



US007408510B2

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

(10) **Patent No.:** **US 7,408,510 B2**

(45) **Date of Patent:** **Aug. 5, 2008**

(54) **PATCH ANTENNA**

(75) Inventors: **Sadahiko Yamamoto**, Osaka (JP);
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(73) Assignee: **SANYO Electric Co., Ltd.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 52 days.

(21) Appl. No.: **10/566,817**

(22) PCT Filed: **Jul. 30, 2004**

(86) PCT No.: **PCT/JP2004/011330**

§ 371 (c)(1),

(2), (4) Date: **Jan. 26, 2006**

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PCT Pub. Date: **Feb. 10, 2005**

(65) **Prior Publication Data**

US 2006/0227051 A1 Oct. 12, 2006

(30) **Foreign Application Priority Data**

Aug. 1, 2003 (JP) 2003-284755

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

(52) **U.S. Cl.** **343/700 MS; 343/700 MS;**
343/702; 343/828; 343/829; 343/846

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

See application file for complete search history.

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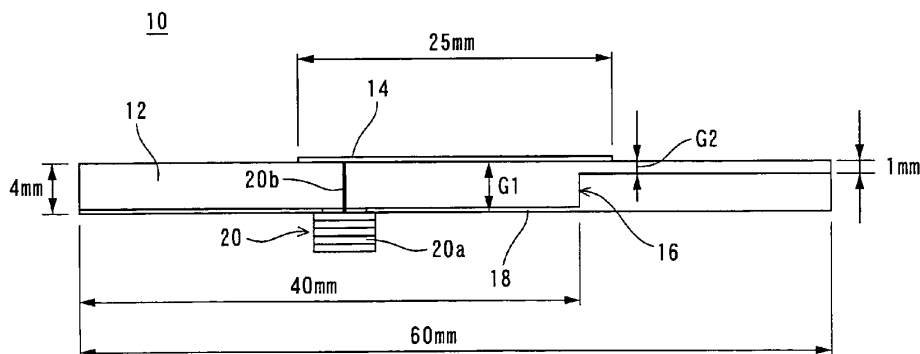
Primary Examiner—Trinh V Dinh

(74) *Attorney, Agent, or Firm*—Gerald T. Bodner

(57) **ABSTRACT**

A patch antenna (10) includes a dielectric substrate (12), a patch conductor (14) and a ground conductor (18) formed on both surfaces thereof. A step (16) is formed on the lower surface of the dielectric substrate, which makes a spacing between the patch conductor and the ground conductor non-uniform in a direction of length of the patch conductor. By making nonuniform the spacing between the patch conductor and the ground conductor in the direction of length of the patch conductor, radiation efficiency and antenna gain are changed in that direction, resulting in asymmetrical directivity.

6 Claims, 7 Drawing Sheets



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US007408511B2

(12) **United States Patent**
Liu

(10) **Patent No.:** **US 7,408,511 B2**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **MIMO ANTENNA CONFIGURATION**

(75) Inventor: **I-Ru Liu**, Taipei (TW)

(73) Assignee: **Accton 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 247 days.

(21) Appl. No.: **11/342,708**

(22) Filed: **Jan. 31, 2006**

(65) **Prior Publication Data**

US 2007/0176829 A1 Aug. 2, 2007

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 1/42 (2006.01)

H01Q 9/16 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/872;
343/793

(58) **Field of Classification Search** 343/700 MS,
343/793, 872, 893

See application file for complete search history.

(56) **References Cited**

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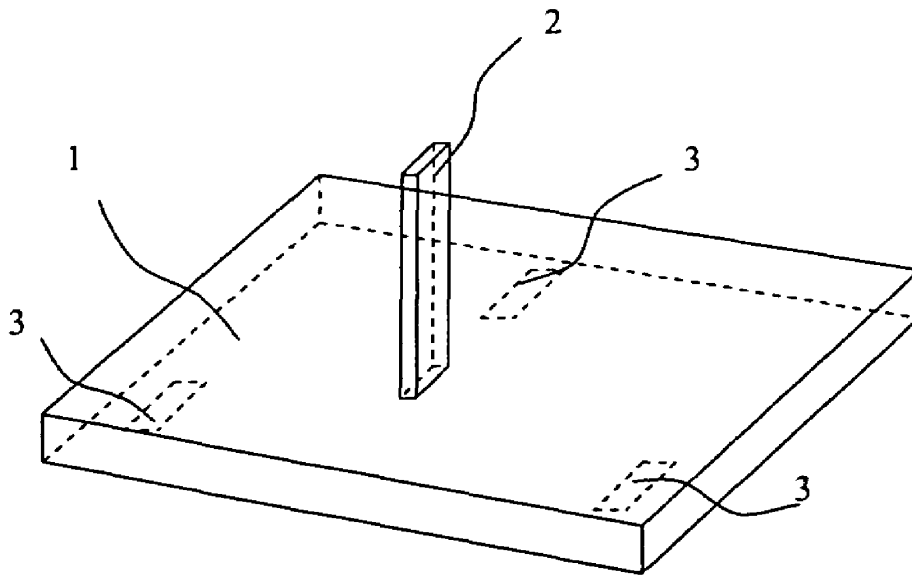
Primary Examiner—Shih-Chao Chen

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

(57) **ABSTRACT**

The present invention provides a MIMO antenna structure and design. A single dipole antenna stands at the center of a triangle which is formed by three PIFAs antennas, and the three PIFA antennas has equal squint angle relative to the neighbors, that is there is 120° sector angle between any two PIFA axes of three such that the dipole and the other PIFAs forms a tetrahedron. The MIMO antenna structure of the present invention is simpler in mechanics but high efficiency in performance.

22 Claims, 7 Drawing Sheets



Convex Cubical antenna Structure
($0^\circ \leq \phi \leq 360^\circ$, $0^\circ \leq \theta \leq 90^\circ$ symmetrically)



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US007408512B1

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

(10) **Patent No.:** **US 7,408,512 B1**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **ANTENNA WITH DISTRIBUTED STRIP AND INTEGRATED ELECTRONIC COMPONENTS**

(75) Inventors: **Christopher T. Rodenbeck**,
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Albuquerque, NM (US); **Cory W. Ottesen**,
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(73) Assignee: **Sandie Corporation**, Albuquerque, MN
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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 359 days.

(21) Appl. No.: **11/415,931**

(22) Filed: **May 2, 2006**

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/243,860,
filed on Oct. 5, 2005, now Pat. No. 7,345,647.

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

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

(58) **Field of Classification Search** **343/895,**
343/700 MS, 702, 767, 749, 830, 846
See application file for complete search history.

(56) **References Cited**

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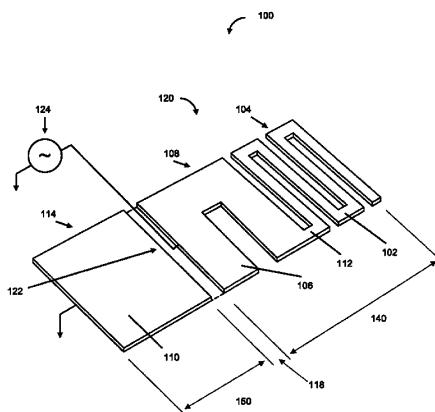
Primary Examiner—Huedung Cao Mancuso

(74) *Attorney, Agent, or Firm*—William R. Conley

(57) **ABSTRACT**

An antenna comprises electrical conductors arranged to form a radiating element including a folded line configuration and a distributed strip configuration, where the radiating element can be in proximity to a ground conductor and/or arranged as a dipole. Embodiments of the antenna include conductor patterns formed on a printed wiring board, having a ground plane, spacedly adjacent to and coplanar with the radiating element. An antenna can comprise a distributed strip patterned on a printed wiring board, integrated with electronic components mounted on top of or below the distributed strip, and substantially within the extents of the distributed strip. Mounting of electronic components on top of or below the distributed strip has little effect on the performance of the antenna, and allows for realizing the combination of the antenna and integrated components in a compact form. An embodiment of the invention comprises an antenna including a distributed strip, integrated with a battery mounted on the distributed strip.

24 Claims, 13 Drawing Sheets



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US007408513B1

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

(10) **Patent No.:** **US 7,408,513 B1**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Masahiro Yanagi**, Shinagawa (JP);
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Kaneko, Shinagawa (JP); **Yuriko**
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(73) Assignee: **Fujitsu Component Limited**, Tokyo
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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/580,910**

(22) Filed: **Oct. 16, 2006**

(30) **Foreign Application Priority Data**

Mar. 30, 2006 (JP) 2006-094459

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

(52) **U.S. Cl.** **343/700 MS; 343/702;**
343/906; 343/846

(58) **Field of Classification Search** 343/700 MS,
343/846, 702, 906

See application file for complete search history.

(56) **References Cited**

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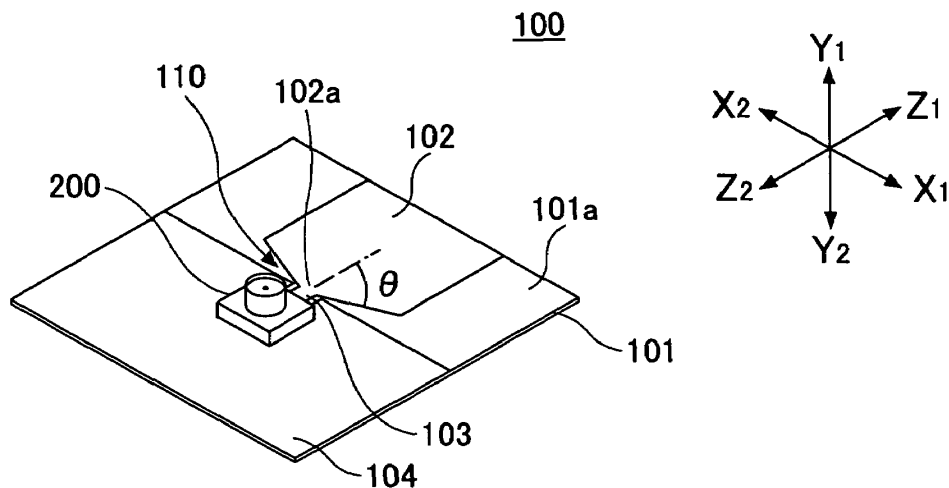
Primary Examiner—Hoang V Nguyen

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

(57) **ABSTRACT**

A disclosed antenna apparatus includes a base made of a
dielectric material; an antenna element pattern formed on a
surface of the base; a ground pattern formed in a position
adjacent to and opposite to the antenna element pattern on the
same surface of the base; and a surface-mounted coaxial
connector mounted on the ground pattern in a position close
to a feeding point of the antenna element pattern.

7 Claims, 7 Drawing Sheets



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US007408515B2

(12) **United States Patent**
Leisten

(10) **Patent No.:** **US 7,408,515 B2**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **MOBILE COMMUNICATION DEVICE AND AN ANTENNA ASSEMBLY FOR THE DEVICE**

(75) Inventor: **Oliver Paul Leisten**, Northampton (GB)

(73) Assignee: **Sarantel Limited**, Wellingborough (GB)

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

(21) Appl. No.: **11/263,643**

(22) Filed: **Oct. 31, 2005**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 22, 2005 (GB) 0519371.9

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

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

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

(56) **References Cited**

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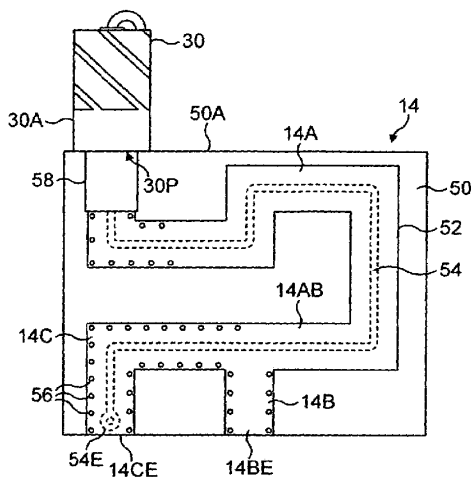
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—John Bruckner PC

(57) **ABSTRACT**

A mobile communication device has an antenna assembly comprising the combination of an inverted-F antenna and a dielectrically-loaded quadrifilar helical antenna, the latter mounted on the distal end of an elongate radiator element of the inverted-F antenna. The dielectrically-loaded antenna has an integral balun on a ceramic antenna core, the balun providing a balanced feed for the radiating elements of the antenna. The elongate radiator structure of the inverted-F antenna acts as a feed path for the dielectrically-loaded antenna, the feed path extending along the elongate radiator structure from the balun to a ground connection element of the inverted-F antenna and, thence, to a signal port associated with a grounding connection of the inverted-F antenna. Placing the dielectrically-loaded quadrifilar antenna at the end of the radiator structure of the inverted-F antenna rather than alongside the latter substantially reduces breakthrough from a transmitter coupled to the inverted-F antenna to receiving circuitry coupled to the dielectrically-loaded antenna.

28 Claims, 6 Drawing Sheets



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US007408517B1

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

(10) **Patent No.:** **US 7,408,517 B1**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **TUNABLE CAPACITIVELY-LOADED
MAGNETIC DIPOLE ANTENNA**

(75) Inventors: **Gregory Poilasne**, San Diego, CA (US);
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(US)

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

(21) Appl. No.: **11/339,926**

(22) Filed: **Jan. 25, 2006**

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/940,935,
filed on Sep. 14, 2004, now Pat. No. 7,239,290.

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

(52) **U.S. Cl.** **343/742; 343/867; 343/793;**
343/702

(58) **Field of Classification Search** 343/742,
343/866, 867, 702, 793
See application file for complete search history.

(56) **References Cited**

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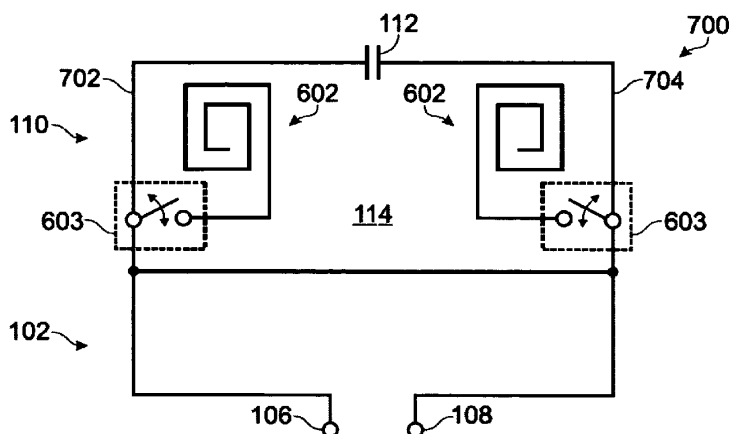
Primary Examiner—Trinh Vo Dinh

Assistant Examiner—Dieu Hien T Duong

(57) **ABSTRACT**

A frequency-tunable capacitively-loaded magnetic dipole antenna includes a transformer loop having a balanced feed interface, and a capacitively-loaded magnetic dipole radiator with a tunable effective electrical length. In one embodiment, the capacitively-loaded magnetic dipole radiator includes a tunable electric field bridge. For example, the capacitively-loaded magnetic dipole radiator may comprise a quasi loop with a tunable electric field bridge interposed between the quasi loop first and second ends. The electric field bridge may be an element such as a ferroelectric (FE) tunable capacitor or a microelectromechanical system (MEMS) capacitor, to name a couple of examples. In certain embodiments, the capacitively-loaded magnetic dipole radiator includes a quasi loop with a loop perimeter. The effective electrical length of the radiator is changed by adjusting the perimeter using an element such as a MEMS switch, or a semiconductor switch.

20 Claims, 5 Drawing Sheets



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US007408522B2

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

(10) **Patent No.:** **US 7,408,522 B2**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **ANTENNA-FEEDER DEVICE AND ANTENNA**

(75) Inventors: **Jiho Ahn**, 105-601, Samhwan Apt.,
897-2, Shingil 7-Dong,
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Bankov, Moscow (RU); **Alexander**
Davydov, Kanischevo (RU)

(73) Assignee: **Jiho Ahn**, Shingil 7-Dong,
Yongdeungpo-Gu, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 164 days.

(21) Appl. No.: **11/287,979**

(22) Filed: **Nov. 28, 2005**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 31, 2005 (RU) 2005116584

(51) **Int. Cl.**
H01Q 13/00 (2006.01)

(52) **U.S. Cl.** **343/781 CA; 343/781 P**

(58) **Field of Classification Search** **343/781 CA,**
343/781 P, 836, 837, 840

See application file for complete search history.

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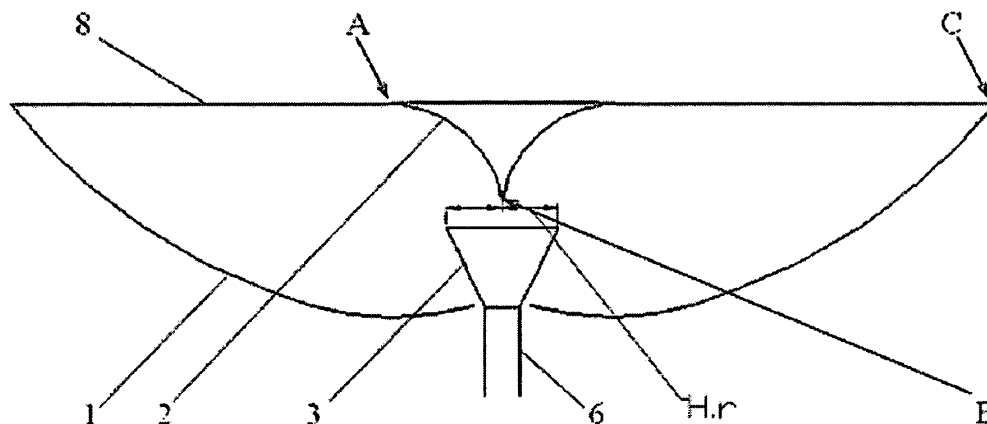
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Park Law Firm; John K. Park

(57) **ABSTRACT**

An antenna comprises: a main reflector being a body of revolution of parabolic shape; a sub-reflector being a body of the revolution of elliptic shape having a circle and a vertex oriented to the main reflector and being placed between the circle and the main reflector, one focal point of the sub-reflector being placed on the axis of revolution and the other focal point of the sub-reflector being placed out of the axis, the sub-reflector circle being placed in the plane of the main reflector edge circle; a radiator being placed along the axis of revolution of the main reflector and being placed between the main reflector and the sub-reflector; and wherein the sub-reflector has eccentricity ranging from 0.55 to 0.75.

14 Claims, 8 Drawing Sheets



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US007408524B2

(12) **United States Patent**
Ogino

(10) **Patent No.:** **US 7,408,524 B2**
(45) **Date of Patent:** **Aug. 5, 2008**

(54) **LOOP ANTENNA**

7,253,773 B2 * 8/2007 Chiba et al. 343/702

(75) Inventor: **Kazushige Ogino**, Kobe (JP)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **Fujitsu Ten Limited**, Kobe-shi (JP)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 55 days.

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(21) Appl. No.: **11/391,756**

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(22) Filed: **Mar. 28, 2006**

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(65) **Prior Publication Data**

US 2006/0220977 A1 Oct. 5, 2006

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(30) **Foreign Application Priority Data**

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Feb. 7, 2006 (JP) 2006-029953

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(51) **Int. Cl.**

H01Q 7/00 (2006.01)

H01Q 1/32 (2006.01)

Primary Examiner—Huedung Mancuso

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

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

(58) **Field of Classification Search** **343/866;**

343/702, 741, 700 MS, 855

See application file for complete search history.

(57)

ABSTRACT

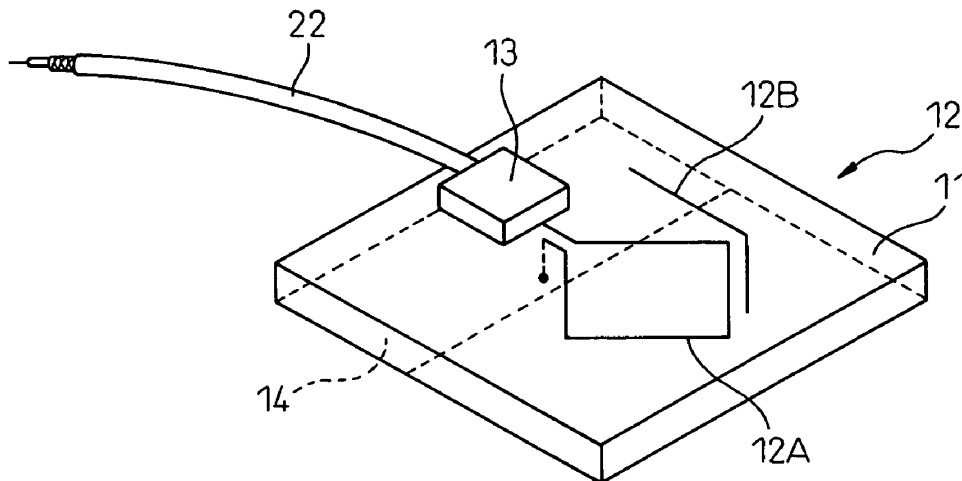
A loop antenna providing a reception performance equivalent to a patch antenna receiving a circularly polarized wave, simple in configuration, and kept low in cost, which forms a loop element and a parasitic element provided independently of this loop element on the same dielectric board to form an antenna element and sends or receives a circularly polarized wave by this antenna element, provides a metal plate parallel with or having a slight inclination with respect to the dielectric board, and sets this metal plate separated from the dielectric board by exactly a predetermined distance.

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16 Claims, 16 Drawing Sheets



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US007411552B2

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

(10) **Patent No.:** **US 7,411,552 B2**
(45) **Date of Patent:** **Aug. 12, 2008**

(54) **GROUNDING ANTENNA FOR A WIRELESS COMMUNICATION DEVICE AND METHOD**

(75) Inventors: **Patrick F King**, Glen Ellyn, IL (US);
Ian J Forster, Essex (GB)

(73) Assignee: **Mineral Lassen LLC**, Las Vegas, NV (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 42 days.

(21) Appl. No.: **11/506,407**

(22) Filed: **Aug. 17, 2006**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 10/131,575, filed on Apr. 24, 2002, now Pat. No. 7,098,850, which is a continuation-in-part of application No. 09/678,271, filed on Oct. 3, 2000, now Pat. No. 6,501,435, which is a continuation-in-part of application No. 09/618,505, filed on Jul. 18, 2000, now Pat. No. 6,483,473.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
G08B 13/14 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 340/572.1**

(58) **Field of Classification Search** **343/793, 795, 893, 846; 340/572.1**
See application file for complete search history.

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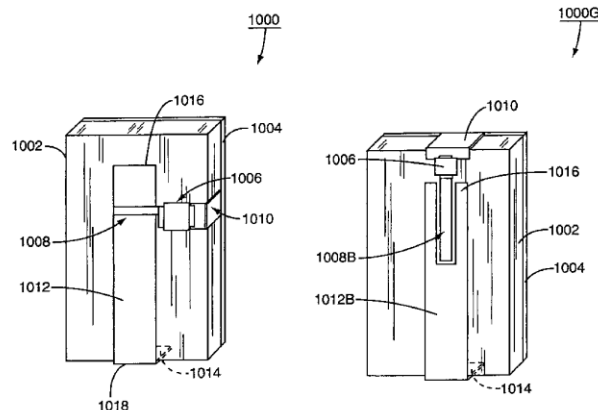
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Christensen O'Connor Johnson Kindness PLLC

(57) **ABSTRACT**

A wireless communication device includes an antenna for wireless communication with a remote interrogator. Several embodiments are disclosed to increase the options available to designers of wireless communication devices. In some embodiments, the antenna is a quarter wavelength long with one end of the antenna being grounded to provide desired impedance matching characteristics. The position of the ground plane relative to the antenna is also varied between embodiments. The connection from a wireless communication chip to the antenna is also varied between embodiments to provide alternate structures.

36 Claims, 30 Drawing Sheets



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US007411554B2

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

(10) **Patent No.:** **US 7,411,554 B2**
(45) **Date of Patent:** **Aug. 12, 2008**

(54) **MIMO ANTENNA OPERABLE IN MULTIBAND**

(75) Inventors: **Chang-won Jung**, Yongin-si (KR);
Byung-tae Yoon, Yongin-si (KR);
Young-eil Kim, Yongin-si (KR);
Se-hyun Park, Yongin-si (KR)

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

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

(21) Appl. No.: **11/637,663**

(22) Filed: **Dec. 13, 2006**

(65) **Prior Publication Data**

US 2008/0018539 A1 Jan. 24, 2008

(30) **Foreign Application Priority Data**

Jul. 20, 2006 (KR) 10-2006-0068208

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 3/24 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS, 343/702, 754, 876, 850, 853, 895**
See application file for complete search history.

(56) **References Cited**

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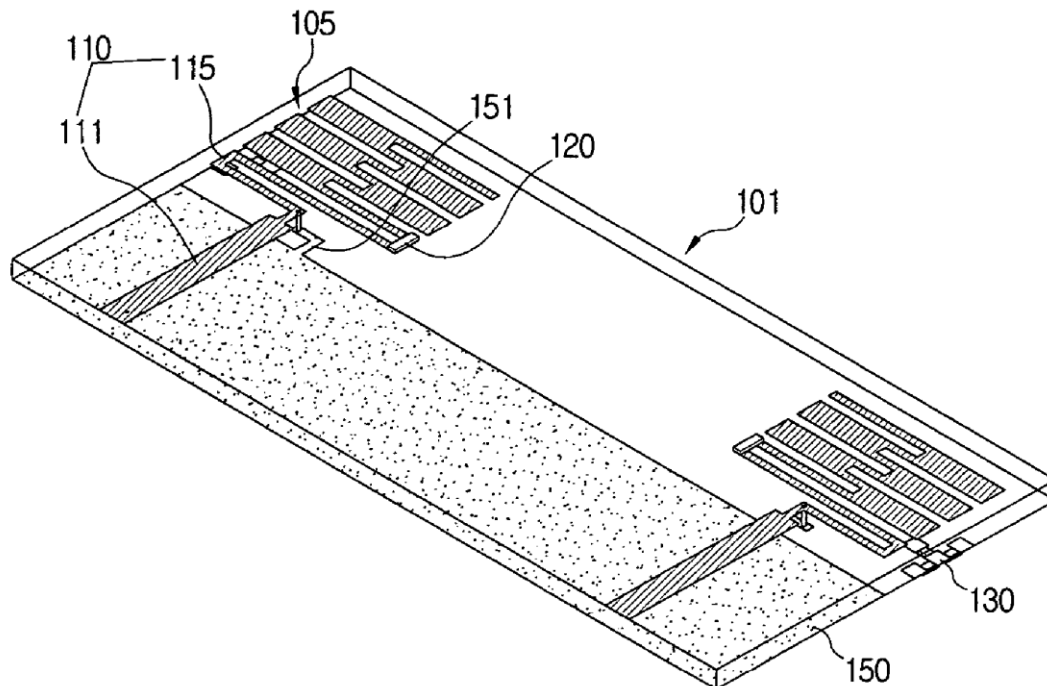
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Sughrue Mion, PLLC

(57) **ABSTRACT**

A multiple-input multiple-output (MIMO) antenna operable in a multiband includes a plurality of antenna elements each including a radiator radiating electromagnetic waves, a ground connected to the radiator, at least one switching element mounted in an area of lengthwise direction of the radiator and short-circuiting or opening the area of the radiator.

16 Claims, 6 Drawing Sheets



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US007411555B2

(12) **United States Patent**
McInnis

(10) **Patent No.:** **US 7,411,555 B2**
(45) **Date of Patent:** **Aug. 12, 2008**

(54) **FOLDED MONOPOLE ANTENNA, BENT, TAPPED, OR BOTH, AND SYSTEMS INCORPORATING SAME**

(75) Inventor: **A. J. McInnis**, Santa Rosa, CA (US)

(73) Assignee: **Texas Instruments Incorporated**,
Dallas, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 615 days.

(21) Appl. No.: **10/716,798**

(22) Filed: **Nov. 19, 2003**

(65) **Prior Publication Data**
US 2004/0166908 A1 Aug. 26, 2004

Related U.S. Application Data

(60) Provisional application No. 60/448,755, filed on Feb. 20, 2003.

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

(52) **U.S. Cl.** **343/702; 343/795; 343/828**

(58) **Field of Classification Search** **343/702, 343/700 MS, 826, 803, 804, 713, 795, 828, 343/829**

See application file for complete search history.

(56) **References Cited**

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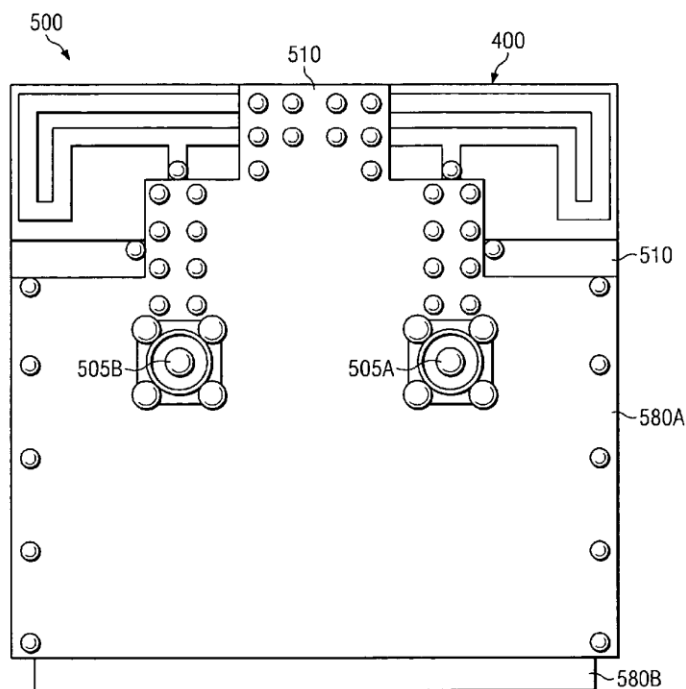
Primary Examiner—Michael C. Wimer

(74) *Attorney, Agent, or Firm*—Steven A. Shaw; W. James Brady; Frederick J. Telecky, Jr.

(57) **ABSTRACT**

Various antenna designs that are small and cost effective are disclosed. In one design, the antenna is a bent and folded monopole antenna. In another design, the antenna is a folded and tapped monopole antenna. In yet another design, the antenna is a folded, bent, and tapped monopole antenna. The antennas may be part of a system using two back-to-back symmetric antennas. The antennas may be part of a modem, such as a wireless computer modem or a wireless handset.

16 Claims, 4 Drawing Sheets



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US007411560B2

(12) **United States Patent**
Jordan

(10) **Patent No.:** **US 7,411,560 B2**
(45) **Date of Patent:** **Aug. 12, 2008**

(54) **LOW PROFILE ANTENNAS AND DEVICES**

(75) Inventor: **David Frederick Jordan**, Danville, NH (US)

(73) Assignee: **M/A-Com, Inc.**, Lowell, MA (US)

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

(21) Appl. No.: **11/537,616**

(22) Filed: **Sep. 30, 2006**

(65) **Prior Publication Data**

US 2008/0079643 A1 Apr. 3, 2008

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

(52) **U.S. Cl.** **343/725; 343/702; 343/895; 343/846**

(58) **Field of Classification Search** **343/725**
See application file for complete search history.

(56) **References Cited**

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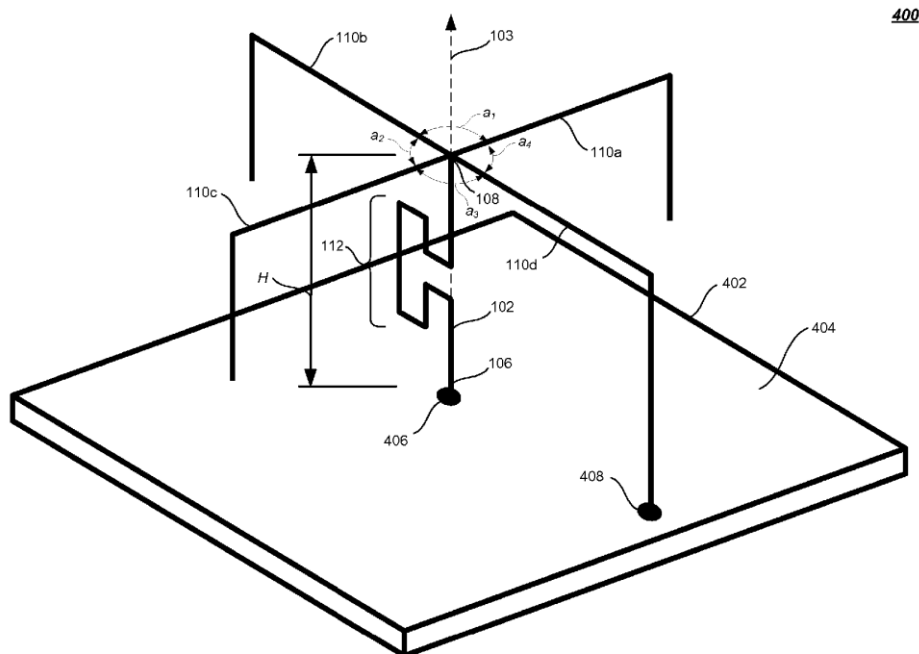
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Primary Examiner—Trinh V Dinh

(57) **ABSTRACT**

An apparatus includes a monopole extending substantially along an axis that may be vertical. However, the monopole may have a loop portion that deviates from the axis. Further, the apparatus includes multiple conductive elements, each having a substantially linear first segment that is coupled to the monopole. The first segments may be coplanar and/or perpendicular to the axis. Each of the conductive elements may further include a second segment that is substantially parallel to the axis. One or more of these segments may be connected to a ground potential. Also, the conductive elements may each include a third segment having a loop pattern.

18 Claims, 5 Drawing Sheets



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US007411563B2

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

(10) **Patent No.:** **US 7,411,563 B2**
(45) **Date of Patent:** ***Aug. 12, 2008**

(54) **ANTENNA DEVICE**

(75) Inventors: **Kuo-Cheng Liu**, Xindian (TW);
Chin-Hon Fan, Xindian (TW);
Kun-Ting Lin, Xindian (TW);
Ren-Peng Chen, Xindian (TW)

(73) Assignee: **High Tech Computer, Corp.**, Taoyuan (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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/826,763**

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

(65) **Prior Publication Data**

US 2007/0262915 A1 Nov. 15, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/099,616, filed on Apr. 6, 2005, now Pat. No. 7,253,787.

(30) **Foreign Application Priority Data**

Nov. 25, 2004 (TW) 93136269 A
Dec. 17, 2004 (CN) 2004 1 0102062 A

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

(52) **U.S. Cl.** **343/895**

(58) **Field of Classification Search** 343/700 MS,
343/725, 829, 846, 853, 895
See application file for complete search history.

(56) **References Cited**

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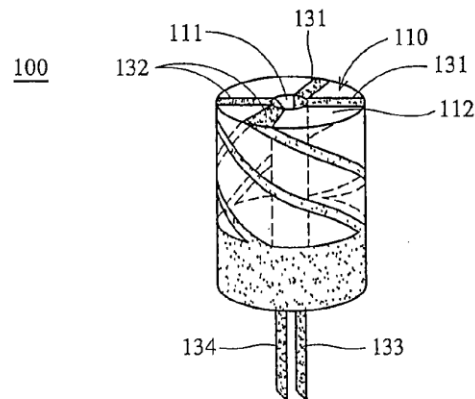
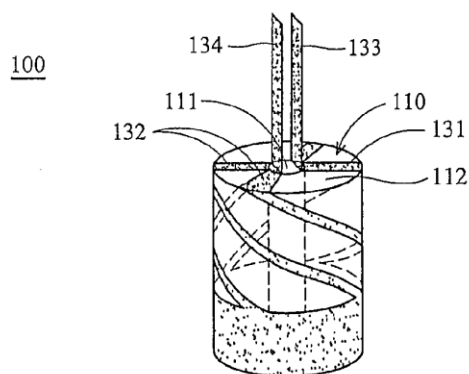
Primary Examiner—Shih-Chao Chen

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

(57) **ABSTRACT**

An antenna device has a dielectric body with a convex surface and a concave surface. The antenna device further has a flexible printed circuit board disposed on the convex surface.

16 Claims, 4 Drawing Sheets



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US007414583B2

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

(10) **Patent No.:** **US 7,414,583 B2**
(45) **Date of Patent:** **Aug. 19, 2008**

(54) **PIFA, RFID TAG USING THE SAME AND
ANTENNA IMPEDANCE ADJUSTING
METHOD THEREOF**

(75) Inventors: **Won-Kyu Choi**, Gyeonggi-do (KR);
Nak-Seon Seong, Daejeon (KR);
Cheol-Sig Pyo, Daegu (KR); **Jong-Suk
Chae**, Daejeon (KR)

(73) Assignee: **Electronics and Telecommunications
Research Institute**, Daejeon (KR)

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

(21) Appl. No.: **11/297,517**

(22) Filed: **Dec. 7, 2005**

(65) **Prior Publication Data**

US 2007/0046543 A1 Mar. 1, 2007

(30) **Foreign Application Priority Data**

Dec. 8, 2004 (KR) 10-2004-0103087
Jun. 9, 2005 (KR) 10-2005-0049266

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/895;
343/846; 343/702**

(58) **Field of Classification Search** **343/770,
343/767, 846, 848**

See application file for complete search history.

(56) **References Cited**

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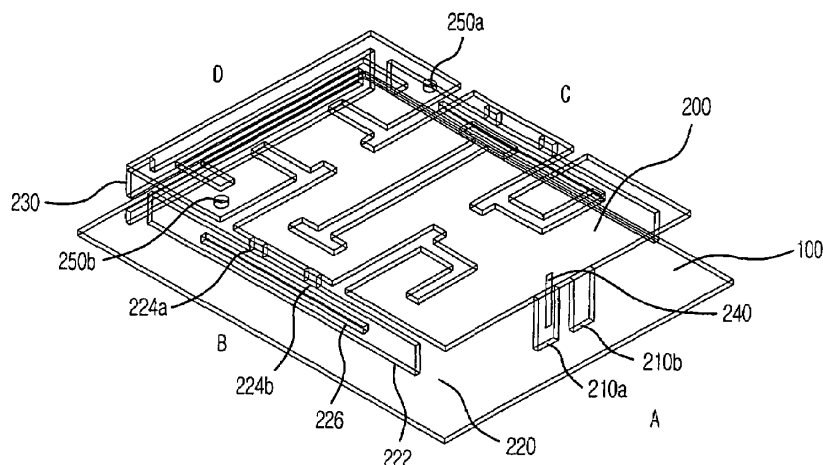
Primary Examiner—Trinh Vo Dinh

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

(57) **ABSTRACT**

Provided are a Planar Inverted-F Antenna (PIFA), a Radio
Frequency Identification (RFID) tag using the PIFA. The
present invention miniaturizes the antenna by using a mean-
der line extended from a radiating edge of a radiation antenna
and adjusting a resonant frequency of the antenna, and it
performs impedance matching by adjusting capacitive reac-
tance of the antenna. Also, it can perform impedance match-
ing by using a stub having a slot formed therein and adjusting
inductive reactance and capacitive reactance of the antenna.
The present invention miniaturizes the antenna by using a
plurality of shorting plates for shorting the radiation patch
from a grounding surface and adjusting the resonant fre-
quency of the antenna. The present invention also provides an
inexpensive PIFA antenna with an excellent radiation effi-
ciency by forming the radiation patch in the form of metal
sheet in the antenna and floating the radiation patch in the air.

27 Claims, 5 Drawing Sheets



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US007414585B2

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

(10) **Patent No.:** **US 7,414,585 B2**
(45) **Date of Patent:** **Aug. 19, 2008**

(54) **ANTENNA ASSEMBLY FOR USE IN A
TELECOMMUNICATION DEVICE**

(75) Inventors: **Shih-Wen Lu**, Taipei Hsien (TW);
Hao-Chun Tung, Chinnmen Hsien (TW)

(73) Assignee: **Qisda Corporation**, Taoyuan (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 316 days.

(21) Appl. No.: **11/342,047**

(22) Filed: **Jan. 27, 2006**

(65) **Prior Publication Data**

US 2006/0176219 A1 Aug. 10, 2006

(30) **Foreign Application Priority Data**

Feb. 5, 2005 (TW) 94103848 A

(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, 846

See application file for complete search history.

(56) **References Cited**

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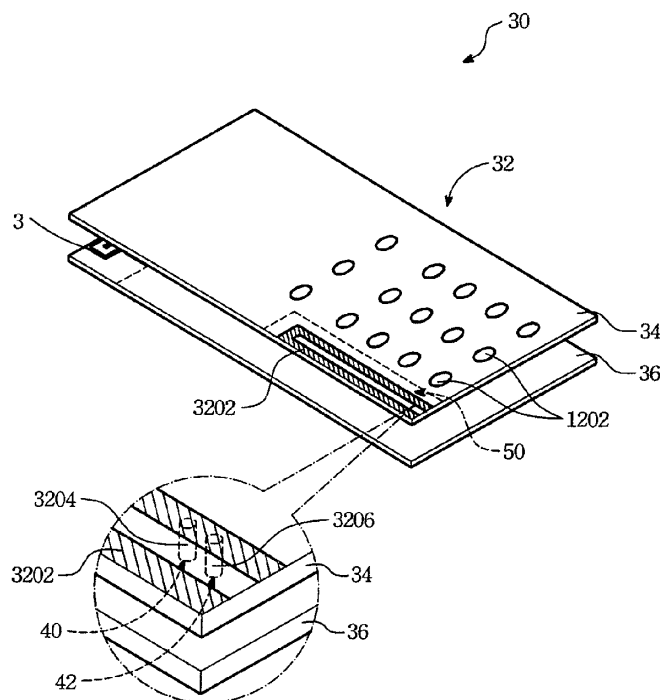
Primary Examiner—HoangAnh T Le

(74) *Attorney, Agent, or Firm*—Ladas and Parry LLP

(57) **ABSTRACT**

An antenna assembly is use in a telecommunication device having a first printed circuit board and a second printed circuit board disposed right below and facing the first printed circuit board. The antenna assembly includes: radiating metal strip having a main strip section for disposing on an upper surface of the first printed circuit board, a feeding strip section extending from the main strip section through a first through hole in the first printed circuit board toward the second printed circuit board, and a grounding strip section extending from the main strip section through a second through hole in the first printed circuit board toward the second printed circuit board. After assembly, the feeding and grounding strip sections tend toward an upper surface of the second printed circuit board.

17 Claims, 4 Drawing Sheets



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US007417588B2

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

(10) **Patent No.:** **US 7,417,588 B2**
(45) **Date of Patent:** **Aug. 26, 2008**

(54) **MULTI-BAND MONOPOLE ANTENNAS FOR MOBILE NETWORK COMMUNICATIONS DEVICES**

(75) Inventors: **Jordi Soler Castany**, Mataró (ES);
Carles Puente Baliarda, Barcelona (ES); **Carmen Borja Borau**, 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.

(21) Appl. No.: **10/587,119**

(22) PCT Filed: **Jan. 28, 2005**

(86) PCT No.: **PCT/ES2005/000879**

§ 371 (c)(1),
(2), (4) Date: **Aug. 29, 2006**

(87) PCT Pub. No.: **WO2005/076409**

PCT Pub. Date: **Aug. 18, 2005**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 60/540,448, filed on Jan. 30, 2004.

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

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

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

See application file for complete search history.

(56) **References Cited**

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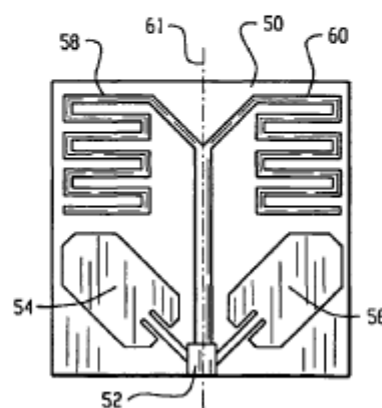
Primary Examiner—Hoang V Nguyen

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

(57) **ABSTRACT**

Multiband monopole antennas are disclosed. The antennas disclosed can include a substrate for mounting conductors, one or more conductors for receiving networking signals mainly in a first frequency band, and one or more conductors for receiving networking signals mainly in a second frequency band. The conductors can have a polygonal shape or the conductors can have a linear, space-filling, or grid dimension shape. The conductors can be connected at a feed point. One or more antenna can be incorporated into a single printed circuit board. When multiple antennas are used with the same printed circuit board, the conducting material of the printed circuit board located between the antenna attachment points can be interrupted to improve the isolation of each antenna.

27 Claims, 7 Drawing Sheets



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US007417591B2

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

(10) **Patent No.:** **US 7,417,591 B2**
(45) **Date of Patent:** **Aug. 26, 2008**

(54) **ANTENNA APPARATUS AND PORTABLE WIRELESS DEVICE USING THE SAME**

(75) Inventors: **Akihiko Iguchi**, Osaka (JP); **Yuki Satoh**, Osaka (JP)

(73) Assignee: **Matsushita Electric Industrial Co., Ltd.**, Osaka (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **11/353,620**

(22) Filed: **Feb. 14, 2006**

(65) **Prior Publication Data**

US 2006/0181468 A1 Aug. 17, 2006

(30) **Foreign Application Priority Data**

Feb. 17, 2005 (JP) 2005-040146
Feb. 17, 2005 (JP) 2005-040147

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/48 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/702; 343/700 MS;
343/846; 343/829

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

(56) **References Cited**

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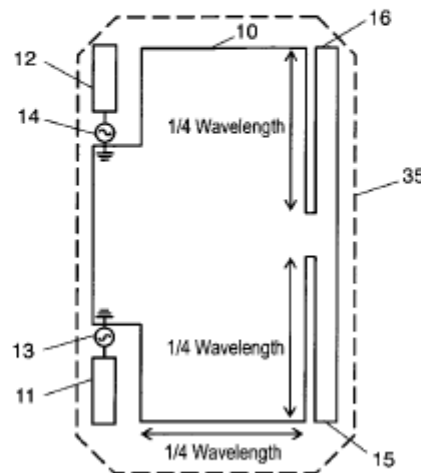
Primary Examiner—Trinh V Dinh

(74) Attorney, Agent, or Firm—RatnerPrestia

(57) **ABSTRACT**

An antenna apparatus and a portable wireless device using the same are disclosed, in which a coupling between antenna elements is reduced and an isolation property is improved even when frequencies of antenna elements are close or overlapped. The antenna apparatus includes a ground board, a first antenna element corresponding to a first frequency band, a second antenna element corresponding to a second frequency band in the vicinity of, or overlapped with the first frequency band, a first power feeding part connecting the ground board to the first antenna element and a second power feeding part connecting the ground board to the second antenna element, in which the first antenna element is arranged in a direction at an angle of an integer multiple of 90 degrees with respect to a long edge of the ground board, and the second antenna element is arranged in parallel with the long edge of the ground board.

26 Claims, 6 Drawing Sheets



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US007417593B1

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

(10) **Patent No.:** **US 7,417,593 B1**

(45) **Date of Patent:** **Aug. 26, 2008**

(54) **WIRELESS APPARATUS FOR INCREASING ANTENNA GAIN**

2006/0202895 A1* 9/2006 Nam et al. 343/702

2007/0176830 A1* 8/2007 Winter 343/702

(75) Inventors: **Lan-Yung Hsiao**, Taipei Hsien (TW);
Kai Shih, Taipei Hsien (TW); **Yu-Yuan Wu**, Taipei Hsien (TW)

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(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, Taipei Hsien (TW)

Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—WPAT, P.C.; Anthony King

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

(57) **ABSTRACT**

(21) Appl. No.: **11/696,604**

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

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/48 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS, 343/702, 767, 846**

See application file for complete search history.

(56) **References Cited**

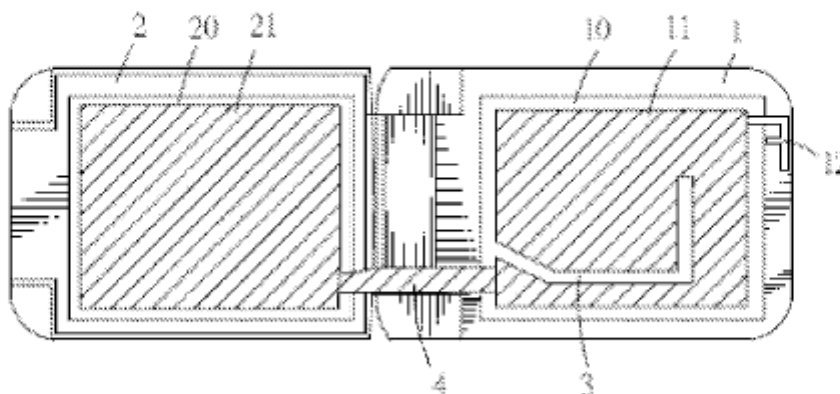
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A wireless apparatus has a main housing, a movable housing relatively extended to the main housing. The main housing contains a first PCB with a first layer being fully laid metal material. The movable housing contains a second PCB with a second layer being fully laid metal material. An insulation route is laid on the second layer and led to the border of the second layer. A connection component electronically connects the first layer and the second layer. When the wireless apparatus is operated at wireless communication, the cooperation of the first layer, the second layer, the insulation route and the connection component adjusts the electrical characteristic of the first and second PCBs for eliminating a parasitic effect being caused of movement of the first and second PCBs and increasing gain of the antenna of the wireless apparatus.

14 Claims, 3 Drawing Sheets

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(54) **MULTI-LOOP ANTENNA FOR RADIO
FREQUENCY IDENTIFICATION (RFID)
COMMUNICATION**

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patent is extended or adjusted under 35
U.S.C. 154(b) by 505 days.

This patent is subject to a terminal dis-
claimer.

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H01Q 21/00 (2006.01)

(52) **U.S. Cl.** **343/867; 343/742; 340/572.7**

(58) **Field of Classification Search** **343/741,**
343/742, 866, 867, 895; 340/825.36, 572.7,
340/572.5, 572.1; 235/451, 492
See application file for complete search history.

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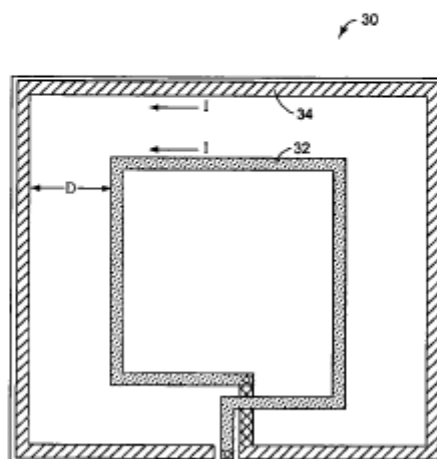
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(57) **ABSTRACT**

A multi-loop antenna is described having a plurality of con-
ductive loops to produce an electromagnetic field for radio
frequency identification (RFID) communication with RFID
tags. The conductive loops are spaced apart at least a distance
that is selected based on a dimension of the RFID tags with
which the antenna communicates. In this manner, the loops
are positioned and spaced in a manner that reduces the size of
the holes within the resulting magnetic field. In addition, the
configuration of the described dual-loop antenna increases
the coverage of the antenna, and decreases inter-winding
capacitance, thereby increasing overall read range achieved
by the antenna.

29 Claims, 8 Drawing Sheets



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