



US007710330B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 7,710,330 B2**
(45) **Date of Patent:** **May 4, 2010**

(54) **DUAL-BAND INVERTED-F ANTENNA**

2003/0206136 A1* 11/2003 Chen 343/702

(75) Inventor: **Chien-Lin Huang**, Jhongli (TW)

(73) Assignee: **Smart Approach Co., Ltd.**, Hsinchu (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 126 days.

Primary Examiner—Hoang V Nguyen

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

(21) Appl. No.: **12/055,176**

(57) **ABSTRACT**

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

A dual-band inverted-F antenna including a radiation element, a ground element, a conductive pin, and a signal feed-in portion is described. The radiation element includes a loop portion, a first radiation portion, and a second radiation portion. After being fed in through the signal feed-in portion, a first band signal and a second band signal are wirelessly transmitted/received by the first radiation portion and the second radiation portion respectively in one aspect, and transmitted to the conductive pin through the loop portion and finally to the ground element in another aspect. The loop portion is directly short-grounding, such that the bandwidths of the first and the second band signals in operation are increased, thereby improving the overall radiation efficiency.

(65) **Prior Publication Data**

US 2009/0243936 A1 Oct. 1, 2009

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

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

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

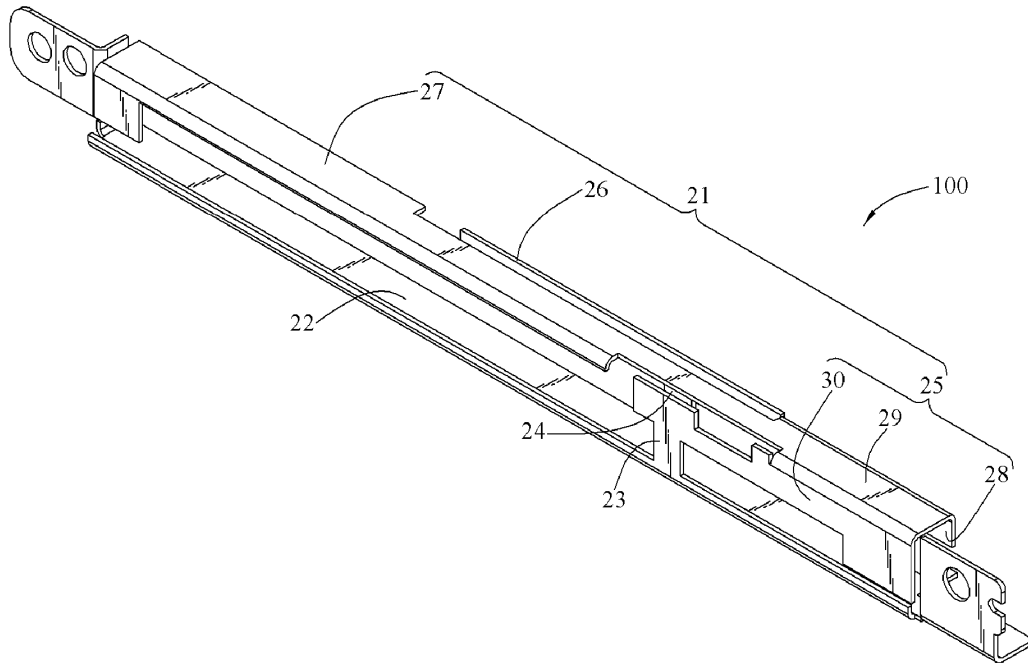
See application file for complete search history.

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5 Claims, 6 Drawing Sheets





US007710332B2

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

(10) **Patent No.:** **US 7,710,332 B2**
(45) **Date of Patent:** **May 4, 2010**

(54) **MOBILE COMMUNICATIONS DEVICE WITH A COMPACT-SIZED THREE-DIMENSIONAL ANTENNA**

(75) Inventors: **Min-Che Chen**, Taoyuan (TW);
Ching-Sung Wang, Taoyuan (TW)

(73) Assignee: **HTC Corporation**, Taoyuan, Taoyuan County (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 40 days.

(21) Appl. No.: **11/889,974**

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

(65) **Prior Publication Data**

US 2009/0046023 A1 Feb. 19, 2009

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

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

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

See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Rexford N Barnie

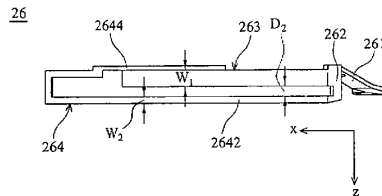
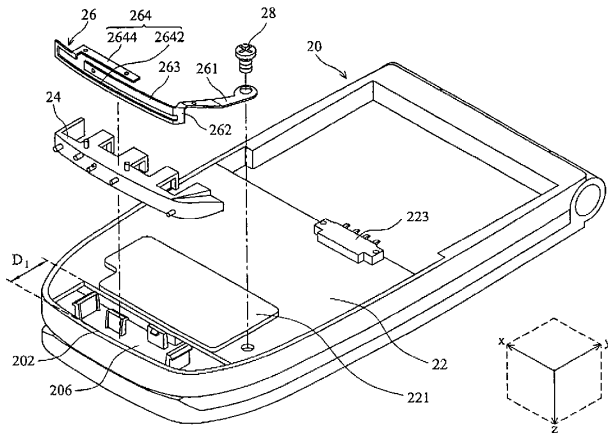
Assistant Examiner—Thienvu V Tran

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

(57) **ABSTRACT**

A mobile communications device includes a circuit board and a monopole antenna. The monopole antenna includes a feed part electrically connected to the circuit board and directed away from the circuit board at an acute angle, a connecting part extending from the feed part in a direction substantially perpendicular to the circuit board, a first radiating part extending from the connecting part, and a second radiating part also extending from the connecting part.

22 Claims, 4 Drawing Sheets





US007710338B2

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

(10) **Patent No.:** **US 7,710,338 B2**
(45) **Date of Patent:** **May 4, 2010**

(54) **SLOT ANTENNA APPARATUS ELIMINATING UNSTABLE RADIATION DUE TO GROUNDING STRUCTURE**

FOREIGN PATENT DOCUMENTS

JP 2004-336328 11/2004
JP 4050307 12/2007

(75) Inventors: **Tomoyasu Fujishima**, Kanagawa (JP);
Hiroshi Kanno, Osaka (JP)

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T. Fukazawa et al., "Impedance Measurement of the Antenna on the Portable Telephone using Fiber-Optics," Proceeding of the 2003 IEICE General Conference, the Institute of Electronics, Information and Communication Engineers (IEICE), B-1-206, 2003, p. 206 (with English translation).

(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 222 days.

* cited by examiner

(21) Appl. No.: **12/113,407**

(22) Filed: **May 1, 2008**

Primary Examiner—Douglas W Owens
Assistant Examiner—Dieu Hien T Duong
(74) *Attorney, Agent, or Firm*—Wenderoth, Lind & Ponack, LLP.

(65) **Prior Publication Data**

US 2009/0066596 A1 Mar. 12, 2009

(30) **Foreign Application Priority Data**

May 8, 2007 (JP) 2007-123205

(57) **ABSTRACT**

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

(52) **U.S. Cl.** **343/767; 343/770; 343/700 MS; 343/859**

(58) **Field of Classification Search** **343/767, 343/770, 700 MS, 850, 859**
See application file for complete search history.

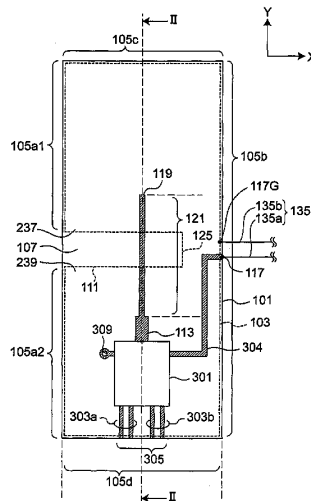
A slot antenna apparatus includes a grounding conductor having an outer edge including a first portion and a second portion, a one-end-opened slot formed in the grounding conductor along a radiation direction such that an open end is provided at a center of the first portion, a first feed line intersecting with the slot to feed radio-frequency signals, a second feed line connected to an external circuit, and a signal processing circuit including active elements and connected between the first and second feed lines and connected to the grounding conductor. The grounding conductor is configured to be symmetric about an axis parallel to the radiation direction and passing through the slot, and is provided with a grounding terminal on the axis of symmetry at the second portion. The grounding terminal is to be connected to a ground of the external circuit.

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5 Claims, 26 Drawing Sheets





US007710343B2

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

(10) **Patent No.:** **US 7,710,343 B2**
(45) **Date of Patent:** **May 4, 2010**

(54) **COMPACT 3-PORT ORTHOGONALLY POLARIZED MIMO ANTENNAS**

2006/0261905 A1* 11/2006 Ham et al. 331/107 SL

(75) Inventors: **Chi Yuk Chiu**, Hong Kong (CN); **Jie Bang Yan**, Hong Kong (CN); **Ross David Murch**, Hong Kong (CN)

(73) Assignee: **Hong Kong Technologies Group Limited**, Apia (WS)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 12 days.

(21) Appl. No.: **11/873,071**

(22) Filed: **Oct. 16, 2007**

(65) **Prior Publication Data**

US 2009/0096699 A1 Apr. 16, 2009

(51) **Int. Cl.**
H01Q 21/26 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.** **343/797**; 343/795

(58) **Field of Classification Search** 343/797,
343/795

See application file for complete search history.

(56) **References Cited**

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D. Su, et al. "A novel broadband polarization diversity antenna using a cross-pair of folded dipoles," *IEEE Antennas and Wireless Propagat. Lett.*, vol. 4, pp. 433-435, 2005. Digital Object Identifier 10.1109/LAWP.2005.860191.1536-1225, IEEE. Last accessed Aug. 27, 2007.

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Primary Examiner—Rexford N Barnie

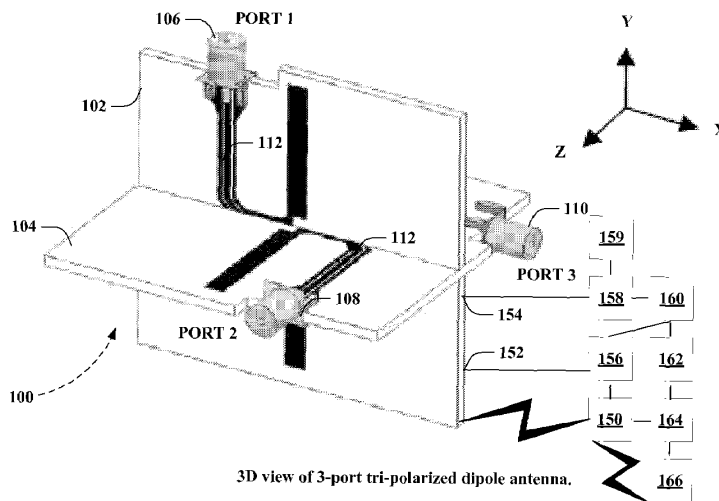
Assistant Examiner—Matthew C Tabler

(74) *Attorney, Agent, or Firm*—Turocy & Watson, LLP

(57) **ABSTRACT**

Generalized non-limiting embodiments include employing a dipole antenna and/or a half slot antenna. Each of the antennas constitutes three mutually perpendicular radiating elements to achieve good isolation and low antenna signal correlation between the three ports. In one generalized non-limiting embodiment the antennas are fabricated on FR-4 epoxy boards. Experimental results show that the antennas resonate a reasonable frequency and have a desired mutual coupling. In addition experimental results for the diversity performance and the MIMO channel capacity are also provided for these antennas and these results show that the herein described antennas offer good diversity gain and the channel capacity can be increased by as much as three times by using these antennas over conventional antennas.

20 Claims, 10 Drawing Sheets





US007714786B2

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

(10) **Patent No.:** **US 7,714,786 B2**
(45) **Date of Patent:** **May 11, 2010**

(54) **ANTENNA DEVICE**
(75) Inventors: **Min-Che Chen**, Tao Yuan (TW);
Kuo-Cheng Chen, Tao Yuan (TW);
Ching-Sung Wang, Tao Yuan (TW)
(73) Assignee: **HTC Corporation**, Taoyuan County
(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 0 days.

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EP 1703586 9/2006

(21) Appl. No.: **11/969,227**

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

(65) **Prior Publication Data**
US 2009/0135067 A1 May 28, 2009

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Primary Examiner—Vibol Tan
Assistant Examiner—Jany Tran
(74) *Attorney, Agent, or Firm*—Jianq Chyun IP Office

(30) **Foreign Application Priority Data**
Nov. 22, 2007 (TW) 96144308 A

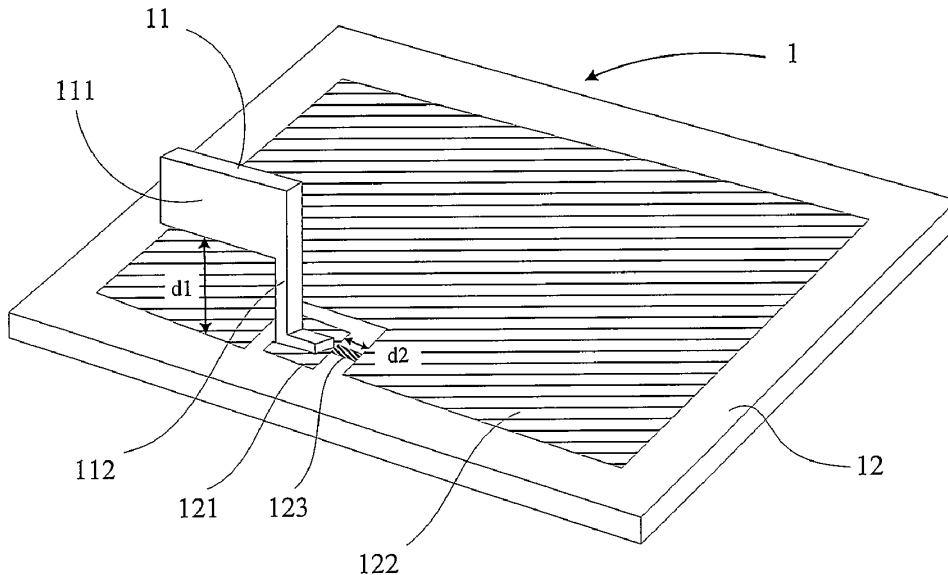
(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/702**
(58) **Field of Classification Search** 343/845–849,
343/700 MS, 702
See application file for complete search history.

An antenna device including a ground plane, a circuit board, an antenna, and a conductive wire is provided. The circuit board includes a signal feed point, and the antenna includes a radiation portion and a feed portion extending externally from the radiation portion. The feed portion is electrically connected to the signal feed point, and the conductive wire is disposed on the circuit board and electrically connected to the ground plane and the signal feed point. The conductive wire is, for example, a printed trace formed on the circuit board.

(56) **References Cited**
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2003/0174092 A1 9/2003 Sullivan et al.

25 Claims, 3 Drawing Sheets





US007714788B2

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

(10) **Patent No.:** **US 7,714,788 B2**
(45) **Date of Patent:** **May 11, 2010**

- (54) **ANTENNA**

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2005/0190108 A1 *	9/2005	Lin et al.	343/702
- (75) Inventors: **Kuan-Hsueh Tseng**, Taipei (TW);
Yi-Ling Chiu, Taipei (TW); **Chia-Tien Li**, Taipei (TW)
- (73) Assignee: **Wistron NeWeb Corp.**, 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 339 days.

(21) Appl. No.: **11/674,055**

(22) Filed: **Feb. 12, 2007**

(65) **Prior Publication Data**
US 2008/0007458 A1 Jan. 10, 2008

(30) **Foreign Application Priority Data**
Jul. 4, 2006 (TW) 95124300 A

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

(52) **U.S. Cl.** **343/702; 373/700 MS; 373/770; 373/860**

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

(56) **References Cited**

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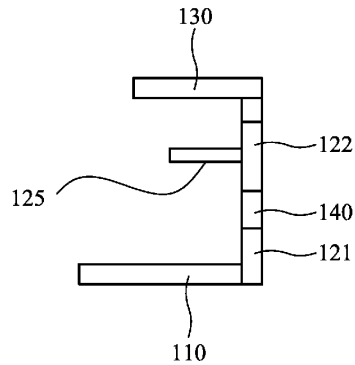
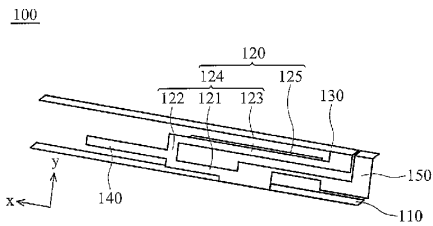
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Primary Examiner—Trinh V Dinh
(74) *Attorney, Agent, or Firm*—Quintero Law Office

(57) **ABSTRACT**

An antenna comprises a ground element, a transmission element, a conductive element and a coupling element. The conductive element connects the ground element and the transmission element. The coupling element extends from the conductive element substantially parallel to the transmission element, wherein the coupling element is located on a first plane, the transmission element is located on a second plane, and the second plane is parallel to the first plane.

8 Claims, 5 Drawing Sheets





US007714789B2

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

(10) **Patent No.:** **US 7,714,789 B2**
(45) **Date of Patent:** **May 11, 2010**

(54) **ANTENNA HAVING A DIVERSITY EFFECT**
(75) Inventors: **Tiao-Hsing Tsai**, Taipei Shien (TW);
Chih-Wei Liao, Yilan Shien (TW);
Chao-Hsu Wu, Tao Yuan 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 66 days.

(56) **References Cited**
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7,183,984 B2 * 2/2007 Jarmuszewski et al. 343/702
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(21) Appl. No.: **12/197,885**

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

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

(65) **Prior Publication Data**
US 2009/0256754 A1 Oct. 15, 2009

(57) **ABSTRACT**

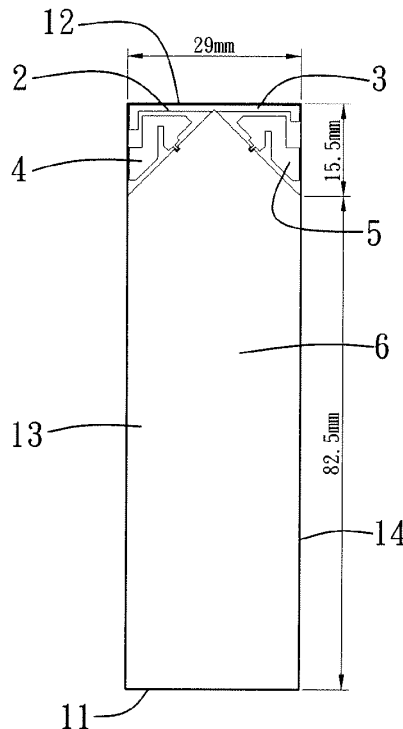
(30) **Foreign Application Priority Data**
Apr. 10, 2008 (TW) 97112992 A

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 and is disposed between the first and second radiating elements. The first and second grounding elements extend from the grounding plane away from each other. The first and second radiating elements are coupled electromagnetically to the first and second grounding elements, respectively.

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/702**
(58) **Field of Classification Search** 343/700 MS,
343/702, 893, 895, 818

See application file for complete search history.

20 Claims, 18 Drawing Sheets





US007714795B2

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

(10) **Patent No.:** **US 7,714,795 B2**
(45) **Date of Patent:** **May 11, 2010**

(54) **MULTI-BAND ANTENNA APPARATUS
DISPOSED ON A THREE-DIMENSIONAL
SUBSTRATE, AND ASSOCIATED
METHODOLOGY, FOR A RADIO DEVICE**

(75) Inventors: **Geyi Wen**, Waterloo (CA); **Qinjiang Rao**, Waterloo (CA); **Mark Pecen**, Waterloo (CA)

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

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

(21) Appl. No.: **11/843,840**

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

(65) **Prior Publication Data**

US 2009/0051615 A1 Feb. 26, 2009

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

(52) **U.S. Cl.** **343/860; 343/700 MS; 343/702; 343/895**

(58) **Field of Classification Search** 343/745, 343/749, 791, 860, 895, 900, 700 MS, 702, 343/750, 793, 795, 806, 850, 852
See application file for complete search history.

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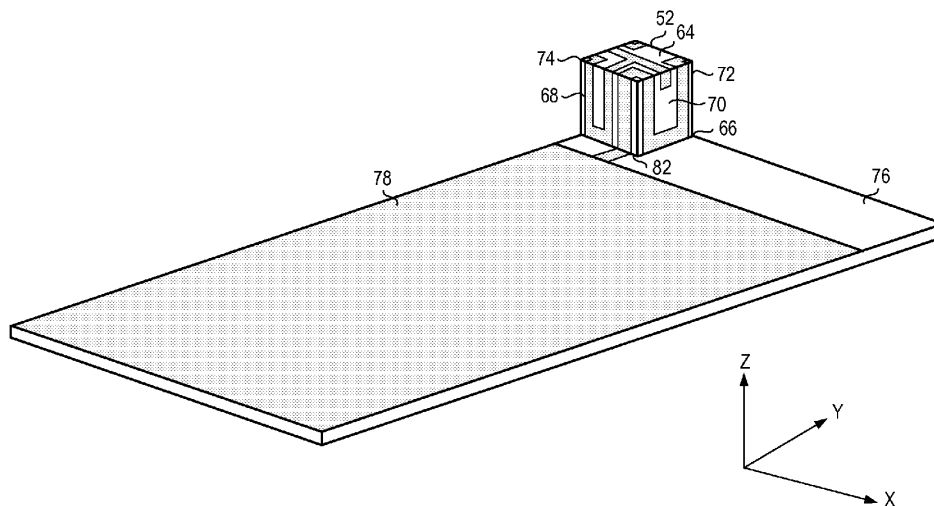
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Primary Examiner—Douglas W Owens
Assistant Examiner—Chuc D Tran

(57) **ABSTRACT**

Antenna apparatus, and an associated methodology, for a multi-frequency-band-capable radio device, such as a quad-band mobile station. The antenna apparatus is formed from a three-dimensional rectilinear non-conductive dielectric antenna substrate, such as cube. An elongated radiation element is disposed over multiple surfaces of the antenna substrate. A T-shaped impedance matching element located at the end of the radiation element permits the antenna input impedance to be matched to a communications device. The length of the radiation element is selected to be substantially equal to a quarter wavelength of the lowest frequency band at which the antenna operates.

43 Claims, 10 Drawing Sheets





US00D615534S

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

(10) **Patent No.:** **US D615,534 S**
(45) **Date of Patent:** **** May 11, 2010**

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Yung-Chih Tsai**, Taipei (TW);
Jia-Hung Su, Taipei (TW); **Kai Shih**,
Taipei (TW)

(73) Assignee: **Cheng Uei Precision Industry Co.,
Ltd.**, Taipei (TW)

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

(21) Appl. No.: **29/351,119**

(22) Filed: **Nov. 30, 2009**

(51) **LOC (9) 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 MS,
343/700 R-705, 711-713, 741, 748, 767,
343/795, 819, 840, 846, 866, 871-908; 455/90.2,
455/90.3, 91, 128, 269, 344, 347, 562.1;
333/193, 195

See application file for complete search history.

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D608,354 S * 1/2010 Yang et al. D14/230
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2009/0284432 A1 * 11/2009 Cozzolino et al. 343/821

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Primary Examiner—T. Chase Nelson
Assistant Examiner—John Windmuller

(57) **CLAIM**

The ornamental design for multi-band antenna, as shown and described.

DESCRIPTION

FIG. 1 is a perspective view of multi-band antenna showing our new design;

FIG. 2 is a front elevational view thereof;

FIG. 3 is a rear elevational view thereof;

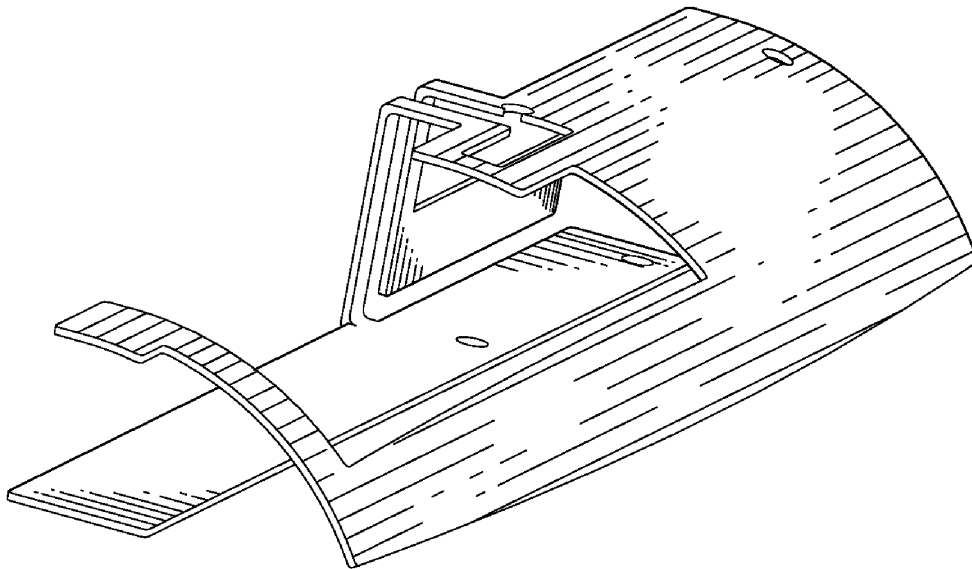
FIG. 4 is a left side elevational view thereof;

FIG. 5 is a right side elevational view thereof;

FIG. 6 is a top plan view thereof; and,

FIG. 7 is a bottom plan view thereof.

1 Claim, 7 Drawing Sheets





US007719470B2

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

(10) **Patent No.:** **US 7,719,470 B2**
(45) **Date of Patent:** **May 18, 2010**

(54) **MULTI-BAND ANTENNA, AND ASSOCIATED METHODOLOGY, FOR A RADIO COMMUNICATION DEVICE**

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

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 320 days.

(21) Appl. No.: **11/843,802**

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

(65) **Prior Publication Data**
US 2009/0051595 A1 Feb. 26, 2009

(51) **Int. Cl.**
H01Q 9/04 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/767; 343/846**

(58) **Field of Classification Search** **343/700 MS, 343/702, 722, 767, 846, 895**
See application file for complete search history.

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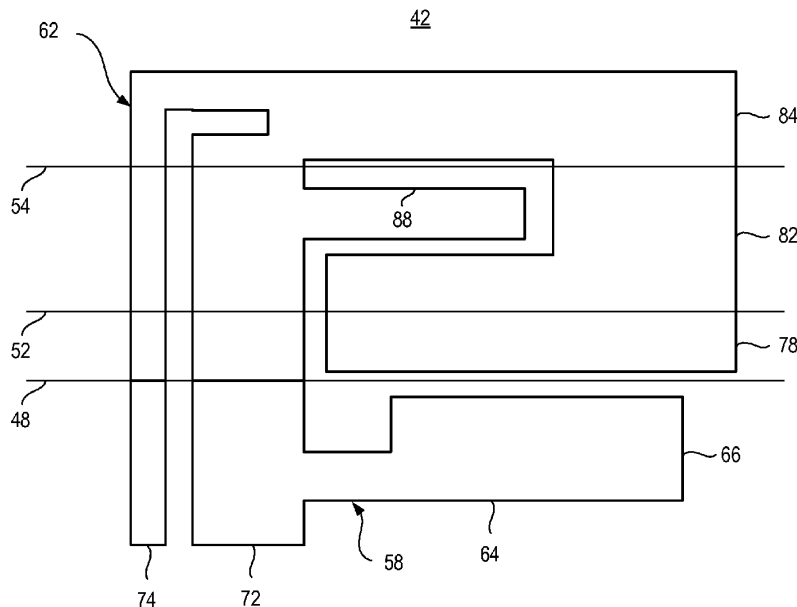
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Primary Examiner—Douglas W Owens
Assistant Examiner—Chuc D Tran

(57) **ABSTRACT**

An antenna, and an associated methodology, for a portable radio device, such as a mobile station capable of operation at a plurality of frequency bands spread across a wide range of frequencies. The antenna includes a first antenna patch and a second antenna patch. The first antenna patch comprises an L-shaped patch disposed upon a substrate. A second antenna patch forms a folded patch formed of three contiguous portions, folded about fold lines in a manner to cause the second antenna patch to include a first contiguous portion that extends upwardly beyond the first antenna patch at an angle perpendicular thereto. Second and third contiguous portions are formed by folding additional portions of the second antenna patch about additional fold lines.

32 Claims, 7 Drawing Sheets





US007719473B2

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

(10) **Patent No.:** **US 7,719,473 B2**
(45) **Date of Patent:** **May 18, 2010**

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

(75) Inventors: **Takeshi Asano**, Abugi (JP); **Shohhei
Fujio**, Machida (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.: **12/127,091**

(22) Filed: **May 27, 2008**

(65) **Prior Publication Data**
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Related U.S. Application Data

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26, 2004, now Pat. No. 7,379,025.

(30) **Foreign Application Priority Data**
Feb. 27, 2003 (JP) 2003-050328

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

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

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

See application file for complete search history.

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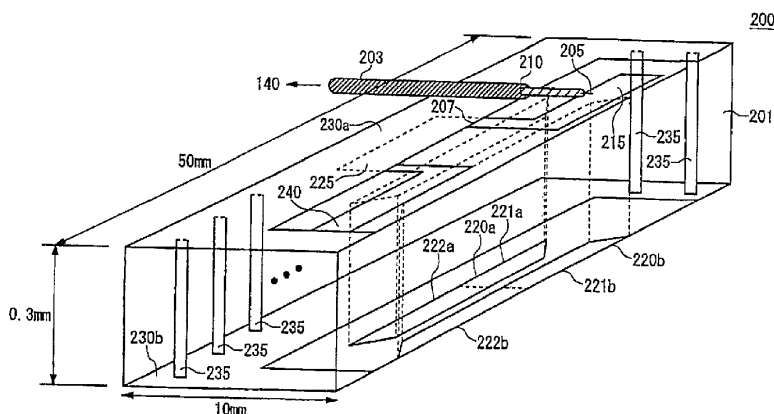
Primary Examiner—Tho G Phan

(74) *Attorney, Agent, or Firm*—Law Office of Frank V.
DeRosa, P.C.

(57) **ABSTRACT**

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

12 Claims, 4 Drawing Sheets





US007724192B2

(12) **United States Patent**
Liu

(10) **Patent No.:** **US 7,724,192 B2**
(45) **Date of Patent:** **May 25, 2010**

(54) **PORTABLE COMMUNICATION DEVICE WITH SLOT-COUPLED ANTENNA MODULE**

(75) Inventor: **I-Ru Liu**, Taipei (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 198 days.

(21) Appl. No.: **11/802,027**

(22) Filed: **May 18, 2007**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 3, 2006 (TW) 95124188 A

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

(52) **U.S. Cl.** **343/700 MS; 343/829; 343/846**

(58) **Field of Classification Search** **343/700 MS, 343/705, 767, 789, 829, 830, 846, 848, 872**
See application file for complete search history.

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Primary Examiner—Douglas W Owens

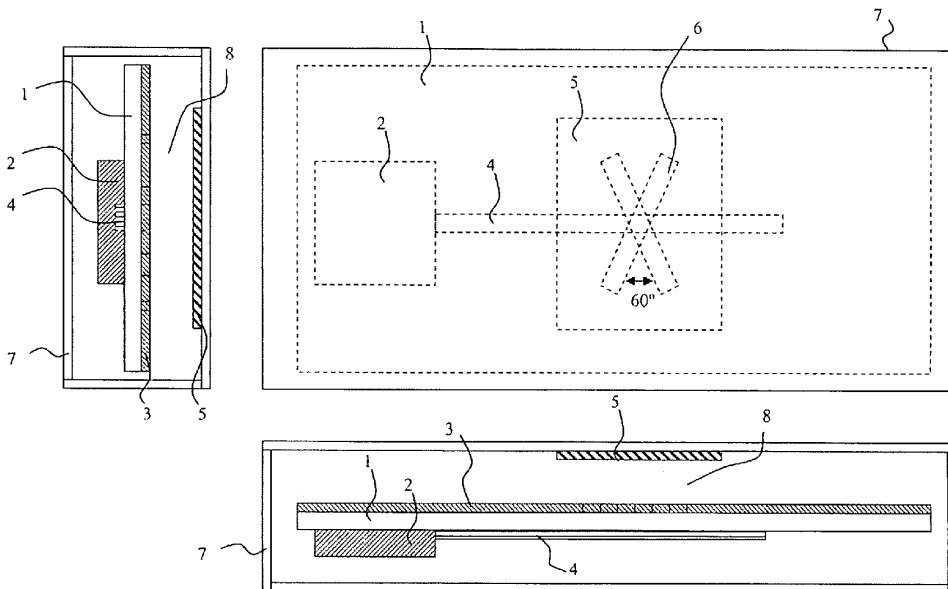
Assistant Examiner—Chuc D Tran

(74) *Attorney, Agent, or Firm*—Bacon & Thomas, PLLC

(57) **ABSTRACT**

The present invention discloses a portable communication device with slot-coupled antenna module the slot-coupled antenna module comprises: a dielectric substrate, radio module, ground plane, air substrate, and patch radiator. The radio module contains a feed line and stub that are coupled on the surface of the dielectric substrate and extending along the long side of the dielectric substrate in parallel. The ground plane with slot-coupled structure is coupled on the other surface of the dielectric substrate, the feed line and stub pass through the intersect portion of the coupled slots. The air gap is therefore formed between the ground plane and the patch radiator, and the patch radiator is substantially parallel with the ground plane and locating substantially on the position of the coupled slots.

18 Claims, 14 Drawing Sheets





US007724195B2

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

(10) **Patent No.:** **US 7,724,195 B2**
(45) **Date of Patent:** **May 25, 2010**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Takashi Yuba**, Shinagawa (JP); **Shigemi Kurashima**, Shinagawa (JP); **Hideki Iwata**, Shinagawa (JP); **Masahiro Yanagi**, Shinagawa (JP); **Takashi Arita**, Shinagawa (JP)

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(73) Assignee: **Fujitsu Component 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 447 days.

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(21) Appl. No.: **11/492,074**

(22) Filed: **Jul. 25, 2006**

(65) **Prior Publication Data**

US 2007/0146214 A1 Jun. 28, 2007

(30) **Foreign Application Priority Data**

Dec. 28, 2005 (JP) 2005-378396

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

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

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

See application file for complete search history.

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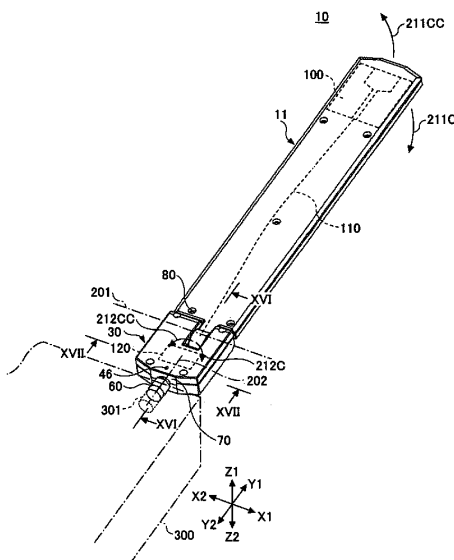
Primary Examiner—Tho G Phan

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

(57) **ABSTRACT**

An antenna apparatus includes an antenna case housing an antenna; a connector to be connected to a device which connector is electrically connected to the antenna; and an antenna case supporting mechanism which supports the antenna case and enables changing a position of the antenna case at least to a horizontal position and a vertical position.

9 Claims, 19 Drawing Sheets





US007724196B2

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

(10) **Patent No.:** **US 7,724,196 B2**
(45) **Date of Patent:** **May 25, 2010**

(54) **FOLDED DIPOLE MULTI-BAND ANTENNA**

(56) **References Cited**

(75) Inventors: **Christos L. Kinezos**, Sunrise, FL (US);
Alejandro Candal, Davie, FL (US);
Lorenzo A. Ponce De Leon, Lake
Worth, FL (US)

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

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 305 days.

Primary Examiner—Huedung Mancuso

(74) *Attorney, Agent, or Firm*—Gregory L. Mayback; Scott B. Smiley; Mayback & Hoffman

(21) Appl. No.: **11/855,583**

(57) **ABSTRACT**

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

A loop antenna includes a ground plane and a conductive element with a first C-shaped element portion having an open end and a closed end, with only the open end extending directly above a first portion of the ground plane, a second C-shaped element portion having an open end and a closed end, with only the open end extending directly above a second portion of the ground plane, and a transmission line element disposed between the first C-shaped element portion and the second C-shaped element portion and positioned directly above a third portion of the ground plane.

(65) **Prior Publication Data**

US 2009/0073055 A1 Mar. 19, 2009

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

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

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

20 Claims, 7 Drawing Sheets

