



US007369012B2

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

(10) **Patent No.:** **US 7,369,012 B2**  
(45) **Date of Patent:** **May 6, 2008**

(54) **ANTENNA DUPLEXER**  
(75) Inventors: **Masanori Hongo**, Osaka (JP); **Natsuyo Nagano**, Osaka (JP); **Takashi Ogura**, Kyoto (JP); **Hideki Ito**, Osaka (JP); **Toshio Tanuma**, Osaka (JP)

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(73) Assignee: **Sanyo Electric Co., Ltd.**, Moriguchi-shi (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.

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*Primary Examiner*—Benny Lee

*Assistant Examiner*—Kimberly E Glenn

(74) *Attorney, Agent, or Firm*—Kratz, Quintos & Hanson, LLP

(21) Appl. No.: **10/992,642**

(22) Filed: **Nov. 22, 2004**

(65) **Prior Publication Data**

US 2005/0116789 A1 Jun. 2, 2005

(30) **Foreign Application Priority Data**

Nov. 27, 2003 (JP) ..... 2003-397970

(51) **Int. Cl.**  
**H01P 5/12** (2006.01)  
**H03H 9/00** (2006.01)

(52) **U.S. Cl.** ..... **333/126; 333/133; 333/193**

(58) **Field of Classification Search** ..... 333/126,  
333/133, 193-196  
See application file for complete search history.

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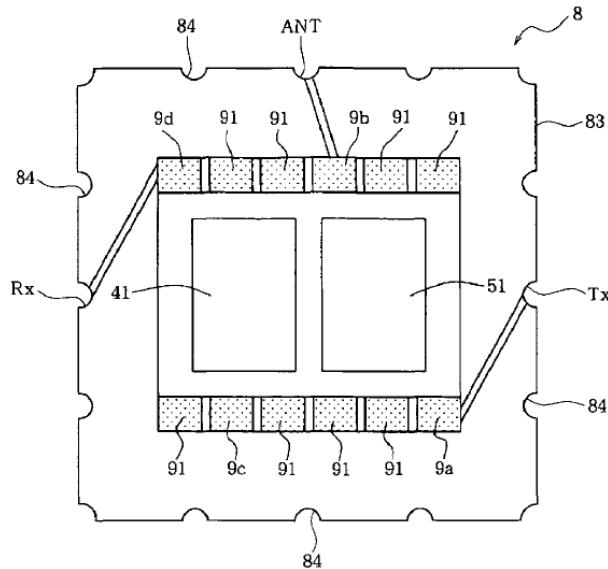
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(57) **ABSTRACT**

The present invention provides an antenna duplexer comprising a transmitting filter and a receiving filter which are mounted on a package, a transmitting signal input pad and a transmitting signal output pad which are connected to input and output ends of the transmitting filter, a receiving signal input pad and a receiving signal output pad which are connected to input and output ends of the receiving filter, and at least one grounding pad. The pads are arranged, on a surface of the package, along at least two sides of four sides of a quadrangle. The transmitting signal input pad and the receiving signal output pad are disposed at diagonal positions of the quadrangle and are furthest away from one another.

**4 Claims, 3 Drawing Sheets**





US007369086B2

(12) **United States Patent**  
**Luen**

(10) **Patent No.:** **US 7,369,086 B2**  
(45) **Date of Patent:** **May 6, 2008**

(54) **MINIATURE VERTICALLY POLARIZED  
MULTIPLE FREQUENCY BAND ANTENNA  
AND METHOD OF PROVIDING AN  
ANTENNA FOR A WIRELESS DEVICE**

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(75) Inventor: **Kong S. Luen**, Germantown, MD (US)

(73) Assignee: **FreeScale Semiconductor, Inc.**, Austin, TX (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 601 days.

(21) Appl. No.: **10/403,492**

(22) Filed: **Mar. 31, 2003**

(65) **Prior Publication Data**  
US 2004/0192226 A1 Sep. 30, 2004

(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, 795, 820, 876**  
See application file for complete search history.

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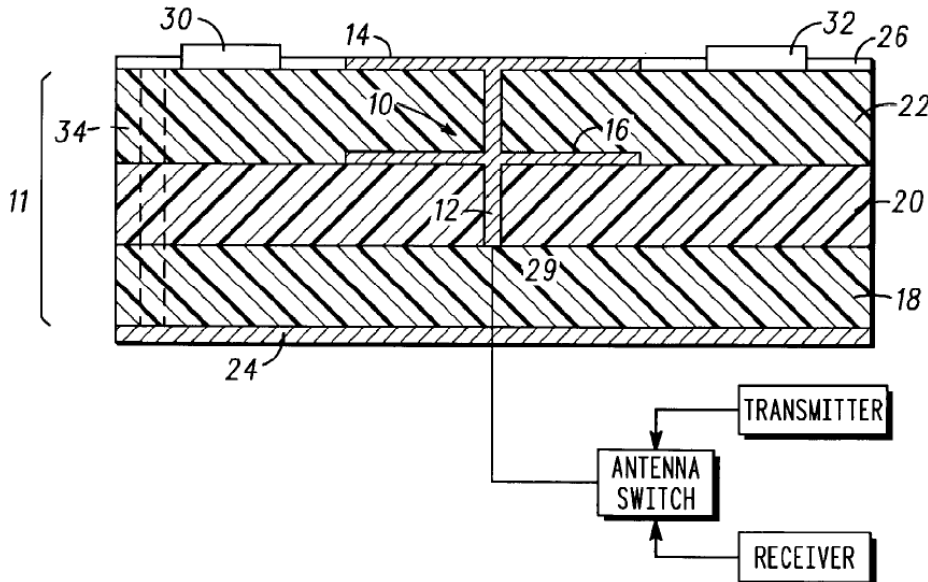
*Primary Examiner*—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Charles W. Bethards

(57) **ABSTRACT**

A miniature vertically polarized multi-frequency antenna 10 is embedded in a substrate 11 and suitable for use within a wireless device. The antenna 10 includes a first lateral member 14 and a second lateral member 16, which is spaced from and parallel to the first lateral member 14. The antenna 10 has a wide tuning range due to multiple resonances provided by the lateral members 14, 16. The antenna 10 is shortened by reactive loading and by embedding the antenna in material having a high dielectric constant. Tuning circuits 30, 32 are coupled to respective ends of one of the lateral members 14, 16. The tuning circuits are located on a common plane with the lateral member to which they are connected. The tuning circuits 30, 32 electronically add reactance to the antenna to alter the frequency at which it resonates. A method of providing the antenna 10 includes forming flat metal strips 14, 16 on layers of a laminated substrate 11 and forming the second lateral member 16 between adjacent layers 20, 22 of the substrate 11.

**20 Claims, 2 Drawing Sheets**





US007369089B2

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

(10) **Patent No.:** **US 7,369,089 B2**  
(45) **Date of Patent:** **May 6, 2008**

(54) **ANTENNA WITH MULTIPLE-BAND PATCH AND SLOT STRUCTURES**

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(75) Inventors: **Geyi Wen**, Waterloo (CA); **Krystyna Bandurska**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA)

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

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(Continued)

(21) Appl. No.: **11/777,448**

*Primary Examiner*—Shih-Chao Chen  
(74) *Attorney, Agent, or Firm*—Jones Day; Krishna K. Pathiyal; Robert C. Liang

(22) Filed: **Jul. 13, 2007**

(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2007/0257846 A1 Nov. 8, 2007

**Related U.S. Application Data**

(63) Continuation of application No. 11/344,753, filed on Feb. 1, 2006, now Pat. No. 7,256,741, which is a continuation of application No. 10/844,685, filed on May 13, 2004, now Pat. No. 7,023,387.

A multiple-band antenna having a plurality of operating frequency bands is provided. The antenna includes a plurality of structures configured for operation in respective ones of the plurality of operating frequency bands, and a plurality of structures configured for operation in more than one of the plurality of operating frequency bands. In one embodiment, a multiple-band antenna has first, second, and third operating frequency bands, and comprises a first patch structure associated with the first operating frequency band, a second patch structure connected to the first patch structure and associated with the second operating frequency band and the third operating frequency band, a first slot structure disposed between a first portion of the first patch structure and the second patch structure and associated with the first operating frequency band and the second operating frequency band, a second slot structure disposed between a second portion of the first patch structure and the second patch structure and associated with the second operating frequency band, and a third slot structure disposed between a third portion of the first patch structure and the second patch structure and associated with the first operating frequency band and the third operating frequency band.

(51) **Int. Cl.**  
**H01Q 1/38** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/702, 725, 770**  
See application file for complete search history.

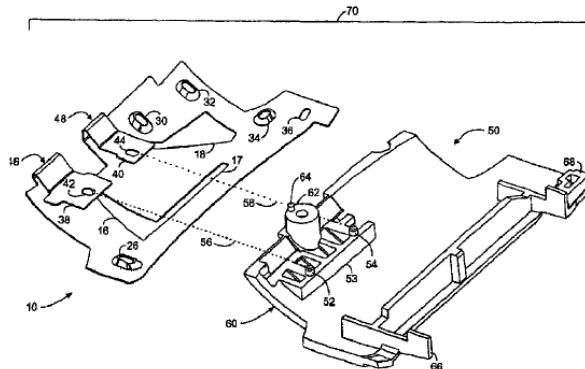
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**20 Claims, 7 Drawing Sheets**





US007369091B2

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

(10) **Patent No.:** **US 7,369,091 B2**  
(45) **Date of Patent:** **May 6, 2008**

(54) **MOBILE WIRELESS COMMUNICATIONS  
DEVICE HAVING DUAL ANTENNA SYSTEM  
FOR CELLULAR AND WIFI**

(75) Inventors: **Ying Tong Man**, Waterloo (CA);  
**Yihong Qi**, St. Agatha (CA)

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

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

(21) Appl. No.: **11/468,803**

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

(65) **Prior Publication Data**  
US 2008/0055163 A1 Mar. 6, 2008

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

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

(58) **Field of Classification Search** ..... **343/702,**  
**343/725, 700 MS, 893**  
See application file for complete search history.

(56) **References Cited**

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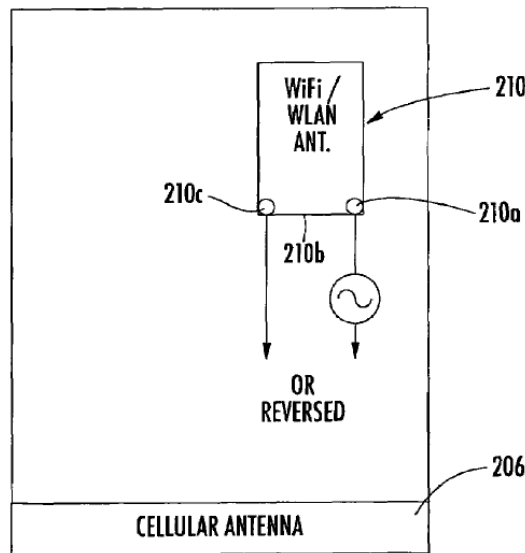
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*Primary Examiner*—Hoang V Nguyen  
(74) *Attorney, Agent, or Firm*—Allen, Dyer, Doppelt,  
Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device includes a housing and circuit board carried by the housing. Radio Frequency (RF) circuitry is mounted on the circuit board. A first antenna is supported by the circuit board within the housing and operatively connected to the RF circuitry and configured for cellular phone communications. A second antenna is supported by the circuit board within the housing and operatively connected to the RF circuitry and configured for WiFi communications. The second antenna comprises an inverted-F or monopole antenna having an opening gap that is pointed away from the first antenna.

**22 Claims, 5 Drawing Sheets**





US007369094B2

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

(10) **Patent No.:** **US 7,369,094 B2**  
(45) **Date of Patent:** **May 6, 2008**

(54) **DUAL-FREQUENCY HIGH-GAIN ANTENNA**

(75) Inventors: **Jia-Jiu Song**, Jhonghe (TW); **Wei-Tong Cheng**, Hsinchu (TW)

(73) Assignee: **Smartant Telecom Co., Ltd.**, Hsinchu County (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.: **11/526,663**

(22) Filed: **Sep. 26, 2006**

(65) **Prior Publication Data**  
US 2008/0074340 A1 Mar. 27, 2008

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

(52) **U.S. Cl.** ..... **343/816**; 343/820; 343/810

(58) **Field of Classification Search** ..... 343/700 MS, 343/793, 810, 816, 820  
See application file for complete search history.

(56) **References Cited**

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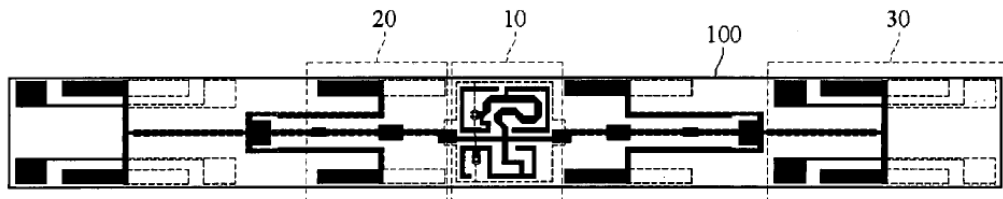
*Primary Examiner*—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Rabin & Berdo, P.C.

(57) **ABSTRACT**

A dual-frequency high-gain antenna is provided, which includes: a diplexer loop portion disposed at the center of the antenna substrate for receiving a feed signal; two single-frequency radiation units, symmetrically connected to two sides of the diplexer loop portion for radiating a radio-frequency signal corresponding to a first frequency value of the feed signal; and two dual-frequency radiation units, respectively connected to each single-frequency radiation portion for radiating radio-frequency signals corresponding to the first frequency value and a second frequency value of the feed signal.

**12 Claims, 11 Drawing Sheets**





US007372373B2

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

(10) **Patent No.:** **US 7,372,373 B2**  
(45) **Date of Patent:** **May 13, 2008**

(54) **EMBEDDED ANTENNA AND FILTER APPARATUS AND METHODOLOGY**

(75) Inventors: **Vladimir Borisov**, Seneca, SC (US); **Philippe Chiumminto**, Seneca, SC (US); **Semyon Lapushin**, Tucker, GA (US); **Sudhir Thumaty**, Clemson, SC (US)

(73) Assignee: **Itron, Inc.**, Liberty Lake, WA (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 442 days.

(21) Appl. No.: **11/211,153**

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

(65) **Prior Publication Data**

US 2006/0055610 A1 Mar. 16, 2006

**Related U.S. Application Data**

(60) Provisional application No. 60/604,973, filed on Aug. 27, 2004.

(51) **Int. Cl.**  
**G08B 23/00** (2006.01)

(52) **U.S. Cl.** ..... **340/870.02; 343/782; 301/659; 301/748; 301/761; 301/765; 333/12; 333/202; 324/84**

(58) **Field of Classification Search** ..... **340/870.02; 343/782; 301/659, 748, 761, 765; 333/12, 333/202; 716/15; 324/84**  
See application file for complete search history.

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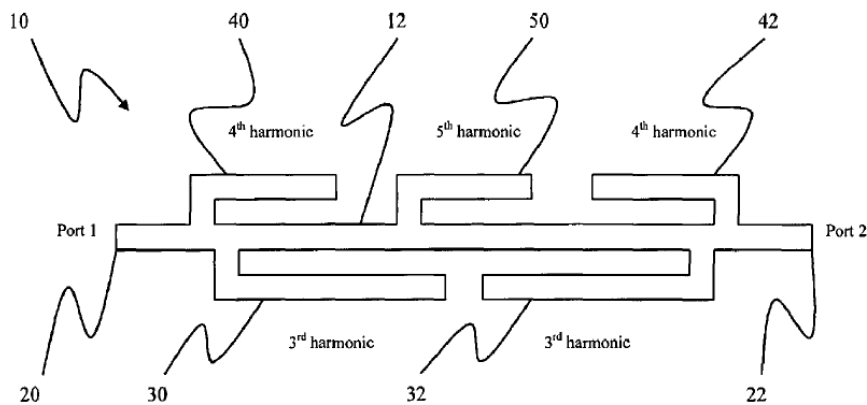
*Primary Examiner*—Albert K. Wong

(74) *Attorney, Agent, or Firm*—Dority & Manning, P.A.

(57) **ABSTRACT**

Apparatus and methodology are disclosed for providing effective transmission of data to and/or from an electricity meter by providing embedded radio frequency components. An antenna and stripline or microline filter arrangement are provided as embedded components in association with a transmitter or transceiver portion of the electricity meter's metrology circuitry so as to provide control of out of band harmonic radiation and to provide enhanced signal transmission to and/or from the electricity meter, to accomplish automated meter reading communications or similar. The antenna element is configured and mounted such that, once the electricity meter is fully assembled, the meter case itself can be used as part of a radiating element. An overall resulting integrated design can achieve greater economy utilizing printed circuit board approaches with no additional parts, and with less uncontrolled surface radiation because of the otherwise buried or embedded structure.

**18 Claims, 3 Drawing Sheets**





US007372406B2

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

(10) **Patent No.:** **US 7,372,406 B2**  
(45) **Date of Patent:** **May 13, 2008**

(54) **ANTENNA APPARATUS INCLUDING  
INVERTED-F ANTENNA HAVING VARIABLE  
RESONANCE FREQUENCY**

(75) Inventors: **Shinichi Shiotsu**, Kawasaki (JP);  
**Isamu Yamada**, Kawasaki (JP);  
**Youichi Kondo**, Kawasaki (JP)

(73) Assignee: **Fujitsu Limited**, Kawasaki (JP)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 551 days.

(21) Appl. No.: **10/639,490**

(22) Filed: **Aug. 13, 2003**

(65) **Prior Publication Data**  
US 2004/0041734 A1 Mar. 4, 2004

(30) **Foreign Application Priority Data**  
Aug. 30, 2002 (JP) ..... 2002-253729

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

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

(58) **Field of Classification Search** ..... 343/700 MS,  
343/702, 745, 795, 846, 850, 860  
See application file for complete search history.

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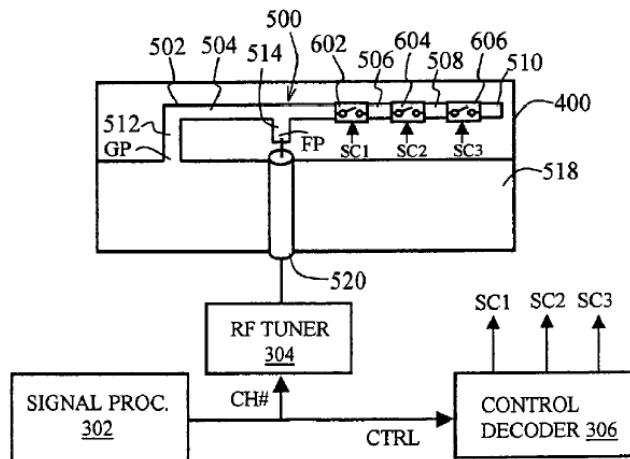
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*Primary Examiner*—Tan Ho  
*Assistant Examiner*—Jimmy T Vu  
(74) *Attorney, Agent, or Firm*—Staas & Halsey LLP

(57) **ABSTRACT**

An inverted-F antenna has at least two antenna conductive elements coupled in series via at least one switch. An antenna apparatus includes control means for controlling the at least one switch.

**2 Claims, 8 Drawing Sheets**





US007372409B2

(12) **United States Patent**  
**Morton**

(10) **Patent No.:** **US 7,372,409 B2**  
(45) **Date of Patent:** **May 13, 2008**

(54) **SLIT LOADED TAPERED SLOT PATCH ANTENNA**

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2007/0080878 A1\* 4/2007 McLean ..... 343/725

(75) Inventor: **Jacob Morton**, Melbourne, FL (US)

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

Chen, Zhi Ning, "Center-Fed Microstrip Patch Antenna", IEEE Transactions on Antennas and Propagation, vol. 51, No. 3, Mar. 2003.

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 244 days.

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Primary Examiner—Hoanganh Le  
(74) Attorney, Agent, or Firm—Darby & Darby; Robert J. Sacco

(21) Appl. No.: **11/358,146**

(22) Filed: **Feb. 21, 2006**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2007/0194999 A1 Aug. 23, 2007

Patch antenna (100) for a wireless communications device has a reduced size. The patch antenna is operable on a fundamental frequency  $f_0$  and a first harmonic  $f_1$  of the fundamental frequency, with substantially co-located peak gain directions on both frequencies. The patch antenna (100) is formed from a conductive ground plane (102) of generally rectangular shape. A first aperture (108) provided in the conductive ground plane member (102) defines a bow-tie shape. Additional elongated apertures (118, 120) are provided for reactive loading. The elongated apertures (118, 120) disrupt the phasing of surface currents within the conductive ground plane member (102) around the periphery of the first aperture (108).

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

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/767, 770, 846, 848, 795**

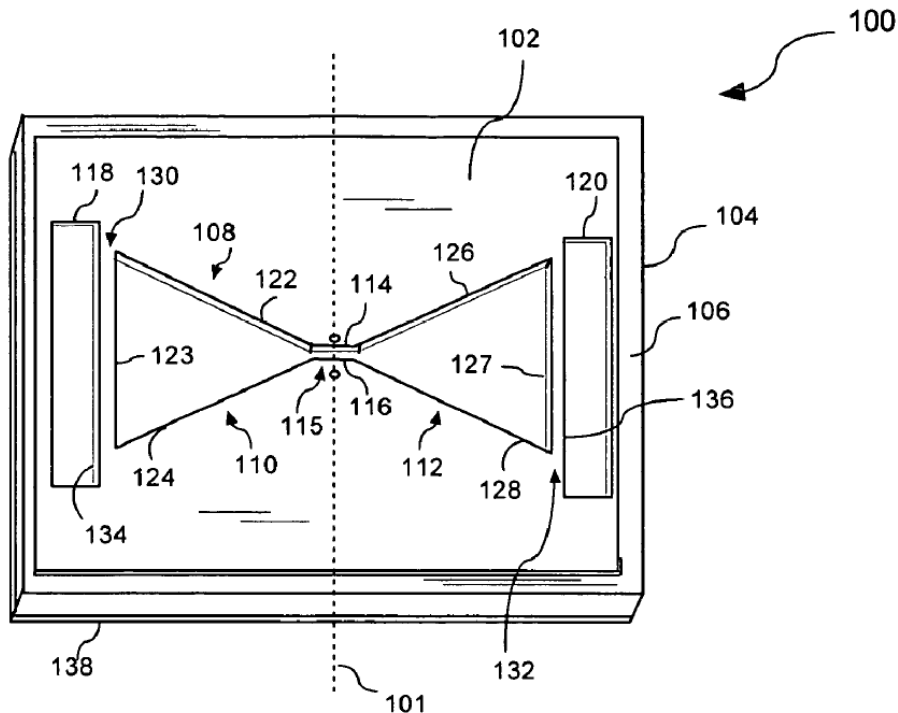
See application file for complete search history.

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**20 Claims, 7 Drawing Sheets**







US007372417B2

(12) **United States Patent**  
**Fukuchi**

(10) **Patent No.:** **US 7,372,417 B2**  
(45) **Date of Patent:** **May 13, 2008**

(54) **WIDEBAND ANTENNA** 2006/0055619 A1\* 3/2006 Sarabandi et al. .... 343/866

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

FOREIGN PATENT DOCUMENTS

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

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

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(21) Appl. No.: **11/444,538**

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(22) Filed: **Jun. 1, 2006**

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(65) **Prior Publication Data**

US 2007/0046554 A1 Mar. 1, 2007

*Primary Examiner*—Hoanganh Le

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

(30) **Foreign Application Priority Data**

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

(57) **ABSTRACT**

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

(52) **U.S. Cl.** ..... **343/767; 343/795; 343/700 MS**

(58) **Field of Classification Search** ..... **343/767, 343/768, 700 MS, 795**  
See application file for complete search history.

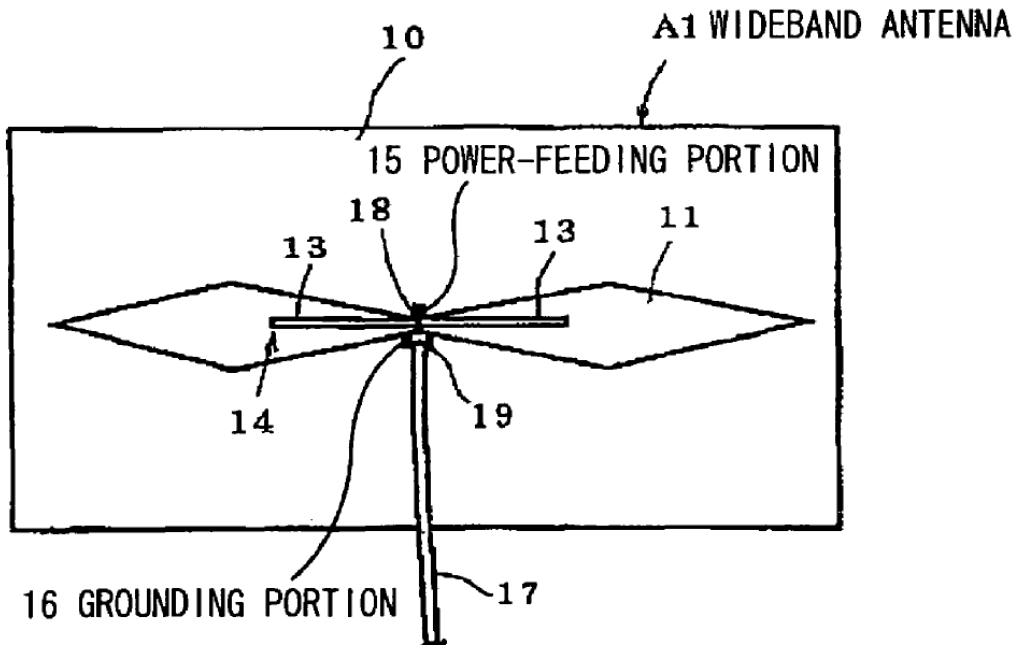
A wideband antenna has: a rectangular conductor sheet; a bow-tie-shaped slit formed in the rectangular conductor sheet, the rectangular conductor sheet having two apex portions defined by the bow-tie-shaped slit, the two apex portions being opposite to each other in the middle of the bow-tie-shaped slit; 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 an other of the two apex portions.

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**6 Claims, 5 Drawing Sheets**





US007372427B2

(12) **United States Patent**  
**Leisten**

(10) **Patent No.:** **US 7,372,427 B2**  
(45) **Date of Patent:** **May 13, 2008**

(54) **DIELECTRICALLY-LOADED ANTENNA**  
(75) Inventor: **Oliver Paul Leisten**, Kingsthorpe (GB)  
(73) Assignee: **Sarentel Limited** (GB)

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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 0 days.

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(21) Appl. No.: **11/088,247**

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(22) Filed: **Mar. 23, 2005**

Search Report Under Section 17(5), Patents Act of 1977, British Patent Office, issued in connection with Application No. GB 0505771.6 issued on Dec. 7, 2005.

(65) **Prior Publication Data**  
US 2005/0195126 A1 Sep. 8, 2005

(Continued)

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 10/457,717, filed on Jun. 9, 2003, now Pat. No. 6,914,580.

*Primary Examiner*—Douglas W. Owens  
*Assistant Examiner*—Minh Dieu A  
(74) *Attorney, Agent, or Firm*—John Bruckner PC

(30) **Foreign Application Priority Data**  
Mar. 21, 2005 (GB) ..... 0505771.6

(57) **ABSTRACT**

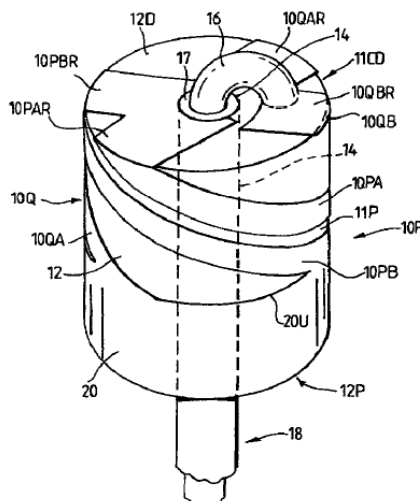
(51) **Int. Cl.**  
**H01Q 1/36** (2006.01)  
(52) **U.S. Cl.** ..... **343/895**  
(58) **Field of Classification Search** ..... **343/895,**  
343/897, 904, 857, 906, 911 R, 843  
See application file for complete search history.

In a dielectrically-loaded quadrifilar antenna for operation with circularly polarised signals, four coextensive composite helical elements are plated on the outer surface of a cylindrical dielectric core, each composite element comprising two mutually adjacent conductive tracks defining between them an elongate channel or slit. The track edges bounding each channel are longer than the opposite edges of the respective tracks in that they follow parallel meandered paths, with the result that each channel deviates from a mean helical path and is longer than the corresponding portion of the mean helical path. At a frequency within the operating band of the antenna, the channels have respective electrical lengths equivalent to a half wavelength. The bandwidth of the antenna is greater than the bandwidth of a correspondingly dimensioned antenna having single-track helical elements.

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**41 Claims, 7 Drawing Sheets**



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

(10) **Patent No.:** **US 7,375,684 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **MULTIBAND PLANAR ANTENNA**

2004/0090379 A1\* 5/2004 Fourdeux et al. .... 343/700 MS

(75) Inventors: **Franck Thudor**, Rennes (FR);  
**François Baron**, Cesson Sevigne (FR);  
**Françoise Le Bolzer**, Rennes (FR)

FOREIGN PATENT DOCUMENTS  
WO WO 01/20718 A 3/2001

(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 0 days.

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Guangping Zhou "Shorting-pin loaded annular ring microstrip antenna" Antennas and Propagation Society International Symposium, 1998 IEEE Atlanta, GA Jun. 21-16, 1998 New York, NY IEEE, US.

(21) Appl. No.: **11/064,350**

Ishii N et al. "Analysis On the Mechanism 1-10 of a Tuning Stub for Circular-Polarized Annular Microstrip Antenna" Electronics & Communications, Scripta Technica New York, US vol. 78, No. 11 pp. 43-501 Nov. 1995.

(22) Filed: **Feb. 23, 2005**

Tanaka M et al. "Suppressing Undesired Modes in a Higher-Order Mode Microstrip Ring Patch Antenna" Electronics & Communications in Japan, Part 1—Communications, Scripta Technica New York, US vol. 85, No. 3, Part 1 Mar. 2002 vol. 85, No. 3, Part 1 pp. 9-18.

(65) **Prior Publication Data**

US 2005/0190112 A1 Sep. 1, 2005

(30) **Foreign Application Priority Data**

Mar. 1, 2004 (FR) ..... 04 50400

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

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

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

(58) **Field of Classification Search** ..... **343/700 MS, 343/767, 768, 769, 770, 846**  
See application file for complete search history.

(57) **ABSTRACT**

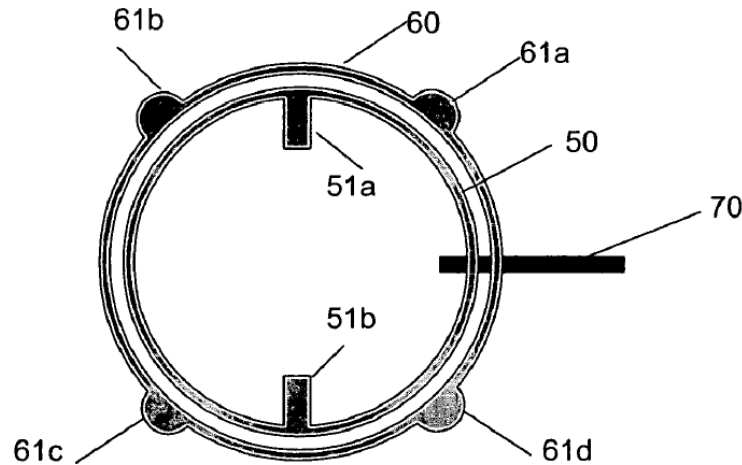
The present invention relates to a multiband planar antenna consisting of at least one resonator formed of an element having a closed shape made on a substrate and dimensioned so as to operate in its fundamental mode at the resonant frequency of the lowest band. The resonator is fed by a feed line in such a way as to operate in all the higher modes. The resonator comprises means for modifying the resonant frequencies of the various modes in such a way as to cover the bands concerned.

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**9 Claims, 7 Drawing Sheets**





US007375685B1

(12) **United States Patent**  
**Nalbandian**

(10) **Patent No.:** **US 7,375,685 B1**  
(45) **Date of Patent:** **May 20, 2008**

- (54) **DUAL BAND ELECTRICALLY SMALL MICROSTRIP ANTENNA**
- (75) Inventor: **Vahakn Nalbandian**, Schwenksville, PA (US)
- (73) Assignee: **The United States of America as represented by the Secretary of the Army**, Washington, DC (US)
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 268 days.
- (21) Appl. No.: **11/416,511**
- (22) Filed: **Apr. 18, 2006**
- (51) **Int. Cl.**  
**H01Q 1/38** (2006.01)
- (52) **U.S. Cl.** ..... **343/700 MS; 343/803; 343/846; 343/829**
- (58) **Field of Classification Search** ..... **343/700 MS**  
See application file for complete search history.
- (56) **References Cited**

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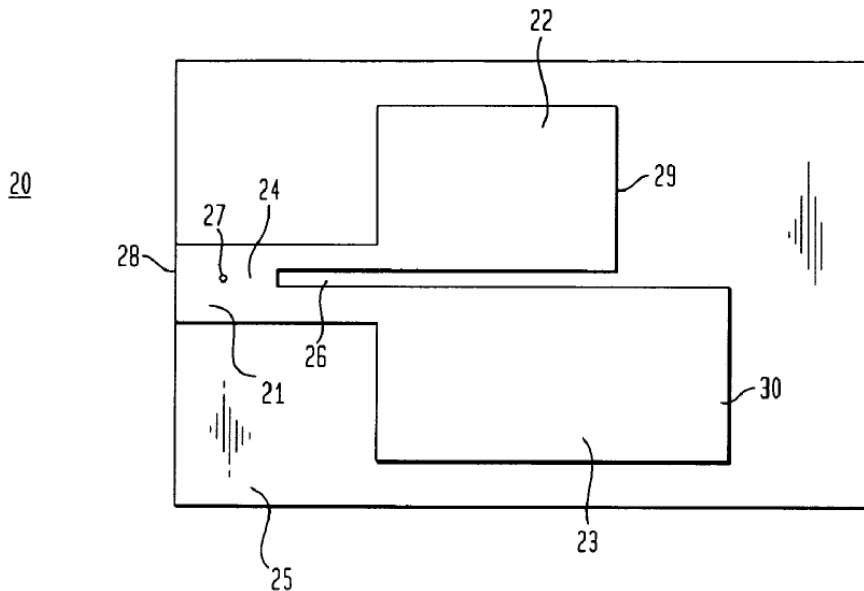
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 2006/0279464 A1\* 12/2006 Mei ..... 343/700 MS  
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*Primary Examiner*—Trinh V Dinh  
 (74) *Attorney, Agent, or Firm*—Michael Zelenka; George B. Tereschuck

(57) **ABSTRACT**

A multiple band electrically small compact planar microstrip antenna at VHF and UHF frequencies is provided that permits both a considerably abbreviated antenna length and significantly high efficiency antenna performance. The multiple band electrically small compact planar microstrip antenna advantageously positions a narrow radiating strip and a group of unequally dimensioned radiating members on a microstrip dielectric substrate that is stacked on a ground plane. The unequally dimensioned, or unlike, radiating members are separated by at least one gap and cause the antenna to resonate at a number of different frequencies instead of a single frequency as the prior art microstrip antenna. The multiple band electrically small compact planar microstrip antenna also innovatively filters unwanted signals at other frequencies because of the narrowband nature of each band. The preferred embodiment is a dual band electrically small compact planar microstrip antenna with two unlike radiating members separated by a single gap. This invention also encompasses methods for providing substantial reduction in antenna size at the VHF and UHF frequencies with multiple band electrically small planar microstrip antennas.

**20 Claims, 4 Drawing Sheets**





US007375686B2

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

(10) **Patent No.:** **US 7,375,686 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **PLANAR INVERTED F ANTENNA AND METHOD OF MAKING THE SAME**

(58) **Field of Classification Search** ..... 343/700 MS, 343/702, 829, 830, 846, 725  
See application file for complete search history.

(75) Inventors: **Po-Kang Ku**, Tu-Cheng (TW);  
**Lung-Sheng Tai**, Tu-Cheng (TW);  
**Chen-Ta Hung**, Tu-Cheng (TW);  
**Yun-Long Ke**, Tu-Cheng (TW);  
**Yao-Shien Huang**, Tu-Cheng (TW)

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2004/0178957	A1 *	9/2004	Chang et al.	343/700 MS

(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 0 days.

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*Primary Examiner*—Shih-Chao Chen  
(74) *Attorney, Agent, or Firm*—Wei Te Chung

(21) Appl. No.: **11/491,602**

(22) Filed: **Jul. 24, 2006**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2007/0018892 A1 Jan. 25, 2007

A multi-band antenna (1) used in wireless communications includes a radiating portion (2), a grounding portion (4), and a connecting portion (3). The radiating portion (2) includes a first radiating element (21) operating at 900 MHz frequency band and a second radiating element (22) operating at 1800 MHz frequency band. The connecting portion (3) connects the radiating portion (2) and the grounding portion (4). The grounding portion (4), the radiating portion (2), and the connecting portion (3) locate in the same plane.

(30) **Foreign Application Priority Data**

Jul. 22, 2005 (CN) ..... 2005 1 0041153

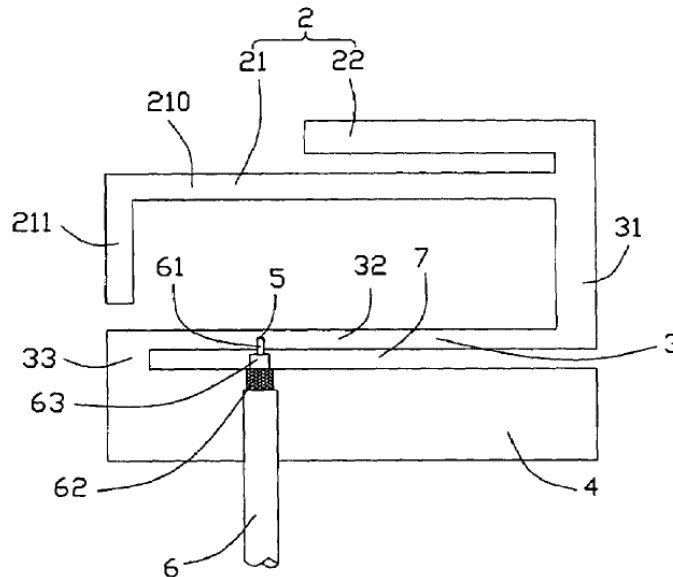
(51) **Int. Cl.**

**H01Q 1/38** (2006.01)  
**H01Q 21/00** (2006.01)  
**H01Q 9/38** (2006.01)

(52) **U.S. Cl.** ..... **343/700 MS; 343/725; 343/830**

**20 Claims, 6 Drawing Sheets**

1





US007375687B2

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

(10) **Patent No.:** **US 7,375,687 B2**  
(45) **Date of Patent:** **May 20, 2008**

- (54) **MONOPOLE ANTENNA**
- (75) Inventors: **Yun-Long Ke**, Tu-Cheng (TW);  
**Lung-Sheng Tai**, Tu-Cheng (TW);  
**Yao-Shien Huang**, Tu-Cheng (TW)
- (73) Assignee: **Hon Hai Precision Ind. Co., Ltd.**,  
Taipei Hsien (TW)
- (\* ) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **11/605,686**
- (22) Filed: **Nov. 28, 2006**
- (65) **Prior Publication Data**  
US 2007/0120743 A1 May 31, 2007
- (30) **Foreign Application Priority Data**  
Nov. 28, 2005 (TW) ..... 94141660 A
- (51) **Int. Cl.**  
**H01Q 1/38** (2006.01)
- (52) **U.S. Cl.** ..... **343/700 MS; 343/767;**  
343/846

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

- (56) **References Cited**
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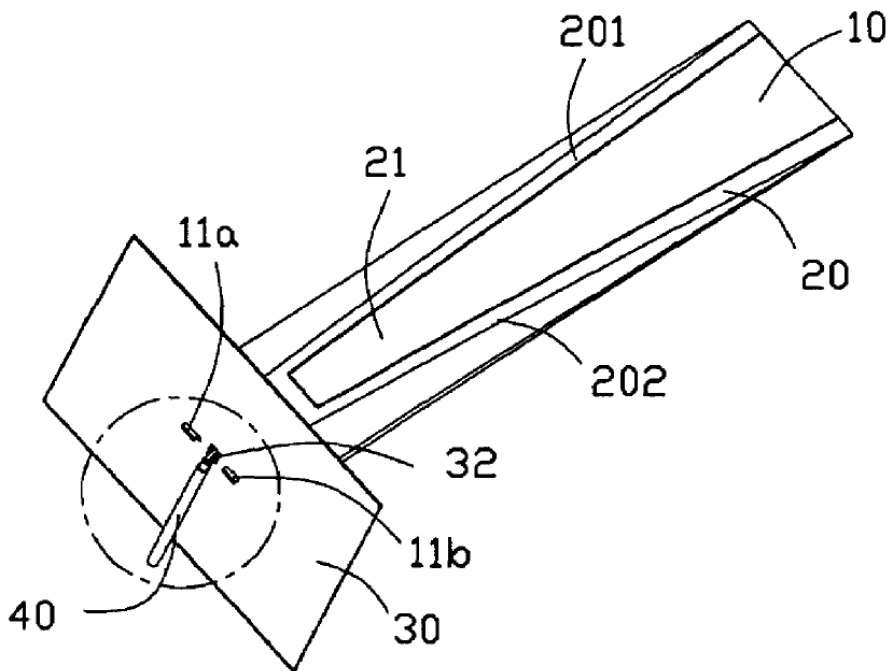
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*Primary Examiner*—Hoang V Nguyen  
(74) *Attorney, Agent, or Firm*—Wei Te Chung

(57) **ABSTRACT**

A monopole antenna comprises a planar substrate, a radiating element arranged on the planar substrate and of long-guide trapezium-shape and comprises a trapezium notch in the middle thereof, a grounding element assembled with said planar base with a predetermined angle.

15 Claims, 6 Drawing Sheets





US007375689B2

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

(10) **Patent No.:** **US 7,375,689 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **MULTI-BAND ANTENNA OF COMPACT SIZE**

(75) Inventors: **Yun-Ta Chen**, Tao-Yuan (TW);  
**Chien-Pang Chou**, Tao-Yuan (TW);  
**Chang-Hao Hsieh**, Tao-Yuan (TW)

(73) Assignee: **High Tech Computer Corp.**, Taoyuan,  
Taoyuan County (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.: **11/560,812**

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

(65) **Prior Publication Data**  
US 2007/0200777 A1 Aug. 30, 2007

(30) **Foreign Application Priority Data**  
Feb. 27, 2006 (TW) ..... 95106679 A

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

(52) **U.S. Cl.** ..... **343/702**; 343/702; 343/803;  
343/764; 343/765

(58) **Field of Classification Search** ..... 343/803,  
343/764, 765  
See application file for complete search history.

(56) **References Cited**

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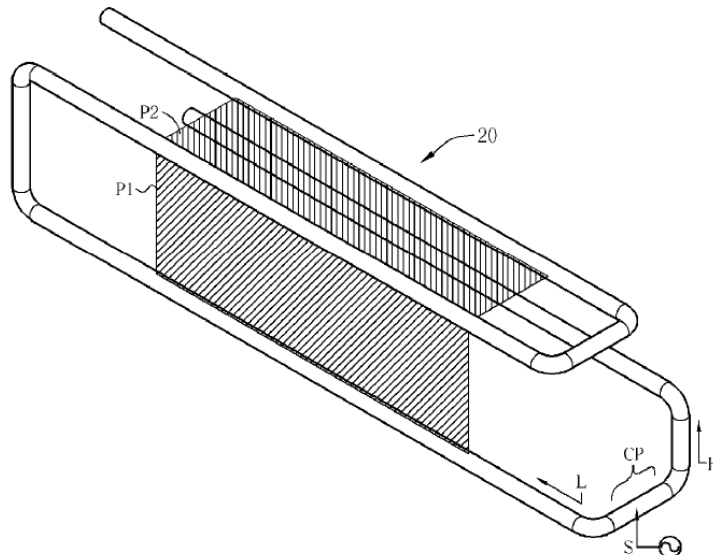
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*Primary Examiner*—Trinh V Dinh  
(74) *Attorney, Agent, or Firm*—Winston Hsu

(57) **ABSTRACT**

A multi-band antenna of compact size includes a conductor of uniform cross-section folded to form the antenna with a connection portion, a low-frequency first radiation portion, and a high-frequency second radiation portion. The connection portion has a feeding point for signal feeding. The first and second radiation portions connect to two ends of the connection portion. The first radiation portion is folded along two different planes to form three main sections. The second radiation portion is folded along a plane to form two sections. A terminal section of the first radiation portion and a terminal section of the second radiation portion are parallel, such that radiation of these two sections is coupled to enhance radiation characteristics of the antenna. Also, the folded structure helps to achieve compact size of the antenna.

**17 Claims, 26 Drawing Sheets**





US007375690B2

(12) **United States Patent  
Chen**

(10) **Patent No.:** **US 7,375,690 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **ANTENNA RING FOR ELECTRONIC  
DEVICE**

(76) Inventor: **Franklin F K Chen**, 6007 Johnston  
Dr., Oakland, CA (US) 94611

(\* ) 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.: **11/626,377**

(22) Filed: **Jan. 24, 2007**

(65) **Prior Publication Data**  
US 2007/0115190 A1 May 24, 2007

**Related U.S. Application Data**

(63) Continuation of application No. 11/162,051, filed on  
Aug. 26, 2005, now Pat. No. 7,196,670.

(60) Provisional application No. 60/686,623, filed on Jun.  
3, 2005.

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

(52) **U.S. Cl.** ..... **343/702; 343/271**

(58) **Field of Classification Search** ..... 343/702,  
343/718, 741, 866; 224/197, 269, 271, 183  
See application file for complete search history.

(56) **References Cited**

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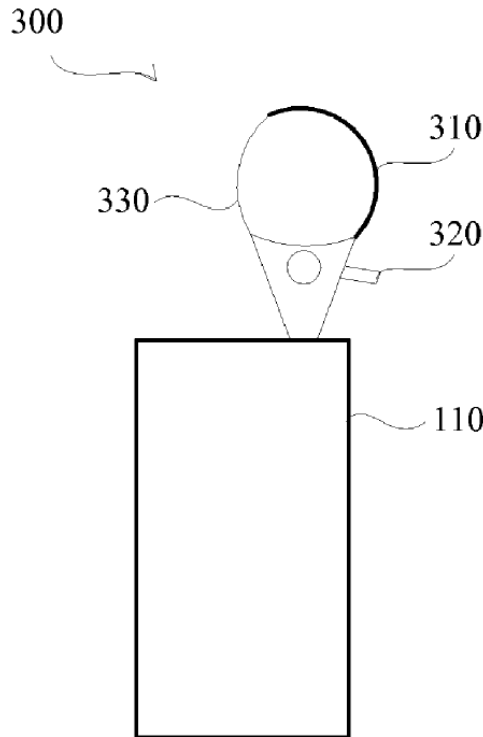
*Primary Examiner*—Tan Ho

(74) *Attorney, Agent, or Firm*—Thelen Reid Brown  
Raysman & Steiner; Aaron Wininger

(57) **ABSTRACT**

An accessory for an electronic device, such as a mobile  
phone, includes a mounting portion and a coupling portion.  
The mounting portion is adapted for mounting to an antenna  
region of the electronic device. The coupling portion is  
coupled to the mounting portion and adapted for detachable  
coupling to an object to thereby couple the electronic device  
to the object.

**29 Claims, 2 Drawing Sheets**







US007375691B1

(12) **United States Patent**  
**Chiang**

(10) **Patent No.:** **US 7,375,691 B1**  
(45) **Date of Patent:** **May 20, 2008**

- (54) **ANTENNA FRAMEWORK**
- (75) Inventor: **Chi Ming Chiang, Pa-Te (TW)**
- (73) Assignee: **Auden Techno Corp., Tao-Yuan Hsien (TW)**
- (\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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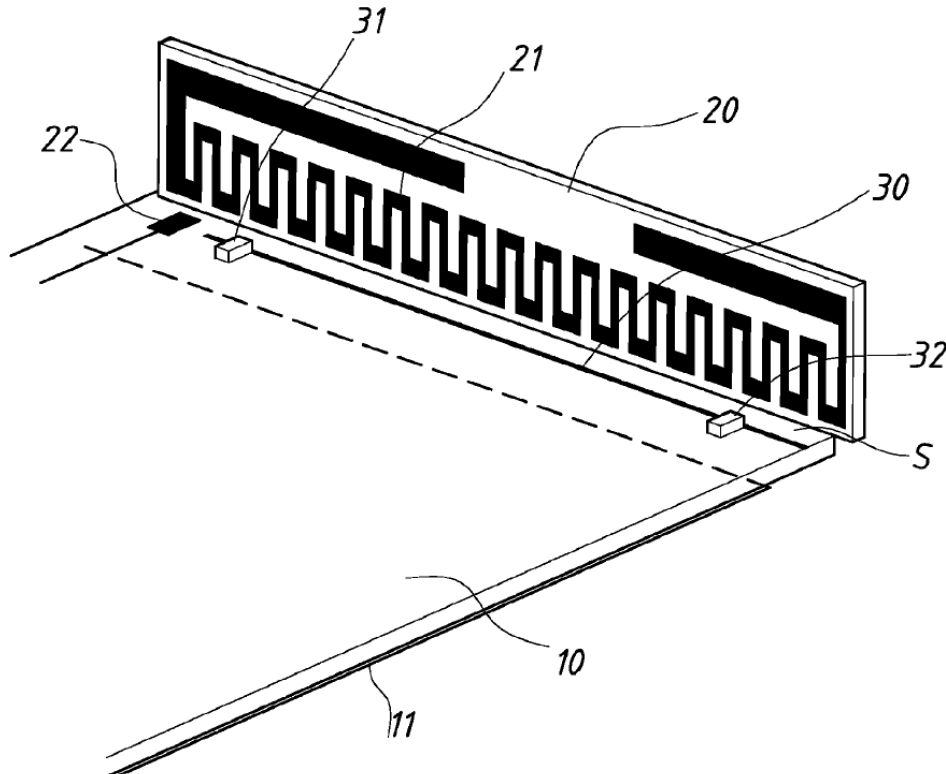
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*Primary Examiner*—Tho G Phan  
 (74) *Attorney, Agent, or Firm*—Ming Chow; Sinorica, LLC

- (21) Appl. No.: **11/683,453**
- (22) Filed: **Mar. 8, 2007**
- (51) **Int. Cl.**  
**H01Q 1/24** (2006.01)
- (52) **U.S. Cl.** ..... **343/702; 343/700 MS; 343/895**
- (58) **Field of Classification Search** ..... **343/700 MS, 343/702, 895, 829, 846**  
See application file for complete search history.

(57) **ABSTRACT**  
 A broadband antenna framework used for receiving and emitting radio signals for a mobile communication device (such as a mobile phone). The mobile communication device is provided on an upper edge of its circuit board (having a grounding surface) with an antenna, and is provided between the antenna and the circuit board with a meandering line; the meandering line is provided thereon with components containing multilayer ceramic capacitors (MLCC) or multilayer ceramic inductors (MLCI); by using the capacitors or the inductors, the coupling effect between the grounding surface and the antenna can be insulated, so that there can be sufficient distance between the grounding surface and the antenna to radiate energy, the capacitors or the inductors do not result a direct current open circuit, hence other electronic elements can be laid around an antenna.

- (56) **References Cited**  
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**5 Claims, 5 Drawing Sheets**





US007375694B2

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

(10) **Patent No.:** **US 7,375,694 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **ANTENNA CAPABLE OF MICRO-TUNING AND MACRO TUNING FOR WIRELESS TERMINAL**

(75) Inventors: **Chang-won Jung**, Yongin-sin (KR);  
**Yong-jin Kim**, Yongin-si (KR);  
**Yong-eil Kim**, Yongin-si (KR); **Se-hyun Park**, Yongin-si (KR)

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

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

(21) Appl. No.: **11/606,146**

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

(65) **Prior Publication Data**

US 2008/0001823 A1 Jan. 3, 2008

(30) **Foreign Application Priority Data**

Jul. 3, 2006 (KR) ..... 10-2006-0062027

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

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

(58) **Field of Classification Search** ..... **343/745, 343/749, 750, 700 MS, 702**  
See application file for complete search history.

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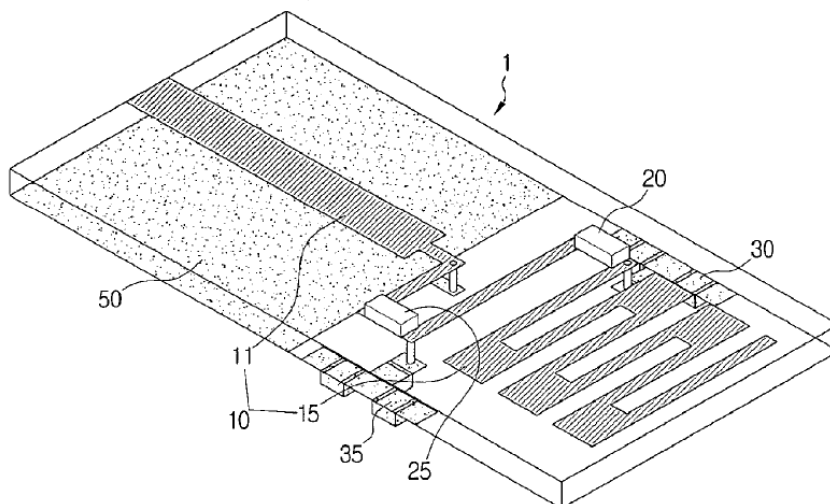
*Primary Examiner*—Hoang V Nguyen

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

(57) **ABSTRACT**

Disclosed is an antenna capable of micro-tuning and macro-tuning for a wireless terminal, comprising: a radiator radiating electromagnetic waves; a ground connected to the radiator; at least one switching element positioned at a lengthwise region of the radiator, for shorting or opening the region of the radiator; and a voltage controlling element positioned at the radiator between the switching element and the ground, for controlling the extent of a voltage potential applied across the radiator. In accordance with the present invention, the antenna is capable of the macro-tuning between the service bands and micro-tuning for channel control within the service bands. Furthermore, the size of the antenna is significantly reduced and the antenna is installed on a circuit board in a patch type, thereby simplifying a work process.

**11 Claims, 6 Drawing Sheets**





US007375695B2

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

(10) **Patent No.:** **US 7,375,695 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **ANTENNA AND WIRELESS COMMUNICATION DEVICE** 7,129,907 B2\* 10/2006 Lin et al. .... 343/876  
7,202,790 B2\* 4/2007 Copeland et al. .... 340/572.7  
2002/0044092 A1 4/2002 Kushihi

(75) Inventors: **Kenichi Ishizuka**, Sagamihara (JP);  
**Kazunari Kawahata**, Machida (JP)

(73) Assignee: **Murata Manufacturing Co., Ltd.**,  
Kyoto (JP)

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

(21) Appl. No.: **11/829,653**

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

(65) **Prior Publication Data**  
US 2007/0268191 A1 Nov. 22, 2007

**Related U.S. Application Data**  
(63) Continuation of application No. PCT/JP2005/022342, filed on Dec. 6, 2005.

(30) **Foreign Application Priority Data**  
Jan. 27, 2005 (JP) ..... 2005-020199  
Aug. 23, 2005 (JP) ..... 2005-241890

(51) **Int. Cl.**  
**H01Q 9/00** (2006.01)

(52) **U.S. Cl.** ..... **343/745**

(58) **Field of Classification Search** .....  
343/702, 700 MS, 744, 750; 340/572.7,  
340/572.8

See application file for complete search history.

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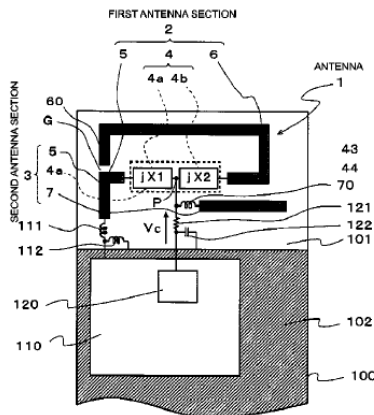
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*Primary Examiner*—Huedung Mancuso  
(74) *Attorney, Agent, or Firm*—Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna and a wireless communication device are adapted to have a plurality of resonant frequencies changed simultaneously by a desired range at a low voltage. The antenna includes a first antenna section and a second antenna section. The first antenna section includes a feeding electrode, a frequency-changing circuit, and a radiating electrode, and the second antenna section includes the feeding electrode, a first reactance circuit, and an additional radiating electrode. The frequency-changing circuit has a circuit configuration in which the first reactance circuit and the second reactance circuit are connected. When a control voltage Vc is applied to a node P, the reactances of the first and second reactance circuits change in accordance with the magnitude of the control voltage Vc, so that a resonant frequency f1 of the first antenna section and a resonant frequency f2 of the second antenna section change simultaneously.

**17 Claims, 18 Drawing Sheets**





US007375697B2

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

(10) **Patent No.:** **US 7,375,697 B2**  
(45) **Date of Patent:** **May 20, 2008**

- (54) **MEANDERED SLIT ANTENNA** 6,392,609 B2\* 5/2002 Nieminen ..... 343/767
- 6,618,020 B2\* 9/2003 Wang et al. .... 343/767
- (75) Inventors: **Young Soon Lee**, Gyeongsangbuk-do (KR); **Ui Jung Kim**, Gyeongsangbuk-do (KR); **Han Chil Cha**, Gyeongsangbuk-do (KR) 6,677,909 B2\* 1/2004 Sun et al. .... 343/767
- 6,750,821 B2\* 6/2004 Fang et al. .... 343/700 MS
- 6,995,714 B2\* 2/2006 Sim et al. .... 343/702
- 2005/0012674 A1\* 1/2005 Takei ..... 343/767
- (73) Assignee: **Ohsung Electrics Co., Ltd.**, Gyeongsangbuk-Do (KR)

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

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KR 1020020071011 5/2004

(21) Appl. No.: **11/229,733**

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

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(65) **Prior Publication Data**  
US 2006/0284777 A1 Dec. 21, 2006

*Primary Examiner*—Tho Phan  
(74) *Attorney, Agent, or Firm*—Apex Juris, PLLC; Tracy M Heims

(30) **Foreign Application Priority Data**  
Jun. 20, 2005 (KR) ..... 10-2005-0053225

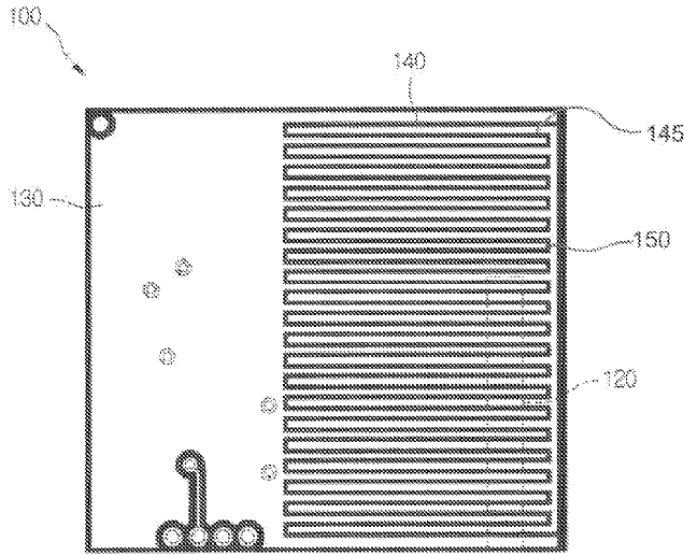
(57) **ABSTRACT**

- (51) **Int. Cl.**  
**H01Q 13/10** (2006.01)
- (52) **U.S. Cl.** ..... **343/767; 343/895**
- (58) **Field of Classification Search** ..... 343/767, 343/770, 700 MS, 702, 829, 846, 895  
See application file for complete search history.

A meandered slit antenna is provided. The meandered slit antenna includes: a printed circuit board; an RF module mounted on the printed circuit board to generate a predetermined electric signal; a microstrip feed line connected with the RF module to transmit the predetermined electric signal; and a slot part for radiating an electromagnetic wave induced by the electric signal that is transmitted through the microstrip feed line, the slot part being formed in a meandered shape.

- (56) **References Cited**  
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**14 Claims, 12 Drawing Sheets**





US007375699B2

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

(10) **Patent No.:** **US 7,375,699 B2**  
(45) **Date of Patent:** **\*May 20, 2008**

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

3,508,274 A 4/1970 Kesler et al.

(75) Inventors: **Ian James Forster**, Essex (GB); **Peter Robert George Horrell**, Essex (GB); **Patrick F. King**, Glen Ellyn, IL (US)

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(73) Assignee: **Mineral Lassen LLC**, Las Vegas, NV (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 0 days.

International Search Report, dated Apr. 11, 2003, for PCT/IB02/05095, filed Oct. 29, 2002.

(Continued)

This patent is subject to a terminal disclaimer.

*Primary Examiner*—Tho Phan

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

(21) Appl. No.: **10/637,326**

(22) Filed: **Aug. 8, 2003**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2004/0041739 A1 Mar. 4, 2004

**Related U.S. Application Data**

(63) Continuation of application No. 10/012,206, filed on Oct. 29, 2001, now Pat. No. 6,630,910.

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

(52) **U.S. Cl.** ..... **343/806; 343/795; 343/895; 340/572.7**

(58) **Field of Classification Search** ..... 343/713, 343/742, 795, 806, 828, 843, 867, 895, 741, 343/866; 340/572.1, 572.7, 572.8

See application file for complete search history.

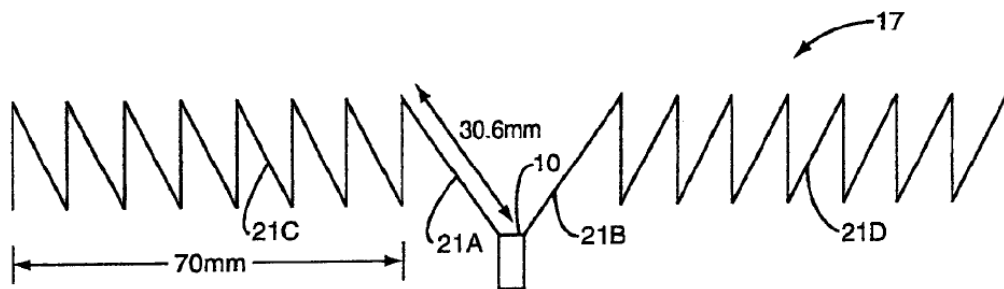
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3,202,985 A 8/1965 Perkins et al.

A wireless communication device coupled to a wave antenna that provides greater increased durability and impedance matching. The wave antenna is a conductor that is bent in alternating sections to form peaks and valleys. The wireless communication device is coupled to the wave antenna to provide wireless communication with other communication devices, such as an interrogation reader. The wireless communication device and wave antenna may be placed on objects, goods, or other articles of manufacture that are subject to forces such that the wave antenna may be stretched or compressed during the manufacture and/or use of such object, good or article of manufacture. The wave antenna, because of its bent structure, is capable of stretching and compressing more easily than other structures, reducing the wireless communication device's susceptibility to damage or breaks that might render the wireless communication device coupled to the wave antenna unable to properly communicate information wirelessly.

**29 Claims, 11 Drawing Sheets**





US007375700B2

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

(10) **Patent No.:** **US 7,375,700 B2**  
(45) **Date of Patent:** **May 20, 2008**

(54) **WIDEBAND MONOPOLE ANTENNA**

(75) Inventors: **Seong-Taek Hwang**, Pyeongtaek-si (KR); **Jae-Hoon Lee**, Seoul (KR); **Young-Sik Kim**, Seoul (KR); **Ji-Chai Jeong**, Seoul (KR); **Jung-Woo Baek**, Seoul (KR); **Young-Je Sung**, Seoul (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Yeongtong-Gu, Suwon-Si, Gyeonggi-Do (KR)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 219 days.

(21) Appl. No.: **11/230,971**

(22) Filed: **Sep. 20, 2005**

(65) **Prior Publication Data**

US 2006/0181463 A1 Aug. 17, 2006

(30) **Foreign Application Priority Data**

Feb. 17, 2005 (KR) ..... 10-2005-0013133

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

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

(58) **Field of Classification Search** ..... 343/702,  
343/872, 906

See application file for complete search history.

(56) **References Cited**

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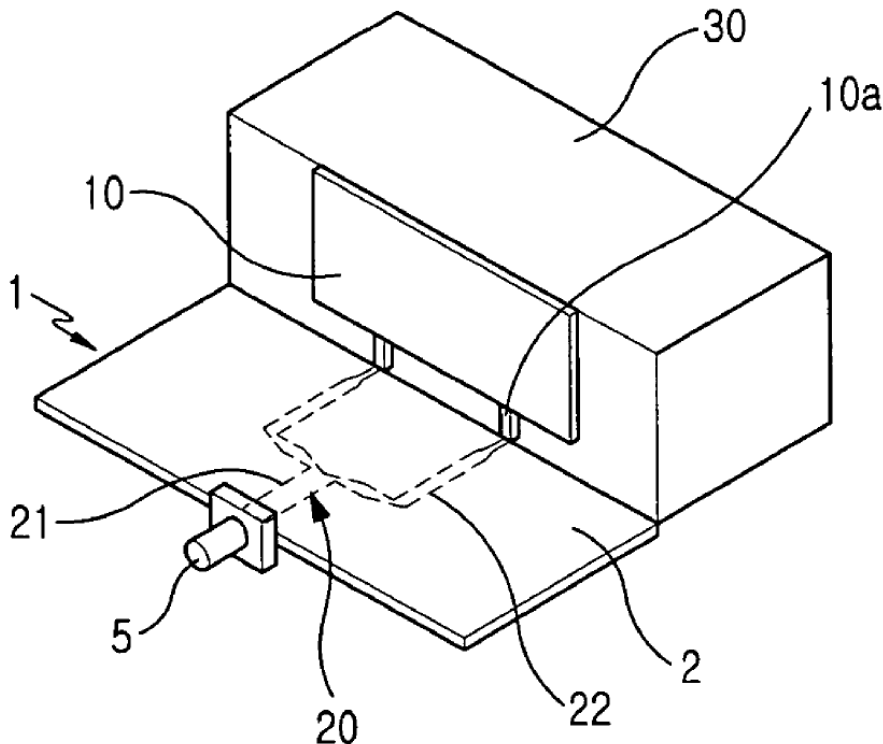
*Primary Examiner*—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Cha & Reiter, LLC

(57) **ABSTRACT**

A wideband monopole antenna assembly includes a substrate having an antenna connector, a wideband monopole antenna positioned on the substrate, and a feeder unit positioned on the rear surface of the substrate for supporting the antenna with a part thereof bent at a predetermined angle. The wideband monopole antenna has a feeder portion shorter than conventional antennas for compactness of the antenna.

**19 Claims, 8 Drawing Sheets**





US007379024B2

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

(10) **Patent No.:** **US 7,379,024 B2**  
(45) **Date of Patent:** **May 27, 2008**

(54) **RFID TAG USING A SURFACE INSENSITIVE ANTENNA STRUCTURE**

(75) Inventors: **Ian J. Forster**, Chelmsford (GB);  
**Adrian N. Farr**, Dunmow (GB);  
**Norman A. Howard**, Ilford (GB);  
**Andrew W. Holman**, West Hills, CA (US)

(73) Assignee: **Avery Dennison Corporation**, Pasadena, CA (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 39 days.

(21) Appl. No.: **11/636,091**

(22) Filed: **Dec. 8, 2006**

(65) **Prior Publication Data**  
US 2007/0080233 A1 Apr. 12, 2007

**Related U.S. Application Data**

(60) Division of application No. 11/245,152, filed on Oct. 6, 2005, which is a continuation of application No. PCT/US2004/011218, filed on Apr. 12, 2004.

(60) Provisional application No. 60/517,156, filed on Nov. 4, 2003.

(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, 895; 340/572.1-572

See application file for complete search history.

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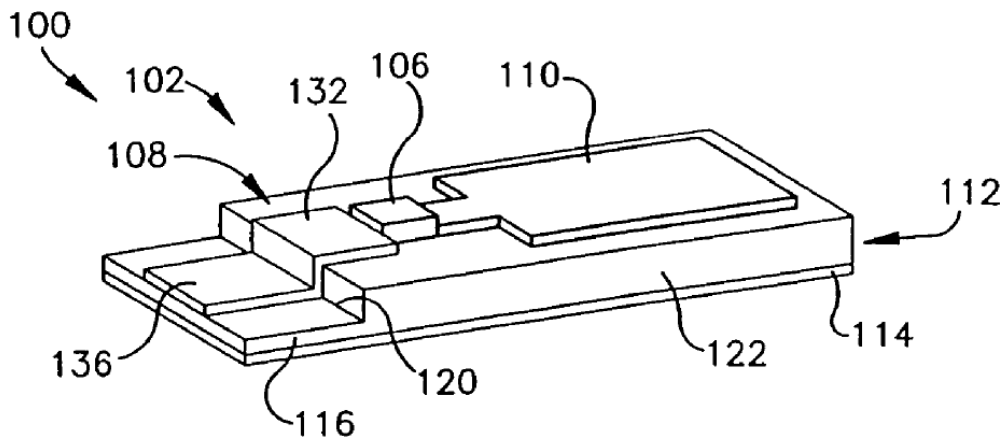
*Primary Examiner*—Hucdung Mancuso

(74) *Attorney, Agent, or Firm*—Renner, Otto, Boisselle & Sklar, LLP

(57) **ABSTRACT**

An RFID device includes conductive tabs, and a conductive structure, with a dielectric layer between the conductive tabs and the conductive structure. The conductive structure overlaps the conductive tabs and acts as a shield, allowing the device to be at least somewhat insensitive to the surface upon which it is mounted, or to the presence of nearby objects, such as goods in a carton or other container that includes the device. The dielectric layer may be a portion of the container, such as an overlapped portion of the container. Alternatively, the dielectric layer may be a separate layer, which may vary in thickness, allowing one of the conductive tabs to be capacitively coupled to the conductive structure. As another alternative, the dielectric layer may be an expandable substrate that may be expanded after fabrication operations, such as printing.

**8 Claims, 5 Drawing Sheets**





US007379025B2

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

(10) **Patent No.:** **US 7,379,025 B2**  
(45) **Date of Patent:** **May 27, 2008**

(54) **MOBILE ANTENNA UNIT AND ACCOMPANYING COMMUNICATION APPARATUS**

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2004/0198293 A1\* 10/2004 Sadler et al. .... 455/280

(75) Inventors: **Takeshi Asano**, Atsugi (JP); **Shohhei Fujio**, Machida (JP)

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JP	2003-051705	2/2003

(73) Assignee: **Lenovo (Singapore) PTE Ltd.**, Singapore (SG)

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

(21) Appl. No.: **10/788,056**

(22) Filed: **Feb. 26, 2004**

(65) **Prior Publication Data**

US 2004/0222929 A1 Nov. 11, 2004

(30) **Foreign Application Priority Data**

Feb. 27, 2003 (JP) ..... 2003-050328

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

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

(58) **Field of Classification Search** ..... **343/702,**  
**343/700 MS, 725, 729**  
See application file for complete search history.

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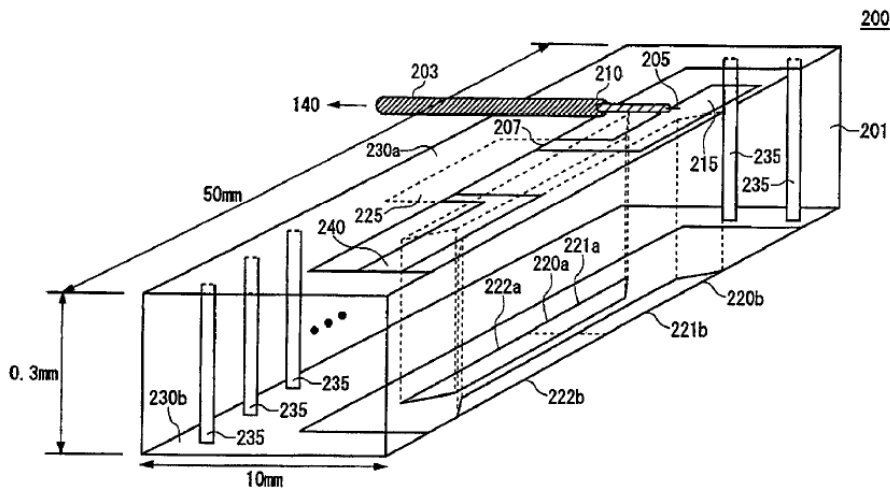
*Primary Examiner*—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Keusey, Tutunjian & Bitetto, P.C.

(57) **ABSTRACT**

An antenna unit is provided with an inverted F-type antenna element provided with a feeding point and a ground connection point, and a non-feed antenna element configured so as to resonate with the inverted F-type antenna element through electrical coupling. In addition, the antenna unit may also be provided with a ground part which is grounded to the earth and connected to the ground connection point provided on one edge of the inverted F-type antenna element, and a resonance element, one edge of which is connected to the ground part, resonated by the non-feed antenna element through electrical coupling.

**11 Claims, 4 Drawing Sheets**







US007379027B2

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

(10) **Patent No.:** **US 7,379,027 B2**  
(45) **Date of Patent:** **May 27, 2008**

- (54) **MOBILE WIRELESS COMMUNICATIONS DEVICE WITH HUMAN INTERFACE DIVERSITY ANTENNA AND RELATED METHODS**
- (75) Inventors: **Vytas Kezys**, Ancaster (CA); **Yihong Qi**, 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.

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- (21) Appl. No.: **11/616,405**
- (22) Filed: **Dec. 27, 2006**

(65) **Prior Publication Data**  
US 2007/0132647 A1 Jun. 14, 2007

**Related U.S. Application Data**  
(63) Continuation of application No. 11/067,935, filed on Feb. 28, 2005, now Pat. No. 7,187,332.

- (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, 867; 455/575.1, 101, 90  
See application file for complete search history.

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*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 portable handheld housing, and a wireless transceiver carried by the housing. A pair of antennas are positioned in side-by-side relation preferably in the upper portion of the portable handheld housing. A human interface diversity controller is connected to the wireless transceiver to preferentially operate with the plurality of antennas based upon a relative position of the portable handheld housing with respect to a hand of a human user. The device can select or weight the antennas based upon the position of the device when being held by a user.

**25 Claims, 4 Drawing Sheets**

