



US007394425B2

(12) **United States Patent**
Luch

(10) **Patent No.:** **US 7,394,425 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **ELECTRICALLY CONDUCTIVE PATTERNS, ANTENNAS AND METHODS OF MANUFACTURE**

(76) Inventor: **Daniel Luch**, 17161 Copper Hill Dr., Morgan Hill, CA (US) 95037

(*) 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.: **11/223,482**

(22) Filed: **Sep. 8, 2005**

(65) **Prior Publication Data**

US 2006/0017623 A1 Jan. 26, 2006

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/472,875, filed as application No. PCT/US02/09408 on Mar. 25, 2002, now abandoned, application No. 11/223,482, which is a continuation-in-part of application No. 10/988,044, filed on Nov. 12, 2004, which is a continuation-in-part of application No. 10/408,532, filed on Apr. 7, 2003, now abandoned, which is a continuation-in-part of application No. 09/818,128, filed on Mar. 26, 2001, now Pat. No. 6,582,887.

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/702, 867, 895; 340/572.2-572.8

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 3,523,875 A 8/1970 Minklei
- 3,619,382 A 11/1971 Lupinski
- 3,682,786 A 8/1972 Brown et al.
- 3,865,699 A 2/1975 Luch
- 4,009,093 A 2/1977 Luch

- 4,038,042 A 7/1977 Adelman
- 4,101,385 A 7/1978 Luch
- 4,158,612 A 6/1979 Luch et al.
- 4,191,617 A 3/1980 Hurley et al.
- 4,195,117 A 3/1980 Luch
- 4,278,510 A 7/1981 Chien et al.
- 4,395,362 A 7/1983 Satoh et al.
- 4,425,262 A 1/1984 Kawai et al.
- 4,429,020 A 1/1984 Luch
- 4,510,079 A 4/1985 Kawai et al.
- 4,603,092 A 7/1986 Luch
- 4,835,541 A 5/1989 Johnson et al.
- 4,862,184 A 8/1989 Ploussios
- 4,985,116 A 1/1991 Mettler et al.
- 4,985,600 A 1/1991 Heerman
- 4,996,391 A 2/1991 Schmidt
- 5,206,657 A 4/1993 Downey
- 5,355,142 A 10/1994 Marshall et al.
- 5,444,453 A 8/1995 Lalezari
- 5,495,260 A 2/1996 Couture
- 5,508,709 A 4/1996 Krenz et al.
- 5,547,516 A 8/1996 Luch

(Continued)

FOREIGN PATENT DOCUMENTS

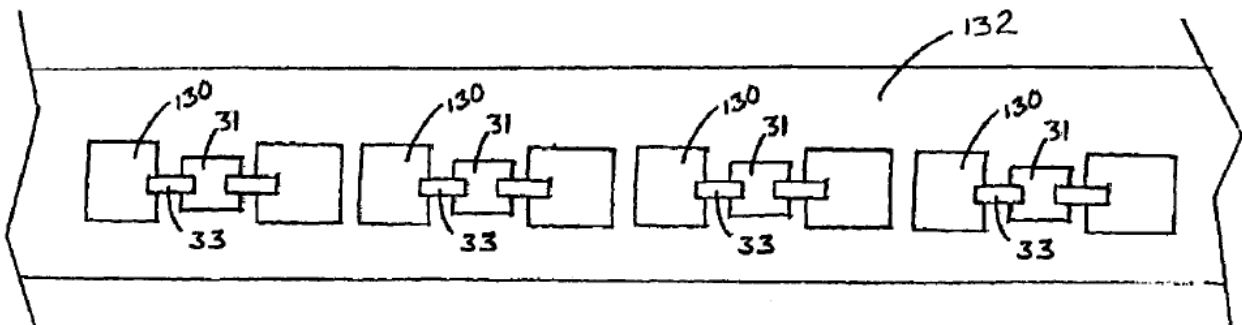
EP 0942441 9/1999

Primary Examiner—Huedung Mancuso

(57) **ABSTRACT**

The invention teaches improved, novel methods and materials for the production of antennas. The invention contemplates the use of Directly Electroplateable Resins for the production of these antennas. The unique suitability of Directly Electroplateable Resins to allow facile manufacture of the antennas desired using a broad range of processing and manufacturing approaches is demonstrated.

11 Claims, 39 Drawing Sheets





US00D572243S

(12) **United States Design Patent**
Lin et al.

(10) **Patent No.:** **US D572,243 S**
(45) **Date of Patent:** **** Jul. 1, 2008**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Ching-Cui Lin**, Tu-Cheng (TW);
Jia-Hung Su, Tu-Cheng (TW); **Kai Shih**, Tu-Cheng (TW); **Yu-Yuan Wu**, Tu-Cheng (TW)

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

(**) Term: **14 Years**

(21) Appl. No.: **29/274,589**

(22) Filed: **May 7, 2007**

(51) **LOC (8) Cl.** **14-03**

(52) **U.S. Cl.** **D14/230**

(58) **Field of Classification Search** D14/138,
D14/230-238, 299, 358; D12/42, 43; 343/700 MS,
343/700 R-705, 711-713, 741, 748, 767,
343/795, 819, 840, 846, 866, 871-908; 455/90.2,
455/90.3, 91, 128, 269, 344, 347, 562.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

D424,063 S * 5/2000 Kudo D14/230
6,667,718 B2 * 12/2003 Back et al. 343/700 MS

D493,446 S * 7/2004 Hung et al. D14/230
D534,527 S * 1/2007 Hung et al. D14/230
D534,903 S * 1/2007 Hung et al. D14/230
D535,290 S * 1/2007 Su et al. D14/230
D554,111 S * 10/2007 Su et al. D14/230
2008/0030407 A1 * 2/2008 Hung et al. 343/700 MS

* cited by examiner

Primary Examiner—Louis S Zarfaz

Assistant Examiner—John Windmuller

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

(57) **CLAIM**

The ornamental design for a multi-band antenna, as shown and described.

DESCRIPTION

FIG. 1 is a perspective view of a multi-band antenna showing our new design;

FIG. 2 is a front elevational view thereof;

FIG. 3 is a rear elevational view thereof;

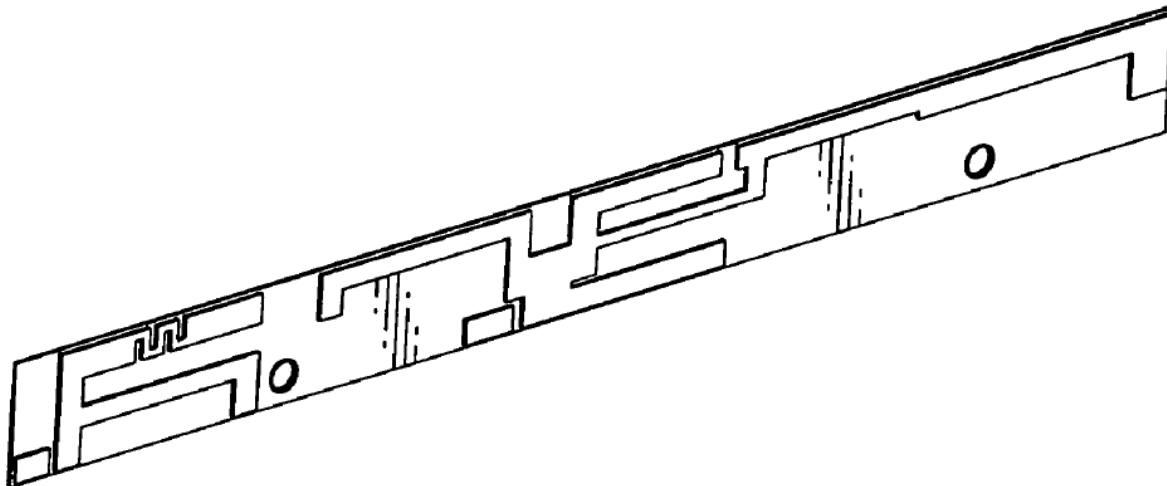
FIG. 4 is a left side elevational view thereof;

FIG. 5 is a right side elevational view thereof;

FIG. 6 is a top plan view thereof; and,

FIG. 7 is a bottom plan view thereof.

1 Claim, 4 Drawing Sheets





US007394426B2

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

(10) **Patent No.:** **US 7,394,426 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **CIRCULAR POLARIZED ANTENNA,
ANTENNA DESIGN SIMULATOR, AND
WIRELESS MODULE WITH THE ANTENNA**

(75) Inventors: **Tomoyuki Ogawa**, Hitachi (JP); **Ken
Takei**, Hitachi (JP)

(73) Assignee: **Hitachi Cable, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 319 days.

(21) Appl. No.: **11/352,405**

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

(65) **Prior Publication Data**

US 2006/0181460 A1 Aug. 17, 2006

(30) **Foreign Application Priority Data**

Feb. 14, 2005 (JP) 2005-036002

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/36 (2006.01)

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

(58) **Field of Classification Search** 343/700 MS,
343/702, 845, 895

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,026,997 B2 * 4/2006 Rahola 343/700 MS
2004/0217916 A1 * 11/2004 Quintero Illera et al. 343/895

FOREIGN PATENT DOCUMENTS

JP 5-152830 6/1993
JP 8-51312 2/1996
JP 2001-251132 9/2001

* cited by examiner

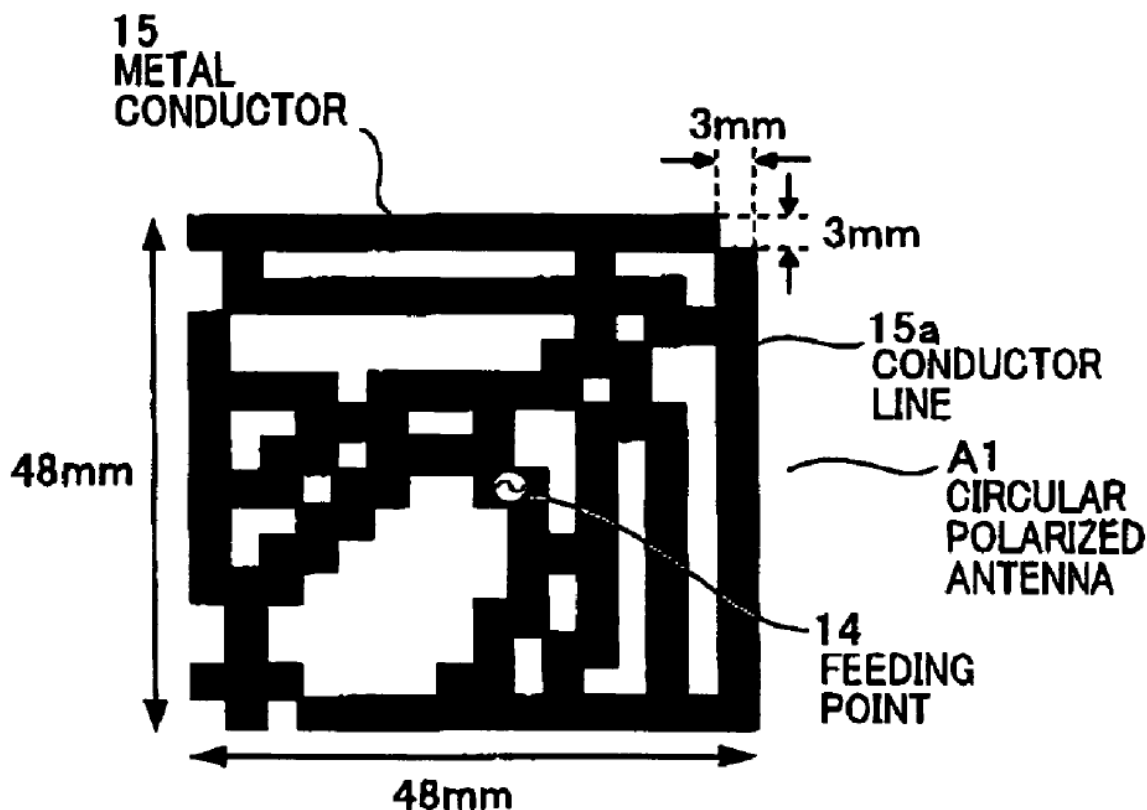
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—McGinn IP Law Group,
PLLC

(57) **ABSTRACT**

A circular polarized antenna has a group of conductor lines that comprise a planar metal conductor, and a feeding point connected to a part of the conductor lines. When a current to be induced on the conductor lines is projected onto two mutually-perpendicular axes to define projections and arguments therebetween, a ratio between absolute values of the projections is 0.7 to 1.3 and an absolute value of a difference between the arguments is 80 to 100 degrees, and a reactance component of an impedance of the feeding point is nearly zero.

10 Claims, 8 Drawing Sheets





US007394429B2

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

(10) **Patent No.:** **US 7,394,429 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **COMMUNICATION DEVICE AND RELATED ANTENNA MODULE**

(75) Inventors: **Chien-Hsing Fang**, Taipei Hsien (TW);
Ho-Chen Chang, Taipei Hsien (TW)

(73) Assignee: **Wistron NeWeb Corporation**,
Hsi-Chih, 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 206 days.

(21) Appl. No.: **10/905,191**

(22) Filed: **Dec. 21, 2004**

(65) **Prior Publication Data**

US 2005/0159196 A1 Jul. 21, 2005

(30) **Foreign Application Priority Data**

Jan. 16, 2004 (TW) 93101235 A

(51) **Int. Cl.**

H01Q 1/50 (2006.01)

H01Q 21/24 (2006.01)

H01Q 21/28 (2006.01)

(52) **U.S. Cl.** **343/702; 343/841; 343/853**

(58) **Field of Classification Search** **343/702, 343/841, 853, 756, 799, 834-838**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,272,312 A * 2/1942 Tunick 455/24
6,914,577 B2 * 7/2005 McCandless 343/841

FOREIGN PATENT DOCUMENTS

EP 1 237 225 A1 9/2002
JP 11-205034 7/1999
JP 2003-110355 4/2003

* cited by examiner

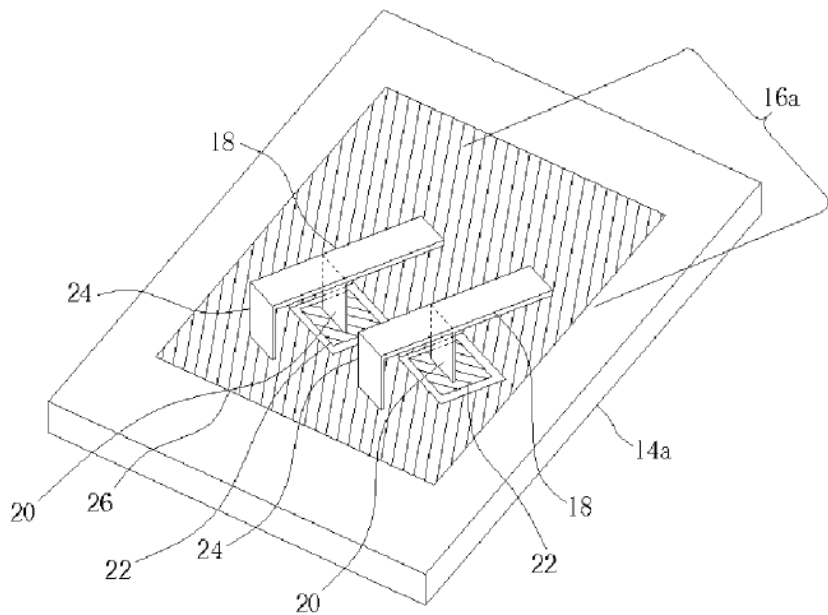
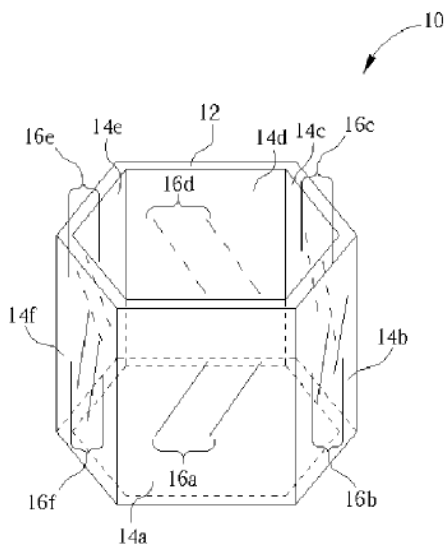
Primary Examiner—Michael C Wimer

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

(57) **ABSTRACT**

A wireless communication device includes a shell having a first shielding surface for shielding electromagnetic waves, a data processing module, a wireless communication module connected to the data processing module, and an antenna module disposed on the shell and connected to the wireless communication module. The antenna module has a first antenna unit and a second antenna unit. The first shielding surface shields the first antenna unit from the second antenna unit.

10 Claims, 11 Drawing Sheets





US007394432B2

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

(10) **Patent No.:** **US 7,394,432 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

- (54) **MULTILEVEL ANTENNA**
- (75) Inventors: **Carles Puente Baliarda**, Barcelona (ES); **Carmen Borja Borau**, Barcelona (ES); **Jaume Anguera Pros**, Barcelona (ES); **Jordi Soler Castany**, Mataro (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.

3,079,602 A	2/1963	Hamel et al.
3,521,284 A	7/1970	Shelton, Jr. et al.
3,599,214 A	8/1971	Altmayer
3,605,102 A	9/1971	Frye
3,622,890 A	11/1971	Fujimoto et al.
3,683,376 A	8/1972	Pronovost
3,818,490 A	6/1974	Leahy
3,967,276 A	6/1976	Goubau
3,969,730 A	7/1976	Fuchser

(Continued)

(21) Appl. No.: **11/550,256**

FOREIGN PATENT DOCUMENTS

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

AU 2438199 A 9/1999

(65) **Prior Publication Data**

US 2007/0279289 A1 Dec. 6, 2007

(Continued)

Related U.S. Application Data

OTHER PUBLICATIONS

- (60) Division of application No. 11/179,257, filed on Jul. 12, 2005, which is a continuation of application No. 11/102,390, filed on Apr. 8, 2005, now Pat. No. 7,123,208, which is a continuation of application No. 10/963,080, filed on Oct. 12, 2004, now Pat. No. 7,015,868, which is a continuation of application No. 10/102,568, filed on Mar. 18, 2002, now abandoned, which is a continuation of application No. PCT/ES99/00296, filed on Sep. 20, 1999.

Nokia Mobile Phones, "User's guide", 1999, 82 pag., Nokia Mobile Phones, Finland.

(Continued)

Primary Examiner—Tho G Phan
(74) *Attorney, Agent, or Firm*—Howison & Arnott, L.L.P.

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702; 343/700 MS; 343/800**
- (58) **Field of Classification Search** **343/700 MS, 343/702, 798, 800, 829, 846**
See application file for complete search history.

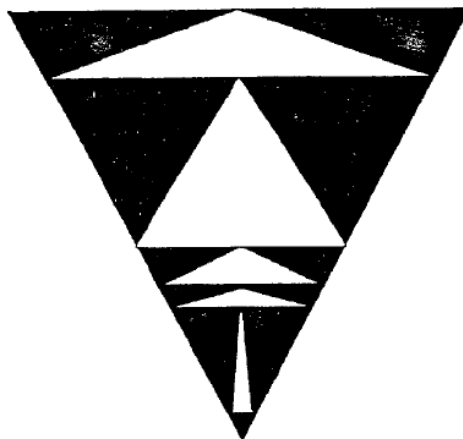
(57) **ABSTRACT**

Antennae in which the corresponding radiative element contains at least one multilevel structure formed by a set of similar geometric elements (polygons or polyhedrons) electromagnetically coupled and grouped such that in the structure of the antenna can be identified each of the basic component elements. The design is such that it provides two important advantages: the antenna may operate simultaneously in several frequencies, and/or its size can be substantially reduced. Thus, a multiband radioelectric behaviour is achieved, that is, a similar behavior for different frequency bands.

(56) **References Cited**
U.S. PATENT DOCUMENTS

621,455 A 3/1899 Hess et al.
646,850 A 4/1900 Lindemeyr

6 Claims, 13 Drawing Sheets





US007394433B2

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

(10) **Patent No.:** **US 7,394,433 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **DUAL BAND WLAN ANTENNA**

(75) Inventors: **James Li**, Santa Clara, CA (US); **Jing Jiang**, San Jose, CA (US)

(73) Assignee: **Marvell World Trade Ltd.**, St. Michael (BB)

(*) 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.: **11/581,502**

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

(65) **Prior Publication Data**

US 2007/0182645 A1 Aug. 9, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/519,979, filed on Sep. 12, 2006.

(60) Provisional application No. 60/771,634, filed on Feb. 9, 2006.

(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, 795, 846**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,343,976 A * 8/1982 Nasretidin et al. 219/748
5,714,961 A 2/1998 Kot et al.
6,184,828 B1 2/2001 Shoki

6,597,316 B2 7/2003 Rao et al.
7,006,043 B1 * 2/2006 Nalbandian 343/700 MS
2002/0163473 A1 * 11/2002 Koyama et al. 343/718
2003/0210187 A1 11/2003 Lu et al.
2004/0004572 A1 1/2004 Ma
2004/0239568 A1 12/2004 Masutani
2005/0062652 A1 * 3/2005 Huang 343/700 MS
2005/0140551 A1 6/2005 Kaluzni et al.

FOREIGN PATENT DOCUMENTS

EP 0 795 926 A2 9/1997
WO WO02/49153 A1 6/2002
WO WO2005/062422 7/2005

OTHER PUBLICATIONS

IEEE Std 802.11a-1999 (Supplement to IEEE Std 802.11-1999) [Adopted by ISO/IEC and redesignated as ISO/IEC 8802-11: 1999/ Amd 1:2000(E)]; Supplement to IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications High-speed Physical Layer in the 5 GHz Band; LAN/MAN Standards Committee of the IEEE Computer Society; 91 pages.

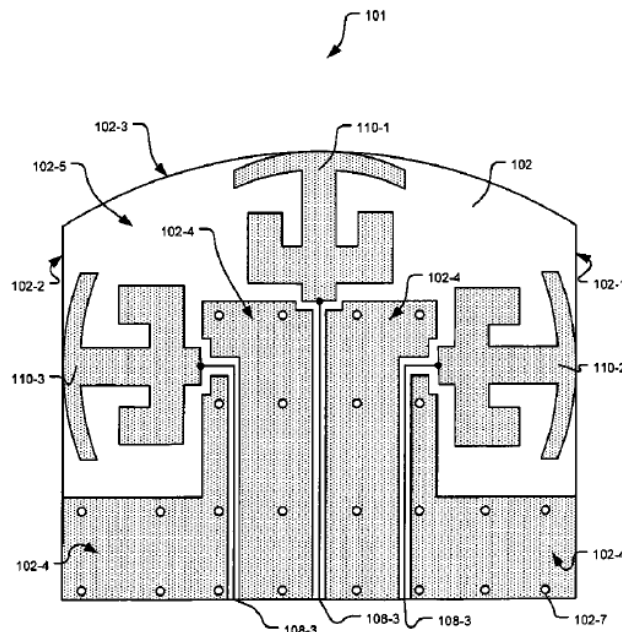
(Continued)

Primary Examiner—HoangAnh T Le

(57) **ABSTRACT**

An antenna system comprises first, second, and third antennas that are arranged on a printed circuit board (PCB) and that include an arc-shaped element having a concave side and a convex side. A conducting element extends substantially radially from a center of the concave side. A U-shaped element has a base portion with a center that communicates with the conducting element and two side portions that extend from ends of the base portion towards the concave side.

34 Claims, 38 Drawing Sheets





US007394434B2

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

(10) **Patent No.:** **US 7,394,434 B2**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **COMBINATION OF TUBE ASSEMBLY AND CLIP FOR WIRELESS ANTENNA GROUNDING**

(75) Inventors: **Chao Chen**, Waterloo (CA); **Timothy H. Kyowski**, Brantford (CA)

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

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

4,730,195 A	3/1988	Phillips et al.
4,847,629 A	7/1989	Shimazaki
4,857,939 A	8/1989	Shimazaki
4,890,114 A	12/1989	Egashira
5,090,925 A	2/1992	Sato et al.
5,214,434 A	5/1993	Hsu
5,218,370 A	6/1993	Blaese
5,334,055 A	8/1994	Sato et al.

(Continued)

(21) Appl. No.: **11/676,342**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Feb. 19, 2007**

EP 0261778 3/1988

(65) **Prior Publication Data**

US 2007/0176837 A1 Aug. 2, 2007

(Continued)

Related U.S. Application Data

OTHER PUBLICATIONS

(63) Continuation of application No. 11/274,121, filed on Nov. 16, 2005, now Pat. No. 7,196,671, which is a continuation of application No. 10/723,838, filed on Nov. 26, 2003, now Pat. No. 7,053,842.

Patent Abstracts of Japan, vol. 018, No. 364 (E-1575), Jul. 8, 1994 and JP 06 097712 A (Yokowo Co. Ltd) Apr. 8, 1994 abstract.

(60) Provisional application No. 60/430,082, filed on Dec. 2, 2002.

Primary Examiner—Tan Ho

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

(30) **Foreign Application Priority Data**

Nov. 29, 2002 (CA) 2413360

(57) **ABSTRACT**

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

(52) **U.S. Cl.** 343/702; 343/846; 343/901

(58) **Field of Classification Search** 343/702, 343/715, 846, 872, 901, 906

See application file for complete search history.

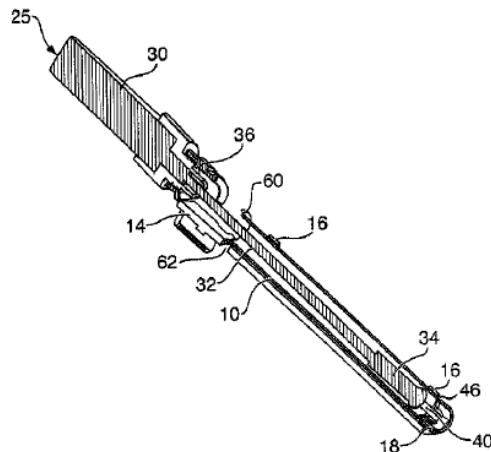
An antenna tube configured to accommodate a grounding clip and an antenna, the antenna tube having a cylindrical tube having an upper end and an inner end opposite the upper end; a circumferentially extending groove in the cylindrical tube located between the upper end and the inner end; and a tapered lip at the inner end of the cylindrical tube, wherein the grounding clip fits between the circumferentially extending groove and the tapered lip, and at least a portion of the antenna slidably fits into the upper end of the cylindrical tube.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,024,542 A 5/1977 Idawa et al.

13 Claims, 6 Drawing Sheets





US007394437B1

(12) **United States Patent**
Loyet

(10) **Patent No.:** **US 7,394,437 B1**
(45) **Date of Patent:** **Jul. 1, 2008**

(54) **MULTI-RESONANT MICROSTRIP DIPOLE ANTENNA**

6,965,353 B2 11/2005 Shirosaka et al.

OTHER PUBLICATIONS

(75) Inventor: **Lowell Lee Loyet**, Woodinville, WA (US)

Nortel Networks. "GSM 900/1800/1900 Univity GSM Base Transceiver Station eCell" (2002) Product Bulletin, 2 pages, no date avail. Katherin. "UMTS Antennas from the World's Largest Antenna Supplier" (1999) Product-Marketing, Mobile Communication Antennas, 4 pages, no date avail.

(73) Assignee: **AT&T Mobility II LLC**, Atlanta, GA (US)

Nokia. "Transmission Solution for Nokia Mobile Networks"(2000) Product Bulletin, 4 pages, no date avail.

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

Katherin. "Technical Information and New Products: Cellular Systems" located at www.katherin.de/de/mca/techn-infos/download/9985654.pdf, last viewed Oct. 23, 2006, 16 pages.

(21) Appl. No.: **11/843,673**

Primary Examiner—Hoang V Nguyen

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

(74) *Attorney, Agent, or Firm*—Amin, Turocy & Calvin, LLP

Related U.S. Application Data

(57) **ABSTRACT**

(63) Continuation of application No. 11/424,664, filed on Jun. 16, 2006, now Pat. No. 7,277,062.

A multi-band antenna for use, for example, in a wireless communications network, employs multi-resonant microstrip dipoles that resonate at multiple frequencies due to microstrip "islands." Gaps in the microstrips create an open RF circuit except for desired frequencies. At a desired frequency, RF energy sees a gap as a short circuit between an island and the rest of a dipole antenna, thus, resonating at the desired frequency. In one instance, the multi-band antenna includes a first, second, third, and fourth dipole elements. Gaps between the first and third dipole elements and the second and fourth dipole elements are sufficiently small that the first, second, third, and fourth dipole elements form a second dipole having a corresponding dipole wavelength longer than that of the first dipole.

(51) **Int. Cl.**

H01Q 9/28 (2006.01)

H01Q 21/00 (2006.01)

(52) **U.S. Cl.** **343/795**; 343/700 MS; 343/810; 343/817; 343/818

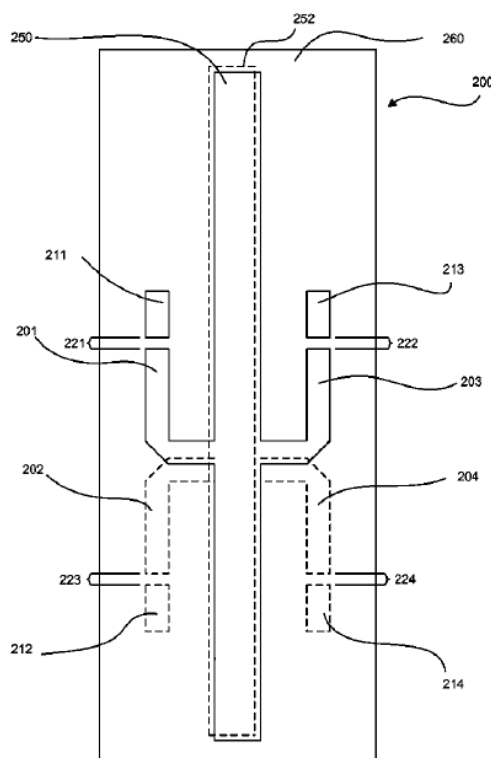
(58) **Field of Classification Search** 343/700 MS, 343/795, 846, 810, 817, 818, 872
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,529,170 B1 3/2003 Nishizawa et al.

20 Claims, 7 Drawing Sheets





US007397430B2

(12) **United States Patent**
Harihara

(10) **Patent No.:** **US 7,397,430 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **SURFACE MOUNTED ANTENNA AND RADIO EQUIPMENT USING THE SAME**

(75) Inventor: **Yasumasa Harihara**, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 150 days.

(21) Appl. No.: **11/190,906**

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

(65) **Prior Publication Data**

US 2006/0044191 A1 Mar. 2, 2006

(30) **Foreign Application Priority Data**

Aug. 5, 2004 (JP) 2004-229752

(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,
343/702, 846

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,434,579 A * 7/1995 Kagoshima et al. ... 343/700 MS

6,040,806 A * 3/2000 Kushihi et al. 343/853

6,067,461 A * 5/2000 Ye et al. 505/210

6,140,968 A * 10/2000 Kawahata et al. 343/700 MS

6,812,894 B2 * 11/2004 Shibata et al. 343/700 MS

FOREIGN PATENT DOCUMENTS

JP 11-074721 3/1999

JP 2003-289219 10/2003

* cited by examiner

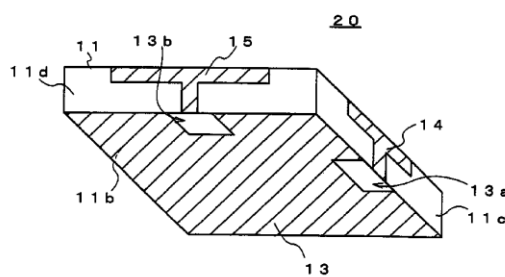
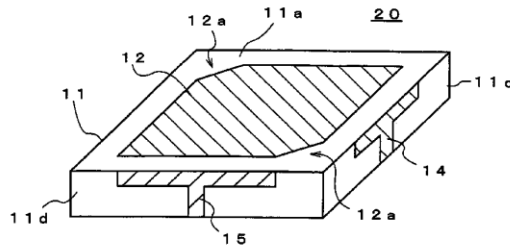
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Wolff Law Offices PLLC;
Kevin Alan Wolff

(57) **ABSTRACT**

A surface mounted antenna according to the present invention includes a dielectric block **11**, a radiating electrode **12** formed on one of a main surface **11a** of the dielectric block **11**, a ground electrode **13** formed on the other main surface **11b** of the dielectric block **11**, and a feed electrode **14** formed on a side surface **11c** of the dielectric block **11** and electromagnetically coupled with the radiating electrode **12**. In the present invention, since the feed electrode **14** is formed on the side surface **11c** of the dielectric block **11**, the size of the main surface **11a** of the dielectric block **11** can be made smaller than that of the conventional dielectric block. Accordingly, since further miniaturization can be realized, when the dielectric block **11** is mounted on a printed circuit board or the like, the mounting area can be reduced as compared with the conventional dielectric block.

25 Claims, 11 Drawing Sheets





US007397432B2

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

(10) **Patent No.:** **US 7,397,432 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **BUILT-IN ANTENNA MODULE FOR PORTABLE WIRELESS TERMINAL**

2004/0160367 A1* 8/2004 Mendolia et al. 343/700 MS
2005/0140554 A1* 6/2005 Wang et al. 343/702

(75) Inventors: **Do-Il Ku**, Suwon-si (KR); **Chin-Sop Choe**, Sungnam-si (KR)

FOREIGN PATENT DOCUMENTS

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

EP	1 209 760	5/2002
EP	1 286 413	2/2003
EP	1 441 412	7/2004
WO	WO 2004/025776	3/2004

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

(21) Appl. No.: **11/227,885**

* cited by examiner

(22) Filed: **Sep. 15, 2005**

Primary Examiner—HoangAnh T Le

(65) **Prior Publication Data**

(74) *Attorney, Agent, or Firm*—The Farrell Law Firm, PC

US 2006/0066490 A1 Mar. 30, 2006

(30) **Foreign Application Priority Data**

(57) **ABSTRACT**

Sep. 17, 2004 (KR) 10-2004-0074748

(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, 343/846, 848, 702**

See application file for complete search history.

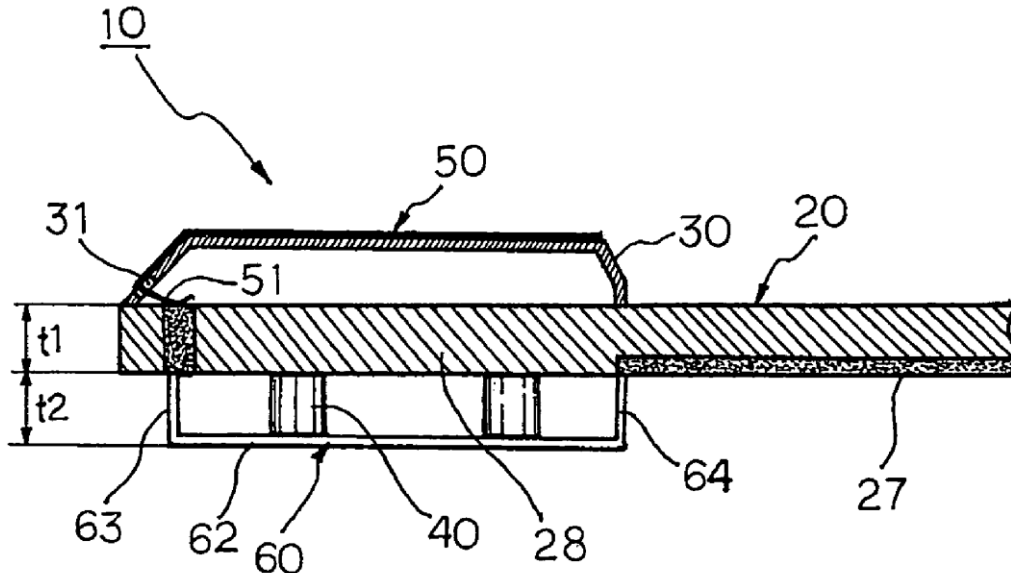
A built-in antenna module for a portable wireless terminal is provided. In the built-in antenna module, a mainboard, which is an RF board, has a feeding unit and a grounding unit. A radiator is disposed on one side of the mainboard and has a feed pin and a ground pin that are electrically connected to the feeding unit and the grounding unit, respectively. A conductive ground plate is disposed on the other side of the mainboard to have a predetermined height. An end of the conductive ground plate is grounded to the grounding unit of the mainboard. The distance between the radiator and the ground plate is maximized to improve antenna performance.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,051,477 A * 9/1977 Murphy et al. 343/700 MS
2003/0151555 A1* 8/2003 Holshouser 343/700 MS

7 Claims, 6 Drawing Sheets





US007397433B2

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

(10) **Patent No.:** **US 7,397,433 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **BUILT-IN ANTENNA MODULE OF WIRELESS COMMUNICATION TERMINAL**

(75) Inventors: **Sun Kyu Han**, Kyungki-do (KR); **Wook Hee Lee**, Kyungki-do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co. Ltd.**, Kyungki-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 100 days.

(21) Appl. No.: **11/430,105**

(22) Filed: **May 9, 2006**

(65) **Prior Publication Data**

US 2006/0256020 A1 Nov. 16, 2006

(30) **Foreign Application Priority Data**

May 10, 2005 (KR) 10-2005-0039044

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/38 (2006.01)

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

(58) **Field of Classification Search** **343/702, 343/700 MS, 840**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2006/0152417 A1* 7/2006 Ying et al. 343/702

FOREIGN PATENT DOCUMENTS

KR 2006-43703 5/2006

OTHER PUBLICATIONS

Korean Intellectual Property Office, Office Action, mailed Aug. 17, 2006.

* cited by examiner

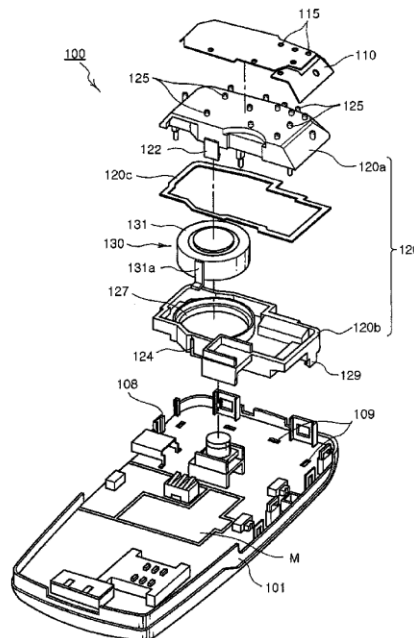
Primary Examiner—Shih-Chao Chen

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

(57) **ABSTRACT**

The invention relates to a built-in antenna module for a wireless communication terminal. The module includes at least one radiator. The module also includes a base having an inner space, disposed on a board of a terminal body, and having the radiator on an outer surface thereof to enable electric connection between an end of the radiator and the board of the terminal body. The module further includes an operator disposed in the inner space of the base for indicating an incoming call when power is supplied. The invention efficiently utilizes a limited space in the terminal body with enhanced capabilities of the antenna.

21 Claims, 8 Drawing Sheets





US007397434B2

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

(10) **Patent No.:** **US 7,397,434 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **BUILT-IN ANTENNA MODULE OF WIRELESS COMMUNICATION TERMINAL**

2003/0179144 A1 9/2003 Takesako et al.
2006/0145934 A1* 7/2006 Park et al. 343/702
2008/0001840 A1* 1/2008 Wong et al. 343/867

(75) Inventors: **Ung Han Mun**, Kyungki-do (KR); **Jae Suk Sung**, Kyungki-do (KR)

FOREIGN PATENT DOCUMENTS

EP 1 677 387 A1 5/2006
GB 2 391 114 A 1/2004
KR 2004-31805 A 4/2004
WO 02/078123 A1 10/2002

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Kyungki-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 17 days.

OTHER PUBLICATIONS

Korean Intellectual Property Office, Office Action mailed, Nov. 17, 2006.
UK Patent Office Search Report, mailed Dec. 13, 2006.

(21) Appl. No.: **11/464,949**

* cited by examiner

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

Primary Examiner—Tan Ho

(65) **Prior Publication Data**

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

US 2007/0063903 A1 Mar. 22, 2007

(30) **Foreign Application Priority Data**

(57) **ABSTRACT**

Sep. 16, 2005 (KR) 10-2005-0086876

The invention relates to a built-in antenna for a wireless communication terminal. The built-in antenna includes at least one first radiator for base station and at least one second radiator for Bluetooth. The built-in antenna also includes a base having the first and second radiators mounted on an outer surface thereof. The base is mounted on a board such that each end of the first and second radiators is electrically connected to the board of a terminal body. The built-in antenna further includes a Bluetooth chip set fixed to the base and electrically connected to the second radiator. The invention efficiently utilizes limited space in a terminal body to miniaturize the product, attaining RF capabilities with high reception sensitivity.

(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, 725**

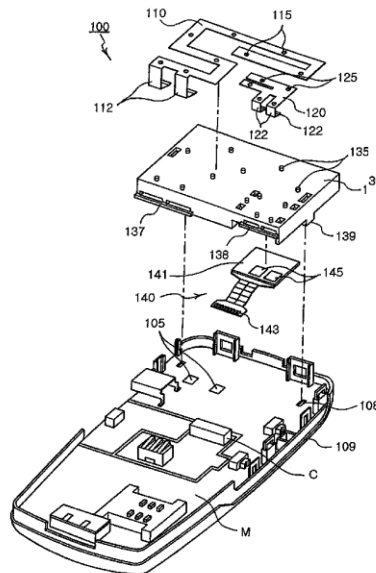
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,917,707 A * 6/1999 Khandros et al. 361/776
6,448,932 B1 * 9/2002 Stoiljkovic et al. 343/700 MS
6,531,985 B1 * 3/2003 Jones et al. 343/702

13 Claims, 6 Drawing Sheets





US007397439B2

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

(10) **Patent No.:** **US 7,397,439 B2**
(45) **Date of Patent:** **Jul. 8, 2008**

(54) **SLOT ANTENNA**

FOREIGN PATENT DOCUMENTS

(75) Inventors: **Hiroshi Kanno**, Osaka (JP); **Kazuyuki Sakiyama**, Osaka (JP); **Ushio Sangawa**, Nara (JP)

JP 31-000464 1/1956

(Continued)

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

OTHER PUBLICATIONS

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

L. Zhu et al. "A Novel Broadband Microstrip-Fed Wide Slot Antenna With Double Rejection Zeros", IEEE Antennas and Wireless Propagation Letters, 2003, pp. 194-196, vol. 2.

(Continued)

(21) Appl. No.: **11/723,786**

Primary Examiner—Michael C Wimer

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

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

(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2007/0164918 A1 Jul. 19, 2007

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2006/321541, filed on Oct. 27, 2006.

(30) **Foreign Application Priority Data**

Nov. 10, 2005 (JP) 2005-325674

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

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

(58) **Field of Classification Search** 343/700 MS,
343/767, 770, 771, 862, 864
See application file for complete search history.

(56) **References Cited**

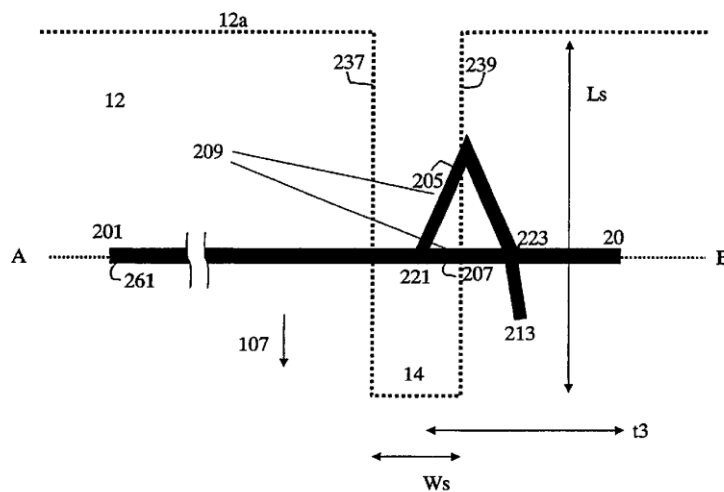
U.S. PATENT DOCUMENTS

5,036,335 A * 7/1991 Jairam 343/767

(Continued)

A slot antenna according to the present invention includes: a ground conductor **12** provided on a rear face side of a dielectric substrate **101**, the ground conductor having a finite area; a slot **14** which recesses into the ground conductor **12**, beginning from an open-end point on a side edge of the ground conductor **12**; and a feed line **261** for supplying a high-frequency signal to the slot **14**, the feed line **261** intersecting the slot **14**. At a first point near the slot, the feed line **261** branches into a group of branch lines including at least two branch lines, such that at least two branch lines in the group of branch lines are connected to each other at a second point near the slot to form at least one loop line **209**. A maximum value of a loop length of each loop line **209** is prescribed to be less than $1 \times$ effective wavelength at an upper limit frequency of an operating band of the slot antenna. In the group of branch lines, any branch line that does not constitute a part of the loop line **209** but terminates with a leading open-end point has a branch length which is less than a $1/4$ effective wavelength at the upper limit frequency of the operating band.

3 Claims, 26 Drawing Sheets





US007397441B1

(12) **United States Patent**
Zweers

(10) **Patent No.:** **US 7,397,441 B1**
(45) **Date of Patent:** **Jul. 8, 2008**

- (54) **ANTENNA ELEMENT FOR A PORTABLE COMMUNICATION DEVICE**
- (75) Inventor: **Jan-Willem Zweers, Wezep (NL)**
- (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 0 days.
- (21) Appl. No.: **11/681,347**
- (22) Filed: **Mar. 2, 2007**

Related U.S. Application Data

- (60) Provisional application No. 60/887,910, filed on Feb. 2, 2007.
- (51) **Int. Cl.**
H01Q 7/00 (2006.01)
- (52) **U.S. Cl.** **343/866; 343/702; 343/741; 343/895**
- (58) **Field of Classification Search** **343/702, 343/741, 742, 866, 867, 846, 718, 895**
See application file for complete search history.

References Cited

U.S. PATENT DOCUMENTS

- 2,273,955 A * 2/1942 Grimditch 343/842
- 3,518,681 A * 6/1970 Kiepe 343/702

- 4,161,737 A * 7/1979 Albright 343/749
- 5,847,683 A 12/1998 Wolfe et al.
- 6,163,300 A * 12/2000 Ishikawa et al. 343/702
- 6,952,186 B2 * 10/2005 Saito et al. 343/702
- 2004/0119657 A1 6/2004 Mayer et al.

FOREIGN PATENT DOCUMENTS

- EP 1 416 585 5/2004
- FR 2 245 097 4/1975

OTHER PUBLICATIONS

International Search Report with Written Opinion for corresponding PCT Application No. PCT/EP2007/057921 dated Oct. 8, 2007, 8 pages.

* cited by examiner

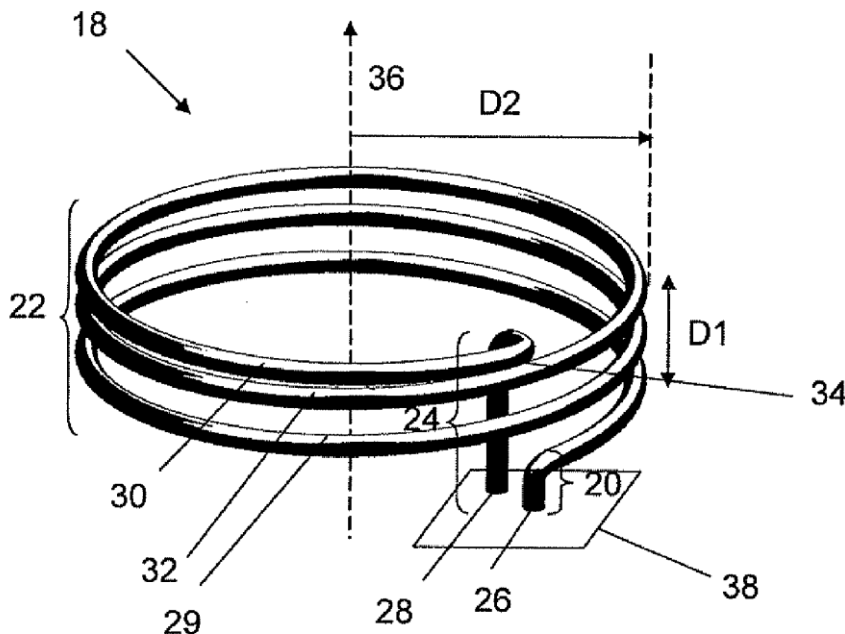
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Harrity Snyder, LLP

(57) **ABSTRACT**

The present invention relates to an antenna element for a portable communication device as well as to a portable communication device including such an antenna element. The antenna element includes a wire of an electrically conducting material having a first and a second feeding end for connection to a radio communication unit and ground. The wire also has a winding section comprising a number of turns around a central axis. The last turn of the winding section, which is provided furthest from the first feeding end is in physical contact with the previous turn and the rest of the turns are separated from each other.

16 Claims, 2 Drawing Sheets





US007400300B2

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

(10) **Patent No.:** **US 7,400,300 B2**
(45) **Date of Patent:** ***Jul. 15, 2008**

- (54) **MULTIPLE-ELEMENT ANTENNA WITH FLOATING ANTENNA ELEMENT**
- (75) Inventors: **Yihong Qi**, Waterloc (CA); **Ying Tong Man**, Kitchener (CA); **Michael E. Certain**, Kitchener (CA); **Perry Jarmuszewski**, 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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/590,200**

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

(65) **Prior Publication Data**
US 2007/0176835 A1 Aug. 2, 2007

Related U.S. Application Data

(63) Continuation of application No. 10/864,145, filed on Jun. 9, 2004, now Pat. No. 7,148,846.

(30) **Foreign Application Priority Data**
Jun. 12, 2003 (EP) 03253713

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 19/10 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/818**

(58) **Field of Classification Search** **343/700 MS, 343/702, 818**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,521,284 A 7/1970 Shelton, Jr. et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0543645 5/1993

(Continued)

OTHER PUBLICATIONS

Antenna Frequency Scaling: The ARRL Antenna Book, p. 2.24-2.25, 1988.

(Continued)

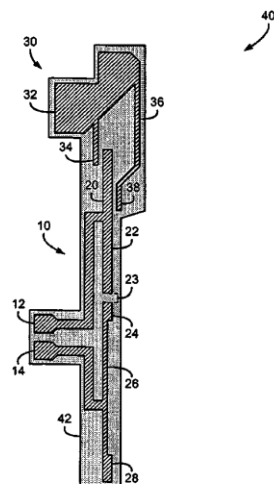
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Jones Day; Krishna K. Pathiyal; Robert C. Liang

(57) **ABSTRACT**

A multiple-element antenna for a wireless communication device is provided. The antenna comprises a first antenna element having a first operating frequency band and a floating antenna element positioned adjacent the first antenna element to electromagnetically couple to the first antenna element. The floating antenna element is configured to operate in conjunction with the first antenna element within a second operating frequency band. A feeding port connected to the first antenna element connects the first antenna element to communications circuitry and exchanges communication signals in both the first operating frequency band and the second operating frequency band between the multiple-element antenna and the communications circuitry. In a wireless mobile communication device having a transceiver and a receiver, the feeding port is connected to both the transceiver and the receiver.

48 Claims, 10 Drawing Sheets





US007400302B2

(12) **United States Patent**
Winter

(10) **Patent No.:** **US 7,400,302 B2**
(45) **Date of Patent:** **Jul. 15, 2008**

(54) **INTERNAL ANTENNA FOR HANDHELD MOBILE PHONES AND WIRELESS DEVICES**

(75) Inventor: **James Blake Winter**, Lincoln, NE (US)

(73) Assignee: **Centurion Wireless Technologies, Inc.**, Lincoln, NE (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 196 days.

5,337,061 A	8/1994	Pye et al.	
5,386,214 A	1/1995	Sugawara	
5,483,678 A	1/1996	Abe	
6,239,764 B1	5/2001	Timofeev et al.	
6,297,774 B1	10/2001	Chung	
6,373,436 B1	4/2002	Chen et al.	
6,466,176 B1	10/2002	Maoz et al.	
7,012,571 B1 *	3/2006	Ozkar et al.	343/702
7,109,945 B2 *	9/2006	Mori	343/861
7,184,808 B2 *	2/2007	Shoji	455/575.7
7,199,762 B2 *	4/2007	Liu et al.	343/702
2007/0021161 A1 *	1/2007	Autti	455/575.7

(21) Appl. No.: **11/343,167**

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

(65) **Prior Publication Data**

US 2007/0176830 A1 Aug. 2, 2007

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

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

(58) **Field of Classification Search** **343/846, 343/702, 850, 860, 767; 455/575.5, 575.7**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,568,201 A	3/1971	Spoonamore
3,573,628 A	4/1971	Cramer, Jr. et al.
4,063,246 A	12/1977	Greiser
4,197,544 A	4/1980	Kaloi
4,571,595 A	2/1986	Phillips et al.
4,746,925 A	5/1988	Toriyama
5,081,466 A	1/1992	Bitter, Jr.

FOREIGN PATENT DOCUMENTS

WO	WO 99/54656	10/1999
WO	WO 99/54956	10/1999

* cited by examiner

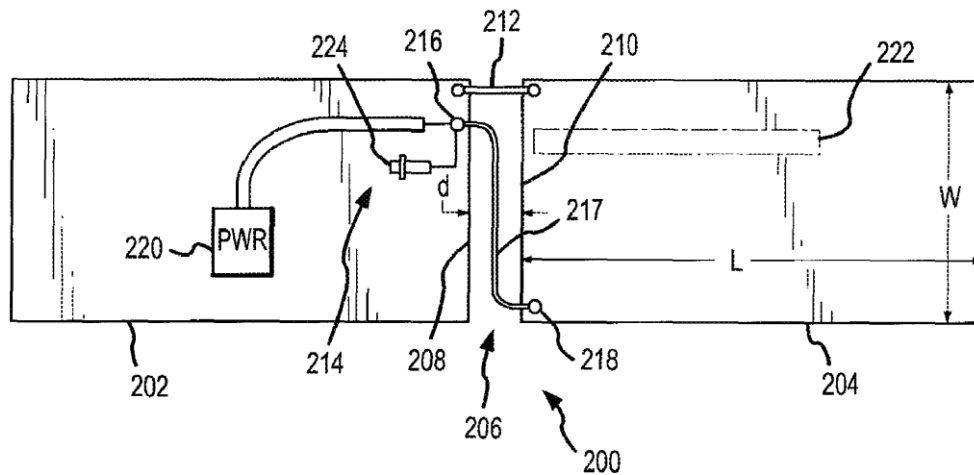
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Holland & Hart LLP

(57) **ABSTRACT**

An antenna for a foldable wireless device is provided. The foldable wireless device and antenna include a first housing and a second housing pivotally connected. A printed circuit board associated with the wireless device comprises a first PCB in the first housing and a second PCB in the second housing. The first and second PCB function as first and second radiating plates respectively. A gap, generally aligned with the pivotal connection separates the first and second PCBs. A short is provided that traverses the gap and connects the first and second PCBs. Radio frequency power is connected to the first and second PCB to supply radio frequency power.

21 Claims, 2 Drawing Sheets





US007394440B2

(12) **United States Patent
Goldberg**

(10) **Patent No.:** US 7,394,440 B2
(45) **Date of Patent:** Jul. 1, 2008

(54) **THREE-DIMENSIONAL ANTENNA
FABRICATION FROM MULTIPLE
TWO-DIMENSIONAL STRUCTURES**

(75) Inventor: **Steven J. Goldberg**, Downingtown, PA (US)

(73) Assignee: **InterDigital Technology Corporation**, Wilmington, DE (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 57 days.

(21) Appl. No.: **11/343,398**

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

(65) **Prior Publication Data**

US 2006/0192721 A1 Aug. 31, 2006

Related U.S. Application Data

(60) Provisional application No. 60/651,608, filed on Feb. 10, 2005.

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 19/10 (2006.01)

(52) **U.S. Cl.** 343/893; 343/834; 343/835; 343/836; 343/837

(58) **Field of Classification Search** 343/893, 343/834, 835, 836, 837

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2002/0015000 A1* 2/2002 Reece et al. 343/795

* cited by examiner

Primary Examiner—Hoang V Nguyen

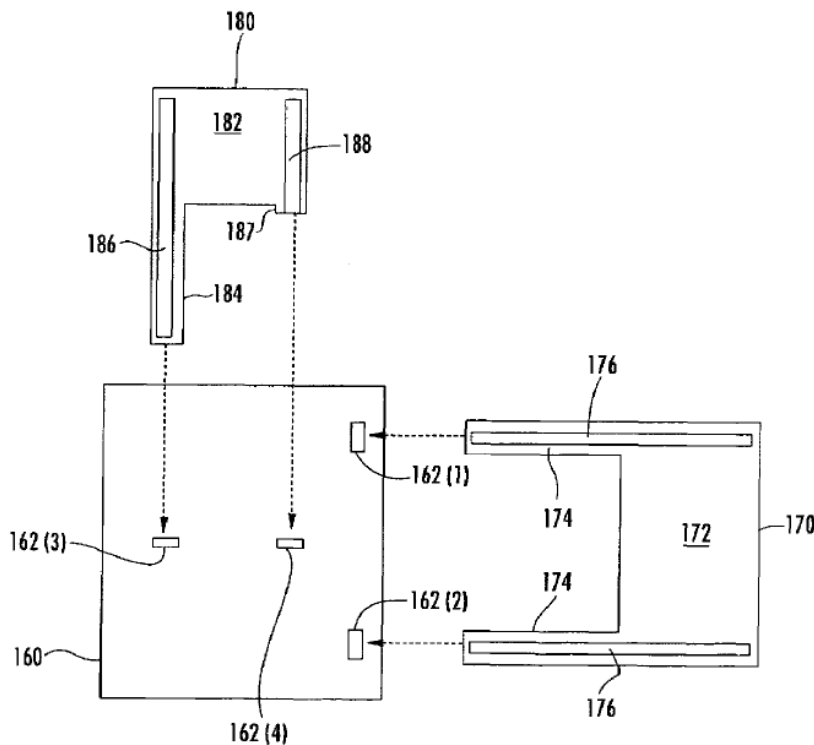
Assistant Examiner—Robert Karacsony

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

(57) **ABSTRACT**

A method for making an antenna array includes forming a ground plane having spaced apart openings extending there-through, and forming a first antenna board having a support section and spaced apart first legs extending outwardly from the support section. An antenna element is formed on each outwardly extending first leg. A second antenna board having a support section and at least one second leg extending outwardly from the support section is formed. An antenna element is formed on the at least one outwardly extending second leg. The outwardly extending first legs are inserted through a corresponding number of openings in the ground plane. Similarly, the at least one outwardly extending second leg is inserted through one of the openings in the ground plane. The first and second legs are inserted so that their respective support sections contact the ground plane.

30 Claims, 6 Drawing Sheets





US007403158B2

(12) **United States Patent**
Kikin

(10) **Patent No.:** **US 7,403,158 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

- (54) **COMPACT CIRCULAR POLARIZED ANTENNA**
- (75) Inventor: **Vadim Kikin**, Spring Valley, NY (US)
- (73) Assignee: **Applied Wireless Identification Group, Inc.**, Morgan Hill, CA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 60 days.

(21) Appl. No.: **11/253,099**

(22) Filed: **Oct. 18, 2005**

(65) **Prior Publication Data**
US 2007/0085742 A1 Apr. 19, 2007

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.** **343/700 MS; 343/846; 340/572.7**
- (58) **Field of Classification Search** **343/700 MS, 343/846, 841; 340/505, 572.1, 572.7**
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
- 3,216,016 A 11/1965 Tanner 343/719
- 4,191,959 A 3/1980 Kerr 343/700
- 4,987,421 A 1/1991 Sunahara et al. 343/700
- 5,055,852 A 10/1991 Dusseux et al. 343/725
- 5,075,691 A 12/1991 Garay et al. 343/830
- 5,371,507 A 12/1994 Kuroda et al. 343/700
- 5,675,346 A 10/1997 Nishikawa et al. 343/700

6,023,244 A	2/2000	Snygg et al.	343/700
6,124,829 A *	9/2000	Iwasaki 343/700 MS	
6,163,306 A	12/2000	Nakamura et al.	343/797
6,300,908 B1	10/2001	Jecko et al.	343/700
6,307,511 B1	10/2001	Ying et al.	343/702
6,329,950 B1	12/2001	Harrell et al.	343/700
6,407,707 B2	6/2002	Nakamura et al.	343/700
6,567,056 B1	5/2003	Waltho 434/797	
6,876,328 B2 *	4/2005	Adachi et al.	343/700 MS
6,956,529 B1 *	10/2005	Chen 343/700 MS	
6,992,630 B2 *	1/2006	Parsche 343/700 MS	
7,019,704 B2 *	3/2006	Weiss 343/770	
2004/0246181 A1	12/2004	Fukushima et al.	343/700
2005/0088342 A1	4/2005	Parsche 343/700	
2005/0110689 A1 *	5/2005	Masutani 343/700 MS	

FOREIGN PATENT DOCUMENTS

JP 2003152431 5/2003

OTHER PUBLICATIONS

Search Report and Written Opinion from PCT Application No. PCT/US06/40958 mailed on Nov. 14, 2007.

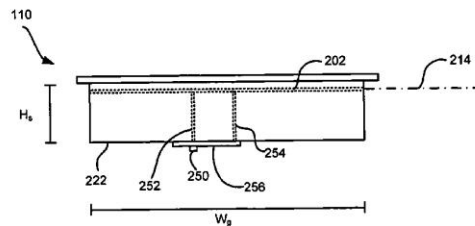
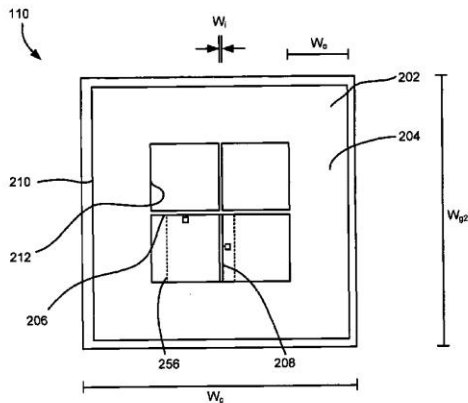
* cited by examiner

Primary Examiner—Tan Ho
(74) *Attorney, Agent, or Firm*—Zilka-Kotab, PC

(57) **ABSTRACT**

A circular polarized antenna having an electrically conductive element having a generally annular outer portion and first and second inner members coupled to the outer portion. A ground shield is spaced from the element, the ground shield providing an effective ground plane. A dielectric material is positioned between the element and at least a portion of the ground shield.

30 Claims, 7 Drawing Sheets





US007403159B2

(12) **United States Patent**
Gooshchin

(10) **Patent No.:** **US 7,403,159 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **MICROSTRIP ANTENNA HAVING A HEXAGONAL PATCH AND A METHOD OF RADIATING ELECTROMAGNETIC ENERGY OVER A WIDE PREDETERMINED FREQUENCY RANGE**

5,903,239	A *	5/1999	Takahashi et al.	343/700 MS
6,664,926	B1	12/2003	Zinanti et al.	
7,015,868	B2	3/2006	Puente Baliarde et al.	
2001/0020920	A1 *	9/2001	Shigihara	343/732
2005/0116862	A1 *	6/2005	du Toit	343/700 MS
2006/0170594	A1 *	8/2006	Cheng	343/700 MS

(76) **Inventor:** **Dmitry Gooshchin**, 39/11 Rubinshtein Street, Jaffo Daled, Tel-Aviv (IL) 68212

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 17 days.

* cited by examiner

Primary Examiner—Trinh Vo Dinh
Assistant Examiner—Dieu Hien T Duong

(21) **Appl. No.:** **11/429,126**

(22) **Filed:** **May 8, 2006**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2007/0257843 A1 Nov. 8, 2007

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

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

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

See application file for complete search history.

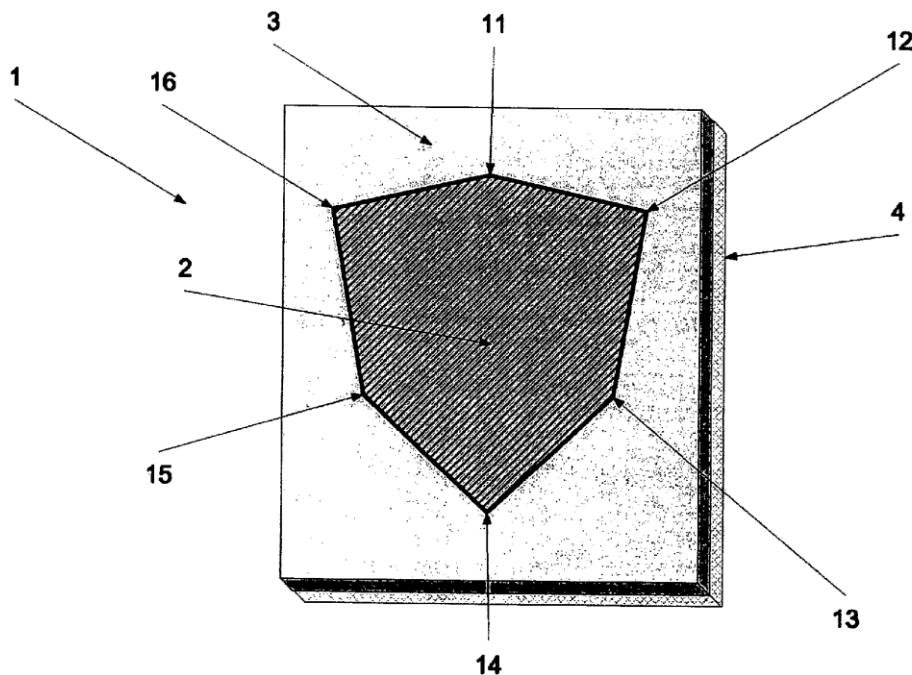
An electrically conductive hexagonal patch element for a patch antenna. The hexagonal patch element comprising a hexagonal shape with a first angle and a second angle opposite the first angle, a third angle and a fourth angle opposite the third angle, a fifth angle and a sixth angle opposite the fifth angle, the first, third, and fifth angles each measuring approximately 150 degrees and the second, fourth, and sixth angles each measuring approximately 90 degrees, wherein the first angle is positioned in between the fourth angle and the sixth angle.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,510,803 A * 4/1996 Ishizaka et al. 343/700 MS

24 Claims, 12 Drawing Sheets





US007403160B2

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

(10) **Patent No.:** **US 7,403,160 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **LOW PROFILE SMART ANTENNA FOR WIRELESS APPLICATIONS AND ASSOCIATED METHODS**

(75) Inventors: **Bing A. Chiang**, Melbourne, FL (US); **Michael J. Lynch**, Merritt Island, FL (US); **Douglas H. Wood**, Palm Bay, FL (US); **Thomas Liu**, Melbourne, FL (US); **Govind R. Kadambi**, Melbourne, FL (US); **Mark W. Kishler**, Melbourne, FL (US)

(73) Assignee: **Interdigital Technology Corporation**, Wilmington, DE (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.: **11/154,428**

(22) Filed: **Jun. 16, 2005**

(65) **Prior Publication Data**
US 2005/0280589 A1 Dec. 22, 2005

Related U.S. Application Data
(60) Provisional application No. 60/636,926, filed on Dec. 17, 2004, provisional application No. 60/587,970, filed on Jul. 14, 2004, provisional application No. 60/580,561, filed on Jun. 17, 2004.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 19/02 (2006.01)
(52) **U.S. Cl.** **343/702; 343/833; 343/834**
(58) **Field of Classification Search** **343/702, 343/752, 833, 834, 829, 846, 818; 455/575.7**
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
3,846,799 A 11/1974 Gueguen 343/833

5,905,473 A	5/1999	Taenzer	343/834
6,337,668 B1 *	1/2002	Ito et al.	343/833
6,369,770 B1	4/2002	Gothard et al.	343/794
6,392,599 B1 *	5/2002	Ganeshmoorthy et al. ..	343/700 MS
6,476,773 B2	11/2002	Palmer et al.	343/795
6,480,157 B1	11/2002	Palmer et al.	343/700 MS
6,753,826 B2	6/2004	Chiang et al.	343/834

(Continued)

FOREIGN PATENT DOCUMENTS

JP	56012102	2/1981
----	----------	--------

(Continued)

OTHER PUBLICATIONS

Ohira et al., Electronically Steerable Passive Array Radiator Antennas for Low-Cost Analog Adaptive Beamforming, 0-7803-6345-0/00, 2000, IEEE.

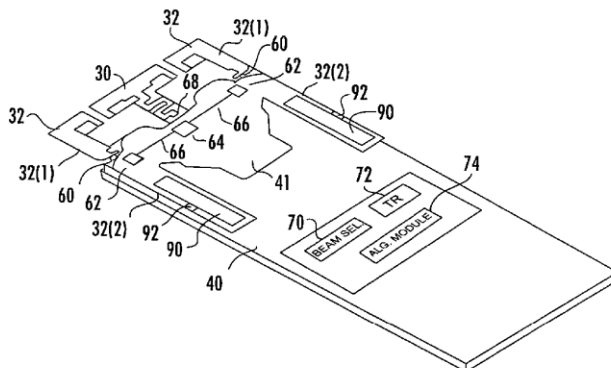
(Continued)

Primary Examiner—Michael C Wimer
(74) *Attorney, Agent, or Firm*—Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A low profile smart antenna includes an active antenna element carried by a dielectric substrate, and active antenna element has a T-shape. Passive antenna elements are carried by the dielectric substrate, and they have an inverted L-shaped portion laterally adjacent the active antenna element. Impedance elements are selectively connectable to the passive antenna elements for antenna beam steering.

34 Claims, 9 Drawing Sheets





US007403161B2

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

(10) **Patent No.:** **US 7,403,161 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **MULTIBAND ANTENNA IN A COMMUNICATION DEVICE**

(75) Inventors: **Carlo DiNallo**, Plantation, FL (US);
Marco Maddaleno, Turin (IT)

(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 201 days.

(21) Appl. No.: **11/250,339**

(22) Filed: **Oct. 14, 2005**

(65) **Prior Publication Data**

US 2007/0085747 A1 Apr. 19, 2007

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

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

(58) **Field of Classification Search** 343/700 MS,
343/767, 770, 702, 846

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,646,610 B2 * 11/2003 Troelsen 343/702
6,650,295 B2 * 11/2003 Ollikainen et al. 343/700 MS
6,762,723 B2 7/2004 Nallo et al.

* cited by examiner

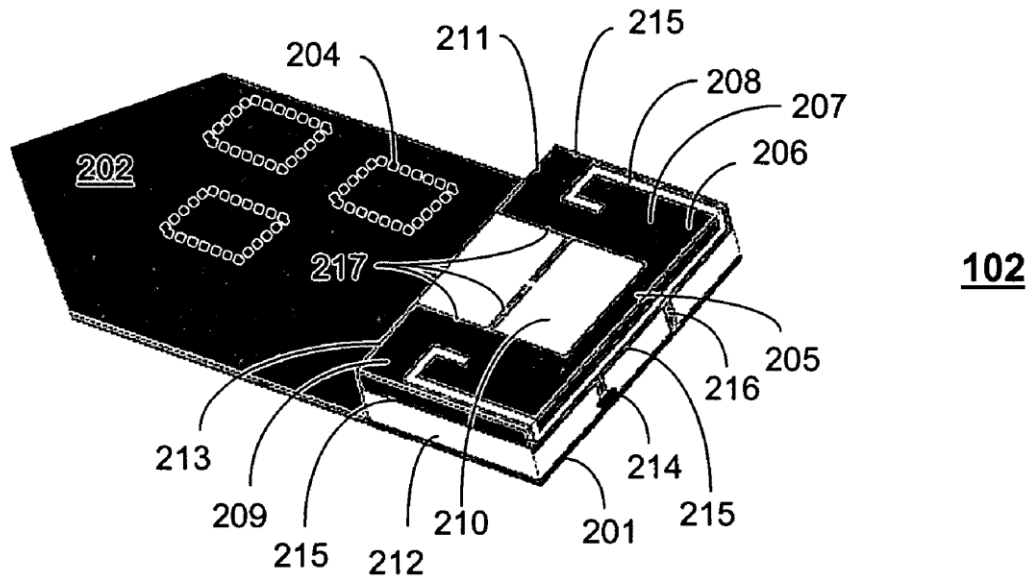
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Pablo Meles

(57) **ABSTRACT**

An apparatus is disclosed for a multiband antenna (102) in a communication device (100). An apparatus that incorporates teachings of the present invention may include, for example, an antenna having a finite ground surface (201, 401), and an elongated conductor (206, 406) that is characterized by a length and is spaced from the finite ground surface. The elongated conductor has a first slot (208, 408) extending through a substantial portion of the length of the elongated conductor, and a second slot (210, 410) having a shorter length than the first slot. The antenna further has a grounding conductor (216, 416) coupling the finite ground surface to the elongated conductor, and a signal feed conductor (214, 414) coupling to the elongated conductor.

18 Claims, 2 Drawing Sheets





US007403162B2

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

(10) **Patent No.:** **US 7,403,162 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **DUAL BAND WLAN ANTENNA** 2005/0062652 A1* 3/2005 Huang 343/700 MS

(75) Inventors: **James Li**, Santa Clara, CA (US); **Jing Jiang**, San Jose, CA (US)

(73) Assignee: **Marvell World Trade Ltd.**, St. Michael (BB)

(Continued)

FOREIGN PATENT DOCUMENTS

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

EP 0 795 926 A2 9/1997

(21) Appl. No.: **11/581,717**

(Continued)

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

OTHER PUBLICATIONS

(65) **Prior Publication Data**

US 2007/0182647 A1 Aug. 9, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/519,979, filed on Sep. 12, 2006.

(60) Provisional application No. 60/771,634, filed on Feb. 9, 2006.

IEEE Std 802.11a-1999 (Supplement to IEEE Std 802.11-1999) [Adopted by ISO/IEC and redesignated as ISO/IEC 8802-11: 1999/ Amd 1:2000(E)]; Supplement to IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications High-speed Physical Layer in the 5 GHz Band; LAN/MAN Standards Committee of the IEEE Computer Society; 91 pages.

(Continued)

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

Primary Examiner—Hoanganh Le

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

(57) **ABSTRACT**

(58) **Field of Classification Search** **343/702, 343/700 MS, 725, 729, 846**

See application file for complete search history.

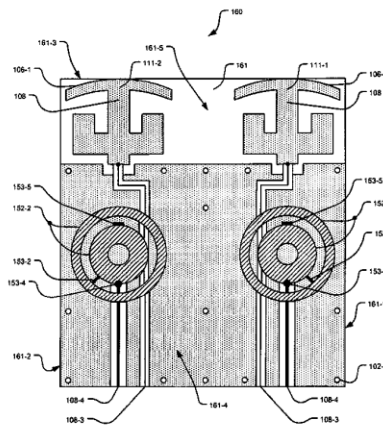
An antenna system comprises first and second antennas that are arranged on a printed circuit board (PCB) and that include an arc-shaped element having a concave side and a convex side. A conducting element extends substantially radially from a center of the concave side. A U-shaped element has a base portion with a center that communicates with the conducting element and two side portions that extend from ends of the base portion towards the concave side. Third and fourth antennas are arranged on the PCB and include an inner ring and an outer ring that is concentric to the inner ring.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 4,343,976 A 8/1982 Nasretin et al.
- 5,714,961 A * 2/1998 Kot et al. 343/769
- 6,184,828 B1 * 2/2001 Shoki 342/372
- 6,597,316 B2 * 7/2003 Rao et al. 343/700 MS
- 7,006,043 B1 2/2006 Nalbandian
- 2002/0163473 A1 * 11/2002 Koyama et al. 343/718
- 2003/0210187 A1 11/2003 Lu et al.
- 2004/0004572 A1 1/2004 Ma
- 2004/0239568 A1 12/2004 Masutani

42 Claims, 38 Drawing Sheets





US007403163B2

(12) **United States Patent**
Kyowski

(10) **Patent No.:** **US 7,403,163 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

- (54) **LOW PROFILE ANTENNA INSERT NUT**
- (75) Inventor: **Timothy H. Kyowski**, Brantford (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 0 days.
- (21) Appl. No.: **11/671,211**
- (22) Filed: **Feb. 5, 2007**

5,936,581	A	8/1999	Roshitsh et al.
5,955,999	A	9/1999	Mutz et al.
5,973,645	A	10/1999	Zigler et al.
6,034,639	A	3/2000	Rawlins et al.
6,133,885	A	10/2000	Luniak et al.
6,157,350	A	12/2000	House et al.
6,300,911	B1	10/2001	Murray et al.
6,509,878	B1	1/2003	Tornatta, Jr. et al.
6,639,561	B2	10/2003	Pruss et al.
6,710,747	B1	3/2004	Chang
6,791,501	B2*	9/2004	Otsuka et al. 343/715
6,930,643	B2	8/2005	Byrne et al.
2002/0070903	A1	6/2002	Nakamura et al.
2002/0101380	A1	8/2002	Pruss et al.
2005/0093755	A1	5/2005	Byrne et al.
2006/0077112	A1*	4/2006	Nakano et al. 343/715

(65) **Prior Publication Data**
US 2007/0126646 A1 Jun. 7, 2007

Related U.S. Application Data
(63) Continuation of application No. 11/107,974, filed on Apr. 18, 2005, now Pat. No. 7,190,314, which is a continuation of application No. 10/723,839, filed on Nov. 26, 2003, now abandoned.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.** 343/702; 343/906; 439/916

(58) **Field of Classification Search** 343/702, 343/715, 878, 906; 439/916
 See application file for complete search history.

(56) **References Cited**
 U.S. PATENT DOCUMENTS
 3,876,277 A 4/1975 Colwell
 5,158,483 A 10/1992 Fishman et al.
 5,714,963 A 2/1998 Cox

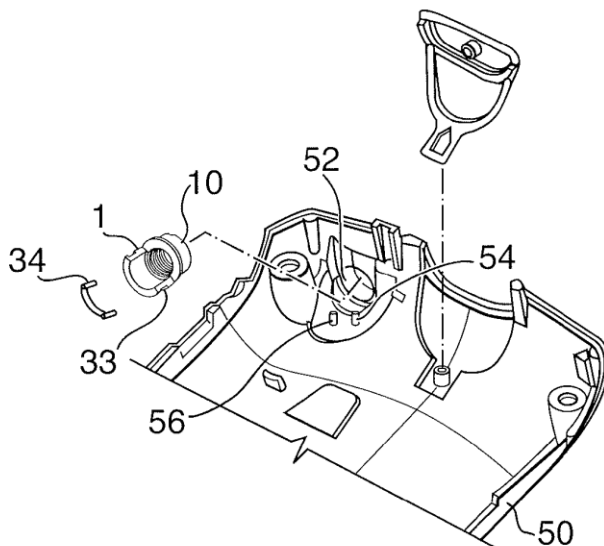
FOREIGN PATENT DOCUMENTS

EP	0800226	10/1997
JP	2000-114835	4/2000
WO	0171844	9/2001
WO	02054539	7/2002

* cited by examiner
Primary Examiner—Tan Ho
(74) *Attorney, Agent, or Firm*—Moffat & Co.

(57) **ABSTRACT**
An antenna mount comprising a front cylindrical mount, the front cylindrical mount having a threaded interior for installing an antenna; a flanged central portion; a base mount consisting of a hollow cylinder cut away along a longitudinal axis, leaving a half-circular cross section. The antenna mount can be installed by inserting it into an opening in the casing of a device and rotating the antenna mount until it abuts a stop stud.

9 Claims, 2 Drawing Sheets





US007403164B2

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

(10) **Patent No.:** **US 7,403,164 B2**
(45) **Date of Patent:** ***Jul. 22, 2008**

(54) **MULTI-BAND MONOPOLE ANTENNA FOR A MOBILE COMMUNICATIONS DEVICE**

(75) Inventors: **Alfonso Sanz**, 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.

5,572,223 A	11/1996	Phillips et al.
5,608,417 A	3/1997	de Vall
5,870,066 A	2/1999	Asakura et al.
5,929,825 A	7/1999	Niu et al.
5,943,020 A	8/1999	Liebendoerfer et al.
5,963,871 A	10/1999	Zhinong et al.

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 884 796 12/1998

(21) Appl. No.: **11/713,324**

(22) Filed: **Mar. 2, 2007**

(65) **Prior Publication Data**

US 2007/0152894 A1 Jul. 5, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/124,768, filed on May 9, 2005, which is a continuation of application No. PCT/EP02/14706, filed on Dec. 22, 2002.

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

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

(58) **Field of Classification Search** **343/702, 895**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,123,756 A	10/1978	Nagata et al.
4,389,651 A	6/1983	Tomasky
4,578,654 A	3/1986	Tait
5,248,988 A	9/1993	Makino
5,337,065 A	8/1994	Bonnet et al.
5,457,469 A	10/1995	Diamond

(Continued)

OTHER PUBLICATIONS

Puente, Fractal antennas, Universitat Politècnica de Catalunya, 1997.

(Continued)

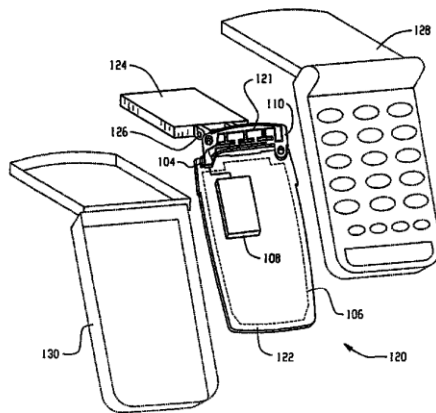
Primary Examiner—Tan Ho

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

(57) **ABSTRACT**

A multi-band monopole antenna for a mobile communications device includes a common conductor coupled to both a first radiating arm and a second radiating arm. The common conductor includes a feeding port for coupling the antenna to communications circuitry in a mobile communications device. In one embodiment, the first radiating arm includes a space-filling curve. In another embodiment, the first radiating arm includes a meandering section extending from the common conductor in a first direction and a contiguous extended section extending from the meandering section in a second direction.

27 Claims, 7 Drawing Sheets





US007403165B2

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

(10) **Patent No.:** **US 7,403,165 B2**
(45) **Date of Patent:** ***Jul. 22, 2008**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE COMPRISING NON-PLANAR INTERNAL ANTENNA WITHOUT GROUND PLANE OVERLAP**

(75) Inventors: **Yihong Qi**, Waterloo (CA); **Ying Tong Man**, Kitchener (CA); **Perry Jarmuszewski**, Waterloo (CA)

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/769,825**

(22) Filed: **Jun. 28, 2007**

(65) **Prior Publication Data**
US 2007/0247389 A1 Oct. 25, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/422,170, filed on Jun. 5, 2006, now Pat. No. 7,256,744, which is a continuation of application No. 11/042,890, filed on Jan. 25, 2005, now Pat. No. 7,091,911.

(60) Provisional application No. 60/576,159, filed on Jun. 2, 2004, provisional application No. 60/576,637, filed on Jun. 3, 2004.

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

(52) **U.S. Cl.** **343/702; 343/700 MS; 343/745**

(58) **Field of Classification Search** **343/700 MS, 343/702, 846, 748, 866, 745**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,571,595 A	2/1986	Phillips et al.	343/745
4,723,305 A	2/1988	Phillips et al.	455/89
5,337,061 A	8/1994	Pye et al.	343/702

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2 489 837	12/2003
----	-----------	---------

(Continued)

OTHER PUBLICATIONS

Film type inverted F antenna, Honda Tsushin Kogyo Co., Ltd., Jun. 17, 2003.

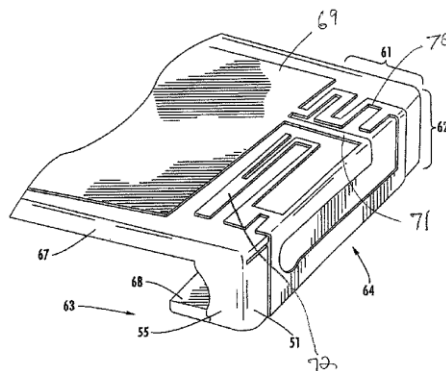
(Continued)

Primary Examiner—Hoang V Nguyen
(74) *Attorney, Agent, or Firm*—Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include a housing, a main dielectric substrate carried by the housing, circuitry carried by the main dielectric substrate, and a ground plane conductor on the main dielectric substrate. The mobile wireless communications device may further include an L-shaped dielectric extension comprising a vertical portion extending outwardly from the main dielectric substrate and an overhang portion extending outwardly from the vertical portion and above an adjacent portion of the main dielectric layer. A main loop antenna conductor comprising at least one conductive trace may be relatively positioned on the overhang portion of the L-shaped dielectric extension so as not to overlap the ground plane conductor.

17 Claims, 11 Drawing Sheets





US007403168B2

(12) **United States Patent**
Ohara

(10) **Patent No.:** **US 7,403,168 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **ANTENNA DEVICE AND COMMUNICATIONS SYSTEM USING THE SAME**

6,522,241 B1 * 2/2003 Baudard 340/5.61
6,621,178 B2 * 9/2003 Morillon 307/10.5
7,271,711 B2 * 9/2007 Daiss et al. 340/447

(75) Inventor: **Masahiro Ohara**, Osaka (JP)

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

FOREIGN PATENT DOCUMENTS

JP 2001-520337 10/2001
WO WO 99/19585 4/1999

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 50 days.

* cited by examiner

(21) Appl. No.: **11/507,591**

Primary Examiner—Tan Ho

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

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

(65) **Prior Publication Data**

US 2007/0091003 A1 Apr. 26, 2007

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Oct. 20, 2005 (JP) 2005-305492

An antenna made by winding a coil on the periphery of a rod-like core made of a magnetic material is housed inside a pillar having a relatively small width and disposed in a manner such that its axis line is nearly orthogonal to the vertical axis line of the pillar. With this arrangement, a predetermined communication range is secured as the electromagnetic waves radiated from the antenna are barely absorbed by the vehicle body and radiated to inside the cabin as well as to the outside. Accordingly, an inexpensive antenna device and a communications system using it are provided which enable communication with a portable device inside and outside a vehicle cabin using a single antenna.

(51) **Int. Cl.**

H01Q 1/32 (2006.01)

H01Q 7/08 (2006.01)

(52) **U.S. Cl.** **343/713; 343/788**

(58) **Field of Classification Search** 343/711, 343/713, 787, 788

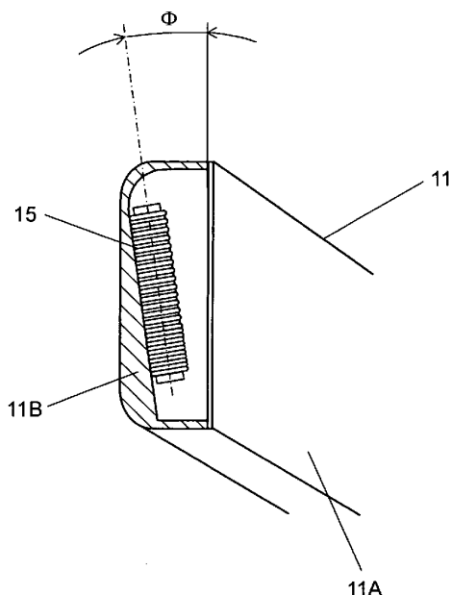
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,400,330 B1 * 6/2002 Maruyama et al. 343/788

4 Claims, 4 Drawing Sheets





US007403169B2

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

(10) **Patent No.:** **US 7,403,169 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) ANTENNA DEVICE AND ARRAY ANTENNA	5,519,408 A * 5/1996 Schnetzer 343/767
(75) Inventors: Bengt Svensson , Mölndal (SE); Anders Höök , Hindås (SE); Joakim Johansson , Töllsjö (SE)	5,748,153 A * 5/1998 McKinzie et al. 343/767 6,043,785 A * 3/2000 Marino 343/767 6,239,761 B1 * 5/2001 Guo et al. 343/767 6,292,153 B1 * 9/2001 Aiello et al. 343/767

(73) **Assignee:** **Telefonaktiebolaget LM 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 209 days.

FOREIGN PATENT DOCUMENTS

EP 0 455 493 11/1991

(21) **Appl. No.:** **10/584,907**

(Continued)

(22) **PCT Filed:** **Dec. 27, 2004**

OTHER PUBLICATIONS

(86) **PCT No.:** **PCT/SE2004/002011**

International Search Report for PCT/SE04/02011 dated Apr. 18, 2005.

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

(Continued)

(87) **PCT Pub. No.:** **WO2005/064748**

Primary Examiner—Shih-Chao Chen
(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye, P.C.

PCT Pub. Date: **Jul. 14, 2005**

(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2007/0126648 A1 Jun. 7, 2007

(30) **Foreign Application Priority Data**

The present invention relates to a broadband non-resonant antenna device for wireless transmission of information using electromagnetic signals, comprising a metal sheet layer, forming a plane, with a slotline that comprises a first part and a second part. The side of the second part that is the most distant from the first part transcends into a widening open-ended tapered slot in the metal sheet layer. The device additionally comprises a feeding line in the metal sheet layer. The feeding line comprises a feeding part, with a first end and a second end, and gaps separating the feeding part from the surrounding metal sheet layer by a certain distance, where the slotline is intersected by the feeding line.

Dec. 30, 2003 (WO) PCT/SE03/02102

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

(52) **U.S. Cl.** 343/767; 343/770; 343/771

(58) **Field of Classification Search** 343/767,
343/770, 771, 747, 786, 859, 865

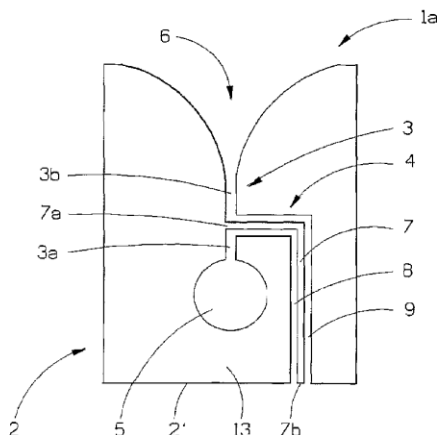
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,853,704 A * 8/1989 Diaz et al. 343/767

23 Claims, 13 Drawing Sheets





US007403172B2

(12) **United States Patent**
Cheng

(10) **Patent No.:** **US 7,403,172 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

(54) **RECONFIGURABLE PATCH ANTENNA APPARATUS, SYSTEMS, AND METHODS**

(75) Inventor: **Dajun Cheng**, Marlborough, MA (US)

(73) Assignee: **Intel Corporation**, 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 0 days.

(21) Appl. No.: **11/379,160**

(22) Filed: **Apr. 18, 2006**

(65) **Prior Publication Data**

US 2007/0241978 A1 Oct. 18, 2007

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

(52) **U.S. Cl.** **343/853**; 343/700 MS; 343/824; 343/876

(58) **Field of Classification Search** 343/700 MS, 343/753, 754, 876, 853, 824
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,469,181 A 11/1995 Yarusnas

5,767,807 A	6/1998	Pritchett
5,841,401 A	11/1998	Bodley et al.
5,977,911 A	11/1999	Green et al.
6,281,847 B1	8/2001	Lee
6,335,703 B1	1/2002	Chang et al.
6,414,646 B2	7/2002	Luh
6,518,931 B1	2/2003	Sievenpiper
6,567,046 B2*	5/2003	Taylor et al. 343/700 MS
6,577,282 B1	6/2003	Rao et al.
6,710,746 B1	3/2004	Anderson et al.
6,768,458 B1	7/2004	Green et al.
6,774,854 B2	8/2004	Wannagot et al.
6,784,835 B2	8/2004	Kohno et al.
6,828,938 B2*	12/2004	Tran 343/700 MS
2004/0155819 A1*	8/2004	Martin et al. 343/700 MS

OTHER PUBLICATIONS

Cheng, D., "Compact Multi-Band, Multi-Port Antenna", U.S. Appl. No. 11/209,218, filed Aug. 23, 2005.

* cited by examiner

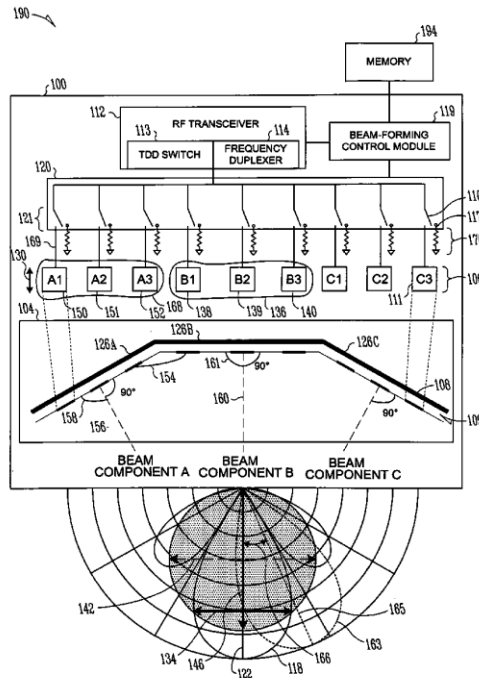
Primary Examiner—Hoang V Nguyen

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

(57) **ABSTRACT**

Embodiments of a beam-reconfigurable patch antenna are described generally herein. Other embodiments may be described and claimed.

23 Claims, 6 Drawing Sheets





US007403173B2

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

(10) **Patent No.:** **US 7,403,173 B2**
(45) **Date of Patent:** **Jul. 22, 2008**

- (54) **ANTENNA DEVICE**
- (75) Inventors: **Takao Shimamori**, Kanagawa-ken (JP);
Minoru Hasegawa, Kanagawa-ken (JP)
- (73) Assignee: **Samsung Electronics Co., Ltd.** (KR)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 19 days.

6,624,795 B2 *	9/2003	Boyle	343/895
7,053,839 B2 *	5/2006	Cassel et al.	343/702
7,158,819 B1 *	1/2007	Pulimi et al.	455/575.5

FOREIGN PATENT DOCUMENTS

EP 1 176 663 1/2002

* cited by examiner

Primary Examiner—Hoang V Nguyen
(74) *Attorney, Agent, or Firm*—McNeely Bodendorf LLP

(21) Appl. No.: **11/644,787**

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

(57) **ABSTRACT**

(65) **Prior Publication Data**
US 2007/0182648 A1 Aug. 9, 2007

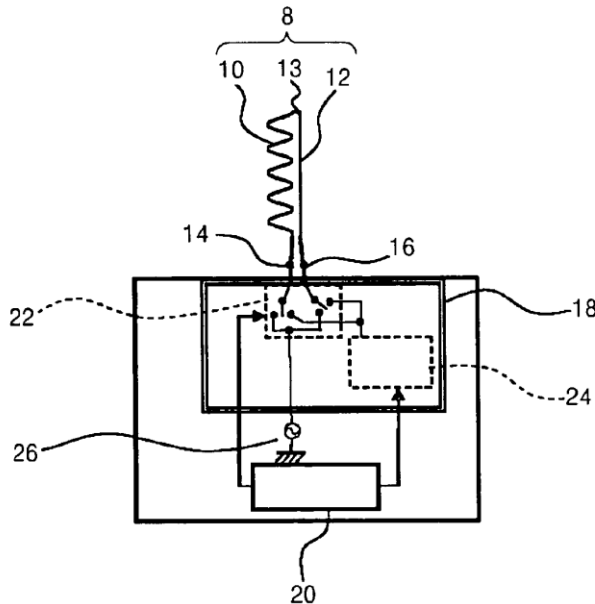
(30) **Foreign Application Priority Data**
Dec. 22, 2005 (JP) 2005-370029
Aug. 21, 2006 (KR) 10-2006-0078761

(51) **Int. Cl.**
H01Q 3/24 (2006.01)
(52) **U.S. Cl.** **343/876**; 343/702; 343/895
(58) **Field of Classification Search** 343/876,
343/895, 702, 850, 860
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
6,181,286 B1 * 1/2001 Roscoe et al. 343/725

Provided is a compact antenna for installment in a portable terminal and adjusting a resonant frequency. The compact antenna device includes an antenna unit including first and second elements, the first element including a first antenna terminal having at least one of meandering and curved patterns wholly or partially, and the second element including an end connected to another end of the first element and another end having a second antenna terminal, a feeding unit exciting the antenna unit through the first and second antenna terminals, a switching circuit connected between the antenna unit and the feeding unit and selectively switching one or both of the first and second elements in order to connect one or both of the first and second elements to the feeding unit. A resonant frequency of the antenna unit varies during feeding by the feeding unit depending on the switching operation of the switching circuit.

15 Claims, 18 Drawing Sheets





US007405697B2

(12) **United States Patent**
Ying

(10) **Patent No.:** **US 7,405,697 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **COMPACT DIVERSITY ANTENNA**

(76) Inventor: **Zhinong Ying**, Skyttejinjaen 50, SE-226 49 Lund (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 15 days.

(21) Appl. No.: **10/549,717**

(22) PCT Filed: **Feb. 18, 2004**

(86) PCT No.: **PCT/EP2004/001503**

§ 371 (c)(1),
(2), (4) Date: **Sep. 16, 2005**

(87) PCT Pub. No.: **WO2004/084344**

PCT Pub. Date: **Sep. 30, 2004**

(65) **Prior Publication Data**

US 2006/0220959 A1 Oct. 5, 2006

Related U.S. Application Data

(60) Provisional application No. 60/458,170, filed on Mar. 27, 2003.

(30) **Foreign Application Priority Data**

Mar. 18, 2003 (EP) 03075785

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

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

(58) **Field of Classification Search** **343/700 MS, 343/846, 876, 702**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,367,474 A 1/1983 Schaubert et al. 343/700
6,104,356 A * 8/2000 Hikuma et al. 343/853
6,211,830 B1 * 4/2001 Monma et al. 343/702
6,369,762 B1 * 4/2002 Yanagisawa et al. .. 343/700 MS

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0 872 912 3/2005

(Continued)

OTHER PUBLICATIONS

International Preliminary Examination Report for PCT/EP2004/001503.

Primary Examiner—Hoang V Nguyen

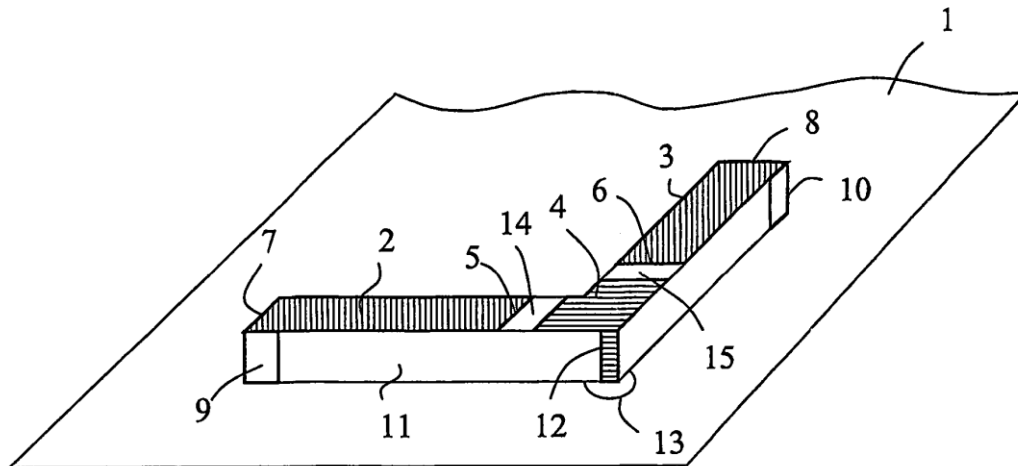
Assistant Examiner—Robert Karacsony

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

(57) **ABSTRACT**

A diversity radio antenna includes a ground substrate and two elongated antenna elements. The antenna elements each extend between respective opposing ends thereof in a plane parallel to and spaced from the ground substrate. An excitation electrode is interposed between the respective ends. A ground connector switch is configured to selectively connect and disconnect the ground substrate to the antenna elements for controlling radiation beam pattern and polarisation diversity of the antenna. The ground connector switch is configured to selectively connect the antenna elements to the ground substrate for adapting the antenna to a circularly-polarised radio wave, or to disconnect one of the antenna elements from the ground substrate for adapting the antenna to a linearly-polarised radio wave.

19 Claims, 4 Drawing Sheets





US007405699B2

(12) **United States Patent**
Qin

(10) **Patent No.:** **US 7,405,699 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **MULTIPLE INPUT MULTIPLE OUTPUT ANTENNA**

(75) Inventor: **Xiang-Hong Qin**, Shenzhen (CN)

(73) Assignees: **Hong Fu Jin Precision Industry (Shenzhen) Co., Ltd.**, Shenzhen, Guangdong Province (CN); **Hon Hai Precision Industry Co., Ltd.**, Tu-Cheng, 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 0 days.

(21) Appl. No.: **11/615,018**

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

(65) **Prior Publication Data**
US 2008/0094282 A1 Apr. 24, 2008

(30) **Foreign Application Priority Data**
Oct. 20, 2006 (TW) 95138886 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/829; 343/846; 343/770; 343/853**

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

(56) **References Cited**
U.S. PATENT DOCUMENTS
6,801,168 B1 * 10/2004 Yeh 343/700 MS

2003/0034917 A1 * 2/2003 Nishizawa et al. 343/700 MS
2004/0164906 A1 * 8/2004 Shih 343/700 MS
2006/0071858 A1 * 4/2006 Suh 343/700 MS
2006/0170594 A1 * 8/2006 Cheng 343/700 MS
2007/0279285 A1 * 12/2007 Hilgers 343/700 MS
2007/0285331 A1 * 12/2007 Sarabandi et al. 343/866
2008/0012769 A1 * 1/2008 Cheng 343/700 MS

FOREIGN PATENT DOCUMENTS

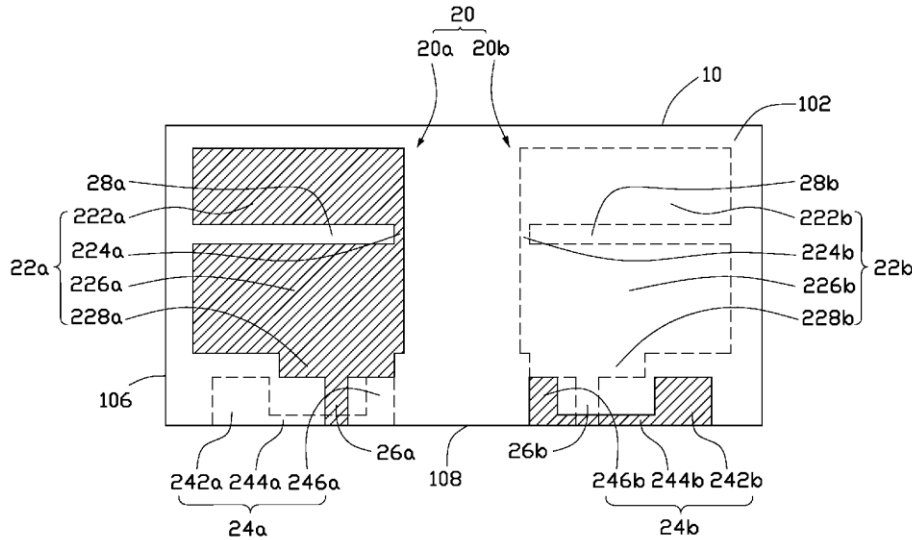
CN 1474478 A 2/2004

* cited by examiner
Primary Examiner—Trinh V Dinh
(74) *Attorney, Agent, or Firm*—Wei Te Chung

(57) **ABSTRACT**

A MIMO antenna (20) disposed on a substrate (10) including a first surface (102) and a second surface (104). The MIMO antenna includes a first antenna (20a) and a second antenna (20b) each including a radiating body (22a), a feeding portion (26a) electrically connected to the radiating body, and a metallic ground plane (24a). The radiating body includes a first radiating portion (222a), a second radiating portion (226a), and a gap (28a) formed between the first radiating portion and the second radiating portion. The radiating body of the first antenna and the feeding portion of the first antenna and the ground plane of the second antenna are laid on the first surface of the substrate, and the radiating body and the feeding portion of the second antenna and the ground plane of the first antenna are laid on the second surface of the substrate.

18 Claims, 6 Drawing Sheets





US007405700B2

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

(10) **Patent No.:** **US 7,405,700 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **SINGLE-FEED MULTI-FREQUENCY
MULTI-POLARIZATION ANTENNA**

(75) Inventors: **Ayman Duzdar**, Holly, MI (US);
Andreas D. Fuchs, Orion, MI (US)

(73) Assignee: **Laird Technologies, Inc.**, St. Louis, MO
(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.: **11/633,923**

(22) Filed: **Dec. 5, 2006**

(65) **Prior Publication Data**

US 2007/0222683 A1 Sep. 27, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/145,878, filed on
Jun. 6, 2005, now Pat. No. 7,164,385.

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/846, 702, 711, 713

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 4,132,995 A 1/1979 Monser
- 4,827,271 A 5/1989 Berneking et al.
- 4,873,529 A 10/1989 Gibson
- 6,008,770 A 12/1999 Sugawara
- 6,181,281 B1 1/2001 Desclos et al.
- 6,466,768 B1 10/2002 Agahi-Kesheh et al.

- 6,538,609 B2 3/2003 Nguyen et al.
- 6,762,729 B2 7/2004 Egashira et al.
- 6,806,838 B2 10/2004 Petros et al.
- 6,825,803 B2 11/2004 Wixforth et al.
- 7,019,705 B2 3/2006 Pletschinger et al.
- 7,116,952 B2 10/2006 Arafa

(Continued)

FOREIGN PATENT DOCUMENTS

DE 101 33 295 A1 1/2003

(Continued)

OTHER PUBLICATIONS

E.B. Perri, "Dual band cellular antenna in a multifunction platform
for vehicular applications", 2006 IEEE, University of Sao
Paulo—Dept. of Telecommunications and Control Engineering Av.
Prof. Luciano Gualberto, trav. 3, 158 ZC 05508-900 Sao Paulo,
Brazil (2006) pp. 2361-2364.

(Continued)

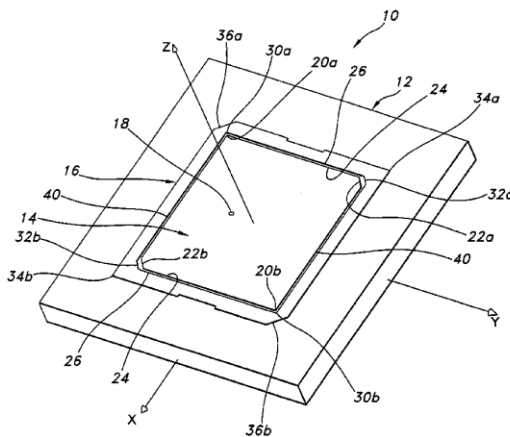
Primary Examiner—Hoang V Nguyen

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

(57) **ABSTRACT**

Various embodiments provide antennas capable of receiving
both left-hand circularly polarized (LHCP) signals and right-
hand circularly polarized (RHCP) signals, and outputting
both signals on a single feed. In one exemplary embodiment,
an antenna generally includes two substantially coplanar con-
centric patches. The inner patch is substantially square. The
outer patch has inner and outer edges both of which are
substantially square. The two patches do not physically con-
tact one another. A single feed is connected to the inner patch.
The inner patch receives the LHCP signal, and the two
patches operate collectively together for receiving the RHCP
signal.

26 Claims, 14 Drawing Sheets





US007405701B2

(12) **United States Patent**
Ozkar

(10) **Patent No.:** **US 7,405,701 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **MULTI-BAND BENT MONOPOLE ANTENNA**

2006/0044187 A1 * 3/2006 Sager et al. 343/700 MS

(75) Inventor: **Mete Ozkar**, Raleigh, NC (US)

FOREIGN PATENT DOCUMENTS

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

EP	1 052 723	11/2000
EP	1 396 906	3/2004
WO	02/078124	10/2002
WO	03/094289	11/2003
WO	03/096474	11/2003

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 272 days.

OTHER PUBLICATIONS

(21) Appl. No.: **11/239,589**

Virga et al., "Low-Profile Enhanced-Bandwidth PIFA Antennas for Wireless Communications Packaging," Oct. 1997, pp. 1879-1888, vol. 45, No. 10, XP11036995.
PCT International Search Report, International Application No. PCT/US2006/017711, Mailed Aug. 31, 2006.

(22) Filed: **Sep. 29, 2005**

* cited by examiner

(65) **Prior Publication Data**

US 2007/0069958 A1 Mar. 29, 2007

Primary Examiner—Tho G Phan

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

(74) *Attorney, Agent, or Firm*—Coats & Bennett, P.L.L.C.

(52) **U.S. Cl.** **343/702**; 343/815; 343/846

(58) **Field of Classification Search** 343/700 MS, 343/702, 815, 833, 834, 846
See application file for complete search history.

(57) **ABSTRACT**

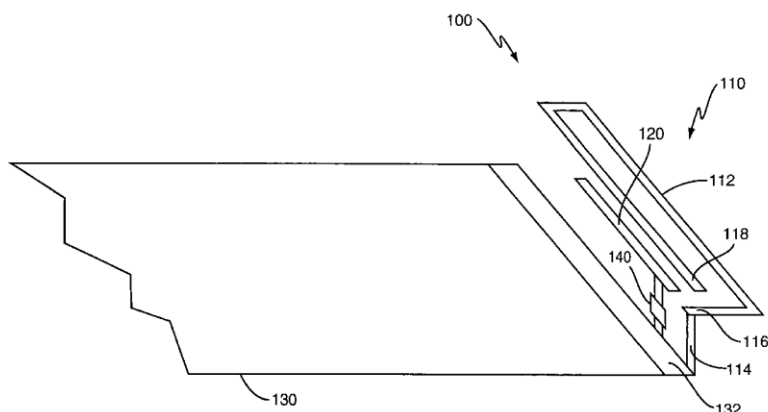
(56) **References Cited**

U.S. PATENT DOCUMENTS

5,714,937	A *	2/1998	Campana, Jr.	340/573.1
6,198,943	B1	3/2001	Sadler et al.	
6,340,952	B1	1/2002	Tsai et al.	
6,535,166	B1	3/2003	Ali	
6,744,409	B2	6/2004	Ellis et al.	
6,768,461	B2	7/2004	Huebner et al.	
6,774,853	B2	8/2004	Wong et al.	
6,819,287	B2	11/2004	Sullivan et al.	
6,822,610	B2	11/2004	Yeh	
6,856,285	B2	2/2005	Bettin et al.	
6,876,329	B2	4/2005	Milosavljevic	
6,882,318	B2	4/2005	Nevermann	
7,202,835	B2 *	4/2007	Chiang et al.	343/834
2005/0128152	A1 *	6/2005	Milosavljevic	343/702
2005/0212706	A1 *	9/2005	Ying et al.	343/702

The method and apparatus described herein improves the bandwidth of a selected frequency band of a multi-band antenna. In particular, a selection circuit selectively applies capacitive coupling to the multi-band antenna to improve the bandwidth of a first frequency band without adversely affecting the bandwidth of a second frequency band. To that end, the multi-band antenna of the present invention comprises a main antenna element and a parasitic element disposed proximate the main antenna element. When the multi-band antenna operates in the first frequency band, the main antenna element capacitively couples to the parasitic element. However, when the multi-band antenna operates in the second frequency band, the selection circuit disables the capacitive coupling. By applying the capacitive coupling only when the multi-band antenna operates in the first frequency band, the present invention increases the bandwidth of the first frequency band without adversely affecting the bandwidth of the second frequency band.

24 Claims, 6 Drawing Sheets





US007405702B2

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

(10) **Patent No.:** **US 7,405,702 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **ANTENNA ARRANGEMENT FOR CONNECTING AN EXTERNAL DEVICE TO A RADIO DEVICE**

(75) Inventors: **Petteri Annamaa**, Oulunsalo (FI); **Veli Torvinen**, Kempele (FI)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 261 days.

(21) Appl. No.: **11/330,714**

(22) Filed: **Jan. 11, 2006**

(65) **Prior Publication Data**
US 2006/0176225 A1 Aug. 10, 2006

Related U.S. Application Data
(63) Continuation of application No. PCT/FI2004/00430, filed on Jul. 7, 2004.

(30) **Foreign Application Priority Data**
Jul. 24, 2003 (FI) 20031101

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/702; 455/575.2**
(58) **Field of Classification Search** **343/700 MS, 343/702, 829, 846, 906; 455/95, 575.2**
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
5,369,782 A * 11/1994 Kawano et al. 455/16
5,532,703 A * 7/1996 Stephens et al. 343/702

5,711,014 A * 1/1998 Crowley et al. 455/575.7
6,134,421 A 10/2000 Lee et al.
6,157,819 A * 12/2000 Vuokko et al. 455/575.7
6,556,812 B1 * 4/2003 Pennanen et al. 343/702
2002/0154066 A1 10/2002 Bama et al.

FOREIGN PATENT DOCUMENTS

EP 0 999 607 A2 5/2000
EP 1 006 605 A1 6/2000
EP 1 170 822 A1 1/2002
EP 1306922 5/2003
GB 2345196 6/2000

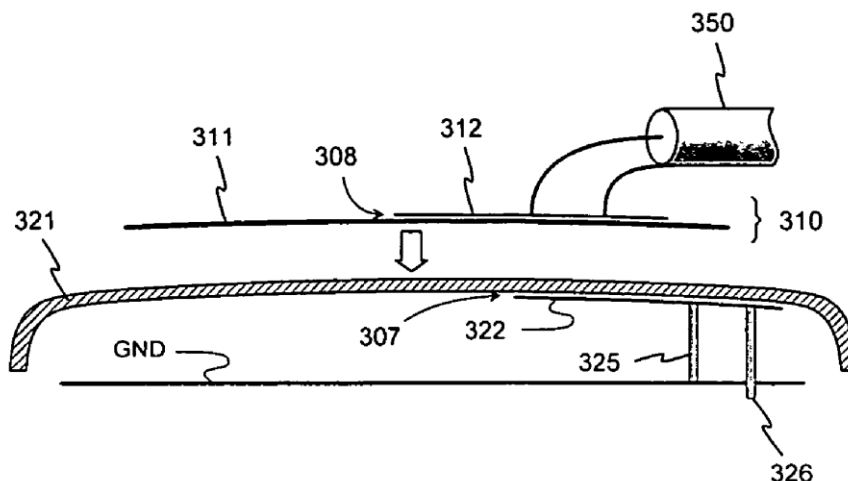
* cited by examiner

Primary Examiner—Tho G Phan
(74) *Attorney, Agent, or Firm*—Darby & Darby P.C.

(57) **ABSTRACT**

An arrangement by which an external device is connected to a radio device via its antenna without modifying the radio device mechanically. The radiating element (311) of the antenna of the radio device is a conductive part of its casing, which is fed electromagnetically by means of a feed element (312). The connecting is implemented by a coupler (310) to be placed at the antenna on top of the casing, from which coupler there is an intermediate cable (350) to the external device. The coupler includes a coupling element (311), from which there is electromagnetic coupling to the radiating element (321) through a thin dielectric membrane, or direct galvanic coupling. From the coupling element to the jumper cable there is electromagnetic coupling through an intermediate element (312), or direct galvanic coupling. Because the radiating plane is located on the outer surface of the radio device, its distance to the coupling element can be made very small. Thus the attenuation caused by the coupler on the transfer path from the antenna port of the radio device to the external device is lower than in the known arrangements.

10 Claims, 4 Drawing Sheets





US007405704B1

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

(10) **Patent No.:** **US 7,405,704 B1**
(45) **Date of Patent:** **Jul. 29, 2008**

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

(75) Inventors: **Ching-chi Lin**, Tu-Cheng (TW); **Kai Shih**, Tu-Cheng (TW); **Yu-yuan Wu**, Tu-Cheng (TW); **Jia-hung Su**, Tu-Cheng (TW)

(73) Assignee: **Cheng Uei Precision Industry 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 10 days.

(21) Appl. No.: **11/699,465**

(22) Filed: **Jan. 30, 2007**

(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, 846**

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,289,071 B2 * 10/2007 Hung et al. 343/702

2007/0096999 A1 * 5/2007 Wang et al. 343/702
2007/0120753 A1 * 5/2007 Hung et al. 343/702
2007/0146216 A1 * 6/2007 Wang et al. 343/702
2007/0200774 A1 * 8/2007 Wang et al. 343/702

* cited by examiner

Primary Examiner—Hoang V Nguyen

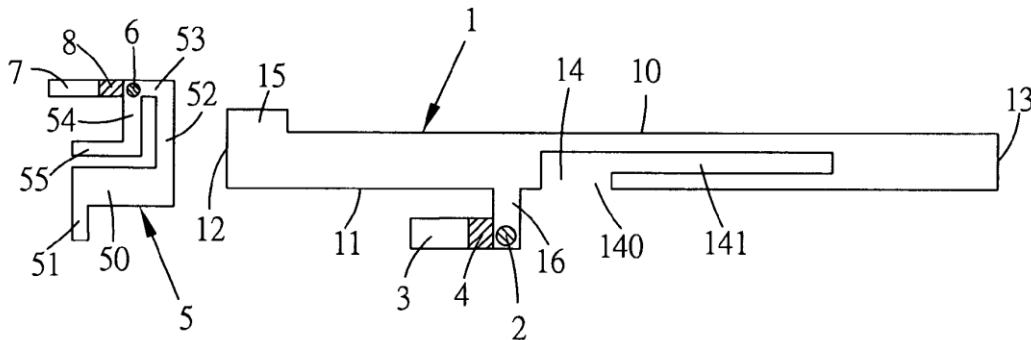
(74) *Attorney, Agent, or Firm*—Rosenberg, Klein & Lee

(57) **ABSTRACT**

An integrated multi-band antenna has a first radiating element and a second radiating element. The first radiating element has a slot and a feeding conductor having a first feeding point. A first ground portion is arranged to close to the feeding conductor. The second radiating element has a first radiating segment, a second radiating segment extending from one end of the first radiating segment, a third, a fourth, a fifth and a sixth radiating segments connecting end to end in sequence wherein one end of the third radiating segment connects to the other end of the first radiating segment, and one end of the sixth radiating segment remains free. A second feeding point is arranged at the corner between the fourth and fifth radiating segments. A second ground portion is arranged to close to the corner. Operation of the integrated multi-band antenna can obtain various wireless communication bands.

20 Claims, 3 Drawing Sheets

100





US007405705B2

(12) **United States Patent**
Fukuchi

(10) **Patent No.:** **US 7,405,705 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **WIDEBAND ANTENNA**

7,268,741 B2* 9/2007 Sarabandi et al. 343/866
2005/0151694 A1* 7/2005 Huang 343/767

(75) Inventor: **Keisuke Fukuchi**, Hitachi (JP)

(73) Assignee: **Hitachi Cable, Ltd.**, 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.

JP 2004-343424 A 12/2004
JP 2005-094437 A 4/2005
JP 2005-094499 A 4/2005

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **11/812,929**

(22) Filed: **Jun. 22, 2007**

OTHER PUBLICATIONS

(65) **Prior Publication Data**

US 2007/0247384 A1 Oct. 25, 2007

Chang et al., *Microwave and Optical Technology Letters*, vol. 25, No. 3, May 5, 2000, pp. 206-211.

* cited by examiner

Related U.S. Application Data

(62) Division of application No. 11/444,538, filed on Jun. 1, 2006.

Primary Examiner—Hoang Anh T Le

(74) *Attorney, Agent, or Firm*—Foley & Lardner LLP

Foreign Application Priority Data

(30) Aug. 31, 2005 (JP) 2005-252142

(57) **ABSTRACT**

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

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

(58) **Field of Classification Search** 343/767,
343/768, 700 MS, 795, 702, 770

See application file for complete search history.

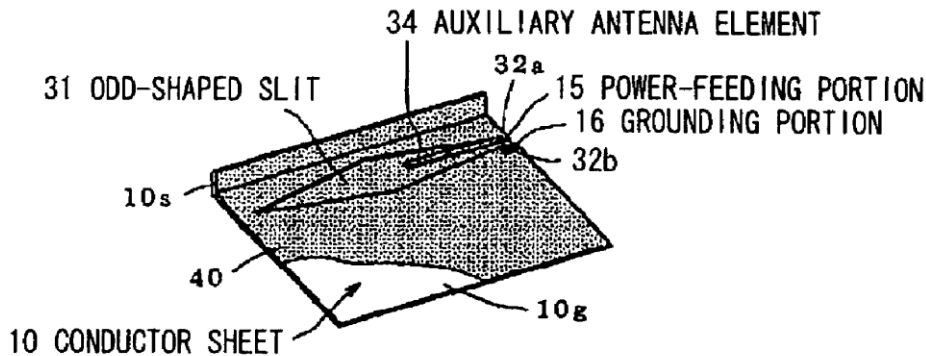
A wideband antenna has: a rectangular conductor sheet; a bow-tie-shaped slit formed in the rectangular conductor sheet, the rectangular conductor sheet having two apex portions defined by the bow-tie-shaped slit, the two apex portions being opposite to each other in the middle of the bow-tie-shaped slit; an auxiliary antenna element formed to extend along the bow-tie-shaped slit on both sides of one of the two apex portions; a power-feeding portion formed at the one of the two apex portions; and a grounding portion formed at the other of the two apex portions.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,914,573 B1* 7/2005 McCorkle 343/767

5 Claims, 5 Drawing Sheets





US007405707B2

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

(10) **Patent No.:** **US 7,405,707 B2**
(45) **Date of Patent:** **Jul. 29, 2008**

(54) **COMPOSITE ANTENNA**
(75) Inventors: **Nobuo Murofushi**, Shizuoka-Ken (JP);
Kouichi Sano, Shizuoka-Ken (JP);
Yasuhito Kiji, Shizuoka-Ken (JP);
Yasuo Matsumoto, Shizuoka-Ken (JP)

6,891,508 B2 * 5/2005 Inoue 343/725
6,927,737 B2 * 8/2005 Inoue 343/727
6,992,634 B2 * 1/2006 Hashidate et al. 343/700 MS
2005/0104789 A1 5/2005 Hashidate et al.

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

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 20 days.

EP	1 450 438	11/2002
EP	1 478 051	11/2004
GB	2 272 575	11/1992
JP	07-038328	2/1995
JP	07-094933	4/1995
JP	2001-102849	4/2001
JP	2003-152445	5/2003
JP	2004-102651	4/2004
JP	2007-028002	2/2007
WO	WO 96/35241	11/1996

(21) Appl. No.: **11/465,293**

OTHER PUBLICATIONS

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

Japanese Office Action issued in corresponding foreign application No. JP 2005-244301, dated Aug. 21, 2007, accompanied by an English language translation.

(65) **Prior Publication Data**

US 2007/0046544 A1 Mar. 1, 2007

* cited by examiner

(30) **Foreign Application Priority Data**

Aug. 25, 2005 (JP) 2005-244301

Primary Examiner—Hoang V Nguyen
(74) *Attorney, Agent, or Firm*—DLA Piper US LLP

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

(57) **ABSTRACT**

(52) **U.S. Cl.** **343/725**; 343/700 MS;
343/895

A composite antenna includes a first antenna structure and a second antenna structure integrally combined with the first antenna structure to operate under different frequency bands respectively that are used in different radio transmission systems such that the first antenna structure has a first conductive layer to operate under a first frequency band and the second antenna structure has a second conductive layer a thickness of which is thicker than that of the first conductive layer to operate under a second frequency band lower than the first frequency band.

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,598,168 A 1/1997 Evans et al.
5,767,808 A 6/1998 Robbins et al.

19 Claims, 4 Drawing Sheets

