



US007768460B2

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

(10) **Patent No.:** **US 7,768,460 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

- (54) **MULTI-BAND ANTENNA**
- (75) Inventors: **Wen-Chieh Yang**, Tu-Cheng (TW); **Yu-Yuan Wu**, Tu-Cheng (TW); **Kai Shih**, Tu-Cheng (TW); **Hsin-Tsung Wu**, Tu-Cheng (TW)
- (73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, Tu-Cheng, Taipei Hsien (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 110 days.

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Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Muncy, Geissler, Olds & Lowe, PLLC

- (21) Appl. No.: **12/178,945**
- (22) Filed: **Jul. 24, 2008**

(65) **Prior Publication Data**
US 2010/0019973 A1 Jan. 28, 2010

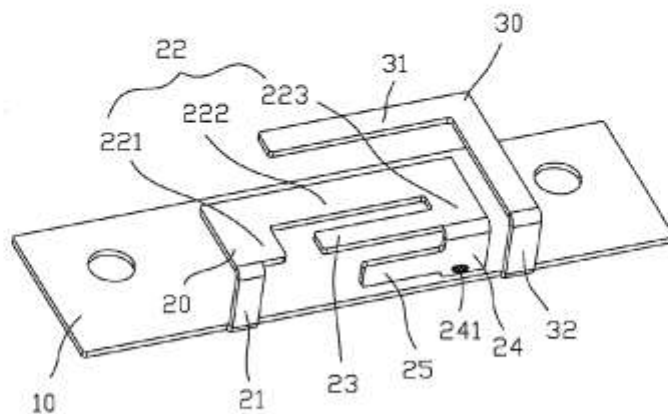
- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 19/10 (2006.01)
- (52) **U.S. Cl.** **343/700 MS; 343/818**
- (58) **Field of Classification Search** **343/700 MS, 343/818, 846, 866**
See application file for complete search history.

- (56) **References Cited**
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7,050,010 B2 * 5/2006 Wang et al. 343/702

(57) **ABSTRACT**

A multi-band antenna has a grounding plate, a radiating element and a parasitic element. The radiating element has a level radiating portion disposed a predetermined distance away from the grounding plate and a first connecting portion connecting the level radiating portion with the grounding plate. The parasitic element has a substantially L-shaped parasitic portion away from the grounding plate and a second connecting portion disposed at the same side of the grounding plate with the first connecting portion to connect a free end of the L-shaped parasitic portion with the grounding plate. The L-shaped parasitic portion is substantially at the same plane with and spatially fences the level radiating portion to define a substantially L-shaped space. The multi-band antenna has simple structure and small size to be assembled in the limited space of notebook.

5 Claims, 2 Drawing Sheets





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

(10) **Patent No.:** **US 7,768,461 B2**
(45) **Date of Patent:** ***Aug. 3, 2010**

(54) **ANTENNA DEVICE WITH INSERT-MOLDED ANTENNA PATTERN**

(75) Inventors: **Yu-Chiang Cheng**, Taipei (TW);
Ping-Cheng Chang, Chaozhou Town (TW);
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(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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/878,667**

(22) Filed: **Jul. 26, 2007**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 11/404,814, filed on Apr. 17, 2006.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/40 (2006.01)

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

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

(56) **References Cited**

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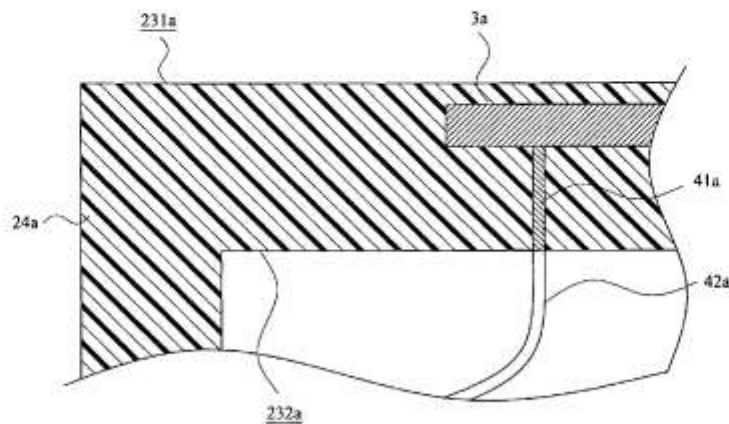
Primary Examiner—Trinh V Dinh

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

(57) **ABSTRACT**

Disclosed is an antenna device for transceiving a wireless signal with an insert-molded antenna pattern embedded inside a casing of an electronic device. The insert-molded antenna pattern is connected to an antenna module of a motherboard of the electronic device in order to feed the wireless signal transceived by the insert-molded antenna pattern through an antenna signal feeding line connected to the insert-molded antenna pattern and the antenna module, or by an antenna coupling element coupled with the insert-molded antenna pattern.

6 Claims, 15 Drawing Sheets





US007768462B2

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

(10) **Patent No.:** **US 7,768,462 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

(54) **MULTIBAND ANTENNA FOR HANDHELD ELECTRONIC DEVICES**

2004/0145521 A1 7/2004 Hebron et al.

(75) Inventors: **Zhijun Zhang**, Santa Clara, CA (US);
Robert W. Schlub, Campbell, CA (US);
Robert J. Hill, Salinas, CA (US);
Ruben Caballero, San Jose, CA (US)

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(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

EP 1 351 334 A 10/2003

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 372 days.

(Continued)

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(21) Appl. No.: **11/895,053**

Hill et al. U.S. Appl. No. 11/650,187, filed Jan. 4, 2007.

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

(Continued)

(65) **Prior Publication Data**

Primary Examiner—Hoang V Nguyen

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Assistant Examiner—Robert Karacsony

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

(74) *Attorney, Agent, or Firm*—Treyz Law Group; G. Victor

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

Treyz; David C. Kellogg

(58) **Field of Classification Search** **343/702, 343/700 MS, 846, 848, 767**

(57) **ABSTRACT**

See application file for complete search history.

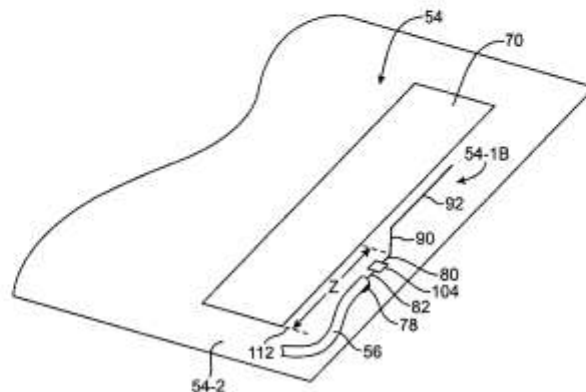
A handheld electronic device is provided that contain wireless communications circuitry. The wireless communications circuitry may include antenna structures. A first antenna may handle first and second communications bands. A second antenna may handle additional communications bands. The first and second antennas may be located at opposite ends of the handheld electronic device. Conductive structures in the handheld electronic device may form an antenna ground plane. The antenna ground plane may have portions defining an antenna slot. An L-shaped antenna resonating element may be located adjacent to the slot. In the first communications band, the L-shaped antenna resonating element may serve as a non-radiating coupling stub that excites the antenna slot. In the second communications band, the L-shaped antenna resonating element may transmit and receive radio-frequency signals.

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20 Claims, 15 Drawing Sheets





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

(10) **Patent No.:** **US 7,768,464 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

- (54) **ANTENNA DEVICE**
- (75) **Inventors:** **Yi Ju Lee**, Tu-Cheng (TW); **An Yu Yen**, Tu-Cheng (TW)
- (73) **Assignee:** **Cheng Uei Precision Industry Co., Ltd.**, Taipei Hsien (TW)
- (*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 172 days.

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Primary Examiner—Tho G Phan

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

- (21) **Appl. No.:** **12/222,131**
- (22) **Filed:** **Aug. 4, 2008**
- (65) **Prior Publication Data**
US 2010/0026591 A1 Feb. 4, 2010

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

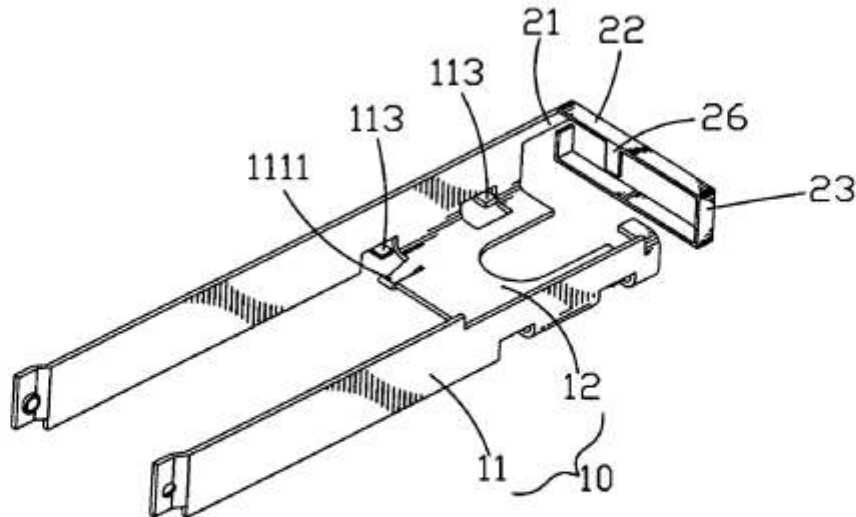
- (56) **References Cited**
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6,246,371 B1 * 6/2001 Kurz et al. 343/702

(57) **ABSTRACT**

An antenna device includes a supporting body and an antenna. The supporting body has two arms and a connecting portion disposed between and connecting the two arms. The antenna has a grounding portion extending from one end of one of the arms. A free end of the grounding portion perpendicularly extends toward the other arm to form a first radiating strip, and a second radiating strip, a third radiating strip and a fourth radiating strip are respectively integrally formed in turn. The first, second, third and fourth radiating strips together define substantially a rectangular shape. A feed-in portion extends from the first radiating strip. The grounding portion connects the supporting body functioning as a ground of the antenna, which increases the area of the grounding for the antenna and enhances the performance of signal transmitting and receiving of the antenna device.

6 Claims, 6 Drawing Sheets

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

(10) **Patent No.:** **US 7,768,466 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

(54) **MULTIBAND FOLDED LOOP ANTENNA**

(75) Inventors: **Yun-Wen Chi**, Taipei County (TW);
Kin-Lu Wong, Kaohsiung (TW)

(73) Assignee: **Acer Incorporated**, 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 218 days.

(21) Appl. No.: **12/213,166**

(22) Filed: **Jun. 16, 2008**

(65) **Prior Publication Data**

US 2009/0256763 A1 Oct. 15, 2009

(30) **Foreign Application Priority Data**

Apr. 9, 2008 (TW) 97112916 A

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

(52) **U.S. Cl.** **343/741; 343/700 MS**

(58) **Field of Classification Search** **343/700 MS, 343/702, 741, 866, 860**

See application file for complete search history.

(56) **References Cited**

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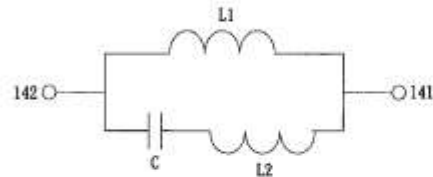
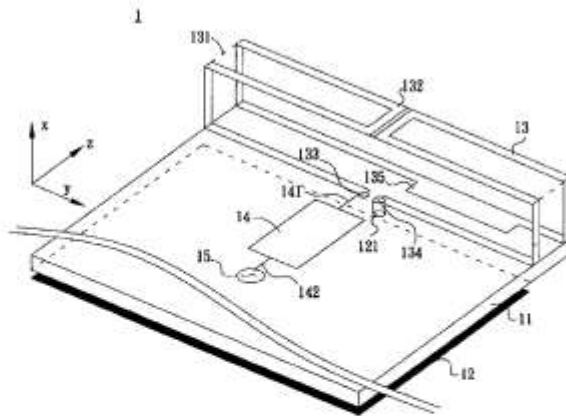
Primary Examiner—Tan Ho

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

(57) **ABSTRACT**

The present invention relates to a multiband folded loop antenna comprising a dielectric substrate, a ground plane, a radiating portion and a matching circuit. The ground plane is located on the dielectric substrate and has a grounding point. The radiating portion comprises a supporter, a loop strip, and a tuning patch. The loop strip has a length about a half-wavelength of the central frequency of the antenna's first resonant mode. The loop strip has a feeding end and a grounding end, with the grounding end electrically connected to the grounding point on the ground plane. The loop strip is folded into a three-dimensional structure and is supported by the supporter. The tuning patch is electrically connected to the loop strip. The matching circuit is located on the dielectric substrate with one terminal electrically connected to the feeding end of the loop strip and another terminal to a signal source.

15 Claims, 15 Drawing Sheets





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

(10) **Patent No.:** **US 7,768,470 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

(54) **ULTRA WIDEBAND ANTENNA**
(75) Inventors: **Xiang-Hong Qin**, Shenzhen (CN);
Jia-Lin Teng, Tu-Cheng (TW)
(73) Assignees: **Hong Fu Jin Precision Industry**
(ShenZhen) Co., Ltd., Shenzhen,
Guangdong Province (CN); **Hon Hai**
Precision Industry Co., Ltd., Tu-Cheng,
Taipei Hsien (TW)

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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 441 days.

(21) Appl. No.: **11/847,357**

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

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Mar. 8, 2007 (CN) 2007 1 0200260

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H01Q 13/10 (2006.01)

(52) **U.S. Cl.** **343/767; 343/700 MS;**
343/770; 343/795; 343/846

(58) **Field of Classification Search** 343/700 MS,
343/767, 769, 829, 846, 770, 795
See application file for complete search history.

(56) **References Cited**
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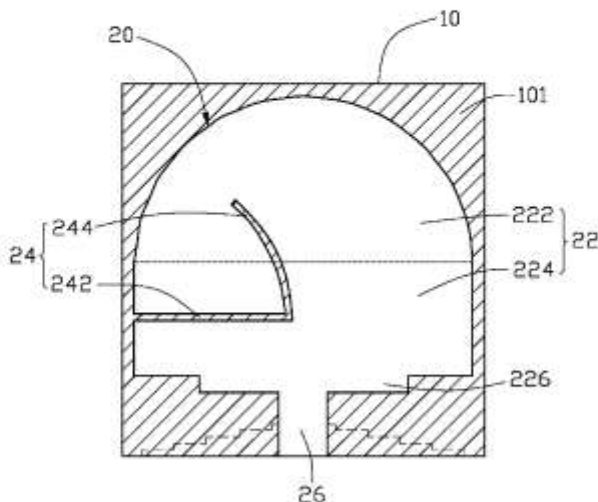
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Primary Examiner—Douglas W Owens
Assistant Examiner—Chuc D Tran
(74) *Attorney, Agent, or Firm*—Frank R. Niranjan

(57) **ABSTRACT**

An ultra wideband antenna (20) is disposed on a substrate (10). The substrate includes a first surface (101) and a second surface (102). The ultra wideband antenna includes a radiation body (22), a feeding portion (26), and a grounded portion (28). The radiation body disposed on the first surface is used for transceiving electromagnetic signals. The radiation body includes a semicircle-shaped metal portion (222) and a rectangle-shaped metal portion (224) and defines a slot (24) starting at an edge therein. The feeding portion is electronically connected to the radiation body for feeding signals to the radiation body. The grounded portion is disposed on the second surface.

13 Claims, 5 Drawing Sheets





US007768471B2

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

(10) **Patent No.:** **US 7,768,471 B2**
(45) **Date of Patent:** **Aug. 3, 2010**

(54) **DIPOLE ANTENNA DEVICE AND DIPOLE ANTENNA SYSTEM**

(75) Inventors: **Saou-Wen Su**, Taipei (TW); **Jui-Hung Chou**, Tai-Chung (TW)

(73) Assignees: **Silitek Electronic (Guangzhou) Co., Ltd.**, Guangzhou (CN); **Lite-On Technology Corp.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 8 days.

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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

(52) **U.S. Cl.** **343/795; 343/820**

(58) **Field of Classification Search** **343/795, 343/793, 803, 820, 821, 700 MS**

See application file for complete search history.

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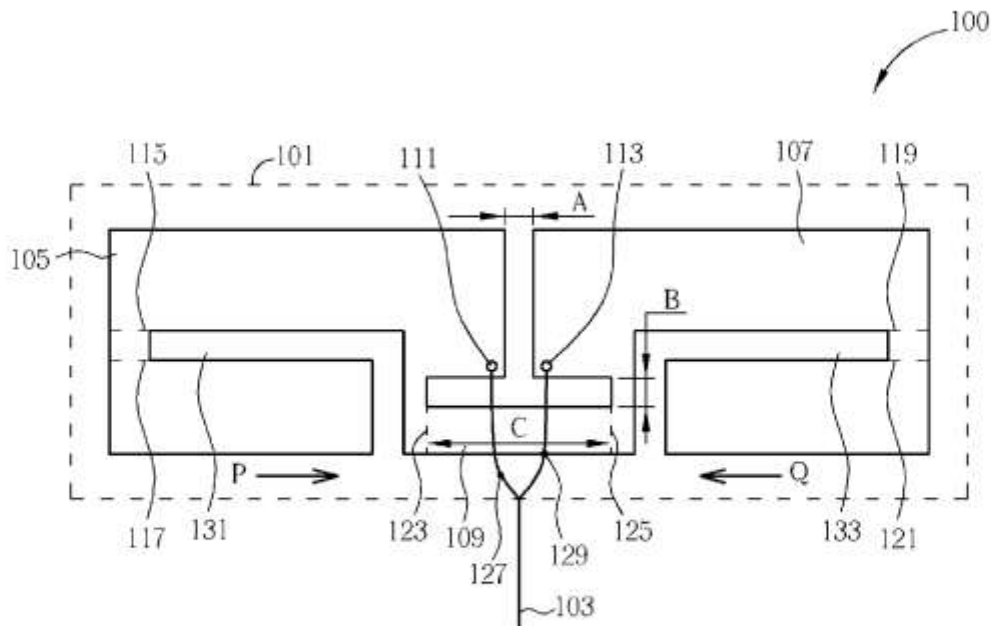
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Kile Goekjian Reed & McManus PLLC

(57) **ABSTRACT**

A dipole antenna device includes a first metal piece including at least one bending part and a first feeding point; a second metal piece including a second bending part and a second feeding point; and a third metal piece electrically connected to a first connection point of the first metal piece and a second connection point of the second metal piece; wherein the first metal piece and the second metal piece are not electrically connected to each other except the first connection point and the second connection point.

12 Claims, 8 Drawing Sheets





US007773036B2

(12) **United States Patent**
Tsai

(10) **Patent No.:** **US 7,773,036 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

- (54) **ANTENNA STRUCTURE**
- (75) **Inventor:** **Hsiao-Ming Tsai**, Taipei (TW)
- (73) **Assignee:** **ASUSTek Computer Inc.**, Taipei (TW)
- (*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 189 days.

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Primary Examiner—Shih-Chao Chen
(74) *Attorney, Agent, or Firm*—Quintero Law Office

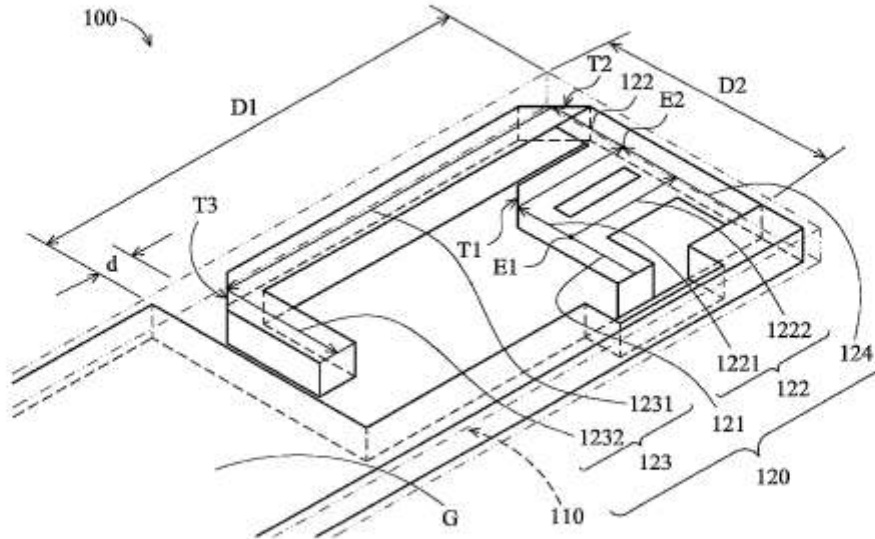
- (21) **Appl. No.:** **12/183,014**
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- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/48 (2006.01)
- (52) **U.S. Cl.** **343/700 MS; 343/702; 343/846**
- (58) **Field of Classification Search** **343/700 MS, 343/702, 846, 850, 873**
See application file for complete search history.
- (56) **References Cited**

(57) **ABSTRACT**

An antenna structure includes a circuit board with a ground surface and a printed antenna. The printed antenna includes a signal feed-in portion, a first radiating unit connected to the signal feed-in portion and a second radiating unit connected to the first radiating unit and has a plurality of printed layers. The first radiating unit diverges and forms a first radiating element having a first turning portion and a second radiating element at a first end, and the first radiating element and the second radiating element are combined at a second end. The second radiating unit includes a third radiating element, a fourth radiating element, a second turning portion located between the third radiating element and the second end and a third turning portion located between the third radiating element and the fourth radiating element. A distance is formed between the fourth radiating element and the ground surface.

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9 Claims, 2 Drawing Sheets





US007773038B2

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

(10) **Patent No.:** **US 7,773,038 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **ELECTRONIC DEVICES WITH ANTENNA SENSORS**

(75) Inventors: **Brett William Degner**, Menlo Park, CA (US); **Chris Ligtenberg**, San Carlos, CA (US); **Douglas Blake Kough**, San Jose, CA (US); **Paul Andrew Gojenola**, San Jose, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 192 days.

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(22) Filed: **Apr. 2, 2008**

(65) **Prior Publication Data**

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H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **343/702; 343/894**

(58) **Field of Classification Search** **343/702, 343/760, 894; 455/90.3**

See application file for complete search history.

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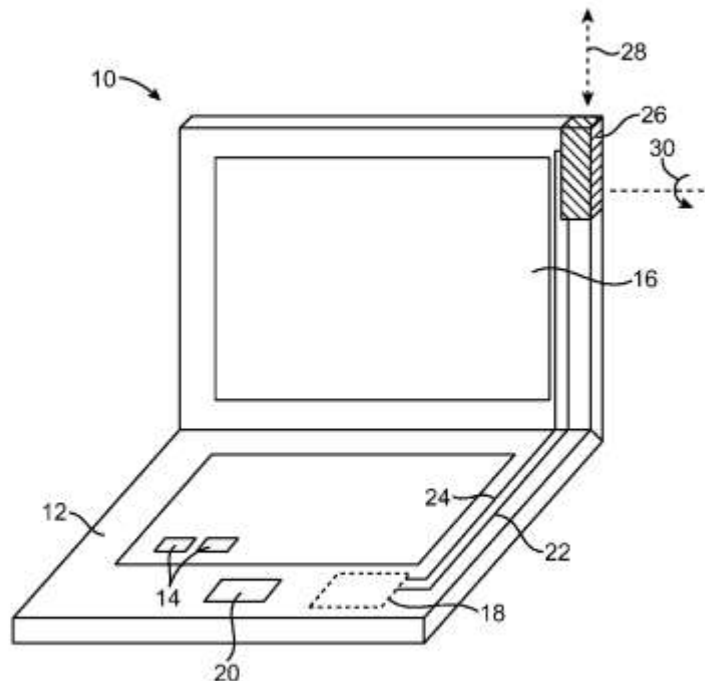
Primary Examiner—Tan Ho

(74) *Attorney, Agent, or Firm*—Treyz Law Group; G. Victor Treyz; David C. Kellogg

(57) **ABSTRACT**

Electronic devices may be provided with sensors for determining the presence and position of extendable and removable antennas. The antennas may extend by rotating about an axis, by reciprocating along their length, or by flexing from a retracted position to an extended position. The electronic device may determine when a removable antenna is attached or detached using signals from the sensors. The electronic device may determine the extent to which an antenna has been extended using signals from the sensors. The electronic device may control the operation of a radio-frequency transceiver that is coupled to the antenna based on signals from the sensors. The electronic device may turn the transceiver off when the antenna is retracted or removed. When the antenna is partially extended, the electronic device may place the transceiver in a low-power mode or place a dual-band transceiver into a single-band mode.

21 Claims, 13 Drawing Sheets





US007773039B2

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

(10) **Patent No.:** **US 7,773,039 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **HIGH FREQUENCY WAVE ANTENNA FOR AN AUTOMOBILE**

(75) Inventors: **Kenichiro Shimo**, Chiyoda-ku (JP);
Kazuyoshi Noda, Chiyoda-ku (JP);
Takuji Hayashi, Chiyoda-ku (JP)

(73) Assignee: **Asahi 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 30 days.

(21) Appl. No.: **12/169,136**

(22) Filed: **Jul. 8, 2008**

(65) **Prior Publication Data**

US 2009/0027283 A1 Jan. 29, 2009

(30) **Foreign Application Priority Data**

Jul. 9, 2007 (JP) 2007-179706

(51) **Int. Cl.**
H01Q 1/32 (2006.01)
H01Q 1/02 (2006.01)

(52) **U.S. Cl.** **343/713; 343/704**

(58) **Field of Classification Search** **343/704, 343/713**

See application file for complete search history.

(56) **References Cited**

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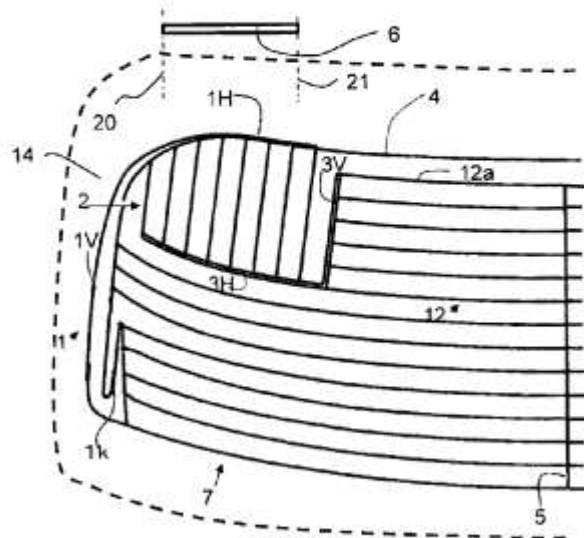
Primary Examiner—Michael C Wimer

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

(57) **ABSTRACT**

A high frequency wave antenna for an automobile is provided, which improves antenna gain of an antenna conductor provided in a spoiler. A defogger is provided on a rear window glass plate 14, a part of a plurality of heater wires extend in a horizontal direction, a spoiler including an antenna conductor 6 embedded therein is provided above the rear window glass plate 14; at least one of a plurality of bus bars has a bus bar horizontal portion 1H extending in a horizontal direction, the bus bar horizontal portion 1H is provided in an upper region of the rear window glass plate 14, and a plurality of vertical heater wires 2 extending in a vertical direction from the bus bar horizontal portion 1H, are provided.

19 Claims, 8 Drawing Sheets





US007773040B2

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

(10) **Patent No.:** **US 7,773,040 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **DUAL-BAND F-SLOT PATCH ANTENNA**

(75) Inventors: **Qinjiang Rao**, Waterloo (CA); **Geyi Wen**, Waterloo (CA); **Dong Wang**, Waterloo (CA); **Mark Pecan**, Waterloo (CA)

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

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

(21) Appl. No.: **11/688,043**

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

(65) **Prior Publication Data**
US 2008/0231530 A1 Sep. 25, 2008

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

(52) **U.S. CL.** **343/729; 343/700 MS; 343/702; 343/767**

(58) **Field of Classification Search** **343/700 MS, 343/767, 702, 729**
See application file for complete search history.

(56) **References Cited**

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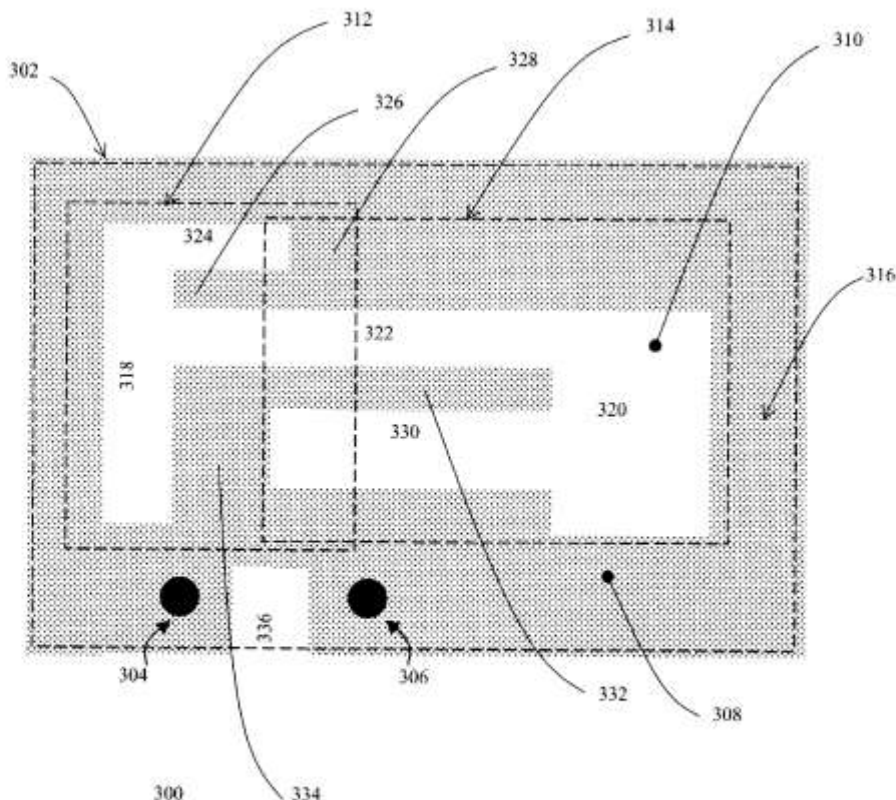
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Heenan Blaikie LLP

(57) **ABSTRACT**

A dual-band antenna includes a planar conductive layer comprising a conductive region and a central non-conductive region. The conductive region and the non-conductive region together define a pair of interconnected F-slot structures, and a loop strip structure coupled to and disposed around the F-slot patch slot antenna structures.

20 Claims, 8 Drawing Sheets





US007773041B2

(12) **United States Patent**
Wang

(10) **Patent No.:** **US 7,773,041 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **ANTENNA SYSTEM**

(75) Inventor: **Shu-Li Wang**, Santa Clara, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 827 days.

(21) Appl. No.: **11/486,223**

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

(65) **Prior Publication Data**

US 2008/0012774 A1 Jan. 17, 2008

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

(52) **U.S. Cl.** **343/741; 343/702; 343/866**

(58) **Field of Classification Search** **343/702, 343/741, 742, 866**

See application file for complete search history.

(56) **References Cited**

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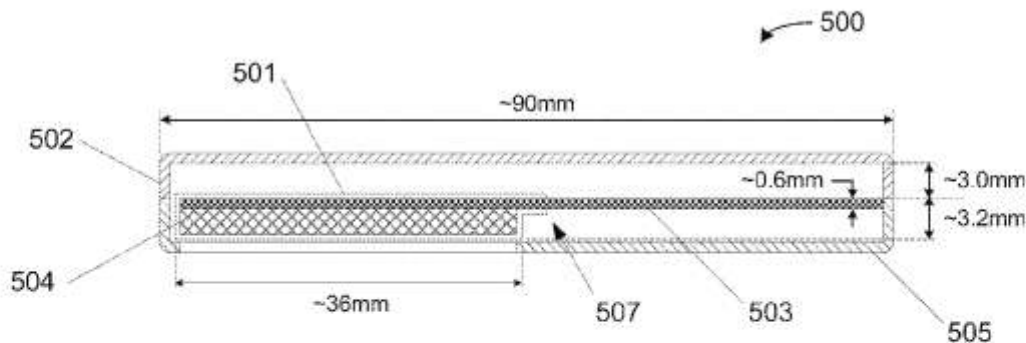
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Primary Examiner—Tan Ho

(57) **ABSTRACT**

An antenna system includes a dielectrically-loaded loop element electromagnetically coupled to a planar element. The antenna system exhibits uniform, broadband radiation and reception patterns.

12 Claims, 12 Drawing Sheets





US007773044B2

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

(10) **Patent No.:** **US 7,773,044 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **METHOD FOR ENHANCING AN ANTENNA PERFORMANCE, ANTENNA, AND APPARATUS**

(75) Inventors: **Markku Oksanen**, Helsinki (FI); **Pekka Ikonen**, Helsinki (FI); **Markku Heino**, Espoo (FI); **Eira Seppälä**, Helsinki (FI); **Reijo Lehtiniemi**, Helsinki (FI)

(73) Assignee: **Nokia Corporation**, Keilalahdentie, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 220 days.

(21) Appl. No.: **12/109,778**

(22) Filed: **Apr. 25, 2008**

(65) **Prior Publication Data**

US 2009/0267854 A1 Oct. 29, 2009

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

(52) **U.S. Cl.** **343/787; 343/700 MS**

(58) **Field of Classification Search** **343/787; 343/700 MS, 702**

See application file for complete search history.

(56) **References Cited**

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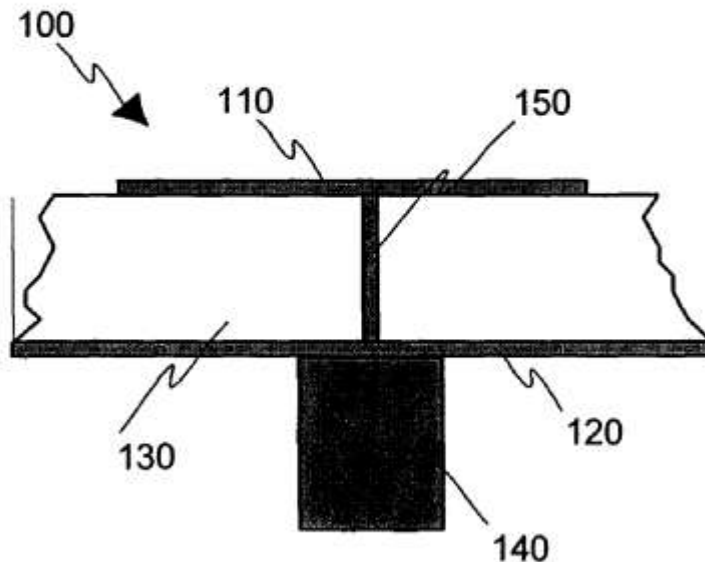
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Alfred A. Fressola; Ware, Fressola, Van Der Sluys & Adolphson, LLP

(57) **ABSTRACT**

The invention relates to a method for enhancing an antenna performance, wherein the property of the antenna substrate is modified by using an ultrasonic field. The invention also relates to an antenna comprising the modified antenna substrate, and to an apparatus comprising the modified antenna substrate.

24 Claims, 3 Drawing Sheets





US007773046B2

(12) **United States Patent**
Shigemoto

(10) **Patent No.:** **US 7,773,046 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **ANTENNA DEVICE**
(75) Inventor: **Hideki Shigemoto, Osaka (JP)**
(73) Assignee: **Panasonic Corporation, Osaka (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.: **11/878,690**
(22) Filed: **Jul. 26, 2007**
(65) **Prior Publication Data**
US 2008/0030423 A1 Feb. 7, 2008
(30) **Foreign Application Priority Data**
Aug. 1, 2006 (JP) 2006-209663

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Primary Examiner—Michael C Wimer
(74) *Attorney, Agent, or Firm*—McDermott Will & Emery LLP

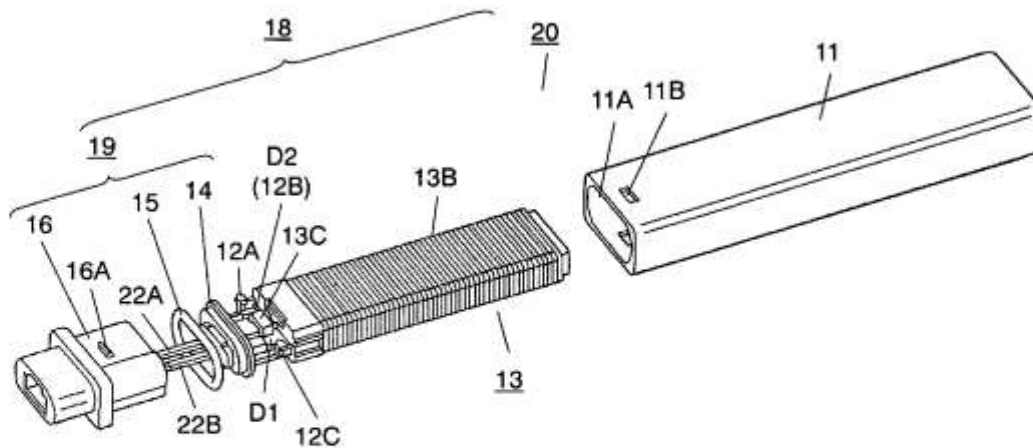
(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/42 (2006.01)
(52) **U.S. Cl.** **343/872**
(58) **Field of Classification Search** 343/702,
343/872, 906, 895, 873; 439/578, 916
See application file for complete search history.

(57) **ABSTRACT**

The present invention provides an antenna device that is easy to manufacture by doing away with the wiring section. The antenna device includes an antenna member housed inside a nearly tubular case and a terminal body electrically connected to the antenna member for taking out electrical signal to outside, and the antenna member is sealed inside the case. The antenna device also has a housing for sealing the antenna member inside the case for engaging with a connector to be coupled, and a plugging member having an O-ring and a terminal stage fit into a nearly integral unit.

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





US007773047B2

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

(10) **Patent No.:** **US 7,773,047 B2**
(45) **Date of Patent:** **Aug. 10, 2010**

(54) **ANTENNA AND METHOD OF MAKING THE SAME**

(75) Inventors: **Toshiyuki Horikoshi**, Hitachi (JP);
Masahiko Kobayashi, Hitachi (JP);
Seigi Aoyama, Kitaibaraki (JP); **Hiroshi Yamanobe**, Hitachi (JP); **Shinsuke Murano**, Kasama (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 726 days.

(21) Appl. No.: **11/523,734**

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

(65) **Prior Publication Data**
US 2007/0069971 A1 Mar. 29, 2007

(30) **Foreign Application Priority Data**
Sep. 21, 2005 (JP) 2005-274011

(51) **Int. Cl.**
H01Q 1/40 (2006.01)

(52) **U.S. Cl.** **343/873; 343/895**

(58) **Field of Classification Search** **343/873, 343/895, 897**
See application file for complete search history.

(56) **References Cited**
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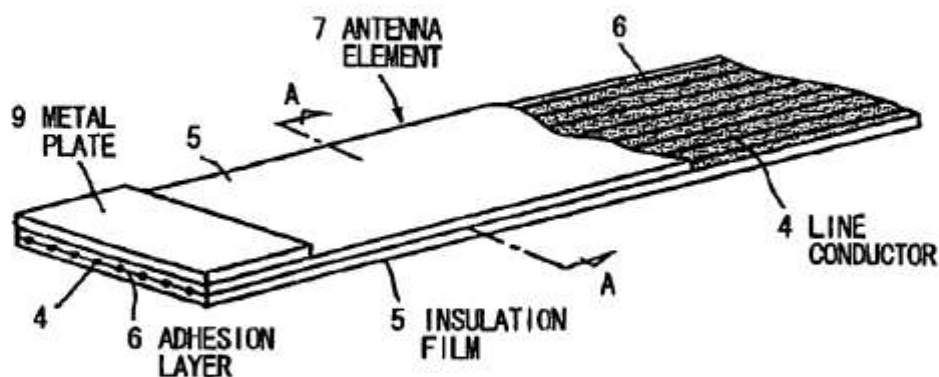
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Primary Examiner—Tan Ho
(74) *Attorney, Agent, or Firm*—McGinn IP Law Group, PLLC

(57) **ABSTRACT**

An antenna having an antenna element bent in a predetermined shape. The antenna element has a plurality of line conductors that are arranged in parallel and are sandwiched by two insulation films. A method of making an antenna has the steps of: arranging in parallel a plurality of line conductors, each of which having a width of 0.04 mm or less, at intervals of 10 times or more the width of each of the line conductors; discharging continuously the plurality of line conductors such that visibility of the line conductors is reduced; and sandwiching continuously the discharged line conductors by planar transparent insulation films with a sticking or adhesion layer to have an antenna element.

17 Claims, 4 Drawing Sheets





US00777677B2

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

(10) **Patent No.:** **US 7,777,677 B2**
(45) **Date of Patent:** **Aug. 17, 2010**

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

(75) Inventors: **Akihiro Bungo**, Tokyo (JP); **Takao Yokoshima**, Tokyo (JP); **Shinsuke Yukimoto**, Kumagaya (JP); **Toshiaki Edamatsu**, Chichibu-gun (JP)

(73) Assignee: **Mitsubishi Material 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 320 days.

(21) Appl. No.: **10/596,812**

(22) PCT Filed: **Dec. 24, 2004**

(86) PCT No.: **PCT/JP2004/019337**

§ 371 (c)(1),

(2), (4) Date: **Jul. 19, 2007**

(87) PCT Pub. No.: **WO2005/064743**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 25, 2003	(JP)	2003-430022
Mar. 12, 2004	(JP)	2004-070875
Mar. 12, 2004	(JP)	2004-071513
Aug. 4, 2004	(JP)	2004-228157
Aug. 31, 2004	(JP)	2004-252435
Oct. 18, 2004	(JP)	2004-302924

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

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

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

(56) **References Cited**

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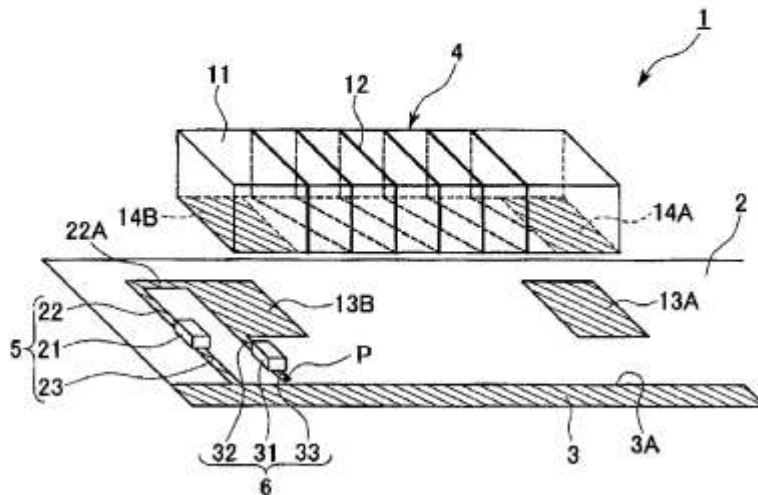
Primary Examiner—Trinh V Dinh

(74) *Attorney, Agent, or Firm*—Leason Ellis LLP.

(57) **ABSTRACT**

There is provided an antenna device including a substrate, an earth section which is disposed on a portion of the substrate, a feed point which is disposed on the substrate, a loading section disposed on the substrate and constructed with a line-shaped conductor pattern which is formed in a longitudinal direction of an elementary body made of a dielectric material, an inductor section which connects one end of the conductor pattern to the earth section, and a feed point which feeds a current to a connection point of the one end of the conductor pattern and the inductor section, wherein a longitudinal direction of the loading section is arranged to be parallel to an edge side of the earth section.

8 Claims, 28 Drawing Sheets





US007777682B2

(12) **United States Patent**
Yagi

(10) **Patent No.:** **US 7,777,682 B2**
(45) **Date of Patent:** **Aug. 17, 2010**

(54) **PLANE CIRCULAR POLARIZATION ANTENNA AND ELECTRONIC APPARATUS**

(75) Inventor: **Shigeru Yagi**, Tokyo (JP)

(73) Assignee: **Casio Computer Co., Ltd.**, Tokyo (JP)

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

(21) Appl. No.: **12/011,952**

(22) Filed: **Jan. 30, 2008**

(65) **Prior Publication Data**

US 2008/0180339 A1 Jul. 31, 2008

(30) **Foreign Application Priority Data**

Jan. 31, 2007 (JP) 2007-021301

(51) **Int. Cl.**

H01Q 21/00 (2006.01)

H01Q 13/10 (2006.01)

(52) **U.S. Cl.** **343/725; 343/702; 343/767**

(58) **Field of Classification Search** **343/702;**

343/725, 767

See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Vibol Tan

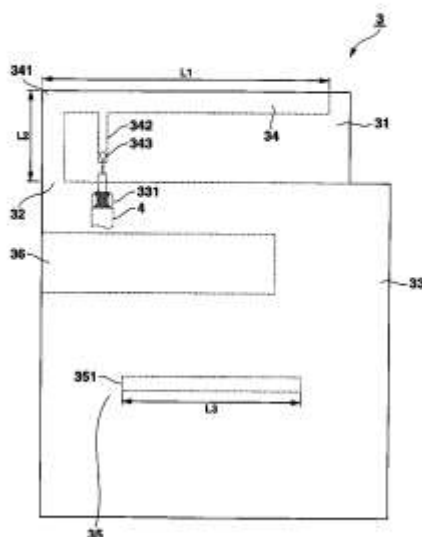
Assistant Examiner—Dylan White

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

(57) **ABSTRACT**

According to an embodiment, a plane circular polarization antenna comprises a flat insulating substrate and a conductor provided on the flat insulating substrate. The conductor comprises an inverted F antenna including a feeding point, a ground portion, the ground portion including a slot antenna including a slot, and a short-circuiting portion provided in a part of an area between the inverted F antenna and the slot antenna.

8 Claims, 13 Drawing Sheets





US007777684B2

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

(10) **Patent No.:** **US 7,777,684 B2**
(45) **Date of Patent:** **Aug. 17, 2010**

(54) **MULTI-BAND SLOT-STRIP ANTENNA**

(75) Inventors: **Qinjiang Rao**, Waterloo (CA); **Geyi Wen**, Waterloo (CA); **Mark Peecn**, 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 462 days.

(21) Appl. No.: **11/688,052**

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

(65) **Prior Publication Data**

US 2008/0231532 A1 Sep. 25, 2008

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

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

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

See application file for complete search history.

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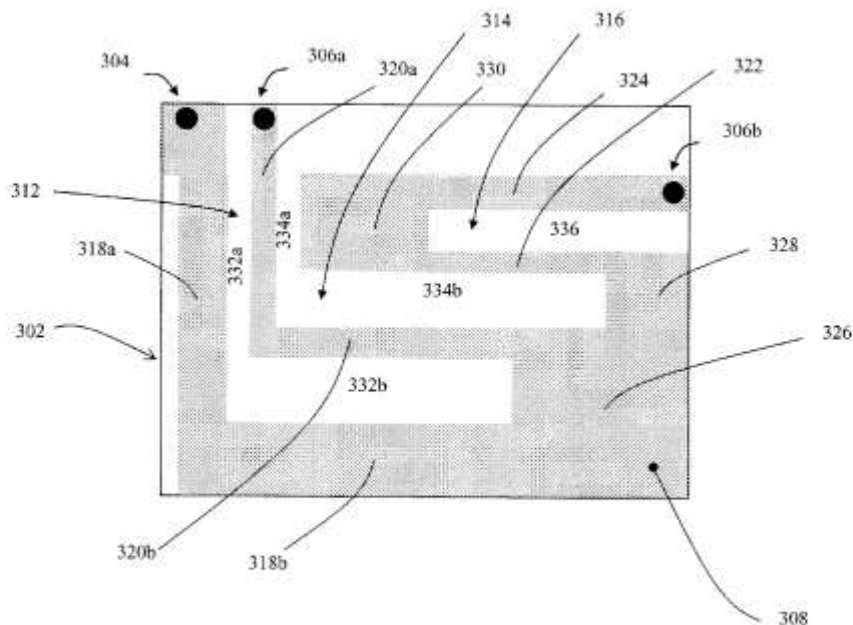
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Heenan Blaikie LLP

(57) **ABSTRACT**

A multi-band antenna includes a planar conductive layer that comprises a conductive region and a non-conductive region. The conductive region and the non-conductive region together define a first slot-strip structure, a second slot-strip structure coupled to the first slot-strip structure, and a third slot-strip structure coupled to the second slot-strip structure. The first slot-strip structure includes a signal feed portion. The second slot-strip structure includes a first signal grounding portion. The third slot-strip structure includes a second signal grounding portion.

20 Claims, 8 Drawing Sheets





US007777685B2

(12) **United States Patent**
Stuart

(10) **Patent No.:** **US 7,777,685 B2**
(45) **Date of Patent:** **Aug. 17, 2010**

(54) **SMALL SPHERICAL ANTENNAS**

(75) Inventor: **Howard R. Stuart**, Glen Ridge, NJ (US)

(73) Assignee: **Alcatel-Lucent USA Inc.**, Murray Hill, NJ (US)

(*) 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.: **11/540,442**

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

(65) **Prior Publication Data**

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

(52) **U.S. Cl.** **343/795**; 343/814; 343/742;
343/867

(58) **Field of Classification Search** 343/700 MS,
343/795, 741, 742, 866, 867, 810, 797, 814
See application file for complete search history.

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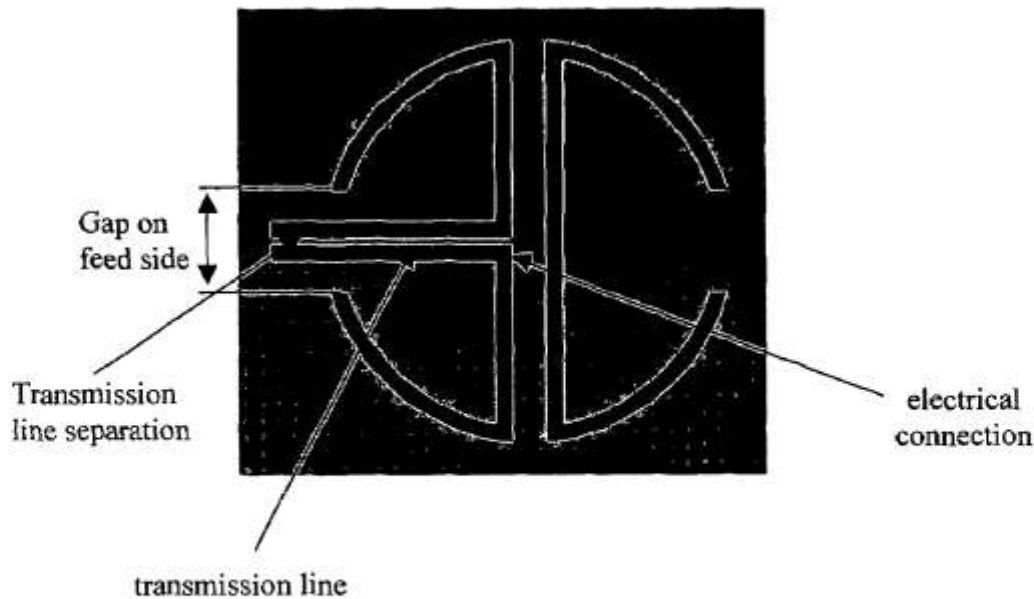
Primary Examiner—Hoang Anh T Le

(74) *Attorney, Agent, or Firm*—Martin L. Finston

(57) **ABSTRACT**

An antenna is provided for operating within the electrically small antenna regime (i.e., $ka \approx 0.5$), and having bandwidth performance quite close to fundamental limits. The antenna of the invention, in various embodiments, is based upon spherical resonator structures that are characterized by a performance factor (Q/Q_{theor}) close to 1.5. The antenna combines a resonator structure determined according to the method of the invention with an appropriate transmission line feeding arrangement, such that the resonator effectively couples the transmission line mode to the radiating spherical harmonic mode in an impedance-matched manner.

19 Claims, 10 Drawing Sheets





US007777686B2

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

(10) **Patent No.:** **US 7,777,686 B2**
(45) **Date of Patent:** **Aug. 17, 2010**

(54) **MULTI-LAYER ISOLATED MAGNETIC DIPOLE ANTENNA**

(75) Inventors: **Laurent Desclos**, San Diego, CA (US);
Jeffrey Shamblin, San Marcos, CA (US); **Sebastian Rowson**, San Diego, CA (US); **Rowland Jones**, Carlsbad, CA (US); **Young Cha**, San Diego, CA (US)

(73) Assignee: **Ethertronics, Inc.**, San Diego, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 235 days.

(21) Appl. No.: **12/059,346**

(22) Filed: **Mar. 31, 2008**

(65) **Prior Publication Data**
US 2009/0243951 A1 Oct. 1, 2009

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

(52) **U.S. Cl.** **343/795; 343/787; 343/846**

(58) **Field of Classification Search** **343/767, 343/787, 795, 829, 846, 700 MS**

See application file for complete search history.

(56) **References Cited**

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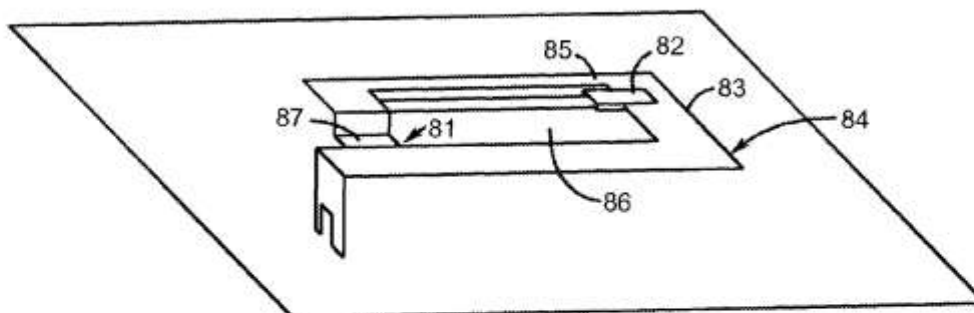
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Joshua S. Schoonover; Coastal Patent, LLC

(57) **ABSTRACT**

A multi-layer isolated magnetic dipole (IMD) with improved bandwidth and efficiency characteristics to be used in wireless communications and other applicable systems. The multi-layer IMD antenna comprises an IMD element positioned above a ground plane, a conductive element positioned above a ground plane and coupled to the first portion having one or more slot regions being defined between the IMD element and the conductive element and one or more capacitive elements positioned across the one or more slot regions. The range of frequencies covered to be determined by the shape, size, and number of elements in the physical configuration of the components.

20 Claims, 10 Drawing Sheets





US007777688B2

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

(10) **Patent No.:** **US 7,777,688 B2**
(45) **Date of Patent:** **Aug. 17, 2010**

(54) **POLARIZATION SWITCHING ANTENNA DEVICE**

(75) Inventors: **Kazuya Tani, Osaka (JP); Yoshio Koyanagi, Kanagawa (JP); Hiroshi Haruki, Kanagawa (JP)**

(73) Assignee: **Panasonic Corporation, Osaka (JP)**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 498 days.

(21) Appl. No.: **11/721,566**

(22) PCT Filed: **Aug. 16, 2005**

(86) PCT No.: **PCT/JP2005/014947**

§ 371 (c)(1),
(2), (4) Date: **Jun. 13, 2007**

(87) PCT Pub. No.: **WO2006/064590**

PCT Pub. Date: **Jun. 22, 2006**

(65) **Prior Publication Data**

US 2009/0251383 A1 Oct. 8, 2009

(30) **Foreign Application Priority Data**

Dec. 16, 2004 (JP) 2004-363844

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

(52) **U.S. Cl.** **343/852**

(58) **Field of Classification Search** 343/753,
343/702, 745, 737, 852

See application file for complete search history.

(56) **References Cited**

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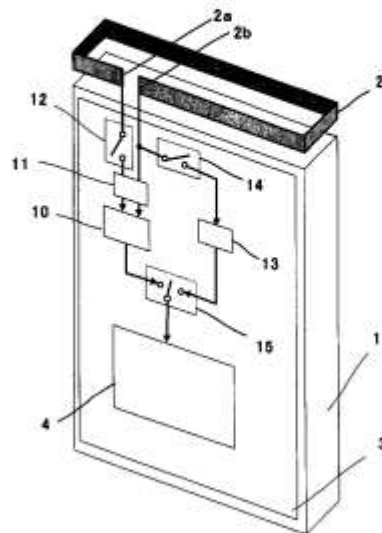
Primary Examiner—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Pearne & Gordon LLP

(57) **ABSTRACT**

A polarization switching antenna device capable of switching a polarization without increase of an antenna installing space and also handling a variety of frequency bands is provided. A connection state of one end of a loop antenna element arranged on a side surface of a case is switched. Thus, the polarization characteristic is switched by switching selectively whether the antenna element should constitute a loop antenna or a linear antenna. Matching circuits suitable for respective characteristics are provided. The loop antenna can be fed in terms of a balanced feeding. A balanced feeding and an unbalanced feeding can be switched.

9 Claims, 9 Drawing Sheets





US007782257B2

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

(10) **Patent No.:** **US 7,782,257 B2**
(45) **Date of Patent:** **Aug. 24, 2010**

(54) **MULTI-BAND INTERNAL ANTENNA OF SYMMETRY STRUCTURE HAVING STUB**

(75) Inventors: **Byung-Chan Kim**, Daejeon (KR); **Jae-Ick Choi**, Daejeon (KR); **Byung-Je Lee**, Seoul (KR); **Byung-Woon Jung**, Seoul (KR); **Han-Phil Rhyu**, Seoul (KR); **Byung-Gil Yu**, Seoul (KR)

(73) Assignee: **Electronics and Telecommunications Research Institute**, Daejeon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 536 days.

(21) Appl. No.: **11/718,087**

(22) PCT Filed: **Jul. 4, 2005**

(86) PCT No.: **PCT/KR2005/002116**

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(2), (4) Date: **Apr. 26, 2007**

(87) PCT Pub. No.: **WO2006/049382**

PCT Pub. Date: **May 11, 2006**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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

(52) **U.S. Cl.** **343/700 MS; 343/843; 343/870; 343/831**

(58) **Field of Classification Search** 343/700 MS, 343/831, 870, 843
See application file for complete search history.

(56) **References Cited**

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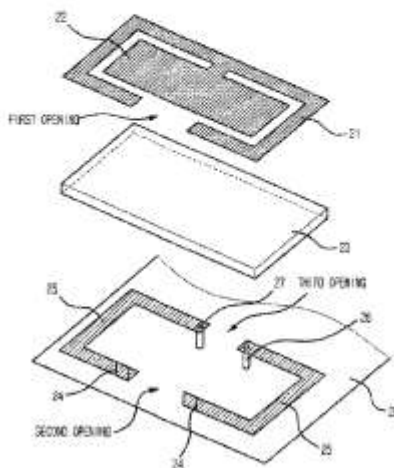
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Primary Examiner—Douglas W Owens
Assistant Examiner—Dieu Hien T Duong

(57) **ABSTRACT**

A multi-band internal antenna includes a top patch defining a first loop that defines a space therein and a first opening; a stub provided within the space defined by the first loop; a bottom patch provided below the top patch and having a first section and a second section connected to a feeder part and a shorting part, respectively, the bottom patch defining a second loop and second and third openings, the second and third openings being provided on opposing sides of the second loop so that the first and second sections of the bottom patch are separated from each other; and a first connecting part and a second connecting part connecting a first portion and a second portion of the top patch, respectively, to the first section and the second section of the bottom patch to transmit a signal from the bottom patch to the top patch.

9 Claims, 8 Drawing Sheets





US007782258B2

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

(10) **Patent No.:** **US 7,782,258 B2**
(45) **Date of Patent:** **Aug. 24, 2010**

(54) **INTEGRATED ANTENNA FOR WORLDWIDE INTEROPERABILITY FOR MICROWAVE ACCESS (WIMAX) AND WLAN**

(75) Inventors: **Cheng-Han Lee**, Kaohsiung (TW);
Ching-Chia Mai, Kaohsiung (TW);
Chi-Yueh Wang, Kaohsiung (TW)

(73) Assignee: **Yageo Corporation**, Kaohsiung (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 103 days.

(21) Appl. No.: **12/020,695**

(22) Filed: **Jan. 28, 2008**

(65) **Prior Publication Data**
US 2009/0146884 A1 Jun. 11, 2009

(30) **Foreign Application Priority Data**
Dec. 5, 2007 (TW) 96146225 A

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

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

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

(56) **References Cited**
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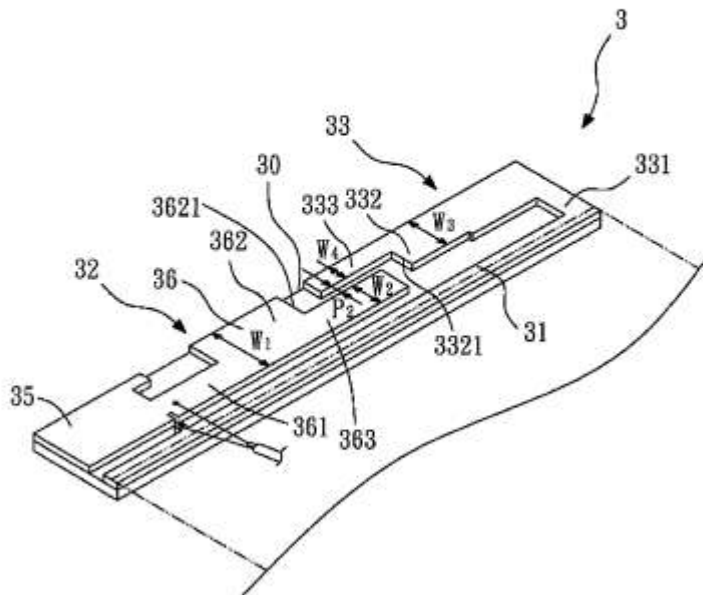
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Primary Examiner—Hoang Anh T Le
(74) *Attorney, Agent, or Firm*—Volentine & Whitt, P.L.L.C.

(57) **ABSTRACT**

An integrated antenna for worldwide interoperability for microwave access (WiMax) and wireless local area network (WLAN), includes a substrate, a grounding metal strip, and first and second radiating metal strips. The first radiating metal strip is disposed on the substrate and is not connected to the grounding metal strip. The first radiating metal strip has a first portion and a second portion on two ends thereof. The first and second portions are used to induce first and second resonance modes, respectively. The second radiating metal strip is disposed on the substrate and is connected to the grounding metal strip. The second radiating metal strip is not connected to the first radiating metal strip. The energy is coupled from the second radiating metal strip to the first radiating metal strip to induce a third resonance mode. The antenna is adapted to the frequencies of WiMax and WLAN.

16 Claims, 6 Drawing Sheets





US007782260B2

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

(10) **Patent No.:** **US 7,782,260 B2**
(45) **Date of Patent:** **Aug. 24, 2010**

(54) **PLANAR ANTENNA**

(75) Inventors: **Tiao-Hsing Tsai**, Taipei Shien (TW);
Chih-Wei Liao, Yilan Shien (TW);
Chao-Hsu Wu, Tao Yuan Shien (TW);
Chieh-Ping Chiu, Yunlin 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 174 days.

(21) Appl. No.: **12/199,143**

(22) Filed: **Aug. 27, 2008**

(65) **Prior Publication Data**
US 2009/0256755 A1 Oct. 15, 2009

(30) **Foreign Application Priority Data**
Apr. 10, 2008 (TW) 97112991 A

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

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

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

See application file for complete search history.

(56) **References Cited**

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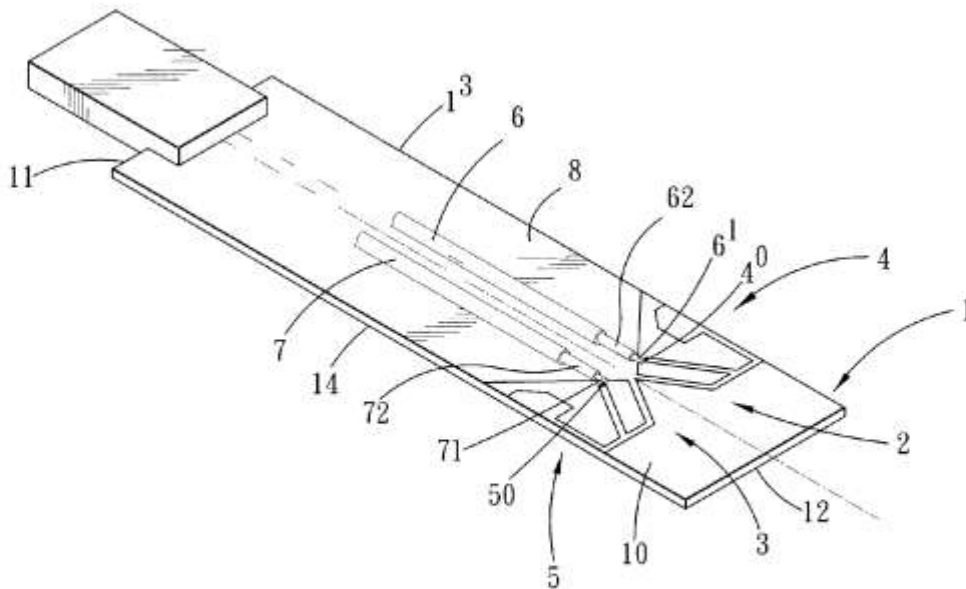
Primary Examiner—Hoang V Nguyen

(74) *Attorney, Agent, or Firm*—Stephen A. Bent; Foley & Lardner LLP

(57) **ABSTRACT**

An antenna includes a dielectric substrate, a grounding plane, first and second grounding elements, and first and second radiating elements. The grounding plane is formed on the dielectric substrate. The first and second grounding elements are formed on the dielectric substrate, have a curved shape and a size that are identical, and are connected to the grounding plane. The first and second radiating elements are formed on the dielectric substrate, have a curved shape and a size that are identical, are operable in the same frequency range, and are connected to the first and second grounding elements, respectively.

15 Claims, 10 Drawing Sheets





US007782261B2

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

(10) **Patent No.:** **US 7,782,261 B2**

(45) **Date of Patent:** **Aug. 24, 2010**

(54) **ANTENNA ARRANGEMENT**

(75) Inventors: **Rongbang-Thomas An**, Beijing (CN);
Lu Youyuan, Beijing (CN); **Liu Shu**,
Beijing (CN)

(73) Assignee: **Nokia Corporation**, Espoo (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 339 days.

(21) Appl. No.: **11/642,342**

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

(65) **Prior Publication Data**

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

(52) **U.S. Cl.** **343/702; 343/860**

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

(56) **References Cited**

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Wagner, R., "Double Stub Matching", pp. 1-8, Aug. 14, 2007, Retrieve from internet (Sep. 30, 2009) URL: <http://cnx.org/content/m1066/latest/>, Fig. 1, pp. 1-8.

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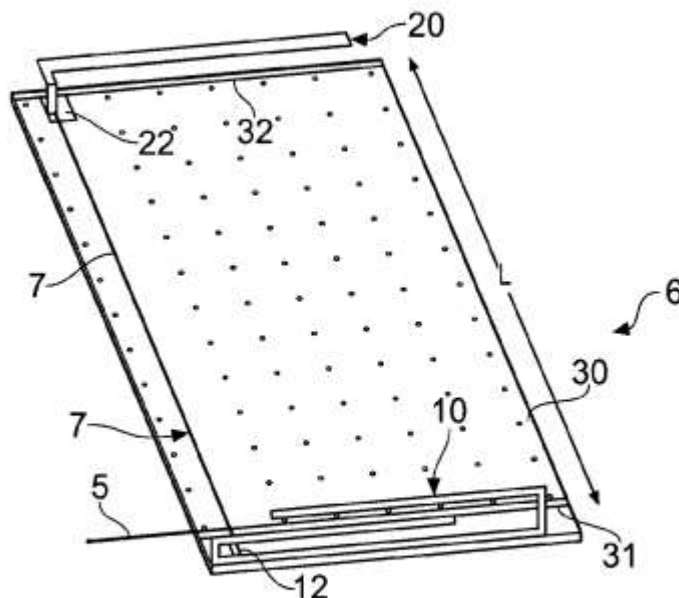
Primary Examiner—Trinh V Dinh

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

(57) **ABSTRACT**

An antenna arrangement including a first antenna element having a first feed for connection to radio frequency circuitry; and a second antenna element, separate to the first antenna element, having a second feed connected to the first feed.

22 Claims, 3 Drawing Sheets





US007782269B2

(12) **United States Patent**
Soler Castany et al.

(10) **Patent No.:** **US 7,782,269 B2**

(45) **Date of Patent:** **Aug. 24, 2010**

(54) **ANTENNA STRUCTURE FOR A WIRELESS DEVICE WITH A GROUND PLANE SHAPED AS A LOOP**

5,363,114 A 11/1994 Shoemaker

(Continued)

(75) Inventors: **Jordi Soler Castany**, Barcelona (ES);
Carles Puente Baliarda, Barcelona (ES)

FOREIGN PATENT DOCUMENTS

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

DE 10345230 A1 4/2005

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 580 days.

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(21) Appl. No.: **11/719,151**

(22) PCT Filed: **Nov. 14, 2005**

(86) PCT No.: **PCT/EP2005/055959**

§ 371 (c)(1),
(2), (4) Date: **Jun. 13, 2007**

Chiou, Designs of compact microstrip antennas with a slotted ground plane, Antennas and propagation society international symposium, Jul. 2001.

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(87) PCT Pub. No.: **WO2006/051113**

PCT Pub. Date: **May 18, 2006**

(Continued)

Primary Examiner—Tan Ho

(74) Attorney, Agent, or Firm—Kenyon & Kenyon LLP

(65) **Prior Publication Data**

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(57) **ABSTRACT**

Related U.S. Application Data

(60) Provisional application No. 60/627,653, filed on Nov. 12, 2004.

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

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

(58) **Field of Classification Search** 343/700 MS,
343/702, 846, 848

See application file for complete search history.

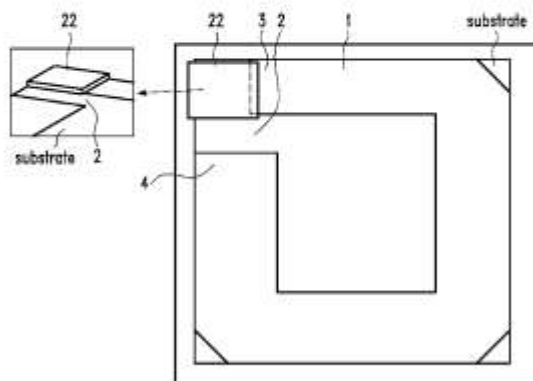
This invention refers to an antenna structure for a wireless device comprising a ground plane and an antenna element, wherein the ground plane has the shape of an open loop. The invention further refers to an antenna structure for a wireless device, such as a light switch or a wrist sensor or wristwatch, comprising an open loop ground plane having a first end portion and a second end portion, the open loop ground plane defining an opening between the first end portion and the second end portion; and an antenna component positioned within the opening defined between the first end portion and the second end portion and overlapping at least one of the first end portion or the second end portion. Further the invention refers to a corresponding wireless device and to a method for integrating such an antenna structure in a wireless device.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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40 Claims, 21 Drawing Sheets





US007782270B2

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

(10) **Patent No.:** **US 7,782,270 B2**

(45) **Date of Patent:** **Aug. 24, 2010**

(54) **PLANAR INVERTED-F ANTENNA WITH EXTENDED GROUNDING PLANE**

(75) Inventors: **Shyh-Jong Chung**, Hsinchu (TW); **Ching-Wei Ling**, Sinhua Township, Tainan County (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 165 days.

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(22) Filed: **May 23, 2008**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

H01Q 1/48 (2006.01)

H01Q 9/38 (2006.01)

(52) **U.S. Cl.** **343/846; 343/830**

(58) **Field of Classification Search** **343/700 MS, 343/702, 846, 828-830, 848**

See application file for complete search history.

(56) **References Cited**

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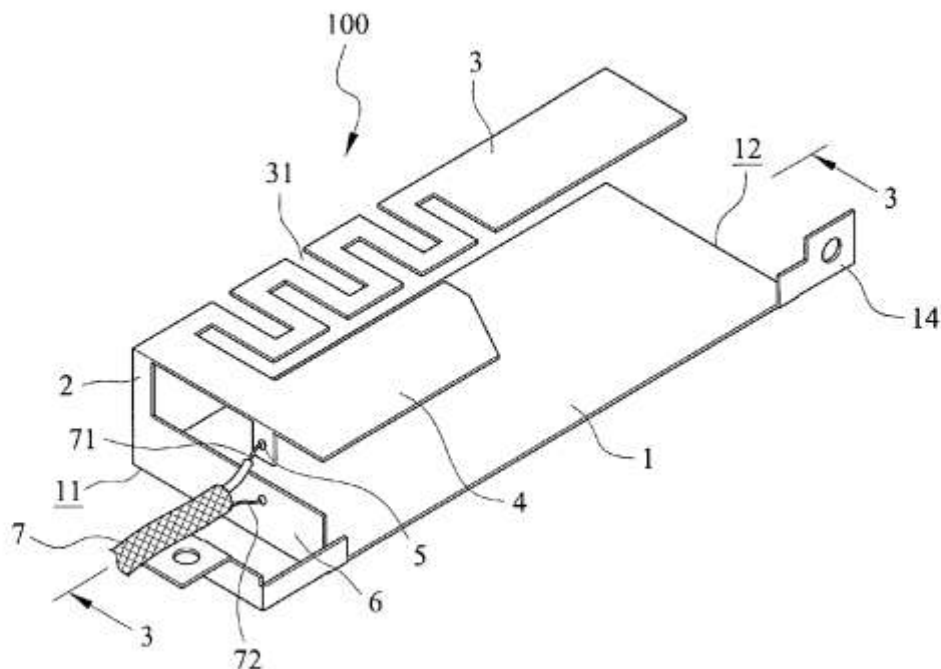
Primary Examiner—Michael C Wimer

(74) *Attorney, Agent, or Firm*—Quintero Law Office, PC

(57) **ABSTRACT**

Disclosed is a planar inverted-F antenna with an extended grounding plane. The planar inverted-F antenna has a grounding metal plate having a selected side edge on which the extended grounding plane is formed and has a predetermined height. At least one antenna signal radiating plate is connected to the grounding metal plate by a short-circuit piece and is substantially parallel to and spaced from the grounding metal plate by a distance. A feeding point extends from the antenna signal radiating plate in a direction toward the grounding metal plate and corresponds to the extended grounding plane with a predetermined gap therebetween. With the arrangement of the extended grounding plane, the impedance matching of the antenna is improved and the impedance bandwidth of the antenna is increased.

16 Claims, 7 Drawing Sheets





US007782272B2

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

(10) **Patent No.:** **US 7,782,272 B2**

(45) **Date of Patent:** **Aug. 24, 2010**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Junichi Noro**, Akita (JP); **Takao Kato**, Oga (JP)

(73) Assignee: **Mitsumi Electric Co., Ltd.**, Tama-Shi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 119 days.

(21) Appl. No.: **11/901,473**

(22) Filed: **Sep. 17, 2007**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Sep. 21, 2006 (JP) 2006-255920

(51) **Int. Cl.**

H01Q 1/36 (2006.01)

H01Q 1/30 (2006.01)

H01Q 1/42 (2006.01)

H01Q 1/12 (2006.01)

(52) **U.S. Cl.** **343/895**; 343/872; 343/878; 343/900

(58) **Field of Classification Search** 343/895, 343/878, 880, 882, 888, 892, 900

See application file for complete search history.

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Primary Examiner—Douglas W Owens

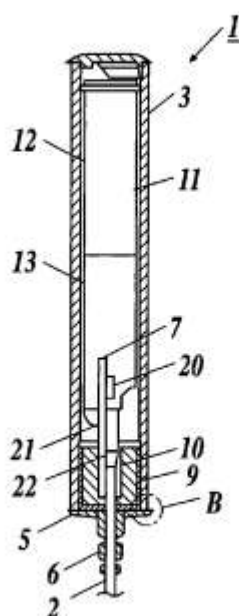
Assistant Examiner—Jennifer F Hu

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

(57) **ABSTRACT**

An antenna apparatus includes: an antenna element; and a substrate on which a low noise amplifier is mounted and on which the antenna element is disposed, wherein the substrate comprises: an input unit for inputting an electric signal into the low noise amplifier from an output terminal formed at a lower part of the antenna element; an output unit for outputting the electric signal to a transmission unit connected to a signal processing unit for processing the electric signal from the antenna element; and a signal blocking unit provided between the input unit and the output unit.

5 Claims, 8 Drawing Sheets





US007786938B2

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

(10) **Patent No.:** **US 7,786,938 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **ANTENNA, COMPONENT AND METHODS**

FOREIGN PATENT DOCUMENTS

(75) Inventors: **Juha Sorvala**, Oulu (FI); **Petteri Annamaa**, Oulunsalo (FI); **Kimmo Koskineniemi**, Oulu (FI)

DE 101 50 149 A1 4/2003

(73) Assignee: **Pulse Finland OY** (FI)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 483 days.

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(21) Appl. No.: **11/648,429**

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

(65) **Prior Publication Data**

(Continued)

US 2007/0171131 A1 Jul. 26, 2007

Related U.S. Application Data

Primary Examiner—Tho G Phan

(74) Attorney, Agent, or Firm—Gazdzinski & Associates, PC

(63) Continuation of application No. PCT/FI2005/050247, filed on Jun. 28, 2005.

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Jun. 28, 2004 (FI) 20040892
Aug. 18, 2004 (FI) 20041088
Mar. 16, 2005 (FI) PCT/FI05/50089

An antenna component (and antenna) with a dielectric substrate and a plurality of radiating antenna elements on the surface of the substrate. In one embodiment, the plurality comprises two (2) elements, each of them covering one of the opposite heads and part of the upper surface of the device. The upper surface between the elements comprises a slot. The lower edge of one of the antenna elements is galvanically coupled to the antenna feed conductor on a circuit board, and at another point to the ground plane, while the lower edge of the opposite antenna element, or the parasitic element, is galvanically coupled only to the ground plane. The parasitic element obtains its feed through the electromagnetic coupling over the slot, and both elements resonate at the operating frequency. Omni-directionality is also achieved. Losses associated with the substrate are low due to the simple field image in the substrate.

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

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

(58) **Field of Classification Search** 343/700 MS, 343/702, 846, 829

See application file for complete search history.

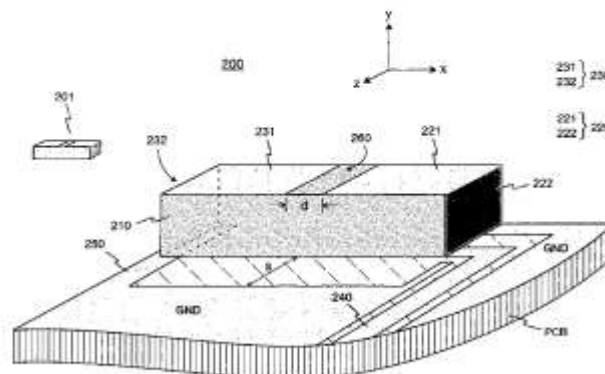
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(Continued)

51 Claims, 5 Drawing Sheets





US007786940B2

(12) **United States Patent**
Hirano

(10) **Patent No.:** **US 7,786,940 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE INCLUDING THE SAME**

(75) Inventor: **Satoru Hirano**, Nomi-gun (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 496 days.

(21) Appl. No.: **11/873,633**

(22) Filed: **Oct. 17, 2007**

(65) **Prior Publication Data**

US 2009/0303144 A1 Dec. 10, 2009

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2005/012680, filed on Jul. 8, 2005.

(30) **Foreign Application Priority Data**

May 11, 2005 (JP) 2005-138725

(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, 750, 846, 848**
See application file for complete search history.

(56) **References Cited**

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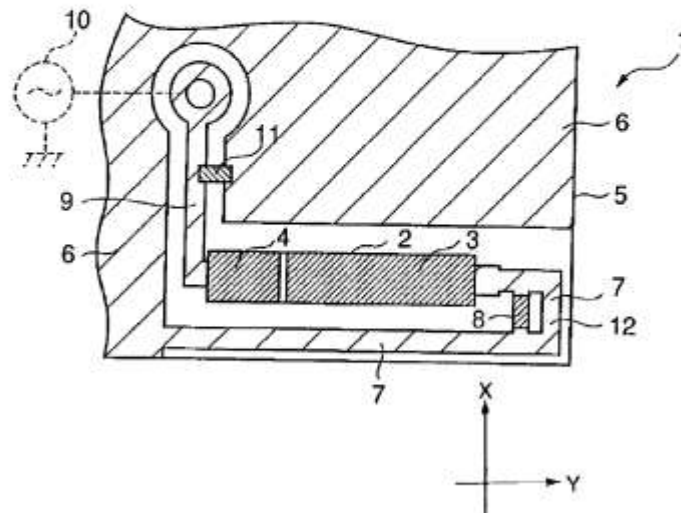
Primary Examiner—HoangAnh T Le

(74) *Attorney, Agent, or Firm*—Keating & Bennett, LLP

(57) **ABSTRACT**

A capacitive-power-feeding-type radiating electrode is provided on a dielectric substrate, and the dielectric substrate is provided in a non-ground region of a circuit board. In the non-ground region of the circuit board, a ground line electrically connecting the radiating electrode with a ground electrode of the circuit board is provided. The ground line is shaped so as to have at least one turnback portion. On the ground line, a resonant-frequency adjusting element is arranged so as to shortcut a portion of the ground line. The resonant-frequency adjusting element has a capacitance or inductance so as to adjust a resonant frequency of an antenna structure to a predetermined resonant frequency.

3 Claims, 5 Drawing Sheets





US007786941B2

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

(10) **Patent No.:** **US 7,786,941 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **ANTENNA MODULE** 7,136,025 B2* 11/2006 Lin et al. 343/770
7,289,071 B2* 10/2007 Hung et al. 343/702
(75) Inventors: **Yi-Wei Tseng**, Taipei County (TW);
Tsung-Wen Chiu, Taipei County (TW);
Fu-Ren Hsiao, Taipei County (TW);
Sheng-Chih Lin, Taipei County (TW)

* cited by examiner

(73) Assignee: **Advanced Connectek, Inc.**, Taipei
County (TW)

Primary Examiner—Shih-Chao Chen
(74) *Attorney, Agent, or Firm*—Schmeiser, Olsen & Watts
LLP

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 176 days.

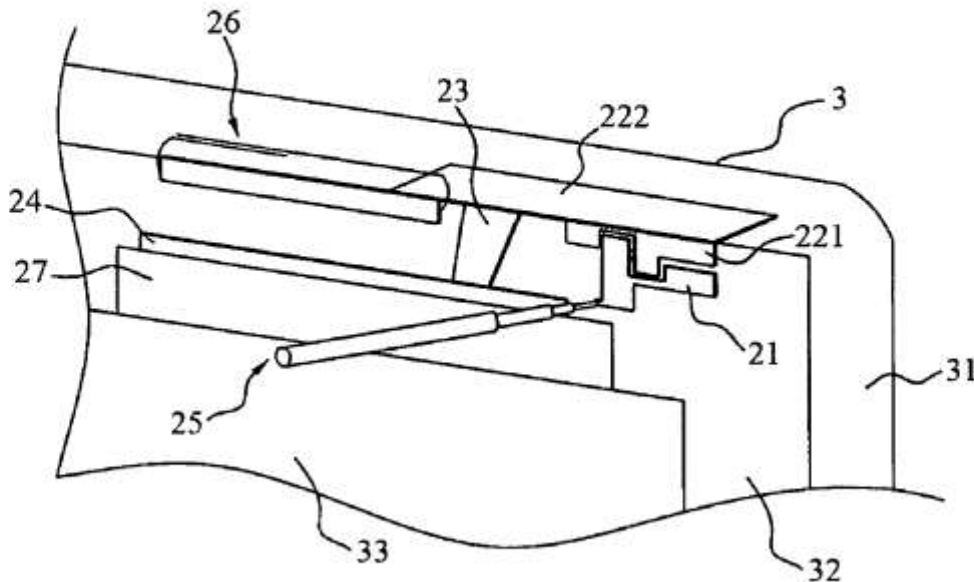
(57) **ABSTRACT**

(21) Appl. No.: **12/182,806**
(22) Filed: **Jul. 30, 2008**
(65) **Prior Publication Data**
US 2009/0040113 A1 Feb. 12, 2009
(30) **Foreign Application Priority Data**
Aug. 10, 2007 (TW) 96129646 A
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/702; 343/700 MS**
(58) **Field of Classification Search** 343/702,
343/700 MS, 846, 830
See application file for complete search history.

An antenna module is provided. The antenna module comprises a first radiation conductor, a second radiation conductor, a short-circuit element (s/c element), a ground plane, a feed-in cable and a spurious radiation conductor. One terminal of the second radiation conductor is near the first radiation conductor with a gap. One terminal of the s/c element is connected to the second radiation conductor and the other side of the s/c element is connected to the ground plane. The feed-in cable comprises a centre conductor and an external conductor, wherein the centre conductor is connected to the first radiation conductor and the external conductor is connected to the ground plane. The spurious radiation conductor is connected to the second radiation conductor. The second radiation conductor comprises a spurious radiation plate, a first radiation piece and a second radiation piece within the two sides of the second radiation conductor. The first radiation piece and a second radiation piece are in parallel and a gap is conducted between the first radiation piece and the second radiation piece.

(56) **References Cited**
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7,050,010 B2* 5/2006 Wang et al. 343/702

10 Claims, 3 Drawing Sheets





US007786942B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 7,786,942 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **HYBRID DUAL DIPOLE SINGLE SLOT ANTENNA FOR MIMO COMMUNICATION SYSTEMS**

(76) Inventor: **Mexx Chen**, 584 Ruei Guang Road, NeiHu District 11492, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 105 days.

(21) Appl. No.: **11/969,243**

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

(65) **Prior Publication Data**

US 2009/0174617 A1 Jul. 9, 2009

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

(52) **U.S. Cl.** **343/727**

(58) **Field of Classification Search** 343/725-727, 343/767

See application file for complete search history.

(56) **References Cited**

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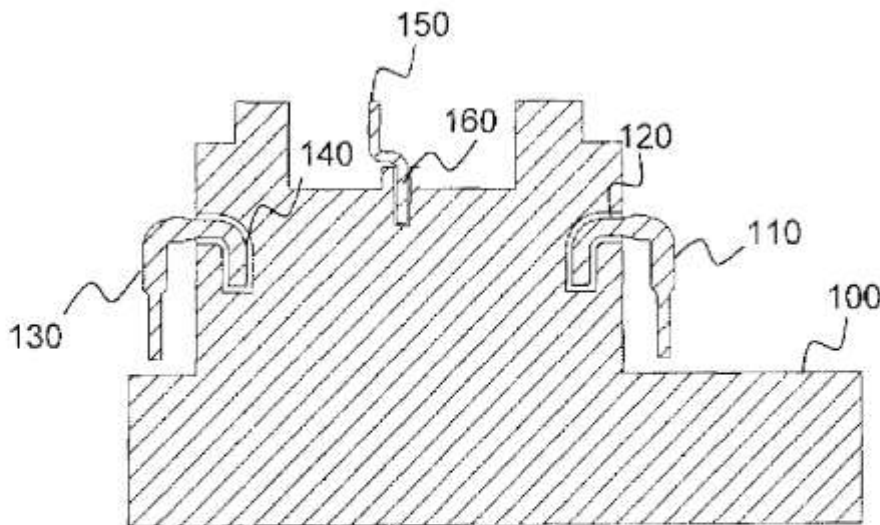
Primary Examiner—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Martin Fleit; Paul D. Bianco; Fleit Gibbons Gutman Bongini & Bianco PL

(57) **ABSTRACT**

An antenna arrangement implemented within a printed circuit board (PCB) having three metal coplanar layers, for use in multiple input multiple output (MIMO) communication systems. The antenna arrangement comprises a first dipole antenna and second dipole antenna, substantially symmetrical to the first dipole antenna a slot antenna positioned substantially between the first and the second dipole antennas. The antenna arrangement is implemented in three coplanar metal layers. The antennas are used for MIMO communication systems, specifically complying with IEEE 802.11n and are shaped such that their combined radiation pattern exhibits a substantially omni directional radiation pattern.

16 Claims, 5 Drawing Sheets





US007786943B2

(12) **United States Patent**
Deguchi

(10) **Patent No.:** **US 7,786,943 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

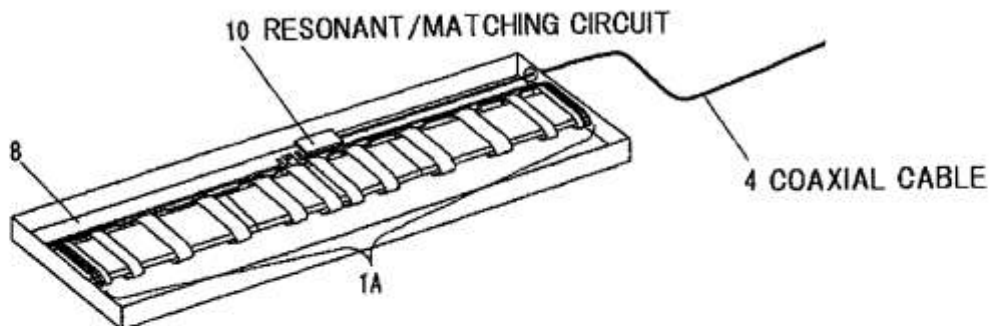
- (54) **ANTENNA DEVICE AND RADIO COMMUNICATION SYSTEM**
- (75) Inventor: **Futoshi Deguchi**, Fukuoka (JP)
- (73) Assignee: **Panasonic Corporation**, Osaka (JP)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 119 days.
- (21) Appl. No.: **12/179,095**
- (22) Filed: **Jul. 24, 2008**
- (65) **Prior Publication Data**
US 2009/0027285 A1 Jan. 29, 2009
- (30) **Foreign Application Priority Data**
Jul. 27, 2007 (JP) 2007-195390
- (51) **Int. Cl.**
H01Q 11/12 (2006.01)
H01Q 19/10 (2006.01)
H01Q 1/36 (2006.01)
- (52) **U.S. Cl.** 343/742; 343/818; 343/895
- (58) **Field of Classification Search** 343/742,
343/818, 866, 895; 340/572.7
See application file for complete search history.

- (56) **References Cited**
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- Primary Examiner*—Shih-Chao Chen
- (74) *Attorney, Agent, or Firm*—Greenblum & Bernstein P.L.C.

(57) **ABSTRACT**

An antenna device includes: a substrate; first and a second antenna units which are wound coaxially on a surface of the substrate, and include a plurality of antenna elements; and a feeder which feeds power only to the first antenna unit. A separation distance between the antenna elements in each of the first and second antenna units is substantially the same.

17 Claims, 5 Drawing Sheets





US007786947B2

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

(10) **Patent No.:** **US 7,786,947 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

- (54) **BROADBAND ANTENNA**
- (75) Inventors: **Seok Bae**, Gyeonggi-Do (KR); **In Young Kim**, Gyeonggi-Do (KR)
- (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 366 days.

- (21) Appl. No.: **11/846,868**
- (22) Filed: **Aug. 29, 2007**

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- (65) **Prior Publication Data**
US 2008/0055176 A1 Mar. 6, 2008

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- (30) **Foreign Application Priority Data**
Aug. 30, 2006 (KR) 10-2006-0083106

Primary Examiner—Douglas W Owens
Assistant Examiner—Chuc D Tran
(74) *Attorney, Agent, or Firm*—Lowe Hauptman Ham & Berner LLP

- (51) **Int. Cl.**
H01Q 11/06 (2006.01)
H01Q 1/00 (2006.01)

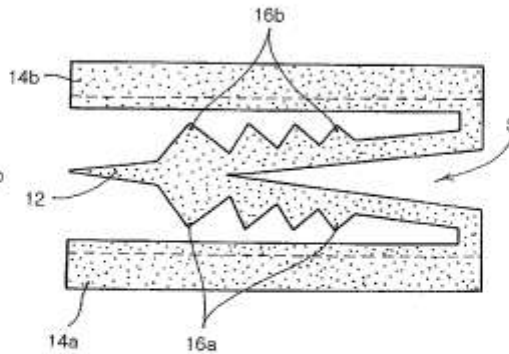
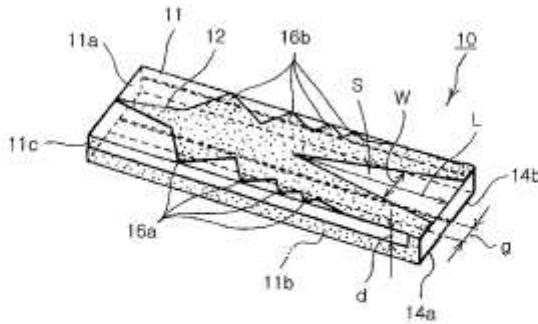
(57) **ABSTRACT**

- (52) **U.S. Cl.** 343/787; 343/700 MS; 343/792.5; 343/846; 343/895
- (58) **Field of Classification Search** 343/700 MS, 343/787, 846, 895, 792.5
See application file for complete search history.

There is provided a broadband antenna including: an insulating block having opposing first and second main surfaces and a side surface between the first and second main surfaces; a first radiator pattern formed on the first main surface and having a tapered slot with an open end; and a second radiator pattern including two patterns connected to opposing ends of the first radiator pattern, respectively, and extending to the second main surface.

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





US007786949B2

(12) **United States Patent**
Kato

(10) **Patent No.:** **US 7,786,949 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **ANTENNA**

(75) Inventor: **Noboru Kato**, Moriyama (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 323 days.

(21) Appl. No.: **11/928,502**

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

(65) **Prior Publication Data**

US 2008/0122724 A1 May 29, 2008

Related U.S. Application Data

(63) Continuation of application No. 11/688,290, filed on Mar. 20, 2007, now Pat. No. 7,629,942.

(60) Provisional application No. 60/745,884, filed on Apr. 28, 2006.

(30) **Foreign Application Priority Data**

Apr. 14, 2006 (JP) 2006-112352
Sep. 20, 2006 (JP) 2006-254153
Nov. 17, 2006 (JP) 2006-311546

(51) **Int. Cl.**

H01Q 1/50 (2006.01)
H01Q 7/00 (2006.01)
H01Q 21/00 (2006.01)

(52) **U.S. Cl.** **343/860; 343/748; 343/867**

(58) **Field of Classification Search** **343/748,**
343/860, 862, 867, 895

See application file for complete search history.

(56) **References Cited**

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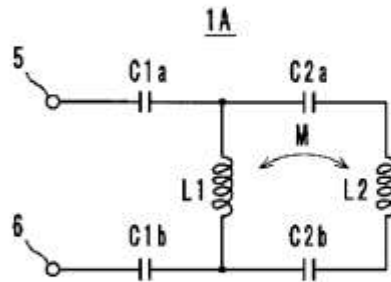
Primary Examiner—Shih-Chao Chen

(74) *Attorney, Agent, or Firm*—Keating & Bennett, LLP

(57) **ABSTRACT**

An antenna includes inductance elements that are magnetically coupled together, an LC series resonant circuit that includes one of the inductance elements and capacitance elements, and an LC series resonant circuit that includes another of the inductance elements and capacitance elements. The plurality of LC series resonant circuits are used to radiate radio waves and are used as inductances of a matching circuit that matches an impedance when a power supply side is viewed from power supply terminals and a radiation impedance of free space.

20 Claims, 22 Drawing Sheets



L 1 L 2
Q : 100 Q : 100
F : 0. 915GHz F : 0. 915GHz
M : 1 M : 1



US007786950B2

(12) **United States Patent**
Ohashi

(10) **Patent No.:** **US 7,786,950 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **LOOP ANTENNA AND LOOP ANTENNA MANUFACTURING METHOD**

7,573,432 B1* 8/2009 Eydelman et al. 343/792

(75) Inventor: **Chie Ohashi**, Tokyo (JP)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **Tyco Electronics AMP K.K.**, Kanagawa-Ken (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 182 days.

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(21) Appl. No.: **12/203,499**

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

Japanese Office Action dated Jun. 30, 2009, for corresponding Japanese Patent Application No. 2007-228028.

(65) **Prior Publication Data**

US 2009/0058743 A1 Mar. 5, 2009

Primary Examiner—Hoang V Nguyen

(74) Attorney, Agent, or Firm—Barley Snyder LLC

(30) **Foreign Application Priority Data**

Sep. 3, 2007 (JP) 2007-228028

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 7/00 (2006.01)
H01Q 11/12 (2006.01)
H01Q 21/00 (2006.01)

A loop antenna is disclosed which can prevent the occurrence of variance in the loop length of the installed loop antenna element, and a method for manufacturing the loop antenna. The loop antenna comprises electrical wires constituting the antenna element and a housing that holds the electrical wires. Furthermore, the housing is formed with first guide grooves that guide the first end portions of the electrical wires and that have wall surfaces against which the tip ends on the side of the first end portions of the electrical wires abut, and second guide grooves that guide the second end portions of the electrical wires and that have wall surfaces against which the tip ends on the side of the second end portions of the electrical wires abut. Moreover, crimp parts with which the end portions of the electrical wires are connected by crimping are provided inside the respective guide grooves. In addition, a pair of contact parts that make contact with external terminals are respectively connected to the crimp parts.

(52) **U.S. Cl.** **343/870; 343/741; 343/742; 343/866; 343/867**

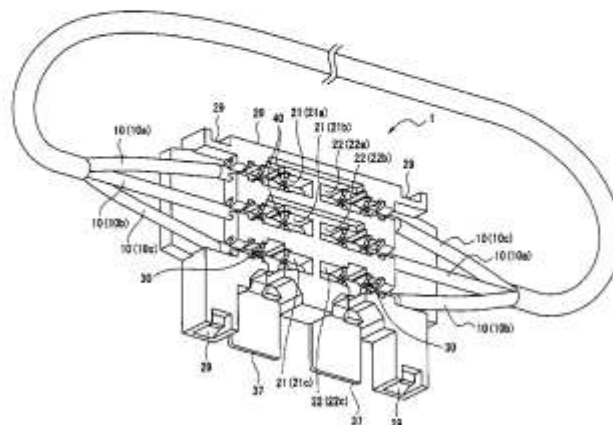
(58) **Field of Classification Search** **343/741, 343/742, 866, 867, 870**
See application file for complete search history.

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7,345,644 B2*	3/2008	Morioka et al.	343/866

4 Claims, 6 Drawing Sheets





US007787920B2

(12) **United States Patent**
Körner

(10) **Patent No.:** **US 7,787,920 B2**
(45) **Date of Patent:** **Aug. 31, 2010**

(54) **DIPOLE ANTENNA FOR A PORTABLE COMMUNICATION DEVICE**

(75) Inventor: **Hans Peter Körner, Lund (SE)**

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 657 days.

(21) Appl. No.: **11/738,708**

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

(65) **Prior Publication Data**
US 2008/0261538 A1 Oct. 23, 2008

(51) **Int. Cl.**
H04M 1/00 (2006.01)
(52) **U.S. Cl.** **455/575.5**; 455/553.1; 455/560
(58) **Field of Classification Search** 455/554.1,
455/554.2, 575.5, 575.7
See application file for complete search history.

(56) **References Cited**
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(57) **ABSTRACT**

The present invention relates to a portable communication device arrangement comprising a main unit and an auxiliary unit. The main unit includes an electrical interface to an auxiliary unit, a ground plane dimensioned for antenna operation at a multiple of a quarter of a wavelength of a desired frequency, and a radio communication unit connected to the ground plane and to the electrical interface. The auxiliary unit comprises at least one electrical conductor to be connected to the electrical interface and including a first radio frequency trap, where the distance between the first radio frequency trap and an end of the conductor that is to be connected to the electrical interface corresponds to an odd multiple of a quarter of a wavelength of the desired frequency. The invention provides a good antenna through reuse of elements already provided in relation to a portable communication device.

11 Claims, 2 Drawing Sheets

