



US007612723B2

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

(10) **Patent No.:** **US 7,612,723 B2**
(45) **Date of Patent:** **Nov. 3, 2009**

(54) **PORTABLE COMMUNICATION DEVICE
ANTENNA ARRANGEMENT**
(75) Inventors: **Jan-Willem Zweers**, Wezep (NL); **Ernst Hupkes**, Kampen (NL)
(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 361 days.

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(21) Appl. No.: **11/681,320**

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(22) Filed: **Mar. 2, 2007**

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(65) **Prior Publication Data**
US 2008/0191947 A1 Aug. 14, 2008

International Search Report with Written Opinion dated Oct. 2, 2007 for corresponding PCT application No. PCT/EP2007/057902, 8 pages.

Related U.S. Application Data

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(60) Provisional application No. 60/887,913, filed on Feb. 2, 2007.

Primary Examiner—Huedung Mancuso

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

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

(57) **ABSTRACT**

(52) **U.S. Cl.** **343/702**
(58) **Field of Classification Search** 343/702,
343/866, 741, 744; 455/269–272
See application file for complete search history.

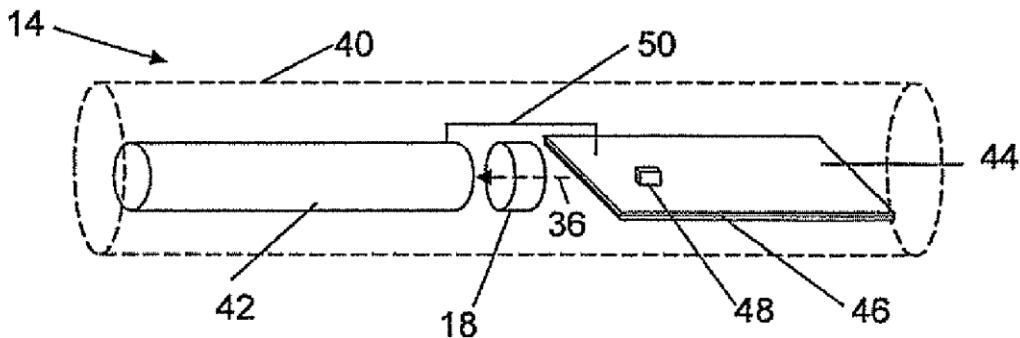
A portable communication device is provided, which includes a radio communication unit, an antenna exciter element for connection to the radio communication unit and ground and at least one further antenna element provided on one side of the antenna exciter element. The further antenna elements comprise a first mass block of electrically conducting material including components provided for the operation of the portable communication device. The mass block is dimensioned for operating in a frequency band in which communication is desired when being excited by the antenna exciter element and each mass block and the antenna exciter element extend in three dimensions.

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23 Claims, 2 Drawing Sheets





US007612724B2

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

(10) **Patent No.:** **US 7,612,724 B2**
(45) **Date of Patent:** **Nov. 3, 2009**

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

(75) Inventors: **Yong-jin Kim**, Yongin-si (KR);
Gyoo-soo Chae, Yongin-si (KR);
Young-eil Kim, Yongin-si (KR); **Ick-jae Yoon**, Yongin-si (KR)

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

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

(21) Appl. No.: **11/703,199**

(22) Filed: **Feb. 7, 2007**

(65) **Prior Publication Data**
US 2008/0055160 A1 Mar. 6, 2008

(30) **Foreign Application Priority Data**
Aug. 29, 2006 (KR) 10-2006-0082099

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/38 (2006.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.** **343/702**; 343/700 MS;
343/829; 343/845; 343/846

(58) **Field of Classification Search** 343/700 MS,
343/702, 829, 845, 846
See application file for complete search history.

(56) **References Cited**
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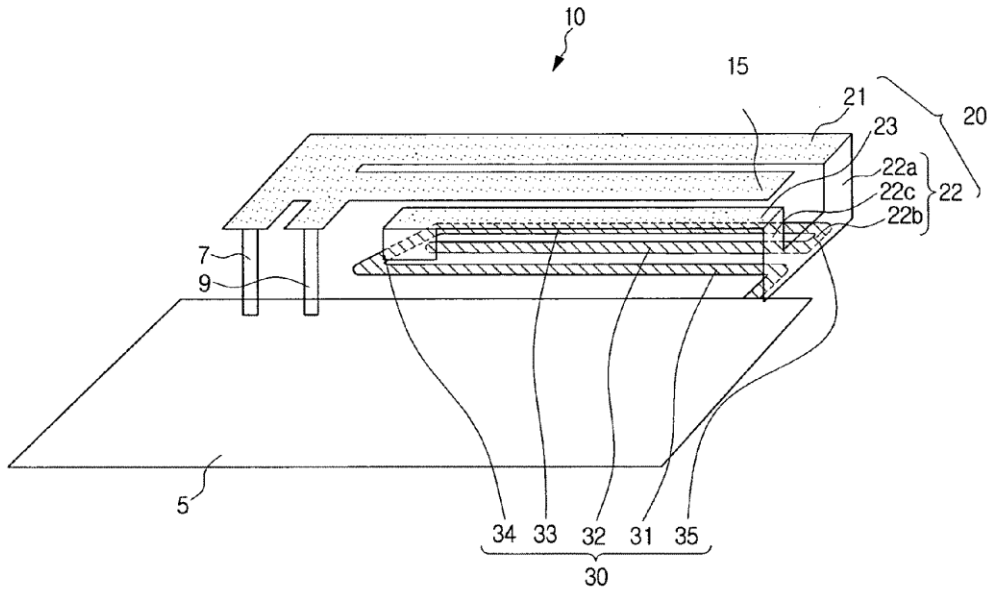
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Primary Examiner—Douglas W Owens
Assistant Examiner—Jennifer F Hu
(74) *Attorney, Agent, or Firm*—Sughrue Mion, PLLC

(57) **ABSTRACT**

An inverted F antenna (IFA) which reduces specific absorption rate (SAR) includes a ground; an auxiliary radiator which is attached to one end of the ground and disposed along a plane direction of the ground; a radiator which lies at an interval from the auxiliary radiator in parallel and radiates electromagnetic waves; a feed which supplies current to the radiator; and a short which interconnects the radiator with the ground and discharges the current to the ground. Accordingly, the SAR can be decreased and the antenna size can be miniaturized.

11 Claims, 5 Drawing Sheets





US007612725B2

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

(10) **Patent No.:** **US 7,612,725 B2**
(45) **Date of Patent:** **Nov. 3, 2009**

- (54) **ANTENNAS FOR HANDHELD ELECTRONIC DEVICES WITH CONDUCTIVE BEZELS** 6,282,433 B1 * 8/2001 Holshouser 455/556.2
6,337,662 B1 1/2002 Cassel
6,622,031 B1 9/2003 McCleary et al.
- (75) Inventors: **Robert J. Hill**, Salinas, CA (US);
Robert W. Schlub, Campbell, CA (US);
Ruben Caballero, 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 322 days.

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EP 1 286 413 2/2003

(21) Appl. No.: **11/821,192**

(22) Filed: **Jun. 21, 2007**

(65) **Prior Publication Data**
US 2008/0316115 A1 Dec. 25, 2008

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

(Continued)
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Primary Examiner—Tho G Phan
(74) *Attorney, Agent, or Firm*—Treyz Law Group; G. Victor Treyz

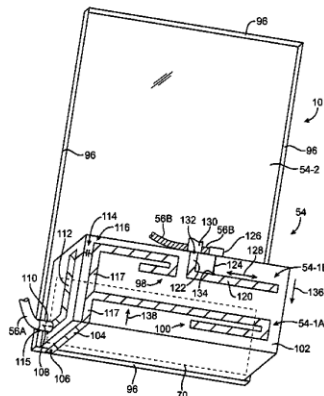
(57) **ABSTRACT**

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A handheld electronic device may be provided that contains wireless communications circuitry. The handheld electronic device may have a housing and a display. The display may be attached to the housing a conductive bezel. The handheld electronic device may have one or more antennas for supporting wireless communications. A ground plane in the handheld electronic device may serve as ground for one or more of the antennas. The ground plane and bezel may define an opening. A rectangular slot antenna or other suitable slot antenna may be formed from or within the opening. One or more antenna resonating elements may be formed above the slot. An electrical switch that bridges the slot may be used to modify the perimeter of the slot so as to tune the communications bands of the handheld electronic device.

20 Claims, 20 Drawing Sheets





US007612726B2

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

(10) **Patent No.:** **US 7,612,726 B2**
(45) **Date of Patent:** ***Nov. 3, 2009**

(54) **MOBILE WIRELESS COMMUNICATIONS DEVICE COMPRISING A TOP-MOUNTED AUXILIARY INPUT/OUTPUT DEVICE AND A BOTTOM-MOUNTED ANTENNA**

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

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

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/167,170**

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

(65) **Prior Publication Data**

US 2008/0287171 A1 Nov. 20, 2008

Related U.S. Application Data

(63) Continuation of application No. 11/422,165, filed on Jun. 5, 2006, now Pat. No. 7,405,703, which is a continuation of application No. 11/042,269, filed on Jan. 25, 2005, now Pat. No. 7,088,294.

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

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

(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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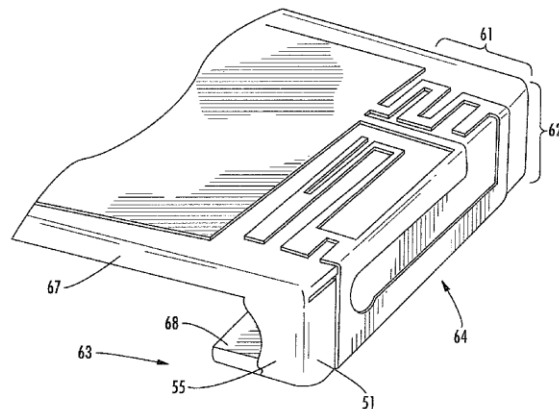
Primary Examiner—Hoang V Nguyen

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

(57) **ABSTRACT**

A mobile wireless communications device may include a housing having an upper portion and a lower portion, a dielectric substrate carried by the housing, circuitry carried by the dielectric substrate, and an audio output transducer carried by the upper portion of the housing and connected to the circuitry. The device may further include a user input interface carried by the housing and connected to the circuitry, and at least one auxiliary input/output device carried by the upper portion of the housing and connected to the circuitry. An antenna may also be carried within the lower portion of the housing comprising a pattern of conductive traces on the dielectric substrate.

19 Claims, 11 Drawing Sheets





US007612732B2

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

(10) **Patent No.:** **US 7,612,732 B2**
(45) **Date of Patent:** **Nov. 3, 2009**

(54) **ANTENNA WITH STRIPLINE SPLITTER CIRCUIT**

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(75) Inventors: **Kei Takeishi**, Tokyo (JP); **Seiji Nishi**, Tokyo (JP)

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(73) Assignee: **Ok Electric Industry Co., Ltd.**, Tokyo (JP)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 25 days.

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(21) Appl. No.: **12/000,810**

Seiji Nishi et al. "Development of Millimeter-Wave Video Transmission System—Development of Antenna." Proc. 2001 Asia-Pacific Microwave Conf., vol. 2, pp. 509-512, Dec. 2001.

(22) Filed: **Dec. 18, 2007**

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(65) **Prior Publication Data**

US 2008/0180329 A1 Jul. 31, 2008

Primary Examiner—Rexford N Barnie

Assistant Examiner—Dylan White

(74) *Attorney, Agent, or Firm*—Rabin & Berdo, PC

(30) **Foreign Application Priority Data**

Jan. 31, 2007 (JP) 2007-021814

(57) **ABSTRACT**

(51) **Int. Cl.**
H01Q 21/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/853; 343/700 MS**

(58) **Field of Classification Search** 343/850, 343/853, 895, 700 MS

See application file for complete search history.

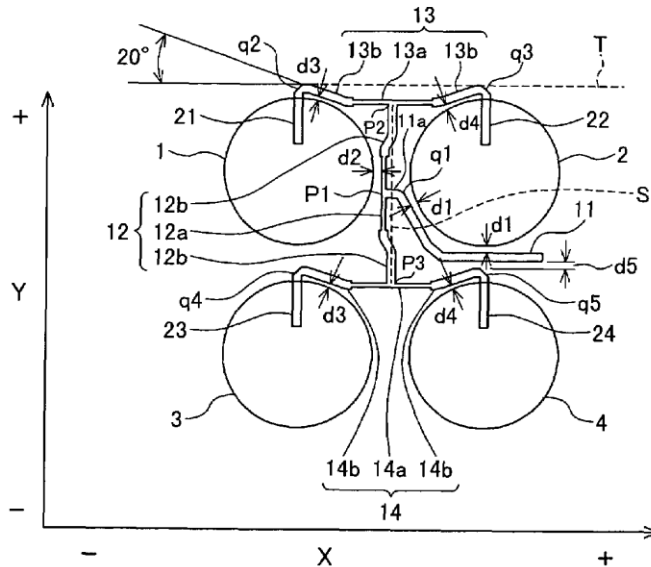
A flat antenna includes a 2x2 array of circular waveguide antenna elements that receive power from a splitting circuit including first to fourth striplines. The second stripline extends in two directions from one end of the first stripline. The third stripline extends in two directions from one end of the second stripline. The fourth stripline extends in two directions from the other end of the second stripline. Four feeder electrodes extend in mutually identical directions from the ends of the third and fourth striplines into the waveguides. The third and fourth striplines are bowed in way that shifts the second stripline closer to the center of the array. This arrangement permits a compact spacing of the waveguide antenna elements.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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2001/0028325 A1* 10/2001 Pretorius et al. 343/700 MS

7 Claims, 10 Drawing Sheets





US007612734B2

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

(10) **Patent No.:** **US 7,612,734 B2**
(45) **Date of Patent:** **Nov. 3, 2009**

(54) **WIDE BANDWIDTH ANTENNA DEVICE**

(75) Inventors: **Tiao-Hsing Tsai**, Tao Yuan Shien (TW);
Chieh-Ping Chiu, Tao Yuan Shien (TW);
Chih-Wei Liao, Tao Yuan Shien (TW);
Chi-Yin Fang, 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 42 days.

(21) Appl. No.: **12/004,315**

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

(65) **Prior Publication Data**

US 2009/0021448 A1 Jan. 22, 2009

(30) **Foreign Application Priority Data**

Jul. 16, 2007 (TW) 96125821 A

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 21/00 (2006.01)

(52) **U.S. Cl.** **343/893; 343/700 MS**

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

(56) **References Cited**

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Primary Examiner—James H. Cho

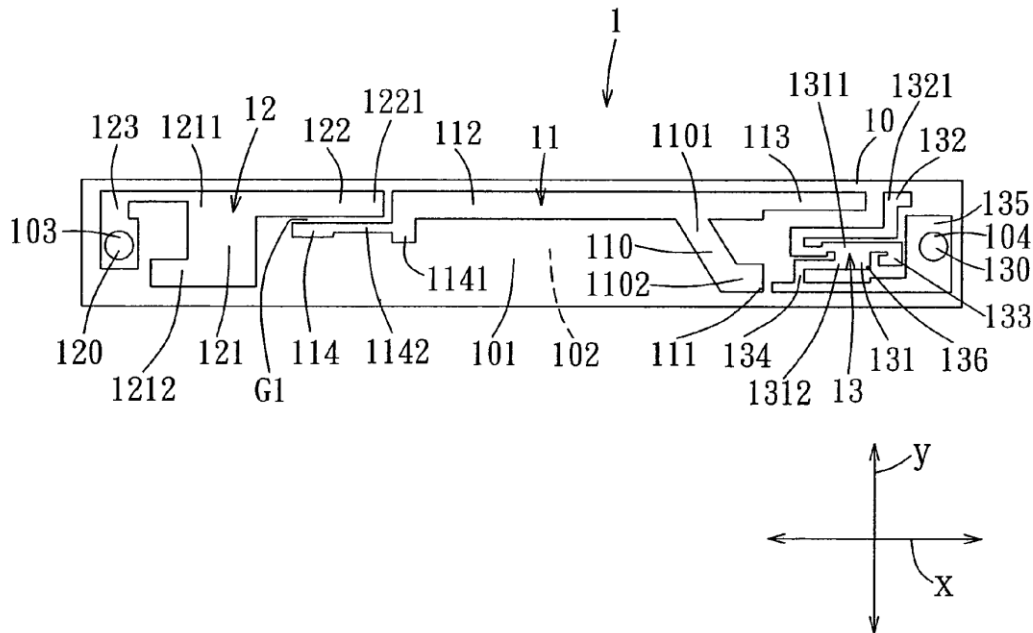
Assistant Examiner—Crystal L. Hammond

(74) *Attorney, Agent, or Firm*—David N. Lathrop

(57) **ABSTRACT**

An antenna device includes a dielectric substrate, first and second antennas, and a parasitic coupler. The first antenna is formed on the dielectric substrate, and includes first and second radiating elements that extend in opposite directions. The parasitic coupler is formed on the dielectric substrate and is electromagnetically coupled to the first radiating element. The second antenna is formed on the dielectric substrate and is disposed proximate to the second radiating element.

10 Claims, 26 Drawing Sheets





US007619566B2

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

(10) **Patent No.:** **US 7,619,566 B2**
(45) **Date of Patent:** **Nov. 17, 2009**

(54) **IMPEDANCE TRANSFORMATION TYPE WIDE BAND ANTENNA**

2004/0201530 A1* 10/2004 Wen et al. 343/725

FOREIGN PATENT DOCUMENTS

(75) Inventors: **Byung-Nam Kim**, Kyonggi-do (KR);
Jin-Seok Kim, Kyonggi-do (KR);
Seung-Yong Lee, Kyonggi-do (KR)

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(73) Assignee: **Ace Antenna Corp.**, Incheon-Shi (KR)

Primary Examiner—Hoang V Nguyen
Assistant Examiner—Robert Karacsony

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 62 days.

(57) **ABSTRACT**

(21) Appl. No.: **11/551,398**

The present invention relates to an impedance transformation-type wide band internal antenna. The wide band antenna includes a radiation part, a short circuit part, a feeding part, and a feeding pin. The radiation part is formed to have a predetermined length and width according to an operating frequency, the radiation part including a plurality of stubs formed in arbitrary shapes according to location of a plurality of slots. The short circuit part causes part of a side surface of the radiation part to be connected to an external ground. The feeding part is extended from the stubs, formed on the side surface of the radiation part to be adjacent to the short circuit part, and is bent multiple times, the feeding part being formed on a bottom surface of the radiation part to have a predetermined length and width. The feeding pin is formed on an end of the feeding part and is fed with current. Accordingly, the present invention is advantageous in that impedances are matched using the length and interval of the feeding part, which is bent multiple times, and the size of a through hole formed in the feeding part, so that a plurality of wide band resonant frequencies is formed, thus enabling the wide band antenna to be simultaneously used for different frequency bands in a wireless communication system that uses different frequency bands.

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

(65) **Prior Publication Data**

US 2007/0091000 A1 Apr. 26, 2007

(30) **Foreign Application Priority Data**

Oct. 20, 2005 (KR) 10-2005-0099343

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)

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

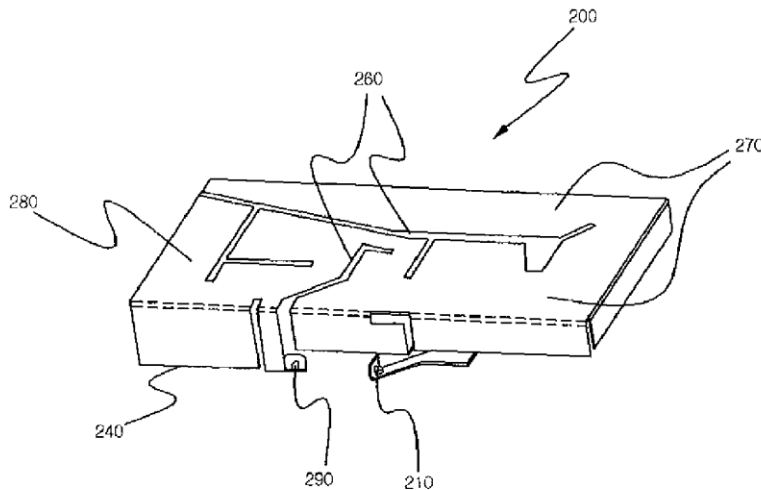
(58) **Field of Classification Search** 343/700 MS,
343/702, 767, 850, 852, 860, 863
See application file for complete search history.

(56) **References Cited**

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5 Claims, 5 Drawing Sheets





US007619569B2

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

(10) **Patent No.:** **US 7,619,569 B2**
(45) **Date of Patent:** **Nov. 17, 2009**

(54) **MULTI-BAND ANTENNA**

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(75) Inventors: **Hsin-Tsung Wu**, Taipei Hsien (TW);
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(73) Assignee: **Cheng Uei Precision Industry Co., Ltd.**, Taipei Hsien (TW)

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Primary Examiner—Douglas W Owens

Assistant Examiner—Chuc D Tran

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 338 days.

(57) **ABSTRACT**

(21) Appl. No.: **11/838,439**

A multi-band antenna has a first radiating conductor defining a first side connected to a feeding conductor and a short portion, and a second side opposite to the first side and connected to a second radiating conductor, a third radiating conductor and a fourth radiating conductor. The second radiating conductor is arranged between the third radiating conductor and the fourth radiating conductor. The length of the first radiating conductor and the second radiating conductor resonates at a first frequency range and a second frequency range which is double frequency higher than the first frequency range. The length of the first radiating conductor and the third radiating conductor resonates at a third frequency range which is higher than and close to the second frequency range. The dimension of the fourth radiating conductor has an effect on antenna characteristics in the third frequency range.

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

(65) **Prior Publication Data**

US 2009/0046014 A1 Feb. 19, 2009

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/767; 343/846; 343/895**

(58) **Field of Classification Search** 343/700 MS, 343/702, 767, 846, 850, 861, 895
See application file for complete search history.

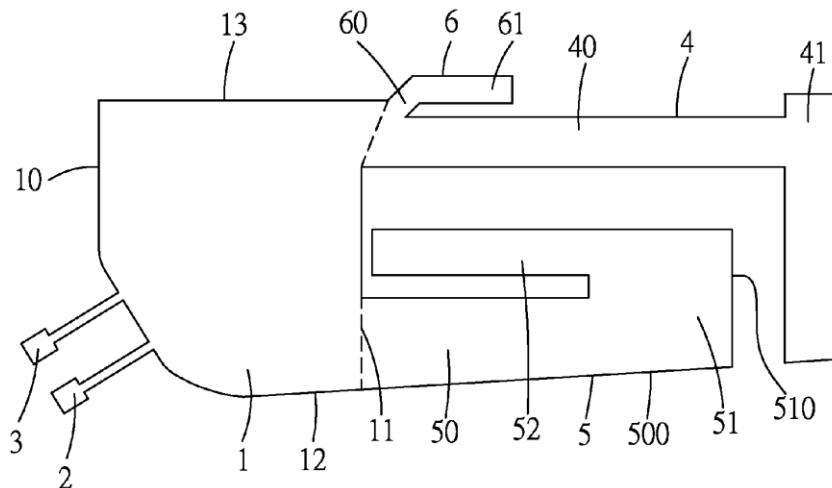
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11 Claims, 4 Drawing Sheets

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US007619572B2

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

(10) **Patent No.:** **US 7,619,572 B2**
(45) **Date of Patent:** **Nov. 17, 2009**

- (54) **DUAL BAND ANTENNA**
- (75) Inventors: **Jia-Hung Su**, Taipei Hsien (TW);
Ching-Chi Lin, Taipei Hsien (TW);
Hung-Jen Chen, Taipei Hsien (TW);
Kai Shih, Taipei Hsien (TW); **Yu-Yuan Wu**, Taipei Hsien (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 239 days.

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Primary Examiner—Huedung Mancuso

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

- (21) Appl. No.: **11/752,766**
- (22) Filed: **May 23, 2007**
- (65) **Prior Publication Data**
US 2008/0291091 A1 Nov. 27, 2008
- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
- (52) **U.S. Cl.** **343/702**
- (58) **Field of Classification Search** 343/700 MS,
343/702, 795, 722, 749
See application file for complete search history.

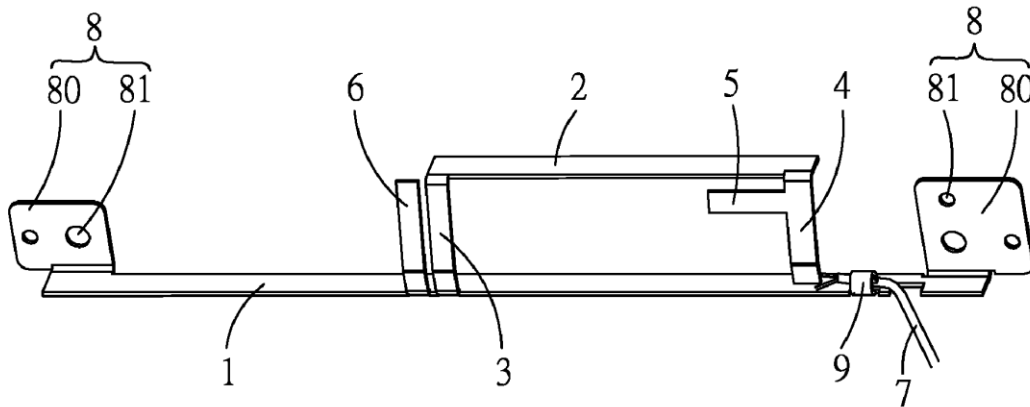
(57) **ABSTRACT**

A dual band antenna has a ground portion, a first radiating conductor spaced from one side of the ground portion, a second radiating conductor connected between one end of the first radiating conductor and the ground portion, a third radiating conductor connected on the other end of the first radiating conductor, a fourth radiating conductor extended from the third radiating conductor, a parasitic element arranged to close to the second radiating conductor and connected to the ground portion and a feeding cable connected to the free end of the third radiating conductor. When the dual band antenna operates, the first, second and third radiating conductors obtain a first wireless location area network bandwidth covering 2.4 GHz to 2.5 GHz, and the third radiating conductor, the fourth radiating conductor and the parasitic element obtain a second wireless location area network bandwidth covering 4.9 GHz to 5.87 GHz.

- (56) **References Cited**
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8 Claims, 2 Drawing Sheets

100





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(12) **Reissued Patent**
Forster et al.

(10) **Patent Number:** **US RE40,972 E**
(45) **Date of Reissued Patent:** **Nov. 17, 2009**

(54) **TUNING TECHNIQUES FOR A SLOT ANTENNA**

(76) Inventors: **Ian J. Forster**, 31 Great Cob, Chelmsford, Essex (GB), CM1 6LA;
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(21) Appl. No.: **11/267,920**

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(Under 37 CFR 1.47)

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

(52) **U.S. Cl.** **343/746; 343/767; 340/539**

(58) **Field of Classification Search** **343/745, 343/746, 767; 340/539, 540, 572, 825**
See application file for complete search history.

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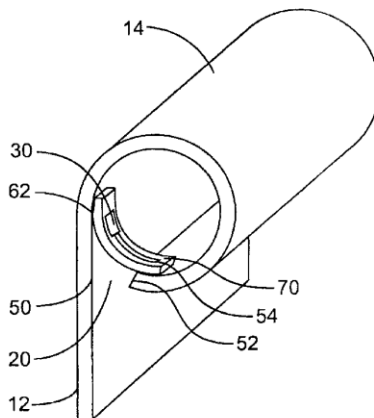
Primary Examiner—Hoang V Nguyen

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

(57) **ABSTRACT**

A wireless communication device and method for identifying a container, or communication information about a container, using a slot in the container as an antenna. The device includes a wireless communication device for transmitting information regarding the container. The container includes an outer wall forming a rim and a slot between the rim edge and the outer wall that is circular and continues without boundaries. The wireless communication device is coupled to the slot to provide the slot antenna for communications. An impedance matching network is additionally provided to make the operating frequency of the slot substantially the same as the operating frequency of the wireless communication device. Alternatively, shorting posts may be placed in the slot to define boundaries of the slot to match the operating frequency of the slot to the operating frequency of the antenna. Variable impedance matching is provided between the wireless communication device and the slot.

49 Claims, 19 Drawing Sheets





US007623072B2

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

(10) **Patent No.:** **US 7,623,072 B2**
(45) **Date of Patent:** **Nov. 24, 2009**

(54) **MULTIBAND ANTENNA AND MULTIBAND ANTENNA SYSTEM**
(75) Inventors: **Zheng He Feng**, Beijing (CN); **Peng Sun**, Columbus, OH (US)
(73) Assignee: **Sanyo Electric Co., Ltd.**, Osaka (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 5 days.

(21) Appl. No.: **11/638,458**
(22) Filed: **Dec. 14, 2006**

(65) **Prior Publication Data**
US 2007/0188388 A1 Aug. 16, 2007

(30) **Foreign Application Priority Data**
Dec. 14, 2005 (CN) 2005 1 0129644

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/702; 343/846**
(58) **Field of Classification Search** **343/700 MS, 343/702, 846**
See application file for complete search history.

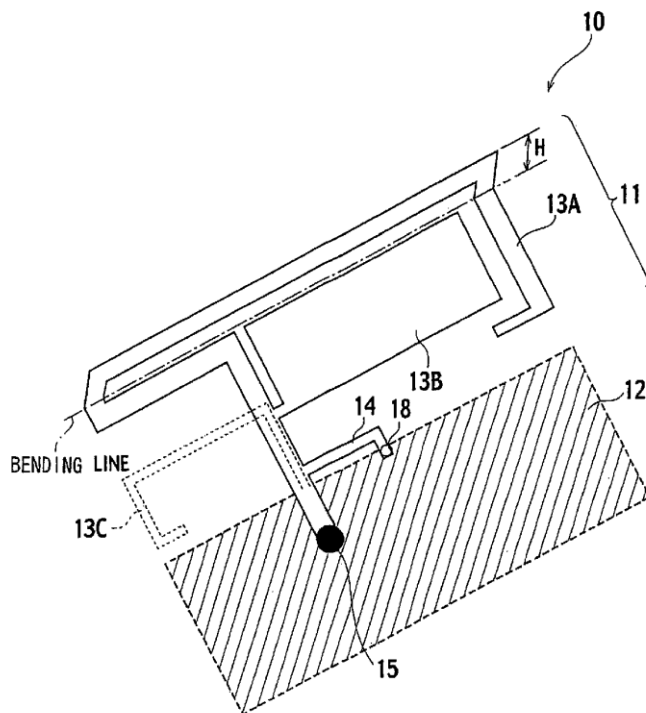
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Primary Examiner—Hoang V Nguyen
(74) *Attorney, Agent, or Firm*—NDQ&M Watchstone LLP

(57) **ABSTRACT**
A multiband antenna includes an antenna portion having a front surface and a back surface and a ground plane located adjacent to the antenna portion. The multiband antenna includes a front surface side element arranged on the front surface side and connected to a feeding point. The back surface side element arranged on the back surface side and connected to the ground plane.

6 Claims, 6 Drawing Sheets





US007623074B2

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

(10) **Patent No.:** **US 7,623,074 B2**
(45) **Date of Patent:** **Nov. 24, 2009**

(54) **MULTI-BAND ANTENNA**

2008/0122714 A1* 5/2008 Ishihara et al. 343/750

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

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(73) Assignees: **Auden Techno Corp.**, Tao-Yuan Hsien (TW); **National Sun Yat-Sen University**, Kaohsiung (TW)

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Primary Examiner—James Cho
(74) *Attorney, Agent, or Firm*—Ming Chow; Sinorica, LLC

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 18 days.

(57) **ABSTRACT**

A multi-band antenna, it comprises: a grounding surface, a supporting base and a radiative metallic portion; the grounding surface has a first shorting point and a second shorting point; the radiative metallic portion is attached to a bottom surface of the supporting base, and includes: a first radiative metallic wire, a radiative metallic sheet, a second radiative metallic wire and a parasitic radiative metallic arm. One end point of the first radiative metallic wire is a feeding end for the antenna, while the other end point is electrically connected to the first shorting point of the grounding surface; the radiative metallic sheet is electrically connected to a section of the first radiative metallic wire; the second radiative metallic wire is surrounded by the first radiative metallic wire, of which one end point is electrically connected to the first radiative metallic wire; one end point of the parasitic radiative metallic arm is electrically connected to the second shorting point of the grounding surface.

(21) Appl. No.: **12/017,019**

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

(65) **Prior Publication Data**

US 2009/0184874 A1 Jul. 23, 2009

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

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

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

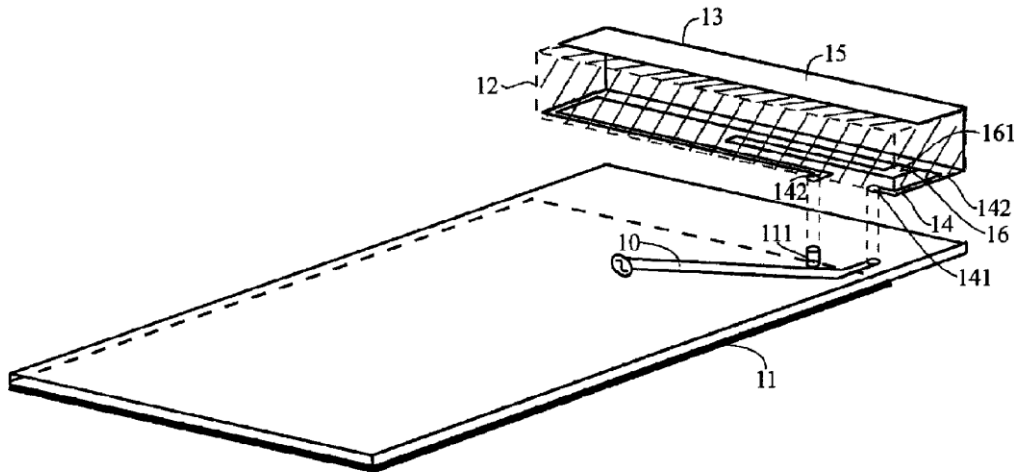
See application file for complete search history.

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7,075,484 B2* 7/2006 Sung 343/700 MS

8 Claims, 8 Drawing Sheets





US007623083B2

(12) **United States Patent**
Chung

(10) **Patent No.:** **US 7,623,083 B2**
(45) **Date of Patent:** **Nov. 24, 2009**

(54) **PLANAR ANTENNA UTILIZING CASCADED RIGHT-HANDED AND LEFT-HANDED TRANSMISSION LINES**

7,446,712 B2 * 11/2008 Itoh et al. 343/700 MS

(75) Inventor: **Shyh-Jong Chung**, Hsinchu (TW)

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

Primary Examiner—Douglas W Owens

Assistant Examiner—Jennifer F Hu

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 182 days.

(57) **ABSTRACT**

(21) Appl. No.: **11/882,121**

(22) Filed: **Jul. 31, 2007**

(65) **Prior Publication Data**

US 2009/0033558 A1 Feb. 5, 2009

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/00 (2006.01)
H01Q 13/10 (2006.01)

(52) **U.S. Cl.** **343/767**; 343/749; 343/700 MS

(58) **Field of Classification Search** 343/749, 343/700 MS, 767

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,006,048 B2 * 2/2006 Chang 343/767

A planar antenna structure is provided. The planar antenna includes a dielectric substrate, a ground plane, a first conductive pattern and a second conductive pattern. The dielectric substrate has a first surface and a second surface. The ground plane is on the second surface of the dielectric substrate. The first conductive pattern is on the first surface of the dielectric substrate, coupled to a feeding line. The second conductive pattern is on the second surface of the dielectric substrate, coupled to the ground plane. The first and second conductive patterns are coupled to serve as cascaded right- and left-handed transmission lines. The first and second conductive patterns include: a first lumped equivalent circuit of the right-handed transmission line; and a second lumped equivalent circuit of the left-handed transmission line, cascaded with the first lumped equivalent circuit, wherein the right- and left-handed transmission lines have electrical lengths with opposite signs respectively.

18 Claims, 10 Drawing Sheets

