



US008098201B2

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

(10) **Patent No.:** **US 8,098,201 B2**
(45) **Date of Patent:** **Jan. 17, 2012**

(54) **RADIO FREQUENCY IDENTIFICATION TAG
AND RADIO FREQUENCY IDENTIFICATION
TAG ANTENNA**

(75) Inventors: **Won Kyu Choi**, Daejeon (KR); **Jeong Seok Kim**, Daejeon (KR); **Gil Young Choi**, Daejeon (KR); **Hae Won Son**, Daejeon (KR); **Cheol Sig Pyo**, Daejeon (KR); **Jong-Suk Chae**, Daejeon (KR)

(73) Assignees: **Electronics & Telecommunications Research Institute**, Daejeon (KR); **Industrial Cooperation Foundation of Chonbuk National University**, Jeonju-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 576 days.

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/741; 343/866;
340/572.7

(58) **Field of Classification Search** 343/700 MS,
343/866, 795, 741; 340/572.7
See application file for complete search history.

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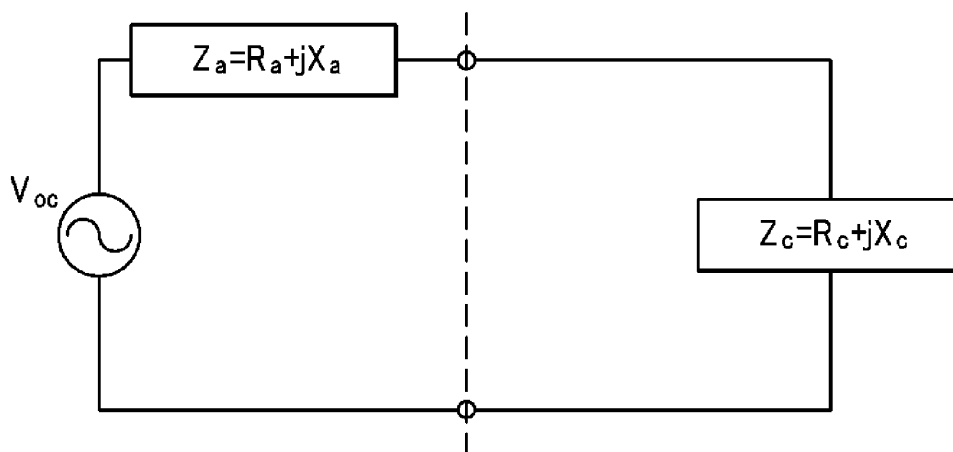
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Kile Park Goekjian Reed & McManus PLLC

(57) **ABSTRACT**

An RFID tag includes an antenna and a chip, and the antenna includes a first polygonal dielectric material, first and second microstrip lines partially formed in the first dielectric material, a second polygonal dielectric material stacked on the first dielectric material, and a third microstrip line partially formed in the second dielectric material. According to the present invention, the RFID tag can efficiently receive electromagnetic waves to thereby maximize a readable range.

13 Claims, 4 Drawing Sheets



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US008098206B2

(12) **United States Patent**
Schätzle

(10) **Patent No.:** **US 8,098,206 B2**
(45) **Date of Patent:** **Jan. 17, 2012**

(54) **ANTENNA ARRANGEMENT FOR HEARING
DEVICE APPLICATIONS**

(75) Inventor: **Ulrich Schätzle**, Erlangen (DE)

(73) Assignee: **Siemens Audiologische Technik
GmbH**, Erlangen (DE)

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patent is extended or adjusted under 35
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(21) Appl. No.: **12/309,712**

(22) PCT Filed: **Jul. 27, 2007**

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(60) Provisional application No. 60/834,310, filed on Jul.
28, 2006.

(51) **Int. Cl.**
H01Q 21/30 (2006.01)

(52) **U.S. Cl.** **343/725; 343/788**

(58) **Field of Classification Search** 343/720,
343/725, 726, 787, 788, 702, 850, 860
See application file for complete search history.

(56) **References Cited**

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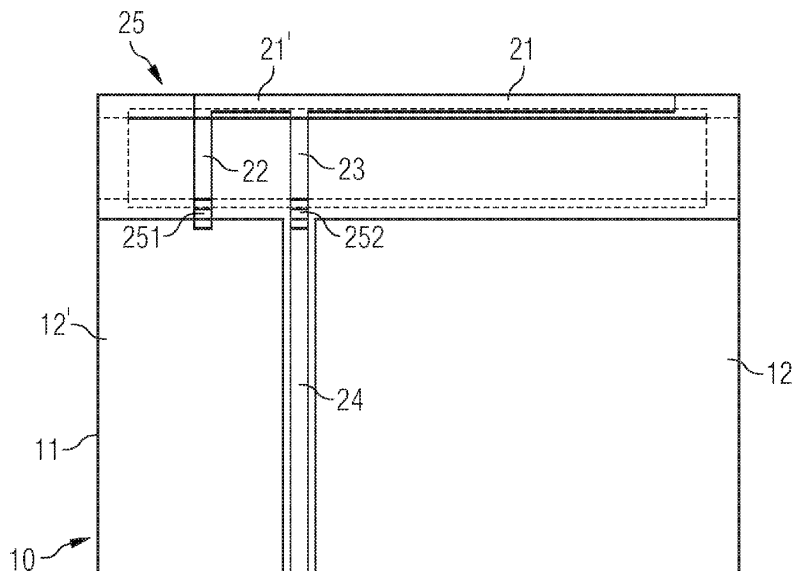
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Primary Examiner — Michael C Wimer

(57) **ABSTRACT**

A device having an electric antenna and a magnetic antenna is described, the antennas being spatially arranged in immediate mutual proximity. The electric antenna has at least one current-carrying electric conductor which acts as a resonator for the electric antenna, while the magnetic antenna has a coil with at least one current-carrying conductor loop which acts as an inductor of the magnetic antenna. Thus the electric antenna and the magnetic antenna are spatially arranged relative to each other such that the direction of the current in the electric conductor of the electric antenna extends substantially at right angles to the direction of the current in the conductor loop of the magnetic antenna.

17 Claims, 2 Drawing Sheets



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US008102318B2

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

(10) **Patent No.:** **US 8,102,318 B2**
(45) **Date of Patent:** **Jan. 24, 2012**

(54) **INVERTED-F ANTENNA WITH BANDWIDTH ENHANCEMENT FOR ELECTRONIC DEVICES**

(75) Inventors: **Bing Chiang**, Cupertino, CA (US);
Enrique Ayala Vazquez, Watsonville, 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 409 days.

(21) Appl. No.: **12/401,594**

(22) Filed: **Mar. 10, 2009**

(65) **Prior Publication Data**

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H01Q 1/38 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS, 343/702**

See application file for complete search history.

(56) **References Cited**

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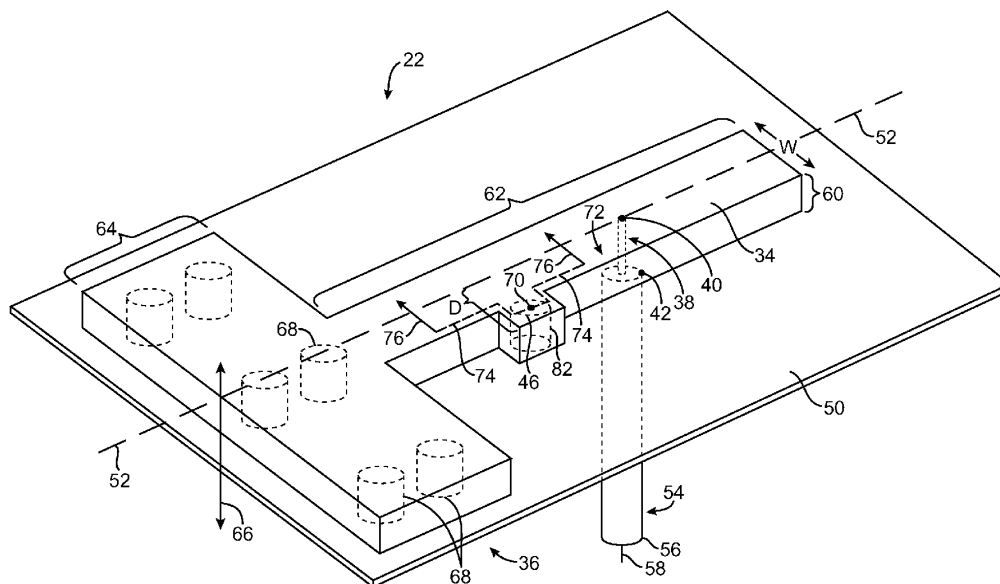
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

An inverted-F antenna is provided that has a resonating element arm and a ground element. A shorting branch of the resonating element arm shorts the resonating element arm to the ground element. An antenna feed that receives a transmission line is coupled to the resonating element arm and the ground element. One or more impedance discontinuity structures are formed along the resonating element arm at locations that are between the shorting branch and the antenna feed. The impedance discontinuity structures may include shorting structures and capacitance discontinuity structures. The impedance discontinuity structures may be formed by off-axis vertical conductors such as vias that pass through a dielectric layer separating the antenna resonating element arm from the ground element. Capacitance discontinuity structures may be formed from hollowed portions of the dielectric or other dielectric portions with a dielectric constant that differs from that of the dielectric layer.

22 Claims, 10 Drawing Sheets



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

(10) **Patent No.:** **US 8,102,319 B2**
(45) **Date of Patent:** **Jan. 24, 2012**

(54) **HYBRID ANTENNAS FOR ELECTRONIC DEVICES**

(75) Inventors: **Robert W. Schlub**, Campbell, CA (US);
Qingxiang Li, Mountain View, CA (US);
Juan Zavala, Watsonville, CA (US);
Robert J. Hill, Salinas, 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 873 days.

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(21) Appl. No.: **12/120,008**

(22) Filed: **May 13, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/044,456, filed on Apr. 11, 2008.

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H01Q 1/24 (2006.01)

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

(58) **Field of Classification Search** **343/702, 343/767, 700 MS**
See application file for complete search history.

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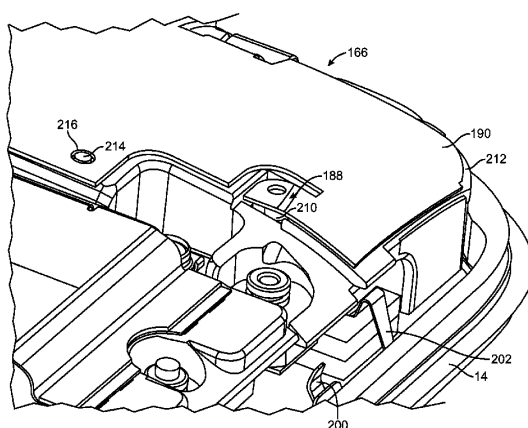
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

A portable electronic device is provided that has a hybrid antenna. The hybrid antenna may include a slot antenna structure and a planar inverted-F antenna structure. The planar inverted-F antenna structure may be formed from traces on a flex circuit substrate. A backside trace may form a series capacitance for the planar inverted-F antenna structure. The antenna slot may have a perimeter that is defined by the location of conductive structures such as flex circuits, metal housing structures, a conductive bezel, printed circuit board ground conductors, and electrical components. Springs may be used in electrically connecting these conductive elements. A spring-loaded pin may be used as part of an antenna feed conductor. The pin may connect a transmission line path on a printed circuit board to the planar inverted-F antenna structure while allowing the planar inverted-F antenna structure to be removed from the device for rework or repair.

14 Claims, 15 Drawing Sheets



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US008102320B2

(12) **United States Patent**
Lin

(10) **Patent No.:** **US 8,102,320 B2**
(45) **Date of Patent:** **Jan. 24, 2012**

(54) **ANTENNA STRUCTURE FOR PORTABLE ELECTRONIC DEVICE**

(75) Inventor: **Chi-Hsiung Lin**, Taipei (TW)

(73) Assignee: **Inventec Appliances Corp.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 525 days.

(21) Appl. No.: **12/333,122**

(22) Filed: **Dec. 11, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 13, 2007 (TW) 96147777 A

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H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702**

(58) **Field of Classification Search** 343/700 MS,
343/702, 795, 767-730

See application file for complete search history.

(56) **References Cited**

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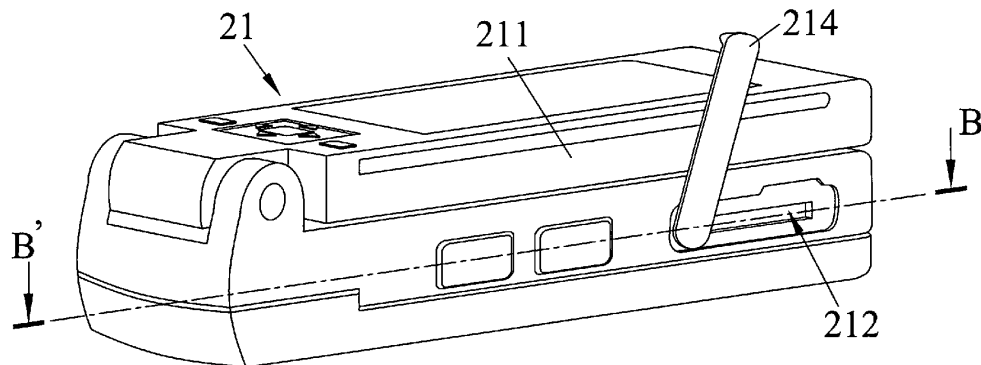
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Egbert Law Offices PLLC

(57) **ABSTRACT**

An antenna structure for portable electronic device includes an antenna and an electrical connection element. The portable electronic device includes a main body, a slotted section, a shaft, and a slot cover. The slot cover is coupled to the main body via the shaft, and the slot cover is located on the slotted section. The antenna is disposed on the slot cover, and the electrical connection element is coupled to the shaft and a printed circuit board mounted in the main body, so that the antenna is electrically coupled via the electrical connection element to the printed circuit board. Since the antenna disposed on the slot cover is not parallel with the printed circuit board, a clearance distance required between the antenna and the printed circuit board can be reduced to enable reduction of a volume of the portable electronic device.

8 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 8,102,321 B2**
(45) **Date of Patent:** **Jan. 24, 2012**

(54) **CAVITY ANTENNA FOR AN ELECTRONIC DEVICE**

(75) Inventors: **Bing Chiang**, Cupertino, CA (US);
Gregory A. Springer, Sunnyvale, 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 408 days.

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(22) Filed: **Mar. 10, 2009**

(65) **Prior Publication Data**

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

(52) **U.S. Cl.** **343/702**; 343/898

(58) **Field of Classification Search** 343/898,
343/700 MS, 702

See application file for complete search history.

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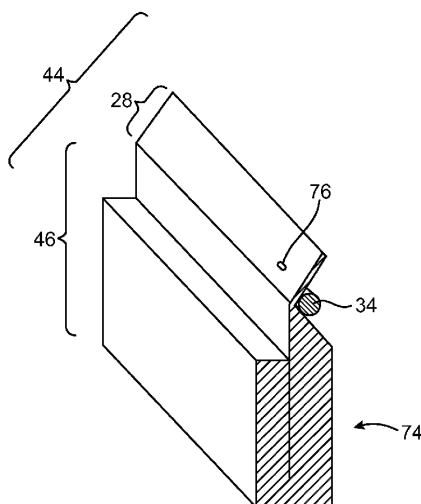
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

A cavity antenna for an electronic device such as a portable computer is provided. The antenna may be formed from a conductive cavity and an antenna probe that serves as an antenna feed. The conductive cavity may have the shape of a folded rectangular cavity. A dielectric support structure may be used in forming the antenna cavity. A fin may protrude from one end of the dielectric support structure. The antenna probe may be formed from conductive structures mounted on the fin. An inverted-F antenna configuration or other antenna configuration may be used in forming the antenna probe. The electronic device may have a housing with conductive walls. When the cavity antenna mounted within an electronic device, a planar rectangular end face of the fin may protrude through a thin rectangular opening in the conductive walls to allow the antenna to operate without being blocked by the housing.

23 Claims, 12 Drawing Sheets



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US008102323B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 8,102,323 B2**
(45) **Date of Patent:** ***Jan. 24, 2012**

(54) **HYBRID DUAL DIPOLE SINGLE SLOT
ANTENNA FOR MIMO COMMUNICATION
SYSTEMS**

(75) Inventor: **Mexx Chen**, Taipei (TW)

(73) Assignee: **Lantiq Deutschland GmbH**, Neubiberg
(DE)

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

(21) Appl. No.: **12/855,689**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

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(58) **Field of Classification Search** 343/725-727,
343/767

See application file for complete search history.

(56) **References Cited**

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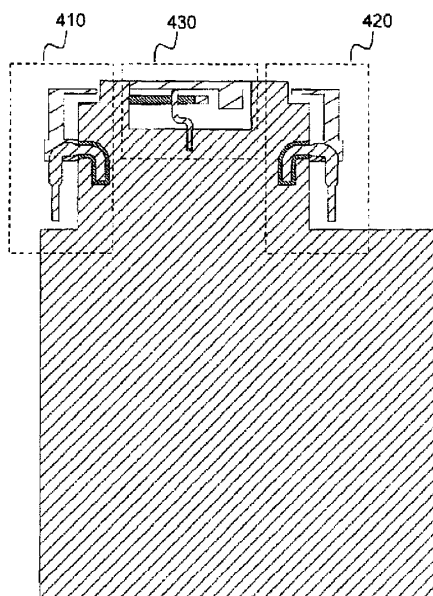
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — SpryIP, LLC

(57) **ABSTRACT**

An antenna arrangement implemented within a printed circuit board (PCB) having three metal coplanar layers, for use in multiple input multiple output (MIMO) communication systems. The antenna arrangement comprises a first dipole antenna and second dipole antenna, substantially symmetrical to the first dipole antenna a slot antenna positioned substantially between the first and the second dipole antennas. The antenna arrangement is implemented in three coplanar metal layers. The antennas are used for MIMO communication systems, specifically complying with IEEE 802.11n and are shaped such that their combined radiation pattern exhibits a substantially omni-directional radiation pattern.

20 Claims, 5 Drawing Sheets



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

(10) **Patent No.:** **US 8,106,779 B2**
(45) **Date of Patent:** ***Jan. 31, 2012**

(54) **DOOR WITH INTEGRAL ANTENNA**

(75) Inventors: **Adam Scott Bergman**, Boca Raton, FL (US); **Denis Chiasson**, Boynton Beach, FL (US)

(73) Assignee: **Sensormatic Electronics, LLC**, Boca Raton, FL (US)

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G08B 13/14 (2006.01)

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(58) **Field of Classification Search** 340/572.1-572.9, 340/10.1, 825.72

See application file for complete search history.

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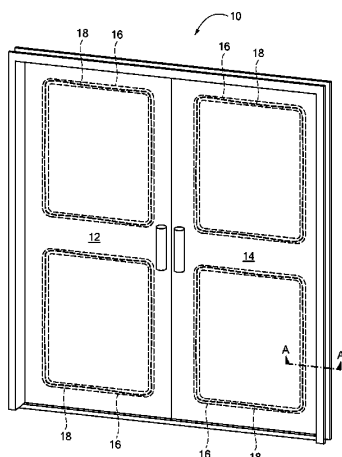
Primary Examiner — Phung Nguyen

(74) *Attorney, Agent, or Firm* — Alan M. Weisberg; Christopher & Weisberg, P.A.

(57) **ABSTRACT**

A door and method of constructing a door whereby a security system antenna is routed through channels that are incorporated within the outer perimeter of the door, and completely or partially hidden from sight. The channels are sized to retain at least a portion of the security system antenna therein. The door can be purchased with the antenna wires already embedded therein and hidden from sight and installed at a facility without the need to mount the antenna wires on a pedestal or dig up floors and/or walls to embed the antenna coils. Existing doors can be retrofitted to install the antenna wires. Such antennas may be used, for example, in an RFID marker system or a magneto-acoustic EAS marker system.

20 Claims, 6 Drawing Sheets



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

(10) **Patent No.:** **US 8,106,830 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **ANTENNA USING ELECTRICALLY
CONDUCTIVE INK AND PRODUCTION
METHOD THEREOF**

(75) Inventors: **Byung-Hoon Ryou**, Seoul (KR);
Won-Mo Sung, Gyeonggi-do (KR);
Sang-Hoon Park, Seoul (KR)

(73) Assignee: **EMW Co., Ltd.**, Incheon (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 377 days.

(21) Appl. No.: **11/993,172**

(22) PCT Filed: **Jun. 20, 2006**

(86) PCT No.: **PCT/KR2006/002350**
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(2), (4) Date: **Sep. 29, 2009**

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PCT Pub. Date: **Dec. 28, 2006**

(65) **Prior Publication Data**
US 2010/0045532 A1 Feb. 25, 2010

(30) **Foreign Application Priority Data**
Jun. 20, 2005 (KR) 10-2005-0052931

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/702**
(58) **Field of Classification Search** **343/700 MS;**
343/702

See application file for complete search history.

(56) **References Cited**

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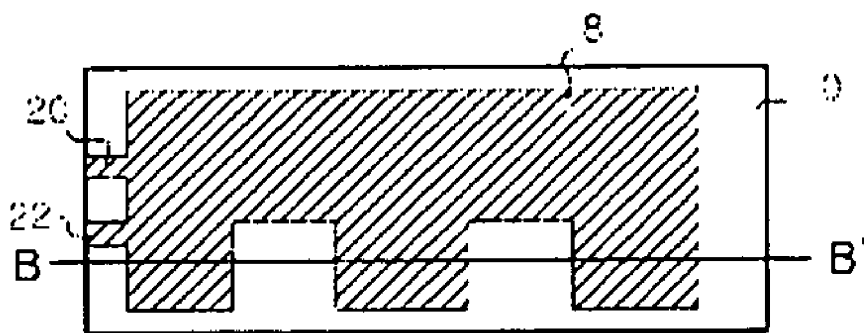
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

Disclosed is an antenna having an antenna radiator formed by
printing electrically conductive ink on a substrate. An antenna
radiator according to an embodiment of the present invention
is formed to the same thickness as a skin depth with respect to
an operation frequency of the antenna. Therefore, an antenna
can be fabricated using a small amount of electrically con-
ductive ink while not reducing the gain of the antenna. Fur-
ther, an antenna radiator according to another embodiment of
the present invention is formed to the same thickness as a skin
depth with respect to a predetermined frequency at a corre-
sponding hot spot with respect to the frequency. Accordingly,
an amount of electrically conductive ink used can be further
reduced while maintaining the gain of the antenna.

13 Claims, 3 Drawing Sheets



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US008106832B2

(12) **United States Patent**
De Vita

(10) **Patent No.:** **US 8,106,832 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **CIRCULARLY POLARIZED PATCH
ANTENNA WITH SINGLE SUPPLY POINT**

(75) Inventor: **Placido De Vita**, Aci Catena (IT)

(73) Assignee: **STMicroelectronics S.r.l.**, Agrate
Brianza (MI) (IT)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 378 days.

(21) Appl. No.: **12/402,844**

(22) Filed: **Mar. 12, 2009**

(65) **Prior Publication Data**
US 2009/0231207 A1 Sep. 17, 2009

(30) **Foreign Application Priority Data**
Mar. 13, 2008 (IT) TO2008A0192

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

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

(58) **Field of Classification Search** 343/700 MS,
343/846, 850, 859
See application file for complete search history.

(56) **References Cited**

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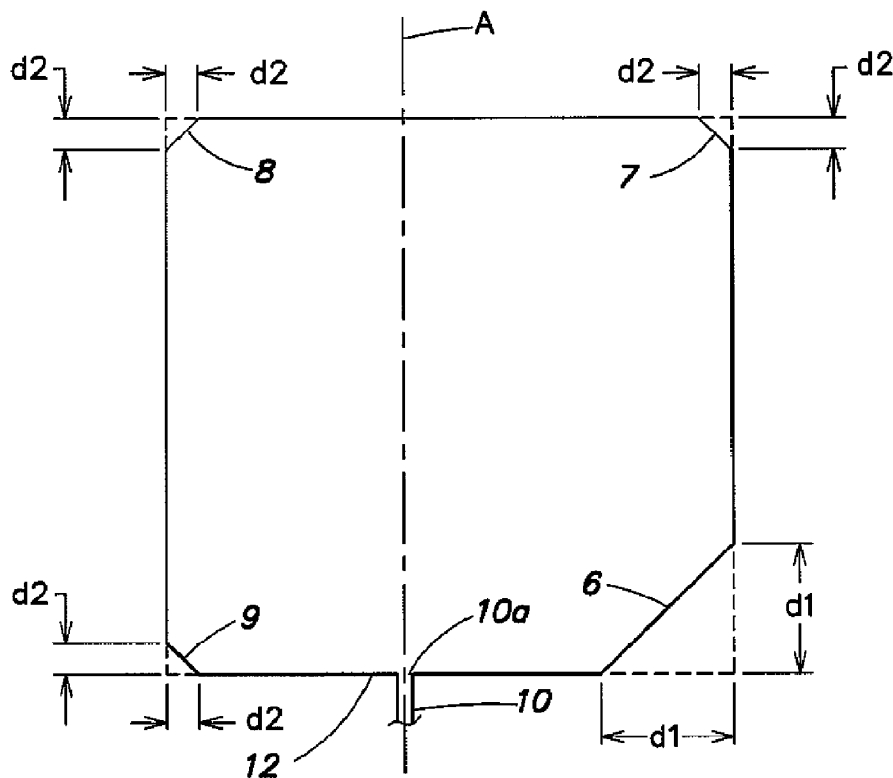
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Lisa K. Jorgenson; James
H. Morris; Wolf, Greenfield & Sacks, P.C.

(57) **ABSTRACT**

An antenna for circularly polarized radiation having a lamina
of electrically conductive material with a generally square
shape and a first chamfer on a first vertex of the generally
square shape. The chamfer determines an asymmetrical shape
of the lamina.

23 Claims, 7 Drawing Sheets



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US008106833B2

(12) **United States Patent**
Chou

(10) **Patent No.:** **US 8,106,833 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **MINIATURE ANTENNA**

(75) Inventor: **Chih-Shen Chou**, Jhunan Township,
Miaoli County (TW)

(73) Assignee: **Unictron Technologies Corporation**,
Hsin-Chu (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 408 days.

(21) Appl. No.: **12/435,428**

(22) Filed: **May 5, 2009**

(65) **Prior Publication Data**

US 2010/0123630 A1 May 20, 2010

(30) **Foreign Application Priority Data**

Nov. 18, 2008 (TW) 97144473 A

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/702, 829, 846

See application file for complete search history.

(56) **References Cited**

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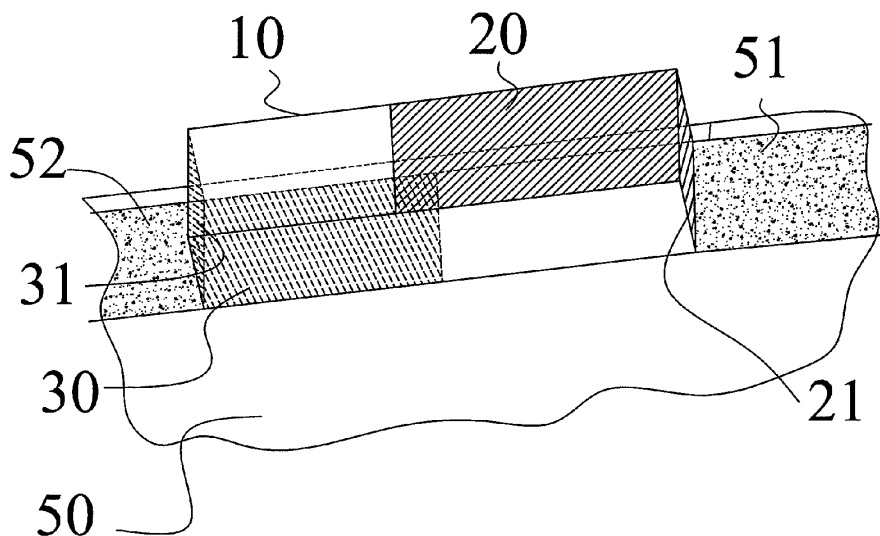
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds &
Lowe, PLLC

(57) **ABSTRACT**

The present invention discloses a miniature antenna that has a simple structure, compact dimension and high efficiency. The miniature antenna is comprised of a dielectric element made of a dielectric material, having a first surface and a second surface opposite to the first surface, a first electrode layer being laid on the first surface, and a second electrode layer being laid on the second surface. The first electrode layer connected to a signal feeding line and the second electrode layer, connected to a ground plane, are partially overlapped to form a region that functions as a capacitor. Thereby, the miniature antenna can transmit and receive signals. The capacitance and resonant frequency of the miniature antenna can be adjusted via varying the pattern of the electrode layers, varying the thickness or permittivity of the dielectric element or via varying the size of the overlapping areas of the two electrode layers.

20 Claims, 9 Drawing Sheets



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US008106834B2

(12) **United States Patent**
Copeland

(10) **Patent No.:** **US 8,106,834 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **SWITCHABLE PATCH ANTENNA FOR RFID
SHELF READER SYSTEM**

(75) Inventor: **Richard Loyd Copeland**, Lake Worth,
FL (US)

(73) Assignee: **Sensormatic Electronics, LLC**, Boca
Raton, FL (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 226 days.

(21) Appl. No.: **12/463,743**

(22) Filed: **May 11, 2009**

(65) **Prior Publication Data**

US 2010/0001921 A1 Jan. 7, 2010

Related U.S. Application Data

(60) Provisional application No. 61/134,167, filed on Jul. 7,
2008.

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/876**

(58) **Field of Classification Search** **343/700 MS,**
343/702, 876

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Tan Ho

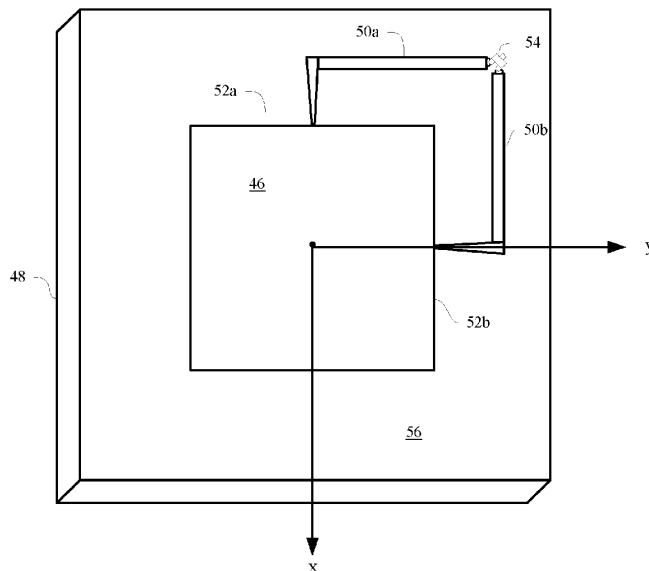
(74) *Attorney, Agent, or Firm* — Alan M. Weisberg;
Christopher & Weisberg, P.A.

(57) **ABSTRACT**

A switchable patch antenna includes a ground plane, a metal
patch, at least two feed lines and a switch. The metal patch is
positioned adjacent, but not in contact with, the ground plane.
Each feed line is electrically connected to the metal patch.
Each feed line is substantially orthogonal to at least one other
feed line. The switch is electrically connected to the at least
two feed lines. The switch is operable to sequentially select
between the at least two feed lines for exciting the switchable
patch antenna.

20 Claims, 10 Drawing Sheets

34



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US008106835B2

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

(10) **Patent No.:** **US 8,106,835 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **DUAL-BAND ANTENNA**

(56) **References Cited**

(75) Inventors: **Ming-Cheng Chien**, Taoyuan County (TW); **Shih-Chieh Cheng**, Tainan 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 379 days.

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Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, PLLC

(21) Appl. No.: **12/540,774**

(22) Filed: **Aug. 13, 2009**

(65) **Prior Publication Data**
US 2010/0039330 A1 Feb. 18, 2010

(30) **Foreign Application Priority Data**
Aug. 15, 2008 (TW) 97131113 A

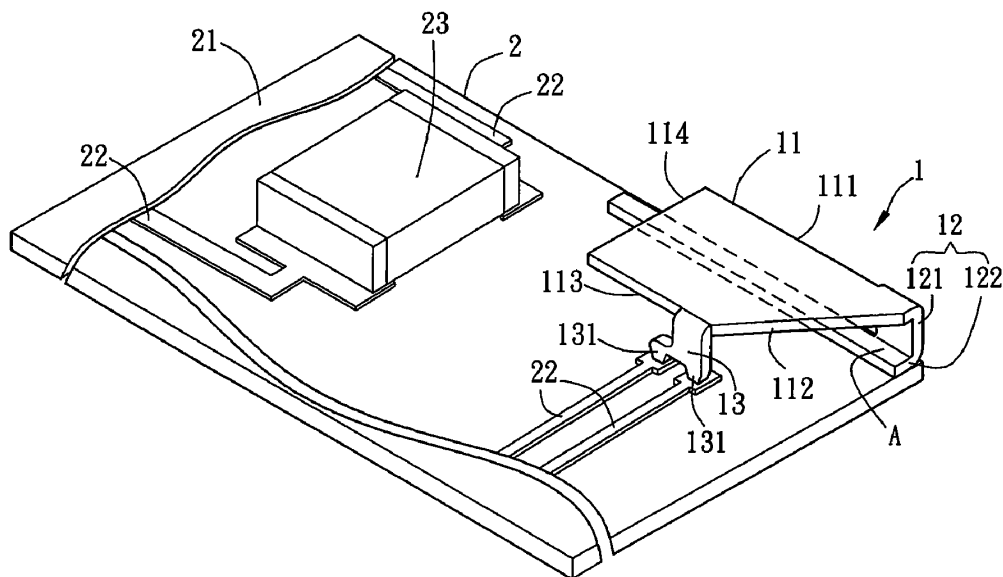
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS**
(58) **Field of Classification Search** 343/700, 343/702

See application file for complete search history.

(57) **ABSTRACT**

A dual-band antenna is disposed on a substrate having an antenna-mounted surface. The dual-band antenna includes a first radiating unit, a second radiating unit, and a feeding terminal. The first radiating unit is disposed opposite to the antenna-mounted surface of the substrate, and at least has a first side, a second side and, a third side. The first side is opposite to the third side, and the length of the first side is not equal to that of the third side. The second side is connected to the first side and the third side. The second radiating unit is connected to the first side of the first radiating unit. The feeding terminal is connected to the third side of the first radiating unit and the antenna-mounted surface of the substrate.

20 Claims, 4 Drawing Sheets



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US008106836B2

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

(10) **Patent No.:** **US 8,106,836 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **HYBRID ANTENNAS FOR ELECTRONIC DEVICES**

(75) Inventors: **Robert J. Hill**, Salinas, CA (US); **Scott A. Myers**, San Francisco, CA (US); **Robert W. Schlub**, Campbell, CA (US); **Dean Floyd Darnell**, Santa Clara, CA (US); **Zhijun Zhang**, Beijing (CN)

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(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 690 days.

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(21) Appl. No.: **12/120,012**

(22) Filed: **May 13, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/044,448, filed on Apr. 11, 2008.

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/797

(58) **Field of Classification Search** 343/702, 343/872, 700 MS, 797

See application file for complete search history.

(56) **References Cited**

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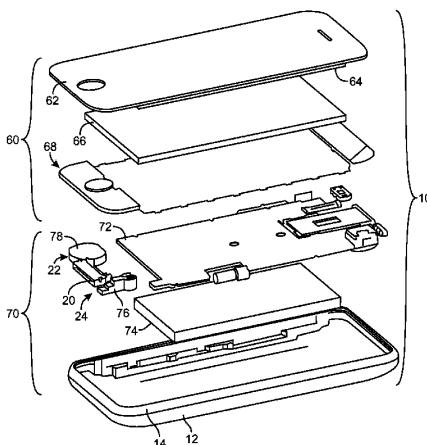
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

A portable electronic device is provided that has a hybrid antenna. The hybrid antenna may include a slot antenna structure and an inverted-F antenna structure. The slot antenna portion of the hybrid antenna may be used to provide antenna coverage in a first communications band and the inverted-F antenna portion of the hybrid antenna may be used to provide antenna coverage in a second communications band. The second communications band need not be harmonically related to the first communications band. The electronic device may be formed from two portions. One portion may contain conductive structures that define the shape of the antenna slot. One or more dielectric-filled gaps in the slot may be bridged using conductive structures on another portion of the electronic device. A conductive trim member may be inserted into an antenna slot to trim the resonant frequency of the slot antenna portion of the hybrid antenna.

28 Claims, 22 Drawing Sheets



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US008106838B2

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

(10) **Patent No.:** **US 8,106,838 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE HAVING DIVERSITY ANTENNA
SYSTEM AND RELATED METHODS**

(75) Inventors: **Ying Tong Man**, Waterloo (CA); **Adrian
Cooke**, Kitchener (CA); **Yihong Qi**, St.
Agatha (CA); **Joshua Wong**, Waterloo
(CA)

(73) Assignee: **Research in Motion 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 345 days.

(21) Appl. No.: **12/365,908**

(22) Filed: **Feb. 5, 2009**

(65) **Prior Publication Data**
US 2010/0194647 A1 Aug. 5, 2010

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

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

(58) **Field of Classification Search** 343/876,
343/853, 702; 455/575.7, 272-279, 101
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

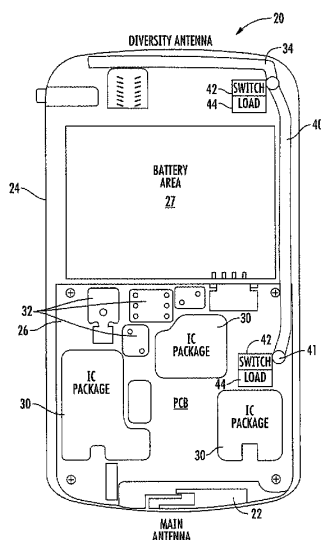
Assistant Examiner — Hasan Islam

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

(57) **ABSTRACT**

A mobile wireless communications device has a portable handheld housing. A circuit board is carried by the portable handheld housing. RP circuitry is carried by the circuit board. A diversity antenna and main antenna are carried by the portable handheld housing and coupled to the RF circuitry and operative together. The RF circuitry tunes the diversity antenna into a diversity communications frequency band to achieve a diversity mode of operation with the main antenna and tunes the diversity antenna into a non-diversity communications frequency band when cross-coupling has occurred from the diversity antenna to the main antenna when operating in the diversity communications frequency band. A switch is carried by the portable handheld housing and connected to the RF circuitry and coupled between the diversity and main antennae and disconnects the diversity antenna when operating in the non-diversity band to prevent cross-coupling from the diversity antenna to the main antenna.

20 Claims, 6 Drawing Sheets



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US008106839B2

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

(10) **Patent No.:** **US 8,106,839 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **MULTI-BAND ANTENNA**

(56) **References Cited**

(75) Inventors: **Yung-Chih Tsai**, Taipei (TW); **Kai Shih**, Taipei (TW); **Jia-Hung Su**, Taipei (TW)

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Primary Examiner — Huedung Mancuso

(73) Assignee: **Cheng Uei 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 352 days.

(57) **ABSTRACT**

A multi-band antenna has a strip-shaped first radiating portion disposed levelly. An end of a long side of the first radiating portion is extended downwardly to form a first grounding portion. A strip-shaped second radiating portion is disposed in alignment with and spaced from the first radiating portion. A long side of the second radiating portion is extended downwards to form a feeding portion at an end thereof away from the first radiating portion. A third radiating portion, which is stretched levelly and oppositely from an end of the second radiating portion adjacent to the feeding portion, is longer than the second radiating portion and has a long side extended downwardly to form a fixing portion adjacent to a free end thereof. The feeding portion and the fixing portion are located at the same side as the first grounding portion with respect to the first, second and third radiating portion.

(21) Appl. No.: **12/568,674**

(22) Filed: **Sep. 29, 2009**

(65) **Prior Publication Data**

US 2011/0074636 A1 Mar. 31, 2011

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

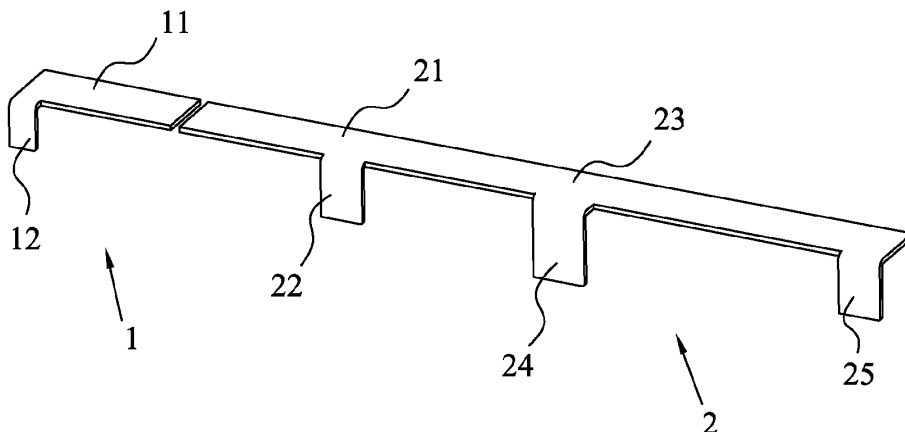
(52) **U.S. Cl.** **343/702**

(58) **Field of Classification Search** 343/700 MS, 343/702, 718, 728, 741, 866, 876

See application file for complete search history.

5 Claims, 4 Drawing Sheets

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US008106841B2

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

(10) **Patent No.:** **US 8,106,841 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **ANTENNA STRUCTURE**

(75) Inventors: **Yin-Yu Chen**, Taipei Hsien (TW);
Chen-Yu Chou, Taipei Hsien (TW);
Chih-Wei Lee, Taipei Hsien (TW)

(73) Assignee: **Wistron Corporation**, Xizhi Dist, 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 476 days.

(21) Appl. No.: **12/407,764**

(22) Filed: **Mar. 19, 2009**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Feb. 9, 2009 (TW) 98201842 U

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

(52) **U.S. Cl.** **343/756**; 343/700 MS; 343/702;
343/846; 343/860

(58) **Field of Classification Search** 343/700 MS,
343/702, 756, 795, 806, 809, 828, 829, 846,
343/860

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

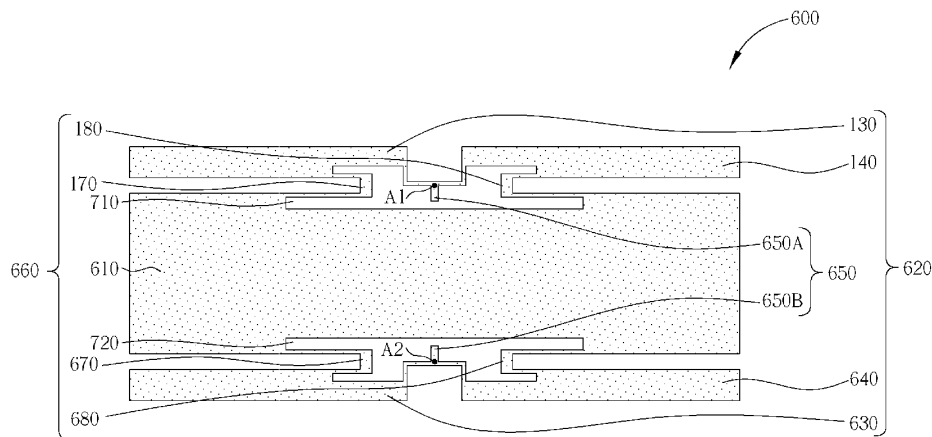
Assistant Examiner — Chuc Tran

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

(57) **ABSTRACT**

An antenna structure consists of a substrate, a radiation element, a signal feeding element, and a grounding element. The radiation element includes a first radiator and a second radiator coupled to the first radiator, wherein the first radiator is identical to the second radiator. The signal feeding element is coupled to a joint of the first radiator and the second radiator, wherein the first radiator and the second radiator are symmetrically disposed in the left and right sides of the signal feeding element to permute an array. The grounding element includes a first grounding sub-element and a second grounding sub-element, wherein the first grounding sub-element is coupled between the first radiator and the substrate and the second grounding sub-element is coupled between the second radiator and the substrate. The first grounding sub-element is identical to the second grounding sub-element.

18 Claims, 6 Drawing Sheets



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US008106848B2

(12) **United States Patent**
Rofougaran

(10) **Patent No.:** **US 8,106,848 B2**
(45) **Date of Patent:** ***Jan. 31, 2012**

(54) **PROGRAMMABLE ANTENNA WITH
PROGRAMMABLE IMPEDANCE MATCHING
AND METHODS FOR USE THEREWITH**

(75) Inventor: **Ahmadreza (Reza) Rofougaran,**
Newport Coast, CA (US)

(73) Assignee: **Broadcom Corporation,** Irvine, CA
(US)

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

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **13/022,625**

(22) Filed: **Feb. 7, 2011**

(65) **Prior Publication Data**

US 2011/0128205 A1 Jun. 2, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/614,870, filed on
Nov. 9, 2009, now Pat. No. 7,893,888, which is a
continuation of application No. 11/525,269, filed on
Sep. 22, 2006, now Pat. No. 7,639,199.

(51) **Int. Cl.**
H01Q 1/50 (2006.01)

(52) **U.S. Cl.** **343/860; 343/850; 343/861; 343/876;**
455/562.1

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

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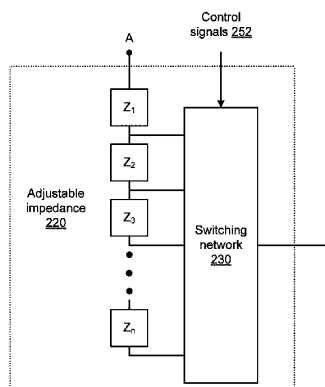
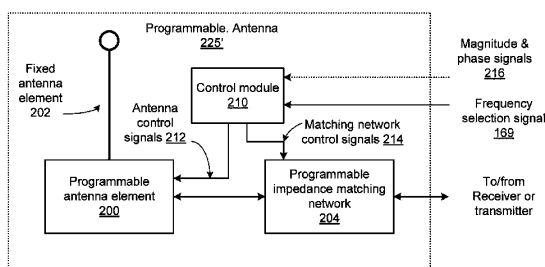
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A programmable antenna includes a fixed antenna element and a programmable antenna element that is tunable in response to at least one antenna control signal, wherein tuning the programmable antenna element changes an impedance of the antenna. A programmable impedance matching network is tunable in response in response to at least one matching network control signal to adjust for the changes in the impedance of the antenna.

11 Claims, 21 Drawing Sheets



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US008108021B2

(12) **United States Patent**
Vance

(10) **Patent No.:** **US 8,108,021 B2**
(45) **Date of Patent:** **Jan. 31, 2012**

(54) **COMMUNICATIONS STRUCTURES
INCLUDING ANTENNAS WITH FILTERS
BETWEEN ANTENNA ELEMENTS AND
GROUND SHEETS**

(75) Inventor: **Scott LaDell Vance**, Staffanstorp (SE)

(73) Assignee: **Sony Ericsson Mobile
Communications AB**, Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 19 days.

(21) Appl. No.: **12/788,714**

(22) Filed: **May 27, 2010**

(65) **Prior Publication Data**

US 2011/0294537 A1 Dec. 1, 2011

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

(52) **U.S. Cl.** **455/575.7**; 455/575.5; 343/841;
343/846

(58) **Field of Classification Search** 455/575.5,
455/575.7, 269, 271, 129; 343/722, 772,
343/787, 795, 841, 846

See application file for complete search history.

(56) **References Cited**

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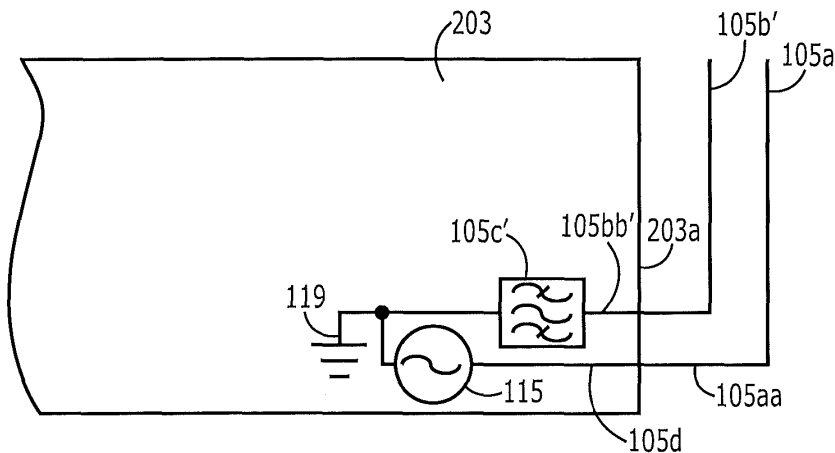
Primary Examiner — Christian Hannon

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

(57) **ABSTRACT**

A communications structure may include a ground sheet, a feed conductor, and an active antenna branch electrically coupled to the feed conductor. A parasitic antenna branch may be electrically coupled to the ground sheet, and the active and parasitic antenna branches may be spaced apart. Moreover, the parasitic antenna branch may be between portions of the active antenna branch and the ground sheet.

20 Claims, 12 Drawing Sheets



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US008111194B2

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

(10) **Patent No.:** **US 8,111,194 B2**
(45) **Date of Patent:** ***Feb. 7, 2012**

(54) **MOBILE TELECOMMUNICATION
TERMINAL**

(75) Inventors: **Ki Won Chang**, Gyeonggi-do (KR);
Jeong Sik Seo, Gyeonggi-do (KR); **Hyun
Do Park**, Gyeonggi-do (KR); **Jae Suk
Sung**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**,
Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 797 days.

This patent is subject to a terminal dis-
claimer.

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(21) Appl. No.: **11/944,573**

(22) Filed: **Nov. 23, 2007**

(65) **Prior Publication Data**

US 2008/0129604 A1 Jun. 5, 2008

(30) **Foreign Application Priority Data**

Nov. 22, 2006 (KR) 10-2006-115951

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 1/48 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS,**
343/702, 846, 872, 873
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

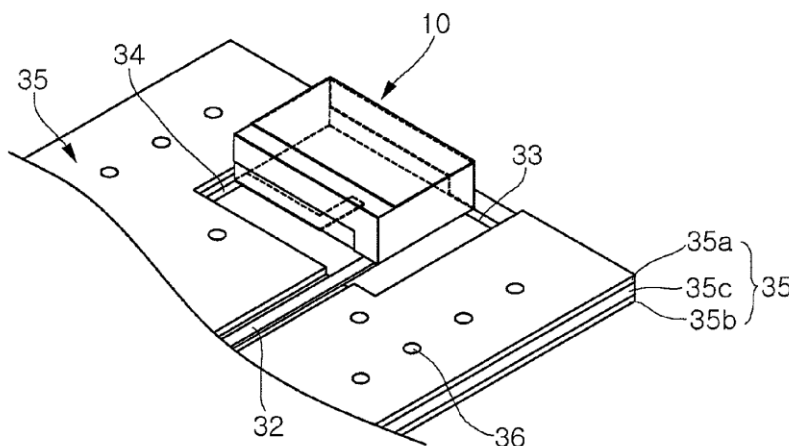
Assistant Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Lowe, Hauptman, Ham &
Berner, LLP

(57) **ABSTRACT**

There is provided a mobile telecommunication terminal com-
prising: a chip antenna, and a printed circuit board having the
chip antenna mounted on one surface thereof, the printed
circuit board comprising a tuning ground pattern formed on a
surface opposing the one surface of the printed circuit board
to have one end connected to a ground part so as to be used for
tuning frequency characteristics of the chip antenna.

10 Claims, 5 Drawing Sheets



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US008111197B2

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

(10) **Patent No.:** **US 8,111,197 B2**
(45) **Date of Patent:** **Feb. 7, 2012**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Junichi Noro**, Akita (JP); **Kazunari Saito**, Akita (JP); **Akira Miyoshi**, Sagami-hara (JP); **Hiroshi Suzuki**, Akita (JP)

(73) Assignee: **Mitsumi Electric Co., Ltd.**, Tama-Shi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 472 days.

(21) Appl. No.: **12/427,874**

(22) Filed: **Apr. 22, 2009**

(65) **Prior Publication Data**

US 2010/0156724 A1 Jun. 24, 2010

(30) **Foreign Application Priority Data**

Dec. 18, 2008 (JP) 2008-322030

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

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

(58) **Field of Classification Search** 343/700 MS, 343/846, 848

See application file for complete search history.

(56) **References Cited**

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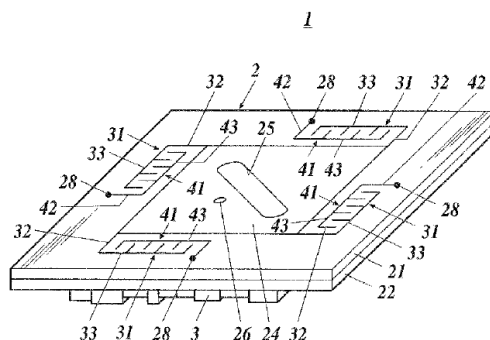
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — Holtz, Holtz, Goodman & Chick, PC

(57) **ABSTRACT**

Disclosed is an antenna apparatus, including: a multi-layer substrate having at least two substrates in a stacking manner and having a first through hole; an amplifying circuit on one face of the multi-layer substrate; a ground pattern formed between two adjacent substrates of the multi-layer substrate; an antenna pattern formed on the other face of the multi-layer substrate; and a first comb electrode having comb teeth and a second comb electrode having comb teeth, both of which are formed around the antenna pattern on the other face of the multi-layer substrate. The first comb electrode is electrically connected to the antenna pattern. The second comb electrode is electrically connected to the ground pattern through the first through hole. The comb teeth of the first comb electrode and the comb teeth of the second comb electrode are spaced from one another at predetermined intervals in a staggered manner.

4 Claims, 6 Drawing Sheets





US008111199B2

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

(10) **Patent No.:** **US 8,111,199 B2**
(45) **Date of Patent:** **Feb. 7, 2012**

(54) **SLOTTED GROUND-PLANE USED AS A SLOT ANTENNA OR USED FOR A PIFA ANTENNA**

(75) Inventors: **Carles Puente Baliarda**, Barcelona (ES); **Jaime Anguera Pros**, Castellon (ES)

(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

(*) 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.: **12/958,522**

(22) Filed: **Dec. 2, 2010**

(65) **Prior Publication Data**

US 2011/0068995 A1 Mar. 24, 2011

Related U.S. Application Data

(63) Continuation of application No. 11/884,991, filed as application No. PCT/EP2006/060766 on Mar. 15, 2006, now Pat. No. 7,872,605.

(30) **Foreign Application Priority Data**

Mar. 15, 2005 (EP) 05005540

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

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

(58) **Field of Classification Search** 343/700 MS,
343/702, 767, 846
See application file for complete search history.

(56) **References Cited**

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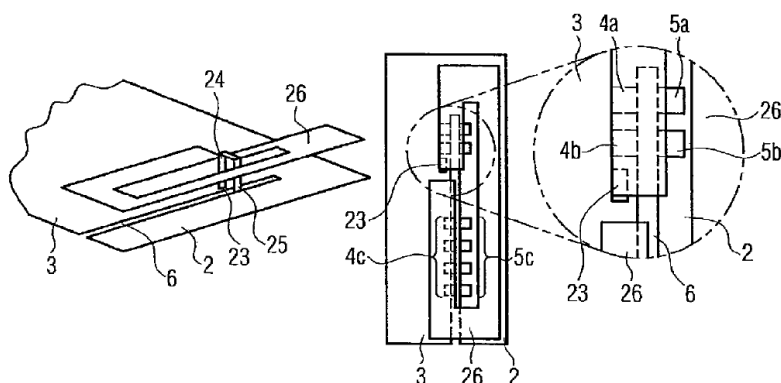
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Winstead PC

(57) **ABSTRACT**

A wireless device includes a ground plane with at least two portions. On each of the at least two portions at least one connecting means is provided. The two connecting means are connected with an electric component for connecting the at least two portions of the ground plane. The ground plane is partially covered with an insulating material and the connecting means are given by a part of the ground plane which is not covered by any insulating material.

40 Claims, 6 Drawing Sheets





US008111201B2

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

(10) **Patent No.:** **US 8,111,201 B2**
(45) **Date of Patent:** **Feb. 7, 2012**

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

(75) Inventors: **Akihiro Tsujimura**, Kokubunji (JP);
Takashi Amano, Soka (JP)

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

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

(21) Appl. No.: **13/154,767**

(22) Filed: **Jun. 7, 2011**

(65) **Prior Publication Data**

US 2011/0254745 A1 Oct. 20, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/110,774, filed on Apr. 28, 2008, now Pat. No. 7,982,675.

(30) **Foreign Application Priority Data**

Sep. 5, 2007 (JP) P2007-230750

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/872

(58) **Field of Classification Search** 343/700,
343/702, 872, 873
See application file for complete search history.

(56) **References Cited**

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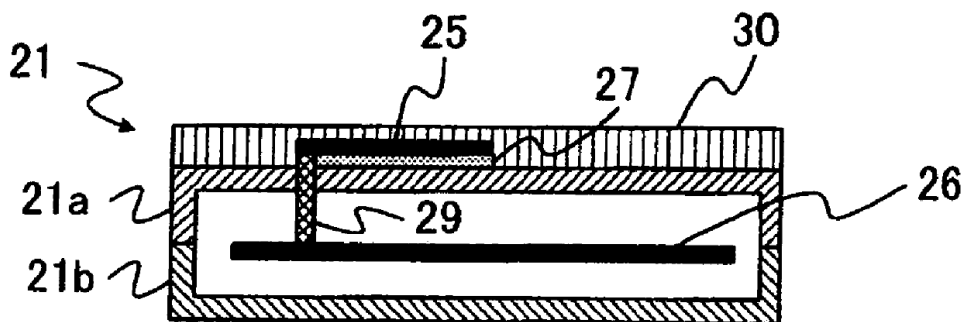
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Holtz, Holtz, Goodman & Chick, PC

(57) **ABSTRACT**

A wireless communication device includes: a case made of a first dielectric material; a cover made of a second dielectric material which covers an outer surface of the case; a wireless communication circuit which is housed in the case; an antenna element made of a conductive material and provided on the outer surface of the case between the case and the cover, the antenna element being electrically connected to the wireless communication circuit by a connection member that penetrates the case; and an adhesive layer which is disposed between the antenna element and the case to adhere the antenna element onto the case, the adhesive layer being made of a third dielectric material.

9 Claims, 4 Drawing Sheets





US008111202B2

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

(10) **Patent No.:** **US 8,111,202 B2**
(45) **Date of Patent:** **Feb. 7, 2012**

(54) **HIGH FREQUENCY WAVE GLASS ANTENNA
FOR AN AUTOMOBILE AND WINDOW
GLASS SHEET FOR AN AUTOMOBILE WITH
THE SAME**

(75) Inventors: **Osamu Kagaya**, Tokyo (JP); **Kotaro
Suenaga**, Tokyo (JP); **Koji Ikawa**,
Tokyo (JP)

(73) Assignee: **Asahi Glass Company, Limited**, Tokyo
(JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 360 days.

(21) Appl. No.: **12/413,709**

(22) Filed: **Mar. 30, 2009**

(65) **Prior Publication Data**

US 2009/0243946 A1 Oct. 1, 2009

(30) **Foreign Application Priority Data**

Mar. 31, 2008 (JP) 2008-093467

(51) **Int. Cl.**
H01Q 1/32 (2006.01)

(52) **U.S. Cl.** **343/713; 343/741; 343/866**

(58) **Field of Classification Search** **343/711,
343/713, 741, 744, 866**

See application file for complete search history.

(56) **References Cited**

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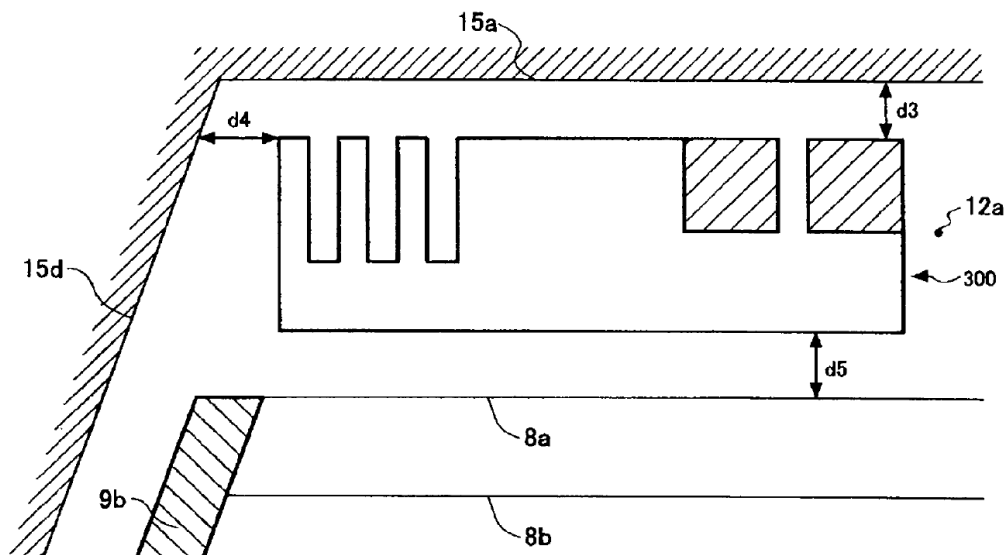
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A high frequency wave glass antenna for an automobile includes an antenna conductor formed in a loop shape and disposed in or an automobile window glass sheet, the antenna conductor having a discontinuity and feeding portions at both ends of the discontinuity or in the vicinity of said both ends, the discontinuity being formed of a portion of the loop shape cut by a length. The antenna conductor includes a detour in a portion of the loop shape, the detour being formed of a single or a plurality of detour elements, the detour being disposed in a position, which satisfies that a rate of a distance from a center of the discontinuity of the original loop shape to a center of the detour of the original loop shape with respect to a length of an inner peripheral edge or an outer peripheral edge of the original loop shape ranges from 0.18 to 0.4.

27 Claims, 12 Drawing Sheets





US008111204B2

(12) **United States Patent**
Croman

(10) **Patent No.:** **US 8,111,204 B2**
(45) **Date of Patent:** **Feb. 7, 2012**

(54) **SLOT ANTENNA FOR A CIRCUIT BOARD
GROUND PLANE**

(75) Inventor: **Russell Croman**, Austin, TX (US)

(73) Assignee: **Silicon Laboratories Inc.**, Austin, TX
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 734 days.

(21) Appl. No.: **12/012,061**

(22) Filed: **Jan. 31, 2008**

(65) **Prior Publication Data**

US 2009/0195468 A1 Aug. 6, 2009

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

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

(58) **Field of Classification Search** 343/767,
343/702, 700 MS, 770, 829

See application file for complete search history.

(56) **References Cited**

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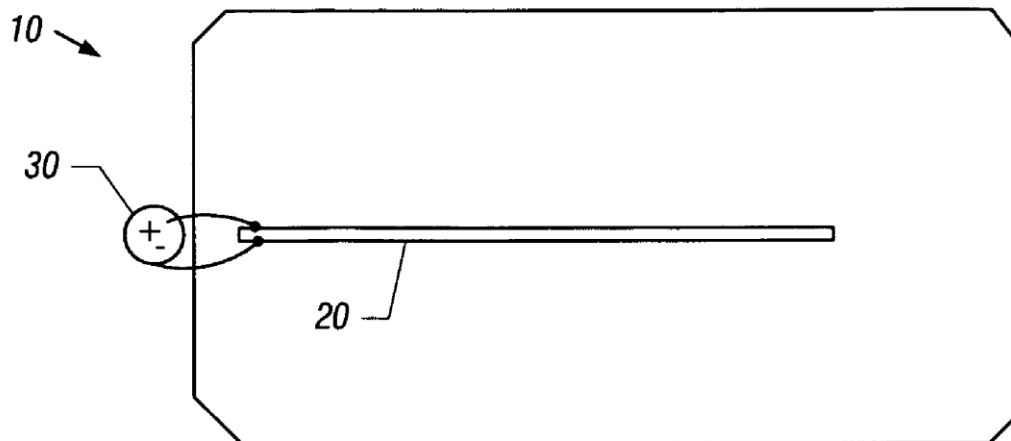
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Primary Examiner — Huedung Mancuso

(57) **ABSTRACT**

In one embodiment, the present invention includes a slot
antenna that is formed on a ground plane of a circuit board.
The slot antenna may be connected to radio circuitry adapted
on the circuit board by way of a feedline, which is coupled to
the radio circuitry and across a portion of the slot antenna.

21 Claims, 4 Drawing Sheets



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US008115682B2

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

(10) **Patent No.:** **US 8,115,682 B2**
(45) **Date of Patent:** **Feb. 14, 2012**

(54) **MULTI-BAND HAC COMPATIBLE ANTENNA MODULE**

(75) Inventors: **Daniel Chang**, Pa-Te (TW); **Chia-Lun Tang**, Pa-Te (TW); **Yan-Wen Zhao**, Chengdu (CN); **Jianliang Shen**, Chengdu (CN)

(73) Assignee: **Auden Techno Corp.**, Pa-Te, 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 416 days.

(21) Appl. No.: **12/344,718**

(22) Filed: **Dec. 29, 2008**

(65) **Prior Publication Data**

US 2010/0164808 A1 Jul. 1, 2010

(51) **Int. Cl.**
H01Q 9/84 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/767

(58) **Field of Classification Search** 343/700 MS, 343/702, 767

See application file for complete search history.

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Primary Examiner — Douglas W Owens

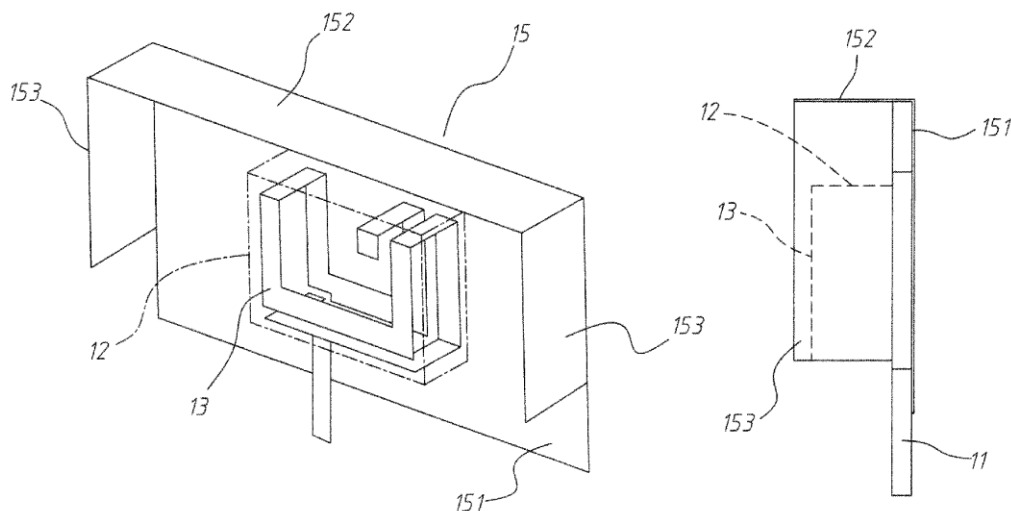
Assistant Examiner — Chuc Tran

(74) *Attorney, Agent, or Firm* — Guice Patents PLLC

(57) **ABSTRACT**

A multi-band HAC compatible antenna module having a metal shield arranged around the built-in antenna for resonant coupling with the antenna to lower electromagnetic interference and to improves hearing aids compatibility characteristic. When compared with a reference antenna without metal shield, the multi-band HAC compatible antenna module shows 3 dB–4 dB HAC improvement in GSM850 and GSM900, and 1 dB HAC improvement in DCS and PCS bands.

6 Claims, 10 Drawing Sheets
(4 of 10 Drawing Sheet(s) Filed in Color)



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US008115686B2

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

(10) **Patent No.:** **US 8,115,686 B2**
(45) **Date of Patent:** **Feb. 14, 2012**

(54) **HANDHELD DEVICE WITH TWO ANTENNAS, AND METHOD OF ENHANCING THE ISOLATION BETWEEN THE ANTENNAS**

(75) Inventors: **Josep Mumbru**, Barcelona (ES); **Jaume Anguera**, Castellon (ES); **Jordi Soler**, Girona (ES); **Carles Puente**, Barcelona (ES)

(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 506 days.

(21) Appl. No.: **11/988,888**

(22) PCT Filed: **Jul. 18, 2006**

(86) PCT No.: **PCT/EP2006/007050**

§ 371 (c)(1),

(2), (4) Date: **Sep. 30, 2008**

(87) PCT Pub. No.: **WO2007/028448**

PCT Pub. Date: **Mar. 15, 2007**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 60/702,205, filed on Jul. 25, 2005.

(30) **Foreign Application Priority Data**

Jul. 21, 2005 (EP) 05106694

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/767; 343/846

(58) **Field of Classification Search** 343/700 MS, 343/702, 767, 770, 846
See application file for complete search history.

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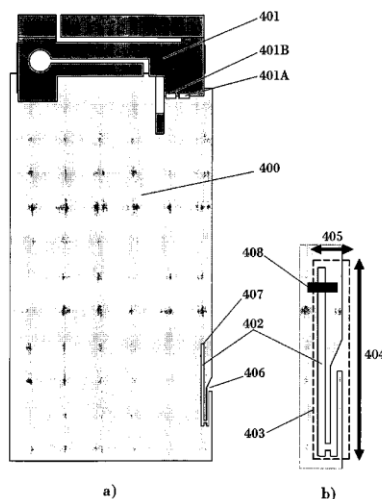
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Winstead PC

(57) **ABSTRACT**

The invention relates to a handheld device comprising a first antenna (401, 701, 901, 931, 961, 1101, 1151, 1301, 1501) arranged to operate in at least a first frequency band, and a second antenna (402, 702, 902, 1102, 1302, 1502, 2210) arranged to operate in at least a second frequency band, wherein said second frequency band is different from said first frequency band. According to the invention, the second antenna comprises a slot antenna comprising at least one slot in at least one conductive layer. The invention also relates to enhancement of the isolation between first and second antennas in a handheld device.

49 Claims, 23 Drawing Sheets



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US008115689B2

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

(10) **Patent No.:** **US 8,115,689 B2**
(45) **Date of Patent:** ***Feb. 14, 2012**

(54) **ELECTRONIC DEVICE**

(75) Inventors: **Koichiro Takeguchi**, Hachioji (JP);
Shigeo Hayashi, Hamura (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 364 days.

This patent is subject to a terminal disclaimer.

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Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

According to one embodiment, an electronic device is provided with the following an antenna, a first radio module configured to perform wireless communications by use of the antenna, a second radio module configured to perform wireless communications by use of the antenna, a first printed circuit board with reference to which the second radio module is attachable or detachable, a first cable which connects the antenna and the second radio module together, a second cable which connects the second radio module and the first radio module together, and a connection mechanism which connects the first and second cables together in a state where the second radio module is detached from the first printed circuit board.

7 Claims, 10 Drawing Sheets

(21) Appl. No.: **12/330,395**

(22) Filed: **Dec. 8, 2008**

(65) **Prior Publication Data**

US 2009/0085817 A1 Apr. 2, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/844,972, filed on Aug. 24, 2007, now Pat. No. 7,463,203.

(30) **Foreign Application Priority Data**

Nov. 30, 2006 (JP) 2006-324478

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

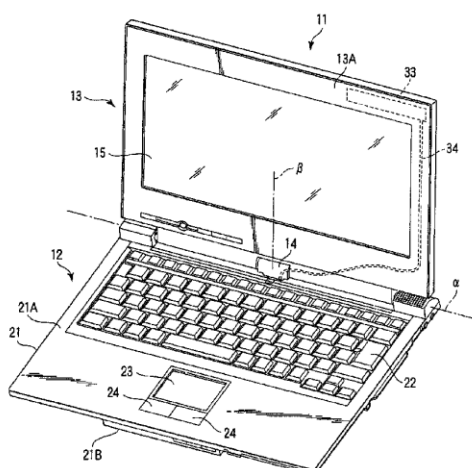
(52) **U.S. Cl.** 343/702

(58) **Field of Classification Search** 343/702,
343/906, 700 MS, 904-905
See application file for complete search history.

(56) **References Cited**

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US008115691B2

(12) **United States Patent**
Takasu

(10) **Patent No.:** **US 8,115,691 B2**
(45) **Date of Patent:** **Feb. 14, 2012**

(54) **ELECTRONIC APPARATUS AND ANTENNA UNIT**

(75) Inventor: **Nobuaki Takasu**, Akishima (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 179 days.

(21) Appl. No.: **12/576,817**

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

(65) **Prior Publication Data**

US 2010/0134362 A1 Jun. 3, 2010

(30) **Foreign Application Priority Data**

Nov. 28, 2008 (JP) 2008-305125

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 7/00 (2006.01)

H01Q 21/00 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/866; 343/893; 343/728

(58) **Field of Classification Search** 343/870, 343/725, 729, 726, 728, 866, 893, 700 MS
See application file for complete search history.

(56) **References Cited**

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Japanese Patent Application No. 2008-305125; Notification of Reasons for Rejection; mailed Dec. 15, 2009 (English Translation).

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Primary Examiner — Jacob Y Choi

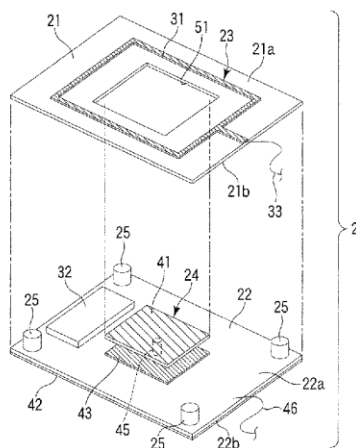
Assistant Examiner — Amal Patel

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

(57) **ABSTRACT**

According to one embodiment, an electronic apparatus includes a housing, a first board contained in the housing, a second board contained in the housing on the inner side of the first board, a first antenna part, and a second antenna part. The first antenna part includes a loop antenna provided on the first board, and configured to communicate with a communication module opposed to the loop antenna. The second antenna part includes an element part provided in an area surrounded by the loop antenna, and positioned in the same plane as the loop antenna, and a ground part provided on the second board, and configured to communicate with a communication module opposed to the element part.

16 Claims, 5 Drawing Sheets



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US008120535B2

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

(10) **Patent No.:** **US 8,120,535 B2**
(45) **Date of Patent:** **Feb. 21, 2012**

(54) **MULTI-BAND ANTENNA WITH IMPROVED CONNECTING PORTION**

(75) Inventors: **Chen-Ta Hung**, Tu-cheng (TW);
Yun-Lung Ke, Tu-cheng (TW);
Hsien-Sheng Tseng, Tu-cheng (TW)

(73) Assignee: **Hon Hai Precision Ind. 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 524 days.

(21) Appl. No.: **12/284,032**

(22) Filed: **Sep. 17, 2008**

(65) **Prior Publication Data**

US 2009/0073052 A1 Mar. 19, 2009

(30) **Foreign Application Priority Data**

Sep. 17, 2007 (TW) 96134664 A

(51) **Int. Cl.**
H01Q 5/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/845; 343/702

(58) **Field of Classification Search** 343/718,
343/700 MS, 702, 844–846, 848, 872
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

Assistant Examiner — Amal Patel

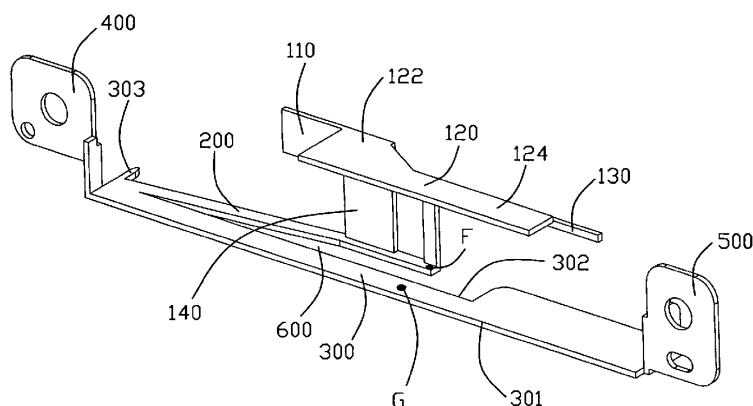
(74) *Attorney, Agent, or Firm* — Wei Te Chung; Andrew C. Cheng; Ming Chieh Chang

(57) **ABSTRACT**

A multi-band antenna includes a grounding element located on a first plane, a connecting element extending from the grounding element to form a slot between the connecting element and the grounding element, a conductive portion extending from the connecting element, a first radiating portion, a second radiating portion, and a third radiating portion. The first radiating portion is narrower than the conductive portion and extends from an end of the conductive portion along a first direction. The second radiating portion is connected to the first radiating portion and extends along a second direction opposite to the first direction. The third radiating portion is narrower than the first radiating portion and extends from an end of the connecting element.

2 Claims, 3 Drawing Sheets

1



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US008120536B2

(12) **United States Patent
Lindmark**

(10) **Patent No.: US 8,120,536 B2**
(45) **Date of Patent: Feb. 21, 2012**

(54) **ANTENNA ISOLATION**

(75) Inventor: **Bjorn Lindmark**, Sollentuna (SE)

(73) Assignee: **Powerwave Technologies Sweden AB**,
Kista (SE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 335 days.

(21) Appl. No.: **12/422,165**

(22) Filed: **Apr. 10, 2009**

(65) **Prior Publication Data**

US 2009/0256773 A1 Oct. 15, 2009

Related U.S. Application Data

(60) Provisional application No. 61/044,382, filed on Apr.
11, 2008.

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/846, 850

See application file for complete search history.

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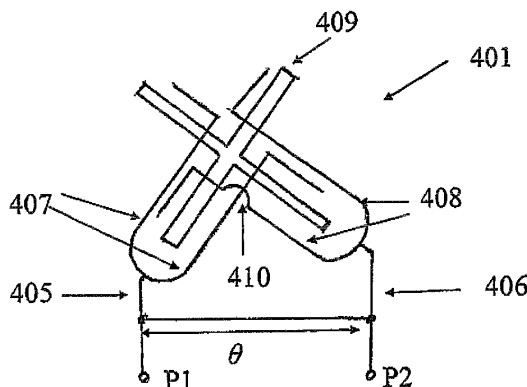
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A dual polarized antenna element having improved antenna
isolation is disclosed by the present invention. The antenna
element includes a first feeder for feeding the antenna ele-
ment in a first polarization direction, and a second feeder for
feeding the antenna element in a second polarization direc-
tion. According to the present invention, a compensation line
is arranged between the first and the second feeders for com-
pensating for an imbalance caused by an essentially capaci-
tive coupling between the first and second feeders. The com-
pensation line is connected to the first and second feeders in
close proximity to a radiating part of said antenna element,
and has a short electrical length θ and a high impedance
relative to an impedance of the first and second feeders,
respectively, thereby giving the compensation line an essen-
tially inductive character.

10 Claims, 10 Drawing Sheets



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US008120539B2

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

(10) **Patent No.:** **US 8,120,539 B2**
(45) **Date of Patent:** **Feb. 21, 2012**

(54) **ANTENNA FORMED WITH CASE AND METHOD OF MANUFACTURING THE SAME**

(75) Inventors: **Ha Ryong Hong**, Gyunggi-Do (KR);
Jae Suk Sung, Gyunggi-Do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**,
Gyunggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 374 days.

(21) Appl. No.: **12/171,064**

(22) Filed: **Jul. 10, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 11, 2007 (KR) 10-2007-0069566

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

(52) **U.S. Cl.** **343/702; 343/906**

(58) **Field of Classification Search** 343/873,
343/700 MS, 872, 343, 702, 906; 29/600
See application file for complete search history.

(56) **References Cited**

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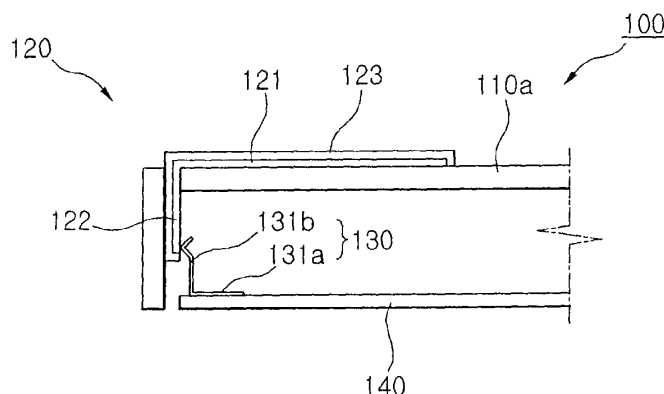
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Lowe, Hauptman, Ham & Berner, LLP

(57) **ABSTRACT**

There are provided an antenna integrally formed with a case and a method of manufacturing the same. An antenna integrally formed with a case according to an aspect of the invention includes: a case unit forming an exterior of an electronic device, a radiator comprising a radiation unit tightly fixed to an outer surface of the case unit and terminal units each extending from an end portion of the radiation unit, passing through the case unit, and exposed on the inside of the case unit, and contact pins provided on a board disposed in an interior space of the case unit and electrically connected to the individual terminal units.

10 Claims, 8 Drawing Sheets



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US008120542B2

(12) **United States Patent**
Shoji

(10) **Patent No.:** **US 8,120,542 B2**
(45) **Date of Patent:** **Feb. 21, 2012**

(54) **NOTCH ANTENNA AND WIRELESS DEVICE**

(75) Inventor: **Hideaki Shoji**, Chiba (JP)

(73) Assignee: **Sony Ericsson Mobile Communications AB**, Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 365 days.

(21) Appl. No.: **12/541,355**

(22) Filed: **Aug. 14, 2009**

(65) **Prior Publication Data**

US 2010/0060530 A1 Mar. 11, 2010

(30) **Foreign Application Priority Data**

Sep. 5, 2008 (JP) 2008-228002

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

(52) **U.S. Cl.** **343/767**; 343/700 MS; 343/702

(58) **Field of Classification Search** 343/700 MS, 343/702, 767, 770, 829, 846
See application file for complete search history.

(56) **References Cited**

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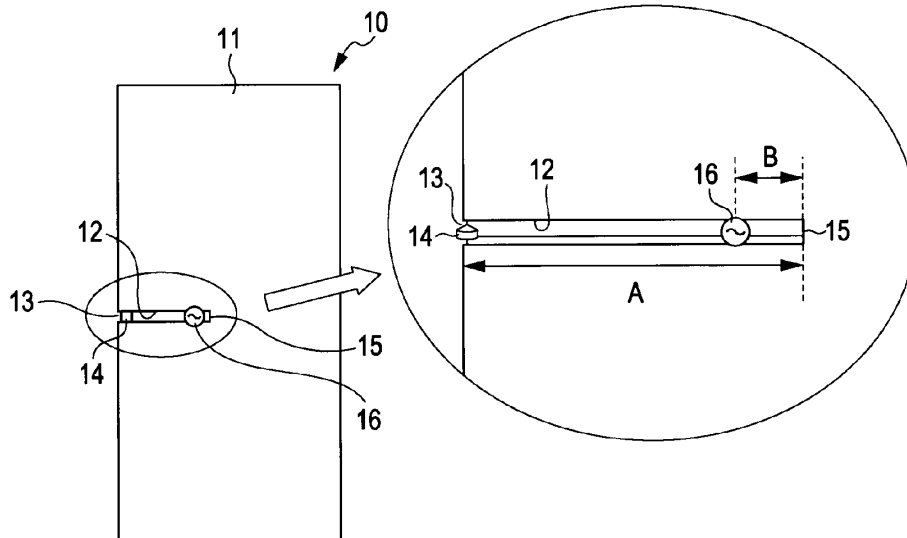
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A notch antenna includes a ground conductor having a slit and a reactance circuit containing a capacitive reactance element and an inductive reactance element, the reactance circuit being placed at an open end of the slit so as to bridge the slit and being connected to the ground conductor. The slit has a closed end to which power is supplied, and the capacitance of the capacitive reactance element and the inductance of the inductive reactance element are set so that the reactance circuit has a capacitance desired to obtain a first antenna resonance point at a first frequency and a capacitance desired to obtain a second antenna resonance point at a second frequency.

11 Claims, 12 Drawing Sheets



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US008120543B2

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

(10) **Patent No.:** **US 8,120,543 B2**
(45) **Date of Patent:** **Feb. 21, 2012**

(54) **TRANSMISSION LINE SLOT ANTENNA**

(76) Inventors: **Oleksandr Sulima**, Toronto (CA);
Volodimir Veremey, Santa Clara, CA
(US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 374 days.

(21) Appl. No.: **12/581,345**

(22) Filed: **Oct. 19, 2009**

(65) **Prior Publication Data**

US 2011/0090128 A1 Apr. 21, 2011

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

(52) **U.S. Cl.** **343/767**; 343/702; 343/841; 343/829;
343/846

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

(56) **References Cited**

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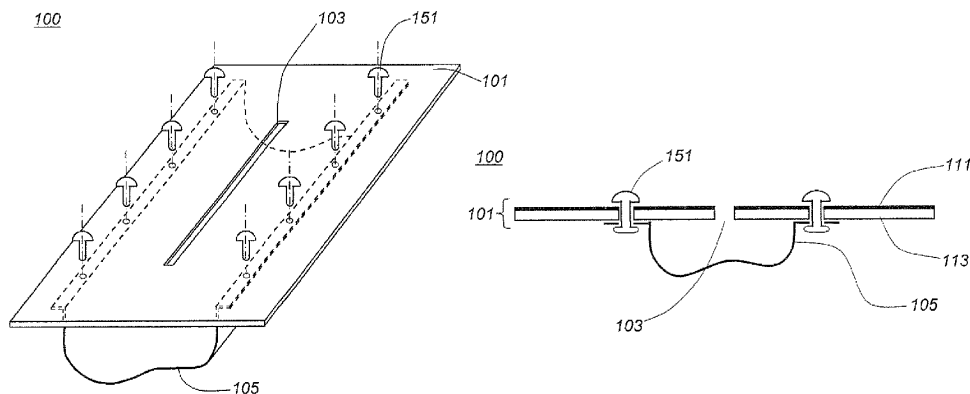
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Davis Wright Tremaine LLP

(57) **ABSTRACT**

A transmission line slot antenna is described. Although more generally applicable, the antenna is particularly adapted to conformal applications. The antenna has a ground plate with a conductive top surface having a slot with a feed whose ground reference terminal is connected to one side of the slot and whose signal terminal is connected to the other side of the slot. A conductive cylindrical screen, which can be of an arbitrary cross section and non-uniform in the longitudinal direction, is formed of one or more sections attached along the bottom surface of the ground plate, with each of the sections having a first and second edge conductively connected to the top surface of the ground plate along opposite sides of the slot. The antenna is tuned to support the fundamental mode (H_{00}) of a slotted cylinder transmission line formed by the screen sections and a part of the ground plate with the slot.

14 Claims, 16 Drawing Sheets



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US008120544B2

(12) **United States Patent**
Sauer

(10) **Patent No.:** **US 8,120,544 B2**
(45) **Date of Patent:** **Feb. 21, 2012**

(54) **COMPACT CONTINUOUS GROUND PLANE SYSTEM**

(75) Inventor: **Rohn Sauer**, Encino, CA (US)

(73) Assignee: **Raytheon Company**, Waltham, MA (US)

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(21) Appl. No.: **12/391,979**

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

(65) **Prior Publication Data**

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(51) **Int. Cl.**
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(52) **U.S. Cl.** **343/846**; 343/848; 343/906; 439/2; 439/12; 439/111; 439/386; 439/916

(58) **Field of Classification Search** 343/705, 343/718, 846, 848, 875, 877, 915, 901, 903, 343/906; 439/2, 6, 12, 111, 120, 916, 386
See application file for complete search history.

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Primary Examiner — Jacob Y Choi

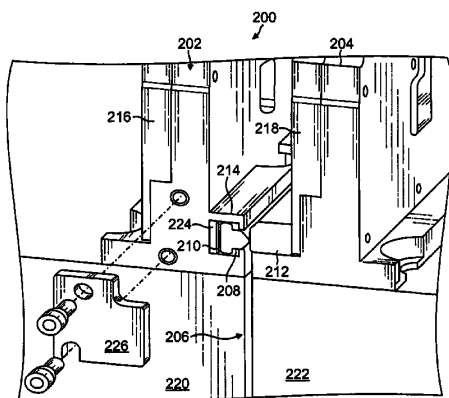
Assistant Examiner — Shawn Buchanan

(74) *Attorney, Agent, or Firm* — Christie, Parker & Hale, LLP

(57) **ABSTRACT**

A compact continuous ground plane system is provided. In one embodiment, the invention relates to an assembly for forming a continuous ground plane for an antenna having at least two elements configured to move relative to one another, the ground assembly including a first element having a housing, a plunger disposed within the housing, a second element, a wear plate coupled to the second element, and a spring disposed between the plunger and the housing, the spring configured to urge the plunger toward the wear plate, where the plunger is configured to be moved within the housing and to make electrical contact with the wear plate.

22 Claims, 7 Drawing Sheets



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(12) **United States Patent**
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(54) **MULTIFUNCTIONAL ANTENNA CHIP**

(56) **References Cited**

(75) Inventors: **Chia-Lun Tang**, Pa-Te (TW); **Shih-Chi Lai**, Pa-Te (TW)

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(73) Assignee: **Auden Techno Corp.**, Pa-Te, Tao-Yuan Hsien (TW)

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Primary Examiner — Tho G Phan

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(74) Attorney, Agent, or Firm — Guice Patents PLLC

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(57) **ABSTRACT**

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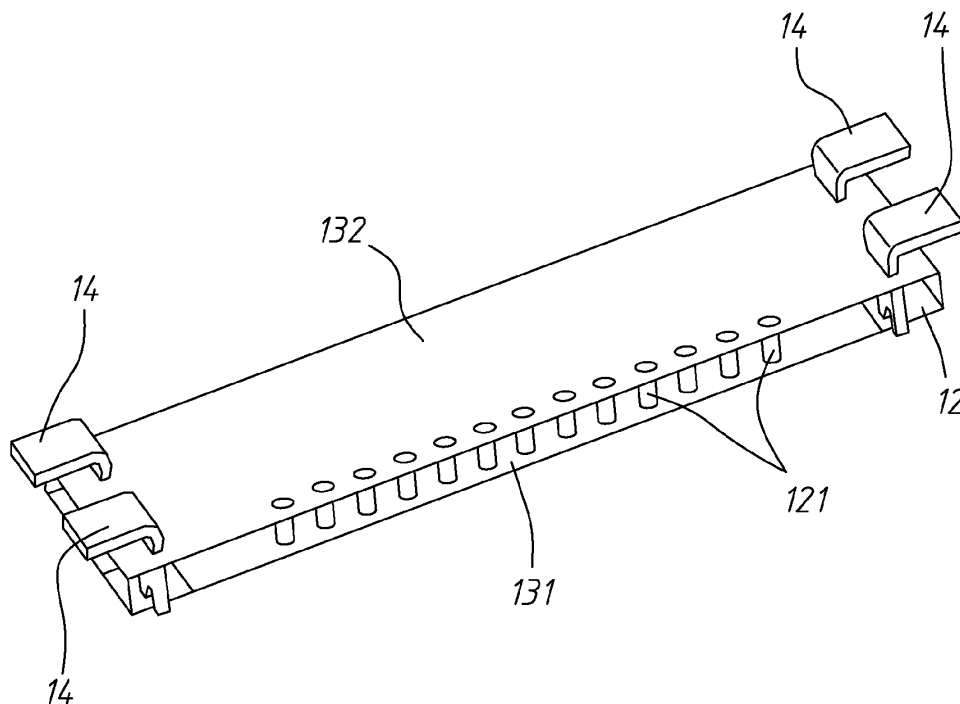
(52) **U.S. Cl.** **343/860**; 343/700 MS; 343/702

(58) **Field of Classification Search** 343/700 MS, 343/702, 850, 860, 861

See application file for complete search history.

A multifunctional antenna chip is able to mate with many kinds of matched circuits and is able to adjust the character of an antenna structure of the multifunctional antenna chip, in order that the antenna structure has one or multiple standard working frequencies. The antenna structure is a folded antenna structure basically; this can save its volume occupied. And the multifunctional antenna chip has a non-signal inputting pin for connection to thereby increase shape of the antenna for adjusting the style of the antenna structure designed.

6 Claims, 14 Drawing Sheets



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