



US008013793B2

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

(10) **Patent No.:** **US 8,013,793 B2**
(45) **Date of Patent:** **Sep. 6, 2011**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Chen-Ta Hung**, Tu-cheng (TW);
Yun-Lung Ke, Tu-cheng (TW);
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(73) Assignee: **Hon Hai Precision Ind. Co., Ltd.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 384 days.

(21) Appl. No.: **12/291,139**

(22) Filed: **Nov. 5, 2008**

(65) **Prior Publication Data**

US 2009/0115665 A1 May 7, 2009

(30) **Foreign Application Priority Data**

Nov. 5, 2007 (TW) 96141630 A

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

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

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

See application file for complete search history.

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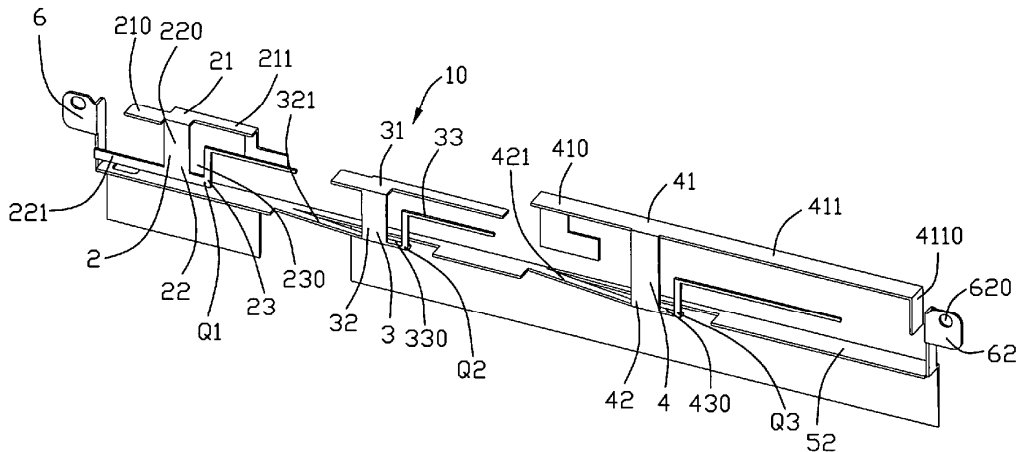
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Wei Te Chung; Andrew C. Cheng; Ming Chieh Chang

(57) **ABSTRACT**

A multi-band antenna, being made from an integrated metal patch, includes a grounding element, a first antenna and a second antenna, both of which are works in wireless local area net, and a third antenna working in wireless wide area net. The first, second, and third antennas extends from the grounding element and substantially along a lengthwise direction.

20 Claims, 5 Drawing Sheets





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

(10) **Patent No.:** **US 8,013,794 B2**
(45) **Date of Patent:** **Sep. 6, 2011**

(54) **SURFACE MOUNT ANTENNA AND ANTENNA MODULE**

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EP	1 063 722 A2	12/2000
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WO	WO 2007/094111 A1	8/2007

(75) Inventors: **Naoki Sotoma**, Tokyo (JP); **Yasumasa Harihara**, Tokyo (JP); **Kenji Endo**, Tokyo (JP); **Takeshi Oohashi**, Tokyo (JP)

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<http://hyperphysics.phy-astr.gsu.edu/hbase/tables/diel.html> (listing of dielectric constants).*
http://searchciomidmarket.techtarget.com/sDefinition/0,,sid183_gci546287,00.html. (definition of permittivity, dielectric).*

(73) Assignee: **TDK Corporation**, Tokyo (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 387 days.

* cited by examiner

(21) Appl. No.: **12/318,415**

Primary Examiner — Huedung Mancuso

(22) Filed: **Dec. 29, 2008**

(74) *Attorney, Agent, or Firm* — Oliff & Berridge, PLC

(65) **Prior Publication Data**

US 2009/0179815 A1 Jul. 16, 2009

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Jan. 15, 2008 (JP) 2008-005516

A surface mount antenna with small size and broadband is provided. The surface mount antenna includes: a substrate including a dielectric material or a magnetic material as a main material; a feed radiation conductor formed on the substrate, one end of the feed radiation conductor being a first feed end to be supplied with power, and the other end being a first open end; and a parasitic radiation conductor formed on the substrate at a distance from the feed radiation conductor, one end of the parasitic radiation conductor being a second feed end to be supplied with power from the feed radiation conductor through electromagnetic coupling, and the other end being a second open end. A region having a dielectric constant or a magnetic permeability lower than that of the main material of the substrate is provided between the feed radiation conductor and the parasitic radiation conductor.

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

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

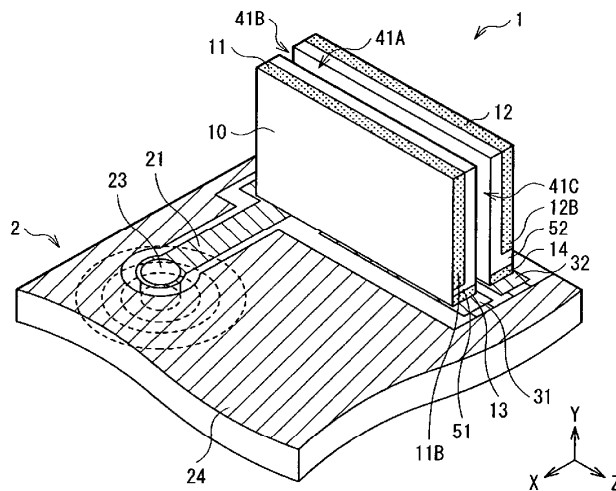
(58) **Field of Classification Search** 343/700 MS, 343/702, 787, 833, 795, 810
See application file for complete search history.

(56) **References Cited**

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10 Claims, 29 Drawing Sheets





US008013796B2

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

(10) **Patent No.:** **US 8,013,796 B2**
(45) **Date of Patent:** **Sep. 6, 2011**

(54) **DUAL-BAND ANTENNA**

- (75) Inventors: **Hsin-Hung Liu**, Tu-Cheng (TW);
Tsung-Lin Hsieh, Tu-Cheng (TW)
- (73) Assignee: **Chi Mei Communications Systems, Inc.**, Tu-Cheng, New Taipei (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 443 days.

(21) Appl. No.: **12/251,550**

(22) Filed: **Oct. 15, 2008**

(65) **Prior Publication Data**
US 2010/0033381 A1 Feb. 11, 2010

(30) **Foreign Application Priority Data**
Aug. 11, 2008 (CN) 2008 1 0303644

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

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

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

See application file for complete search history.

(56) **References Cited**

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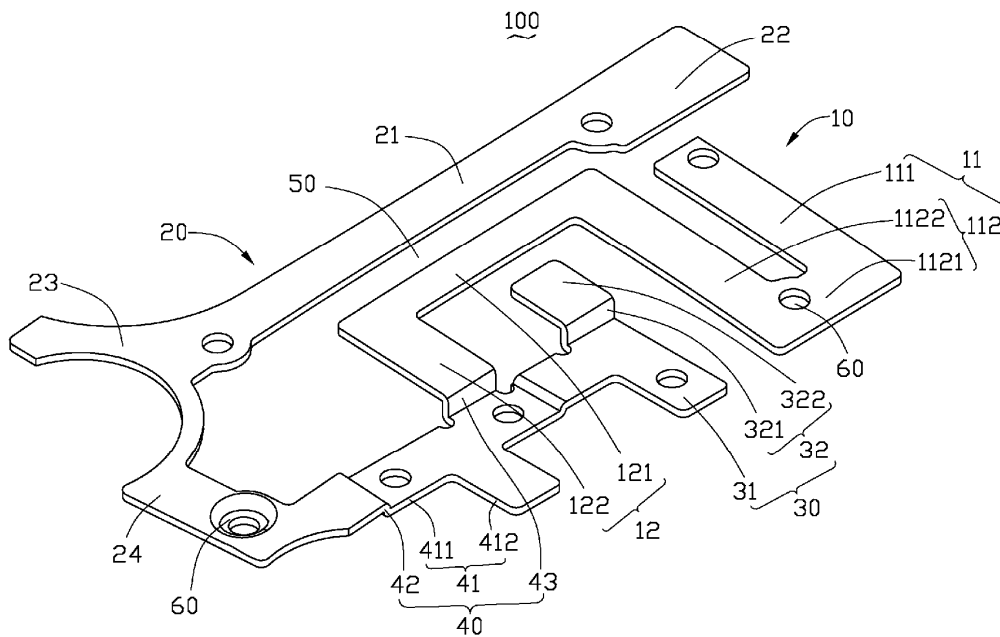
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Primary Examiner — Huedung Mancuso
(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

An dual-band antenna (100) used in a portable electronic device includes a first antenna unit (10) configured for receiving and/or sending wireless signals in low frequency bands, a second antenna unit (20) configured for receiving and/or sending wireless signals in high frequency bands; a feed unit (30) and a grounding unit (40). The first antenna unit, the second antenna unit and the feed unit are all connected to the grounding unit. A portion of the first antenna unit is positioned between the second antenna unit and the grounding unit. The first antenna unit and the second antenna unit are respectively positioned in different parallel planes.

13 Claims, 1 Drawing Sheet





US008013797B2

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

(10) **Patent No.:** **US 8,013,797 B2**
(45) **Date of Patent:** ***Sep. 6, 2011**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE INCLUDING A GROUND PATCH PROVIDING SPECIFIC ABSORPTION RATE (SAR) REDUCTION AND RELATED METHODS**

(75) Inventors: **Yihong Qi**, St. Agatha (CA); **Ying Tong Man**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (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.
This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/872,533**

(22) Filed: **Aug. 31, 2010**

(65) **Prior Publication Data**
US 2010/0328183 A1 Dec. 30, 2010

Related U.S. Application Data
(63) Continuation of application No. 12/472,638, filed on May 27, 2009, now Pat. No. 7,791,547, which is a continuation of application No. 11/733,360, filed on Apr. 10, 2007, now Pat. No. 7,554,496.

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

(52) **U.S. Cl.** **343/702; 343/846**
(58) **Field of Classification Search** 343/702, 343/846, 700 MS
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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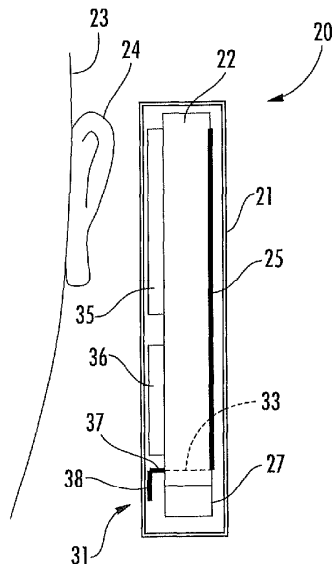
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

A mobile wireless communications device may include a portable housing, a dielectric substrate carried by the portable housing having a front side facing toward a user and a back side opposite the front side, and a ground plane carried by the dielectric substrate. The device may further include at least one circuit carried by the dielectric substrate, and an antenna carried by the dielectric substrate adjacent an end thereof and electrically connected to the at least one circuit. A ground patch may be adjacent the front side of the dielectric substrate that is electrically connected to the ground plane and spaced apart from and at least partially overlapping the antenna.

29 Claims, 3 Drawing Sheets





US008013799B2

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

(10) **Patent No.:** **US 8,013,799 B2**
(45) **Date of Patent:** **Sep. 6, 2011**

(54) **DUAL-BAND MONOPOLE ANTENNA WITH ANTENNA SIGNAL FED THROUGH SHORT-CIRCUIT TERMINAL OF TRANSMISSION LINE**

(75) Inventors: **Shyh-Jong Chung**, Hsinchu (TW);
Yu-Hsin Wang, Taichung (TW);
Yu-Chiang Cheng, Taipei (TW)

(73) Assignee: **Getac 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 664 days.

(21) Appl. No.: **12/213,606**

(22) Filed: **Jun. 23, 2008**

(65) **Prior Publication Data**
US 2009/0115677 A1 May 7, 2009

(30) **Foreign Application Priority Data**
Nov. 5, 2007 (TW) 96141725 A
Mar. 4, 2008 (TW) 97107521 A

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
(52) **U.S. Cl.** **343/791**; 343/895
(58) **Field of Classification Search** 343/790,
343/791, 895

See application file for complete search history.

(56) **References Cited**

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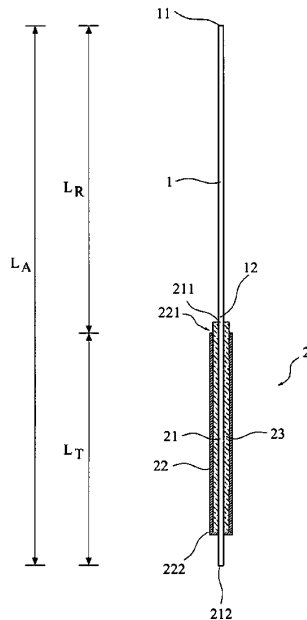
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Primary Examiner — Tan Ho

(57) **ABSTRACT**

Disclosed is a dual-band monopole antenna with antenna signal fed through a short-circuit terminal of a transmission line load. The dual-band monopole antenna includes an antenna extension section and a transmission line load. The antenna extension section has a top terminal and a transmission line connection terminal. The transmission line connection terminal is connected to the transmission line load. The transmission line load includes a core transmission line, an outer circumferential conductor, and a dielectric layer. The core transmission line has an extension section connection terminal and a signal feeding terminal. The extension section connection terminal is connected to the transmission line connection terminal of the antenna extension section. The outer circumferential conductor circumferentially surrounds and is spaced from the core transmission line by a given distance and the outer circumferential conductor has an open terminal and a short-circuit terminal.

16 Claims, 14 Drawing Sheets





US008013800B2

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

(10) **Patent No.:** **US 8,013,800 B2**
(45) **Date of Patent:** **Sep. 6, 2011**

(54) **MULTIBAND CONFORMED FOLDED
DIPOLE ANTENNA**

(56) **References Cited**

(75) Inventors: **Tianji Zheng**, Coral Springs, FL (US);
Julio Castaneda, Coral Springs, FL
(US)

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(73) Assignee: **Motorola Mobility, Inc.**, Libertyville, IL
(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 308 days.

JP	2007-142799	6/2007
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Primary Examiner — Tan Ho

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

(21) Appl. No.: **12/465,460**

(57) **ABSTRACT**

(22) Filed: **May 13, 2009**

A multiband conformed-slotted-folded dipole antenna (200) having a unitary conformed shape conductor conforming to an internal communication device configuration (400). The antenna can include a folded dipole (203, 205, 209, 206, 204) forming a part of the unitary conformed shape and having a first portion (212 or 213) forming at least one slot in a slotted plane (220) and a second portion (210 or 211) forming at least one slot in a second plane (230) substantially perpendicular to the slotted plane. The at least one slot in the second plane controls high band antenna resonance and a length (209) of a metal portion in the slotted plane controls lower band resonance. Additional embodiments are disclosed.

(65) **Prior Publication Data**

US 2010/0289712 A1 Nov. 18, 2010

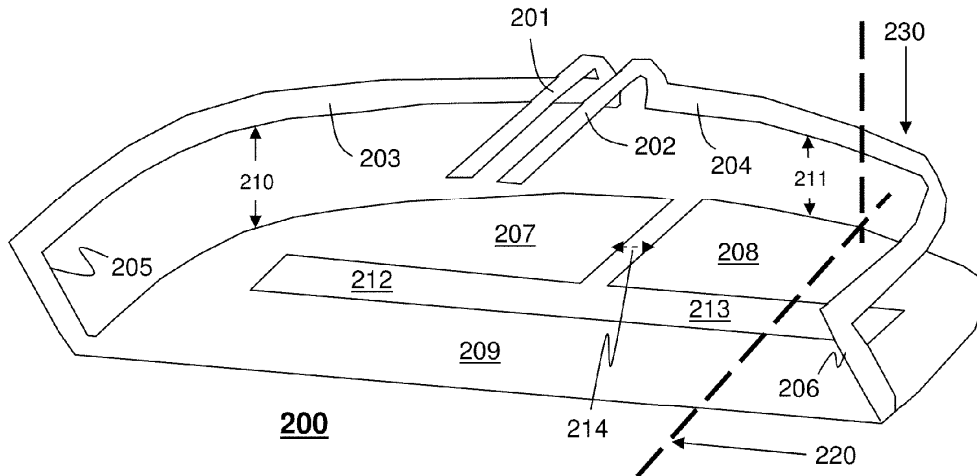
(51) **Int. Cl.**
H01Q 9/26 (2006.01)

(52) **U.S. Cl.** 343/803; 343/702; 343/770

(58) **Field of Classification Search** 343/702,
343/803, 770, 741, 846, 767

See application file for complete search history.

20 Claims, 2 Drawing Sheets





US008018343B2

(12) **United States Patent**
Tang

(10) **Patent No.:** **US 8,018,343 B2**
(45) **Date of Patent:** ***Sep. 13, 2011**

(54) **IC PACKAGE ANTENNA**

(75) Inventor: **Chia-Lun Tang**, 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 455 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/285,388**

(22) Filed: **Oct. 3, 2008**

(65) **Prior Publication Data**

US 2009/0295675 A1 Dec. 3, 2009

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/127,041, filed on May 27, 2008, now Pat. No. 7,595,731.

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

(52) **U.S. Cl.** **340/572.1; 340/572.5; 343/700 MS**

(58) **Field of Classification Search** **343/700 MS, 343/872, 873; 340/572.1, 572.5**

See application file for complete search history.

(56) **References Cited**

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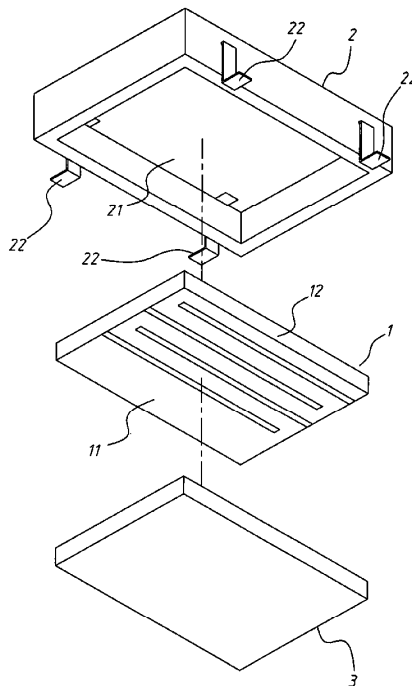
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An IC package antenna of which a metal radiating member is firstly provided on a board to form an antenna base board; the board is formed thereon at least a feed point; and the IC package antenna is packaged with an IC packaging housing and a packaging bottom portion to form an IC chip. The IC packaging housing has a plurality of connecting pins extending outward from inside of itself; wherein the inner end of at least one connecting pin is soldering connected with a feed point of the base board of the antenna. Such an IC package antenna can allow standardized and miniaturized antenna designing, and is applicable to Surface Mount Technology (SMT).

13 Claims, 7 Drawing Sheets





US008018381B2

(12) **United States Patent**
Mori

(10) **Patent No.:** **US 8,018,381 B2**
(45) **Date of Patent:** **Sep. 13, 2011**

- (54) **ANTENNA APPARATUS**
- (75) Inventor: **Nobuyuki Mori**, Tokyo (JP)
- (73) Assignee: **Sony Corporation** (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 301 days.

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- (21) Appl. No.: **12/288,040**
- (22) Filed: **Oct. 16, 2008**
- (65) **Prior Publication Data**
US 2009/0109092 A1 Apr. 30, 2009

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- (30) **Foreign Application Priority Data**
Oct. 25, 2007 (JP) P2007-278099

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- (51) **Int. Cl.**
H01Q 3/02 (2006.01)
H01Q 3/12 (2006.01)
- (52) **U.S. Cl.** **342/374**
- (58) **Field of Classification Search** **342/374**
See application file for complete search history.

Primary Examiner — Thomas H Tarca

Assistant Examiner — Frank McGue

(74) *Attorney, Agent, or Firm* — Lerner, David, Littenberg, Krumholz & Mentlik, LLP

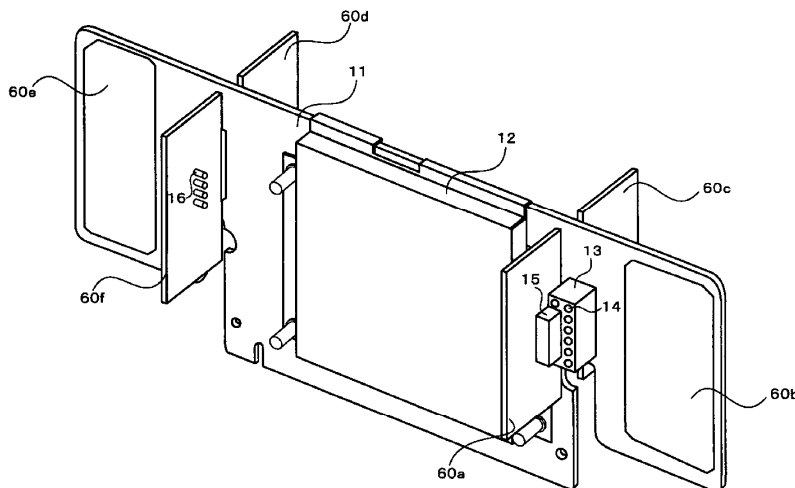
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(57) **ABSTRACT**

An antenna apparatus is disclosed. The antenna apparatus has a first antenna, a second antenna, and a third antenna which have different directivity directions each other and are switched for a desired directivity direction. The first antenna is disposed on a substrate which is in parallel therewith. The second antenna is disposed on one principal surface of the substrate which is nearly perpendicular thereto. The third antenna is disposed on the other principal surface of the substrate which is nearly perpendicular thereto.

4 Claims, 11 Drawing Sheets





US008018385B2

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

(10) **Patent No.:** **US 8,018,385 B2**
(45) **Date of Patent:** ***Sep. 13, 2011**

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

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

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

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

(73) Assignee: **Motorola Mobility, Inc.**, Libertyville, IL (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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/749,683**

(22) Filed: **Mar. 30, 2010**

(65) **Prior Publication Data**

US 2010/0182208 A1 Jul. 22, 2010

Related U.S. Application Data

(63) Continuation of application No. 12/169,049, filed on Jul. 8, 2008, now Pat. No. 7,705,792, which is a continuation of application No. 11/769,825, filed on Jun. 28, 2007, now Pat. No. 7,403,165, which is a continuation of application No. 11/422,170, filed on Jun. 5, 2006, now Pat. No. 7,256,744, which is a continuation of application No. 11/042,890, filed on Jan. 25, 2005, now Pat. No. 7,091,911.

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

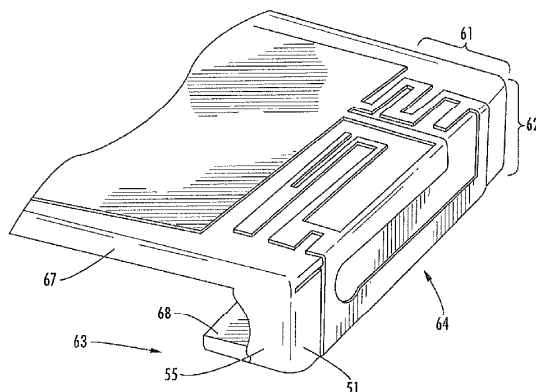
(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)

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

(57) **ABSTRACT**

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

18 Claims, 11 Drawing Sheets





US008018386B2

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

(10) **Patent No.:** **US 8,018,386 B2**
(45) **Date of Patent:** **Sep. 13, 2011**

(54) **MULTIPLE-ELEMENT ANTENNA WITH
FLOATING ANTENNA ELEMENT**

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

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

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

(21) Appl. No.: **12/138,704**

(22) Filed: **Jun. 13, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 11/590,200, filed on
Oct. 31, 2006, now Pat. No. 7,400,300, which is a
continuation of application No. 10/864,145, filed on
Jun. 9, 2004, now Pat. No. 7,148,846.

(30) **Foreign Application Priority Data**

Jun. 12, 2003 (EP) 03253713

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 19/10 (2006.01)
H01Q 19/00 (2006.01)

(52) **U.S. Cl.** **343/702; 343/818; 343/833**

(58) **Field of Classification Search** **343/702,**
343/795, 815, 817, 818, 834, 833
See application file for complete search history.

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Primary Examiner — Douglas W Owens

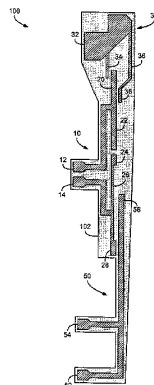
Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — Jones Day

(57) **ABSTRACT**

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

21 Claims, 10 Drawing Sheets





US008018388B2

(12) **United States Patent**
Kyowski

(10) **Patent No.:** **US 8,018,388 B2**
(45) **Date of Patent:** ***Sep. 13, 2011**

- (54) **LOW PROFILE ANTENNA INSERT NUT**
- (75) Inventor: **Timothy H. Kyowski**, Brantford (CA)
- (73) Assignee: **Research In Motion Limited**, Waterloo (CA)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 188 days.

This patent is subject to a terminal disclaimer.
- (21) Appl. No.: **12/420,537**
- (22) Filed: **Apr. 8, 2009**

(65) **Prior Publication Data**

US 2009/0195476 A1 Aug. 6, 2009

Related U.S. Application Data

- (63) Continuation of application No. 12/142,478, filed on Jun. 19, 2008, now Pat. No. 7,525,495, which is a continuation of application No. 11/671,211, filed on Feb. 5, 2007, now Pat. No. 7,403,163, which is a continuation of application No. 11/107,974, filed on Apr. 18, 2005, now Pat. No. 7,190,314, which is a continuation of application No. 10/723,839, filed on Nov. 26, 2003, now abandoned.
- (60) Provisional application No. 60/430,078, filed on Dec. 2, 2002.
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/50 (2006.01)
- (52) **U.S. Cl.** **343/702**; 343/906; 439/916
- (58) **Field of Classification Search** 343/702, 343/715, 906, 878; 439/916

See application file for complete search history.

(56) **References Cited**

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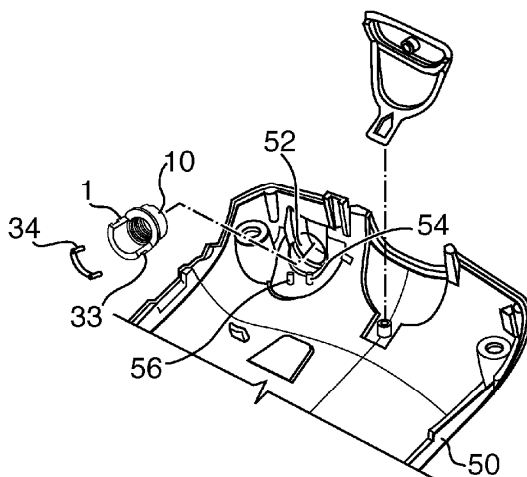
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

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

18 Claims, 2 Drawing Sheets





US008018391B2

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

(10) **Patent No.:** **US 8,018,391 B2**
(45) **Date of Patent:** **Sep. 13, 2011**

(54) **PLATE-SHAPED ANTENNA HAVING AT LEAST THREE PLANES**

(75) Inventors: **Atsushi Kaneko**, Saitama (JP); **Shuji Hagiwara**, Saitama (JP)

(73) Assignee: **Yagi Antenna Inc.**, Saitama (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.: **12/637,035**

(22) Filed: **Dec. 14, 2009**

(65) **Prior Publication Data**

US 2010/0090919 A1 Apr. 15, 2010

Related U.S. Application Data

(62) Division of application No. 11/994,190, filed as application No. PCT/JP2006/305160 on Mar. 15, 2006.

(30) **Foreign Application Priority Data**

Jun. 30, 2005 (JP) P.2005-192060
Jul. 5, 2005 (JP) P.2005-196436
Sep. 26, 2005 (JP) P.2005-277923

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

(52) **U.S. Cl.** **343/770**

(58) **Field of Classification Search** **343/803, 343/793, 872, 770-772**

See application file for complete search history.

(56) **References Cited**

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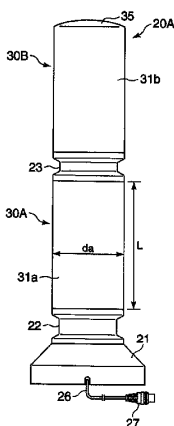
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

A plate-shaped radiating element of a shape having at least three planes is formed by bending a metal plate having a substantially rectangular shape. A first slit is provided from a lower edge of the plate-shaped radiating element up to a portion in the vicinity of an upper edge of the plate-shaped radiating element while passing through a center point of the plate-shaped radiating element, and forms plate-shaped dipole elements on both sides thereof. A second slit is provided parallel to the upper edge of the plate-shaped radiating element and forms a folded element on an upper side thereof. Feeding points are provided on both sides of the first slit at the lower edge of the plate-shaped radiating element.

6 Claims, 21 Drawing Sheets





US008018396B2

(12) **United States Patent**
Yu

(10) **Patent No.:** **US 8,018,396 B2**
(45) **Date of Patent:** **Sep. 13, 2011**

(54) **DUAL-RESONANCE RETRACTABLE ANTENNA**

(75) Inventor: **Yao-Wen Yu, Pa-Te (TW)**

(73) Assignee: **Auden Techno Corp., Pa-Te, 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 420 days.

(21) Appl. No.: **12/222,821**

(22) Filed: **Aug. 18, 2008**

(65) **Prior Publication Data**
US 2010/0039349 A1 Feb. 18, 2010

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

(52) **U.S. Cl.** **343/901**; 343/715

(58) **Field of Classification Search** 343/714, 343/715, 718, 745, 750, 789, 790, 808, 812, 343/813, 823, 841, 861, 863, 883, 888, 889, 343/900, 901

See application file for complete search history.

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Primary Examiner — Douglas W Owens

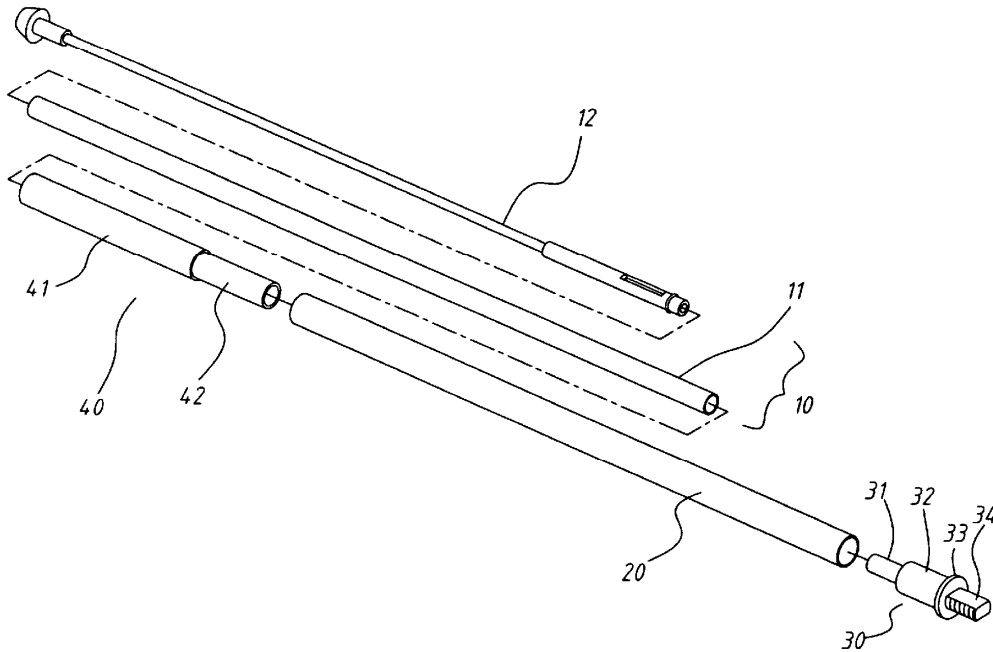
Assistant Examiner — Jae Kim

(74) *Attorney, Agent, or Firm* — Guice Patents PLLC

(57) **ABSTRACT**

A dual-resonance retractable antenna including a connector, a telescopic radiating device mounted on the connector, and a radiating tube mounted on the connector around the tubular outer radiating element of the telescopic radiating device and electrically isolated from the telescopic radiating device. The telescopic radiating device is movable between an extended position and a retracted position, the dual-resonance retractable antenna can oscillate at two different resonance frequencies, having multi-band multi-system capabilities for multiplex application.

5 Claims, 6 Drawing Sheets





US008018397B2

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

(10) **Patent No.:** **US 8,018,397 B2**
(45) **Date of Patent:** ***Sep. 13, 2011**

(54) **HIGH DIELECTRIC ANTENNA SUBSTRATE AND ANTENNA THEREOF**

(75) Inventors: **Uei-Ming Jow**, Hsinchu (TW);
Chang-Sheng Chen, Hsinchu (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 460 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/234,427**

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

(65) **Prior Publication Data**
US 2009/0015488 A1 Jan. 15, 2009

Related U.S. Application Data
(63) Continuation-in-part of application No. 11/555,107, filed on Oct. 31, 2006, now Pat. No. 7,446,711.

(30) **Foreign Application Priority Data**
Dec. 30, 2005 (TW) 94147751 A

(51) **Int. Cl.**
H01Q 15/02 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/911 R**; 343/700 MS

(58) **Field of Classification Search** 343/700 MS,
343/911 R, 702, 846
See application file for complete search history.

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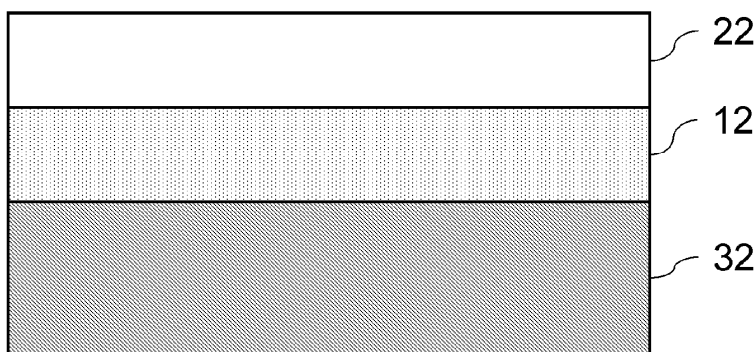
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Workman Nydegger

(57) **ABSTRACT**

A high dielectric antenna substrate includes a first dielectric layer having a first dielectric constant, and a second dielectric layer having a second dielectric constant. The second dielectric layer is formed on one surface of the first dielectric layer. The second dielectric constant is lower than the first dielectric constant. Furthermore, a first metal layer and a second metal layer are optionally formed on the same surface or two surfaces of the first dielectric layer to compose a capacitor.

27 Claims, 14 Drawing Sheets





US008022879B2

(12) **United States Patent**
Ikeyama

(10) **Patent No.:** **US 8,022,879 B2**
(45) **Date of Patent:** **Sep. 20, 2011**

(54) **ANTENNA STRUCTURE FOR WIRELESS COMMUNICATION DEVICE**

(75) Inventor: **Masahiro Ikeyama, Aichi (JP)**

(73) Assignee: **Kabushiki Kaisha Tokai Rika Denki Seisakusho, Aichi (JP)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 587 days.

(21) Appl. No.: **12/120,168**

(22) Filed: **May 13, 2008**

(65) **Prior Publication Data**
US 2008/0284659 A1 Nov. 20, 2008

(30) **Foreign Application Priority Data**
May 18, 2007 (JP) 2007-133259

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS**: 343/866; 343/895; 343/711; 343/718

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

(56) **References Cited**
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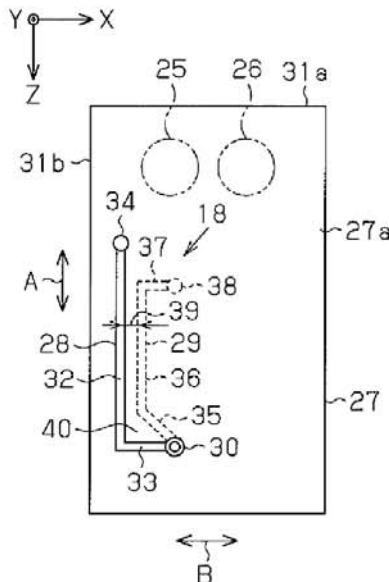
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Primary Examiner — Trinh V Dinh
(74) *Attorney, Agent, or Firm* — Patterson Thunete Christensen Pedersen, P.A.

(57) **ABSTRACT**

An antenna structure for a wireless communication device including a substrate having a first surface that supports an electronic component and a second surface opposite to the first surface. The antenna structure includes a first surface pattern formed on the first surface of the substrate. A second surface pattern is formed on the second surface of the substrate. The second surface pattern is at least partially separated from the first surface pattern in a direction perpendicular to a thicknesswise direction of the substrate.

13 Claims, 4 Drawing Sheets





US008022881B2

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

(10) **Patent No.:** **US 8,022,881 B2**
(45) **Date of Patent:** **Sep. 20, 2011**

(54) **MULTIBAND ANTENNA**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Cheng-Tse Lee, Taipei Hsien (TW)

(73) Assignee: **Acer Inc.**, 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 378 days.

(21) Appl. No.: **12/403,462**

(22) Filed: **Mar. 13, 2009**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Dec. 12, 2008 (TW) 97148561 A

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

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

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

(56) **References Cited**

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2009/0174604	A1 *	7/2009	Keskitalo et al.	343/700 MS

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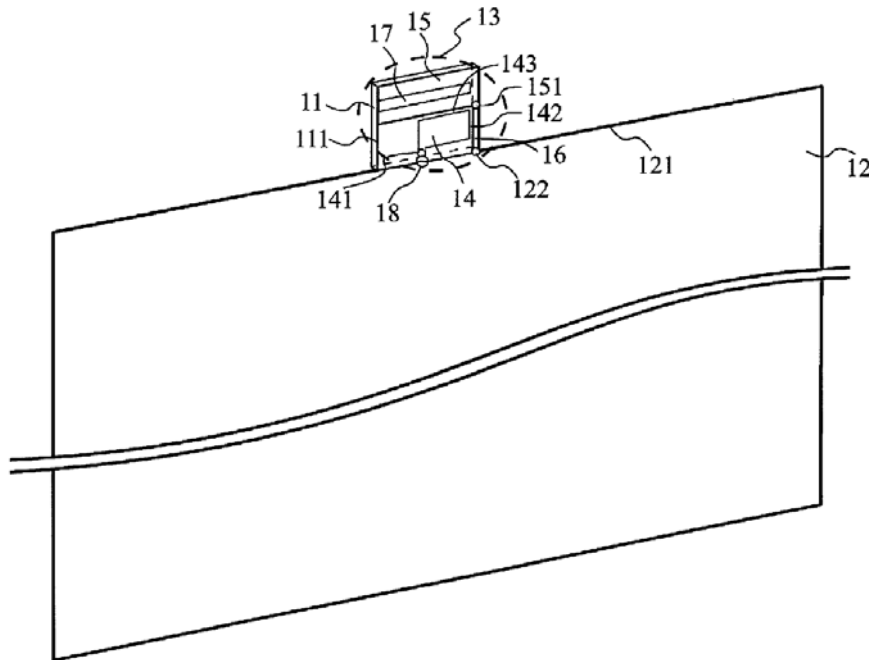
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Alan Kamrath; Kamrath & Associates PA

(57) **ABSTRACT**

A multiband antenna comprises a ground plane, a substrate, and a radiating metal element, wherein a side of the substrate is substantially adjacent to a side of the ground plane; the radiating metal element is on a surface of the substrate. The radiating metal element comprises a radiating portion having a slit, a shorting portion having a first end electrically connected to the radiating portion and a second end electrically connected to the ground plane, and a feeding portion; the feeding portion comprises an antenna feeding point for electrically connecting to a signal source, wherein a first spacing is formed between the feeding portion and the radiating portion, and a second spacing is formed between the feeding portion and the shorting portion.

18 Claims, 6 Drawing Sheets





US008022882B2

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

(10) **Patent No.:** **US 8,022,882 B2**
(45) **Date of Patent:** **Sep. 20, 2011**

(54) **ANTENNA DEVICE FOR WIRELESS WIDE AREA NETWORK (WWAN) AND WIRELESS LOCAL AREA NETWORK (WLAN)**

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

(75) **Inventors:** **Tiao-Hsing Tsai**, Tao Yuan Shien (TW); **Chih-Wei Liao**, Tao Yuan Shien (TW); **Chao-Hsu Wu**, Tao Yuan Shien (TW)

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

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

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

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 379 days.

(21) **Appl. No.:** **12/423,045**

(22) **Filed:** **Apr. 14, 2009**

(65) **Prior Publication Data**
US 2010/0149043 A1 Jun. 17, 2010

(30) **Foreign Application Priority Data**
Dec. 15, 2008 (TW) 97148751 A

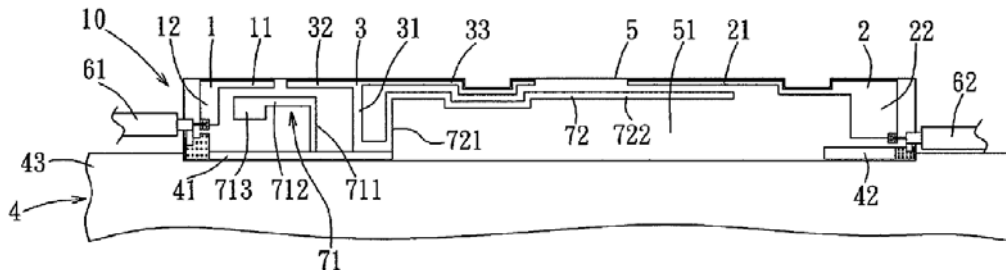
(51) **Int. Cl.**
H01Q 1/38 (2006.01)

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

(57) **ABSTRACT**

An antenna device includes a grounding element, a radiating element, and first and second feeding elements. The radiating element includes a first segment that extends from the grounding element and that has an end distal from the grounding element, and second and third segments that extend from the end of the first segment in opposite directions. Each of the first and second feeding elements includes first and second segments. The first segment of each of the first and second feeding elements is disposed proximate to a respective one of the second and third segments of the radiating element. The second segment of each of the first and second feeding elements is disposed proximate to the grounding element.

14 Claims, 10 Drawing Sheets





US008022887B1

(12) **United States Patent**
Zarnaghi

(10) **Patent No.:** **US 8,022,887 B1**
(45) **Date of Patent:** **Sep. 20, 2011**

(54) **PLANAR ANTENNA**

(75) Inventor: **Rokhsareh Zarnaghi**, Santa Clara, CA (US)

(73) Assignee: **Sibeam, Inc.**, Sunnyvale, CA (US)

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

(21) Appl. No.: **11/588,472**

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

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

(52) **U.S. Cl.** **343/846**; 343/700 MS; 343/833; 343/803

(58) **Field of Classification Search** 343/803, 343/833, 859, 700 MS, 846-849, 810-821
See application file for complete search history.

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Primary Examiner — Jacob Y Choi

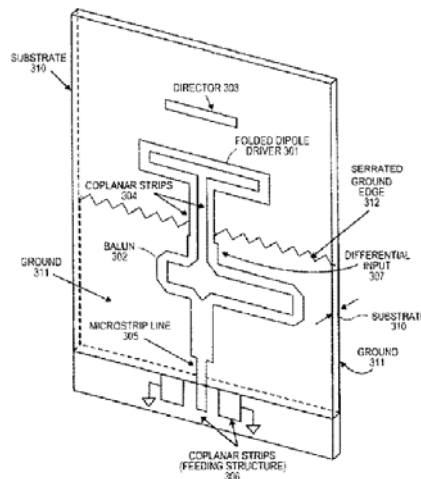
Assistant Examiner — Robert Karacsony

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

(57) **ABSTRACT**

An antenna is disclosed. In one embodiment, the antenna comprises a driver comprising a folded dipole and an integral balun coupled to the folded dipole.

18 Claims, 10 Drawing Sheets





US008022888B2

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

(10) **Patent No.:** **US 8,022,888 B2**
(45) **Date of Patent:** **Sep. 20, 2011**

(54) **ANTENNA DEVICE**
(75) Inventors: **Ju Hyung Kim**, Seoul (KR); **Tae Wook Lim**, Gyeonggi-Do (KR); **Seung Mo Park**, Gyeonggi-Do (KR); **Tae Sung Kim**, Seoul (KR); **Jae Suk Sung**, Gyeonggi-Do (KR)

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(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, Gyeonggi-do (KR)

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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 318 days.

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(21) Appl. No.: **12/332,280**

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(22) Filed: **Dec. 10, 2008**

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(65) **Prior Publication Data**
US 2009/0224996 A1 Sep. 10, 2009

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(30) **Foreign Application Priority Data**
Mar. 4, 2008 (KR) 10-2008-0020014

Primary Examiner — Huedung Mancuso

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
(52) **U.S. Cl.** **343/860**
(58) **Field of Classification Search** **343/860,**
343/749, 700 MS, 702
See application file for complete search history.

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

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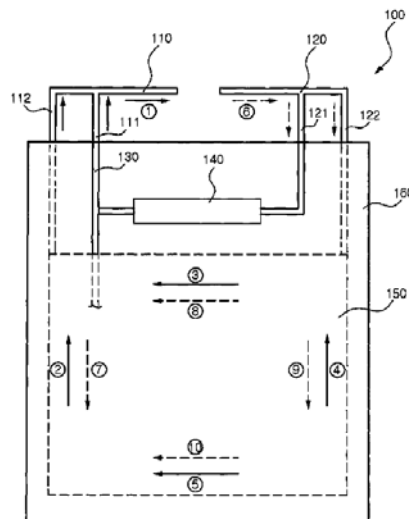
(57) ABSTRACT

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6,903,687	B1 *	6/2005	Fink et al.	343/700 MS
7,164,387	B2 *	1/2007	Sievenpiper	343/702

An antenna device includes a first radiator receiving a first feed signal, a second radiator spaced apart from the first radiator at a predetermined distance and capacitively coupled with the first radiator, a feed line connected to a feed terminal of the first radiator, and a phase shifter diverging from the feed line, connected to a feed terminal of the second radiator, and supplying a second feed signal having a predetermined phase difference with the first feed signal to the second radiator.

13 Claims, 3 Drawing Sheets





US008023890B2

(12) **United States Patent**
Washiro

(10) **Patent No.:** **US 8,023,890 B2**
(45) **Date of Patent:** **Sep. 20, 2011**

(54) **COMMUNICATION SYSTEM,
COMMUNICATION APPARATUS, AND
ELECTRIC-FIELD-COUPLING ANTENNA**

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2004/0266332 A1 12/2004 Lang

(75) Inventor: **Takanori Washiro**, Kanagawa (JP)

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

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JP 2002-253955 9/2002

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1071 days.

(21) Appl. No.: **11/838,544**

(22) Filed: **Aug. 14, 2007**

(Continued)

(65) **Prior Publication Data**

US 2008/0076351 A1 Mar. 27, 2008

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(30) **Foreign Application Priority Data**

Sep. 11, 2006 (JP) 2006-245614
Jun. 6, 2007 (JP) 2007-150500

(Continued)

Primary Examiner — Tuan A Tran
(74) *Attorney, Agent, or Firm* — Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.

(51) **Int. Cl.**
H04B 5/00 (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.** 455/41.1; 343/745; 343/750; 343/790;
343/791; 343/850; 343/853; 343/857; 343/858;
343/860

A communication system includes the following elements: a transmitter including a transmission circuit unit configured to generate an RF signal for transmitting data and an EFC antenna configured to transmit the RF signal as an electrostatic field or an induced electric field; a receiver including an EFC antenna and a reception circuit unit configured to receive and process the RF signal received by the EFC antenna; and an impedance snatching unit configured to make an impedance of the EFC antenna of the transmitter equal to an impedance of the EFC antenna of the receiver. The RF signal is transmitted by electric-field coupling between the EFC antennas, facing each other, of the transmitter and the receiver.

(58) **Field of Classification Search** 455/41.1;
343/745, 747, 750, 790-792, 850, 853, 857,
343/858, 860

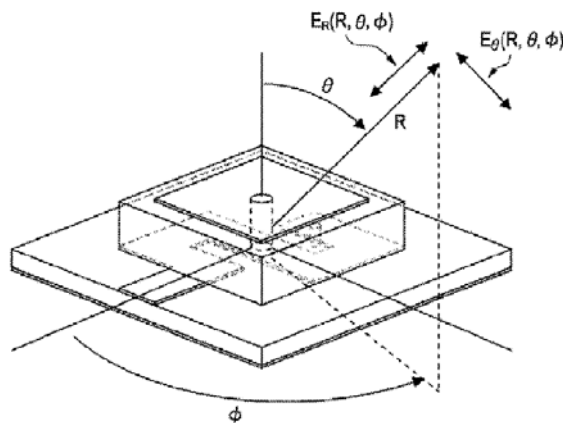
See application file for complete search history.

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25 Claims, 17 Drawing Sheets





US008026851B2

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

(10) **Patent No.:** **US 8,026,851 B2**
(45) **Date of Patent:** **Sep. 27, 2011**

(54) **PLANAR ANTENNA AND MANUFACTURING METHOD THEREOF**

7,102,520 B2* 9/2006 Liu et al. 340/572.1

(75) Inventors: **Kiyohiko Itoh**, Kameyama (JP);
Kentaro Mori, Kusatsu (JP)

(73) Assignee: **Toray Industries, Inc.**, Chou-Ku (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 589 days.

(21) Appl. No.: **11/909,570**

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

(86) PCT No.: **PCT/JP2006/305643**

§ 371 (c)(1),
(2), (4) Date: **Dec. 15, 2008**

(87) PCT Pub. No.: **WO2006/103981**

PCT Pub. Date: **Oct. 5, 2006**

(65) **Prior Publication Data**

US 2009/0219212 A1 Sep. 3, 2009

(30) **Foreign Application Priority Data**

Mar. 25, 2005 (JP) 2005-087897

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

(52) **U.S. Cl.** **343/700 MS**; 29/600

(58) **Field of Classification Search** 343/700 MS,
343/873, 895; 340/572.1, 572.7, 572.8; 29/600
See application file for complete search history.

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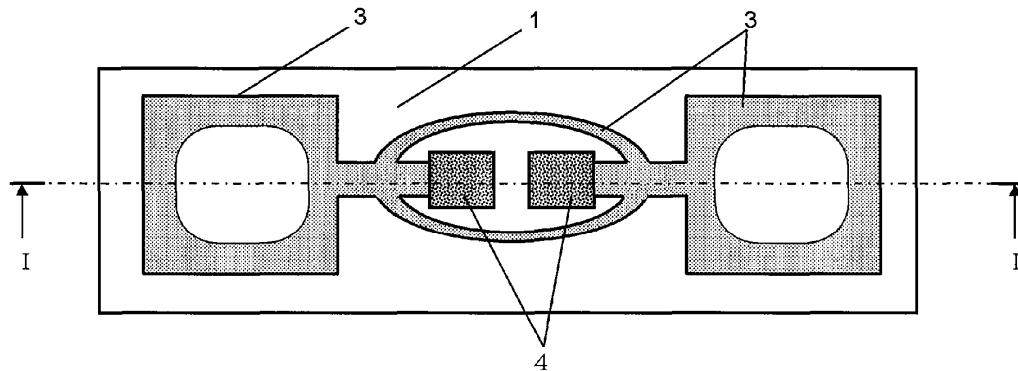
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — RatnerPrestia

(57) **ABSTRACT**

A planar antenna has a circuit pattern including an antenna part and a connection terminal part on a plastic film, in which the circuit pattern has a metal layer and a heat-sealable conductive layer provided on a surface layer of a connection terminal part of the metal layer. The planar antenna is obtained by forming a circuit pattern including a metal layer on a plastic film, providing a heat-sealable conductive layer in a connection terminal part of the circuit pattern, and then removing an unnecessary part with etching.

13 Claims, 1 Drawing Sheet





US008026853B2

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

(10) **Patent No.:** **US 8,026,853 B2**
(45) **Date of Patent:** ***Sep. 27, 2011**

(54) **BROADSIDE HIGH-DIRECTIVITY MICROSTRIP PATCH ANTENNAS**
(75) Inventors: **Carles Puente Baliarda**, Barcelona (ES); **Jaume Anguera Pros**, Vinarós (ES); **Carmen Borja Borau**, Barcelona (ES)

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(73) Assignee: **Fractus, S.A.**, Barcelona (ES)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 116 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/204,492**

(22) Filed: **Sep. 4, 2008**

(65) **Prior Publication Data**

US 2009/0046015 A1 Feb. 19, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/186,538, filed on Jul. 21, 2005, now Pat. No. 7,423,593, which is a continuation of application No. PCT/EP03/00757, filed on Jan. 24, 2003.

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/833, 834

See application file for complete search history.

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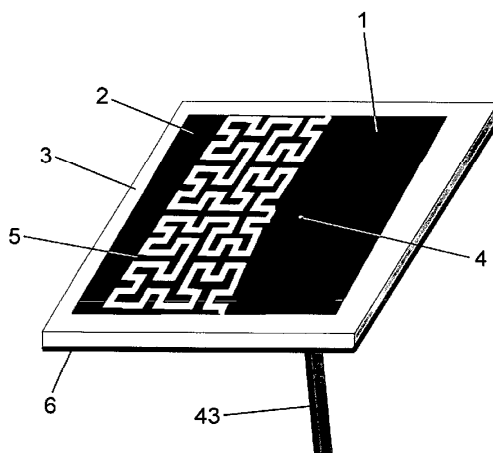
Primary Examiner — Michael C Wimer

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

(57) **ABSTRACT**

High-directivity microstrip antennas comprising a driven patch and at least one parasitic element placed on the same plane, operate at a frequency larger than the fundamental mode of the driven patch in order to obtain a resonant frequency with a high-directivity broadside radiation pattern. The driven patch, the parasitic elements and the gaps between them may be shaped as multilevel and/or Space Filling geometries. The gap defined between the driven and parasitic patches according to the invention is used to control the resonant frequency where the high-directivity behavior is obtained. The invention provides that with one single element it is possible to obtain the same directivity than an array of microstrip antennas operating at the fundamental mode.

20 Claims, 10 Drawing Sheets





US008026855B2

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

(10) **Patent No.:** **US 8,026,855 B2**
(45) **Date of Patent:** **Sep. 27, 2011**

(54) **RADIO APPARATUS AND ANTENNA THEREOF**

(75) Inventors: **Masao Sakuma**, Yokohama (JP);
Norikazu Ebisawa, Yokohama (JP)

(73) Assignee: **Fujitsu Semiconductor Limited**,
Yokohama (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 383 days.

(21) Appl. No.: **12/198,271**

(22) Filed: **Aug. 26, 2008**

(65) **Prior Publication Data**

US 2009/0058738 A1 Mar. 5, 2009

(30) **Foreign Application Priority Data**

Aug. 31, 2007 (JP) 2007-226327

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

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

(58) **Field of Classification Search** 333/133-134;
343/702, 700 MS, 741-742

See application file for complete search history.

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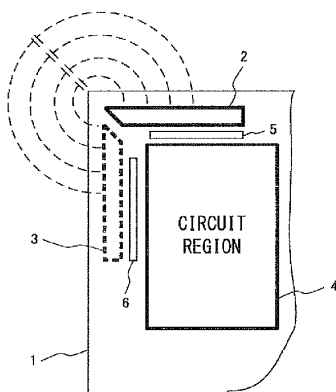
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

A feed element and a parasitic element are formed on the ends of a board. The feed element is formed on the surface of the board, and the parasitic element is formed on the back of the board. A circuit region of the board is mounted with a radio communication circuit. The feed element is connected with a signal line, and the parasitic element is connected with a GND line. A slit is provided between the feed element and the circuit region, and a slit is provided between the parasitic element and the circuit element.

9 Claims, 15 Drawing Sheets





US008026856B2

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

(10) **Patent No.:** **US 8,026,856 B2**
(45) **Date of Patent:** **Sep. 27, 2011**

(54) **ANTENNA AND WIRELESS COMMUNICATION DEVICE USING SAME**

(75) Inventors: **Chih-Yuan Yang**, Taipei Hsien (TW);
Po-Wei Kuo, Taipei Hsien (TW);
Suo-Bing Su, Taipei Hsien (TW)

(73) Assignee: **Hon Hai Precision Industry Co., Ltd.**,
Tu-Cheng, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 331 days.

(21) Appl. No.: **12/489,411**

(22) Filed: **Jun. 22, 2009**

(65) **Prior Publication Data**

US 2010/0026594 A1 Feb. 4, 2010

(30) **Foreign Application Priority Data**

Aug. 4, 2008 (CN) 2008 1 0303370

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

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

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

See application file for complete search history.

(56) **References Cited**

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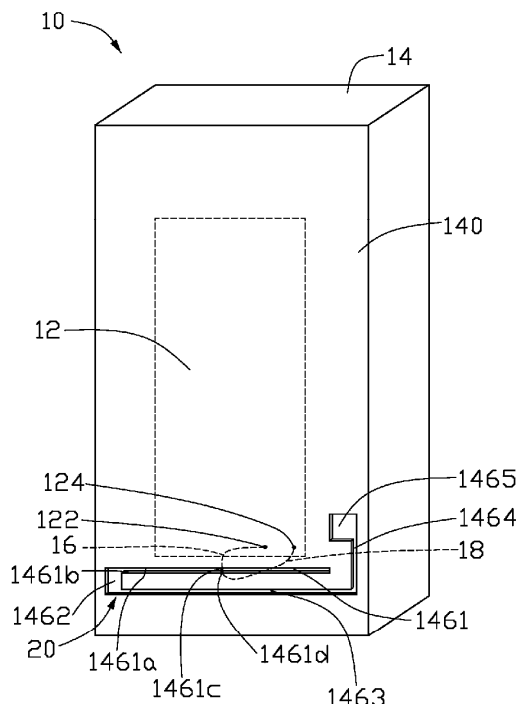
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

An antenna includes a metallic sheet defining a first slot, a second slot, a third slot parallel to the first slot, a fourth slot parallel to the second slot, and a fifth slot parallel to the third slot. The second slot perpendicularly connects the first slot to the third slot and has a length smaller than that of the fourth slot. The third slot has a length greater than that of the first slot. The fourth slot extends perpendicularly from a side of the third slot away from the second slot. The fifth slot extends perpendicularly from an end of the fourth slot away from the third slot. The metallic sheet includes a first longitudinal side and a second longitudinal side opposite to the first longitudinal side. A feeding point is formed on the first longitudinal side and a grounding point is formed on the second longitudinal side.

13 Claims, 4 Drawing Sheets





US008026860B2

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

(10) **Patent No.:** **US 8,026,860 B2**
(45) **Date of Patent:** **Sep. 27, 2011**

(54) **ELECTRICALLY SMALL ANTENNA DEVICES, SYSTEMS, APPARATUS, AND METHODS**

(75) Inventors: **Paul E. Mayes**, Champaign, IL (US); **Paul W. Klock**, Urbana, IL (US); **Suhail Barot**, Urbana, IL (US)

(73) Assignee: **The Board of Trustees of the University of Illinois**, Urbana, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 475 days.

(21) Appl. No.: **12/284,161**

(22) Filed: **Sep. 18, 2008**

(65) **Prior Publication Data**
US 2009/0146893 A1 Jun. 11, 2009

Related U.S. Application Data
(60) Provisional application No. 60/994,171, filed on Sep. 18, 2007, provisional application No. 61/192,277, filed on Sep. 17, 2008.

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
(52) **U.S. Cl.** **343/810; 343/797; 343/798; 343/799; 343/800; 343/815; 343/816; 343/812; 343/813; 343/814**
(58) **Field of Classification Search** None
See application file for complete search history.

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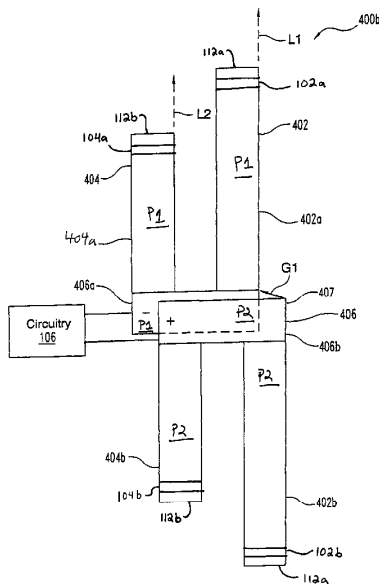
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Krieg DeVault LLP; L. Scott Paynter

(57) **ABSTRACT**

The utilization of small antennas for mobile devices and for low frequency (long wavelength) applications is desired. Further, efficient use of transmission power is desirable, especially in mobile applications. For this purpose, a system is provided that includes one or more of: a multiple-resonator transmitter/receiver, a high bandwidth electrically small antenna, a resonator with a variable feed location, a resonator with a variable reactive component load, and a method for estimating a resonator system response to a component configuration and selected excitation.

27 Claims, 18 Drawing Sheets





US00RE42672E

(19) **United States**
(12) **Reissued Patent**
Stutzman et al.

(10) **Patent Number:** **US RE42,672 E**
(45) **Date of Reissued Patent:** **Sep. 6, 2011**

(54) **WIDEBAND COMPACT PLANAR
INVERTED-F ANTENNA**

(75) Inventors: **Warren L. Stutzman**, Blacksburg, VA
(US); **Minh-Chau Huynh**, Foster City,
CA (US)

(73) Assignee: **Virginia Tech Intellectual Properties,
Inc.**, Blacksburg, VA (US)

(21) Appl. No.: **11/516,804**

(22) PCT Filed: **Apr. 27, 2001**

(86) PCT No.: **PCT/US01/13603**
§ 371 (c)(1),
(2), (4) Date: **May 9, 2003**

(87) PCT Pub. No.: **WO01/82412**
PCT Pub. Date: **Nov. 1, 2001**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **6,795,028**
Issued: **Sep. 21, 2004**
Appl. No.: **10/258,534**
Filed: **May 9, 2003**

U.S. Applications:

(60) Provisional application No. 60/200,009, filed on Apr.
27, 2000.

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

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

(58) **Field of Classification Search** 343/700 MS,
343/702, 846, 829, 848
See application file for complete search history.

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* cited by examiner

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(57) **ABSTRACT**

An improved low profile antenna of the [PIPA] PIFA style is formed from a single piece of useful conductive material and includes a first plate spaced apart from an elongated ground plate. The first and ground plates are interconnected by a shorting plate having a width less than that of either the first or ground plate. A feed plate is interposed between the two plates and is either completely covered by the first plate or slightly exposed. Such antennas have extremely large bandwidth of up to about 50%.

26 Claims, 4 Drawing Sheets

