (22) Filed: **Dec. 1, 2010**
- (65) **Prior Publication Data**  
US 2012/0139792 A1 Jun. 7, 2012
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 5/00** (2006.01)  
**H01Q 9/04** (2006.01)
- (52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/0051** (2013.01); **H01Q 9/0471** (2013.01)  
USPC ..... **343/702**; 343/828
- (58) **Field of Classification Search**  
USPC ..... 343/702, 741, 825, 826, 828, 829, 343/700 MS  
See application file for complete search history.

- (56) **References Cited**  
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*Primary Examiner* — Michael C Wimer  
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**  
A dual-band antenna is disclosed, comprising a radiating body, a shorting element, and a feeding element. The radiating body comprises a plurality of radiating portions located in a first, a second, a third, and a fourth planes, respectively. The shorting element and the feeding element both extend from the radiating body and are located in the first plane. The radiating portions located in the first, the second, and the third planes transmit and/or receive signals in a first frequency band. The radiating portions located in the first, the second, and the fourth planes transmit and/or receive signals in a second frequency band. A first angle between the first and the second planes, a second angle between the second and the third planes, and a third angle between the second and the fourth planes range between 80 degrees to 100 degrees.

**19 Claims, 9 Drawing Sheets**





US008933844B2

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

(10) **Patent No.:** **US 8,933,844 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **ANTENNA PATTERN FRAME, ELECTRONIC DEVICE CASE PROVIDED WITH ANTENNA PATTERN FRAME AND ELECTRONIC DEVICE INCLUDING ELECTRONIC DEVICE CASE**

*I/40* (2013.01); *B29L 2031/3431* (2013.01);  
*B29L 2031/3456* (2013.01)

USPC ..... **343/702**; 343/700 MS

(58) **Field of Classification Search**

CPC ..... H01Q 1/243; H01Q 1/38; H01Q 9/0421

USPC ..... 343/702, 700 MS

See application file for complete search history.

(75) Inventors: **Ha Ryong Hong**, Gyeonggi-do (KR);  
**Sung Eun Cho**, Gyeonggi-do (KR); **Tae Sung Kim**, Seoul (KR); **Duk Woo Lee**, Gyeonggi-do (KR); **Dae Kyu Lee**, Gyeonggi-do (KR); **Chan Gwang An**, Gyeonggi-do (KR); **Jae Suk Sung**, Gyeonggi-do (KR); **Ki Won Chang**, Gyeonggi-do (KR); **Chang Mok Han**, Chungcheongnam-do (KR); **Hyun Do Park**, Gyeonggi-do (KR)

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*Primary Examiner* — Dameon E Levi

*Assistant Examiner* — Collin Dawkins

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

(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 711 days.

(57) **ABSTRACT**

There is provided an antenna pattern frame according to an exemplary embodiment of the present invention, including: a film radiator that includes a protective film supporting one surface or both surfaces of a radiator provided with an antenna pattern part; and a radiator frame that is an injection molded part to which the film radiator is fixed and embeds the antenna pattern part in the electronic device case.

**17 Claims, 10 Drawing Sheets**

(21) Appl. No.: **13/032,365**

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

(65) **Prior Publication Data**

US 2011/0260932 A1 Oct. 27, 2011

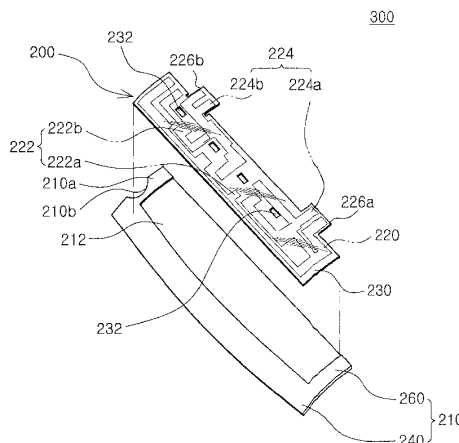
(30) **Foreign Application Priority Data**

Apr. 22, 2010 (KR) ..... 10-2010-0037351

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**B29C 45/14** (2006.01)

(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **B29C 45/14065** (2013.01); **B29C 45/14639** (2013.01); **H01Q**





US008933845B2

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

(10) **Patent No.:** **US 8,933,845 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **DATA COMMUNICATION DEVICE**

(75) Inventors: **Changil Kim**, Gyeonggi-Do (KR);  
**Soyeon Lee**, Gyeonggi-Do (KR);  
**Yeomin Youn**, Gyeonggi-Do (KR);  
**Kyunghack Yi**, Seoul (KR); **Jin Lee**,  
Seoul (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(\* ) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 450 days.

(21) Appl. No.: **13/086,764**

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

(65) **Prior Publication Data**

US 2012/0064843 A1 Mar. 15, 2012

(30) **Foreign Application Priority Data**

Sep. 10, 2010 (KR) ..... 10-2010-0089087

(51) **Int. Cl.**

**H01Q 1/12** (2006.01)  
**H01Q 1/00** (2006.01)  
**H01Q 1/42** (2006.01)  
**H04B 1/38** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 5/00** (2006.01)  
**H01Q 9/42** (2006.01)

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

CPC ..... **H04B 1/3838** (2013.01); **H01Q 1/243**  
(2013.01); **H01Q 1/245** (2013.01); **H01Q 1/48**  
(2013.01); **H01Q 5/0062** (2013.01); **H01Q 9/42**  
(2013.01); **H04B 1/3816** (2013.01)  
USPC ..... **343/702**; **343/841**; **343/718**; **343/720**;  
**343/872**; **455/83**

(58) **Field of Classification Search**

CPC ..... H04W 88/02; H01Q 1/24  
USPC ..... 343/702, 841; 455/83  
See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Dameon E Levi

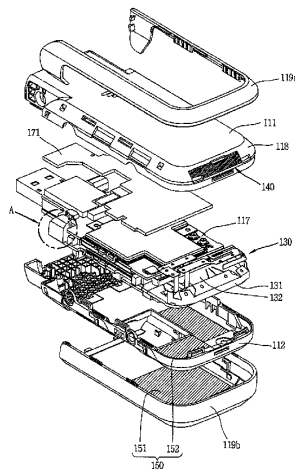
*Assistant Examiner* — Ricardo Magallanes

(74) *Attorney, Agent, or Firm* — Ked & Associates, LLP

(57) **ABSTRACT**

A communication device as disclosed herein may include a body, an antenna assembly provided in the body, and configured to transmit or receive wireless signals, and a circuit board connected to the antenna assembly and configured to process the wireless signals. The antenna assembly may include a carrier having at least one region that is dimensioned to be farther away from the body than other portions thereof, and a radiator provided on the at least one dimensioned region of the carrier and configured to receive or radiate electromagnetic waves corresponding to the wireless signals. The radiator may be positioned on the dimensioned region of the carrier such that a specific absorption rate (SAR) due to the antenna assembly is reduced.

**15 Claims, 7 Drawing Sheets**





US008933847B2

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

(10) **Patent No.:** **US 8,933,847 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE HAVING ANTENNA ASSEMBLY WITH ELECTRICALLY CONDUCTIVE BASE ENCLOSING AN ELONGATE SLOT AND ASSOCIATED METHODS**

(75) Inventors: **Shing Lung Steven Yang**, San Diego, CA (US); **Firass Mirza Badaruzzaman**, Forest Park, IL (US); **David Kazmierz Szczyplinski**, Elgin, IL (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 201 days.

(21) Appl. No.: **13/439,924**

(22) Filed: **Apr. 5, 2012**

(65) **Prior Publication Data**

US 2012/0280868 A1 Nov. 8, 2012

**Related U.S. Application Data**

(60) Provisional application No. 61/472,289, filed on Apr. 6, 2011.

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/0421** (2013.01); **H01Q 1/243** (2013.01)  
USPC ..... **343/702**; 343/700 MS

(58) **Field of Classification Search**  
CPC ..... H01Q 1/38; H01Q 1/243; H01Q 9/0421  
USPC ..... 343/702, 700 MS, 846  
See application file for complete search history.

(56) **References Cited**

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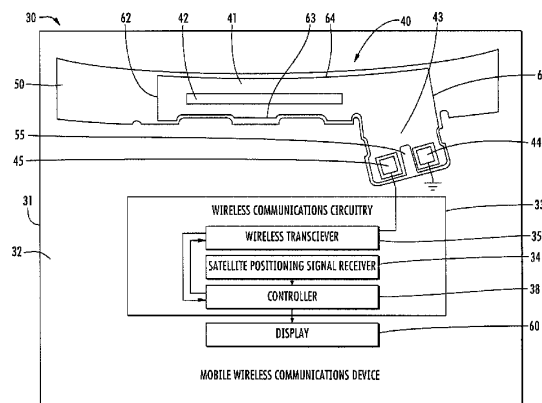
*Primary Examiner* — Hoanganh Le

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

(57) **ABSTRACT**

A mobile wireless communications device may include a housing carrying a circuit board and wireless communications circuitry. An antenna assembly is carried by the housing and coupled to the wireless communications circuitry. The antenna assembly may include an electrically conductive base having a rectangular shape with opposing first and second ends and opposing first and second sides extending between the first and second ends. The electrically conductive base may have an elongate slot therein extending within a medial portion thereof and contained within the opposing first and second ends and the opposing first and second sides. The antenna assembly also may include an electrically conductive feed arm extending outwardly from the first side of the electrically conductive base adjacent the first end thereof. The electrically conductive feed arm may have a distal end with an antenna feed defined thereon.

**20 Claims, 8 Drawing Sheets**





US008933848B2

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

(10) **Patent No.:** **US 8,933,848 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **MULTI-BAND MULTI-POLARIZATION STUB-TUNED ANTENNA**  
(75) Inventors: **David Nghiem**, Shoreview, MN (US); **Peter J. Musto**, Prior Lake, MN (US); **Larry D. Canady**, Ham Lake, MN (US); **Keith R. Maile**, New Brighton, MN (US); **Thao Nguyen**, Eagan, MN (US)

(73) Assignee: **Cardiac Pacemakers, Inc.**, St. Paul, MN (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 279 days.

(21) Appl. No.: **13/537,873**

(22) Filed: **Jun. 29, 2012**

(65) **Prior Publication Data**  
US 2013/0009839 A1 Jan. 10, 2013

**Related U.S. Application Data**

(60) Provisional application No. 61/504,954, filed on Jul. 6, 2011, provisional application No. 61/504,950, filed on Jul. 6, 2011.

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 5/00** (2006.01)  
**H01Q 9/42** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/42** (2013.01); **H01Q 5/0051** (2013.01)  
USPC ..... **343/702**; 343/700 MS

(58) **Field of Classification Search**  
CPC ..... H01Q 9/42; H01Q 1/243; H01Q 1/36; H01Q 11/00  
USPC ..... 343/702, 700 MS, 895  
See application file for complete search history.

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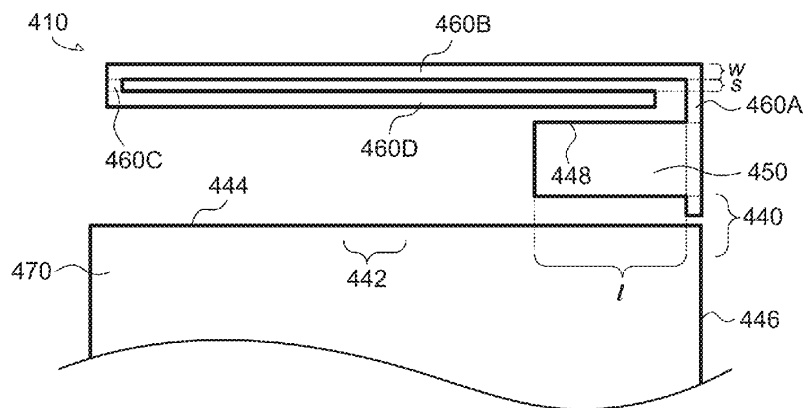
*Primary Examiner* — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(57) **ABSTRACT**

Apparatus and techniques can include a planar antenna that can include a folded conductive strip portion coupled to a driven node of a wireless communication circuit, the folded conductive strip portion comprising at least two segments laterally offset from each other and at least partially laterally overlapping with each other, and a first region oriented along a first axis in a plane of the planar antenna and a second region oriented along a second axis in the plane of the planar antenna, the two axes and the two regions specified to provide polarization diversity of radiation from the planar antenna. The planar antenna can include a stub coupled to the folded conductive strip portion, the stub configured to provide a first specified operating frequency range at or near resonance using a mode corresponding to a total physical path length along the folded conductive strip portion.

**20 Claims, 10 Drawing Sheets**





US008933849B2

(12) **United States Patent**  
**Kurihara**

(10) **Patent No.:** **US 8,933,849 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **PORTABLE WIRELESS DEVICE**  
(75) Inventor: **Kazuhiro Kurihara**, Tokyo (JP)  
(73) Assignee: **Lenovo Innovations Limited (Hong Kong)**, Quarry Bay (HK)  
(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 162 days.

USPC ..... 343/702; 455/90, 575.4  
See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Tho G Phan

(74) *Attorney, Agent, or Firm* — Scully, Scott, Murphy & Presser, P.C.

(21) Appl. No.: **13/637,832**  
(22) PCT Filed: **Mar. 28, 2011**  
(86) PCT No.: **PCT/JP2011/057522**  
§ 371 (c)(1),  
(2), (4) Date: **Sep. 27, 2012**

(87) PCT Pub. No.: **WO2011/125569**  
PCT Pub. Date: **Oct. 13, 2011**

(65) **Prior Publication Data**  
US 2013/0009829 A1 Jan. 10, 2013

(30) **Foreign Application Priority Data**  
Mar. 31, 2010 (JP) ..... P2010-082097

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/38** (2006.01)  
**H01Q 9/42** (2006.01)  
**H04M 1/02** (2006.01)

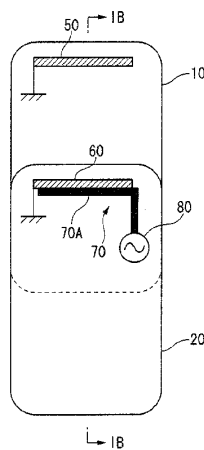
(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 9/42** (2013.01); **H04M 1/0235** (2013.01)  
USPC ..... **343/702**; 455/575.4

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 1/38; H01Q 9/42; H04M 1/235

(57) **ABSTRACT**

A slide type portable wireless device includes: a first housing; a second housing which slides relative to the first housing, and is positioned at either of a first relative position and a second relative position different from the first relative position; an antenna element which is embedded in the first housing; and a plurality of parasitic elements which are provided in the second housing, and includes first and second parasitic elements capacity coupled with the antenna element. The first parasitic element faces the antenna element at the first relative position. The second parasitic element faces the antenna element at the second relative position.

**4 Claims, 5 Drawing Sheets**





US008933852B2

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

(10) **Patent No.:** **US 8,933,852 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **MOBILE COMMUNICATION DEVICE AND ANTENNA STRUCTURE THEREIN**

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2009/0079657 A1\* 3/2009 Chung et al. .... 343/876  
2009/0256763 A1 10/2009 Chi

(75) Inventors: **Kin-Lu Wong**, New Taipei (TW);  
**Yeh-Chun Kao**, New Taipei (TW)

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

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 759 days.

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(21) Appl. No.: **13/116,010**

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

(65) **Prior Publication Data**  
US 2012/0262352 A1 Oct. 18, 2012

Wei-Yu Li et al., "Internal penta-band printed loop-type mobile phone antenna", TENCON 2007—2007 IEEE Region 10 Conference Digital Object Identifier: 10.1109/TENCON.2007.4428859, Publication Year: 2007, pp. 1-4.

(30) **Foreign Application Priority Data**

Apr. 14, 2011 (TW) ..... 100112948 A

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(51) **Int. Cl.**  
**H01Q 21/00** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/00** (2006.01)  
**H01Q 7/00** (2006.01)  
**H01Q 9/42** (2006.01)

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/0062** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/42** (2013.01)  
USPC ..... **343/728**; 343/725

(57) **ABSTRACT**

(58) **Field of Classification Search**  
USPC ..... 343/726–735  
See application file for complete search history.

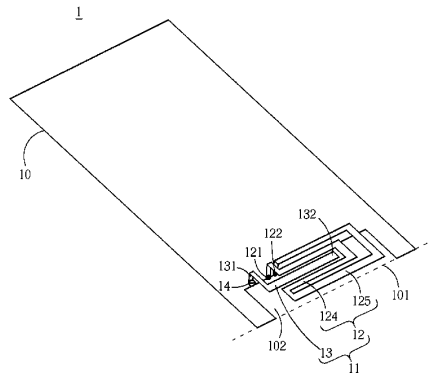
A mobile communication device includes an antenna structure which includes a grounding element and an antenna element. There is a notch at an edge of the grounding element. The antenna element is disposed in the notch and includes a metal loop portion and a monopole antenna. The metal loop portion is electrically connected to the grounding element with at least one shorting point, such that a short-circuited closed metal loop is formed. The monopole antenna has a first end and a second end, wherein the first end of the monopole antenna is a feeding point connected to a signal source, and the second end of the monopole antenna is an open end surrounded by the closed metal loop.

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**18 Claims, 5 Drawing Sheets**







US008933853B2

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

(10) **Patent No.:** **US 8,933,853 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

(54) **SMALL ANTENNA APPARATUS OPERABLE IN MULTIPLE BANDS**

(75) Inventors: **Kenichi Asanuma**, Kyoto (JP); **Atsushi Yamamoto**, Kyoto (JP); **Tsutomu Sakata**, Osaka (JP)

(73) Assignee: **Panasonic Intellectual Property Corporation of America**, Torrance, CA (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 184 days.

(21) Appl. No.: **13/814,833**

(22) PCT Filed: **Jan. 31, 2012**

(86) PCT No.: **PCT/JP2012/000617**

§ 371 (c)(1),  
(2), (4) Date: **Feb. 7, 2013**

(87) PCT Pub. No.: **WO2013/008356**

PCT Pub. Date: **Jan. 17, 2013**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 11, 2011 (JP) ..... 2011-152744

(51) **Int. Cl.**  
**H01Q 9/00** (2006.01)  
**H01Q 1/24** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 5/0034** (2013.01); **H01Q 5/01** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/26** (2013.01)  
USPC ..... **343/749**; 343/702

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 5/01; H01Q 5/0034; H01Q 7/00; H01Q 9/26  
USPC ..... 343/702, 722, 741, 742, 744, 749  
See application file for complete search history.

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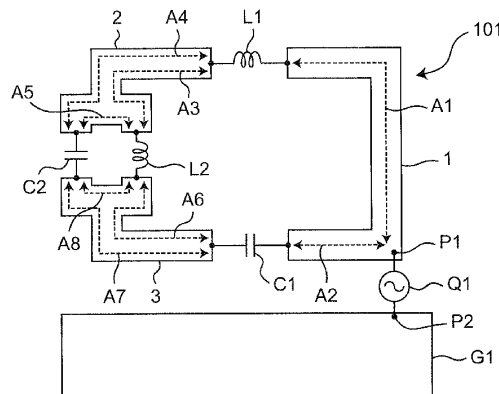
*Primary Examiner* — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Wenderoth, Lind & Ponack, L.L.P.

(57) **ABSTRACT**

In a radiator, a large loop is formed by radiation conductors, first and second capacitors, and first and second inductors, and a small loop is formed by portions of the radiation conductors close to each other, the second capacitor, and the second inductor. The radiator is configured such that its first portion, second portion, and third portion resonate at predetermined frequencies, respectively. The first portion extends along the large loop, and includes the first inductor, the first capacitor, and one of the second inductor and the second capacitor. The second portion includes a section extending from a feed point to a second position through one of the first inductor and the first capacitor, and includes the small loop. The third portion includes a section extending from the feed point to the second position through the first capacitor.

**16 Claims, 53 Drawing Sheets**





US008933857B2

(12) **United States Patent**  
**Ryu**

(10) **Patent No.:** **US 8,933,857 B2**  
(45) **Date of Patent:** **Jan. 13, 2015**

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

(75) Inventor: **Seungwoo Ryu**, Gyeonggi-Do (KR)

(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 176 days.

(21) Appl. No.: **13/536,714**

(22) Filed: **Jun. 28, 2012**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Nov. 7, 2011 (KR) ..... 10-2011-0115269

(51) **Int. Cl.**  
**H01Q 1/48** (2006.01)  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 21/30** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0485** (2013.01); **H01Q 21/30** (2013.01)

USPC ..... **343/848**; 343/702

(58) **Field of Classification Search**  
CPC ..... H01Q 5/01; H01Q 9/04; H01Q 9/0485; H01Q 1/48; H01Q 1/243; H01Q 21/30  
USPC ..... 343/848, 702, 846  
See application file for complete search history.

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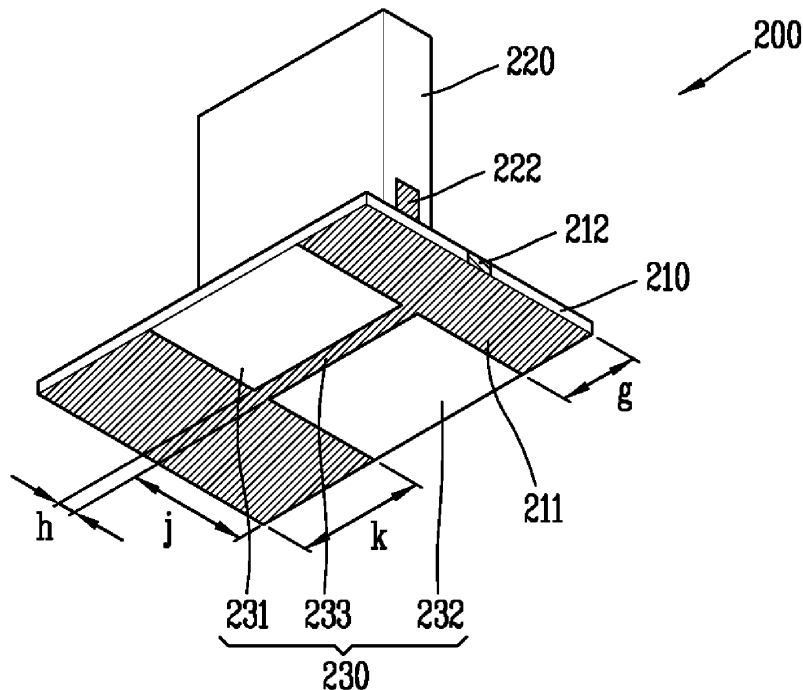
*Primary Examiner* — Hoanganh Le

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

(57) **ABSTRACT**

An antenna device including a dielectric resonator antenna configured to generate resonances in a first frequency band; a printed circuit board electrically connected to the dielectric resonator antenna and configured to process radio signals; and a defected ground structure formed on the printed circuit board and configured to generate resonances in a second frequency band using a current flowing on the dielectric resonator antenna and the printed circuit board.

**18 Claims, 11 Drawing Sheets**





US008937578B2

(12) **United States Patent  
Montgomery**

(10) **Patent No.:** US 8,937,578 B2  
(45) **Date of Patent:** Jan. 20, 2015

- (54) **HIGH ISOLATION ANTENNA SYSTEM**
- (75) Inventor: **Mark T. Montgomery**, Melbourne Beach, FL (US)
- (73) Assignee: **Skycross, Inc.**, San Jose, CA (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 290 days.

- (21) Appl. No.: **12/873,823**
- (22) Filed: **Sep. 1, 2010**
- (65) **Prior Publication Data**  
US 2011/0050528 A1 Mar. 3, 2011

- (60) **Related U.S. Application Data**  
Provisional application No. 61/238,931, filed on Sep. 1, 2009.

- (51) **Int. Cl.**  
*H01Q 1/24* (2006.01)  
*H01Q 1/52* (2006.01)  
*H01Q 5/00* (2006.01)  
*H01Q 9/16* (2006.01)  
*H01Q 9/42* (2006.01)
- (52) **U.S. Cl.**  
CPC ..... *H01Q 1/243* (2013.01); *H01Q 1/521* (2013.01); *H01Q 5/0048* (2013.01); *H01Q 5/0072* (2013.01); *H01Q 9/16* (2013.01); *H01Q 9/42* (2013.01)  
USPC ..... **343/841**; 343/702
- (58) **Field of Classification Search**  
USPC ..... 343/841, 702, 700 MS  
See application file for complete search history.

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Primary Examiner — Dieu H Duong  
(74) Attorney, Agent, or Firm — Guntin & Gust, PLC; Douglas Schnabel

- (57) **ABSTRACT**  
An antenna system supports a common resonance mode and differential resonance mode, each with approximately equal radiation resistance and bandwidth at a given operating frequency band. The antenna system includes a resonant antenna section, a counterpoise, and two antenna ports. The resonant antenna section includes two spaced-apart poles and a distributed network therebetween. Each of the poles has a proximal end connected to the distributed network and an opposite distal end. The distal ends of the poles are separated from each other by a distance of  $\frac{1}{3}$  to  $\frac{2}{3}$  of the electrical wavelength at the given operating frequency. Each of the two antenna ports is defined by a pair of feed terminals with one feed terminal located on the counterpoise and the other feed terminal located on a different one of the poles of the resonant antenna section. The resonant antenna section, counterpoise, and ports are configured such that a signal within the given operating frequency band applied to one port is isolated from the other port.

**23 Claims, 7 Drawing Sheets**

