



US007327315B2

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

(10) **Patent No.:** **US 7,327,315 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

- (54) **ULTRAWIDEBAND ANTENNA**
- (75) Inventors: **Timothy John Stefan Starkie**,
Cambridge (GB); **Leslie David Smith**,
Ely (GB)
- (73) Assignee: **Artimi Ltd.**, Cambridgeshire (GB)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 173 days.

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(21) Appl. No.: **10/931,217**

(22) Filed: **Sep. 1, 2004**

(65) **Prior Publication Data**
US 2005/0110687 A1 May 26, 2005

Related U.S. Application Data
(63) Continuation-in-part of application No. PCT/GB03/05070, filed on Nov. 21, 2003.

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

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

(58) **Field of Classification Search** 343/700 MS,
343/769, 793, 846, 873, 900
See application file for complete search history.

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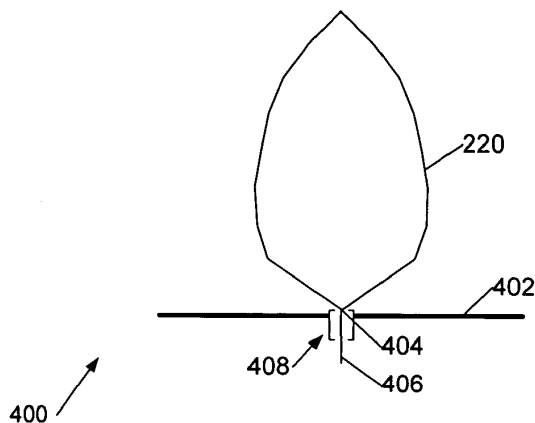
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Primary Examiner—Shih-Chao Chen
(74) *Attorney, Agent, or Firm*—Sterne, Kessler, Goldstein & Fox, P.L.L.C.

(57) **ABSTRACT**

Antennas for transmitting and receiving ultrawideband (UWB) signals are disclosed. A UWB antenna structure includes a planar conductor of substantially uniform resistance. The structure has the shape of a pair of conjoined, generally triangular figures, each with a long side, a short side, and a curved side. The triangular figures have an antenna feed connection at one corner. The structure has an axis of symmetry passing through the antenna feed connection.

20 Claims, 36 Drawing Sheets





US007327316B2

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

(10) **Patent No.:** **US 7,327,316 B2**

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

(54) **EMBEDDED PLANAR INVERTED F ANTENNA (PIFA) TUNED WITH VARIABLE GROUNDING POINT**

(75) Inventors: **Eric Peter Geoca**, Penfield, NY (US);
Thomas R. Schleaf, Palm Bay, FL (US)

(73) Assignee: **Tyco Electronics Corporation**,
Middletown, PA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 197 days.

(21) Appl. No.: **11/229,879**

(22) Filed: **Sep. 19, 2005**

(65) **Prior Publication Data**
US 2007/0063899 A1 Mar. 22, 2007

(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, 829, 846

See application file for complete search history.

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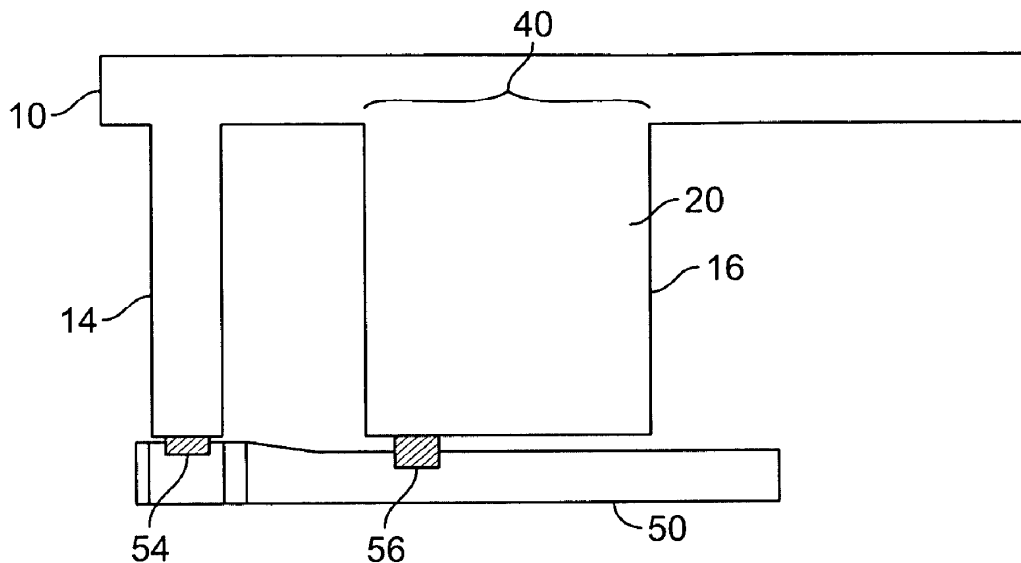
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Primary Examiner—Tho Phan

(57) **ABSTRACT**

An antenna system is described that includes a radiating element, a feed point configured for electrical connection to the radiating element, and a grounding point configured for electrical connection to the radiating element. At least one of the feed point and the grounding point are configured to accommodate a range of distances between the electrical connections to the radiating element.

5 Claims, 4 Drawing Sheets





US007327317B2

(12) **United States Patent**
Heiniger

(10) **Patent No.:** **US 7,327,317 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

(54) **DUAL-POLARIZED MICROSTRIP PATCH ANTENNA**

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2002/0089452 A1 7/2002 Lovestead
2003/0063031 A1 4/2003 Wong et al.

(75) Inventor: **Markus Heiniger**, Herisau (CH)

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(73) Assignee: **Huber + Suhner AG**, Herisau (CH)

EP 1 006 608 A1 6/2000
JP 56-160103 A1 12/1981
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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 233 days.

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(21) Appl. No.: **11/331,834**

Shu-Shi Zhong et al. "Corner-Fed Microstrip Antenna Element and Arrays for Dual-Polarization Operation," IEEE Transactions on Antennas and Propagation, vol. 50, Issue 10, pp. 1473-1480, no date.

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

(65) **Prior Publication Data**

US 2006/0139215 A1 Jun. 29, 2006

Related U.S. Application Data

(63) Continuation of application No. PCT/CH03/00481, filed on Jul. 16, 2003.

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Primary Examiner—Tho Phan

(74) *Attorney, Agent, or Firm*—Burr & Brown

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

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

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

See application file for complete search history.

(57) **ABSTRACT**

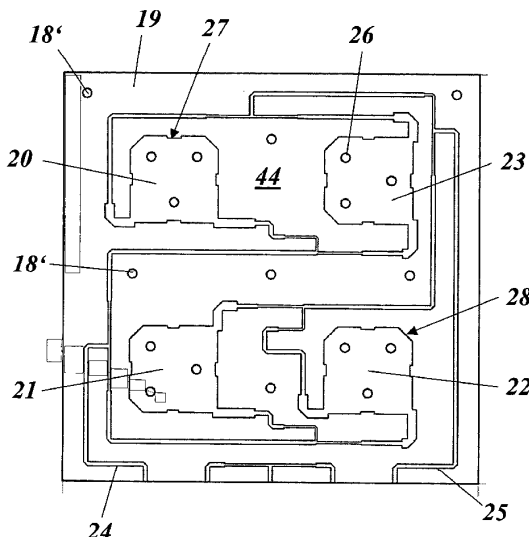
The invention relates to a dual polarised microstrip patch antenna comprising at least one individual element, each individual element comprising at least one rectangular, preferably quadratic, patch arranged on the upper face of a printed circuit board, having a feed network on the upper side thereof and being metallized on the entire surface of the lower face thereof. The aim of the invention is to improve the polarization isolation, while simultaneously simplifying the feed network. To this end, the feed network is embodied in such a way that the feed is only fed on two corners of the patch, and the at least one patch is modified in such a way that the isolation is improved between the polarizations of at least one antenna element and a plurality of individual antenna elements in relation to a non-modified patch.

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21 Claims, 6 Drawing Sheets





US007327318B2

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

(10) **Patent No.:** **US 7,327,318 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

(54) **ULTRA WIDE BAND FLAT ANTENNA**

OTHER PUBLICATIONS

- (75) Inventors: **Zvi Henry Frank**, Elkana (IL); **Ran Timar**, Kfar Saba (IL)
- (73) Assignees: **MTI Wireless Edge, Ltd.**, Rosh Ha'Ayin (IL); **Camero-Tech Ltd.**, Netanya (IL)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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Primary Examiner—Tan Ho

(74) *Attorney, Agent, or Firm*—Pearl Cohen Zedek Latzer, LLP

(21) Appl. No.: **11/363,133**

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

(65) **Prior Publication Data**

US 2007/0200762 A1 Aug. 30, 2007

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

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

(58) **Field of Classification Search** 343/700 MS,
343/745, 795, 821

See application file for complete search history.

(56) **References Cited**

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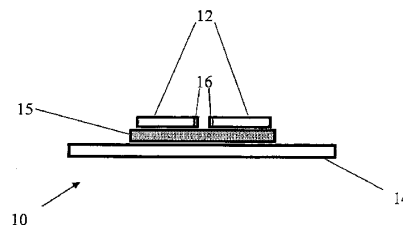
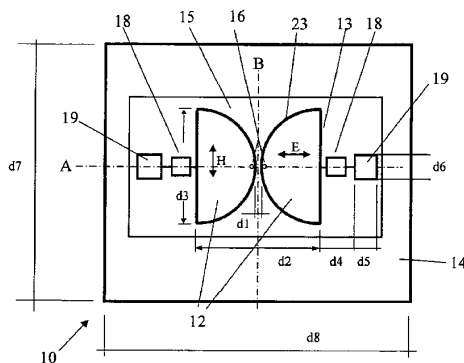
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(57) **ABSTRACT**

A flat, ultra wideband, unidirectional antenna is disclosed, the antenna may comprise a pair of active elements having the shape of substantially half-circles or half-ellipsoids made of thin conductive material and a ground element made of thin conductive material placed parallel and against to the active electrodes and spaced from them, the antenna having a nominal gain of at least 6 dbi and variations of gain in that range of +/-1.5 dbi at its bore sight.

19 Claims, 8 Drawing Sheets





US007327320B2

(12) **United States Patent**
Dejean

(10) **Patent No.:** **US 7,327,320 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

(54) **BROADBAND ANTENNA ARRANGEMENT**

(75) Inventor: **Cédric Dejean**, St. Gallen (CH)

(73) Assignee: **Huber + Suhner AG**, Herisau (CH)

(*) 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.: **11/257,966**

(22) Filed: **Oct. 25, 2005**

(65) **Prior Publication Data**

US 2006/0033669 A1 Feb. 16, 2006

Related U.S. Application Data

(63) Continuation of application No. PCT/CH03/00275, filed on Apr. 28, 2003.

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

(52) **U.S. Cl.** **343/702**; 343/700 MS;
343/713

(58) **Field of Classification Search** 343/700 M,
343/702, 846, 906, 700 MS, 713, 715
See application file for complete search history.

(56) **References Cited**

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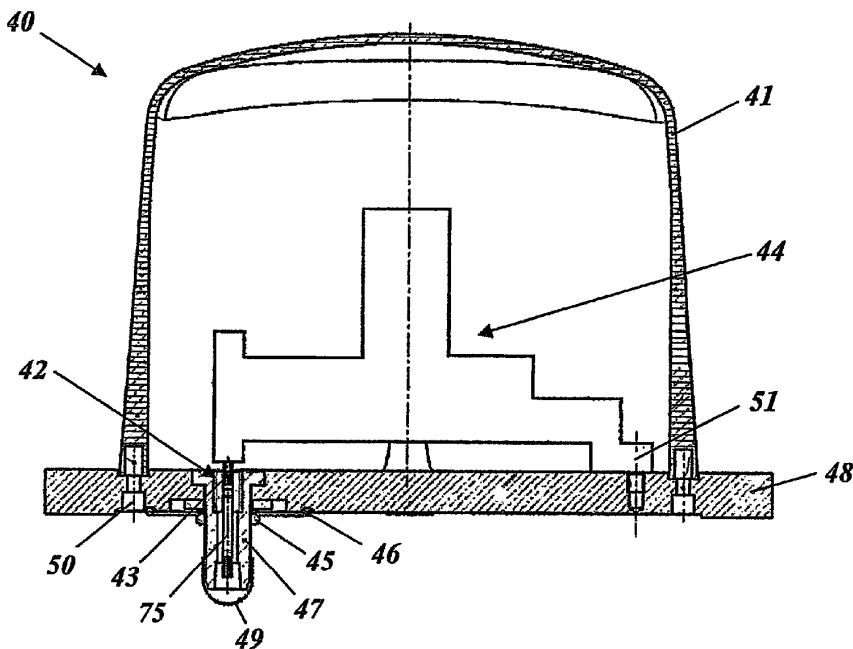
Primary Examiner—Tho Phan

(74) *Attorney, Agent, or Firm*—Burr & Brown

(57) **ABSTRACT**

The invention relates to a compact and robust broadband antenna, for the frequency range from about 800 MHz up to 9 GHz, in particular, for use on railways. The antenna includes a monopole antenna element, extending in a longitudinal direction essentially parallel to and at a distance above a planar electrically-conducting base plate, between two opposing ends of the antenna element. The antenna element is electrically connected to the base plate at the first end thereof and is insulated from the base plate at the second end thereof, creating an injection point by means of which the antenna element may be connected to a device operating at high frequency.

16 Claims, 7 Drawing Sheets





US007327324B2

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

(10) **Patent No.:** **US 7,327,324 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

- (54) **MONOPOLE SLOT ANTENNA**
- (75) Inventors: **Hanyang Wang**, Witney (GB); **Ming Zheng**, Farnborough (GB); **Su Qing Zhang**, Oxford (GB); **Alan Johnson**, Frimley (GB)
- (73) Assignee: **Nokia Corporation**, Espoo (FI)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **10/498,577**

(22) PCT Filed: **Dec. 16, 2002**

(86) PCT No.: **PCT/IB02/05433**

§ 371 (c)(1),
(2), (4) Date: **Jan. 13, 2005**

(87) PCT Pub. No.: **WO03/052867**

PCT Pub. Date: **Jun. 26, 2003**

(65) **Prior Publication Data**

US 2005/0116870 A1 Jun. 2, 2005

Related U.S. Application Data

(63) Continuation of application No. 10/020,195, filed on Dec. 18, 2001, now Pat. No. 6,618,020.

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

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

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

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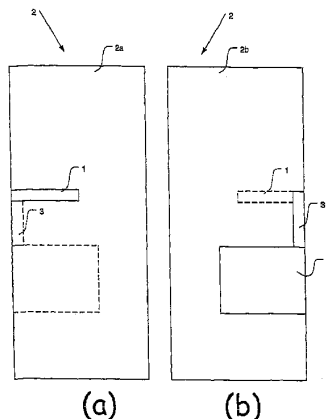
Primary Examiner—Tho Phan

(74) *Attorney, Agent, or Firm*—Harrington & Smith, PC

(57) **ABSTRACT**

A resonant monopole slot antenna comprising a ground plane, having a radiating slot which is dimensioned such that the slot is equivalent electromagnetically to an odd number of quarter wavelengths at the antenna's operating frequency, wherein the antenna's feed is arranged at the open end of the radiating slot.

21 Claims, 5 Drawing Sheets





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

(10) **Patent No.:** **US 7,327,327 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

(54) **OMNIDIRECTIONAL BROADBAND MONOPOLE ANTENNA**
(75) Inventors: **Kin-Lu Wong**, Kaohsiung (TW);
Chia-Lun Tang, Miaoli County (TW);
Saou-Wen Su, Taipei (TW)

(73) Assignee: **Industrial Technology Research Institute**, Hsinchu (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.: **10/945,046**

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

(65) **Prior Publication Data**
US 2005/0243009 A1 Nov. 3, 2005

(30) **Foreign Application Priority Data**
Apr. 29, 2004 (TW) 93111988 A

(51) **Int. Cl.**
H01Q 9/38 (2006.01)
(52) **U.S. Cl.** **343/829**; 343/900; 343/895
(58) **Field of Classification Search** 343/829
See application file for complete search history.

(56) **References Cited**
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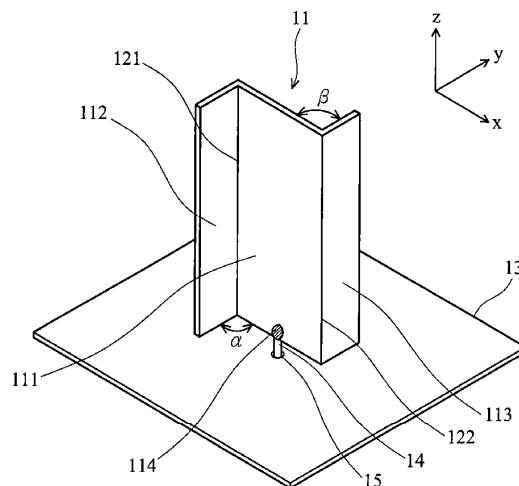
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Primary Examiner—Wilson Lee
Assistant Examiner—Binh V Ho
(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

An omnidirectional broadband monopole antenna comprises a ground plane, a radiating member, and a feed member. The ground plane is made of a metal plate. The radiating member comprises a first sub-radiating member, a second sub-radiating member connected to one side of the first sub-radiating member to provide a first angle therebetween, and a third radiating member connected to another side of the first sub-radiating member opposite the second sub-radiating member; a second angle is provided by the first and third sub-radiating members. The feed member is made of a metal rod with one end connected to the radiating member and the other to a signal source. Gain variations of the antenna's horizontal radiation pattern across the operating bandwidth are less than 3 dB.

20 Claims, 12 Drawing Sheets





US007327328B2

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

(10) **Patent No.:** **US 7,327,328 B2**
(45) **Date of Patent:** **Feb. 5, 2008**

(54) **ANTENNA UNIT HAVING A SHIELD COVER WITH NO GAP BETWEEN FOUR SIDE WALL PORTIONS AND FOUR CORNER PORTIONS**

(75) Inventors: **Akira Yoneya**, Akita (JP); **Kazunari Saito**, Akita (JP); **Yoshiaki Imano**, Akita (JP)

(73) Assignee: **Mitsumi Electric Co., 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 35 days.

(21) Appl. No.: **11/448,632**

(22) Filed: **Jun. 7, 2006**

(65) **Prior Publication Data**

US 2006/0279468 A1 Dec. 14, 2006

(30) **Foreign Application Priority Data**

Jun. 8, 2005 (JP) 2005-167992

(51) **Int. Cl.**
H01Q 1/52 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS, 343/702, 841; 455/575.5**
See application file for complete search history.

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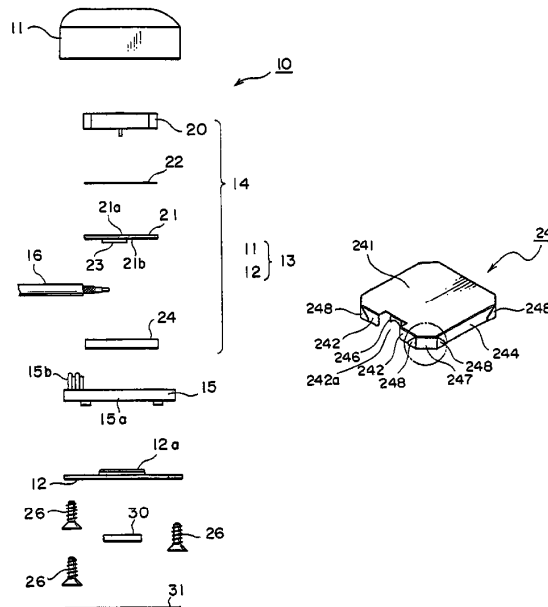
Primary Examiner—Tan Ho

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

(57) **ABSTRACT**

Mounted on a back surface (21b) of a circuit board (21), a shield cover (24) has a substantially rectangular ceiling portion (241) with four corners which are chamfered, four side wall portions (242-245), and four corner portions (247). The shield cover (24) is mounted on the back surface (21b) of the circuit board by soldering at the four corner portions (247). There is no gap between the four side wall portions (242-245) and the four corner portions (247). The shield cover (24) is formed by bending working of a metal plate (40) and has extension portions (248) at both ends of the four corner portions (247) so as to interpose with the side wall portions (242-245).

13 Claims, 6 Drawing Sheets





US007330153B2

(12) **United States Patent**
Rentz

(10) **Patent No.:** **US 7,330,153 B2**

(45) **Date of Patent:** **Feb. 12, 2008**

(54) **MULTI-BAND INVERTED-L ANTENNA**

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7,176,844 B2* 2/2007 Chiang et al. 343/815

(75) Inventor: **Mark L. Rentz**, Torrance, CA (US)

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(73) Assignee: **Navcom Technology, Inc.**, Torrance, CA (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 102 days.

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Primary Examiner—Hoanganh Le

(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(21) Appl. No.: **11/402,141**

(57) **ABSTRACT**

(22) Filed: **Apr. 10, 2006**

(65) **Prior Publication Data**

US 2007/0236400 A1 Oct. 11, 2007

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

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

(58) **Field of Classification Search** 343/700 MS, 343/850, 853, 860, 864, 865; 333/156, 160
See application file for complete search history.

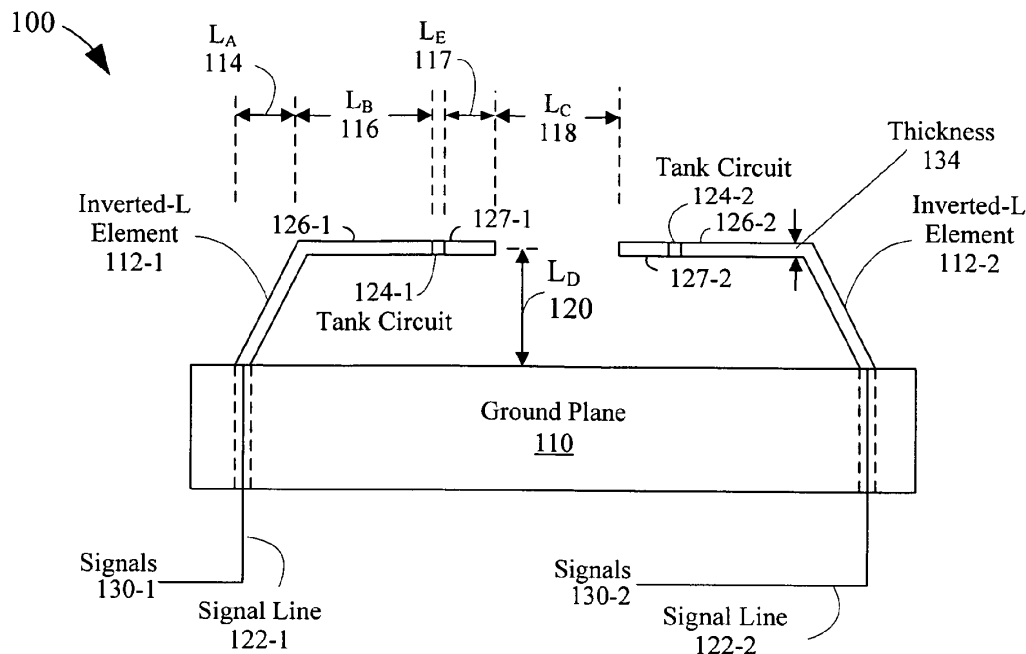
An antenna includes a first antenna element and a second antenna element. The first antenna element and the second antenna element are configured to transmit and receive signals in a first band of frequencies and in a second band of frequencies. A first pair of delay lines is coupled to the first antenna element and a second pair of delay lines coupled to the second antenna element. A first delay line in the first pair of delay lines and the second pair of delay lines is configured to phase shift electrical signals coupled to the first antenna element and the second antenna element such that a first impedance of the antenna is approximately equal in the first band of frequencies and the second band of frequencies. A second delay line in the first pair of delay lines and the second pair of delay lines is configured to convert the first impedance to a second impedance.

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21 Claims, 10 Drawing Sheets





US007330155B2

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

(10) **Patent No.:** **US 7,330,155 B2**
(45) **Date of Patent:** **Feb. 12, 2008**

(54) **ANTENNA SYSTEM**

(75) Inventors: **Yiu K. Chan**, Vernon Hills, IL (US);
Antonio Faraone, Plantation, FL (US);
Carlo DiNallo, Plantation, FL (US);
Istvan J. Szini, Grayslake, IL (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 113 days.

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(21) Appl. No.: **11/168,950**

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

(65) **Prior Publication Data**

US 2006/0290572 A1 Dec. 28, 2006

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

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

(58) **Field of Classification Search** **343/702,**
343/700 MS, 895, 720, 725, 834
See application file for complete search history.

(56) **References Cited**

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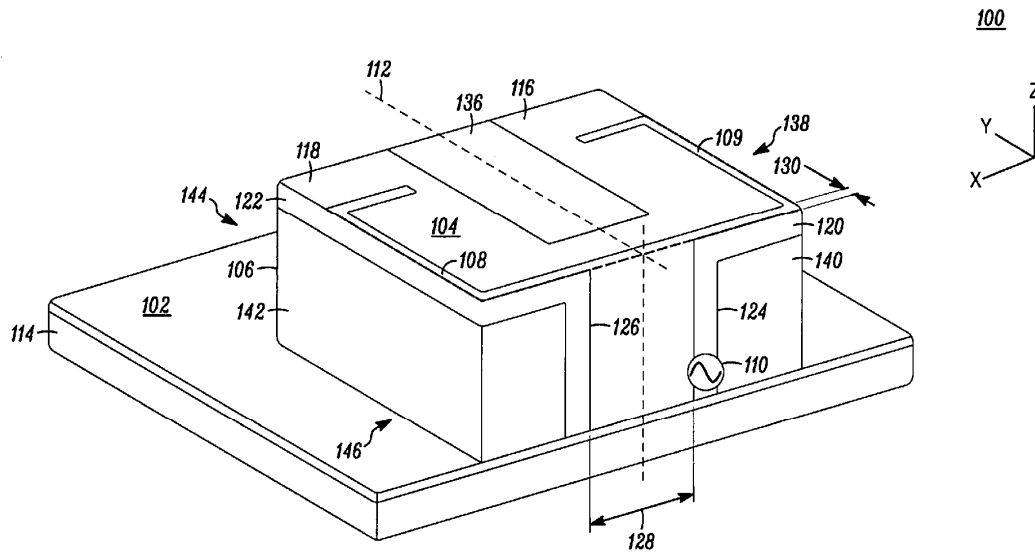
Primary Examiner—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Sylvia Chen

(57) **ABSTRACT**

A wireless communication device (600) with an antenna system (602) is disclosed. The antenna system (100) is an internal antenna with broadband characteristics which provides coverage over multiple frequency bands. The antenna system (100) has a finite ground surface (102), an elongated conductor (104) supported by a dielectric spacer (106), and at least one series signal feed (110).

18 Claims, 7 Drawing Sheets





US007330156B2

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

(10) **Patent No.:** **US 7,330,156 B2**
(45) **Date of Patent:** **Feb. 12, 2008**

- (54) **ANTENNA ISOLATION USING GROUNDED MICROWAVE ELEMENTS**
- (75) Inventors: **Aimo Arkko**, Ruutana (FI); **Jani Ollikainen**, Helsinki (FI); **Shunya Sato**, Tokyo (JP); **Hawk Yin Pang**, Tokyo (JP)
- (73) Assignee: **Nokia Corporation**
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 5 days.

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- (21) Appl. No.: **11/179,811**
- (22) Filed: **Jul. 11, 2005**

(65) **Prior Publication Data**
US 2006/0044195 A1 Mar. 2, 2006

Related U.S. Application Data
(60) Provisional application No. 60/603,459, filed on Aug. 20, 2004.

(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, 84.6, 846, 848, 841**
See application file for complete search history.

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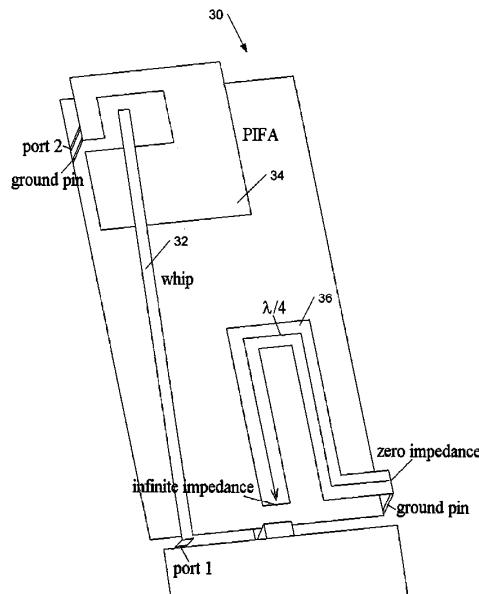
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Primary Examiner—Hoanganh Le

(57) **ABSTRACT**

This invention describes a method for improving antenna isolation in an electronic communication device using grounded RF microwave elements and patterns (structures). According to embodiments of the present invention, the RF microwave element can be implemented as a short-circuited section of a quarter-wavelength long transmission line (such as a stripline), or the RF microwave element can contain a metallic coupler and two thin striplines with different lengths, or the RF microwave element can be implemented using a balun concept.

27 Claims, 18 Drawing Sheets





US007333057B2

(12) **United States Patent**
Snyder

(10) **Patent No.:** **US 7,333,057 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

- (54) **STACKED PATCH ANTENNA WITH DISTRIBUTED REACTIVE NETWORK PROXIMITY FEED**
- (75) Inventor: **Christopher A. Snyder**, Melbourne, FL (US)
- (73) Assignee: **Harris Corporation**, Melbourne, FL (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.: **10/903,930**
- (22) Filed: **Jul. 31, 2004**

(65) **Prior Publication Data**
US 2006/0022874 A1 Feb. 2, 2006

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
- (52) **U.S. Cl.** **343/700 MS; 343/745; 343/815; 343/822; 343/850**
- (58) **Field of Classification Search** **343/860, 343/745**
See application file for complete search history.

- (56) **References Cited**
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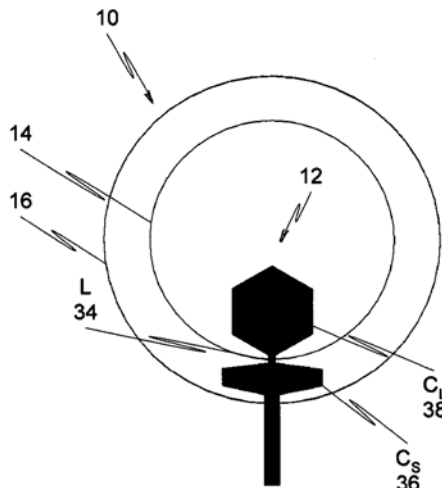
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Primary Examiner—Trinh Vo Dinh
(74) *Attorney, Agent, or Firm*—Holland & Knight LLP

(57) **ABSTRACT**

A stacked patch antenna including a distributed reactive network proximity feed, preferably implemented in a microstrip metallization network, coupled to an active antenna patch element to feed the active antenna patch element to emit a field to parasitically stimulate a parasitic antenna patch element.

10 Claims, 5 Drawing Sheets





US007333059B2

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

(10) **Patent No.:** **US 7,333,059 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

(54) **COMPACT CIRCULARLY-POLARIZED
PATCH ANTENNA**

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(75) Inventors: **Qian Li**, Ann Arbor, MI (US);
Wladimiro Villarroel, Worthington,
OH (US)

(Continued)

(73) Assignee: **AGC Automotive Americas R&D,
Inc.**, Ypsilanti, MI (US)

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 188 days.

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(21) Appl. No.: **11/190,445**

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35, No. 10, pp. 759-761.

(22) Filed: **Jul. 27, 2005**

(65) **Prior Publication Data**

(Continued)

US 2007/0024511 A1 Feb. 1, 2007

Primary Examiner—Michael C. Wimer

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

(74) *Attorney, Agent, or Firm*—Howard & Howard
Attorneys, P.C.

(52) **U.S. Cl.** **343/700 MS; 343/713**

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

See application file for complete search history.

(57) **ABSTRACT**

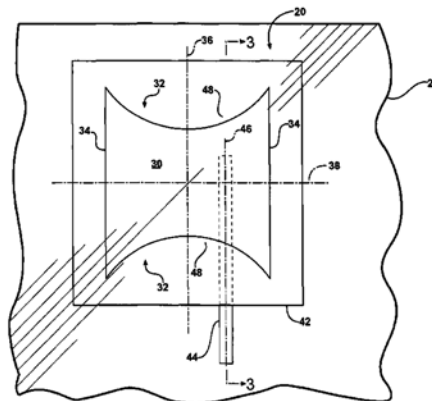
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An antenna for receiving and/or transmitting circularly polarized RF signals includes a patch element, a ground plane, a dielectric, and a feed line. The patch element is disposed on a pane of glass and includes a pair of radiating sides disposed opposite each other and a pair of spacer sides disposed opposite each other. The radiating sides form an angle less than 90 degrees with the spacer sides. A first axis is defined through a center of the radiating sides and a second axis defined through a center of the spacer sides. The ground plane is disposed substantially parallel to and spaced from the patch element. The dielectric substrate is sandwiched between the patch element and the ground plane. The feed line is disposed substantially parallel to and offset from the first axis for providing the antenna with a circular polarization radiation characteristic. The antenna is compact in size and generally conformal to the pane of glass.

40 Claims, 9 Drawing Sheets





US007333060B2

(12) **United States Patent**
Ando

(10) **Patent No.:** **US 7,333,060 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

(54) **PLANAR ANTENNA**

(75) Inventor: **Koji Ando**, Kyoto-Fu (JP)

(73) Assignee: **Omron Corporation**, Kyoto (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 22 days.

(21) Appl. No.: **11/330,319**

(22) Filed: **Jan. 12, 2006**

(65) **Prior Publication Data**

US 2006/0187123 A1 Aug. 24, 2006

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

(52) **U.S. Cl.** **343/700 MS; 343/752; 343/846**

(58) **Field of Classification Search** **343/700 MS, 343/752**

See application file for complete search history.

(56) **References Cited**

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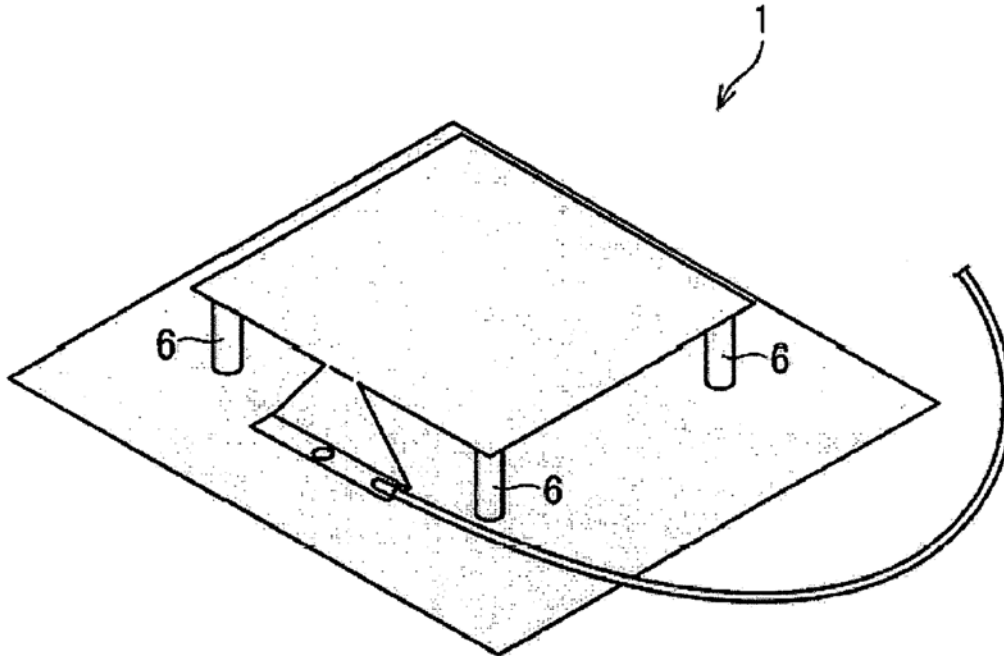
Primary Examiner—Trinh Vo Dinh

(74) *Attorney, Agent, or Firm*—Dickstein Shapiro LLP

(57) **ABSTRACT**

A planar antenna able to secure a wide frequency band and having high reliability. Therefore, the planar antenna has at least a grounding plate, a radiating conductor, a matching portion, a power supply portion, a spacer, a central conductor and a coaxial connector. The matching portion is a flat plate having a taper shape (an inverse taper shape) narrowed in width from the power supply portion to the radiating conductor. Further, the matching portion is slantingly arranged with respect to the grounding plate.

16 Claims, 10 Drawing Sheets





US007333062B2

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

(10) **Patent No.:** **US 7,333,062 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

(54) **WIRELESS COMMUNICATION DEVICE WITH INTEGRATED ANTENNA**

(75) Inventors: **Gustavo D. Leizerovich**, Aventura, FL (US); **Donald W. Burnette**, Sunrise, FL (US); **Julio C. Castaneda**, Coral Springs, FL (US); **Orlando Gomez**, Hialeah, FL (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 98 days.

(21) Appl. No.: **11/227,367**

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

(65) **Prior Publication Data**
US 2007/0057852 A1 Mar. 15, 2007

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

(52) **U.S. Cl.** **343/702; 343/873**

(58) **Field of Classification Search** 343/702, 343/741, 866, 872, 742, 867, 873
See application file for complete search history.

(56) **References Cited**

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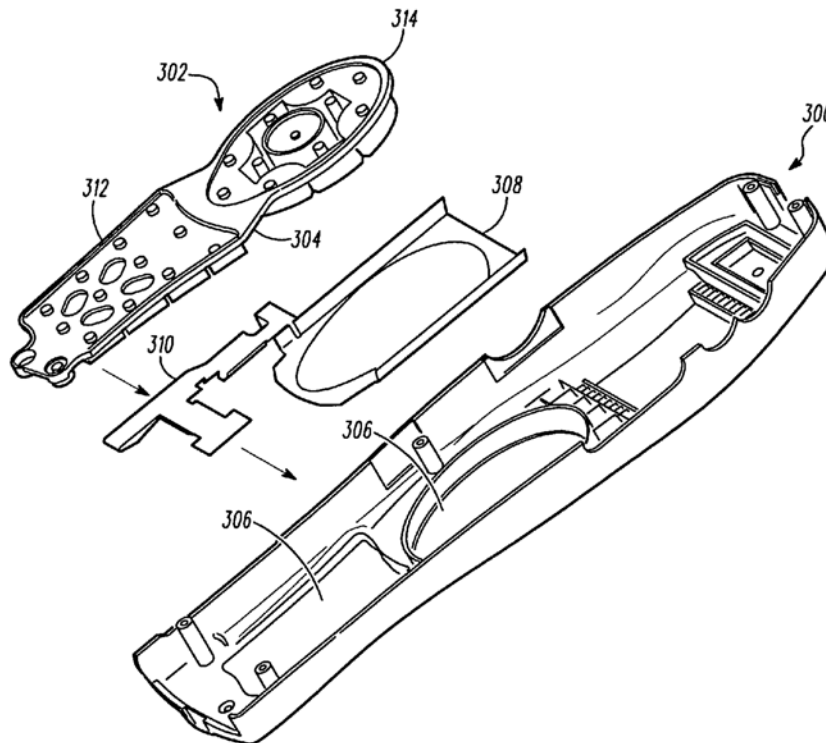
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Primary Examiner—Hoanganh Le

(57) **ABSTRACT**

A near field communication loop antenna (308) is mechanically coupled to the cover (300) of a cellular telephone. The antenna (308) is coupled on the inside of the cover (300) between a keypad (302) and the cover (300), whereby the antenna (308) surrounds the keys (314) and is sandwiched between the keypad assembly (302) and the cover (300). A near field communication antenna (406) is coupled to the outside surface of the cover (300) surrounding a display and sandwiched between a lens (400) and the phone cover (300). A near field communication antenna embedded in the phone cover material, whereby the antenna surrounds either the keys or the display, is disclosed as well.

7 Claims, 4 Drawing Sheets





US007333063B2

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

(10) **Patent No.:** **US 7,333,063 B2**
(45) **Date of Patent:** ***Feb. 19, 2008**

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

(75) Inventors: **Junro Yano**, Hamura (JP); **Soh Kimura**, Kodaira (JP); **Makoto Sawada**, Ome (JP)

(73) Assignee: **Casio Computer Co., 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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/516,918**

(22) Filed: **Sep. 7, 2006**

(65) **Prior Publication Data**

US 2007/0001917 A1 Jan. 4, 2007

Related U.S. Application Data

(63) Continuation of application No. 11/002,348, filed on Dec. 1, 2004, now Pat. No. 7,126,548.

(30) **Foreign Application Priority Data**

Dec. 2, 2003 (JP) 2003-402675
Apr. 21, 2004 (JP) 2004-125922

(51) **Int. Cl.**

H01Q 1/22 (2006.01)
H01Q 7/00 (2006.01)
G04B 47/00 (2006.01)

(52) **U.S. Cl.** **343/702; 343/718; 343/788; 368/10**

(58) **Field of Classification Search** 343/702, 343/718, 788; 455/575.7; 368/10
See application file for complete search history.

(56) **References Cited**

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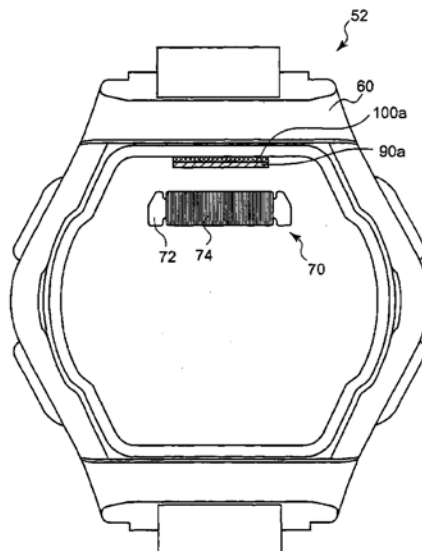
Primary Examiner—Michael C. Wimer

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

(57) **ABSTRACT**

In an electronic device having a metal device case, and an antenna disposed inside the device case, a magnetic member having a magnetic permeability higher than a magnetic permeability of the device case is placed between an inner surface of the device case and the antenna.

23 Claims, 33 Drawing Sheets





US007333065B2

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

(10) **Patent No.:** **US 7,333,065 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

- (54) **MODULAR ANTENNA ASSEMBLY FOR AUTOMOTIVE VEHICLES**
- (75) Inventors: **Ralf Lindackers**, Waterford, MI (US); **Hasan Yasin**, Holly, MI (US); **Andreas D. Fuchs**, Lake Orion, MI (US); **Ayman Duzdar**, Holly, MI (US)
- (73) Assignee: **Receptec Holdings, LLC**, Holly, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 95 days.

(21) Appl. No.: **11/271,372**

(22) Filed: **Nov. 10, 2005**

(65) **Prior Publication Data**
US 2007/0103374 A1 May 10, 2007

- (51) **Int. Cl.**
H01Q 1/32 (2006.01)
 - (52) **U.S. Cl.** **343/713; 343/872**
 - (58) **Field of Classification Search** 343/711, 343/712, 713, 872, 704
- See application file for complete search history.

(56) **References Cited**

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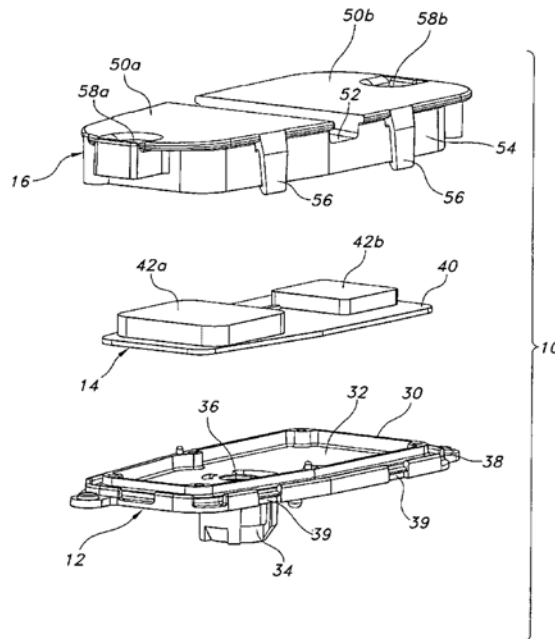
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Primary Examiner—Tho Phan
(74) *Attorney, Agent, or Firm*—Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

The specification discloses a modular antenna for automotive vehicles. The antenna includes a base assembly that can be used on a variety of vehicle platforms and a radome assembly that is specific to a particular vehicle platform. The radome assembly snap-fits onto the base assembly, and can be installed during or after vehicle assembly. A wide variety of radome assemblies of different shapes, styles, and colors can be used in conjunction with a single base assembly.

8 Claims, 8 Drawing Sheets





US007333067B2

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

(10) **Patent No.:** **US 7,333,067 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

(54) **MULTI-BAND ANTENNA WITH WIDE BANDWIDTH**

(75) Inventors: **Chen-Ta Hung**, Tu-chen (TW);
Lung-Sheng Tai, Tu-Chen (TW); **Hsien Chu Lin**, Tu-chen (TW); **Yun-Lung Ke**, Tu-chen (TW)

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

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

(21) Appl. No.: **11/026,601**

(22) Filed: **Dec. 30, 2004**

(65) **Prior Publication Data**
US 2005/0259024 A1 Nov. 24, 2005

(30) **Foreign Application Priority Data**
May 24, 2004 (TW) 93114591 A

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

(52) **U.S. Cl.** **343/770**; 343/700 MS;
343/702

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

(56) **References Cited**

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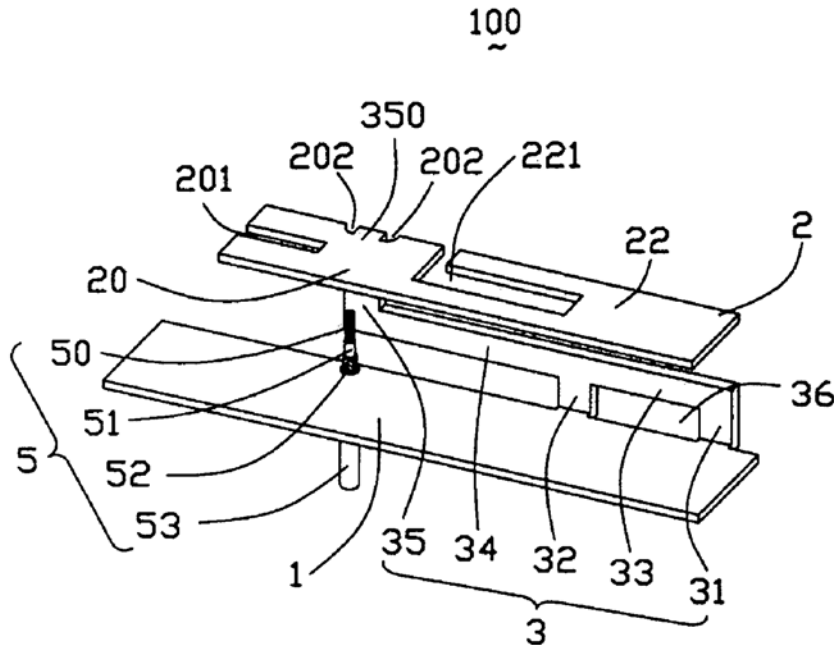
Primary Examiner—Tho Phan

(74) *Attorney, Agent, or Firm*—Wei Te Chung

(57) **ABSTRACT**

A multi-band antenna (100) used in wireless communications includes a first radiating patch (20) arranged in a first plane and extending in a first direction, a second radiating patch (22) arranged in the first plane and extending in a second direction different from the first direction, a grounding portion (1) arranged in second plane parallel to the first plane, and an inverted F-shaped connecting portion (3) connecting the first and the second radiating patches and the grounding portion. The radiating patches define a plurality of slots (201, 202) for increasing a bandwidth of the antenna. The connecting portion defines a rectangular slot (35) for adjusting an impedance matching of the antenna.

17 Claims, 9 Drawing Sheets





US007333068B2

(12) **United States Patent**
Biddulph

(10) **Patent No.:** **US 7,333,068 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

(54) **PLANAR ANTI-REFLECTIVE INTERFERENCE ANTENNAS WITH EXTRA-PLANAR ELEMENT EXTENSIONS**

(75) Inventor: **Stuart Biddulph**, Provo, UT (US)

(73) Assignee: **ClearOne Communications, Inc.**, Salt Lake City, UT (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 31 days.

(21) Appl. No.: **11/274,644**

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

(65) **Prior Publication Data**

US 2007/0109194 A1 May 17, 2007

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

(52) **U.S. Cl.** **343/794**; 343/846; 343/799;
343/700 MS; 343/802; 343/834; 343/836

(58) **Field of Classification Search** 343/844,
343/810, 814, 872, 834, 836, 793, 795, 853,
343/846

See application file for complete search history.

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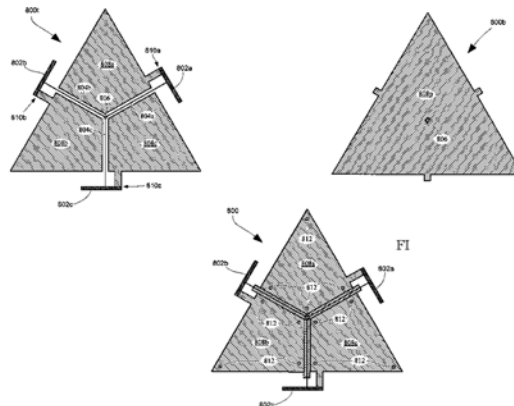
Primary Examiner—Douglas W. Owens
Assistant Examiner—Chuc Tran

(74) *Attorney, Agent, or Firm*—Everett D. Robinson;
Echelon IP, LLC

(57) **ABSTRACT**

Disclosed herein are wireless products adapted to be positioned in a normal or resting position, that also include an antenna composed of a set of elements arranged in a plane in a radially symmetrical configuration providing a reduction in the susceptibility of reflected waves having the potential to cancel or weaken a main wave or signal, the plane positioned with respect to the normal position to direct a main communication line with a second wireless device into the plane and provide reception of a main and/or secondary signal at a plurality of phases. One exemplary product is a wireless conferencing device configured to rest on a tabletop, the antenna array oriented in a horizontal plane. Detailed information on various example embodiments of the inventions are provided in the Detailed Description below, and the inventions are defined by the appended claims.

45 Claims, 27 Drawing Sheets





US007333069B2

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

(10) **Patent No.:** **US 7,333,069 B2**
(45) **Date of Patent:** **Feb. 19, 2008**

(54) **RADIATING ELEMENT DESIGNED TO OPERATE IN A SMALL ANTENNA**

(75) Inventors: **Ali Louzir**, Rennes (FR); **Franck Thudor**, Rennes (FR); **Jean-Luc Robert**, Betton (FR)

(73) Assignee: **Thomson Licensing**, Boulogne-Billancourt (FR)

(*) 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.: **11/348,205**

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

(65) **Prior Publication Data**

US 2006/0176234 A1 Aug. 10, 2006

(30) **Foreign Application Priority Data**

Feb. 7, 2005 (FR) 05 50347

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 11/12 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS, 343/741, 748, 866**
See application file for complete search history.

(56) **References Cited**

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Search report dated Sep. 12, 2005.

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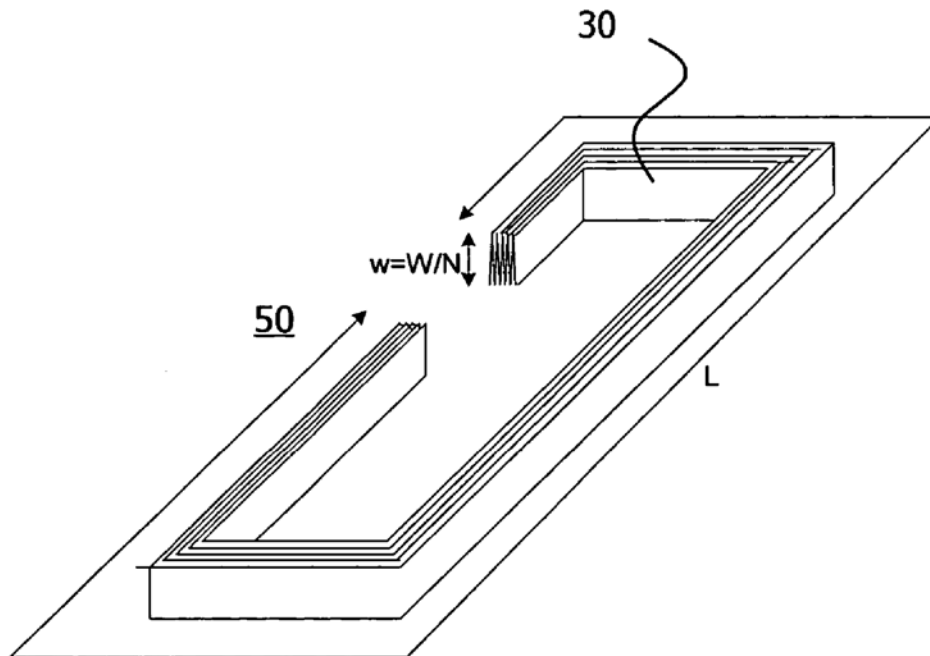
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Joseph J. Laks; Robert D. Shedd; Brian J. Cromarty

(57) **ABSTRACT**

The present invention relates to a radiating element designed to operate in an electrically small antenna including a conducting strip folded N times like a bellows.

7 Claims, 3 Drawing Sheets





US00D562311S

(12) **United States Design Patent** (10) **Patent No.:** **US D562,311 S**
Chen et al. (45) **Date of Patent:** **** Feb. 19, 2008**

(54) **TRI-BAND MINIATURE ANTENNA FOR WIRELESS HANDSETS**

(75) Inventors: **Li Chen**, Melbourne, FL (US); **Frank M. Caimi**, Vero Beach, FL (US)

(73) Assignee: **Sky Cross, Inc.**, Melbourne, FL (US)

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

(21) Appl. No.: **29/243,371**

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

(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 R-705, 343/871-908, 795, 840, 711-713, 819, 846; 455/90.2, 90.3, 91, 128, 269, 344, 347, 562.1
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Stella M. Reid
Assistant Examiner—John Windmuller
(74) *Attorney, Agent, or Firm*—John DeAngelis; Beusse Wolter Sanks Mora & Maire, P.A.

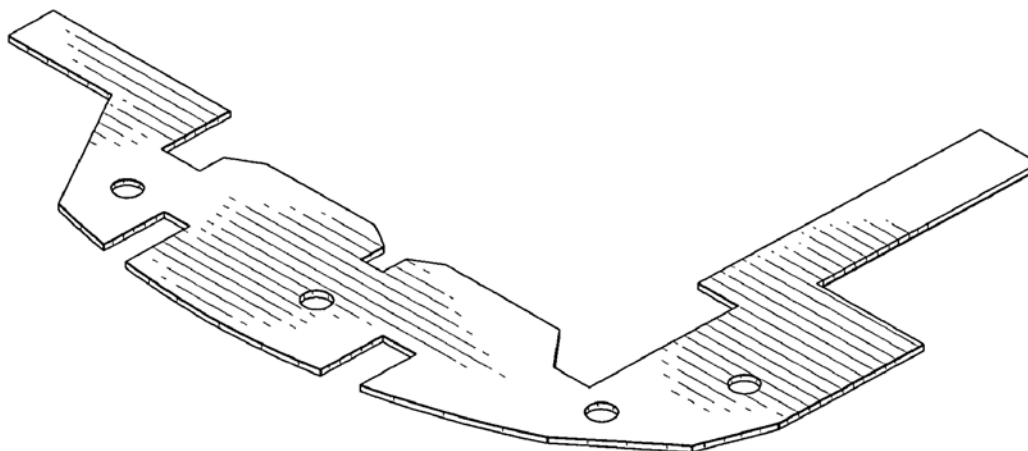
(57) **CLAIM**

The ornamental design for a tri-band miniature antenna for wireless handsets, as shown and described.

DESCRIPTION

FIG. 1 is an isometric view of a tri band miniature antenna for wireless handsets showing our new design;
FIG. 2 is a front view thereof;
FIG. 3 is a rear view thereof;
FIG. 4 is a top view thereof;
FIG. 5 is a left side view thereof; and,
FIG. 6 is a right side view thereof.

1 Claim, 2 Drawing Sheets





US00D562810S

(12) **United States Design Patent** (10) **Patent No.:** **US D562,810 S**
Oliver (45) **Date of Patent:** **** Feb. 26, 2008**

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

(75) Inventor: **Ronald A. Oliver**, Seattle, WA (US)

(73) Assignee: **Impinj, Inc.**, Seattle, WA (US)

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

(21) Appl. No.: **29/285,827**

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

Related U.S. Application Data

(63) Continuation of application No. 29/220,493, filed on Dec. 30, 2004, now abandoned, which is a continuation-in-part of application No. 10/812,493, filed on Mar. 29, 2004, now abandoned, and a continuation-in-part of application No. 10/815,474, filed on Mar. 31, 2004, now abandoned.

(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 R-705, 343/871-908, 795, 840, 711-713, 819, 846; 455/90.2, 90.3, 91, 128, 269, 344, 347, 562.1

See application file for complete search history.

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Primary Examiner—Stella M. Reid
Assistant Examiner—John Windmuller
(74) *Attorney, Agent, or Firm*—Thelen Reid Brown Raysman & Steiner LLP; David B. Ritchie

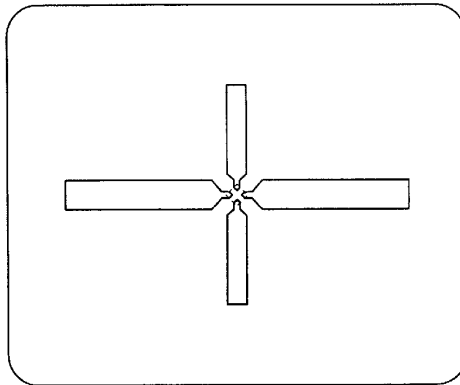
(57) **CLAIM**

The ornamental design for a radio frequency identification tag antenna assembly, as shown and described.

DESCRIPTION

The FIGURE is a top plan view of a radio frequency identification tag antenna assembly showing my new design.

1 Claim, 1 Drawing Sheet





US007334736B2

(12) **United States Patent**
Uesaka

(10) **Patent No.:** **US 7,334,736 B2**
(45) **Date of Patent:** **Feb. 26, 2008**

(54) **ANTENNA-COIL DESIGN APPARATUS AND DESIGN METHOD**

(75) Inventor: **Kouichi Uesaka**, Yokohama (JP)

(73) Assignee: **Hitachi, 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 393 days.

(21) Appl. No.: **10/890,320**

(22) Filed: **Jul. 14, 2004**

(65) **Prior Publication Data**
US 2005/0011961 A1 Jan. 20, 2005

(30) **Foreign Application Priority Data**
Jul. 14, 2003 (JP) 2003-196179

(51) **Int. Cl.**
G06K 19/06 (2006.01)

(52) **U.S. Cl.** **235/492**; 235/451; 235/487; 235/380

(58) **Field of Classification Search** 235/492, 235/451, 487, 380; 343/855, 867
See application file for complete search history.

(56) **References Cited**
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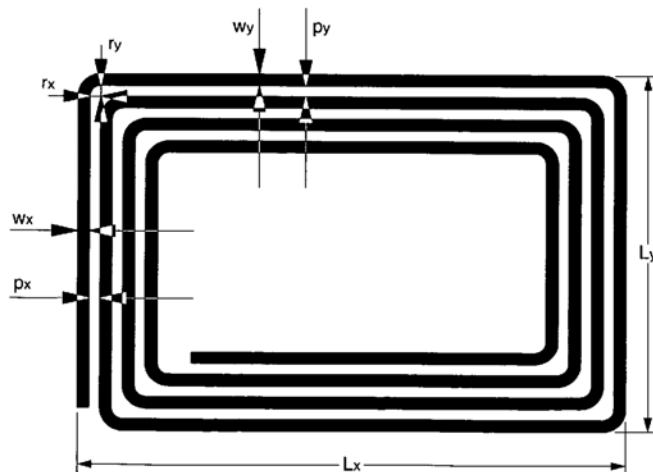
Primary Examiner—Steven S. Paik

(74) *Attorney, Agent, or Firm*—Antonelli, Terry, Stout & Kraus, LLP.

(57) **ABSTRACT**

A method of designing on a short-time basis an antenna which satisfies desired electrical characteristic values. There is provided the method of designing the antenna coil used in a non-contact IC card or a RFID. Here, the antenna-coil design method includes the following steps: Inputting information about plural configurations of the antenna coil and materials thereof, analyzing resistance, inductance, and stray capacitance of the antenna coil relative to the number of turns of the antenna coil in the inputted plural configurations of the antenna coil, and, based on the analysis result, selecting one of the plural configurations of the antenna coil.

10 Claims, 7 Drawing Sheets



SQUARE-FIGURED TYPE



US007336229B1

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

(10) **Patent No.:** **US 7,336,229 B1**
(45) **Date of Patent:** **Feb. 26, 2008**

(54) **ANTENNA CAPABLE OF ADJUSTING IMPEDANCE MATCHING**

7,292,194 B2* 11/2007 Tai et al. 343/702
2007/0030198 A1* 2/2007 Wei 343/700 MS
2007/0188388 A1* 8/2007 Feng et al. 343/700 MS

(75) Inventors: **Kuan-Hsueh Tseng**, Taipei Hsien (TW); **Feng-Chi Eddie Tsai**, Taipei Hsien (TW)

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(73) Assignee: **Wistron NeWeb Corporation**, Hsi-Chih, Taipei Hsien (TW)

Primary Examiner—Trinh Dinh
Assistant Examiner—Dieu Hien T Duong
(74) *Attorney, Agent, or Firm*—Winston Hsu

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

(57) **ABSTRACT**

(21) Appl. No.: **11/670,422**

An antenna includes a substrate, a radiation element, a feeding element, a connection element, and a matching circuit. The substrate includes a first side and a second side. The first side includes a short point and a grounding point. The radiation element includes a first radiator, a second radiator, and a first metal arm. The first radiator and the second radiator are parallel to the first side. The first metal arm is coupled to a joint of the first radiator and the second radiator. The feeding element is coupled between the first metal arm and the grounding point. The connection element is coupled between the first metal arm and the short point. The matching circuit includes a second metal arm and a matching element. The second metal arm extends from the first metal arm. The matching element is coupled to the second metal arm.

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

(30) **Foreign Application Priority Data**

Dec. 18, 2006 (TW) 95222262 U

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

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

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

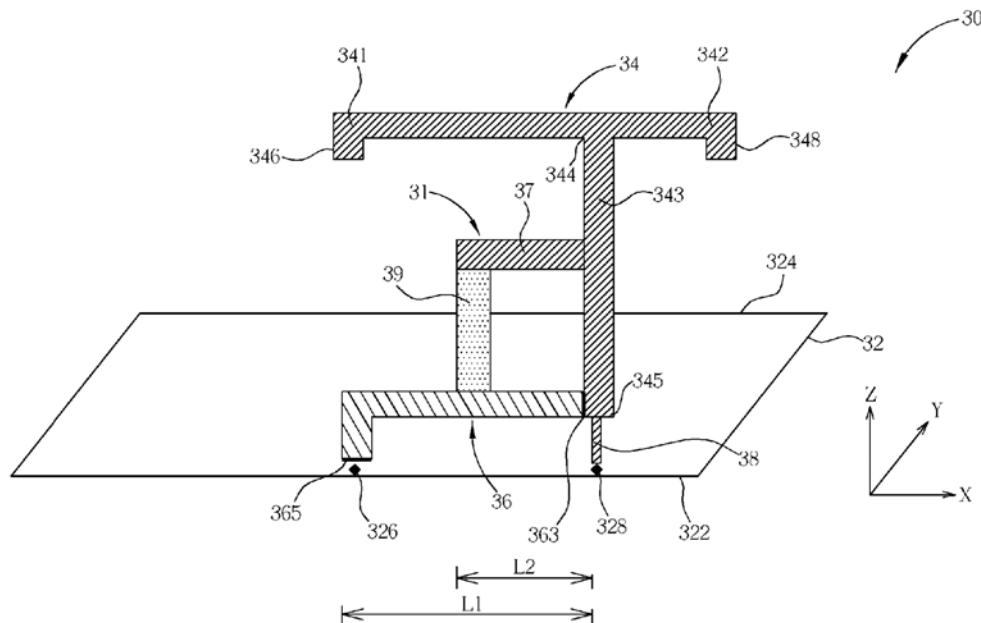
See application file for complete search history.

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19 Claims, 10 Drawing Sheets





US007336233B2

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

(10) **Patent No.:** **US 7,336,233 B2**
(45) **Date of Patent:** **Feb. 26, 2008**

(54) **RADIATION DIVERSITY ANTENNAS**

6,864,848 B2* 3/2005 Sievenpiper 343/767
6,885,344 B2* 4/2005 Mohamadi 343/700 MS

(75) Inventors: **Franck Thudor**, Rennes (FR);
Françoise Le Bolzer, Rennes (FR);
Bernard Denis, Saint Senoux (FR)

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(73) Assignee: **Thomson Licensing**,
Boulogne-Billancourt (FR)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 456 days.

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(21) Appl. No.: **10/791,978**

(22) Filed: **Mar. 3, 2004**

(65) **Prior Publication Data**
US 2005/0237252 A1 Oct. 27, 2005

Primary Examiner—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Joseph J. Laks; Robert D. Shedd; Brian J. Cromarty

(30) **Foreign Application Priority Data**
Mar. 7, 2003 (FR) 03 02842

(57) **ABSTRACT**

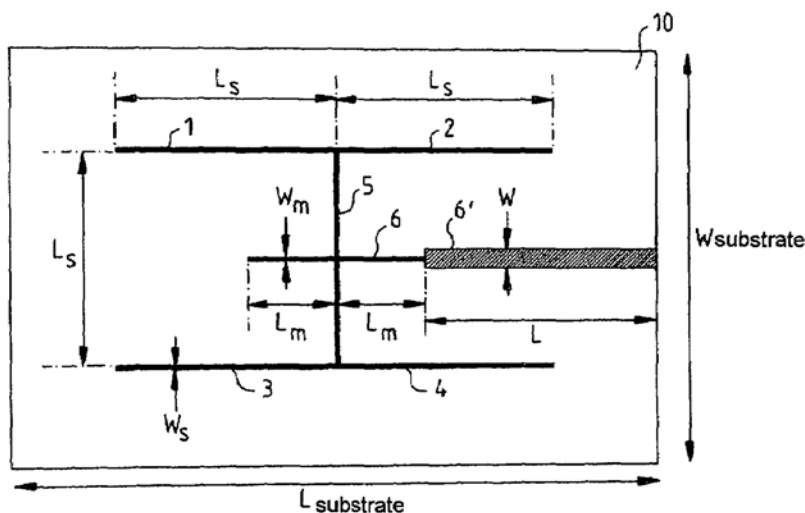
(51) **Int. Cl.**
H01Q 13/10 (2006.01)
(52) **U.S. Cl.** **343/767**
(58) **Field of Classification Search** **343/767,**
343/700 MS, 795, 768, 770, 876
See application file for complete search history.

The present invention relates to a radiation diversity antenna consisting of radiating elements of the slot-line type coupled electromagnetically to a feed line, in which the radiating elements have a tree structure, each radiating element having a length equal to $k\lambda_s/2$ where k is an identical or different integer from one element to the next and λ_s is the guided wavelength in the slot-line constituting the radiating element with at least one radiating element comprising a switching means positioned in the slot-line constituting the said radiating element in such a way as to control the coupling between the said radiating element and the feed line as a function of a command. The invention applies chiefly to wireless transmissions.

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8 Claims, 9 Drawing Sheets





US007336236B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 7,336,236 B2**
(45) **Date of Patent:** **Feb. 26, 2008**

(54) **TRIANGULAR DIPOLE ANTENNA**

(75) Inventor: **Chang-Jung Lee**, Taoyuan County (TW)

(73) Assignee: **Arcadyan Technology Corporation**, Hsinchu (TW)

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

(21) Appl. No.: **11/209,807**

(22) Filed: **Aug. 24, 2005**

(65) **Prior Publication Data**
US 2007/0052610 A1 Mar. 8, 2007

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

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

(58) **Field of Classification Search** **343/795, 343/700 MS, 702, 846**
See application file for complete search history.

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Primary Examiner—Hoanganh Le

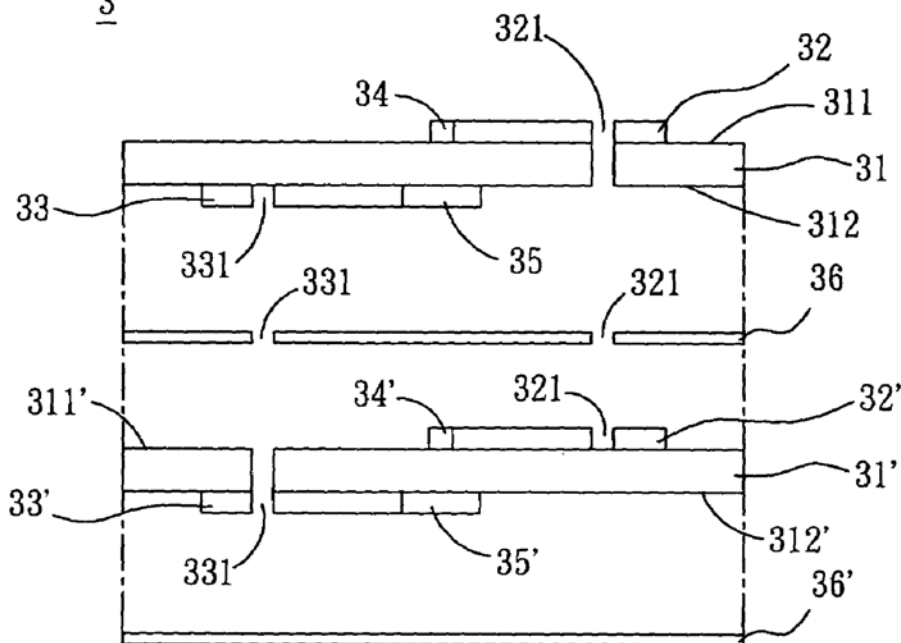
(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A triangle dipole antenna includes a first substrate, a first radiating part, and a second radiating part. The first substrate has a first surface and a second surface, which is opposite to the first surface. In this case, the first surface has a first feeding point and the second surface has a first grounding. The first radiating part is triangular and disposed on the first surface of the first substrate. The first radiating part has a first interior angle electrically connected to the first feeding point. The second radiating part is triangular and disposed on the second surface of the first substrate. The second radiating part has a second interior angle electrically connected to the first grounding.

17 Claims, 6 Drawing Sheets

3





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

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(54) **SHAPED GROUND PLANE FOR DYNAMICALLY RECONFIGURABLE APERTURE COUPLED ANTENNA**

(75) Inventors: **James J. Rawnick**, Palm Bay, FL (US); **Timothy E. Durham**, Palm Bay, FL (US); **Stephen B. Brown**, Palm Bay, FL (US)

(73) Assignee: **Harris Corporation**, Melbourne, FL (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.

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

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

(58) **Field of Classification Search** **343/846, 343/700 MS, 702, 789, 793**
See application file for complete search history.

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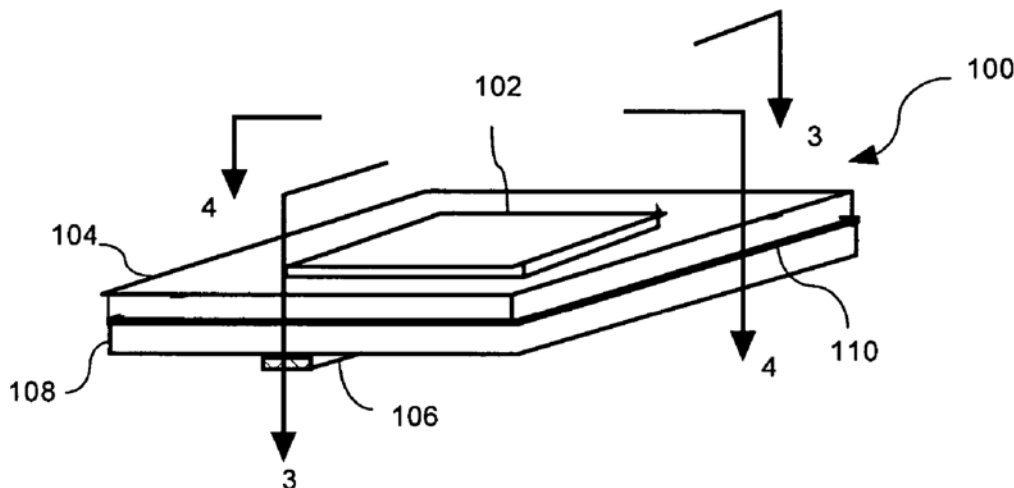
Primary Examiner—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Darby & Darby; Robert J. Sacco

(57) **ABSTRACT**

Method for controlling an input impedance of an antenna (100). The method can include the steps of coupling RF energy from an input RF transmission line (106) to an antenna radiating element (102) through an aperture (112) defined in a ground plane (110). For example, the aperture (112) can be a slot and the radiating element (102) can be a patch type element. The input impedance can thereafter be controlled by selectively varying a volume or a position of a conductive fluid (128) disposed in a predetermined region between the RF transmission line and the antenna radiating element. The volume of conductive fluid (128) can be automatically varied in response to at least one control signal (132).

10 Claims, 6 Drawing Sheets





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(12) **United States Patent**
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(10) **Patent No.:** **US 7,336,239 B2**

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(54) **SMALL MULTI-MODE ANTENNA AND RF MODULE USING THE SAME**

(75) Inventor: **Ken Takei**, Kawasaki (JP)

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

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(58) **Field of Classification Search** **343/702, 343/850, 895, 722, 749, 851, 858, 860**
See application file for complete search history.

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Primary Examiner—Tho Phan

(74) *Attorney, Agent, or Firm*—Reed Smith LLP; Stanley P. Fisher, Esq.; Juan Carlos A. Marquez, Esq.

(57) **ABSTRACT**

A small multi-mode antenna in which a single feeding point can be used commonly for multiple frequencies and an RF module using such antenna for use in less-costly and small multimedia wireless apparatus is provided. The antenna is configured such that a single feeding point 4 which is common for multiple frequencies is set up at one end of a radiating conductor 1, a first one-port resonant circuit 2 is connected to the one end thereof, and a second one-port resonant circuit 3 is connected to the other end of the radiating conductor 1. With a conductance component of admittance in view from the feeding point 4 toward free space equaling the characteristic admittance in the RF circuit, a susceptance component of the admittance is canceled out by the resonant circuit 2 connected to the feeding point 4 for multiple frequencies.

15 Claims, 23 Drawing Sheets

