



US007898483B2

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

(10) **Patent No.:** **US 7,898,483 B2**
(45) **Date of Patent:** **Mar. 1, 2011**

(54) **DIGITAL TV ANTENNA**

(56) **References Cited**

(75) Inventors: **Yen-Yu Chen**, Chung Ho (TW);
Yung-Da Lin, Chung Ho (TW);
Kuo-Ying Su, Chung Ho (TW)

(73) Assignee: **Avermedia Technology, Inc.**, Chung Ho,
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 375 days.

(21) Appl. No.: **12/254,120**

(22) Filed: **Oct. 20, 2008**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Jul. 31, 2008 (TW) 97129120 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
(52) **U.S. Cl.** **343/700 MS; 343/893**
(58) **Field of Classification Search** 343/828,
343/848, 770, 786, 711, 772, 791, 792.5,
343/771, 795, 895, 713, 767, 702, 700 MS;
174/2, 33, 36; 333/204, 247, 238; 361/118,
361/302, 816

See application file for complete search history.

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Primary Examiner — Douglas W Owens

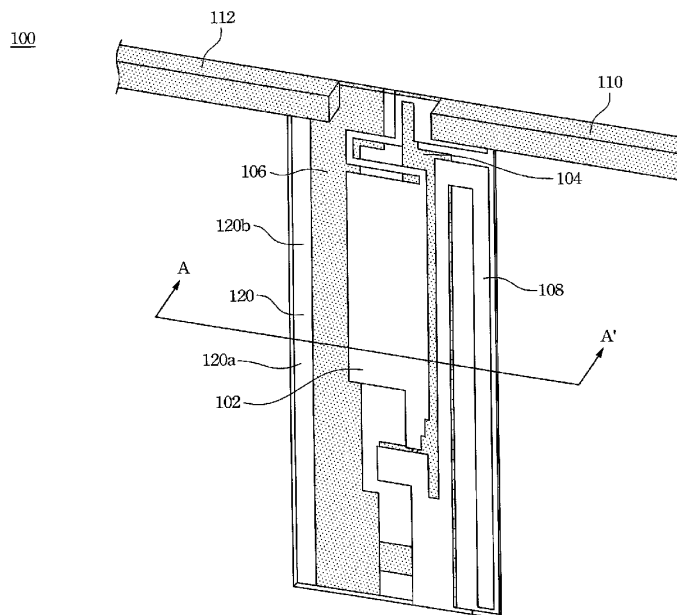
Assistant Examiner — Jae K Kim

(74) *Attorney, Agent, or Firm* — Thomas, Kayden,
Horstemeyer & Risley, LLP

(57) **ABSTRACT**

A digital TV antenna includes a grounding plane, a first radiation conductor, a second radiation conductor and a third radiation conductor. The grounding plane and the first radiation conductor are located in the first surface of a substrate. The second radiation conductor and the third radiation conductor are located in the second surface opposite to the first surface. Partial second radiation conductor covers the first radiation conductor to form an overlapping region. Partial third radiation conductor covers the first radiation conductor to form an overlapping region.

20 Claims, 5 Drawing Sheets



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US007898485B2

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

(10) **Patent No.:** **US 7,898,485 B2**
(45) **Date of Patent:** **Mar. 1, 2011**

(54) **HANDHELD ELECTRONIC DEVICES WITH ISOLATED ANTENNAS**

(75) Inventors: **Robert W. Schlub**, Campbell, CA (US);
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(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 21 days.

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(21) Appl. No.: **12/504,443**

(22) Filed: **Jul. 16, 2009**

(65) **Prior Publication Data**
US 2009/0278753 A1 Nov. 12, 2009

Related U.S. Application Data

(62) Division of application No. 11/650,071, filed on Jan. 4, 2007, now Pat. No. 7,595,759.

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

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

(58) **Field of Classification Search** **343/700 MS, 343/702, 725, 767, 846**
See application file for complete search history.

(56) **References Cited**

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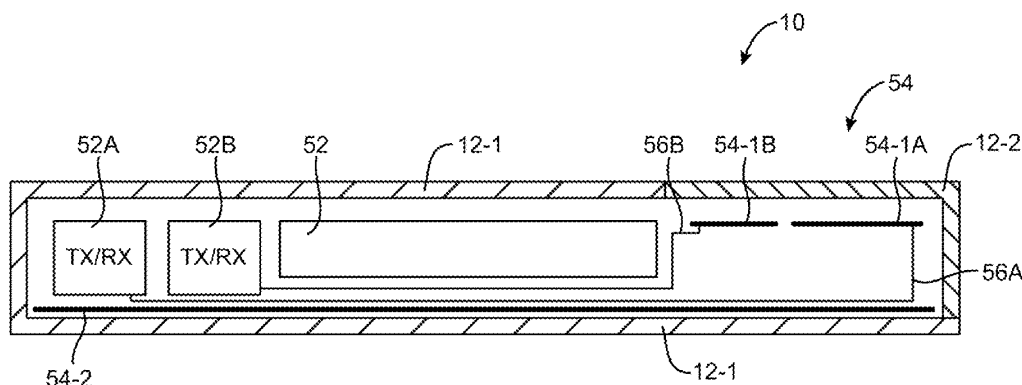
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

Handheld electronic devices are provided that contain wireless communications circuitry having at least first and second antennas. An antenna isolation element reduces signal interference between the antennas, so that the antennas may be used in close proximity to each other. A planar ground element may be used as a ground by the first and second antennas. The first antenna may be formed using a hybrid planar-inverted-F and slot arrangement in which a planar resonating element is located above a rectangular slot in the planar ground element. The second antenna may be formed from an L-shaped strip. The planar resonating element of the first antenna may have first and second arms. The first arm may resonate at a common frequency with the second antenna and may serve as the isolation element. The second arm may resonate at approximately the same frequency as the slot portion of the hybrid antenna.

10 Claims, 12 Drawing Sheets



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US007898488B2

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

(10) **Patent No.:** **US 7,898,488 B2**
(45) **Date of Patent:** **Mar. 1, 2011**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Nobuyasu Takemura**, Tokyo (JP);
Masataka Ohtsuka, Tokyo (JP)

(73) Assignee: **Mitsubishi Electric Corporation**,
Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/970,636**

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

(65) **Prior Publication Data**
US 2008/0169991 A1 Jul. 17, 2008

(30) **Foreign Application Priority Data**
Jan. 12, 2007 (JP) 2007-004706

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

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

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

See application file for complete search history.

(56) **References Cited**

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Primary Examiner—Huedung Mancuso

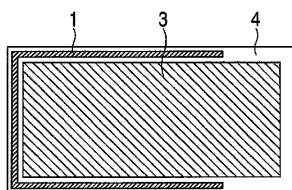
(74) *Attorney, Agent, or Firm*—Sughrue Mion, PLLC

(57) **ABSTRACT**

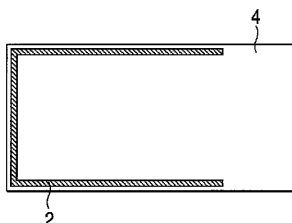
A ground conductor constituting a bottom board and a loop antenna formed of a strip conductor formed separately from and around the ground conductor are provided on one face of a dielectric substrate, and a transmitter-receiver is connected to one end of the loop antenna serving as the power dispatching unit via a first matching circuit, and a second matching circuit is connected to the other end. A conductor formed of the strip conductor is provided on the dielectric substrate on the other face of the dielectric substrate so as to oppose the loop antenna with the intermediary of the dielectric substrate. A third matching circuit is connected to one end of the conductor and a fourth matching circuit is connected to the other end of the conductor. The loop antenna and the conductor are set to have a wavelength shorter than that of the frequency band to be used.

16 Claims, 7 Drawing Sheets

(FRONT FACE OF SUBSTRATE)



(BACK FACE OF SUBSTRATE)



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US007898493B1

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

(10) **Patent No.:** **US 7,898,493 B1**
(45) **Date of Patent:** **Mar. 1, 2011**

(54) **IMPLEMENTATION OF ULTRA WIDE BAND (UWB) ELECTRICALLY SMALL ANTENNAS BY MEANS OF DISTRIBUTED NON FOSTER LOADING**

(75) Inventors: **Roberto G. Rojas**, Upper Arlington, OH (US); **Bryan D. Raines**, Columbus, OH (US); **Khaled A. Obeidat**, Columbus, OH (US)

(73) Assignee: **The Ohio State University**, Columbus, OH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 340 days.

(21) Appl. No.: **12/139,424**

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

Related U.S. Application Data

(60) Provisional application No. 60/943,776, filed on Jun. 13, 2007.

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

(52) **U.S. Cl.** **343/850; 343/860**

(58) **Field of Classification Search** **343/850, 343/860**
See application file for complete search history.

(56) **References Cited**

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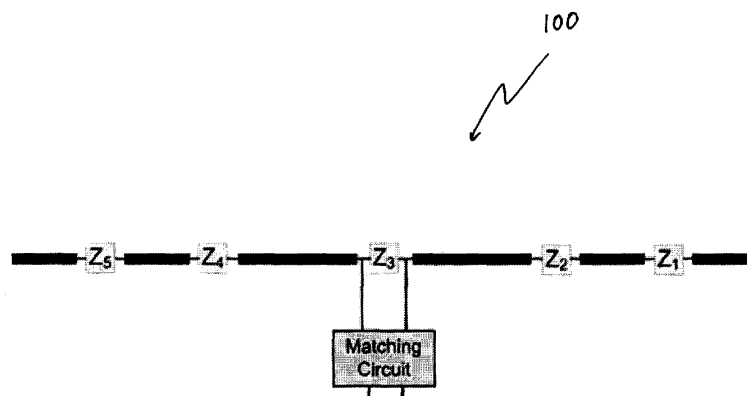
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Standley Law Group LLP

(57) **ABSTRACT**

A method to design antennas with broadband characteristics. In an exemplary embodiment, a method comprises loading an antenna structure with multiple reactive loads. The multiple loads are synthesized by applying the theory of Characteristic Modes. Another exemplary embodiment includes an antenna adapted to have broadband characteristics. One example is a wire dipole antenna. In an exemplary embodiment, a loaded antenna may be adapted to resonate an arbitrary current over a wide frequency band. The loads may require non-Foster elements when realized. Exemplary embodiments may include the broadband characteristics of the both the input impedance at the terminal of the antenna as well as the radiation pattern.

21 Claims, 22 Drawing Sheets



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US007903030B2

(12) **United States Patent**
Nagai

(10) **Patent No.:** **US 7,903,030 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **PLANAR ANTENNA DEVICE AND RADIO COMMUNICATION DEVICE USING THE SAME**

(75) Inventor: **Shuichi Nagai**, Kyoto (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 409 days.

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(21) Appl. No.: **11/916,547**

(22) PCT Filed: **Apr. 12, 2006**

(86) PCT No.: **PCT/JP2006/307723**

§ 371 (c)(1),
(2), (4) Date: **Dec. 5, 2007**

(87) PCT Pub. No.: **WO2006/132032**

PCT Pub. Date: **Dec. 14, 2006**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 6, 2005 (JP) 2005-166091

(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, 848
See application file for complete search history.

(56) **References Cited**

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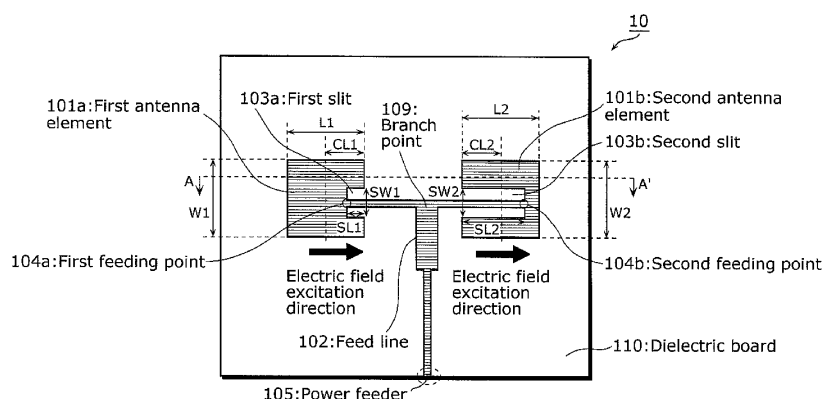
Primary Examiner — HoangAnh T Le

(74) *Attorney, Agent, or Firm* — Greenblum & Bernstein P.L.C.

(57) **ABSTRACT**

Provided a practical planar antenna device which has antenna elements facing each other, in which electrical power is fed between the antenna elements. The first feeding point is provided near an end of the first antenna element, which faces the opposite antenna element. The second feeding point is provided near an outer end of the second antenna element, by providing a second slit longer than the distance from the end of the second antenna element to its center. Since the feeding points are provided at the same level, the same electric field is excited in the two antenna elements in phase. The planar antenna device, to which electrical power is fed from the facing sides of the pair of opposite antenna elements, saves a bend conventionally required in a feed line, thereby allowing a wiring area to be smaller than in the conventional method.

6 Claims, 9 Drawing Sheets



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US007903031B2

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

(10) **Patent No.:** **US 7,903,031 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **ANTENNA APPARATUS**

(75) Inventors: **Masahiro Yanagi**, Shinagawa (JP); **Shigemi Kurashima**, Shinagawa (JP); **Hideki Iwata**, Shinagawa (JP); **Takashi Yuba**, Shinagawa (JP); **Masahiro Kaneko**, Shinagawa (JP); **Yuriko Segawa**, Shinagawa (JP); **Takashi Arita**, Shinagawa (JP); **Toshihiro Kusagaya**, Shinagawa (JP); **Kazuhiko Ikeda**, Iiyama (JP); **Hiroshi Matsumiya**, Iiyama (JP); **Kazuo Nomura**, Iiyama (JP)

(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 0 days.

(21) Appl. No.: **12/662,691**

(22) Filed: **Apr. 28, 2010**

(65) **Prior Publication Data**
US 2010/0212142 A1 Aug. 26, 2010

Related U.S. Application Data

(62) Division of application No. 11/581,376, filed on Oct. 17, 2006, now Pat. No. 7,737,908.

(30) **Foreign Application Priority Data**

Mar. 30, 2006 (JP) 2006-094429
Sep. 6, 2006 (JP) 2006-242016

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H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/846; 343/873;
343/906

(58) **Field of Classification Search** 343/700 MS,
343/830, 846, 873, 906
See application file for complete search history.

(56) **References Cited**

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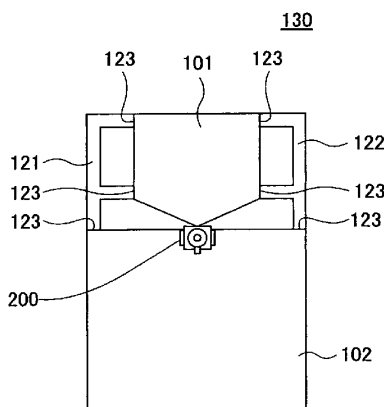
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A disclosed antenna apparatus includes: a punched out antenna element made of a sheet metal; a punched out ground element made of a sheet metal, the ground element facing the antenna element; and a surface mount type coaxial connector mounted across the antenna element and the ground element.

2 Claims, 27 Drawing Sheets



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US007903032B2

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

(10) **Patent No.:** **US 7,903,032 B2**
(45) **Date of Patent:** ***Mar. 8, 2011**

(54) **ANTENNA FOR A COMMUNICATION
TERMINAL**

(75) Inventors: **Zhinong Ying**, Lund (SE); **Johan
Andersson**, Malmö (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 924 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **11/740,310**

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

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 60/910,252, filed on Apr.
5, 2007.

(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, 895, 846

See application file for complete search history.

(56) **References Cited**

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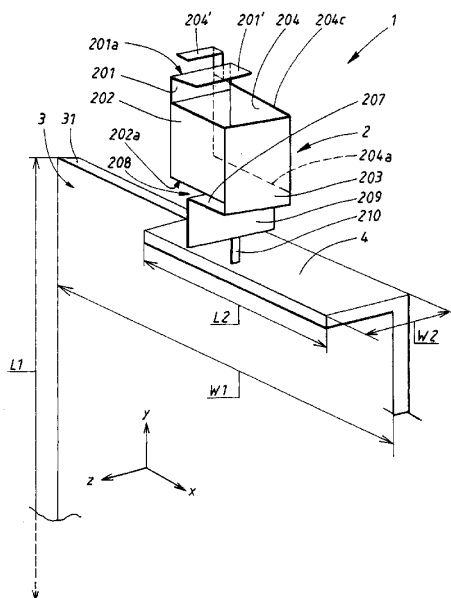
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Renner, Otto, Boisselle &
Sklar, LLP

(57) **ABSTRACT**

A radio antenna device for a radio communication terminal,
e.g. a mobile telephone, comprising a flat ground plane and an
antenna element having a radio signal feeding point disposed
at the ground plane. The antenna element has a folded three
dimensional box-like shape. The inventive antenna design
provides for an antenna device with compact size, which at
the same time is operable in UWB (Ultra Wideband) fre-
quency regions. The antenna device may therefore advanta-
geously be incorporated into a portable communication ter-
minal such as a mobile telephone.

18 Claims, 6 Drawing Sheets



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US007903033B2

(12) **United States Patent**
Bellows

(10) **Patent No.:** **US 7,903,033 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **ANTENNAS INCORPORATED IN A FITTED
ACCESSORY OF A MOBILE UNIT**

- (75) Inventor: **David Bellows**, Wantagh, NY (US)
(73) Assignee: **Symbol Technologies, Inc.**, Holtsville,
NY (US)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/872,388**

(22) Filed: **Oct. 15, 2007**

(65) **Prior Publication Data**

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- (51) **Int. Cl.**
H01Q 1/24 (2006.01)
(52) **U.S. Cl.** **343/702; 343/797**
(58) **Field of Classification Search** **343/702,**
343/700 MS, 795, 797, 770, 867
See application file for complete search history.

(56) **References Cited**

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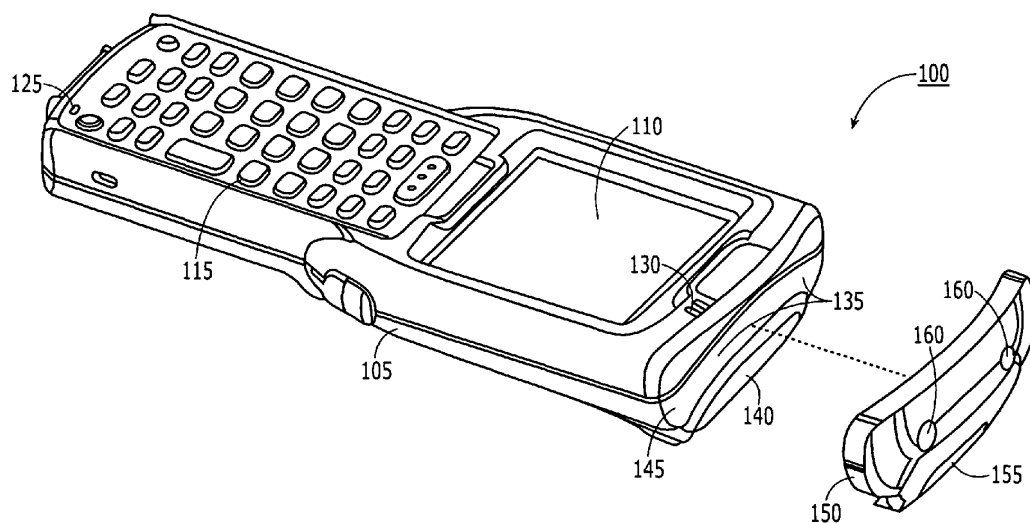
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Primary Examiner — HoangAnh T Le

(57) **ABSTRACT**

A fitted accessory comprises two antennas incorporated within the fitted accessory. The fitted accessory also comprises an electrical contact coupling to a corresponding electrical contact disposed on the housing so that an electrical connection is established between the components of the fitted accessory and components in the housing. The fitted accessory couples to the housing.

10 Claims, 4 Drawing Sheets



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US007903034B2

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

(10) **Patent No.:** **US 7,903,034 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **ANTENNA SET, PORTABLE WIRELESS
DEVICE, AND USE OF A CONDUCTIVE
ELEMENT FOR TUNING THE
GROUND-PLANE OF THE ANTENNA SET**

(75) Inventors: **Jaume Anguera**, Vinaros (ES); **Antonio
Condes**, Sta. Coloma de Cervelló (ES)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 286 days.

(21) Appl. No.: **12/066,897**

(22) PCT Filed: **Sep. 15, 2006**

(86) PCT No.: **PCT/EP2006/009019**

§ 371 (c)(1),
(2), (4) Date: **Apr. 22, 2008**

(87) PCT Pub. No.: **WO2007/039071**

PCT Pub. Date: **Apr. 12, 2007**

(65) **Prior Publication Data**

US 2008/0252536 A1 Oct. 16, 2008

Related U.S. Application Data

(60) Provisional application No. 60/718,537, filed on Sep.
19, 2005.

(30) **Foreign Application Priority Data**

Sep. 19, 2005 (EP) 05108616

(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
See application file for complete search history.

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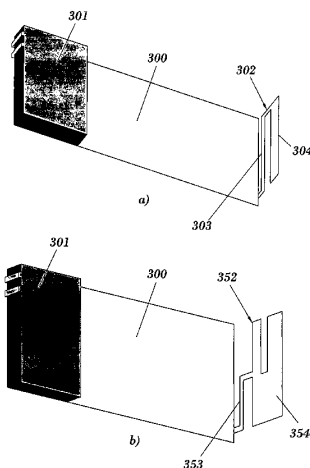
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna set comprising at least one antenna element and a
ground plane, is complemented by a conductive element
coupled to the ground plane, so as to modify the frequency
performance of the antenna set, adding an operating band to
the antenna set, and/or increasing the bandwidth of one oper-
ating band of the antenna set, and/or enhancing voltage stand-
ing wave ration, efficiency and/or gain of the antenna set.
Thus, the conductive element can be used to tune the antenna
set in accordance with specific requirements concerning, for
example, compatibility with different wireless services.

42 Claims, 17 Drawing Sheets



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US007903035B2

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

(10) **Patent No.:** **US 7,903,035 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **INTERNAL ANTENNA AND METHODS**

(75) Inventors: **Jyrki Mikkola**, Evijärvi (FI); **Ari Raappana**, Kello (FI); **Pasi Keskitalo**, Oulu (FI); **Pertti Nissinen**, Kempele (FI)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 68 days.

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(21) Appl. No.: **12/082,514**

(22) Filed: **Apr. 11, 2008**

(65) **Prior Publication Data**

US 2009/0140942 A1 Jun. 4, 2009

Related U.S. Application Data

(63) Continuation of application No. PCT/FI2006/050407, filed on Sep. 25, 2006.

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

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

(58) **Field of Classification Search** 343/702, 343/845, 846, 825, 829, 700 MS
See application file for complete search history.

(56) **References Cited**

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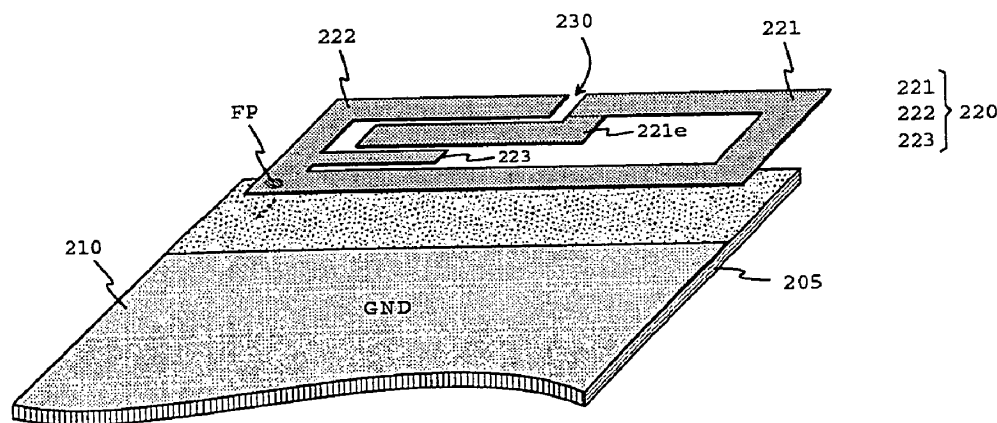
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An internal antenna especially aimed at flat radio devices. The antenna (200) comprises a planar radiator (220) with a branch (221) for forming a lower operating band for the antenna and a second branch (222) for forming an upper operating band. The branches typically form a frame-like pattern. There remains a slot (230) between the branches, opening to the outer edge of the radiator approximately in the middle of the edge running in the direction of the end of the circuit board (205) and being outside the circuit board as seen from above. The omnidirectional radiation of the antenna on its upper operating band improves as compared to the corresponding, known antennas, and its efficiency improves, because the average antenna gain increases.

53 Claims, 4 Drawing Sheets



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US007903037B2

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

(10) **Patent No.:** **US 7,903,037 B2**
(45) **Date of Patent:** ***Mar. 8, 2011**

(54) **MULTIBAND ANTENNA FOR HANDHELD
TERMINAL**

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

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

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

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **12/316,460**

(22) Filed: **Dec. 12, 2008**

(65) **Prior Publication Data**

US 2010/0149064 A1 Jun. 17, 2010

Related U.S. Application Data

(63) Continuation of application No. 11/021,597, filed on
Dec. 23, 2004, now Pat. No. 7,486,242, which is a
continuation of application No. PCT/EP02/07002,
filed on Jun. 25, 2002.

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

(52) **U.S. Cl.** **343/702**; 343/843; 343/846

(58) **Field of Classification Search** 343/700 MS,
343/702, 846, 895, 825, 826, 828, 829, 843;
455/575.7

See application file for complete search history.

(56) **References Cited**

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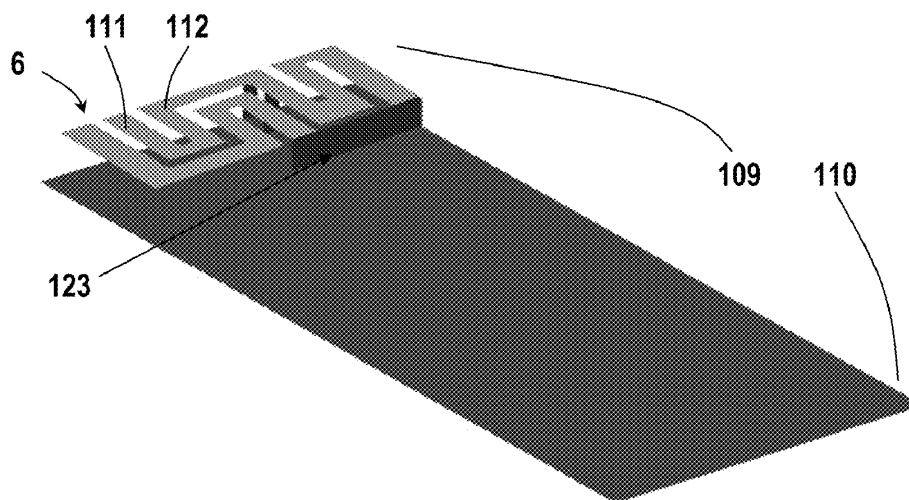
Primary Examiner — Michael C Wimer

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

(57) **ABSTRACT**

A multiband antenna includes a first conducting layer and a
second conducting layer. The first conducting layer acts as a
radiating element being placed over the second conducting
layer while the second conducting layer acts as a ground
plane. The first conducting layer includes a feeding point, the
feeding point being a starting point for a first shorter arm and
a second longer arm, the first and second arms forming a
multilevel structure for the multiband antenna.

44 Claims, 11 Drawing Sheets



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US007903039B2

(12) **United States Patent**
Yu

(10) **Patent No.:** **US 7,903,039 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **BROADBAND MULTI-LOOP ANTENNA FOR
MOBILE COMMUNICATION DEVICE**

(75) Inventor: **Wei Yu**, Shenzhen (CN)

(73) Assignee: **Shenzhen Sunway Communication
Co., Ltd.**, Shenzhen (CN)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 253 days.

(21) Appl. No.: **11/721,336**

(22) PCT Filed: **Feb. 5, 2005**

(86) PCT No.: **PCT/CN2005/000163**

§ 371 (c)(1),
(2), (4) Date: **Apr. 28, 2009**

(87) PCT Pub. No.: **WO2006/081704**

PCT Pub. Date: **Aug. 10, 2006**

(65) **Prior Publication Data**

US 2010/0134366 A1 Jun. 3, 2010

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

(52) **U.S. CL.** **343/742; 343/702; 343/867**

(58) **Field of Classification Search** **343/700 MS,**
343/702, 742, 867
See application file for complete search history.

(56) **References Cited**

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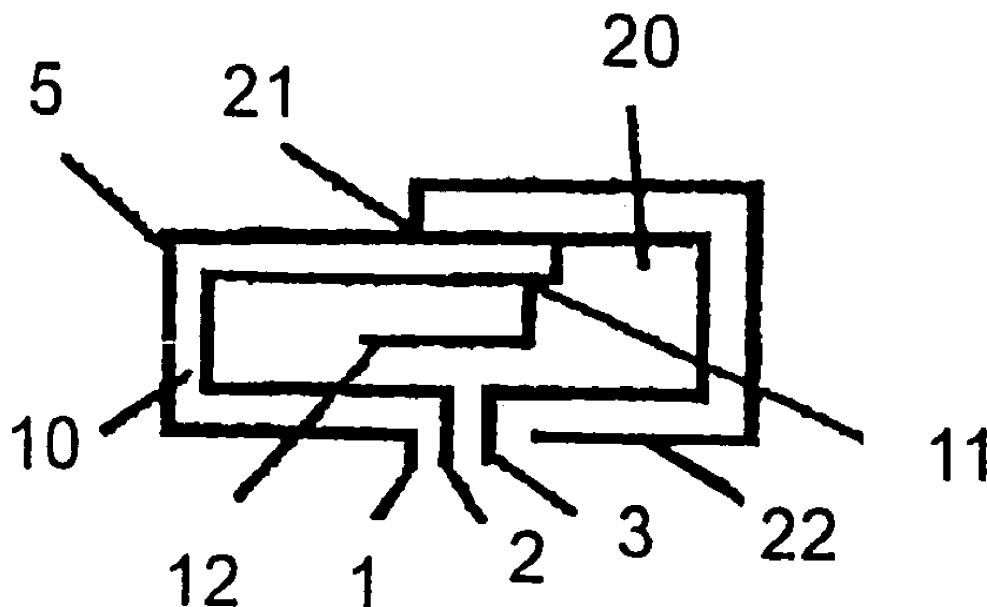
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Primary Examiner — Tan Ho

(57) **ABSTRACT**

A broadband multi-signal loop antenna in a mobile communication device such as a cellular phone having a chassis is disclosed. The antenna includes a conductor assembly electrically connected to the chassis and including a plurality of loops each starting at a common feed point and ending at respective grounding point; and a member for mounting the conductor assembly thereon. The loop has a grounding point. The ground points are located at different physical positions. The antenna is adapted to operate at multi-band.

14 Claims, 8 Drawing Sheets



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US007904126B2

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

(10) **Patent No.:** **US 7,904,126 B2**
(45) **Date of Patent:** **Mar. 8, 2011**

(54) **ANTENNA APPLIED TO SLIDE TYPE
MOBILE COMMUNICATION TERMINAL**

(75) Inventors: **Yong-jin Kim**, Seoul (KR); **Do-hoon Kwon**, Seoul (KR); **Young-eil Kim**, Suwon-si (KR); **Ji-hun Koo**, Yongin-si (KR); **Ick-jae Yoon**, Seoul (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 1155 days.

(21) Appl. No.: **11/486,280**

(22) Filed: **Jul. 14, 2006**

(65) **Prior Publication Data**

US 2007/0126644 A1 Jun. 7, 2007

(30) **Foreign Application Priority Data**

Dec. 5, 2005 (KR) 10-2005-0117554

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.** **455/575.4**; 343/702

(58) **Field of Classification Search** 455/575.4,
455/575.5, 41.1, 575.3, 575.1, 550.1; 343/702,
343/700, 729, 795, 725, 102, 821, 793, 797,
343/799, 830

See application file for complete search history.

(56) **References Cited**

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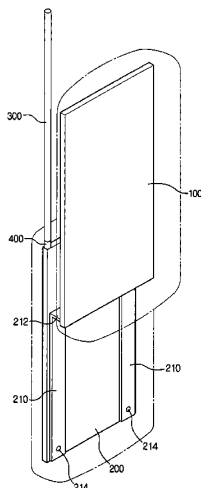
Primary Examiner — Melody Mehrpour

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

(57) **ABSTRACT**

An antenna applied to a slide type mobile communication terminal includes a first board mounted in a first body; a second board mounted in a second body; a radiating element mounted to the second body; and a first contact formed to connect to the second board at one end and contact with the first board at the other end when the first body slides. Accordingly, an antenna with directionality can be realized for applications to short range communication systems.

10 Claims, 6 Drawing Sheets



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US007907092B2

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

(10) **Patent No.:** **US 7,907,092 B2**
(45) **Date of Patent:** ***Mar. 15, 2011**

(54) **ANTENNA WITH ONE OR MORE HOLES**

(75) Inventors: **Jordi Soler Castany**, Sant Cugat del Valles (ES); **Carles Puente Baliarda**, Sant Cugat del Valles (ES)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 159 days.

This patent is subject to a terminal disclaimer.

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(21) Appl. No.: **12/246,964**

(22) Filed: **Oct. 7, 2008**

(65) Prior Publication Data

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Related U.S. Application Data

(63) Continuation of application No. 11/036,509, filed on Jan. 12, 2005, now Pat. No. 7,471,246, which is a continuation of application No. PCT/EP02/07836, filed on Jul. 15, 2002.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 13/12 (2006.01)
H01Q 13/10 (2006.01)

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

(58) **Field of Classification Search** 343/700 MS, 343/767, 769, 770, 793, 810
See application file for complete search history.

(56) References Cited

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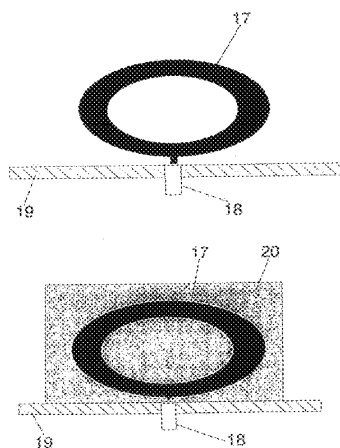
Primary Examiner — Shih-Chao Chen

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

(57) ABSTRACT

A new type of multihole antenna which is mainly suitable for mobile communications or in general to any other application where the integration of telecom systems or applications in a single antenna is important. The antenna includes a radiating element which at least includes one hole. By means of this configuration, the antenna provides a broadband and multi-band performance, and hence it features a similar behaviour through different frequency bands. Also, the antenna features a smaller size with respect to other prior art antennas operating at the same frequency.

42 Claims, 10 Drawing Sheets



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US007907099B2

(12) **United States Patent**
Chiang

(10) **Patent No.:** **US 7,907,099 B2**

(45) **Date of Patent:** ***Mar. 15, 2011**

(54) **ANTENNA**

(75) Inventor: **Yu-Yu Chiang**, 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 0 days.
This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/649,140**

(22) Filed: **Dec. 29, 2009**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(30) **Foreign Application Priority Data**

Jan. 31, 2008 (TW) 97202097 U

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

(52) **U.S. Cl.** **343/828; 343/846**

(58) **Field of Classification Search** 343/700 MS, 343/702, 828, 846, 893
See application file for complete search history.

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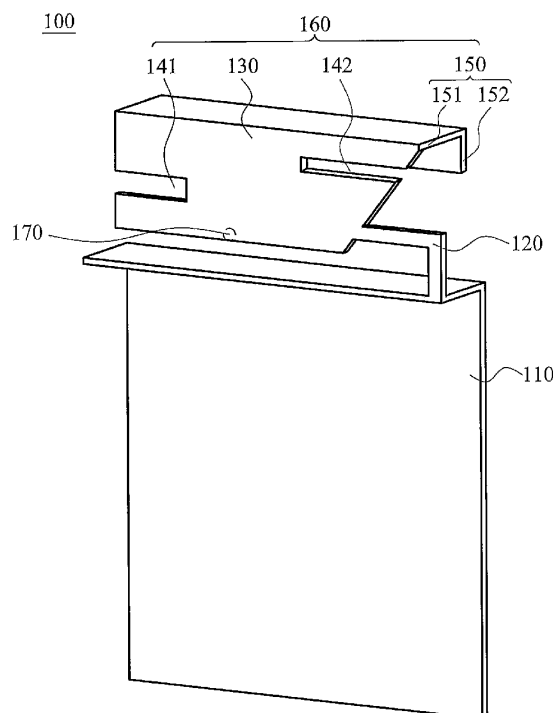
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7,667,662 B2 * 2/2010 Chiang 343/846
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Primary Examiner — Michael C Wimer

(57) **ABSTRACT**

An antenna is provided. The antenna has a ground element, a radiator and a conductive element. The radiator has a body, wherein the body has a first edge, a second edge, a third edge and a fourth edge, and the first edge is parallel to the third edge, a length of the first edge is shorter than a length of the third edge, the first edge is close to the ground element, the second edge connects the first edge and the third edge, a fourth edge connects the first edge and the third edge, and a first slot is formed on the radiator. The second edge and the fourth edge extend separately from the first edge to the third edge. The conductive element connects the ground element and the radiator.

18 Claims, 10 Drawing Sheets



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US007911014B2

(12) **United States Patent**
Doan

(10) **Patent No.:** **US 7,911,014 B2**
(45) **Date of Patent:** **Mar. 22, 2011**

(54) **ON CHIP ANTENNA AND METHOD OF MANUFACTURING THE SAME**

(76) Inventor: **My The Doan**, Calgary (CA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 226 days.

(21) Appl. No.: **12/241,031**

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

(65) **Prior Publication Data**

US 2009/0085133 A1 Apr. 2, 2009

Related U.S. Application Data

(60) Provisional application No. 60/976,412, filed on Sep. 29, 2007.

(51) **Int. Cl.**
H01L 27/14 (2006.01)

(52) **U.S. Cl.** **257/428**; 257/531; 257/E31.001;
438/59; 438/73; 438/463; 438/676; 438/767

(58) **Field of Classification Search** 257/428,
257/531, E31.001; 438/59, 73, 463, 676,
438/767

See application file for complete search history.

(56) **References Cited**

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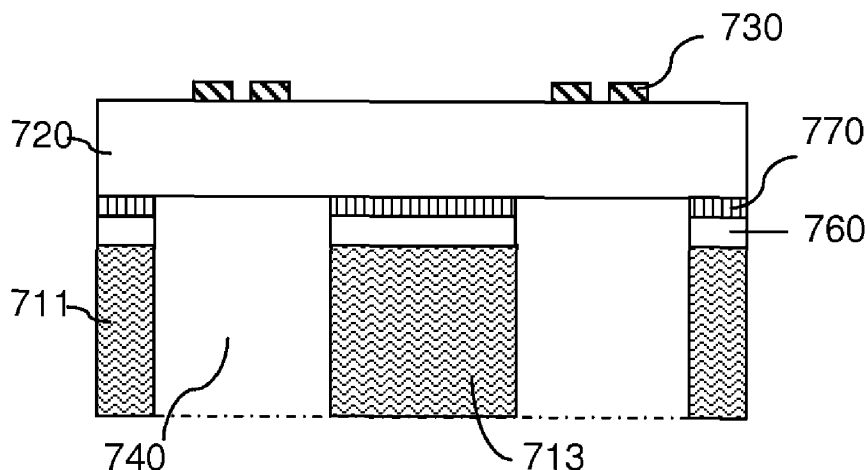
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Primary Examiner — Tan N Tran

(57) **ABSTRACT**

An antenna with air-filled trench is integrated with a radio frequency (RF) circuit. The trench locates directly under the metal lines that made up the antenna and is formed by etching from the back side of the semiconductor substrate until all the substrate material in the trench is removed. The air-filled trench greatly reduces the losses due to the semiconductor substrate; therefore the performance of the antenna improves greatly. When the antenna is a large planar spiral inductor, the air-filled trench means the semiconductor substrate inside the spiral inductor is untouched; hence integrated circuit can be built inside the antenna and on that substrate. Therefore the RF integrated circuit has a smaller size. Air-filled trench can also be used to reduce the semiconductor substrate noise coupling between digital circuit block and analog/RF circuit block. This air-filled trench and the air-filled trench under the antenna are formed at the same time.

7 Claims, 7 Drawing Sheets



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US007911387B2

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

(10) **Patent No.:** **US 7,911,387 B2**
(45) **Date of Patent:** **Mar. 22, 2011**

(54) **HANDHELD ELECTRONIC DEVICE**
ANTENNAS

(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 932 days.

(21) Appl. No.: **11/821,363**

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

(65) **Prior Publication Data**

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(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/48 (2006.01)

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

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

See application file for complete search history.

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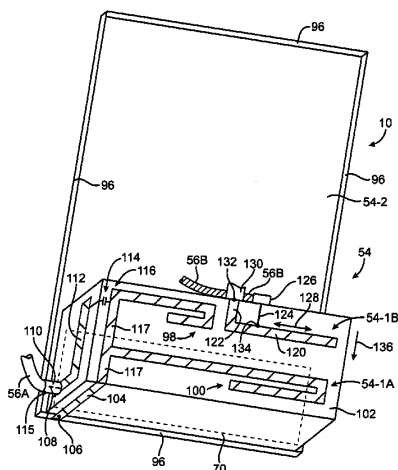
Primary Examiner — Shih-Chao Chen

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

(57) **ABSTRACT**

A handheld electronic device may be provided that contains a conductive housing and other conductive elements. The conductive elements may form an antenna ground plane. One or more antennas for the handheld electronic device may be formed from the ground plane and one or more associated antenna resonating elements. Transceiver circuitry may be connected to the resonating elements by transmission lines such as coaxial cables. Ferrules may be crimped to the coaxial cables. A bracket with extending members may be crimped over the ferrules to ground the coaxial cables to the housing and other conductive elements in the ground plane. The ground plane may contain an antenna slot. A dock connector and flex circuit may overlap the slot in a way that does not affect the resonant frequency of the slot. Electrical components may be isolated from the antenna using isolation elements such as inductors and resistors.

24 Claims, 38 Drawing Sheets



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US007911390B2

(12) **United States Patent**
Chiu

(10) **Patent No.:** **US 7,911,390 B2**
(45) **Date of Patent:** **Mar. 22, 2011**

(54) **ANTENNA STRUCTURE**

(56) **References Cited**

(75) Inventor: **Yi-Hung Chiu**, Taipei Hsien (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **Wistron NeWeb Corporation**,
Hsi-Chih, 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 341 days.

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(21) Appl. No.: **12/099,787**

Primary Examiner — Trinh V Dinh

(22) Filed: **Apr. 9, 2008**

(74) Attorney, Agent, or Firm — Winston Hsu; Scott Margo

(65) **Prior Publication Data**

US 2009/0179800 A1 Jul. 16, 2009

(30) **Foreign Application Priority Data**

Jan. 15, 2008 (TW) 97101505 A

(57) **ABSTRACT**

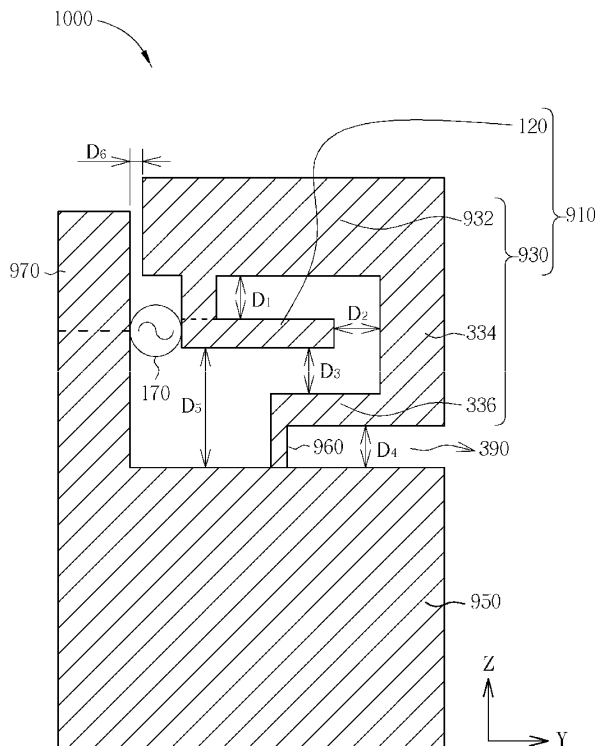
An antenna structure includes a radiation element, a grounding element, a short point, and a feeding point. The radiation element includes a first radiator and a second radiator. The second radiator partially surrounds the first radiator and there is a predetermined distance included between the first radiator and the second radiator for matching impedance. The short point is coupled between the second radiator and the grounding element. The feeding point is coupled between a joint point of the first radiator and the second radiator and the grounding element.

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/830;
343/829; 343/846

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

20 Claims, 13 Drawing Sheets



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US007911391B2

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

(10) **Patent No.:** **US 7,911,391 B2**
(45) **Date of Patent:** **Mar. 22, 2011**

(54) **DUAL-BAND ANTENNA**

(56) **References Cited**

(75) Inventors: **Yung-Chih Tsai**, Taipei Hsien (TW);
Lan-Yung Hsiao, 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 372 days.

(21) Appl. No.: **12/145,418**

(22) Filed: **Jun. 24, 2008**

(65) **Prior Publication Data**

US 2009/0315781 A1 Dec. 24, 2009

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

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

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

See application file for complete search history.

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Primary Examiner — Douglas W Owens

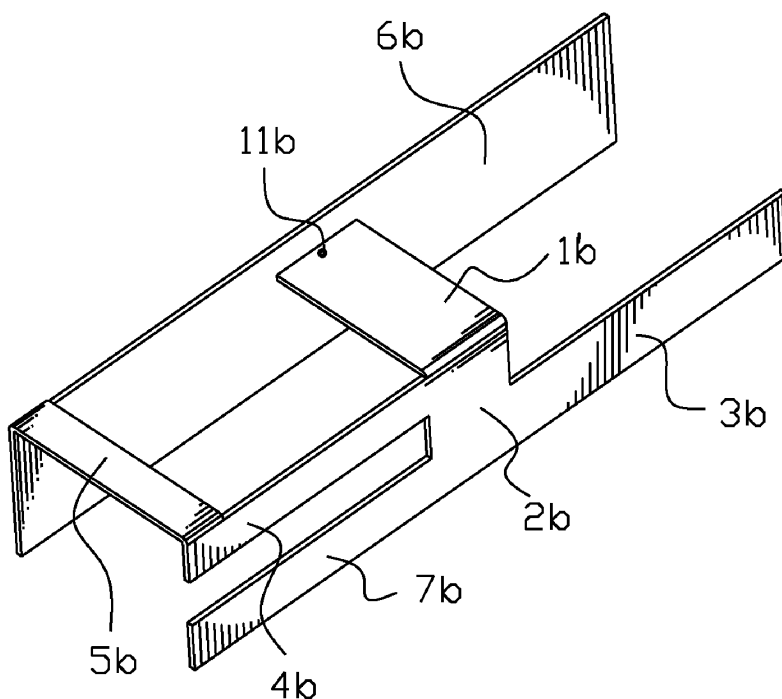
Assistant Examiner — Chuc D Tran

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

(57) **ABSTRACT**

A dual-band antenna has a feeding conductor with a feeding point and a connecting portion extending downwardly from the feeding conductor. A first radiating conductor and a loop protrusion respectively extend outward from two opposite sides of the connecting portion. A grounding portion faces the loop protrusion and is spaced apart from the feeding conductor to form a small gap therebetween. A loop connection is disposed away from the feeding conductor and connects an upper portion of the loop protrusion and an upper portion of the grounding portion.

6 Claims, 9 Drawing Sheets



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US007911394B2

(12) **United States Patent**
Quintero Illera et al.

(10) **Patent No.:** **US 7,911,394 B2**
(45) **Date of Patent:** ***Mar. 22, 2011**

(54) **MULTILEVEL AND SPACE-FILLING
GROUND-PLANES FOR MINIATURE AND
MULTIBAND ANTENNAS**

(75) Inventors: **Ramiro Quintero Illera**, Barcelona
(ES); **Carles Puente Baliarda**,
Barcelona (ES)

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

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

This patent is subject to a terminal dis-
claimer.

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(21) Appl. No.: **12/652,412**

(22) Filed: **Jan. 5, 2010**

(65) **Prior Publication Data**

US 2010/0141548 A1 Jun. 10, 2010

Related U.S. Application Data

(63) Continuation of application No. 12/033,446, filed on
Feb. 19, 2008, now Pat. No. 7,688,276, which is a
continuation of application No. 10/797,732, filed on
Mar. 10, 2004, now Pat. No. 7,362,283, which is a
continuation of application No. PCT/EP01/10589,
filed on Sep. 13, 2001.

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

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

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

See application file for complete search history.

(56) **References Cited**

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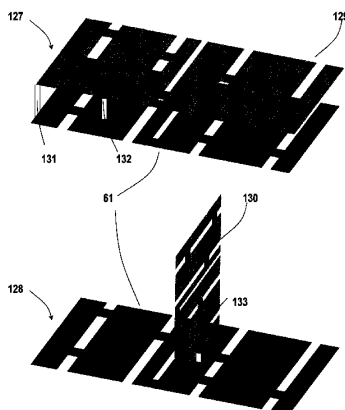
Primary Examiner — HoangAnh T Le

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

(57) **ABSTRACT**

An antenna system includes one or more conductive elements acting as radiating elements, and a multilevel or space-filling ground-plane, wherein said ground-plane has a particular geometry which affects the operating characteristics of the antenna. The return loss, bandwidth, gain, radiation efficiency, and frequency performance can be controlled through multilevel and space-filling ground-plane design. Also, said ground-plane can be reduced compared to those of antennas with solid ground-planes.

50 Claims, 19 Drawing Sheets



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US007911396B2

(12) **United States Patent**
Rudant

(10) **Patent No.:** **US 7,911,396 B2**
(45) **Date of Patent:** **Mar. 22, 2011**

(54) **MEANDERED ANTENNA**

(56) **References Cited**

(75) Inventor: **Lionel Rudant**, Grenoble (FR)

(73) Assignee: **Radiall**, Rosny-Sous-Bois (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 120 days.

(21) Appl. No.: **11/920,834**

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

(86) PCT No.: **PCT/FR2006/050492**

§ 371 (c)(1),
(2), (4) Date: **Feb. 20, 2008**

(87) PCT Pub. No.: **WO2007/003827**

PCT Pub. Date: **Jan. 11, 2007**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 2, 2005 (FR) 05 51484

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

(52) **U.S. Cl.** **343/702; 343/806**

(58) **Field of Classification Search** **343/700 MS,**
343/895, 702, 804, 806, 803, 792

See application file for complete search history.

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Primary Examiner — Jacob Y Choi

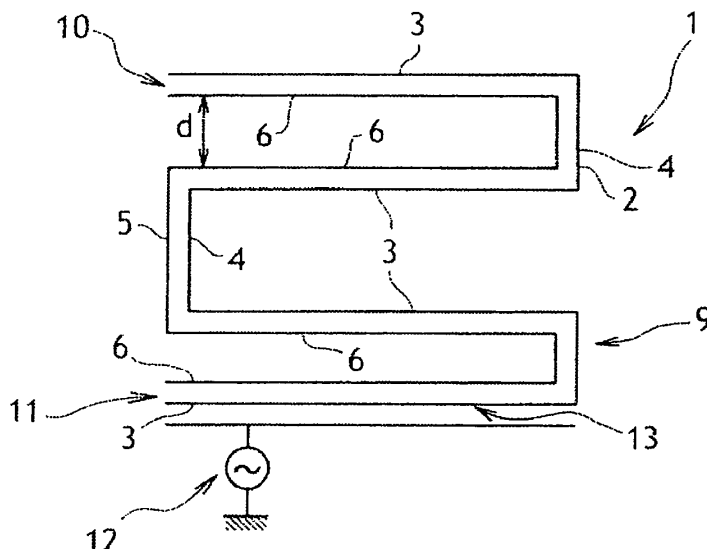
Assistant Examiner — Kyana R Robinson

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

(57) **ABSTRACT**

The invention concerns a meandered antenna comprising: a first meandered conductive element including a plurality of arms, two consecutive arms forming a meander; a second conductive element forming with the first conductive element a radiating two-wired line, the second conductive element including a plurality of arms engaged each between two consecutive arms of the first conductive element. The antenna is characterized in that it is designed to operate without ground element, in particular without ground plane.

15 Claims, 1 Drawing Sheet



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US007911399B2

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

(10) **Patent No.:** **US 7,911,399 B2**

(45) **Date of Patent:** **Mar. 22, 2011**

(54) **ANTENNA ASSEMBLY**

(75) Inventors: **Jia-Jia Yang**, Kunshan (CN); **Dao-Yuan Chen**, Kunshan (CN)

(73) Assignee: **Hon Hai Precision Ind. Co., Ltd.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 411 days.

(21) Appl. No.: **12/150,359**

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

(65) **Prior Publication Data**

US 2008/0266200 A1 Oct. 30, 2008

(30) **Foreign Application Priority Data**

Apr. 27, 2007 (CN) 2007 2 0037201

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/42 (2006.01)

(52) **U.S. CL.** **343/702; 343/872**

(58) **Field of Classification Search** 343/872,
343/702

See application file for complete search history.

(56) **References Cited**

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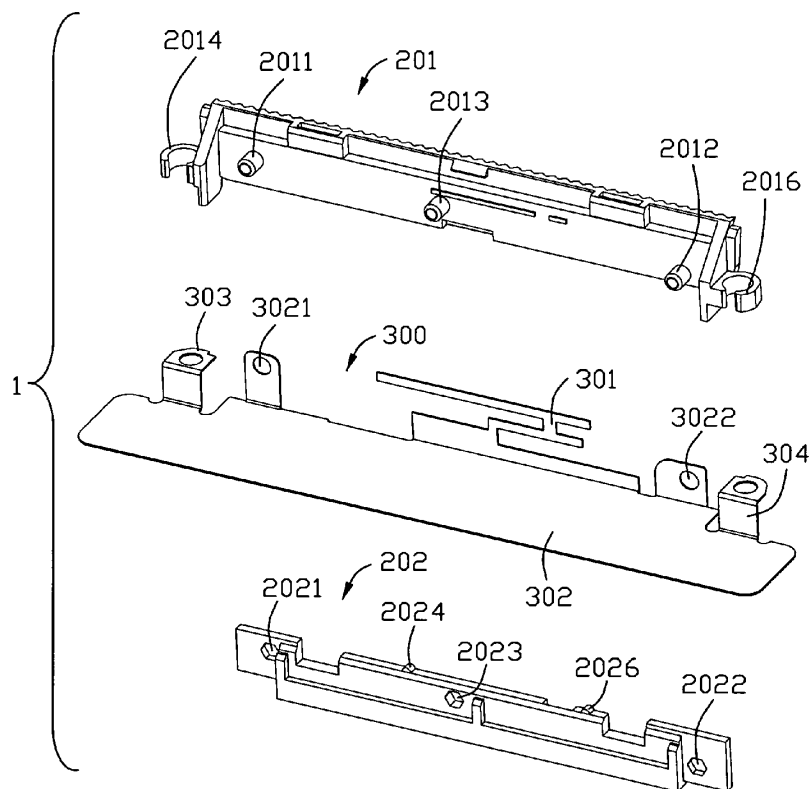
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna assembly assembled in an electric device includes an inner antenna comprising a planar radiating element, a cover fixing the antenna on the electric device and comprising at least one protrusion to fix the radiating element.

18 Claims, 3 Drawing Sheets



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US007916086B2

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

(10) **Patent No.:** **US 7,916,086 B2**
(45) **Date of Patent:** **Mar. 29, 2011**

(54) **ANTENNA COMPONENT AND METHODS**

(75) Inventors: **Kimmo Koskiniemi**, Oulu (FI); **Vesa Kuronen**, Oulu (FI)

(73) Assignee: **Pulse Finland Oy**, Kempele (FI)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 568 days.

(21) Appl. No.: **11/801,894**

(22) Filed: **May 11, 2007**

(65) **Prior Publication Data**

US 2008/0007459 A1 Jan. 10, 2008

Related U.S. Application Data

(63) Continuation of application No. PCT/FI2005/050382, filed on Oct. 27, 2005.

(30) **Foreign Application Priority Data**

Nov. 11, 2004 (FI) 20041455

(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.

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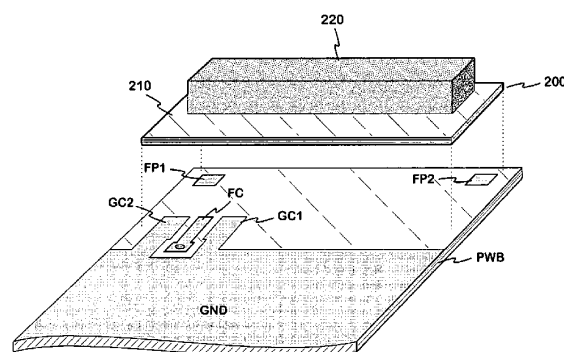
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna component suited for small-sized radio devices for forming a dielectric antenna. A small auxiliary circuit board (210) is used for the matching of the antenna, the matching being based on a conductor pattern on it. A substrate chip (220), on the surface of which the radiator is, and the auxiliary board are fastened to each other, whereby the radiator is electrically connected to said conductor pattern. The radiator, its substrate and the auxiliary board form a unitary, solid antenna component (200), which is mounted on the circuit board (PWB) of the radio device. The antenna with its feed and matching circuits can be designed and tested as a whole of its own, in which case the reproducibility is good. In the design of the circuit board of the radio device, the antenna needs to be taken into account only by reserving a space for the antenna component on the circuit board.

45 Claims, 3 Drawing Sheets



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US007916087B2

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

(10) **Patent No.:** **US 7,916,087 B2**
(45) **Date of Patent:** **Mar. 29, 2011**

(54) **MULTIPLE-BAND ANTENNA WITH PATCH AND SLOT STRUCTURES**

(75) Inventors: **Geyi Wen**, Waterloo (CA); **Perry Jarmuszewski**, Waterloo (CA); **Adam D. Stevenson**, 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 249 days.

(21) Appl. No.: **12/331,518**

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

(65) **Prior Publication Data**
US 2009/0091502 A1 Apr. 9, 2009

Related U.S. Application Data

(63) Continuation of application No. 11/838,751, filed on Aug. 14, 2007, now Pat. No. 7,466,271, which is a continuation of application No. 11/456,025, filed on Jul. 6, 2006, now Pat. No. 7,283,097, which is a continuation of application No. 10/723,840, filed on Nov. 26, 2003, now Pat. No. 7,224,312.

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

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

(58) **Field of Classification Search** **343/700 MS, 343/702, 767, 770**
See application file for complete search history.

(56) **References Cited**

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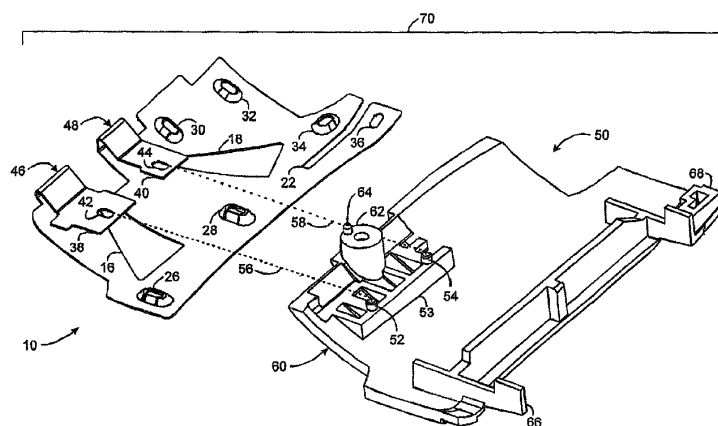
Primary Examiner — Tan Ho

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

(57) **ABSTRACT**

A multiple-band antenna having first and second operating frequency bands is provided. The antenna includes a first patch structure associated primarily with the first operating frequency band, a second patch structure electrically coupled to the first patch structure and associated primarily with the second operating frequency band, a first slot structure disposed between a first portion of the first patch structure and the second patch structure and associated primarily with the first operating frequency band, and a second slot structure disposed between a second portion of the first patch structure and the second patch structure and associated primarily with the second operating frequency band. A mounting structure for the multiple-band antenna is also provided. The mounting structure includes a first surface and a second surface opposite to and overlapping the first surface. The first and second patch structures are mounted to the first surface, and a feeding point and ground point, respectively connected to the first and second patch structures, are mounted to the second surface.

26 Claims, 7 Drawing Sheets



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US007916091B2

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

(10) **Patent No.:** **US 7,916,091 B2**

(45) **Date of Patent:** **Mar. 29, 2011**

(54) **ANTENNA MODULE FOR A WIRELESS ELECTRONIC DEVICE**

(75) Inventors: **I-Huang Chang**, Kaohsiung (TW);
Hung-Hsien Chiu, Hsinchu (TW)

(73) Assignee: **Wha Yu Industrial Co., Ltd.**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 349 days.

(21) Appl. No.: **12/237,352**

(22) Filed: **Sep. 24, 2008**

(65) **Prior Publication Data**
US 2009/0015511 A1 Jan. 15, 2009

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/324,391, filed on Jan. 4, 2006, now abandoned.

(30) **Foreign Application Priority Data**
Feb. 5, 2005 (TW) 94103977 A

(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, 893, 725
See application file for complete search history.

(56) **References Cited**

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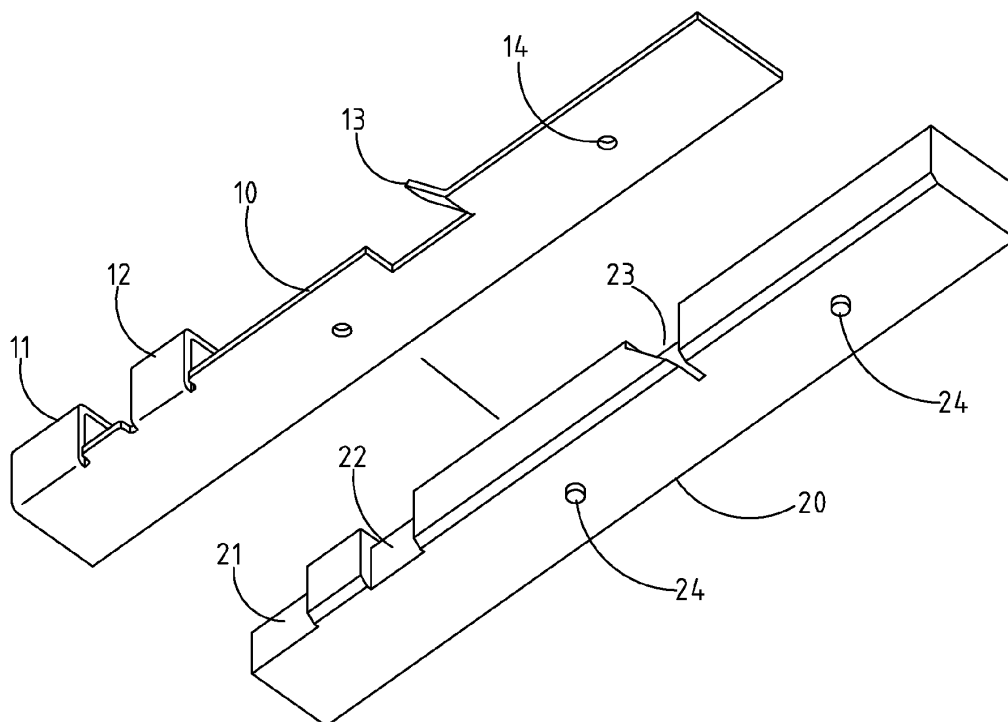
Primary Examiner — HoangAnh T Le

(74) *Attorney, Agent, or Firm* — Egbert Law Offices PLLC

(57) **ABSTRACT**

The antenna module fabrication for a wireless electronic device includes setting up the antenna and the assembly base that is to connect the antenna to the designated circuit board. The antenna and the assembly base are two independent pieces, and the positioning parts are for positioning so that the antenna and assembly base are one body. The antenna module of the invention can achieve the advantages such as simple production, cost effectiveness, prevention of the antenna module from deforming and quality improvement.

3 Claims, 9 Drawing Sheets



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US007916093B2

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

(10) **Patent No.:** **US 7,916,093 B2**
(45) **Date of Patent:** **Mar. 29, 2011**

(54) **MULTIBAND ANTENNA**

(75) Inventors: **Li-Cheng Chiang**, Taipei Hsien (TW);
Chih-Yuan Yang, Taipei Hsien (TW);
Hung-Chang Ko, Taipei Hsien (TW);
Po-Wei Kuo, Taipei Hsien (TW);
Suo-Bing Su, Taipei Hsien (TW);
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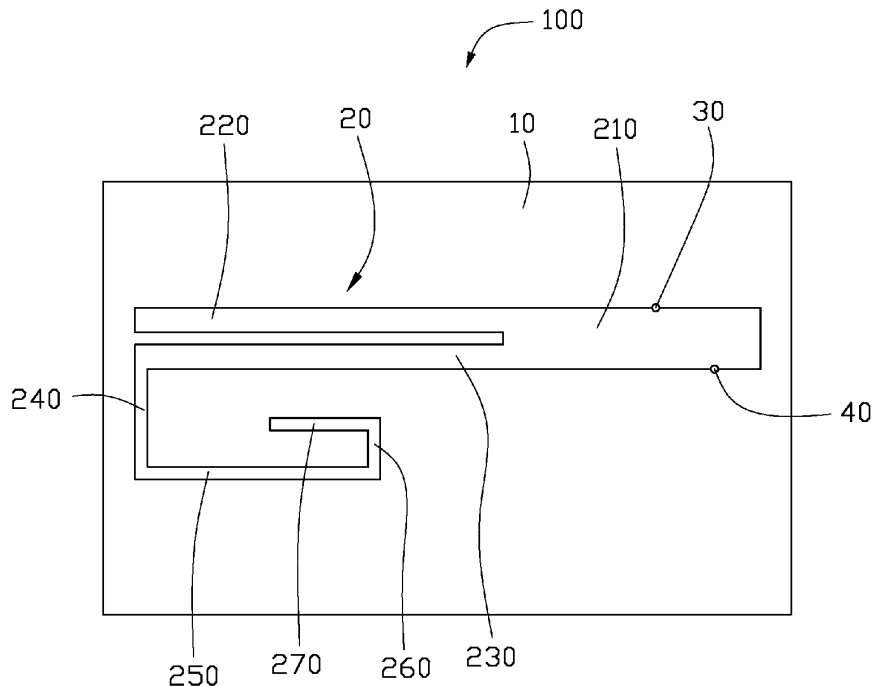
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(57) **ABSTRACT**

A multiband antenna includes a conductive sheet, a feeding point, and a grounding point. The conductive sheet defines a first slot, a second slot, a third slot, a fourth slot, a fifth slot, a sixth slot, and a seventh slot thereon. The second slot and the third slot extend from a same short side of the first slot and are parallel to each other. The fourth slot, the fifth slot, the sixth slot, and the seventh slot extend perpendicularly from a short side of the third slot away from the first slot in sequence. The feeding point is formed on the conductive sheet at a long side of the first slot away from the third slot. The grounding point is formed on the conductive sheet at a margin of the slots different from the location of the feeding point.

18 Claims, 2 Drawing Sheets



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