US007688266B2

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

(10) **Patent No.: US 7,688,266 B2**
(45) **Date of Patent: Mar. 30, 2010**

(54) **ANTENNA MODULE**

(75) Inventors: **Kiyokazu Akiyama**, Okazaki (JP); **Yuji Sugimoto**, Kariya (JP); **Taizo Mizutani**, Nagoya (JP)

(73) Assignee: **Denso Corporation**, Kariya (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 204 days.

(21) Appl. No.: **12/080,265**

(22) Filed: **Apr. 1, 2008**

(65) **Prior Publication Data**

US 2008/0284658 A1 Nov. 20, 2008

(30) **Foreign Application Priority Data**

Apr. 3, 2007 (JP) 2007-097455

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

(52) **U.S. Cl.** ..... **343/700 MS**; 343/846; 343/829

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

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Office action dated Sep. 8, 2009 in corresponding Japanese Application No. 2007-097455.

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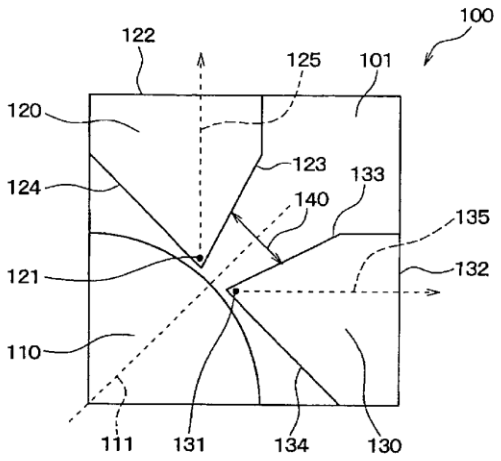
Primary Examiner—Trinh V Dinh
(74) *Attorney, Agent, or Firm*—Harness, Dickey & Pierce, PLC

(57) **ABSTRACT**

An antenna module includes a substrate; a ground element disposed on the substrate; a first antenna element disposed on the substrate; and a second antenna element disposed on the substrate. The first antenna element and the second antenna element are, respectively, capable of transmitting radio waves having a first polarization direction and a second polarization direction unparallel to each other. A spacing between a perimeter of the ground element and the first antenna element increases as a function of increasing distance from the second antenna element. A spacing between the perimeter of the ground element and the second antenna element increases as a function of increasing distance from the first antenna element.

10 Claims, 4 Drawing Sheets



US007688267B2

(12) **United States Patent**
Hill

(10) **Patent No.: US 7,688,267 B2**
(45) **Date of Patent: Mar. 30, 2010**

(54) **BROADBAND ANTENNA WITH COUPLED FEED FOR HANDHELD ELECTRONIC DEVICES**

(75) Inventor: **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 495 days.

(21) Appl. No.: **11/593,752**

(22) Filed: **Nov. 6, 2006**

(65) **Prior Publication Data**

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

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

(58) **Field of Classification Search** ..... 343/700 MS, 343/702, 725, 815–817, 846
See application file for complete search history.

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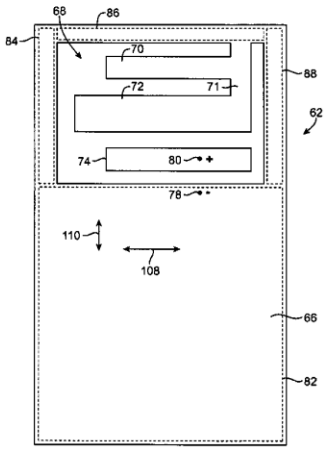
Primary Examiner—Huedung Mancuso
(74) *Attorney, Agent, or Firm*—Treyz Law Group; G. Victor Treyz; Nancy Y. Ru

(57) **ABSTRACT**

Broadband antennas and handheld electronic devices with broadband antennas are provided. A handheld electronic device may have a housing in which electrical components such as integrated circuits and a broadband antenna are mounted. The broadband antenna may have a ground element and a resonating element. The resonating element may have two arms of unequal length and may have a self-resonant element. The antenna may have a feed terminal connected to the self-resonant element and a ground terminal connected to the ground element. The self-resonant element may be near-field coupled to one of the arms of the resonating element. With one suitable arrangement, the self-resonant element may be formed using a conductive rectangular element that is not electrically shorted to the ground element or the arms of the resonating element. The antenna may operate over first and second frequency ranges of interest.

27 Claims, 16 Drawing Sheets



US007688276B2

(12) **United States Patent**
Quintero Illera et al.

(10) **Patent No.: US 7,688,276 B2**
(45) **Date of Patent: *Mar. 30, 2010**

(54) **MULTILEVEL AND SPACE-FILLING GROUND-PLANES FOR MINIATURE AND MULTIBAND ANTENNAS**

(75) Inventors: **Ramiro Quintero Illera**, Barcelona (ES); **Carles Puente Baliarda**, 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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/033,446**

(22) Filed: **Feb. 19, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 10/797,732, filed on Mar. 10, 2004, now Pat. No. 7,362,283, which is a continuation of application No. PCT/EP01/10589, filed on Sep. 13, 2001.

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

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

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

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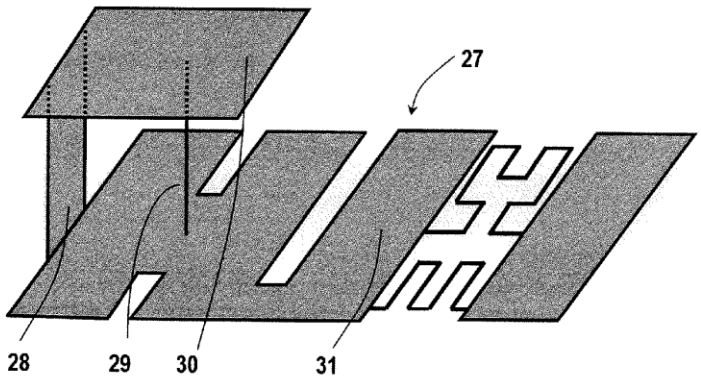
Primary Examiner—HoangAnh T Le
(74) *Attorney, Agent, or Firm*—Winstead PC

(57) **ABSTRACT**

An antenna system includes one or more conductive elements acting as radiating elements, and a multilevel or space-filling ground-plane, wherein said ground-plane has a particular geometry which affects the operating characteristics of the antenna. The return loss, bandwidth, gain, radiation efficiency, and frequency performance can be controlled through multilevel and space-filling ground-plane design. Also, said ground-plane can be reduced compared to those of antennas with solid ground-planes.

51 Claims, 19 Drawing Sheets



US007692595B2

(12) **United States Patent**
Kim

(10) **Patent No.: US 7,692,595 B2**
(45) **Date of Patent: Apr. 6, 2010**

(54) **BROADBAND INTERNAL ANTENNA COMBINED WITH MONOPOLE ANTENNA AND LOOP ANTENNA**

(75) Inventor: **Sung-Min Kim**, Seongnam-si (KR)

(73) Assignee: **KT Tech, Inc.**, Seongnam-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 120 days.

(21) Appl. No.: **12/073,626**

(22) Filed: **Mar. 7, 2008**

(65) **Prior Publication Data**

US 2009/0073048 A1 Mar. 19, 2009

(30) **Foreign Application Priority Data**

Sep. 14, 2007 (KR) 10-2007-0093875

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

(52) **U.S. Cl.** **343/728**; 343/702; 343/725

(58) **Field of Classification Search** ..... 343/700 MS, 343/702, 725, 728

See application file for complete search history.

(56) **References Cited**

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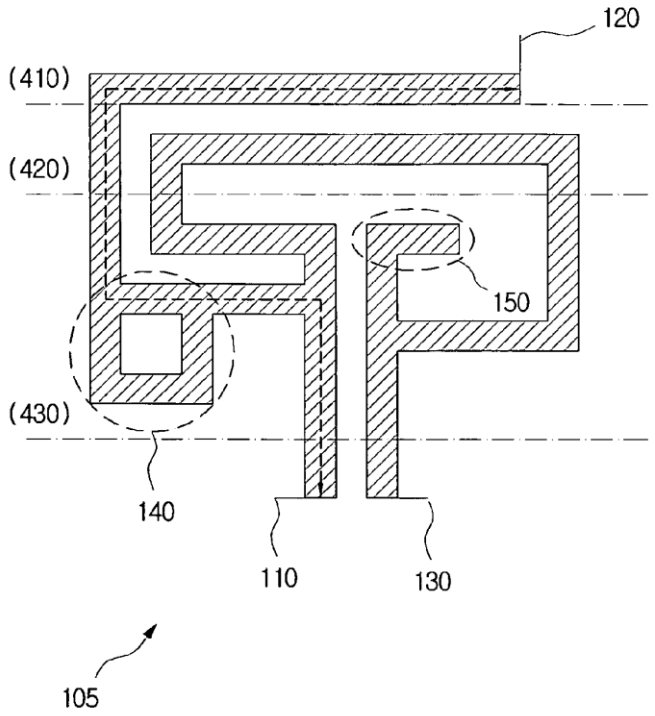
Primary Examiner—Tan Ho
(74) *Attorney, Agent, or Firm*—Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

Provided is a broadband internal antenna including a ground plate and an antenna unit. The antenna unit can include a feed point; a first radiator, formed with a bar shape having the feed point as one end part and the other end part from which an uncurved 'C' shape is extended; a ground point, connected to the ground plate; a second radiator, having one end part on which the ground point is mounted and the other end part that is connected to an area from which the uncurved 'C' shape of the first radiator starts to be formed in an open loop form; a first protrusion part, protruded from the uncurved 'C' shape of the first radiator to be formed in a closed loop form; and a second protrusion part, formed inside the open loop shape of the first radiator in an inverse L' form.

12 Claims, 12 Drawing Sheets



US007692599B2

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

(10) **Patent No.: US 7,692,599 B2**
(45) **Date of Patent: Apr. 6, 2010**

(54) **ULTRA-WIDEBAND SHORTED DIPOLE ANTENNA**

(75) Inventors: **Kin-Lu Wong**, Kaohsiung (TW); **Wei-Yu Li**, Yilan (TW); **Saou-Wen Su**, Taipei (TW)

(73) Assignees: **National Sun Yat-Sen University**, Kaohsiung (TW); **Lite-On Technology 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 0 days.

(21) Appl. No.: **12/007,919**

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

(65) **Prior Publication Data**

US 2008/0174505 A1 Jul. 24, 2008

(30) **Foreign Application Priority Data**

Jan. 18, 2007 (TW) ..... 96101962 A

(51) **Int. Cl.**
H01Q 9/28 (2006.01)
H01Q 9/16 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.** ..... **343/795**; 343/793; 343/700 MS

(58) **Field of Classification Search** 343/793–823
See application file for complete search history.

(56) **References Cited**

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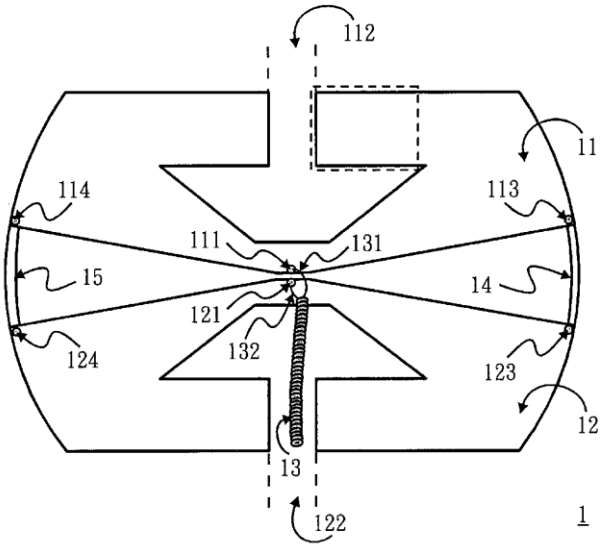
Primary Examiner—Vibol Tan
Assistant Examiner—Dylan White
(74) *Attorney, Agent, or Firm*—Bacon & Thomas, PLLC

(57) **ABSTRACT**

An ultra-wideband shorted dipole antenna includes a coaxial cable line and first and second open-loop radiating metal plates with substantially the same shape. The coaxial cable line has a central conducting wire and an outer grounder sheath. The first and second open-loop radiating metal plates are symmetrically disposed on two sides of the antenna to form two arms of the antenna and are electrically connected to each other. Each of the first and second open-loop radiating metal plates has a signal feeding point electrically connected to the central conducting wire or the outer grounder sheath of the coaxial cable line.

10 Claims, 9 Drawing Sheets



US007696927B2

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

(10) **Patent No.: US 7,696,927 B2**
(45) **Date of Patent: Apr. 13, 2010**

(54) **CAPACITIVE FEED ANTENNA**

(75) Inventors: **Charlie Bae**, Seoul (KR); **Haim Yona**, Tiberias (IL); **Snir Azulay**, Tiberias (IL); **Stefan Quantz**, Tianjin (CN); **Xiujuan Xu**, Tianjin (CN); **Xiao Da Tian**, Yin Hai Li Wuxi (CN)

(73) Assignee: **Galtronics Ltd.**, Tiberias (IL)

(*) 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.: **10/573,350**

(22) PCT Filed: **Mar. 12, 2006**

(86) PCT No.: **PCT/IL2006/000322**

§ 371 (c)(1),
(2), (4) Date: **Jul. 29, 2008**

(87) PCT Pub. No.: **WO2006/097918**

PCT Pub. Date: **Sep. 21, 2006**

(65) **Prior Publication Data**

US 2008/0291111 A1 Nov. 27, 2008

Related U.S. Application Data

(60) Provisional application No. 60/661,750, filed on Mar. 15, 2005, provisional application No. 60/749,364, filed on Dec. 9, 2005.

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

(52) **U.S. Cl.** ..... **343/700 MS**; 343/848

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

See application file for complete search history.

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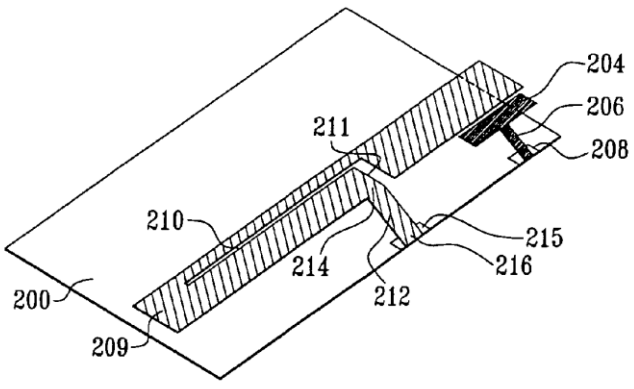
Primary Examiner—Tan Ho
(74) *Attorney, Agent, or Firm*—Abelman, Frayne & Schwab

(57) **ABSTRACT**

The present invention seeks to provide an antenna having multiple radiating bands, including a ground plane, a feed plate extending generally parallel to and being spaced from the ground plane by a first distance and having a feed connection extending between the feed plate and the ground plane, at least one radiating element extending generally parallel to and being spaced from the feed plate by a second distance and at least one galvanic connector connecting the at least one radiating element at a first location on the at least one radiating element to the ground plane at a first location on the ground plane, the first location on the ground plane being separated from the feed connection by a third distance, the first, second and third distances being selected to achieve desired impedance matching of the feed plate, and the feed plate feeding the at least one radiating element at a location corresponding to an impedance substantially greater than 50 Ohm at least one band.

26 Claims, 4 Drawing Sheets



US007696931B2

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

(10) **Patent No.: US 7,696,931 B2**
(45) **Date of Patent: Apr. 13, 2010**

(54) **ANTENNA FOR ENHANCING BANDWIDTH AND ELECTRONIC DEVICE HAVING THE SAME**

(75) Inventors: **Hong-Teuk Kim**, Gyeonggi-Do (KR); **Kyung-Hack Yi**, Seoul (KR); **Ho-Seon Lee**, Chungcheongnam-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 225 days.

(21) Appl. No.: **11/604,122**

(22) Filed: **Nov. 22, 2006**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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Nov. 24, 2005 (KR) 10-2005-0113152
Mar. 29, 2006 (KR) 10-2006-0028608

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

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

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

(56) **References Cited**

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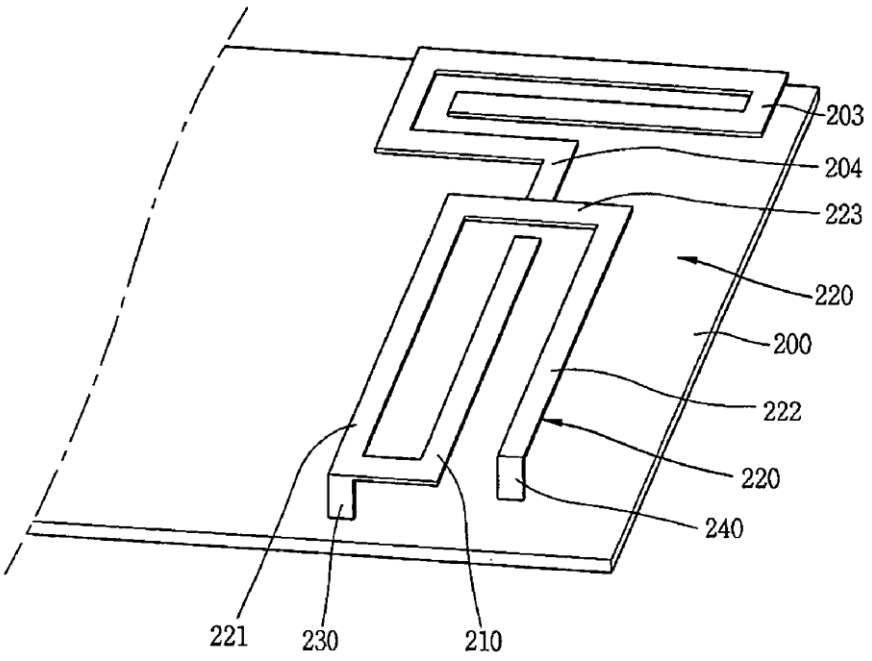
Primary Examiner—Trinh V Dinh
Assistant Examiner—Dieu Hien T Duong
(74) *Attorney, Agent, or Firm*—Lee, Hong, Degerman, Kang & Waimey

(57) **ABSTRACT**

An antenna comprises a high frequency antenna body, and a low frequency antenna body electrically connected to a point of the high frequency antenna body where a high frequency current distribution is minimized. By independently designing a high frequency bandwidth and a low frequency bandwidth from each other, an antenna having an optimum function in a desired frequency band can be easily fabricated.

24 Claims, 14 Drawing Sheets



US007696950B2

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

(10) **Patent No.: US 7,696,950 B2**
(45) **Date of Patent: Apr. 13, 2010**

(54) **ANTENNA WITH SYMMETRICAL FIRST AND SECOND MONOPOLE RADIATING ELEMENTS**

(75) Inventors: **Tiao-Hsing Tsai**, Tao Yuan Shien (TW); **Chao-Hsu Wu**, Tao Yuan Shien (TW); **Chieh-Ping Chiu**, Tao Yuan Shien (TW)

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

(*) 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.: **12/152,696**

(22) Filed: **May 15, 2008**

(65) **Prior Publication Data**

US 2009/0135069 A1 May 28, 2009

(30) **Foreign Application Priority Data**

Nov. 22, 2007 (TW) ..... 96144237 A

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

(52) **U.S. Cl.** **343/893**; 343/702; 343/806

(58) **Field of Classification Search** ..... 343/700 MS, 343/702, 806, 795, 803, 850, 853, 893, 895
See application file for complete search history.

(56) **References Cited**

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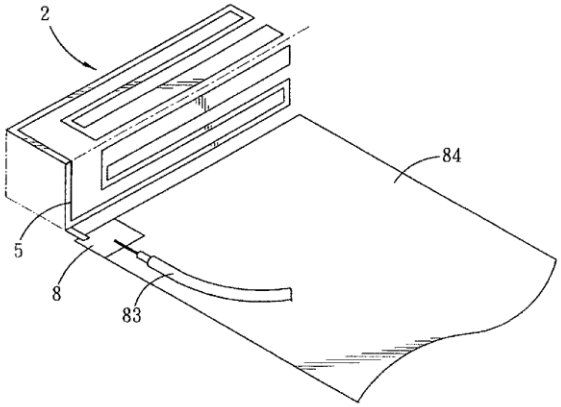
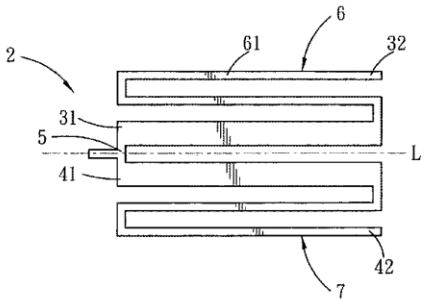
Primary Examiner—Michael C Wimer
(74) *Attorney, Agent, or Firm*—David N. Lathrop

(57) **ABSTRACT**

An antenna, which is operable in a digital video broadcasting for handhelds (DVB-H) frequency range, includes first and second monopole radiating elements and a feeding element. The first and second monopole radiating elements are symmetrical about an axis of symmetry and have a meandering shape. The feeding element interconnects the first and second monopole radiating elements.

10 Claims, 7 Drawing Sheets





US007701394B2

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

(10) **Patent No.: US 7,701,394 B2**
(45) **Date of Patent: Apr. 20, 2010**

(54) **PATCH ANTENNA**

(75) Inventors: **Anders Hook**, Hindas (SE); **Jessica Westerberg**, Gothenburg (SE); **Joakim Johansson**, Tollsjo (SE)

(73) Assignee: **Telefonaktiebolaget L M Ericsson (publ)**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 229 days.

(21) Appl. No.: **11/569,011**

(22) PCT Filed: **Jun. 10, 2004**

(86) PCT No.: **PCT/SE2004/000918**

§ 371 (c)(1),
(2), (4) Date: **Nov. 13, 2006**

(87) PCT Pub. No.: **WO2005/122330**

PCT Pub. Date: **Dec. 22, 2005**

(65) **Prior Publication Data**

US 2008/0012770 A1 Jan. 17, 2008

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.** ..... **343/700 MS**; 343/893; 343/725

(58) **Field of Classification Search** ..... 343/700 MS, 343/893, 725, 824, 826
See application file for complete search history.

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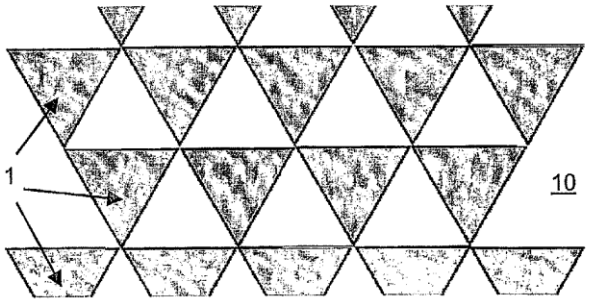
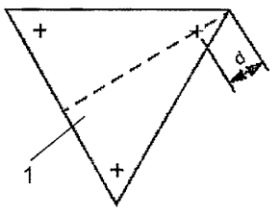
Primary Examiner—Douglas W Owens
Assistant Examiner—Jennifer F Hu
(74) *Attorney, Agent, or Firm*—Roger S. Burleigh

(57) **ABSTRACT**

A self-complementary patch antenna is disclosed. A hexagonal lattice (**10**) consisting of triangular conducting patches (**1**) is formed together with at least one dielectric layer onto a ground-plane. Each triangular patch is then fed by means of three RF signal probes in a symmetrical configuration positioned near each corner of the triangle, whereby an arbitrary lobe-steering and polarization state can be established by selection of amplitude and phase for each RF signal probe.

10 Claims, 3 Drawing Sheets





US007701400B2

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

(10) **Patent No.: US 7,701,400 B2**
(45) **Date of Patent: Apr. 20, 2010**

(54) **ANTENNA ASSEMBLY WITH A MOVEABLE ANTENNA**

(75) Inventors: **Wen-Fong Su**, Tu-Cheng (TW); **Lung-Sheng Tai**, Tu-Cheng (TW); **Yao-Shien Huang**, Tu-Cheng (TW); **Yu-Lung Shih**, Tu-Cheng (TW); **Li-Heng Cheng**, Tu-Cheng (TW)

(73) Assignee: **Hon Hai Precision Ind. Co., Ltd.**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 336 days.

(21) Appl. No.: **11/890,954**

(22) Filed: **Aug. 8, 2007**

(65) **Prior Publication Data**

US 2008/0036684 A1 Feb. 14, 2008

(30) **Foreign Application Priority Data**

Aug. 8, 2006 (TW) ..... 95128971 A

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

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

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

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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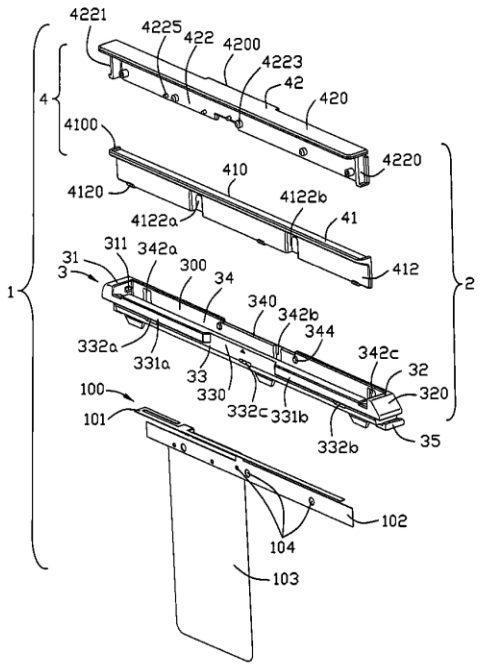
Primary Examiner—Trinh V Dinh
Assistant Examiner—Dieu Hien T Duong
(74) *Attorney, Agent, or Firm*—Wei Te Chung; Andrew C. Cheng; Ming Chieh Chang

(57) **ABSTRACT**

An antenna assembly with a movable antenna, assembled on an electronic device, includes a fixed portion adapted for assembling to said electronic device, an active portion movably assembled to the fixed portion and receiving the antenna therein, a first guiding means is served by some guiding slots formed on one of the fixed portion and the active portion and some guiding tabs corresponding to the guiding slots and formed on one of the active portion and the fixed portion; wherein the movable antenna capable of moving between a close position and an open position, and said guiding tabs are capable of sliding along the guiding slots and being stopped by the guiding slots to achieve the open position and close position of the antenna.

12 Claims, 4 Drawing Sheets



US007701401B2

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

(10) **Patent No.: US 7,701,401 B2**
(45) **Date of Patent: Apr. 20, 2010**

(54) **ANTENNA DEVICE HAVING NO LESS THAN TWO ANTENNA ELEMENTS**

(75) Inventors: **Hiromichi Suzuki**, Tokyo (JP); **Satoshi Mizoguchi**, Tokyo (JP); **Isao Ohba**, Tokyo (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 174 days.

(21) Appl. No.: **11/975,332**

(22) Filed: **Oct. 18, 2007**

(65) **Prior Publication Data**

US 2009/0009401 A1 Jan. 8, 2009

(30) **Foreign Application Priority Data**

Jul. 4, 2007 (JP) 2007-176503

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

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

(58) **Field of Classification Search** ..... 343/702, 343/700 MS, 846–848, 767
See application file for complete search history.

(56) **References Cited**

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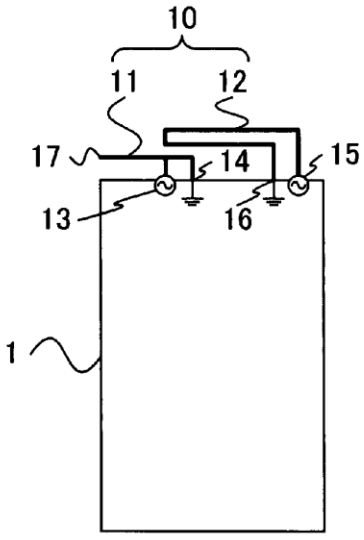
Primary Examiner—Huedung Mancuso
(74) *Attorney, Agent, or Firm*—Frishauf, Holtz, Goodman & Chick, P.C.

(57) **ABSTRACT**

An antenna device provided in a radio apparatus having a printed circuit board includes a first antenna element and a second antenna element. The first antenna element is configured to be fed and grounded at a first feed portion and at a first short-circuit portion both on the printed circuit board, respectively. The second antenna element is configured to be fed and grounded at a second feed portion and at a second short-circuit portion both on the printed circuit board, respectively. The second feed portion is located farther from the first feed portion than from the first short-circuit portion, farther than the first short-circuit portion is from the first feed portion, farther from the first short-circuit portion than from the second short-circuit portion, and farther than the second short-circuit portion is from the first short-circuit portion.

12 Claims, 6 Drawing Sheets



US007701402B2

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

(10) **Patent No.: US 7,701,402 B2**
(45) **Date of Patent: Apr. 20, 2010**

(54) **ANTENNA HAVING WIDE IMPEDANCE BANDWIDTHS BOTH AT LOW AND HIGH FREQUENCIES**

(75) Inventors: **Tiao-Hsing Tsai**, Yungho (TW); **Chieh-Ping Chiu**, Yunlin Shien (TW); **Chih-Wei Liao**, Yilan Shien (TW)

(73) Assignee: **Quanta Computer Inc.** (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 82 days.

(21) Appl. No.: **12/188,321**

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

(65) **Prior Publication Data**

US 2009/0179808 A1 Jul. 16, 2009

(30) **Foreign Application Priority Data**

Jan. 16, 2008 (TW) ..... 97101651 A

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

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

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

(56) **References Cited**

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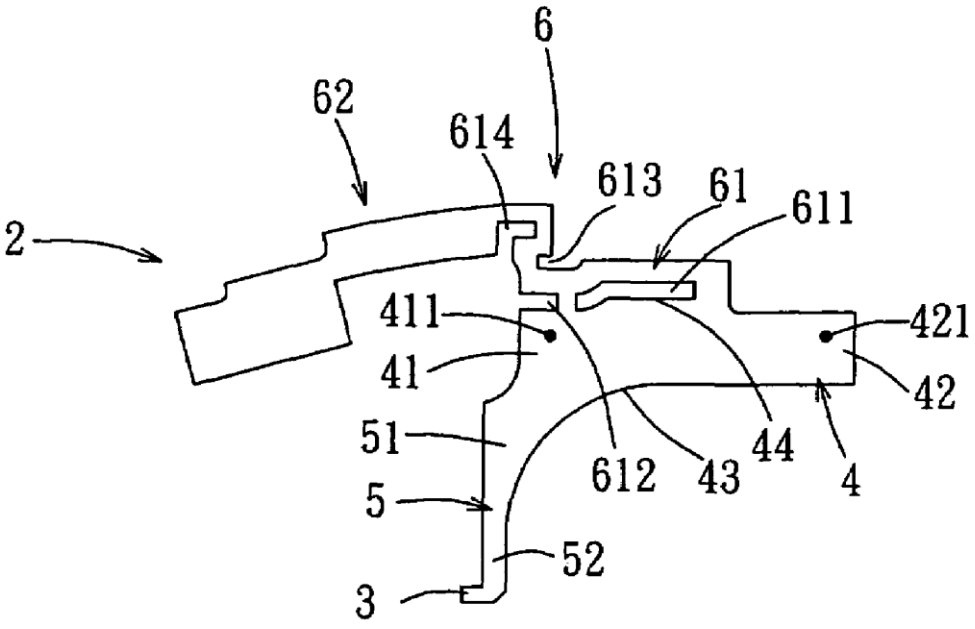
Primary Examiner—Tan Ho
(74) *Attorney, Agent, or Firm*—Sunstein Kahn Murphy & Timbers LLP

(57) **ABSTRACT**

An antenna includes a base element, grounding and feeding points, and first and second radiating elements. Each of the grounding and feeding points is provided on the base element. The first radiating element is operable in a first frequency band, and extends from the base element. The second radiating element is operable in a second frequency band lower than the first frequency band, extends from the base element, and is formed with a slot.

10 Claims, 6 Drawing Sheets



US007701407B2

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

(10) **Patent No.: US 7,701,407 B2**
(45) **Date of Patent: Apr. 20, 2010**

(54) **WIDE-BAND SLOT ANTENNA APPARATUS WITH STOP BAND**

(75) Inventors: **Hiroshi Kanno**, Osaka (JP); **Tomoyasu Fujishima**, Kanagawa (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 203 days.

(21) Appl. No.: **12/116,754**

(22) Filed: **May 7, 2008**

(65) **Prior Publication Data**

US 2008/0284670 A1 Nov. 20, 2008

(30) **Foreign Application Priority Data**

May 8, 2007 (JP) 2007-123206

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

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

(58) **Field of Classification Search** ..... 343/767, 343/768, 770, 700 MS, 846
See application file for complete search history.

(56) **References Cited**

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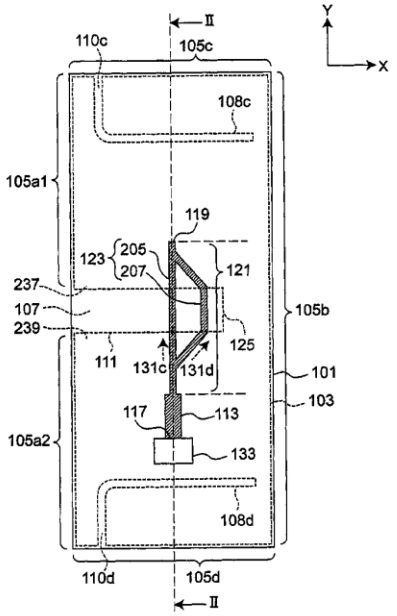
Primary Examiner—Hoang V Nguyen
(74) *Attorney, Agent, or Firm*—Wenderoth, Lind & Ponack, L.L.P.

(57) **ABSTRACT**

A slot antenna apparatus includes a grounding conductor having an outer edge including a first portion facing a radiation direction and a second portion other than the first portion, a one-end-open feed slot formed in the grounding conductor along the radiation direction such that an open end is provided at a center of the first portion, and a feed line including a strip conductor close to the grounding conductor and intersecting with the feed slot at at least a part thereof to feed a radio frequency signal to the feed slot. The slot antenna apparatus further comprises at least one one-end-open parasitic slot having an electrical length equivalent to one-quarter effective wavelength in a certain stop band, the parasitic slot having an open end at the second portion, and being formed in the grounding conductor so as not to intersect with the feed line.

5 Claims, 29 Drawing Sheets



US007705783B2

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

(10) **Patent No.: US 7,705,783 B2**
(45) **Date of Patent: Apr. 27, 2010**

(54) **SLOT-STRIP ANTENNA APPARATUS FOR A RADIO DEVICE OPERABLE OVER MULTIPLE FREQUENCY BANDS**

(75) Inventors: **Qinjiang Rao**, Waterloo (CA); **Geyi Wen**, Waterloo (CA); **Mark Pecen**, Waterloo (CA)

(73) Assignee: **Research In Motion Limited**, Waterloo (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 424 days.

(21) Appl. No.: **11/697,349**

(22) Filed: **Apr. 6, 2007**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.** ..... **343/700 MS**; 343/770

(58) **Field of Classification Search** ..... 343/700 MS, 343/702, 770, 895
See application file for complete search history.

(56) **References Cited**

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2008/0231532	A1 *	9/2008	Rao et al.	343/770

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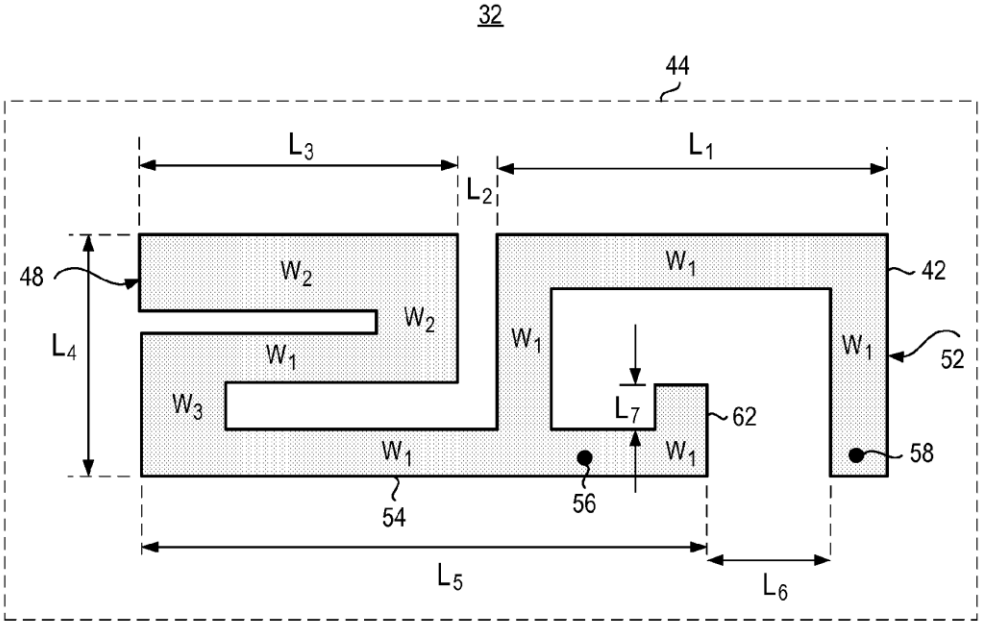
Primary Examiner—Shih-Chao Chen

(57) **ABSTRACT**

A hybrid slot-strip antenna apparatus, and an associated methodology, for a multi-mode mobile station or other radio device. The antenna is formed of a plurality of slot-strips disposed upon a printed circuit board, or other substrate. The antenna is defined by width and length design parameters, the selections of which are determinative of the antenna functionality. Through appropriate selection of the design parameters, the antenna is operable, that is, resonant, at each of the frequency bands of the multi-mode mobile station.

15 Claims, 9 Drawing Sheets



US007705784B2

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

(10) **Patent No.: US 7,705,784 B2**
(45) **Date of Patent: Apr. 27, 2010**

(54) **MULTI-FREQUENCY ANTENNA**

(75) Inventors: **Ying-Jiunn Lai**, Taipei Hsien (TW); **Jiunn-Ming Huang**, Taipei Hsien (TW); **Kuan-Hsueh Tseng**, Taipei Hsien (TW)

(73) Assignee: **Wistron NeWeb Corp.**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 419 days.

(21) Appl. No.: **11/853,020**

(22) Filed: **Sep. 11, 2007**

(65) **Prior Publication Data**

US 2008/0136711 A1 Jun. 12, 2008

(30) **Foreign Application Priority Data**

Dec. 7, 2006 (TW) ..... 95145782 A

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

(52) **U.S. Cl.** ..... **343/700 MS**; 343/702; 343/846; 343/848

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

(56) **References Cited**

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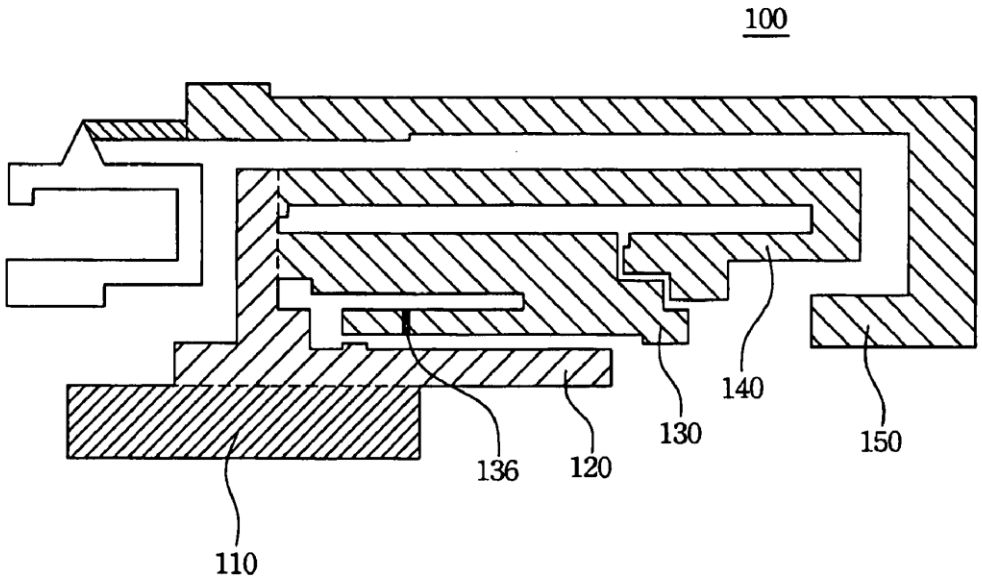
Primary Examiner—Douglas W Owens
Assistant Examiner—Chuc D Tran
(74) *Attorney, Agent, or Firm*—Pai Patent & Trademark Law Firm; Chao-Chang David Pai

(57) **ABSTRACT**

A multi-frequency antenna for receiving a first frequency and second frequency signals comprises a grounding element, a first conductive member, a first radiation member, and a second radiation member. The first conductive member connects to the grounding element. The first radiation member and the second radiation member connect to the first conductive member separately. The multi-frequency antenna further comprises a parasitic structure. The parasitic structure structurally encircles the second radiation member and the encirclement is a partial encirclement. Moreover, the parasitic structure connects to the grounding element.

30 Claims, 18 Drawing Sheets



US007705786B2

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

(10) **Patent No.: US 7,705,786 B2**
(45) **Date of Patent: Apr. 27, 2010**

(54) **ANTENNA FOR MOBILE TELEPHONE HANDSETS, PDAS, AND THE LIKE**

(75) Inventors: **Devis Iellici**, Cambridge (GB); **Simon Philip Kingsley**, Cambridge (GB); **James William Kingsley**, Cambridge (GB); **Steven Gregory O'Keefe**, Queensland (AU)

(73) Assignee: **Antenova Ltd.**, Cambridge (GB)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 554 days.

(21) Appl. No.: **10/582,641**

(22) PCT Filed: **Dec. 10, 2004**

(86) PCT No.: **PCT/GB2004/005158**

§ 371 (c)(1),
(2), (4) Date: **Jun. 12, 2006**

(87) PCT Pub. No.: **WO2005/057722**

PCT Pub. Date: **Jun. 23, 2005**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 12, 2003 (GB) 0328811.5

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

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

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

See application file for complete search history.

(56) **References Cited**

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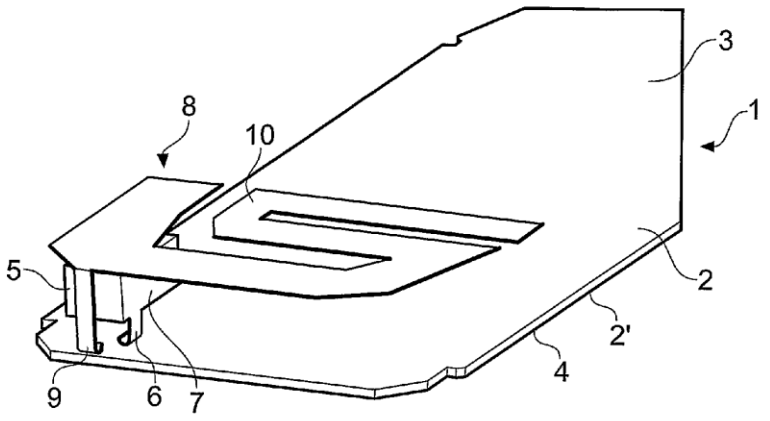
Primary Examiner—Trinh V Dinh
Assistant Examiner—Dieu Hien T Duong
(74) *Attorney, Agent, or Firm*—Pearl Cohen Zedek Latzer, LLP

(57) **ABSTRACT**

The present invention relates to an antenna structure comprising a dielectric pellet and a dielectric substrate with upper and lower surfaces and at least one groundplane, wherein the dielectric pellet is elevated above the upper surface of the dielectric substrate such that the dielectric pellet does not directly contact the dielectric substrate or the groundplane, and wherein the dielectric pellet is provided with a conductive direct feed structure. A radiating antenna component is additionally provided and arranged so as to be excited by the dielectric pellet. Elevating the dielectric antenna component so that it does not directly contact the groundplane or the dielectric substrate significantly improves bandwidth of the antenna as a whole.

27 Claims, 11 Drawing Sheets



US007705787B2

(12) **United States Patent**
Ponce De Leon et al.

(10) **Patent No.: US 7,705,787 B2**
(45) **Date of Patent: Apr. 27, 2010**

(54) **COUPLED SLOT PROBE ANTENNA**

(75) Inventors: **Lorenzo A. Ponce De Leon**, Lake Worth, FL (US); **Naveed Mirza**, Boynton Beach, FL (US); **Paul Morningstar**, North Lauderdale, FL (US)

(73) Assignee: **Motorola, Inc.**, Schaumburg, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 79 days.

(21) Appl. No.: **11/691,186**

(22) Filed: **Mar. 26, 2007**

(65) **Prior Publication Data**

US 2008/0238780 A1 Oct. 2, 2008

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

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

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

See application file for complete search history.

(56) **References Cited**

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JP	2007028255	A	2/2007
KR	1020030082101	A	10/2003
KR	1020060122046	A	11/2006

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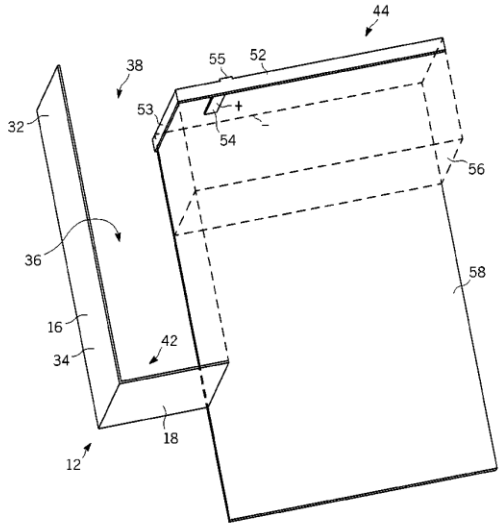
Primary Examiner—Douglas W Owens
Assistant Examiner—Dieu Hien T Duong

(57) **ABSTRACT**

A coupled slot probe antenna for use with antenna structures in mobile communication devices, such as cellular telephones and other wireless communication devices. The coupled slot probe antenna includes at least one first conductive element, and a second conductive element coupled between the first conductive element and the printed circuit board (PCB) ground plane of the mobile communication device. The first and second conductive elements define a tunable coupled slot area and the coupled slot probe antenna is coupled to the PCB ground plane in such a way that the coupled slot area is near a low-impedance point of the antenna structure, wherein coupling therebetween improves the bandwidth and the efficiency of the antenna structure. The coupled slot area can be tuned by changing the size of the coupled slot area and by changing the position of the coupled slot area relative to the low-impedance point of the antenna structure.

19 Claims, 6 Drawing Sheets



US007705788B2

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

(10) **Patent No.: US 7,705,788 B2**
(45) **Date of Patent: Apr. 27, 2010**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Chen-Ta Hung**, Tu-Cheng (TW); **Shang-Jen Chen**, Tu-Cheng (TW); **Hsien-Sheng Tseng**, Tu-Cheng (TW)

(73) Assignee: **Hon Hai Precision Ind. Co., Ltd.**, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 175 days.

(21) Appl. No.: **11/825,889**

(22) Filed: **Jul. 9, 2007**

(65) **Prior Publication Data**

US 2008/0007469 A1 Jan. 10, 2008

(30) **Foreign Application Priority Data**

Jul. 7, 2006 (CN) 2006 1 0086343

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

(52) **U.S. Cl.** ..... **343/702**; 343/700 MS; 343/803; 343/846; 343/853

(58) **Field of Classification Search** ..... 343/700 MS, 343/846, 853, 895, 702, 803
See application file for complete search history.

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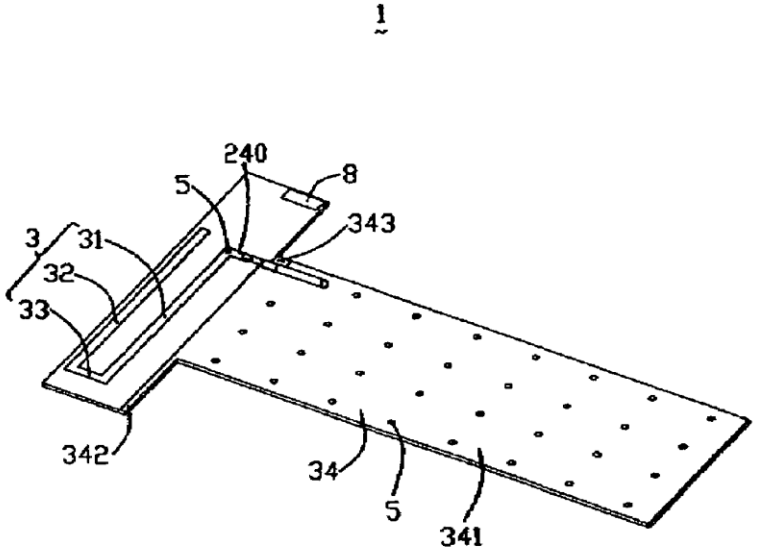
(57) **ABSTRACT**

A multi-band antenna used in a portable electrical device can operate in WWAN. The multi-band antenna includes a PCB, a first antenna body, and a second antenna body. The PCB has a first surface and an opposite second surface and defines a through hole extending from the first surface to the second surface. The first antenna body is formed on the first surface of the PCB comprising a first radiating element and a first grounding element. The second antenna body is formed on the second surface of the PCB. The second antenna body comprises a second radiating element, a second grounding element, and a connecting element connecting the second radiating element and the second grounding element. The first radiating element and the second radiating element electrically connect with each other via the through hole of the PCB. A feeding line has an inner conductor electrically connecting to the first radiating element and an outer conductor electrically connecting to the first grounding element.

19 Claims, 4 Drawing Sheets



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(54) **ANTENNA HAVING A PLURALITY OF RESONANT FREQUENCIES**

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See application file for complete search history.

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(57) **ABSTRACT**

An antenna having a plurality of resonant frequencies and including a ground plane having an edge; a feed point; a ground point; and

an antenna track extending between the feed point and the ground point and comprising, in series connection, a first loop and a second loop wherein a least a portion of the first loop and a portion of the second loop are adjacent at least the edge of the ground plane.

19 Claims, 5 Drawing Sheets