



US007265717B2

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

(10) **Patent No.:** **US 7,265,717 B2**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **ULTRA-WIDEBAND ANTENNA AND
ULTRAHIGH FREQUENCY CIRCUIT
MODULE**

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(75) Inventors: **Akira Saitou**, Machida (JP); **Kazuhiko
Honjo**, Chofu (JP)

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

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(*) Notice: Subject to any disclaimer, the term of this
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Primary Examiner—Hoanganh Le

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

(21) Appl. No.: **10/971,490**

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

(65) **Prior Publication Data**

US 2005/0088344 A1 Apr. 28, 2005

(30) **Foreign Application Priority Data**

Oct. 24, 2003 (JP) 2003-365149

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 9/28 (2006.01)

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

(58) **Field of Classification Search** **343/700 MS,**
343/795, 793, 821, 822

See application file for complete search history.

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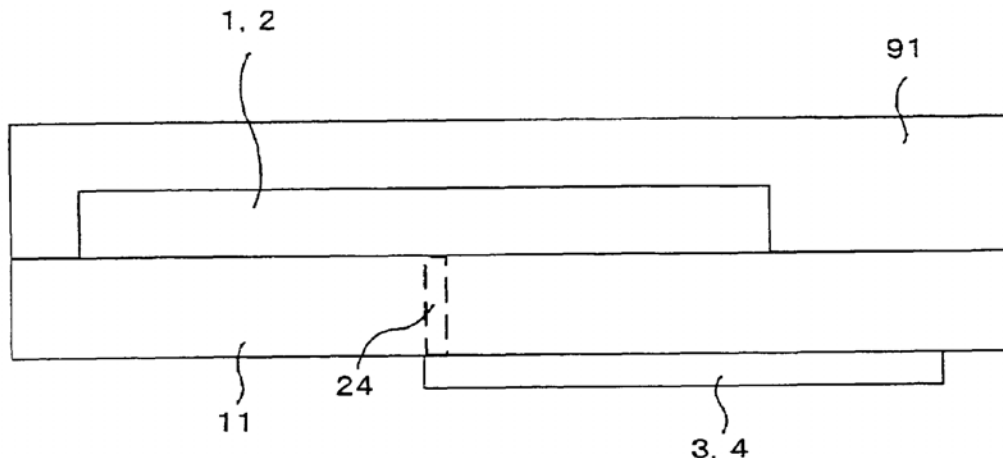
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(57) **ABSTRACT**

One of the objects of this invention is to realize an antenna
having low reflection loss over an extremely wideband. The
antenna of the present invention is provided with a dielectric
substrate, a plurality of antenna conductors formed on one
surface of the dielectric substrate that are pseudo self-
complementary on the surface, and a plurality of feed
conductors symmetrical with respect to symmetrical sur-
faces of the antenna conductors, wherein a gap for a wave-
length of $\frac{1}{10}$ or less that of the wavelength of a usage
frequency in a vacuum is provided at a center of rotational
symmetry between the plurality of antenna conductors.

7 Claims, 17 Drawing Sheets





US007265718B2

(12) **United States Patent**
Tsai

(10) **Patent No.:** **US 7,265,718 B2**
(45) **Date of Patent:** **Sep. 4, 2007**

- (54) **COMPACT MULTIPLE-FREQUENCY Z-TYPE INVERTED-F ANTENNA**
- (75) Inventor: **Feng-Chi Eddie Tsai, Taipei Hsien (TW)**
- (73) Assignee: **Wistron NeWeb Corporation, Hsi-Chih, Taipei Hsien (TW)**
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 9 days.

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(21) Appl. No.: **11/306,918**

Primary Examiner—Trinh Vo Dinh

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

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

(65) **Prior Publication Data**

US 2007/0164906 A1 Jul. 19, 2007

(57) **ABSTRACT**

- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/16 (2006.01)
- (52) **U.S. Cl.** **343/700 MS; 343/793; 343/795**
- (58) **Field of Classification Search** None
See application file for complete search history.

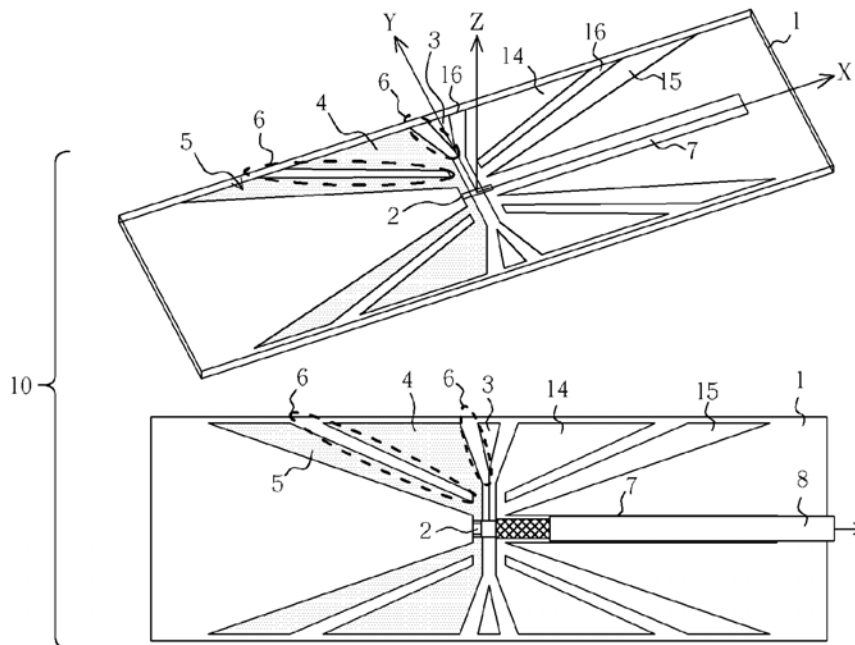
A compact multiple-frequency Z-type Inverted-F antenna includes a dielectric substrate having a horizontal axis and a vertical axis perpendicular to the horizontal axis. A feed point is disposed along the horizontal axis on a first side of the vertical axis and a ground strip is disposed along the horizontal axis on a second side of the vertical axis opposite the feed point. A plurality of wedge-shaped radiating traces is arranged symmetrically with respect to the horizontal axis and disposed on the first side of the vertical axis. A plurality of wedge-shaped ground traces symmetrical to the plurality of radiating traces with respect to the vertical axis are disposed on the second side of the vertical axis.

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3 Claims, 9 Drawing Sheets





US007265720B1

(12) **United States Patent**
Ponce De Leon et al.

(10) **Patent No.:** **US 7,265,720 B1**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **PLANAR INVERTED-F ANTENNA WITH PARASITIC CONDUCTOR LOOP AND DEVICE USING SAME**

(75) Inventors: **Lorenzo A. Ponce De Leon**, Lake Worth, FL (US); **Jacob Marvin**, Plantation, FL (US); **Naveed Mirza**, Boynton Beach, FL (US)

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

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

(21) Appl. No.: **11/618,037**

(22) Filed: **Dec. 29, 2006**

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/834; 343/846**

(58) **Field of Classification Search** **343/700 MS, 343/702, 833, 834, 846, 848**
See application file for complete search history.

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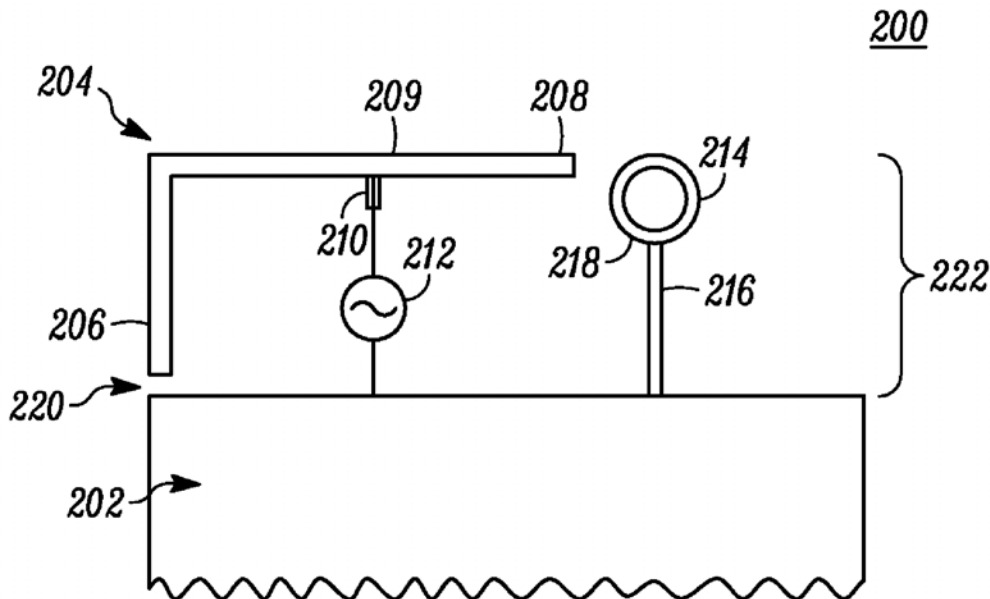
Primary Examiner—Tan Ho

(74) *Attorney, Agent, or Firm*—Scott M. Garrett

(57) **ABSTRACT**

A planar inverted-F antenna structure (204) is parasitically coupled to a conductor loop (214) at an open end (208) of the main radiator of the inverted-F antenna. The conductor loop is grounded (216).

15 Claims, 3 Drawing Sheets





US007265722B2

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

(10) **Patent No.:** **US 7,265,722 B2**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **ANTENNA STRUCTURE**

(75) Inventors: **I-Ru Liu**, Taipei (TW); **Hong-Kun Tyan**, Dasi Township, Taoyuan County (TW)

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

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

(21) Appl. No.: **11/291,971**

(22) Filed: **Dec. 2, 2005**

(65) **Prior Publication Data**

US 2006/0250307 A1 Nov. 9, 2006

(30) **Foreign Application Priority Data**

May 5, 2005 (TW) 94114548 A

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

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

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

See application file for complete search history.

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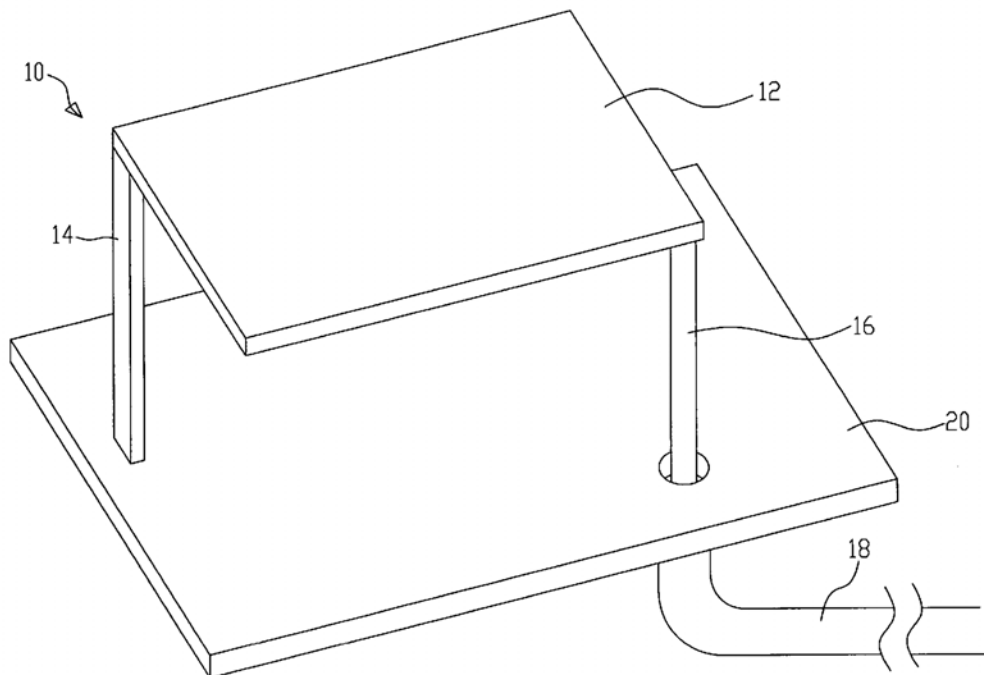
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Primary Examiner—Hoang V. Nguyen
(74) *Attorney, Agent, or Firm*—Rosenberg, Klein & Lee

(57) **ABSTRACT**

An antenna structure is proposed in the present invention. It includes a radiative element having at least two ends. One end of the radiative element has a grounding element connected to a ground plane. Another end of the radiative element has a feed element connected to a transmission line. The feed element is disposed diagonally relative to the grounding element. In this way, the present invention increases the bandwidth of the antenna and improves its functionality. Therefore, the antenna of the present invention is more convenient when in use.

13 Claims, 7 Drawing Sheets





US007265724B1

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

(10) **Patent No.:** **US 7,265,724 B1**
(45) **Date of Patent:** **Sep. 4, 2007**

- (54) **COMMUNICATIONS ASSEMBLY AND ANTENNA ASSEMBLY WITH A SWITCHED TUNING LINE**
- (75) Inventors: **Yu Chee Tan**, Singapore (SG); **Guan Hong Ng**, Singapore (SG); **Kok Kiong Tang**, Singapore (SG); **Yew Siow Tay**, Singapore (SG)
- (73) Assignee: **Motorola Inc.**, Schaumburg, IL (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.
- (21) Appl. No.: **11/391,042**
- (22) Filed: **Mar. 28, 2006**
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702; 343/700 MS**
- (58) **Field of Classification Search** **343/702, 343/700 MS, 846, 848**
See application file for complete search history.
- (56) **References Cited**

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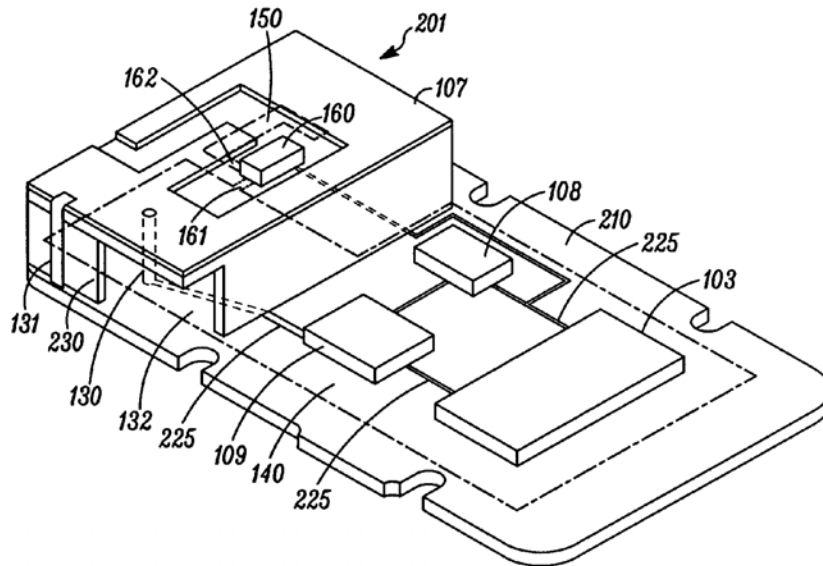
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Primary Examiner—Hoanganh Le
(74) *Attorney, Agent, or Firm*—Randall S. Vaas

(57) **ABSTRACT**

An antenna radiator assembly (201) and radio communications assembly (200) comprising a circuit board (210) supporting electrical conductors (225), one of the electrical conductors (225) being coupled to a feed point (130), and the circuit board (210) having a ground plane (140) formed from at least one conductive sheet. There is a tuning plate (132), a parasitic tuning line (150), a switching unit (160) selectively electrically coupling the tuning plate (132) to the tuning line (150). There is also an antenna radiator element (107) spaced from the circuit board (210) and coupled to the feed point (130), and when viewed in plan view there is an overlapping area where an overlapping surface area of the antenna radiator element (107) overlaps an overlapping surface area of the circuit board (210) thereby forming a sandwiched dielectric region therebetween, the sandwiched dielectric region providing capacitive coupling of the tuning plate (132) and the antenna radiator element (107); and a ground connector (131) inductively coupling the antenna radiator element (107) to the ground plane (140), wherein the tuning plate (132) is disposed in the overlapping surface area of the circuit board (210).

20 Claims, 7 Drawing Sheets





US007265726B2

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

(10) **Patent No.:** **US 7,265,726 B2**
(45) **Date of Patent:** **Sep. 4, 2007**

- (54) **MULTI-BAND ANTENNA**
- (75) Inventors: **Robert Kenoun**, Palatine, IL (US);
Donald L. Cantrell, Jr., Chicago, IL (US)
- (73) Assignee: **Motorola, Inc.**, Schaumburg, IL (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 32 days.

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(21) Appl. No.: **11/235,283**

Primary Examiner—Tan Ho

(22) Filed: **Sep. 26, 2005**

(74) *Attorney, Agent, or Firm*—David S. Noskowicz

(65) **Prior Publication Data**

US 2007/0069954 A1 Mar. 29, 2007

- (51) **Int. Cl.**
H01Q 21/00 (2006.01)
- (52) **U.S. Cl.** **343/725; 343/700 MS;**
343/726; 343/866
- (58) **Field of Classification Search** **343/700 MS,**
343/702, 725, 726, 741, 866
See application file for complete search history.

(57) **ABSTRACT**

A multi band antenna system (100) and a wireless communication device are disclosed. The multi band antenna system provides coverage over multiple frequency bands. The multi band antenna system comprises a ground surface, a first conductor (102), a second conductor (104), a common feed conductor (106) coupled to the first conductor and the second conductor, and a ground conductor (108) coupled to the first conductor and the second conductor. The first conductor has a first physical length operationally equal to a half wavelength in a first RF band and operationally equal to a full wavelength in a second RF band. The second conductor has a second physical length operationally equal to a half wavelength in a third RF band.

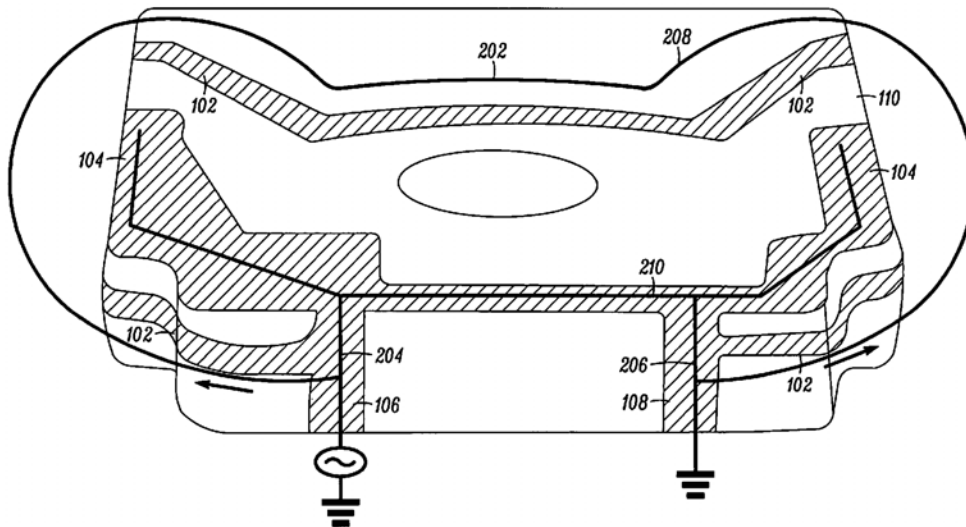
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17 Claims, 5 Drawing Sheets

100





US007265727B2

(12) **United States Patent**
Connor

(10) **Patent No.:** **US 7,265,727 B2**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **TOP LOADED DISK MONOPOLE ANTENNA**

JP 2003 273638 9/2003

(75) Inventor: **Wendy A. Connor**, Santa Barbara, CA (US)

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(73) Assignee: **Raytheon Company**, Waltham, MA (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.

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(21) Appl. No.: **11/144,145**

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(22) Filed: **Jun. 3, 2005**

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(65) **Prior Publication Data**

US 2006/0273971 A1 Dec. 7, 2006

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

Primary Examiner—Hoang V. Nguyen

(52) **U.S. Cl.** **343/752**; 343/749; 343/846

(74) *Attorney, Agent, or Firm*—Leonard A. Alkov

(58) **Field of Classification Search** 343/752, 343/749, 781 P, 781 CA, 846, 829, 828
See application file for complete search history.

(57) **ABSTRACT**

In an exemplary aspect of the invention, an antenna is disclosed that includes a ground plane and a disk disposed adjacent to the ground plane. The disk has a perimeter. The antenna further includes a loading reflector having an underside. At least a portion of the underside is electrically connected to a portion of the perimeter of the disk. The loading reflector has a width at a widest point, and the width at the widest point of the loading reflector is larger than a thickness of the disk. The disk may be circular or elliptical. The ground plane may include a cavity, where the disk is disposed within an outer border of the cavity. When an elliptical disk is used, the cavity may also be elliptical. An elliptical cavity may have a parabolic surface.

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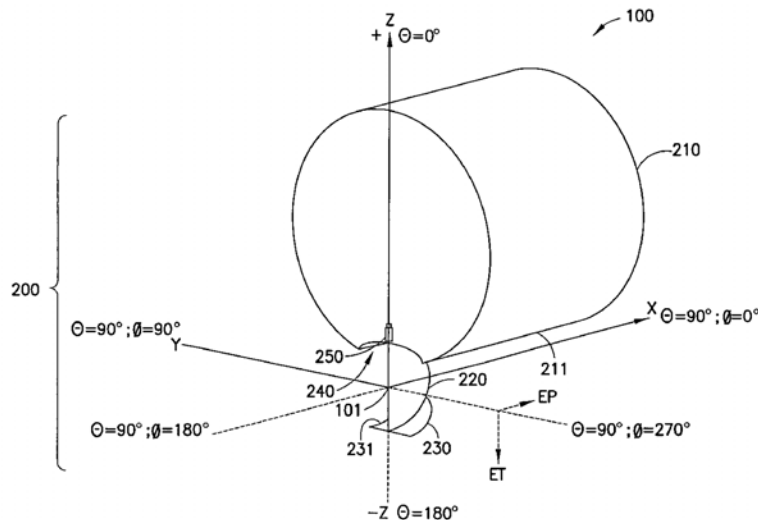
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30 Claims, 20 Drawing Sheets





US007265729B1

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

(10) **Patent No.:** **US 7,265,729 B1**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **MICROSTRIP ANTENNA HAVING
EMBEDDED SPIRAL INDUCTOR**

(75) Inventors: **Tze-Hsuan Chang**, Taipei (TW);
Jean-Fu Kiang, Taipei (TW)

(73) Assignee: **National Taiwan University**, Da-an
District, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/461,379**

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

(51) **Int. Cl.**
H01Q 9/28 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/795**; 343/795; 343/700 MS;
343/895; 343/767; 343/770; 343/769

(58) **Field of Classification Search** 343/700 MS,
343/795, 895, 893, 769-770, 767
See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Douglas W. Owens

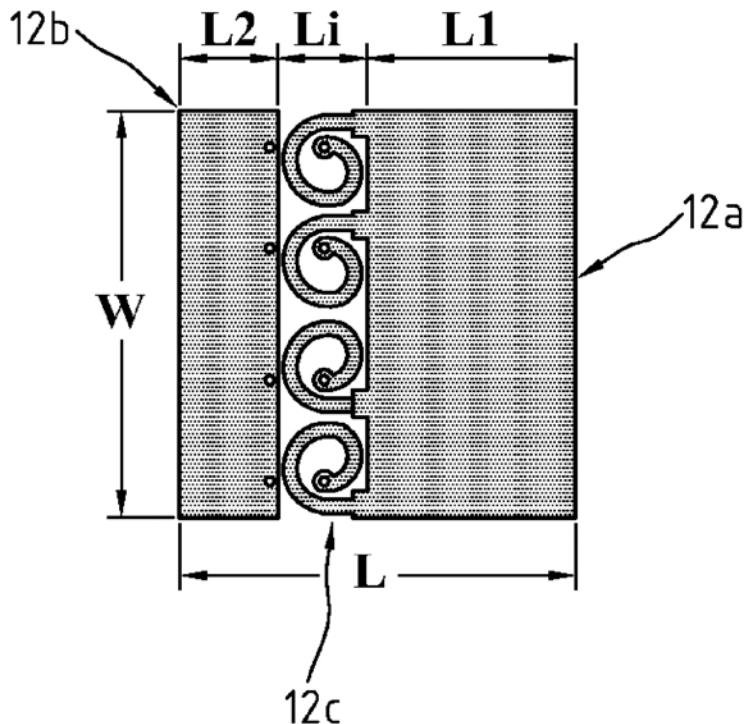
Assistant Examiner—Chuc Tran

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

(57) **ABSTRACT**

A microstrip antenna comprises of an antenna element and a feed-in/feed-out element. Wherein, a wiring pattern of the antenna element includes a plurality of spiral inductors, so that in the antenna element, the path of the electric current is lengthened, the resonant frequency is lowered, and the length of the antenna is shortened.

11 Claims, 5 Drawing Sheets





US007265730B2

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

(10) **Patent No.:** **US 7,265,730 B2**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **DIPOLE ANTENNA HAVING A PERIODIC STRUCTURE**

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6,859,114 B2 2/2005 Eleftheriades et al.
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(75) Inventors: **Hideo Iizuka**, Nisshin (JP); **Peter S Hall**, Birmingham (GB)

(73) Assignee: **Kabushiki Kaisha Toyota Chuo Kenkyusho**, Aichi-gun (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 6 days.

(21) Appl. No.: **11/376,267**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Mar. 18, 2005 (JP) 2005-080056
Aug. 5, 2005 (JP) 2005-228886

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H01Q 9/16 (2006.01)

(52) **U.S. Cl.** **343/802; 343/793**

(58) **Field of Classification Search** 343/793,
343/795, 802, 803, 810, 812
See application file for complete search history.

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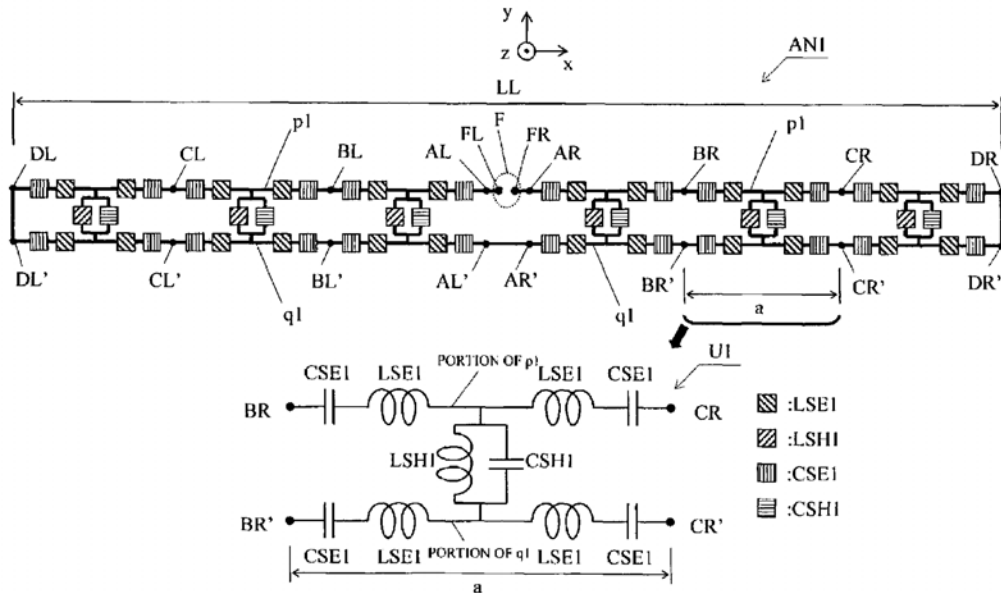
Primary Examiner—Hoang V. Nguyen

(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

(57) **ABSTRACT**

A dipole antenna includes a plurality of generally parallel metal wiring lines, and a plurality of identical or similar unit circuits arranged in a row along the extending direction of the metal wiring lines and connected with one another. Each unit circuit includes a connection portion for connecting the metal wiring lines together via at least one first inductor, and at least one first capacitor inserted into at least one of the metal wiring lines. The plurality of unit circuits are identical unit circuits. Alternatively, the plurality of unit circuits include unit circuits operable in the right-hand system and unit circuits operable in the left-hand system.

37 Claims, 21 Drawing Sheets





US007265731B2

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

(10) **Patent No.:** US 7,265,731 B2
(45) **Date of Patent:** Sep. 4, 2007

(54) **METHOD AND APPARATUS FOR IMPROVING THE PERFORMANCE OF A MULTI-BAND ANTENNA IN A WIRELESS TERMINAL**

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(75) Inventors: **Scott LaDell Vance**, Cary, NC (US);
Bruce Wilcox, Cary, NC (US)

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

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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 41 days.

PCT International Search Report, International Application No. PCT/US2005/023093, mailed Oct. 18, 2005.

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(21) Appl. No.: **11/025,459**

Primary Examiner—Tho Phan

(22) Filed: **Dec. 29, 2004**

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

(65) **Prior Publication Data**

US 2006/0139211 A1 Jun. 29, 2006

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/50 (2006.01)
(52) **U.S. Cl.** **343/860; 343/850; 333/32**
(58) **Field of Classification Search** **343/860, 343/702, 850; 333/32**
See application file for complete search history.

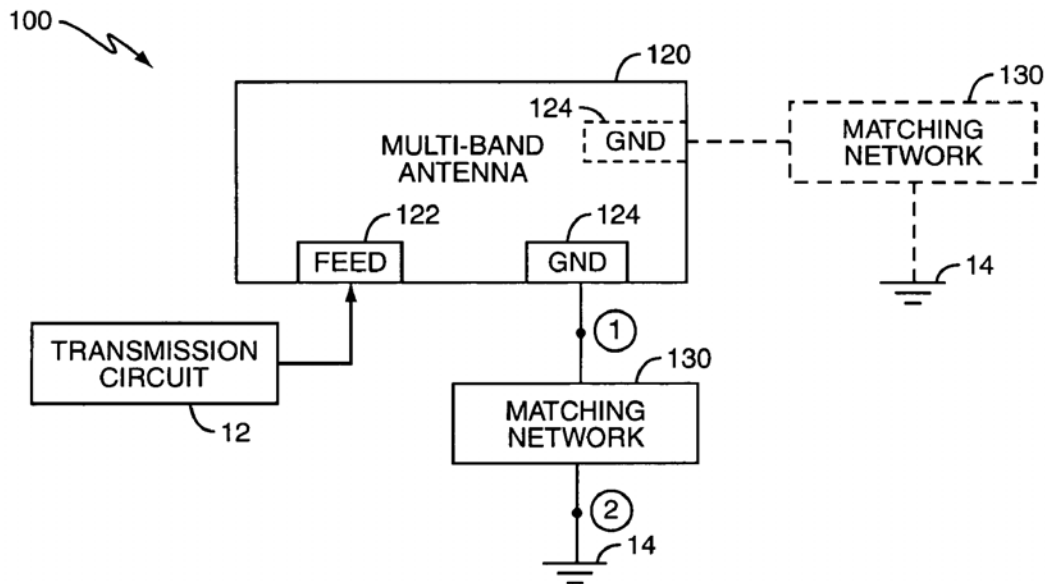
A method and apparatus for improving the efficiency of a multi-band antenna in a wireless terminal over a wide range of frequencies is described herein. To compensate for the undesirable coupling that occurs in a low frequency band between a parasitic antenna and a primary antenna in certain designs, a matching network is connected to at least one ground port of the multi-band antenna. The matching network controls the multi-band antenna performance based on the current transmission frequency band. In some embodiments, the matching network is configured to operate as an open circuit when multi-band antenna operates in the low frequency band, and to operate as a short circuit when multi-band antenna operates in the high frequency band.

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17 Claims, 5 Drawing Sheets





US007265733B1

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

(10) **Patent No.:** **US 7,265,733 B1**
(45) **Date of Patent:** **Sep. 4, 2007**

(54) **PLANAR ANTENNA HAVING A WIDE OPERATING BANDWIDTH**

(75) Inventors: **Tiao-Hsing Tsai**, Yungho (TW);
Chieh-Ping Chiu, Yunlin Shien (TW);
Chih-Wei Liao, Yilan Shien (TW)

(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 0 days.

(21) Appl. No.: **11/486,258**

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

(30) **Foreign Application Priority Data**

Feb. 17, 2006 (TW) 95105414 A

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

(52) **U.S. Cl.** **343/895**; 343/700 MS;
343/845; 343/846

(58) **Field of Classification Search** 343/895,
343/700 MS, 845, 846, 767, 768, 824

See application file for complete search history.

(56) **References Cited**

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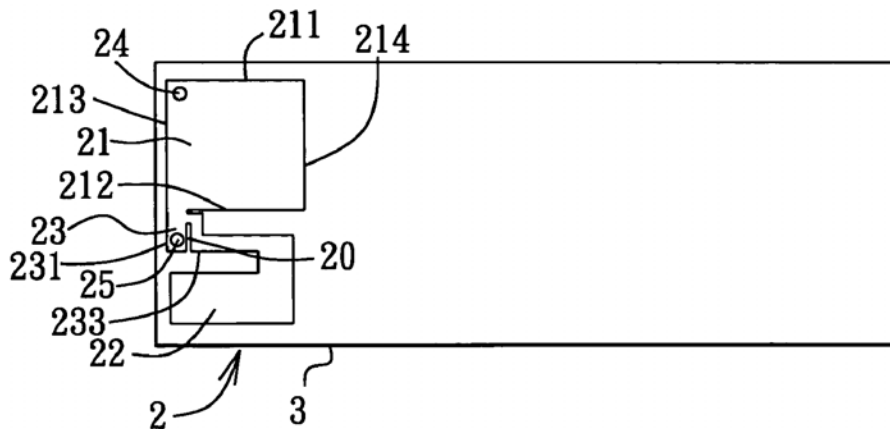
Primary Examiner—Tuyet Vo

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

(57) **ABSTRACT**

A planar antenna includes a high frequency radiating element, a meandering low frequency radiating element, and an interconnecting element. The low frequency radiating element has an operating bandwidth which is lower than that of the high frequency radiating element. The interconnecting element interconnects the high frequency radiating element and the low frequency radiating element. A feeding point is provided on the high frequency radiating element and is distal from the interconnecting element. A grounding point is provided on either the interconnecting element, or the high frequency radiating element proximate to the interconnecting element.

15 Claims, 3 Drawing Sheets





US00D550659S

(12) **United States Design Patent** (10) **Patent No.:** **US D550,659 S**
Noro (45) **Date of Patent:** **** Sep. 11, 2007**

(54) **ANTENNA**
(75) Inventor: **Junichi Noro, Katagami (JP)**
(73) Assignee: **Mitsumi Electric Co., Ltd., Tokyo (JP)**
(**) Term: **14 Years**
(21) Appl. No.: **29/254,190**
(22) Filed: **Feb. 21, 2006**
(30) **Foreign Application Priority Data**
Sep. 15, 2005 (JP) 2005-026721
(51) **LOC (8) Cl.** **14-03**
(52) **U.S. Cl.** **D14/230**
(58) **Field of Classification Search** D14/138,
D14/230-238, 299, 358; D12/42, 43; 343/700 R-705,
343/871-908, 795, 840, 711-713, 819, 846;
455/90.2, 90.3, 91, 128, 269, 344, 347, 562.1
See application file for complete search history.

(56) **References Cited**
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Primary Examiner—Louis S. Zarfes

Assistant Examiner—John Windmuller

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

(57) **CLAIM**

The ornamental design for a antenna, as shown.

DESCRIPTION

FIG. 1 is a perspective view of the top, front and right side of an antenna showing my new design;

FIG. 2 is a front elevational view thereof;

FIG. 3 is a rear elevational view thereof;

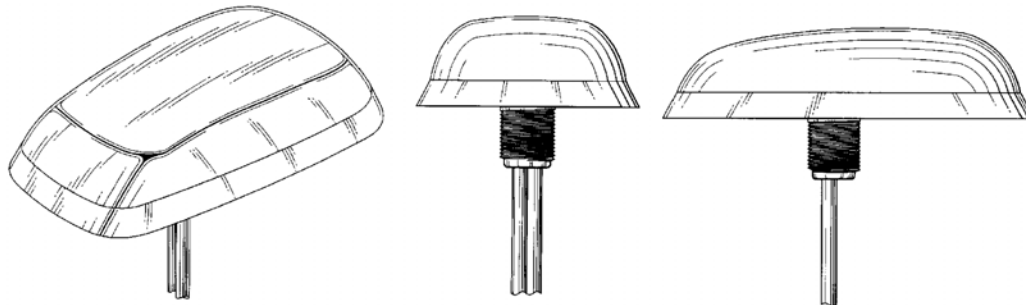
FIG. 4 is a top plan view thereof;

FIG. 5 is a bottom plan view thereof;

FIG. 6 is a left side elevational view thereof; and,

FIG. 7 is a right side elevational view thereof.

1 Claim, 3 Drawing Sheets





US00D550660S

(12) **United States Design Patent** (10) **Patent No.:** **US D550,660 S**
Noro et al. (45) **Date of Patent:** **** Sep. 11, 2007**

(54) **ANTENNA**
(75) Inventors: **Junichi Noro**, Katagami (JP); **Kyuichi Sato**, Katagami (JP)
(73) Assignee: **Mitsumi Electric Co., Ltd.**, Tokyo (JP)
(**) Term: **14 Years**
(21) Appl. No.: **29/260,430**
(22) Filed: **May 25, 2006**
(30) **Foreign Application Priority Data**
Jan. 25, 2006 (JP) 2006-001521

(51) **LOC (8) Cl.** **14-03**
(52) **U.S. Cl.** **D14/230**
(58) **Field of Classification Search** D14/138,
D14/230-238, 299, 358; D12/42, 43; 343/700 R-705,
343/871-908, 795, 840, 711-713, 819, 846;
455/90.2, 90.3, 91, 128, 269, 344, 347, 562.1
See application file for complete search history.

(56) **References Cited**
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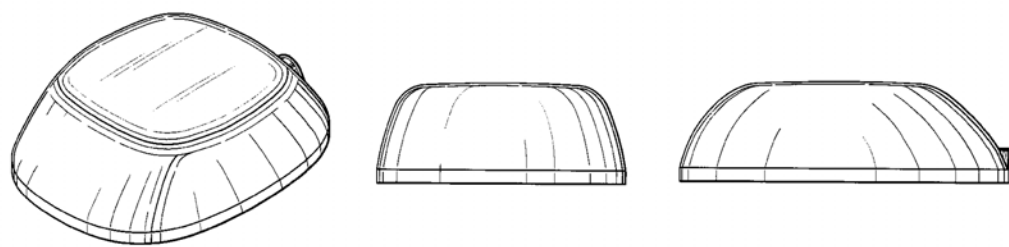
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Primary Examiner—Louis S. Zarfes
Assistant Examiner—John Windmuller
(74) *Attorney, Agent, or Firm*—Sughrue Mion, PLLC

(57) **CLAIM**
The ornamental design for an antenna, as shown.

DESCRIPTION
FIG. 1 is a top perspective view of an antenna showing our new design;
FIG. 2 is a front elevational view thereof;
FIG. 3 is a rear elevational view thereof;
FIG. 4 is a right side elevational view thereof;
FIG. 5 is a left side elevational view thereof;
FIG. 6 is a top plan view thereof; and,
FIG. 7 is a bottom plan view thereof.

1 Claim, 2 Drawing Sheets





US007268730B2

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

(10) **Patent No.:** **US 7,268,730 B2**
(45) **Date of Patent:** **Sep. 11, 2007**

(54) **SMALL BROADBAND MONOPOLE ANTENNA HAVING PERPENDICULAR GROUND PLANE WITH ELECTROMAGNETICALLY COUPLED FEED**

(75) Inventors: **Ikmo Park**, Yongin-si (KR); **Jong-ho Jung**, Yongin-si (KR); **Young-min Moon**, Seoul (KR); **Seong-soo Lee**, Suwon-si (KR); **Young-eil Kim**, Suwon-si (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, 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 0 days.

(21) Appl. No.: **11/376,336**

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

(65) **Prior Publication Data**
US 2006/0256015 A1 Nov. 16, 2006

(30) **Foreign Application Priority Data**
Mar. 16, 2005 (KR) 10-2005-0021872

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

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

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

(56) **References Cited**

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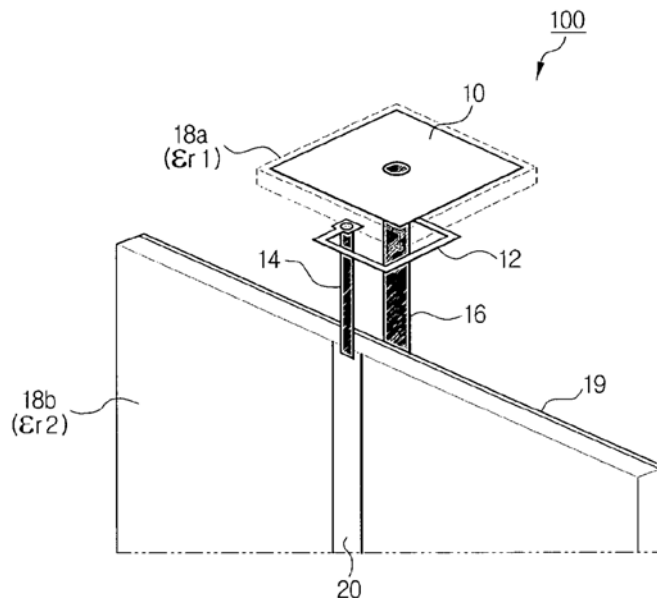
Primary Examiner—Tan Ho

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

(57) **ABSTRACT**

A small broadband monopole antenna having a perpendicular ground plane with an electromagnetically coupled feed is provided. The small broadband monopole antenna may be realized as a small antenna having a size of $0.085\lambda_0 \times 0.085\lambda_0$ by positioning a folded strip line under a shorted square disc. A resonance of the shorted square disc may be coupled to a resonance of the square folded strip line so as to form a wide bandwidth of about 36.6% of a central frequency of 2.313 GHz based on a $VSWR \leq 2$. Also, rectangular slits may be inserted into the perpendicular ground plane to improve a distortion of a radiation pattern that forms on the perpendicular ground plane so as to reduce a backward radiation by 3 dBi or more. The small broadband monopole antenna exhibits a forward radiation pattern similar to that of a general monopole antenna and has a gain of about 2.6 dBi within a bandwidth.

12 Claims, 18 Drawing Sheets





US007268731B2

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

(10) **Patent No.:** **US 7,268,731 B2**
(45) **Date of Patent:** **Sep. 11, 2007**

- (54) **MULTI-BAND ANTENNA FOR WIRELESS APPLICATIONS**
- (75) Inventors: **Bing Chiang**, Melbourne, FL (US); **Michael J. Lynch**, Merritt Island, FL (US); **Douglas H. Wood**, Palm Bay, FL (US)
- (73) Assignee: **IPR Licensing, Inc.**, Wilmington, DE (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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Primary Examiner—Trinh Dinh

Assistant Examiner—Tung Le

(74) *Attorney, Agent, or Firm*—Volpe and Koenig, P.C.

- (21) Appl. No.: **10/895,813**
- (22) Filed: **Jul. 20, 2004**
- (65) **Prior Publication Data**
US 2005/0057410 A1 Mar. 17, 2005

Related U.S. Application Data

- (60) Provisional application No. 60/489,149, filed on Jul. 21, 2003.

- (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, 343/906, 739, 702**

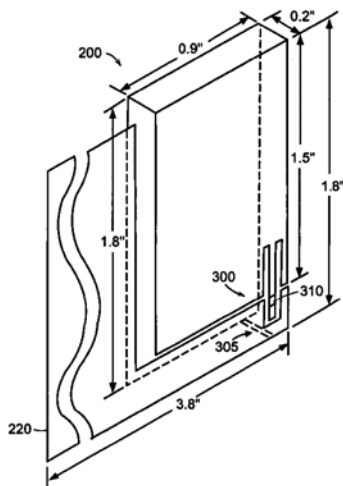
See application file for complete search history.

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(57) **ABSTRACT**

A folded monopole antenna that supports lower and upper frequency bands may be used in CDMA, WLAN, or other wireless communications systems. The folded monopole antenna may be located in a handset next to a vertical ground plane. The folded monopole antenna may be folded at least twice and connected to the ground plane through a reactance. The dimensions of different sections of the folded monopole antenna define lower and upper frequency band characteristics, and an offset location of an input feed affects the bandwidth of the frequency bands. The reactance between the antenna and ground plane can be selected to fine tune the frequency bands. Various input feeds, including a co-planar waveguide, may be employed. Dynamically adjustable reactances may be used in the input feed and ground line for adapting the antenna to various environments.

49 Claims, 15 Drawing Sheets





US007268733B2

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

(10) **Patent No.:** **US 7,268,733 B2**
(45) **Date of Patent:** **Sep. 11, 2007**

(54) **HIGH FREQUENCY GLASS ANTENNA FOR AUTOMOBILES**

(75) Inventors: **Yoshinobu Tsurume**, Tokyo (JP);
Hitoshi Kakizawa, Tokyo (JP)

(73) Assignee: **Nippon Sheet Glass Company, Limited**, Tokyo (JP)

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

(21) Appl. No.: **11/106,127**

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

(65) **Prior Publication Data**
US 2005/0231432 A1 Oct. 20, 2005

(30) **Foreign Application Priority Data**
Apr. 16, 2004 (JP) 2004-121144

(51) **Int. Cl.**
H01Q 1/32 (2006.01)
(52) **U.S. Cl.** **343/713; 343/713; 343/700 MS**
(58) **Field of Classification Search** **343/713, 343/700 MS**

See application file for complete search history.

(56) **References Cited**

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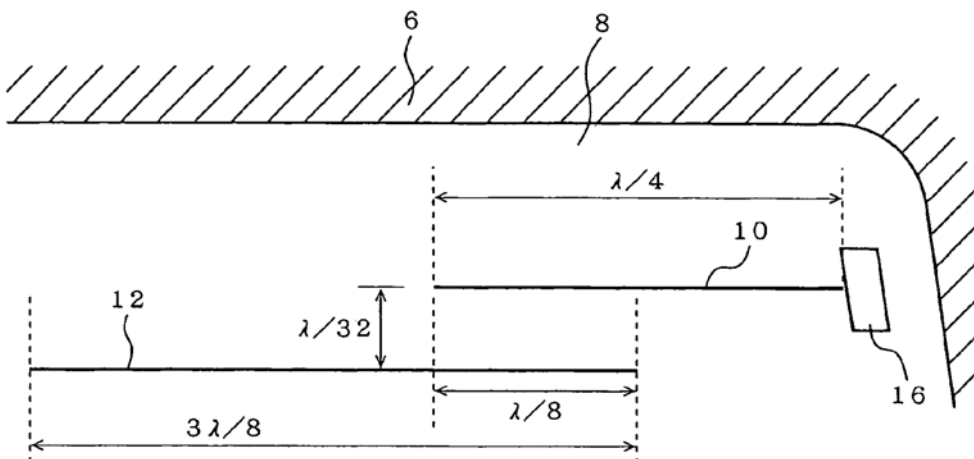
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Primary Examiner—Thuy V. Tran
Assistant Examiner—Dieu Hien T Duong
(74) *Attorney, Agent, or Firm*—RatnerPrestia

(57) **ABSTRACT**

A high frequency and broad band glass antenna for automobiles has a strong directivity in one direction even if the antenna is provided near to the metal portion of a body. The antenna comprises an antenna line provided near to the metal portion of a body, one end of the antenna line neighboring the metal portion being fed; and a parasitic line positioned near to the antenna line for adjusting a directivity and a frequency characteristic of reception sensitivity of the glass antenna. The antenna line consists of a straight antenna line has the length $(\lambda/4)\kappa$. The parasitic line extends in parallel with the antenna line and consists of at least one straight conductor line having the length of $(\lambda/8)\kappa$. The length that the conductor line overlaps with the antenna line is $(\lambda/8)\kappa$. The distance between the conductor line and the antenna line is $(\lambda/64)\kappa$.

6 Claims, 10 Drawing Sheets





US007268735B2

(12) **United States Patent
Chung**

(10) **Patent No.: US 7,268,735 B2**
(45) **Date of Patent: Sep. 11, 2007**

(54) **ANTENNA STRUCTURE**

(76) Inventor: **Chin-Yuan Chung**, No. 20, Lane 222,
Sanfu St., Changhua City, Changhua
County 500 (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.: **11/315,374**

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

(65) **Prior Publication Data**
US 2007/0146220 A1 Jun. 28, 2007

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

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

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

(56) **References Cited**

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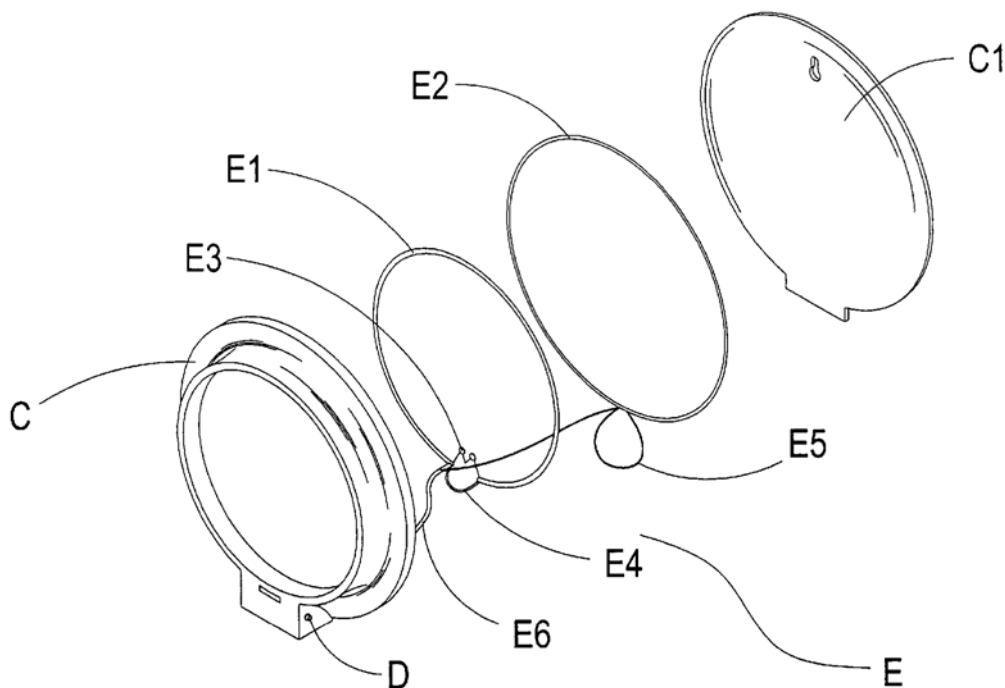
Primary Examiner—Tho Phan

(74) *Attorney, Agent, or Firm*—Troxell Law Office, PLLC

(57) **ABSTRACT**

An antenna structure is composed of an antenna seat, a terminal, and an antenna set. The antenna set includes antennae, a matching circuit, conducting wires, and a lead wire. By the conducting wires and matching circuit connected on the antennae, an impedance matching can be achieved to be coupled with frequency of radio wave signal to be received for reducing a standing-wave ration, when the antenna are receiving the radio wave signal. In addition, the frequency and wavelength of radio wave signal received by the antennae can be adjusted by changing lengths of conducting wires.

5 Claims, 8 Drawing Sheets





US007268737B1

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

(10) **Patent No.:** **US 7,268,737 B1**
(45) **Date of Patent:** **Sep. 11, 2007**

(54) **HIGH GAIN BROADBAND PLANAR ANTENNA**

(75) Inventors: **Ching-Yuan Ai**, Wurih Township, Taichung County (TW); **Li-Chi Chiu**, Yuanlin Township, Changhua County (TW)

(73) Assignee: **Universal Scientific Industrial Co., Ltd.**, Nan-Tou (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 53 days.

(21) Appl. No.: **11/378,434**

(22) Filed: **Mar. 20, 2006**

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

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

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

See application file for complete search history.

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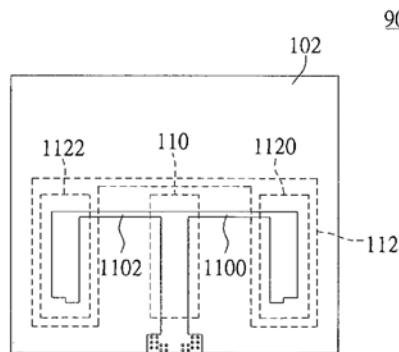
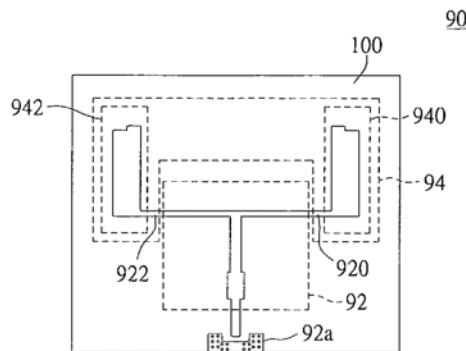
Primary Examiner—Tan Ho

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

(57) **ABSTRACT**

A high gain broadband planar antenna is provided for overcoming conventional antenna structure that cannot be applied to a high gain broadband. The antenna includes a microwave substrate having a first surface and a second surface, a first symmetric radiation unit having a first radiation part and a second radiation part disposed on the first surface, a second symmetric radiation unit having a third radiation part and a fourth radiation part disposed on the second surface, and at least one connecting unit connected to the microwave substrate and a reflector. An end terminal of each first radiation part, second radiation part, third radiation part and fourth radiation part adopts a step structure design. The planar antenna of the present invention can achieve a high gain broadband effect.

14 Claims, 6 Drawing Sheets





US007268740B2

(12) **United States Patent**
Oberle

(10) **Patent No.:** **US 7,268,740 B2**
(45) **Date of Patent:** ***Sep. 11, 2007**

- (54) **METHOD FOR FORMING RADIO FREQUENCY ANTENNA**
- (75) Inventor: **Robert R. Oberle**, Macungie, PA (US)
- (73) Assignee: **RCD Technology Inc.**, Quakertown, PA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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This patent is subject to a terminal disclaimer.

(Continued)

(21) Appl. No.: **10/925,229**

FOREIGN PATENT DOCUMENTS

(22) Filed: **Aug. 24, 2004**

EP 0903805 A2 3/1999

(65) **Prior Publication Data**

US 2005/0078035 A1 Apr. 14, 2005

Related U.S. Application Data

- (63) Continuation-in-part of application No. 10/238,598, filed on Sep. 11, 2002, now Pat. No. 6,933,892, which is a continuation of application No. 09/524,505, filed on Mar. 13, 2000, now Pat. No. 6,476,775.

Primary Examiner—Trinh Vo Dinh
(74) *Attorney, Agent, or Firm*—Fliesler Meyer LLP

(57) **ABSTRACT**

- (51) **Int. Cl.**
H01Q 7/00 (2006.01)
- (52) **U.S. Cl.** **343/866; 343/867**
- (58) **Field of Classification Search** None
See application file for complete search history.

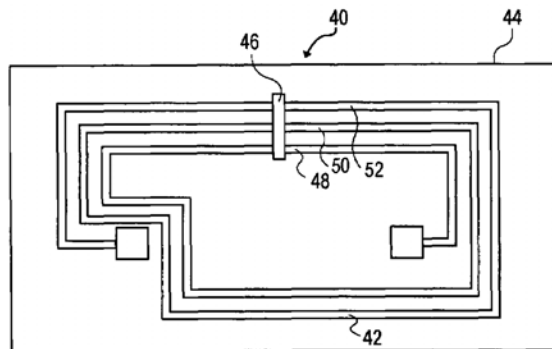
A metalized circuit suitable for application as a radio frequency antenna is produced by forming an antenna coil pattern on a flexible substrate. The antenna coil pattern is formed using a conductive ink which is patterned on the substrate. The conductive ink is cured and an electrical-short layer is formed across the coils of the conductive ink pattern. An insulating layer is formed over top of the electrical-short layer, a metal layer electroplated on top of the conductive layer, and then the electrical-short layer is removed. The use of the electrical-short layer during the electroplating allows for the voltage at the different points on the conductive ink layer to be relatively similar, so that a uniform electroplate layer is formed on top of the conductive ink layer. This results in a better quality radio frequency antenna at a reduced cost.

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23 Claims, 6 Drawing Sheets





US007268741B2

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

(10) **Patent No.:** **US 7,268,741 B2**
(45) **Date of Patent:** **Sep. 11, 2007**

(54) **COUPLED SECTORIAL LOOP ANTENNA FOR ULTRA-WIDEBAND APPLICATIONS**

(75) Inventors: **Kamal Sarabandi**, Ann Arbor, MI (US); **Nader Behdad**, Ann Arbor, MI (US)

(73) Assignee: **EMAG Technologies, Inc.**, Ann Arbor, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **11/208,700**

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

(65) **Prior Publication Data**
US 2006/0055619 A1 Mar. 16, 2006

Related U.S. Application Data
(60) Provisional application No. 60/609,381, filed on Sep. 13, 2004.

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

(52) **U.S. Cl.** **343/866; 343/867; 343/795**

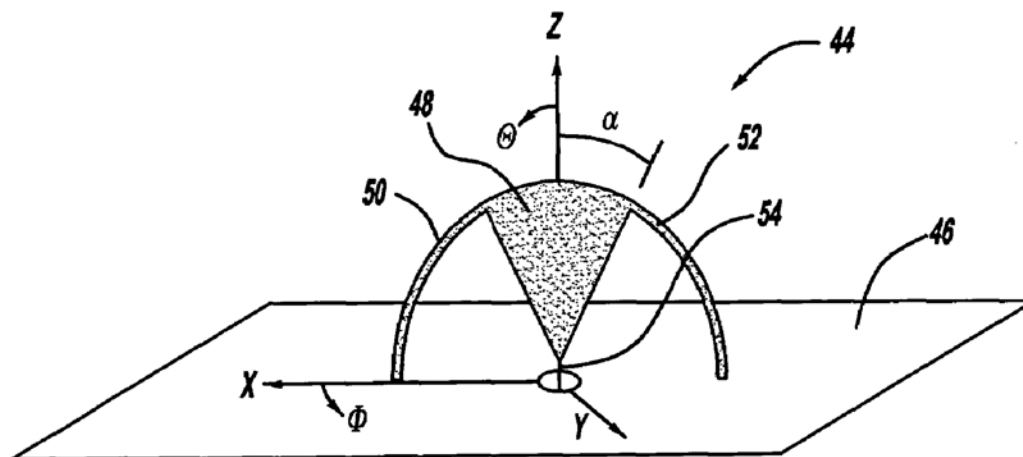
(58) **Field of Classification Search** 343/866, 343/867, 700 MS, 846, 795, 830, 873, 844
See application file for complete search history.

(56) **References Cited**
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Primary Examiner—Hoanganh Le
(74) *Attorney, Agent, or Firm*—John A. Miller, Esq.; Miller IP Group, PLC

(57) **ABSTRACT**
A single-element antenna system that provides a wide bandwidth and consistent polarization over the frequency range to which the antenna is impedance matched. In one embodiment, the wideband antenna system includes two parallel coupled sectorial loop antennas (CSLA) that are coupled along an axis of symmetry. In another embodiment, half of the coupled sectorial loop antenna is electrically coupled to a ground plane, where the antenna includes one pie-slice shaped sector and two arches. In alternate embodiments, sections of the sector can be removed to reduce the weight of the antenna system.

30 Claims, 9 Drawing Sheets





US007268745B2

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

(10) **Patent No.:** **US 7,268,745 B2**
(45) **Date of Patent:** **Sep. 11, 2007**

(54) **COAXIAL CABLE FREE QUADRI-FILAR
HELICAL ANTENNA STRUCTURE**

(75) Inventors: **Pei-Lin Yang**, Hsinchu (TW);
Chia-Chun Hung, Hsinchu (TW)

(73) Assignee: **Jabil Circuit Taiwan Limited**, Hsinchu
(TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 19 days.

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Primary Examiner—Trinh Vo Dinh
(74) *Attorney, Agent, or Firm*—Bacon & Thomas, PLLC

(21) Appl. No.: **11/274,418**

(57) **ABSTRACT**

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

(65) **Prior Publication Data**
US 2007/0013606 A1 Jan. 18, 2007

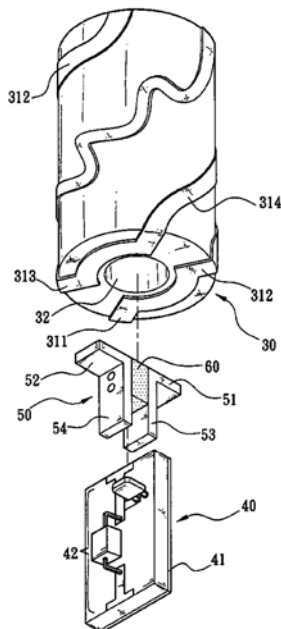
(30) **Foreign Application Priority Data**
Jul. 13, 2005 (TW) 94123696 A

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
(52) **U.S. Cl.** **343/895; 343/702**
(58) **Field of Classification Search** 343/895,
343/702, 860
See application file for complete search history.

A quadri-filar helical antenna structure includes a cylindrical body having a relative dielectric constant greater than 4, and four radial metal plates on a distal end of the cylindrical body, and each radial metal plate is extended along the cylindrical body. The ends of every two adjacent radial metal plates are connected to form two antenna structures, and a circuit board is fixed. A ground surface is installed on one side of the circuit board and coupled to one of the antennas. An impedance matching circuit is installed on another side of the circuit board, and one end of the impedance matching circuit is coupled to another antenna. A feeder is installed at another end of the impedance matching circuit. Four radial metal plates having an electric length about odd multiples of a quarter of wavelength of the cylindrical body can receive satellite signals.

(56) **References Cited**
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24 Claims, 9 Drawing Sheets





US007271769B2

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

(10) **Patent No.:** **US 7,271,769 B2**
(45) **Date of Patent:** **Sep. 18, 2007**

(54) **ANTENNAS ENCAPSULATED WITHIN PLASTIC DISPLAY COVERS OF COMPUTING DEVICES**

(75) Inventors: **Takeshi Asano**, Kanagawa (JP); **Shohhei Fujio**, Tokyo (JP); **Brian Paul Gaucher**, Brookfield, CT (US); **Peter Lee**, Chapel Hill, NC (US); **Duixian Liu**, Yorktown Heights, NY (US); **Kazuo Masuda**, Kanagawa-ken (JP); **Hideyuki Usui**, Kanagawa-ken (JP); **Osamu Yamamoto**, Kanagawa-Pre (JP)

(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 0 days.

(21) Appl. No.: **10/946,868**

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

(65) **Prior Publication Data**
US 2006/0061512 A1 Mar. 23, 2006

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

(52) **U.S. Cl.** **343/702; 343/873; 343/872; 343/700 MS; 361/683**

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

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Primary Examiner—Don Wong

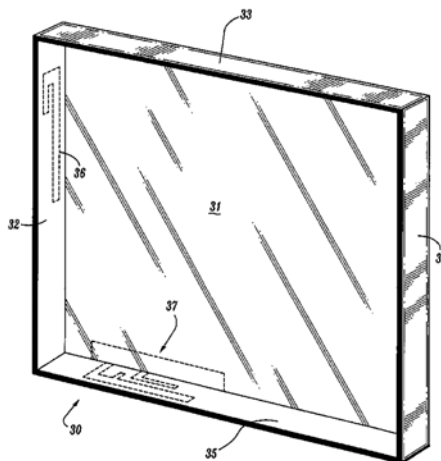
Assistant Examiner—Binh Van Ho

(74) *Attorney, Agent, or Firm*—F. Chau & Associates, LLC; Frank V. DeRosa

(57) **ABSTRACT**

Antenna devices are provided comprising antenna structures encapsulated or molded into plastic covers of computing devices to enable wireless communication. For example, one or more antenna structures can be encasulated within, or molded into, a plastic display cover of a portable laptop computer. Embedded antenna designs can include various antenna types that are built using one or more wires or thin metallic strips encapsulated into plastic device covers. Insert/injection molding methods can be used to encapsulate antenna structures in plastic device covers during fabrication of the plastic device covers.

37 Claims, 7 Drawing Sheets





US007271770B2

(12) **United States Patent**
Washiro

(10) **Patent No.:** **US 7,271,770 B2**
(45) **Date of Patent:** **Sep. 18, 2007**

- (54) **REVERSE F-SHAPED ANTENNA**
- (75) Inventor: **Takanori Washiro**, Kanagawa (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 0 days.

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- (21) Appl. No.: **11/058,001**
- (22) Filed: **Feb. 15, 2005**

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- (65) **Prior Publication Data**
US 2005/0190109 A1 Sep. 1, 2005

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- (30) **Foreign Application Priority Data**
Mar. 1, 2004 (JP) 2004-056377

Primary Examiner—Trinh Dinh
Assistant Examiner—Tung Le
 (74) *Attorney, Agent, or Firm*—Lerner, David, Littenberg, Krumholz & Mentlik, LLP

- (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, 895, 795
See application file for complete search history.

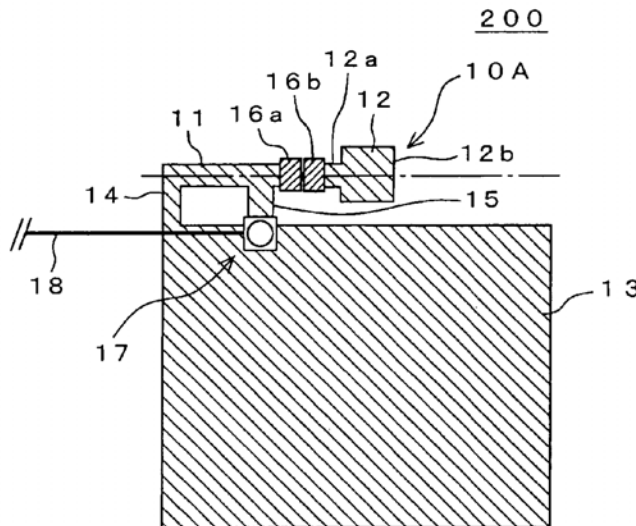
(57) **ABSTRACT**

In a reverse F-shaped antenna formed on a surface of a printed board, the radiating element has a first radiating conductor, a second radiating conductor, and a chip coil. The chip coil is positioned between the first and second radiating conductors and electrically connects the first radiating conductor to the second radiating conductor. The reverse F-shaped antenna is effectively downsized. A component of current flow in the chip coil in a three-dimensional direction allows sensitivity to some extent to a wave polarized in all directions. By merely changing the inductance in the chip coil, it is possible to easily alter the resonance frequency in the reverse F-shaped antenna.

- (56) **References Cited**
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3 Claims, 4 Drawing Sheets

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US007271771B2

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

(10) **Patent No.:** **US 7,271,771 B2**
(45) **Date of Patent:** **Sep. 18, 2007**

- (54) **FILM ANTENNA**
- (75) Inventors: **Makoto Usui**, Hitachi (JP); **Yuuki Yamamoto**, Hitachi (JP); **Ryo Sato**, Hitachi (JP)
- (73) Assignee: **Hitachi Cable, Ltd.**, Tokyo (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **11/067,014**

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

(65) **Prior Publication Data**
US 2006/0077104 A1 Apr. 13, 2006

(30) **Foreign Application Priority Data**
Oct. 13, 2004 (JP) 2004-298819

- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702**; 343/700 MS;
343/846; 343/829; 343/845
- (58) **Field of Classification Search** 343/700 MS,
343/702
See application file for complete search history.

(56) **References Cited**
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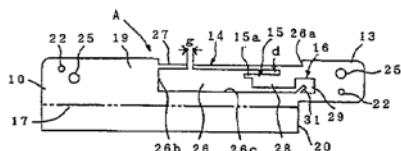
Primary Examiner—Don Wong
Assistant Examiner—Binh V Ho

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

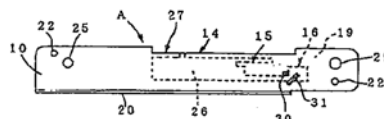
(57) **ABSTRACT**

A film antenna whose antenna characteristics are unaffected by chassis is provided. A recessed groove portion **26** is formed in a ground portion **13** which is attached to a chassis **18**. A first radiating element portion **14** is formed from a wall **26a** on one side of the groove portion **26** to a wall **26b** on the other side. A capacitive coupling piece portion **27** which is capacitively coupled via a specified gap *g* to the first radiating element portion **14** is formed on the wall **26b** on the other side to thereby allow antenna characteristics to be unaffected by the chassis **18**.

14 Claims, 3 Drawing Sheets



A: FILM ANTENNA
13: GROUND PORTION
14: FIRST RADIATING ELEMENT PORTION
15: SECOND RADIATING ELEMENT PORTION
16: SECOND LOOP ELEMENT PORTION



26: RECESSED GROOVE
27: CAPACITIVE COUPLING PIECE PORTION
30: POWER FEED PORTION



US007271772B2

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

(10) **Patent No.:** **US 7,271,772 B2**
(45) **Date of Patent:** ***Sep. 18, 2007**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE COMPRISING MULTI-FREQUENCY BAND ANTENNA AND RELATED METHODS**

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

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/422,158**

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

(65) **Prior Publication Data**

US 2006/0214858 A1 Sep. 28, 2006

Related U.S. Application Data

(63) Continuation of application No. 11/042,693, filed on Jan. 25, 2005, now Pat. No. 7,068,230.

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

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

(52) **U.S. Cl.** **343/702; 343/700 MS; 343/748**

(58) **Field of Classification Search** **343/700 MS, 343/702, 895, 867, 745, 748, 866**
See application file for complete search history.

(56) **References Cited**

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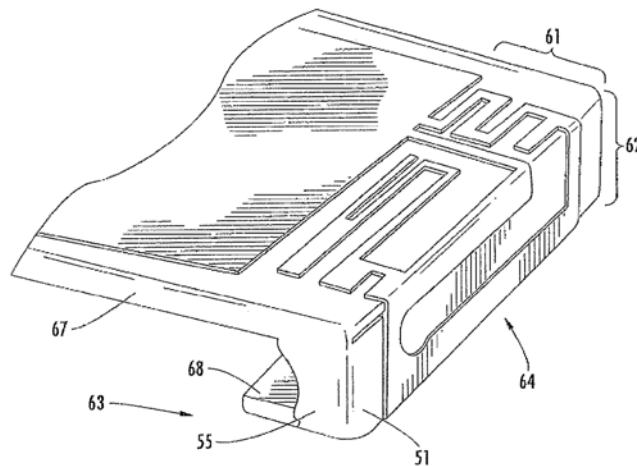
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Primary Examiner—Hoang V. Nguyen
(74) *Attorney, Agent, or Firm*—Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57) **ABSTRACT**

A mobile wireless communications device may include a housing and a multi-frequency band antenna carried within the housing. The multi-frequency band antenna may include a main loop conductor having a gap therein defining first and second ends of the main loop conductor, a first branch conductor having a first end connected adjacent the first end of the main loop conductor and having a second end defining a first feed point, and a second branch conductor having a first end connected adjacent the second end of the main loop conductor and a second end defining a second feed point. The antenna may further include a tuning branch conductor having a first end connected to the main loop conductor between the respective first ends of the first and second branches.

18 Claims, 11 Drawing Sheets





US007271777B2

(12) **United States Patent**
Yuanzhu

(10) **Patent No.:** **US 7,271,777 B2**
(45) **Date of Patent:** **Sep. 18, 2007**

- (54) **ANTENNA DEVICE WITH IMPROVED ISOLATION CHARACTERISTIC**
- (75) Inventor: **Dou Yuanzhu**, Fukushima-ken (JP)
- (73) Assignee: **Alps Electric Co., Ltd.**, Tokyo (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

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

(74) *Attorney, Agent, or Firm*—Brinks Hofer Gilson & Lione

- (21) Appl. No.: **11/303,295**
- (22) Filed: **Dec. 15, 2005**

- (65) **Prior Publication Data**
US 2006/0132373 A1 Jun. 22, 2006

- (30) **Foreign Application Priority Data**
Dec. 20, 2004 (JP) 2004-367764

- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 1/36 (2006.01)

- (52) **U.S. Cl.** **343/767; 343/700 MS; 343/770; 343/767; 343/725**

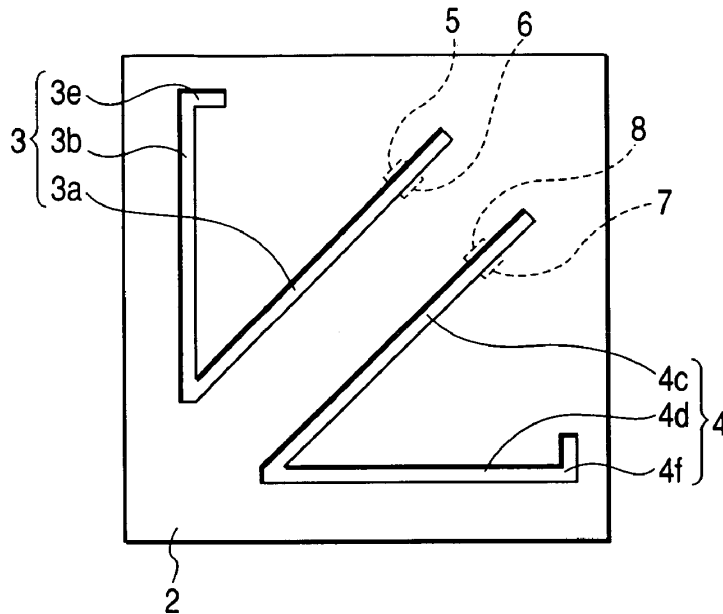
- (58) **Field of Classification Search** 343/700 MS, 343/767, 770, 895, 725, 795, 727
See application file for complete search history.

- (56) **References Cited**
U.S. PATENT DOCUMENTS
6,133,879 A * 10/2000 Grangeat et al. 343/700 MS

(57) **ABSTRACT**

A pair of radiating slots open in a flat metal plate having a square shape to be line-symmetrically arranged with respect to a symmetry axis, and power feeding lines and ground lines are provided at power feeding positions of the respective radiating slots. The respective radiating slots have first slot portions and second slot portions that contact at 45 degrees and linearly extend, respectively. Both the radiating slots are arranged in a back-to-back manner that edges of the first slot portions face each other, and the second slot portions extend in a direction to be separated from each other along two sides of the flat metal plate. Further, a polarization direction of an electric wave to be generated by one radiating slot and a polarization direction of an electric wave to be generated by the other radiating slot are set to be perpendicular to each other.

7 Claims, 3 Drawing Sheets





US007274334B2

(12) **United States Patent**
O’Riordan et al.

(10) **Patent No.:** **US 7,274,334 B2**
(45) **Date of Patent:** **Sep. 25, 2007**

(54) **STACKED MULTI-RESONATOR ANTENNA**

2001/0011964 A1 8/2001 Sadler et al. 343/824
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(75) Inventors: **Pauline O’Riordan**, Kildare (IE);
Joseph Modro, Dublin (IE)

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(73) Assignee: **TDK Corporation**, 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 36 days.

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(21) Appl. No.: **11/088,960**

Primary Examiner—Douglas W. Owens

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

Assistant Examiner—Ephrem Alemu

(65) **Prior Publication Data**

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

US 2006/0214850 A1 Sep. 28, 2006

(57) **ABSTRACT**

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

An antenna structure having a ground plane, a feed line and at least one resonator element that is embedded in a dielectric substrate and which is meandering in shape such that it includes at least two adjacent resonator segments. As a result, the resonator element resonates in two separate frequency bands. A second resonator element is provided, the second resonator element being dimensioned to resonate in a frequency band below a third operating frequency band, the feed line and ground plane being arranged to cause a resonance in a frequency band located above the third operating frequency band. During use, the combined effect of the resonance of the second resonator element and of the feed line and ground plane is to cause the antenna structure to resonate in the third operating frequency band.

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

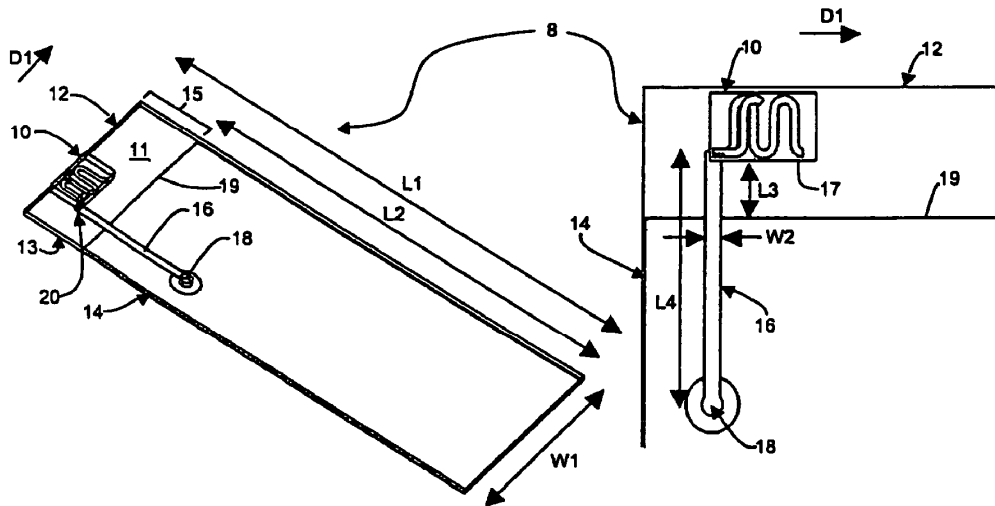
(58) **Field of Classification Search** 343/702,
343/700 MS, 895, 873, 893
See application file for complete search history.

(56) **References Cited**

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18 Claims, 6 Drawing Sheets





US007274335B2

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

(10) **Patent No.:** **US 7,274,335 B2**
(45) **Date of Patent:** **Sep. 25, 2007**

(54) **ANTENNA FOR SLIDE-TYPE WIRELESS
TERMINAL DEVICE**

(75) Inventors: **Yong-jin Kim**, Seoul (KR); **Do-hoon
Kwon**, Seoul (KR); **Seong-soo Lee**,
Suwon-si (KR); **Young-eil Kim**,
Suwon-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.: **11/442,529**

(22) Filed: **May 30, 2006**

(65) **Prior Publication Data**
US 2007/0120750 A1 May 31, 2007

(30) **Foreign Application Priority Data**
Nov. 30, 2005 (KR) 10-2005-0115343

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

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

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

See application file for complete search history.

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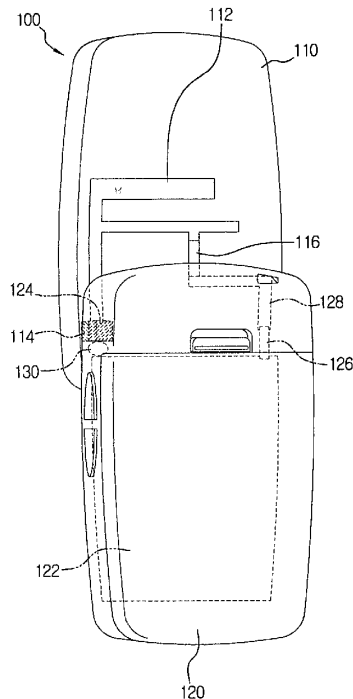
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(57) **ABSTRACT**

An antenna for a slide-type wireless terminal device includes a radiator formed in a first body, a ground surface formed on a second body, a power feeder connected to the ground surface in the second body, a first connection part connected to the radiator in the first body and operative to come in contact with the power feeder when the first body is slidably moved, and a short-circuit wire operative to come in contact with the radiator and the ground surface when the first body is slidably moved.

6 Claims, 4 Drawing Sheets





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

(10) **Patent No.:** **US 7,274,338 B2**
(45) **Date of Patent:** **Sep. 25, 2007**

(54) **MEANDER LINE CAPACITIVELY-LOADED
MAGNETIC DIPOLE ANTENNA**

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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 122 days.

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H01Q 1/36 (2006.01)

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(58) **Field of Classification Search** **343/741, 343/793, 795, 866, 702, 895**
See application file for complete search history.

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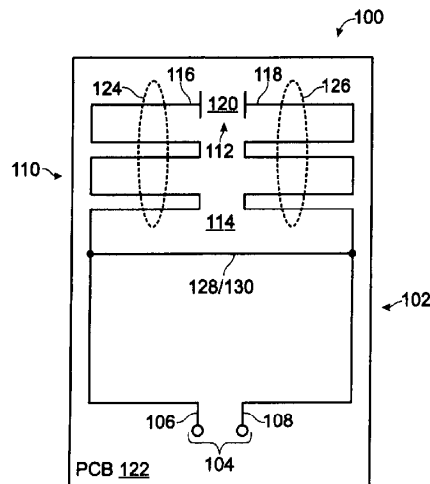
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Primary Examiner—Shih-Chao Chen

(57) **ABSTRACT**

A meander line capacitively-loaded magnetic dipole antenna is disclosed. The antenna includes a transformer loop having a balanced feed interface, and a meander line capacitively-loaded magnetic dipole radiator. The meander line capacitively-loaded magnetic dipole radiator also includes an electric field bridge. For example, the meander line capacitively-loaded magnetic dipole radiator may include a quasi loop with a first end and a second end, with the electric field bridge interposed between the quasi loop first and second ends. The electric field bridge may be an element such as a dielectric gap, lumped element, circuit board surface-mounted, ferroelectric tunable, or a microelectromechanical system (MEMS) capacitor. The transformer loop has a radiator interface coupled to a quasi loop transformer interface. In one aspect, the coupled interfaces are a shared perimeter portion shared by both loops.

22 Claims, 8 Drawing Sheets





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(54) **QUAD-BAND COUPLING ELEMENT**
ANTENNA STRUCTURE

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(58) **Field of Classification Search** 343/860,
343/822
See application file for complete search history.

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

(57) **ABSTRACT**

An antenna module has a substrate, first and second coupling elements, and first and second resonant circuits disposed on the substrate. The first and second coupling elements are mounted to the substrate and particularly adapted to couple respective first and second frequency bands to a ground plane through respective first and second ports. The first resonant circuit has a plurality of components having electrical values selected so as to function as a band-pass filter within the first frequency band and to present a high impedance at least in the second frequency band. The second resonant circuit is coupled to the second port and has a plurality of components that have electrical values selected so as to function as a band-pass filter within the second frequency band and to present a high impedance at least in the first frequency band.

22 Claims, 12 Drawing Sheets

