



US008405552B2

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

(10) **Patent No.:** **US 8,405,552 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **MULTI-RESONANT BROADBAND ANTENNA**

(75) Inventors: **Ki-Hyoung Bae**, Gumi (KR); **Kun-Woo Kim**, Gumi (KR); **Hyun-Sik Tae**, Gumi (KR)

(73) Assignee: **Samsung Thales Co., Ltd.**, Gumi, Kyungsangbuk-Do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 896 days.

(21) Appl. No.: **11/826,358**

(22) Filed: **Jul. 13, 2007**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 16, 2007 (KR) 10-2007-0037160
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(51) **Int. Cl.**
H01Q 1/48 (2006.01)

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

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

See application file for complete search history.

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Primary Examiner — Hoang V Nguyen

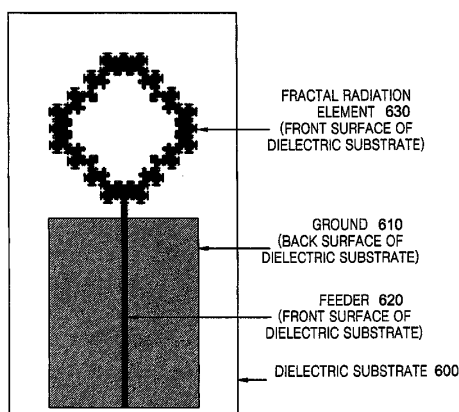
Assistant Examiner — Kyana R McCain

(74) *Attorney, Agent, or Firm* — Robert E. Bushnell, Esq.

(57) **ABSTRACT**

A multi-resonant broadband antenna constructed with a dielectric substrate; a fractal radiation element having a pre-determined fractal grid structure adhered on an upper surface of the dielectric substrate. A feed line adhered on the upper surface of the dielectric substrate feeds the fractal radiation element, and a ground plane positioned on a lower surface of the dielectric substrate opposite to the feed line, is physically separated by the dielectric substrate from the feed line.

15 Claims, 16 Drawing Sheets



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US008405553B2

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

(10) **Patent No.:** **US 8,405,553 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **COMPACT ANTENNA SYSTEM WITH A DIVERSITY ORDER OF 2**

(75) Inventors: **Jean-Francois Pintos**, Bourgbarre (FR);
Philippe Minard, Saint Medard sur Ille (FR); **Jean-Luc Le Bras**, Rennes (FR)

(73) Assignee: **Thomson Licensing**, Issy les Moulineaux (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 325 days.

(21) Appl. No.: **12/660,383**

(22) Filed: **Feb. 25, 2010**

(65) **Prior Publication Data**
US 2010/0220015 A1 Sep. 2, 2010

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

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

(58) **Field of Classification Search** 343/700 MS,
343/702, 767, 770, 725
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Huedung Mancuso

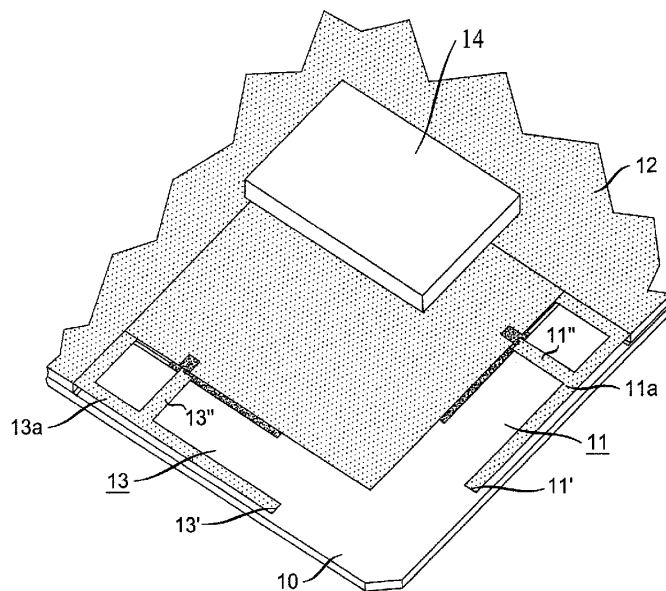
(74) Attorney, Agent, or Firm — Tutunjian & Bitetto, P.C.

(57) **ABSTRACT**

The present invention relates to a very compact antenna system with a diversity order of 2. An antenna system with a diversity order of 2 integrated on an electronic card comprising a first radiating element of F-inverted type with a first extremity connected to a ground plane, a second extremity free and a conductive power supply part, a second radiating element of F-inverted type with a first extremity connected to a ground plane, a second extremity free and a conductive power supply part, characterized in that the free extremities of the first and second radiating elements are opposite one another and are separated by a projecting element of the ground plane.

Application in electronic cards for multi-standard communication devices.

4 Claims, 6 Drawing Sheets



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US00840555B2

(12) **United States Patent**
Liu

(10) **Patent No.:** **US 8,405,555 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **EMBEDDED UWB ANTENNA AND
PORTABLE DEVICE HAVING THE SAME**

(75) Inventor: **Chih-Kai Liu**, Taipei Hsien (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 370 days.

(21) Appl. No.: **12/461,665**

(22) Filed: **Aug. 20, 2009**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 9, 2008 (TW) 97139055 A

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

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

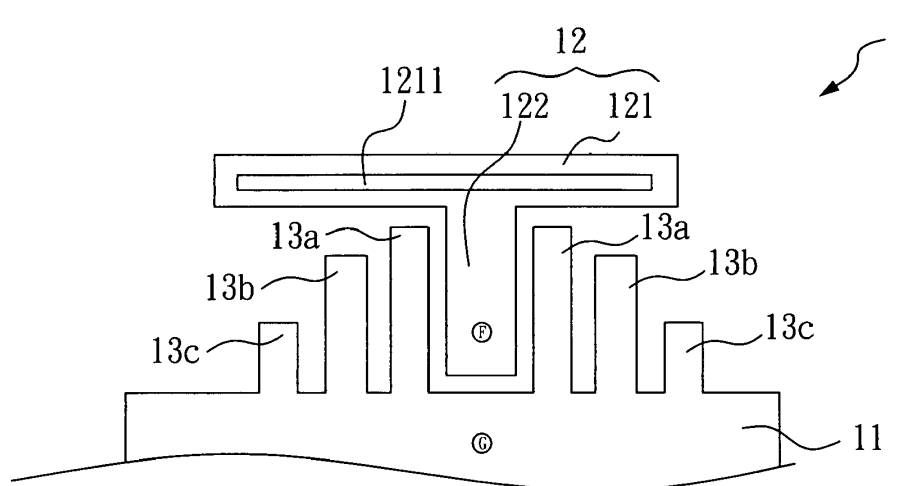
Assistant Examiner — Hasan Islam

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

(57) **ABSTRACT**

An embedded UWB antenna and a portable device having the
same are disclosed. The embedded UWB antenna comprises
a grounding element; a T-shaped radiating element having a
horizontal portion comprising at least an opening for cutting
off undesired frequency and a vertical portion comprising a
feed point for feeding current to resonate frequency; and a
plurality of sleeve elements extended from the grounding
element along two sides of the vertical portion; wherein the
plurality of sleeve elements and the vertical portion are sub-
stantially parallel to each other.

9 Claims, 11 Drawing Sheets



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US008405556B2

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

(10) **Patent No.:** **US 8,405,556 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **BUILT-IN ANTENNA FOR GLOBAL POSITIONING SYSTEM IN A PORTABLE TERMINAL**

(75) Inventors: **Sang-Bong Sung**, Gyeonggi-do (KR);
Kong-Min Sa, Gyeongbuk (KR);
Kyung-Jong Lee, Gyeonggi-do (KR);
Dong-Hwan Kim, Gyeonggi-do (KR);
Jae-Ho Lee, Yongin-si (KR);
Byung-Chan Jang, Gyeongbuk (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 370 days.

(21) Appl. No.: **12/802,592**

(22) Filed: **Jun. 9, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 9, 2009 (KR) 10-2009-0050970

(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,
343/700 MS, 846, 848

See application file for complete search history.

(56) **References Cited**

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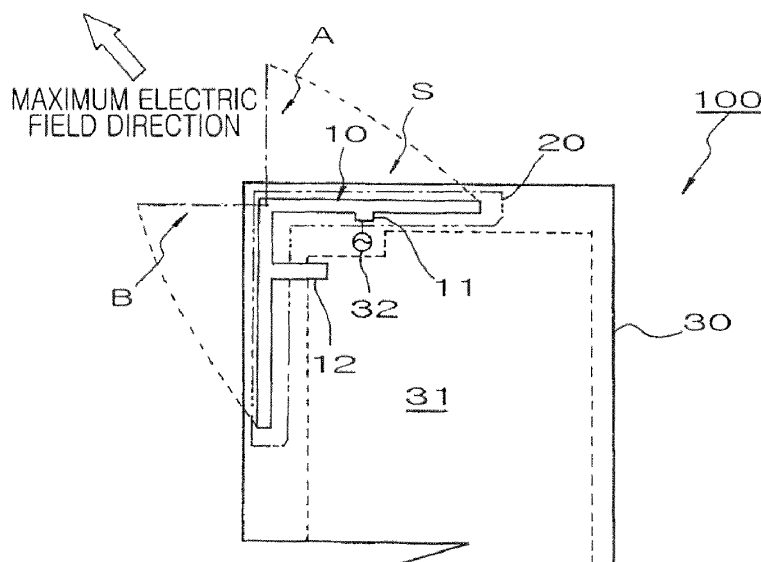
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC

(57) **ABSTRACT**

A built-in antenna apparatus for a Global Positioning System (GPS) of a portable terminal is provided. The apparatus includes a case frame for forming an exterior of the terminal, a main board fastened by the case frame and having a feeding portion and a ground portion of an antenna radiator, and an antenna radiator having a feeding point and ground point to be electrically connected to the feeding portion and ground portion of the main board, and is curved in a horizontal direction and a vertical direction of the terminal about a center of one upper-side corner of the terminal.

20 Claims, 5 Drawing Sheets
(2 of 5 Drawing Sheet(s) Filed in Color)



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US008405557B2

(12) **United States Patent**
Lu

(10) **Patent No.:** **US 8,405,557 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **ANTENNA FOR PORTABLE ELECTRONIC DEVICE**

(56) **References Cited**

(75) Inventor: **Chun-Yi Lu**, Tu-Cheng (TW)
(73) Assignee: **Chi Mei Communication Systems, Inc.**, 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 359 days.

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(21) Appl. No.: **12/859,160**

(22) Filed: **Aug. 18, 2010**

(65) **Prior Publication Data**

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Primary Examiner — Vibol Tan

(74) Attorney, Agent, or Firm — Altis Law Group, Inc.

(30) **Foreign Application Priority Data**

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

(52) **U.S. Cl.** **343/702**; 343/700 MS; 343/767;
343/893

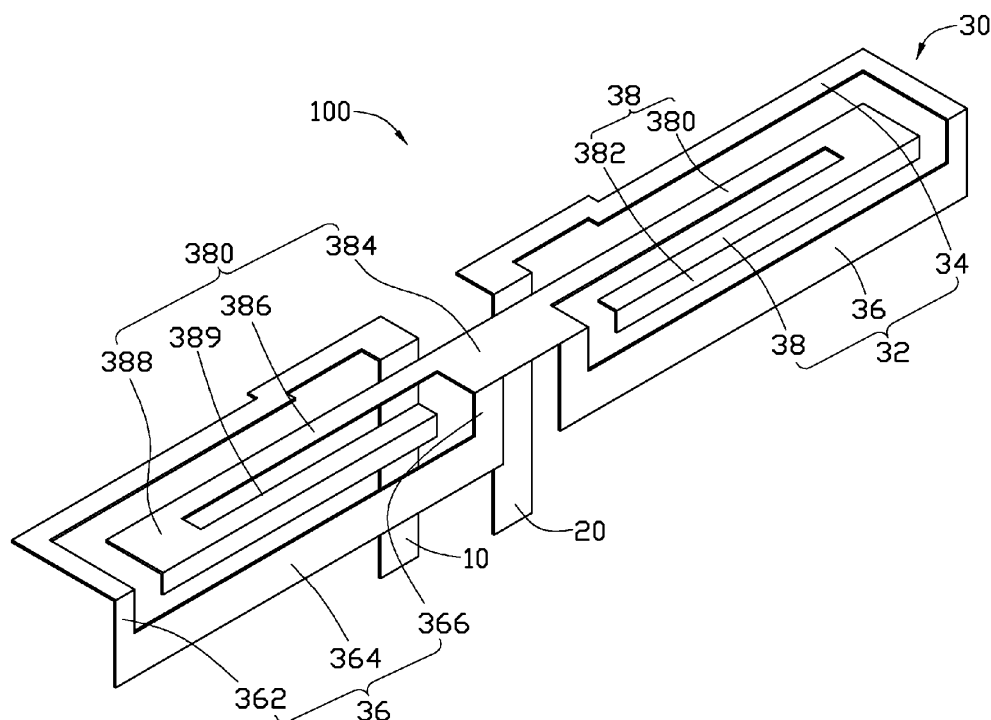
(58) **Field of Classification Search** 343/700 MS,
343/702, 718, 728, 741, 767, 818, 866, 876,
343/893, 895

See application file for complete search history.

(57) **ABSTRACT**

An antenna for a portable electronic device includes a feeding end, a grounding end; and a radiating body. The radiating body includes two symmetrical radiating units respectively connected to the feeding end and the grounding end. Each radiating unit includes a first radiating part, a second radiating part connected to the first radiating part and a third radiating part connected to the second radiating part and surrounded by the first and second radiating parts.

18 Claims, 3 Drawing Sheets



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US008405558B2

(12) **United States Patent**
Hikino

(10) **Patent No.:** **US 8,405,558 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **WIRELESS DEVICE**

(56) **References Cited**

(75) Inventor: **Nozomu Hikino**, Osaka (JP)
(73) Assignee: **Sharp Kabushiki Kaisha**, Osaka (JP)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 324 days.

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(21) Appl. No.: **12/920,541**

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(22) PCT Filed: **May 18, 2009**

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(86) PCT No.: **PCT/JP2009/059149**

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§ 371 (c)(1),
(2), (4) Date: **Sep. 1, 2010**

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Primary Examiner — Dieu H Duong

PCT Pub. Date: **Dec. 23, 2009**

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

(65) **Prior Publication Data**

US 2011/0001674 A1 Jan. 6, 2011

ABSTRACT

A wireless device having two appropriately placed antennas can reduce deterioration in properties of an antenna included in a casing. The wireless device includes upper and lower casings, a hinge part, and at least one transmission element. The upper casing houses a casing antenna resonating with a first frequency. The lower casing houses a matching circuit of the casing antenna and houses a radio unit circuit for processing a signal having a second frequency. The hinge part joins the upper casing with the lower casing, includes a built-in antenna resonating with the second frequency, and includes feeding sections for electrically coupling the matching circuit to the casing antenna. The transmission element is disposed on a signal path connecting the built-in antenna and the radio unit circuit, and (i) gives passage to the signal having the second frequency and (ii) blocks a signal having the first frequency.

(30) **Foreign Application Priority Data**

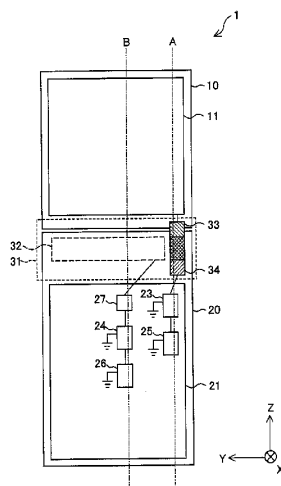
Jun. 19, 2008 (JP) 2008-160793

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

(52) **U.S. Cl.** **343/702**; 343/850; 343/852; 455/562.1; 455/575.3; 455/575.7

(58) **Field of Classification Search** 343/702, 343/876, 850, 852; 455/562.1, 575.3, 575.7
See application file for complete search history.

5 Claims, 7 Drawing Sheets



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US008405563B2

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

(10) **Patent No.:** **US 8,405,563 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **ADAPTIVELY TUNABLE ANTENNAS
INCORPORATING AN EXTERNAL PROBE
TO MONITOR RADIATED POWER**

(75) Inventors: **William E. McKinzie**, Fulton, MD
(US); **Keith Manssen**, Bull Valley, IL
(US); **Gregory Mendolia**, Nashua, NH
(US)

(73) Assignee: **Research In Motion RF, Inc.**,
Wilmington, DE (US)

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

(21) Appl. No.: **13/404,456**

(22) Filed: **Feb. 24, 2012**

(65) **Prior Publication Data**

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Related U.S. Application Data

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14, 2006.

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

(52) **U.S. Cl.** **343/746**

(58) **Field of Classification Search** **343/745-746,**
343/700 MS, 702
See application file for complete search history.

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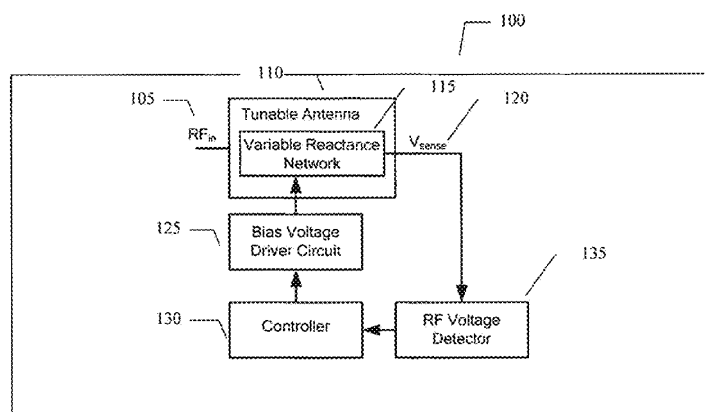
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Guntin & Gust PLC; Andrew
Gust

(57) **ABSTRACT**

An embodiment of the present invention an apparatus, comprising an apparatus, comprising an adaptively-tuned antenna including a variable reactance network connected to the antenna, an RF field probe located near the antenna, an RF detector to sense voltage from the field probe, a controller that monitors the RF voltage and supplies control signals to a driver circuit and wherein the driver circuit converts the control signals to bias signals for the variable reactance network.

20 Claims, 24 Drawing Sheets



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US008405565B2

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

(10) **Patent No.:** **US 8,405,565 B2**
(45) **Date of Patent:** **Mar. 26, 2013**

(54) **ANTENNA COIL**

(75) Inventors: **Hiroyuki Kubo**, Kanazawa (JP);
Hiromitsu Ito, Hakusan (JP); **Kuniaki**
Yosui, Kanazawa (JP)

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

(*) Notice: Subject to any disclaimer, the term of this
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(21) Appl. No.: **13/439,918**

(22) Filed: **Apr. 5, 2012**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 12/542,026, filed on
Aug. 17, 2009, now Pat. No. 8,179,332, which is a
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(30) **Foreign Application Priority Data**

Mar. 9, 2007 (JP) 2007-060063

(51) **Int. Cl.**
H01Q 7/08 (2006.01)

(52) **U.S. Cl.** 343/788; 343/787

(58) **Field of Classification Search** 343/788,
343/787, 867, 742
See application file for complete search history.

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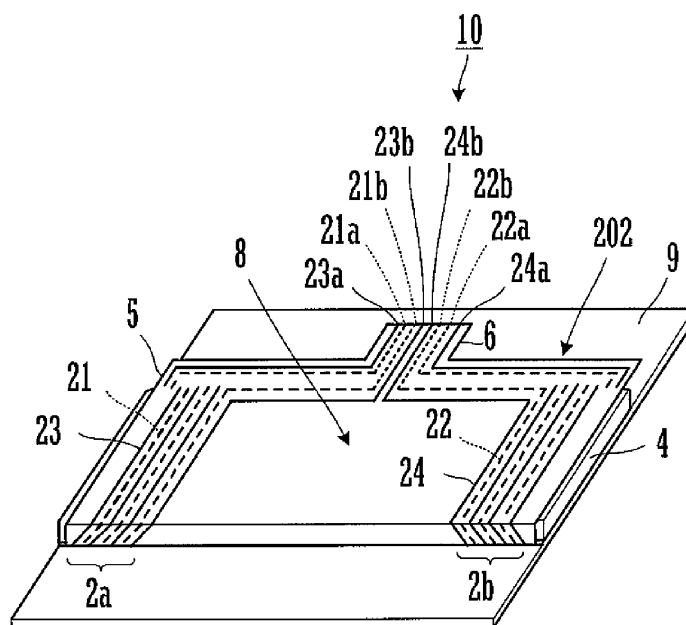
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna coil includes a magnetic layer such as a flat magnetic sheet, a transmission coil portion defined by a coiled conductor, a reception coil portion defined by a coiled conductor, a transmission coil connection defined by the conductor and defining a portion of the transmission coil portion, and a reception coil connection defined by the conductor and defining a portion of the reception coil portion. The transmission coil portion and the reception coil portion are at least partly formed side by side on the magnetic layer and are arranged to be connected to a wiring pattern on an external circuit.

4 Claims, 8 Drawing Sheets



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US008410983B2

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

(10) **Patent No.:** **US 8,410,983 B2**
(45) **Date of Patent:** **Apr. 2, 2013**

(54) **WIDE-BAND ANTENNA**

(56) **References Cited**

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

(73) Assignee: **Cheng Uei Precision Industry 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 317 days.

(21) Appl. No.: **13/005,527**

(22) Filed: **Jan. 12, 2011**

(65) **Prior Publication Data**

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

(52) **U.S. Cl.** **343/700 MS**; 343/702; 343/846;
343/848

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

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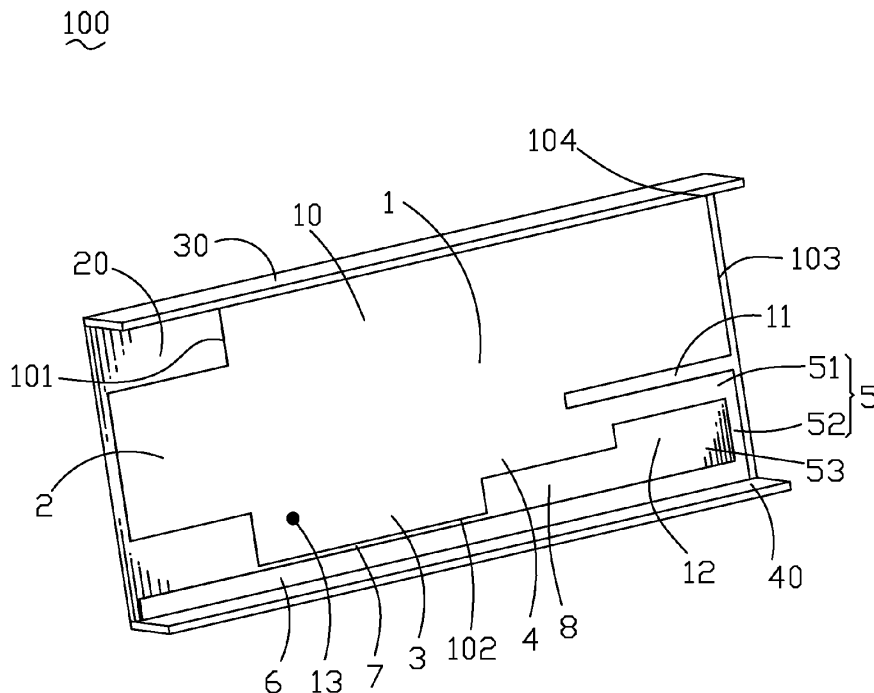
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Lin & Associates IP, Inc.

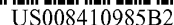
(57) **ABSTRACT**

A wide-band antenna mounted on a circuit board includes a ground plate, a radiating plate perpendicularly connected to two side edges of the circuit board, and a planar antenna element which includes a base plate, an extending plate, and a ground portion. One side of the base plate defines a gap with a first coupling portion being formed, and a slot adjacent to the gap with a first strip being formed therebetween. A second strip is extended perpendicularly from the first strip. The extending plate is extended outward from one end of the base plate. The ground portion is extended outward from the second strip and connected to the ground plate. The first coupling portion and the ground portion have an interspace to form a capacitive coupling therebetween. A groove is formed among the first and second strips and the ground portion to form a simulation inductance thereamong.

5 Claims, 1 Drawing Sheet



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(10) **Patent No.:** US 8,410,985 B2
(45) **Date of Patent:** Apr. 2, 2013

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US008410986B2

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

(10) **Patent No.:** **US 8,410,986 B2**
(45) **Date of Patent:** **Apr. 2, 2013**

(54) **HYBRID ANTENNAS FOR ELECTRONIC DEVICES**

(75) Inventors: **Robert J. Hill**, Salinas, CA (US); **Scott A. Myers**, San Francisco, CA (US); **Robert W. Schlub**, Campbell, CA (US); **Dean Floyd Darnell**, Santa Clara, CA (US); **Zhijun Zhang**, Beijing (CN)

(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 0 days.

(21) Appl. No.: **13/343,420**

(22) Filed: **Jan. 4, 2012**

(65) **Prior Publication Data**

US 2012/0098720 A1 Apr. 26, 2012

Related U.S. Application Data

(62) Division of application No. 12/120,012, filed on May 13, 2008, now Pat. No. 8,106, 836.

(60) Provisional application No. 61/044,448, filed on Apr. 11, 2008.

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

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

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

See application file for complete search history.

(56) **References Cited**

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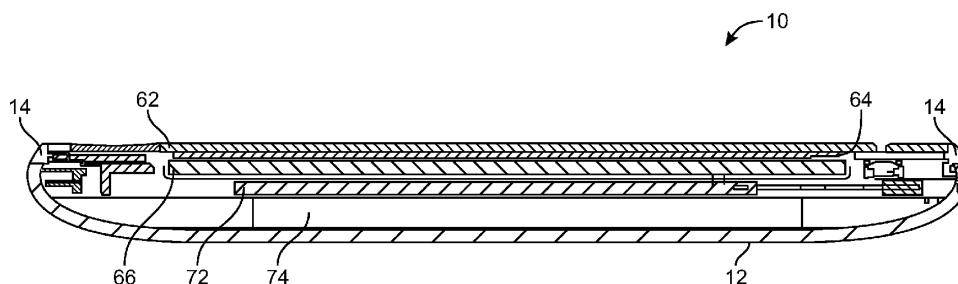
Primary Examiner — Dieu H Duong

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

(57) **ABSTRACT**

A portable electronic device is provided that has a hybrid antenna. The hybrid antenna may include a slot antenna structure and an inverted-F antenna structure. The slot antenna portion of the hybrid antenna may be used to provide antenna coverage in a first communications band and the inverted-F antenna portion of the hybrid antenna may be used to provide antenna coverage in a second communications band. The second communications band need not be harmonically related to the first communications band. The electronic device may be formed from two portions. One portion may contain conductive structures that define the shape of the antenna slot. One or more dielectric-filled gaps in the slot may be bridged using conductive structures on another portion of the electronic device. A conductive trim member may be inserted into an antenna slot to trim the resonant frequency of the slot antenna portion of the hybrid antenna.

7 Claims, 22 Drawing Sheets



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US008410988B2

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

(10) **Patent No.:** **US 8,410,988 B2**
(45) **Date of Patent:** **Apr. 2, 2013**

(54) **DUAL MODE ROTARY JOINT FOR PROPAGATING RF AND OPTICAL SIGNALS THEREIN**

(75) Inventors: **Derek E. Iverson**, Kent, CA (US);
Jonathan M. Saint Clair, Seattle, CA (US)

(73) Assignee: **The Boeing Company**, Chicago, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1532 days.

(21) Appl. No.: **11/944,214**

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

(65) **Prior Publication Data**
US 2012/0235882 A1 Sep. 20, 2012

(51) **Int. Cl.**
H01Q 3/12 (2006.01)
H01P 1/06 (2006.01)

(52) **U.S. Cl.** **343/763; 333/257; 333/135; 385/26**

(58) **Field of Classification Search** **333/256, 333/257, 261, 135; 343/757, 763; 385/26**
See application file for complete search history.

(56) **References Cited**

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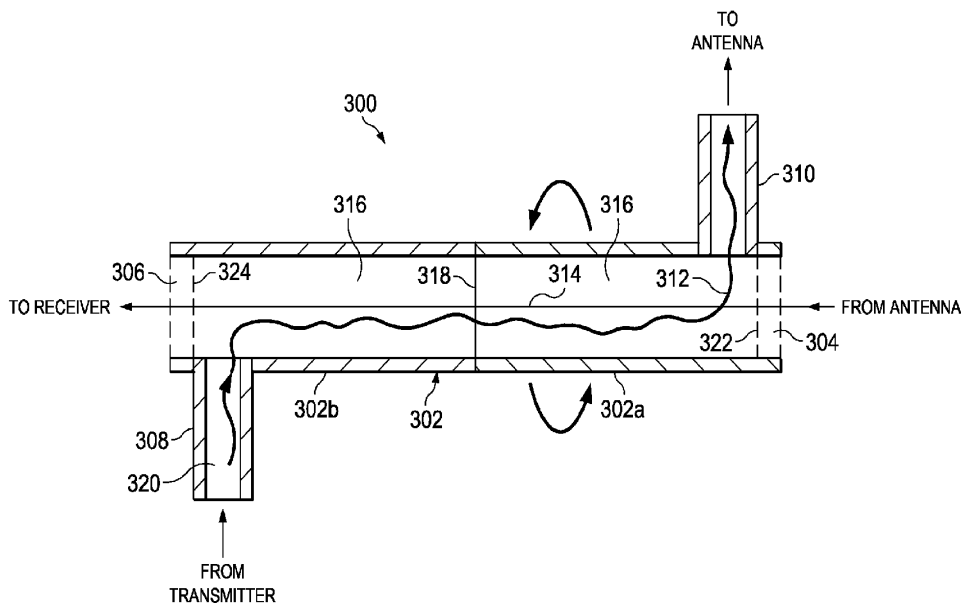
Primary Examiner — Benny Lee

(74) *Attorney, Agent, or Firm* — Yee & Associates, P.C.

(57) **ABSTRACT**

A dual mode rotary joint as described herein can be utilized in an electromagnetic communication system such as a radar system. The dual mode rotary joint can be used to rotatably couple an antenna architecture to its mounting structure. One embodiment of the dual mode joint includes a waveguide configured to propagate radio frequency (RF) signals, and endcaps coupled to the ends of the waveguide. Each endcap is reflective for RF signals and transmissive for optical signals.

18 Claims, 5 Drawing Sheets



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US008410989B2

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

(10) **Patent No.:** **US 8,410,989 B2**
(45) **Date of Patent:** **Apr. 2, 2013**

(54) **ANTENNA STRUCTURE INCLUDING
RADIATING CONDUCTOR AND MAGNETIC
MATERIAL HAVING DIELECTRIC
PROPERTY**

(75) Inventors: **Masatoshi Hayakawa**, Kanagawa (JP);
Kiyotada Yokogi, Tokyo (JP); **Yoshimi
Takahashi**, Miyagi (JP); **Kenji Asakura**,
Fukui (JP); **Shuichi Goto**, Miyagi (JP)

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

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

(21) Appl. No.: **11/511,621**

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

(65) **Prior Publication Data**

US 2007/0080866 A1 Apr. 12, 2007

(30) **Foreign Application Priority Data**

Sep. 1, 2005 (JP) 2005-253081

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

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

(58) **Field of Classification Search** 343/700 MS,
343/787
See application file for complete search history.

(56) **References Cited**

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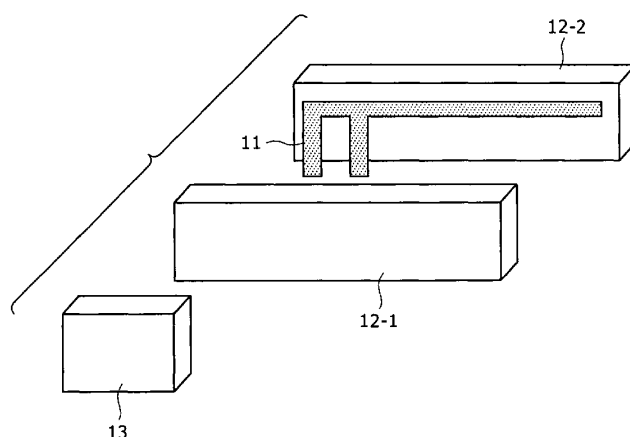
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Robert J. Depke; The
Chicago Technology Law Group, LLC

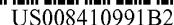
(57) **ABSTRACT**

An antenna for receiving electromagnetic waves in a desired
frequency band, includes a radiating conductor and a ground
conductor, a feeder part, a wavelength-shortening section,
and a magnetic field applying section. The radiating conduc-
tor and a ground conductor resonate at a resonance point
frequency. The feeder part is configured to feed the radiating
conductor with electricity. The wavelength-shortening sec-
tion in which a magnetic body having both a dielectric prop-
erty and a magnetic property is disposed close to the radiating
conductor shifts the resonance point frequency into a band
lower than the desired frequency band by a wavelength-short-
ening effect obtained based on the dielectric property and the
magnetic property. The magnetic field applying section is
configured to apply a magnetic field to the magnetic body so
as to reduce a magnetic loss due to the magnetic body.

11 Claims, 17 Drawing Sheets



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(10) **Patent No.:** US 8,410,991 B2
(45) **Date of Patent:** Apr. 2, 2013

(56) **References Cited**

See application file for complete search history.

(74) *Attorney, Agent, or Firm* — Rabin & Berdo, P.C.

(57) **ABSTRACT**

The present invention relates to an antenna system mounted on a mobile vehicle. In the present invention, a power distributor and a part of a high-frequency module that includes a frequency converter are placed in an external fixed unit that is placed outside a radome. In addition, an active cooler/cooling fin, a heater, and an air circulation fan are placed at an internal bottom plane of the antenna system, and a cooling fin and cooling fan are placed at an external bottom plane of the antenna system.

10 Claims, 2 Drawing Sheets



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US008412276B2

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

(10) **Patent No.:** **US 8,412,276 B2**

(45) **Date of Patent:** **Apr. 2, 2013**

(54) **PROXIMITY TYPE ANTENNA AND RADIO COMMUNICATION DEVICE**

(75) Inventors: **Toshinori Matsuura**, Tokyo (JP);
Sadaharu Yoneda, Tokyo (JP); **Koichi Kimura**, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 153 days.

(21) Appl. No.: **13/114,839**

(22) Filed: **May 24, 2011**

(65) **Prior Publication Data**

US 2011/0287715 A1 Nov. 24, 2011

(30) **Foreign Application Priority Data**

May 24, 2010 (JP) 2010-118760
May 24, 2010 (JP) 2010-118761
May 24, 2010 (JP) 2010-118762
May 24, 2010 (JP) 2010-118763

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

(52) **U.S. Cl.** **455/562.1**; 455/575.7; 455/129;
455/25; 343/767

(58) **Field of Classification Search** 455/562.1,
455/575.7, 129, 25, 63.4, 82, 83; 343/767,
343/789

See application file for complete search history.

(56) **References Cited**

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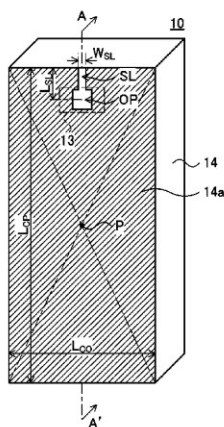
Primary Examiner — Minh D Dao

(74) *Attorney, Agent, or Firm* — Tomoki Tanida

(57) **ABSTRACT**

A proximity type antenna includes an antenna pattern for wirelessly communicating with an external communication device by magnetic coupling and a conductive plate arranged near the antenna pattern. The conductive plate has an aperture and a slit extending from the aperture to an end of the conductive plate and at least part of the aperture is arranged at a position of overlapping either the antenna pattern or the region surrounded by the inner periphery of the antenna pattern.

50 Claims, 58 Drawing Sheets



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US008416034B2

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

(10) **Patent No.:** **US 8,416,034 B2**

(45) **Date of Patent:** **Apr. 9, 2013**

(54) **SIGNAL SPLITTING DEVICE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**

(58) **Field of Classification Search** 333/124-129, 333/132-134, 32, 33; 455/78, 80, 82, 83
See application file for complete search history.

(75) Inventors: **Shen Yi Liao**, Hsinchu County (TW);
Shao Chin Lo, Hsinchu County (TW)

(56) **References Cited**

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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 402 days.

Primary Examiner — Barbara Summons

(21) Appl. No.: **12/903,665**

(74) *Attorney, Agent, or Firm* — Hamre, Schumann, Mueller & Larson, P.C.

(22) Filed: **Oct. 13, 2010**

(65) **Prior Publication Data**

US 2011/0086596 A1 Apr. 14, 2011

(30) **Foreign Application Priority Data**

Oct. 14, 2009 (TW) 98134718 A

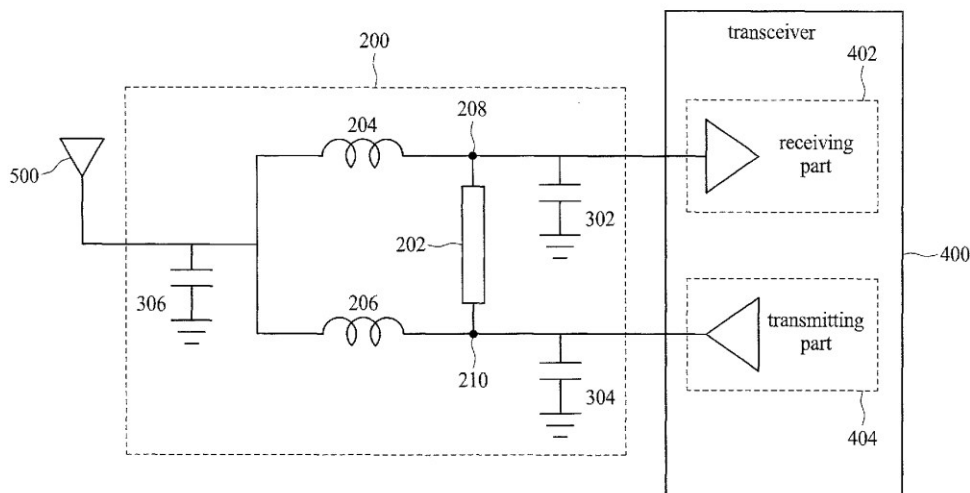
(51) **Int. Cl.**
H03H 7/38 (2006.01)
H03H 7/46 (2006.01)
H04B 1/48 (2006.01)
H04B 1/50 (2006.01)

(52) **U.S. Cl.**
USPC 333/124; 333/126; 333/129; 333/132;
333/134; 455/78; 455/80; 455/82

(57) **ABSTRACT**

A signal splitting apparatus comprises a micro-strip line, a first inductor and a second inductor. A first end and a second end of the micro-strip line are grounded via a first capacitor and a second capacitor, respectively. The first end and the second end of the micro-strip line are electrically coupled to a receiving part of a transceiver and a transmitting part of the transceiver, respectively. One end of the first inductor is coupled to the first end of the micro-strip, and the other end of the first inductor is electrically coupled to an antenna module and grounded via a third capacitor. One end of the second inductor is coupled to the second end of the micro-strip, and the other end of the second inductor is electrically coupled to the antenna module.

22 Claims, 7 Drawing Sheets



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US008416135B2

(12) **United States Patent**
Ni

(10) **Patent No.:** **US 8,416,135 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **PLANE ANTENNA**

(56) **References Cited**

(75) Inventor: **Chin Wei Ni**, Taipei (TW)

(73) Assignee: **Sercomm Corporation**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 690 days.

(21) Appl. No.: **12/360,632**

(22) Filed: **Jan. 27, 2009**

(65) **Prior Publication Data**

US 2010/0188293 A1 Jul. 29, 2010

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

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

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

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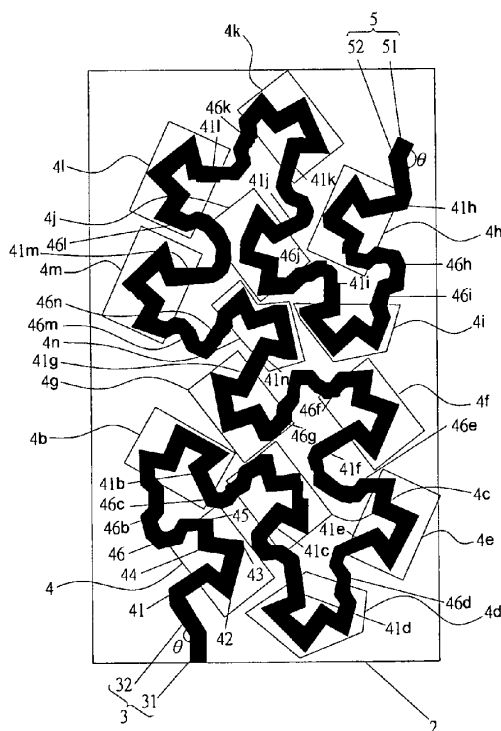
Primary Examiner — Robert Karacsony

(74) Attorney, Agent, or Firm — WPAT PC; Justin King

(57) **ABSTRACT**

A wireless internet with a plane antenna, the plane antenna comprises a plane, an import and an export antenna and plural radiators. The import antenna has a first and a second import line which connect with each other and an included angle is formed between the second and the first import line, the export antenna has a first and a second export line which connect with each other and the included angle is formed between the second and the first export line. The radiators are disposed between the import and the export antenna, each radiator having a first and a second conducting wire, a sharp part, a first and a second protruding fringe and a fillister. The radiators are divided into two symmetrically arranged teams. The connected angles between two neighboring radiators in the one of the teams are different.

4 Claims, 6 Drawing Sheets



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US008416136B2

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

(10) **Patent No.:** **US 8,416,136 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **MODIFICATION ON MONOPOLE ANTENNA**

- (75) Inventors: **Wen-Yuan Lo**, Jung-He (TW);
Cheng-Hsu Yang, Jung-He (TW);
Yueh-Cheng Chen, Jung-He (TW)
- (73) Assignee: **Micro-Star Int'l Co., Ltd.**, Jung-He (TW)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 369 days.

(21) Appl. No.: **12/939,448**

(22) Filed: **Nov. 4, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 28, 2010 (TW) 99214403 U

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/702, 846, 834

See application file for complete search history.

(56) **References Cited**

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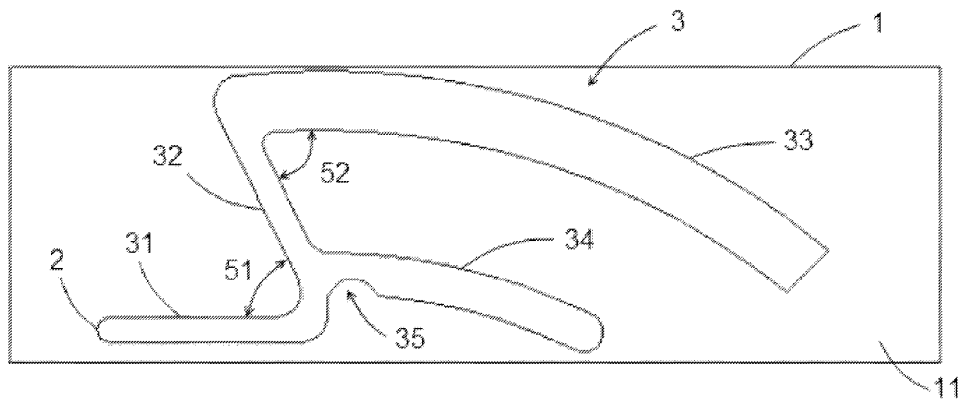
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Ditthavong Mori & Steiner, P.C.

(57) **ABSTRACT**

A monopole antenna is disposed on a substrate including a first surface and a second surface. The monopole antenna includes a feeding point, a radiation unit, and a reflecting element. The radiation unit is disposed on the first surface of the substrate, and includes a feeding section, a first radiation section, a second radiation section, and a third radiation section. The feeding section, the first radiation section, and the second radiation section are connected sequentially. The feeding point is electrically connected to the feeding section. The second radiation section and the feeding section are respectively placed at two sides of a longitudinal axis of the first radiation section. The third radiation section is electrically connected to the first radiation section. The reflecting element is disposed on the second surface of the substrate, and corresponds to a position of the second radiation section.

10 Claims, 10 Drawing Sheets



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US008416137B2

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

(10) **Patent No.:** **US 8,416,137 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **LOW-PROFILE WIDE-BANDWIDTH RADIO
FREQUENCY ANTENNA**

(75) Inventors: **Dean Kitchener**, Brentwood (GB);
Andrew Urquhart, Hertfordshire (GB)

(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 0 days.

(21) Appl. No.: **13/229,870**

(22) Filed: **Sep. 12, 2011**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 12/415,604, filed on
Mar. 31, 2009, now Pat. No. 8,040, 289.

(60) Provisional application No. 61/050,028, filed on May
2, 2008.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/846; 343/860

(58) **Field of Classification Search** 343/700 MS,
343/702, 846, 860

See application file for complete search history.

(56) **References Cited**

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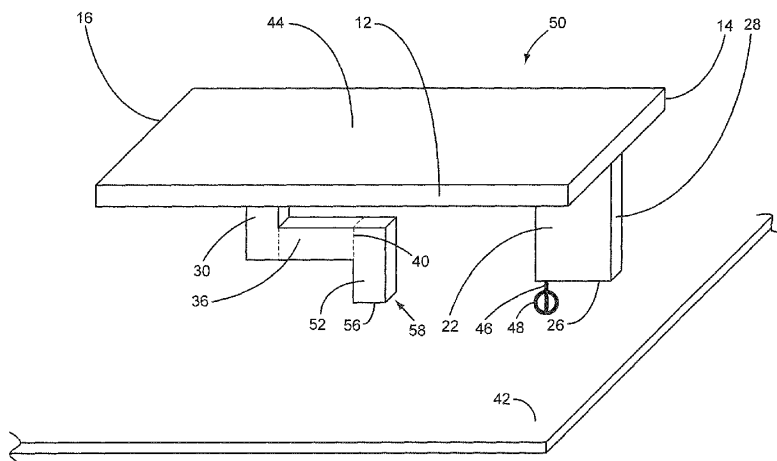
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Meyertons, Hood, Kivlin,
Kowert & Goetzel, P.C.

(57) **ABSTRACT**

The present invention relates to an RF antenna structure that includes a planar structure and a loading plate, such that the planar structure is mounted between a ground plane and the loading plate to form an RF antenna. The loading plate may be about parallel to the ground plane and the planar structure may be about perpendicular to the loading plate and the ground plane. The loading plate may allow the height of the RF antenna structure above the ground plane to be relatively small. For example, the height may be significantly less than one-quarter of a wavelength of RF signals of interest. The planar structure may include two conductive matching elements to help increase the bandwidth of the RF antenna structure.

26 Claims, 29 Drawing Sheets



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US008416138B2

(12) **United States Patent**
Quddus

(10) **Patent No.:** **US 8,416,138 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **MULTIBAND ANTENNA INCLUDING
ANTENNA ELEMENTS CONNECTED BY A
CHOKING CIRCUIT**

(75) Inventor: **Momin Quddus**, Camarillo, CA (US)

(73) Assignee: **Calamp Corp.**, Oxnard, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 260 days.

(21) Appl. No.: **12/345,492**

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

(65) **Prior Publication Data**

US 2010/0164819 A1 Jul. 1, 2010

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

(52) **U.S. Cl.**
USPC **343/722; 343/702**

(58) **Field of Classification Search** **343/700 MS, 343/722, 702**

See application file for complete search history.

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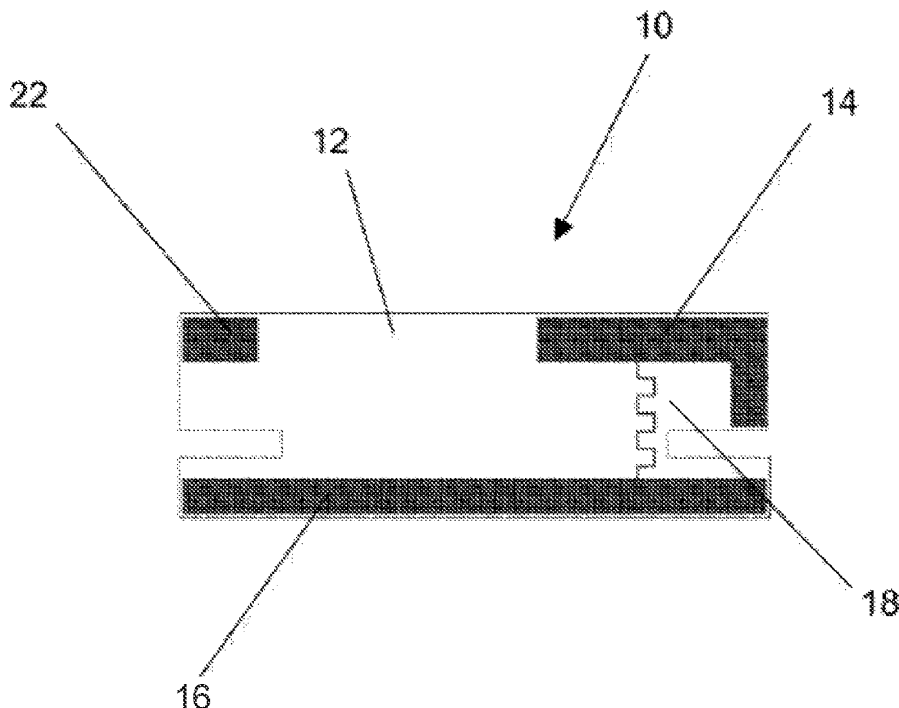
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Kauth, Pomeroy, Peck & Bailey LLP

(57) **ABSTRACT**

Multiband antennas are disclosed that incorporate a high frequency antenna element connected to a low frequency antenna element by a choking circuit. The choking circuit couples the high frequency antenna element to the low frequency antenna at a low frequency band and decouples the high frequency antenna element at a high frequency band. The connection created by the choking circuit can be a direct connection or can be an indirect connection via coupling elements that are capacitively coupled to the high frequency antenna element and/or the low frequency element to increase the bandwidth of the multiband antenna. One embodiment includes a high frequency antenna element including a feed, and a low frequency antenna element connected to the high frequency antenna element via a choking circuit.

24 Claims, 3 Drawing Sheets



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US008416139B2

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

(10) **Patent No.:** **US 8,416,139 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **METHODS AND APPARATUS FOR IMPROVING THE PERFORMANCE OF AN ELECTRONIC DEVICE HAVING ONE OR MORE ANTENNAS**

(75) Inventors: **Bing Chiang**, Cupertino, CA (US);
Gregory Allen Springer, Sunnyvale, CA (US); **Douglas B. Kough**, San Jose, CA (US); **Enrique Ayala**, Watsonville, CA (US); **Matthew Ian McDonald**, San Jose, 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 0 days.

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(21) Appl. No.: **13/209,325**

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(22) Filed: **Aug. 12, 2011**

(Continued)

(65) **Prior Publication Data**

US 2012/0001825 A1 Jan. 5, 2012

Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — David C. Kellogg

Related U.S. Application Data

(62) Division of application No. 11/702,039, filed on Feb. 1, 2007, now Pat. No. 8,018,389.

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

(52) **U.S. Cl.** **343/745**; 343/749; 343/767

(58) **Field of Classification Search** 343/745, 343/749, 767, 700 MS
See application file for complete search history.

(56) **References Cited**

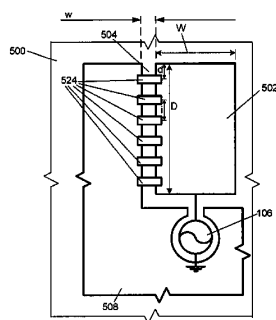
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5,955,995 A 9/1999 Silverstein

(57) **ABSTRACT**

An electronic device comprising a first conductive unit and a second conductive unit disposed such that a gap exists between the first component and the second component. The electronic device further includes one or more components disposed along the gap and configured to counteract one or more capacitance effects in the gap, wherein at least one of the first conductive unit and the second conductive unit represents a part of an antenna. By counteracting the capacitance effects in the gap, certain radiation attributes of the antenna, such as radiation efficiency, can be improved. The one or more components are also employed to counteract one or more capacitance effects in a slot of a conductive unit in an electronic device.

20 Claims, 9 Drawing Sheets



Number of added components $\geq 3/(A/(4D))$, i.e.,
Number of added components $\geq 12D/A$ (504)
wherein
D = length of gap 504
A = wavelength of radiation
A = c/f (502)
wherein
c = velocity of light
f = operating frequency



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US008416141B2

(12) **United States Patent**
Kunze

(10) **Patent No.:** **US 8,416,141 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **DUAL POLARISED RADIATING ELEMENT
FOR CELLULAR BASE STATION ANTENNAS**

(75) Inventor: **Marco Kunze**, Hamburg (DE)

(73) Assignee: **Alcatel Lucent**, Paris (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 798 days.

(21) Appl. No.: **12/339,576**

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

(65) **Prior Publication Data**

US 2009/0160730 A1 Jun. 25, 2009

(30) **Foreign Application Priority Data**

Dec. 21, 2007 (EP) 07291582

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

(52) **U.S. Cl.**
USPC **343/797**; 343/835

(58) **Field of Classification Search** 343/797,
343/834, 835, 836, 837, 908, 912, 799
See application file for complete search history.

(56) **References Cited**

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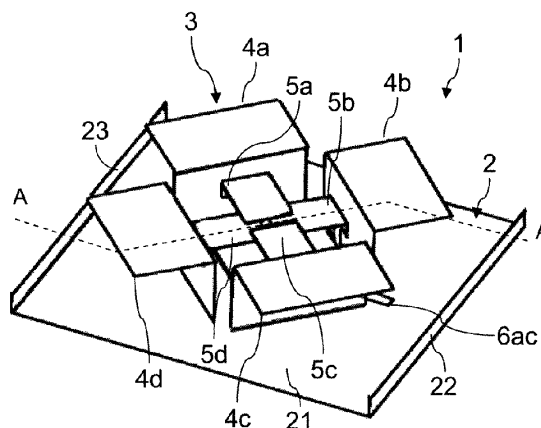
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Fay Sharpe LLP

(57) **ABSTRACT**

The invention relates to a dual polarized radiating element for a cellular base station antenna, comprising a reflector surface for reflecting radiation energy, four radiating monopoles distributed around an aperture area, each radiating monopole comprising a footing protruding from said reflector surface and a flange located above the reflector surface and protruding from said footing radially towards the outside, the flanges from adjacent monopoles extending radially perpendicular to each other. The element further comprises four element feeds, each capacitively coupled to a respective monopole and protruding radially therefrom within the aperture area, and powering means connected to the element feeds.

11 Claims, 2 Drawing Sheets



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US008416145B2

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

(10) **Patent No.:** **US 8,416,145 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **MULTI-BAND PRINTED ANTENNA**

(75) Inventors: **Han-Jung Shih**, Tainan (TW);
Chao-Hua Lu, Zhubei (TW)

(73) Assignee: **Realtek Semiconductor Corp.**, Hsinchu
(TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 402 days.

(21) Appl. No.: **12/657,080**

(22) Filed: **Jan. 13, 2010**

(65) **Prior Publication Data**
US 2010/0177004 A1 Jul. 15, 2010

(30) **Foreign Application Priority Data**

Jan. 13, 2009 (TW) 98101102 A

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

(52) **U.S. Cl.**
USPC **343/843**

(58) **Field of Classification Search** 343/834,
343/817, 810, 818, 833, 835, 843
See application file for complete search history.

(56) **References Cited**

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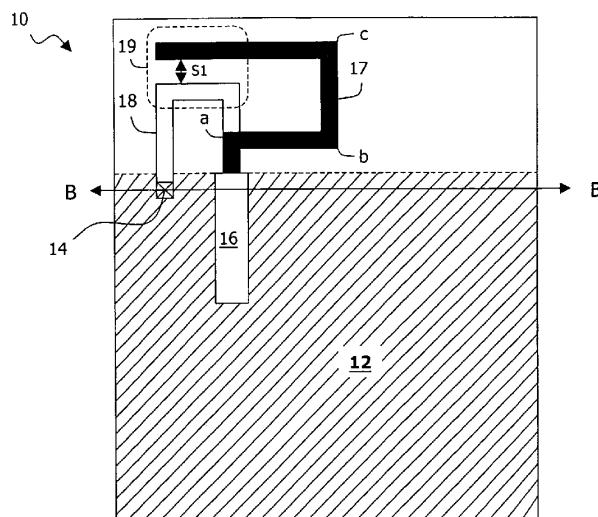
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — McClure, Qualey &
Rodack, LLP

(57) **ABSTRACT**

The present invention discloses a multi-band printed antenna,
comprising: a grounding plane; and an antenna part, includ-
ing a shorted arm electrically connected to the grounding
plane, a folded arm connected to the shorted arm, and a
feeding arm connected to the folded arm, feeding arm being
for providing signals to the folded arm and shorted arm;
wherein the folded arm includes at least one turning corner
and provides at least two resonant frequencies according to
the turning corner and the total length of the folded arm.

10 Claims, 5 Drawing Sheets



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US008417296B2

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

(10) **Patent No.:** **US 8,417,296 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **ELECTRONIC DEVICE WITH
PROXIMITY-BASED RADIO POWER
CONTROL**

(75) Inventors: **Ruben Caballero**, San Jose, CA (US);
Robert W. Schlub, Campbell, 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 867 days.

(21) Appl. No.: **12/207,326**

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

(65) **Prior Publication Data**
US 2009/0305742 A1 Dec. 10, 2009

Related U.S. Application Data

(60) Provisional application No. 61/059,247, filed on Jun.
5, 2008.

(51) **Int. Cl.**
H04B 1/38 (2006.01)
H04M 1/00 (2006.01)

(52) **U.S. Cl.**
USPC **455/566**; 455/550.1; 455/522; 455/13.4;
455/550

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

(56) **References Cited**

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Primary Examiner — Yuwen Pan

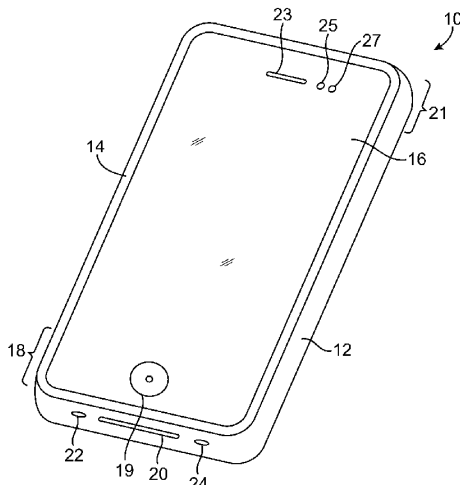
Assistant Examiner — Fanghua Wang

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

(57) **ABSTRACT**

An electronic device such as a portable electronic device may have an antenna and associated wireless communications circuitry. A sensor such as a proximity sensor may be used to detect when the electronic device is in close proximity to a user's head. Control circuitry within the electronic device may be used to adjust radio-frequency signal transmit power levels. When it is determined that the electronic device is within a given distance from the user's head, the radio-frequency signal transmit power level may be reduced. When it is determined that the electronic device is not within the given distance from the user's head, proximity-based limits on the radio-frequency signal transmit power level may be removed. Data may be gathered from a touch sensor, accelerometer, ambient light sensor and other sources for use in determining how to adjust the transmit power level.

5 Claims, 8 Drawing Sheets



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US008417300B2

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

(10) **Patent No.:** **US 8,417,300 B2**
(45) **Date of Patent:** ***Apr. 9, 2013**

(54) **MOBILE WIRELESS COMMUNICATIONS
DEVICE HAVING FREQUENCY SELECTIVE
GROUNDING AND RELATED METHOD**

(75) Inventors: **Joshua Kwan Ho Wong**, Waterloo
(CA); **Adrian Matthew Cooke**,
Kitchener (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 dis-
claimer.

(21) Appl. No.: **13/442,968**

(22) Filed: **Apr. 10, 2012**

(65) **Prior Publication Data**

US 2012/0195011 A1 Aug. 2, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/868,763, filed on
Aug. 26, 2010, now Pat. No. 8,180,412.

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

(52) **U.S. Cl.**
USPC **455/575.1**; 455/114.1; 455/347;
455/550.1; 343/700 R; 333/189

(58) **Field of Classification Search** 455/575.1;
361/56, 752, 753

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dwayne Bost

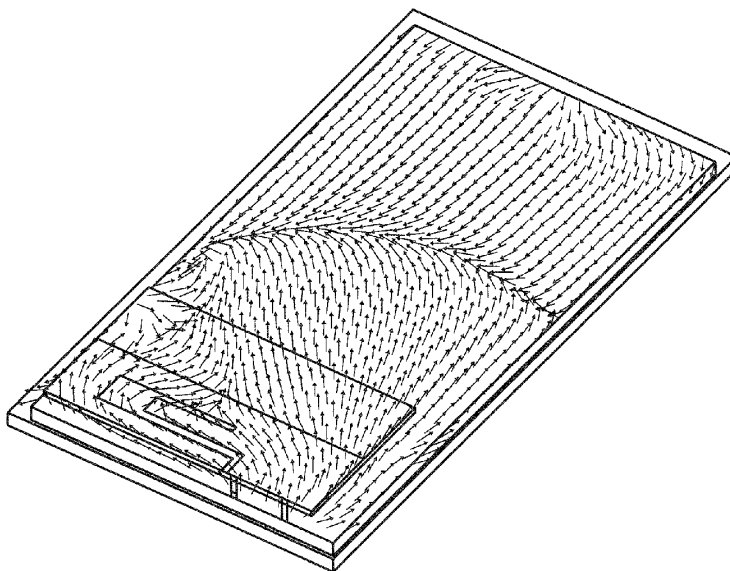
Assistant Examiner — Gerald Johnson

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

(57) **ABSTRACT**

A mobile wireless communications device includes a portable housing having a metallic front housing forming a peripheral sidewall as a metallic ring. A circuit board is carried by the portable housing and forms a chassis ground plane. A wireless communications circuit is carried by a circuit board. An antenna circuit is carried by a circuit board and connected to the wireless communications circuit. A frequency selective grounding circuit is positioned at a selected grounding location at the chassis ground plane and metallic front housing and forms a harmonic trap that responds to a specific range of frequencies.

16 Claims, 13 Drawing Sheets



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US008418211B2

(12) **United States Patent**
Beals

(10) **Patent No.:** **US 8,418,211 B2**
(45) **Date of Patent:** **Apr. 9, 2013**

(54) **ANTENNA DIVERSITY FOR CONTROL
DEVICE APPLICATIONS**

(75) Inventor: **William Michael Beals**, Englewood, CO
(US)

(73) Assignee: **EchoStar Technologies L.L.C.**,
Englewood, CO (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 985 days.

(21) Appl. No.: **12/347,632**

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

(65) **Prior Publication Data**

US 2010/0165216 A1 Jul. 1, 2010

(51) **Int. Cl.**
H04N 7/173 (2011.01)
H04N 5/44 (2006.01)
H04N 5/445 (2011.01)

(52) **U.S. Cl.** **725/81; 348/552; 348/734; 725/80**

(58) **Field of Classification Search** **725/80,**
725/81; 348/734, 552

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Pankaj Kumar

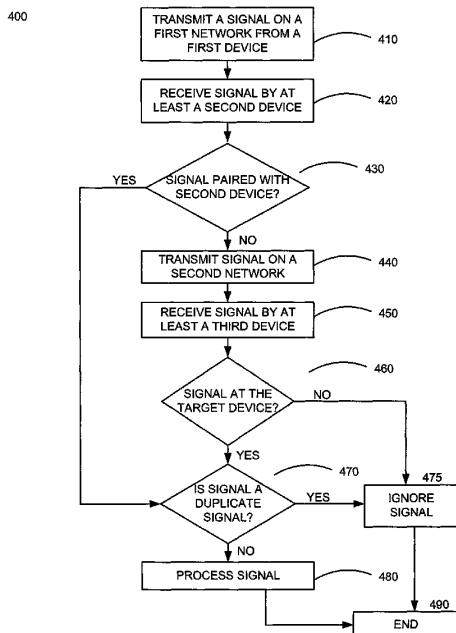
Assistant Examiner — Reuben M Brown

(74) *Attorney, Agent, or Firm* — Seed IP Law Group PLLC

(57) **ABSTRACT**

One embodiment may take the form of a method for routing
a signal to a target device. The method may include a control
device that may transmit a signal on a first network. The
signal may reach devices other than the target device. The
devices that receive the signal may recognize that the signal is
intended for another device and may transmit the signal on a
second network. The signal may be received by the target
device via the second network.

20 Claims, 4 Drawing Sheets



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US008421679B2

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

(10) **Patent No.:** **US 8,421,679 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **ANTENNA DEVICE AND ANTENNA
ELEMENT USED THEREFOR**

(75) Inventors: **Kei Suzuki**, Tokyo (JP); **Masaki
Matsushima**, Tokyo (JP); **Naoaki
Utagawa**, Tokyo (JP); **Tetsuya Shibata**,
Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 453 days.

(21) Appl. No.: **12/715,887**

(22) Filed: **Mar. 2, 2010**

(65) **Prior Publication Data**
US 2010/0225542 A1 Sep. 9, 2010

(30) **Foreign Application Priority Data**

Mar. 3, 2009 (JP) 2009-049971

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

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

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

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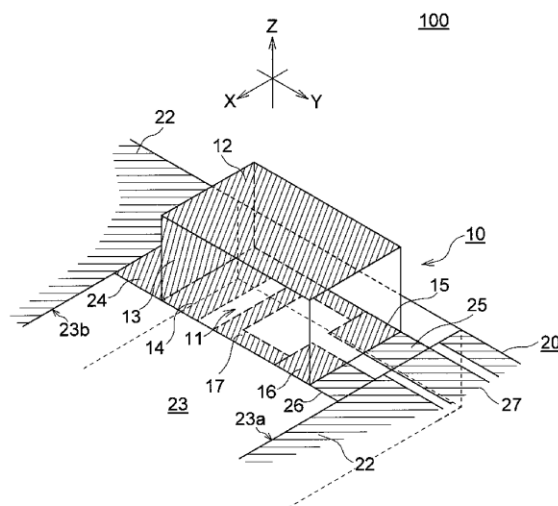
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — McDermott Will & Emery
LLP

(57) **ABSTRACT**

An antenna device includes an antenna element and a printed circuit board on which the antenna element is mounted. The antenna element includes a base, a radiation conductor formed on an upper surface of the substrate and one end of the radiation conductor being an open end, a plurality of terminal electrodes formed on a bottom surface of the substrate, and a loop conductor of a substantially U-shape. The loop conductor is arranged to face one of the terminal electrodes via a gap having a predetermined width. An antenna mounting region is provided on a upper surface of the printed circuit board to be adjacent to an edge of a long side of the printed circuit board. A feed line is led in the antenna mounting region along the edge. One and the other end of the loop conductor are connected to the feed line and a ground pattern, respectively.

15 Claims, 21 Drawing Sheets



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US008421681B2

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

(10) **Patent No.:** **US 8,421,681 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **MULTI-BAND ANTENNA**

- (75) Inventors: **Chieh-Ping Chiu**, Tianwei (TW);
Feng-Jen Weng, Kuei Shan Hsiang
(TW); **Hsiao-Wei Wu**, Zhongli (TW);
I-Ping Yen, Yonghe (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 354 days.

(21) Appl. No.: **12/872,038**

(22) Filed: **Aug. 31, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 20, 2010 (TW) 99112352 A

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 5/00 (2006.01)

H01Q 9/04 (2006.01)

H01Q 1/48 (2006.01)

(52) **U.S. Cl.**

USPC **343/700 MS**; **343/846**

(58) **Field of Classification Search** **315/700 MS**,
315/846

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Shawki Ismail

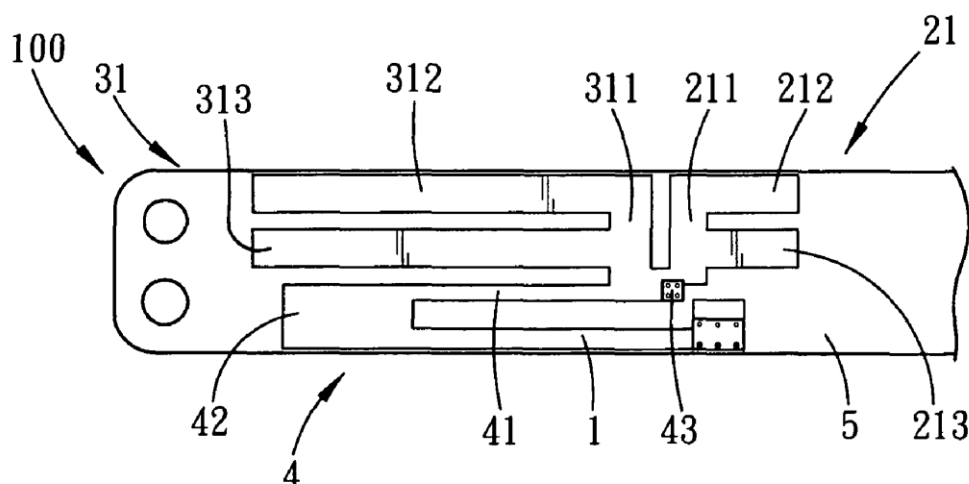
Assistant Examiner — Dylan White

(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

An antenna includes a grounding element, a connecting element, and first and second radiator elements. The connecting element includes an elongated first connecting section, and a second connecting section connecting the first connecting section to the grounding element. The first radiator element includes a first radiator section extending substantially perpendicular from one side of the first connecting section, and second and third radiator sections extending substantially perpendicular from one side of the first radiator section. The second radiator element includes a first radiator portion extending substantially perpendicular from the one side of the first connecting section, and second and third radiator portions extending substantially perpendicular from one side of the first radiator portion and extending in an opposite direction relative to the second and third radiator sections.

18 Claims, 8 Drawing Sheets



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US008421683B2

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

(10) **Patent No.:** **US 8,421,683 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **ROLLABLE AND/OR FOLDABLE ANTENNA SYSTEMS AND METHODS FOR USE THEREOF**

(75) Inventors: **Chi Lun Mak**, Ma On Shan (HK); **Hau Wah Lai**, Lam Tin (HK); **Corbett R. Rowell**, Mongkok (HK)

(73) Assignee: **Hong Kong Applied Science and Technology Research Institute Co., Ltd.**, Hong Kong (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 793 days.

(21) Appl. No.: **12/491,685**

(22) Filed: **Jun. 25, 2009**

(65) **Prior Publication Data**
US 2010/0328171 A1 Dec. 30, 2010

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

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

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

(56) **References Cited**

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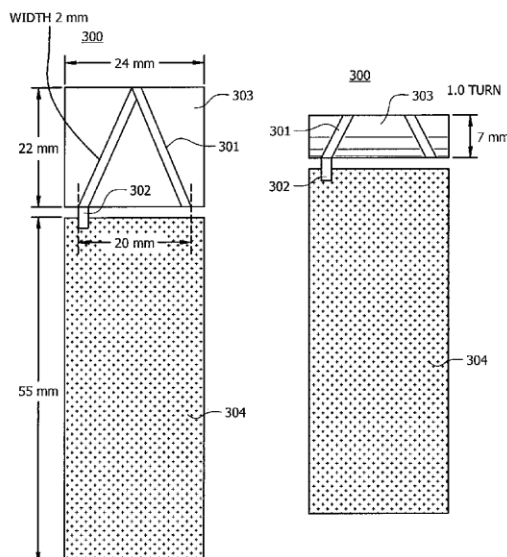
Primary Examiner — Hoanganh Le

(74) Attorney, Agent, or Firm — Fulbright & Jaworski L.L.P.

(57) **ABSTRACT**

An antenna system comprises a ground plane, a flexible substrate, a first antenna element disposed upon the flexible substrate and proximal to the ground plane, the flexible substrate configured so as to be at least partially rolled, and a Radio Frequency (RF) module in communication with the first antenna element and transmitting and receiving radio waves through the first antenna element.

13 Claims, 8 Drawing Sheets



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US008421685B2

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

(10) **Patent No.:** **US 8,421,685 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **SPATIAL FILTER FOR NEAR FIELD
MODIFICATION IN A WIRELESS
COMMUNICATION DEVICE**

(75) Inventors: **Xiaomeng Su**, San Diego, CA (US);
Ting Ting Dong, Shanghai (CN);
Sebastian Rowson, San Diego, CA
(US); **Jeffrey Shamblyn**, San Marcos,
CA (US); **Laurent Desclos**, San Diego,
CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 399 days.

(21) Appl. No.: **12/776,322**

(22) Filed: **May 7, 2010**

(65) **Prior Publication Data**
US 2010/0283691 A1 Nov. 11, 2010

Related U.S. Application Data
(60) Provisional application No. 61/176,435, filed on May
7, 2009.

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

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

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

(56) **References Cited**

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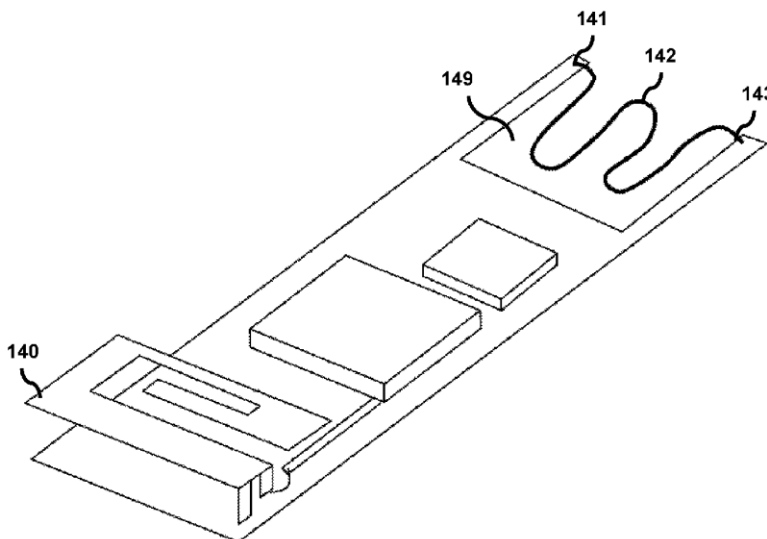
Primary Examiner — Hoanganh Le

(74) *Attorney, Agent, or Firm* — Coastal Patent Agency;
Joshua Schoonover

(57) **ABSTRACT**

A spatial filter is developed for specific absorption rate (SAR)
reduction in a wireless device. A conductive element is
designed to modify the near field distribution of an antenna
operating in a wireless device. This reduces SAR while mini-
mizing degradation of antenna efficiency at one or several
frequency bands that the antenna is designed to operate over.
Lumped reactance can be designed into the conductive ele-
ment to generate low pass, band pass, and/or high pass fre-
quency characteristics. Distributed reactance can be designed
into the conductive element to replace or to work in conjunc-
tion with the lumped reactance. Active components can be
designed into the conductive element to provide dynamic
tuning of the frequency response of the conductive element.

15 Claims, 10 Drawing Sheets



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US008421688B2

(12) **United States Patent**
Tu

(10) **Patent No.:** **US 8,421,688 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **SOLID ANTENNA WITH UPPER-LOWER STRUCTURE**

(75) Inventor: **Hsin-Lung Tu**, Taipei Hsien (TW)

(73) Assignee: **Hon Hai Precision Industry 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 374 days.

(21) Appl. No.: **12/948,768**

(22) Filed: **Nov. 18, 2010**

(65) **Prior Publication Data**
US 2012/0105291 A1 May 3, 2012

(30) **Foreign Application Priority Data**
Mar. 15, 2013 (CN) 2010 2 0587467

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

(52) **U.S. Cl.**
USPC 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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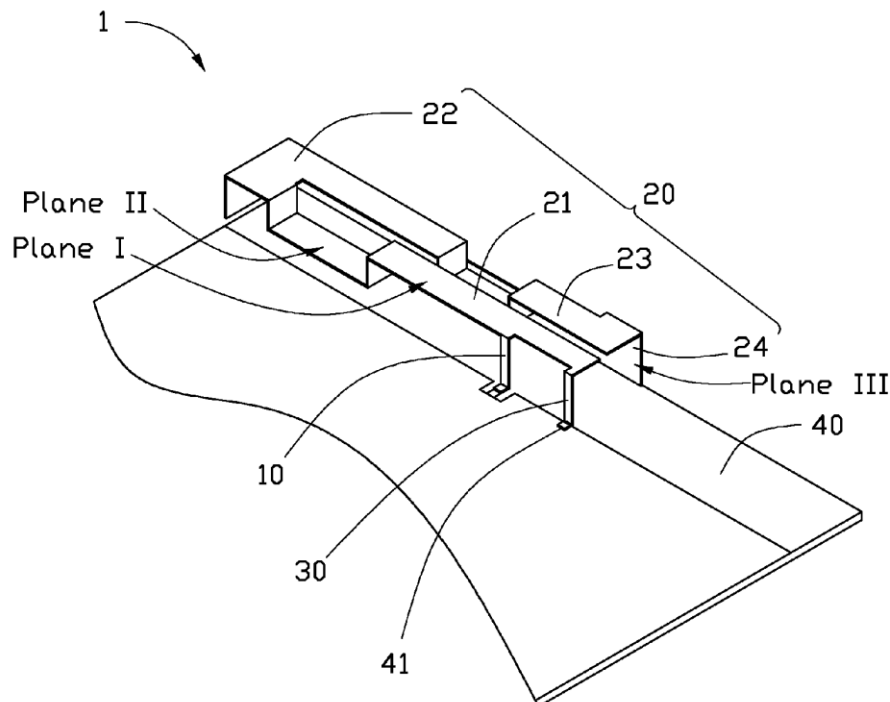
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Altis Law Group, Inc.

(57) **ABSTRACT**

A solid antenna configured above a substrate includes a short portion, a feeding portion and a radiating portion including four radiators connected one-by-one. A first radiator includes a first upper section on a first plane, a first lower section on a second plane, and a first connection section connecting the first upper section to the first lower section. The second radiator includes a second upper section on the first plane, and a second connection portion connecting the second upper section to the first lower section. The third radiator includes a third upper section and a fourth upper section on the first plane, a second lower section on the second plane, a third connection section connecting the third upper section to the second lower section, and a fourth connection section connecting the second lower section to the fourth upper section. The fourth radiator extends towards the substrate.

10 Claims, 5 Drawing Sheets



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US008421689B2

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

(10) **Patent No.:** **US 8,421,689 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **ANTENNAS WITH TUNING STRUCTURE
FOR HANDHELD DEVICES**

(75) Inventors: **Robert W. Schlub**, Campbell, CA (US);
Dean F. Darnell, Santa Clara, CA (US);
Robert J. Hill, Salinas, CA (US);
Teodor Dabov, Mountain View, CA
(US); **Hui Leng Lim**, 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 0 days.

(21) Appl. No.: **13/447,200**

(22) Filed: **Apr. 14, 2012**

(65) **Prior Publication Data**

US 2012/0198689 A1 Aug. 9, 2012

Related U.S. Application Data

(62) Division of application No. 12/205,829, filed on Sep.
5, 2008, now Pat. No. 8,169,373.

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

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

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

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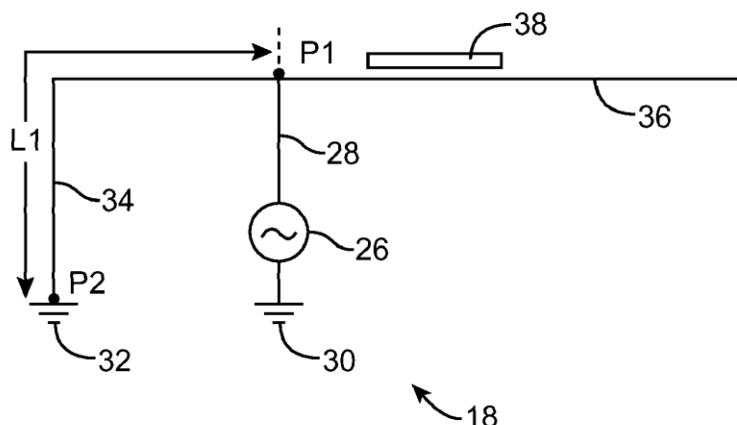
Primary Examiner — Tho G Phan

(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. The wireless communications circuitry may include antenna structures. To accommodate manufacturing variations, the antenna structures and handheld electronic devices may be characterized by performing measurements such as antenna performance measurements. Appropriate antenna adjustments may be made during manufacturing of a handheld electronic device based on the characterizing measurements. An antenna may be formed using an inverted-F design in which an antenna flex circuit is mounted to a dielectric antenna support structure. Cavities in the support may be selectively filled with dielectric material and dielectric patches may be added to the antenna flex circuit to adjust the dielectric loading of the antenna. The length of a ground return path in the antenna may be adjusted by appropriate positioning of an electrical connector within the ground return path.

19 Claims, 19 Drawing Sheets



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US008421702B2

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

(10) **Patent No.:** **US 8,421,702 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

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

(75) Inventors: **Laurent Desclos**, San Diego, CA (US);
Sebastian Rowson, San Diego, CA
(US); **Jeffrey Shamblyn**, San Diego, CA
(US); **Young Cha**, San Diego, CA (US);
Chulmin Han, San Diego, CA (US);
Byoeng Sug Kwak, Gunpo-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 403 days.

(21) Appl. No.: **12/758,725**

(22) Filed: **Apr. 12, 2010**

(65) **Prior Publication Data**

US 2010/0259456 A1 Oct. 14, 2010

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/847,207,
filed on Aug. 29, 2007, now abandoned, and a
continuation-in-part of application No. 12/059,346,
filed on Mar. 31, 2008, now Pat. No. 7,777, 686.

(60) Provisional application No. 61/168,550, filed on Apr.
10, 2009.

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

(52) **U.S. Cl.**

USPC **343/795**; 343/700 MS; 343/846

(58) **Field of Classification Search** 343/700,
343/730, 795, 846
See application file for complete search history.

(56) **References Cited**

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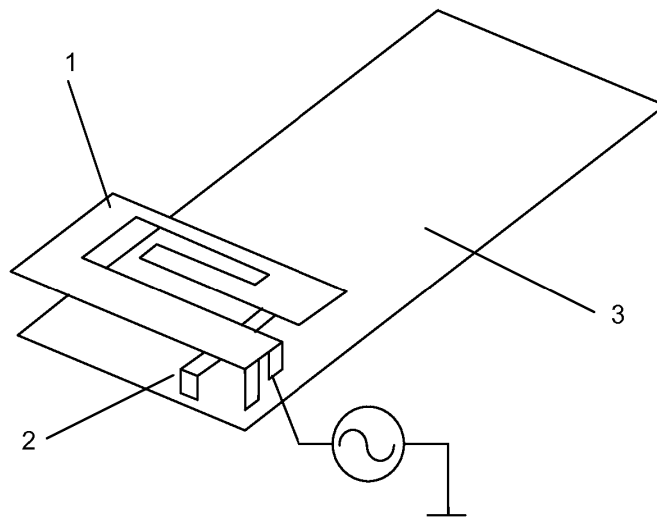
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

A multi-layer reactively loaded isolated magnetic (IMD) dipole with improved bandwidth and efficiency characteristics to be used in wireless communications and other applicable systems. The multi-layer IMD antenna comprises a first element positioned above a ground plane, a second element positioned above a ground plane and coupled to the first portion. Reactive components are integrated into one or both elements to optimize the frequency response of the antenna. The range of frequencies covered to be determined by the shape, size, and number of elements in the physical configuration of the components. Portions of or the entire ground plane can be removed beneath the elements.

17 Claims, 9 Drawing Sheets



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US008421703B2

(12) **United States Patent**
Ranta

(10) **Patent No.:** **US 8,421,703 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **APPARATUS FOR ENABLING TWO ELEMENTS TO SHARE A COMMON FEED**

(75) Inventor: **Tero Ta Ranta**, San Diego, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 795 days.

(21) Appl. No.: **12/312,564**

(22) PCT Filed: **Nov. 17, 2006**

(86) PCT No.: **PCT/IB2006/004018**

§ 371 (c)(1),

(2), (4) Date: **Dec. 11, 2009**

(87) PCT Pub. No.: **WO2008/059316**

PCT Pub. Date: **May 22, 2008**

(65) **Prior Publication Data**

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

(52) **U.S. Cl.**
USPC **343/853**; 343/850

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

See application file for complete search history.

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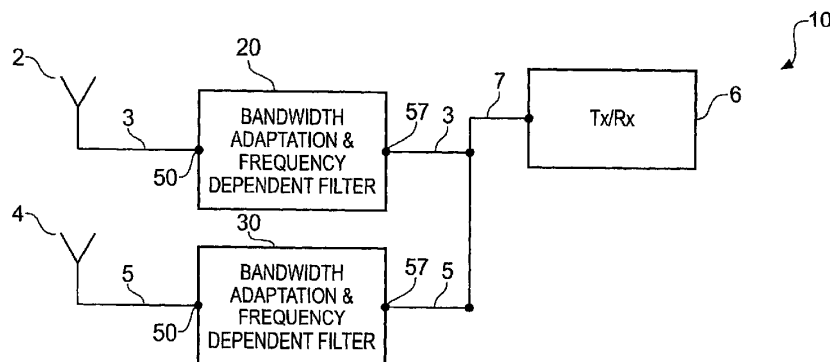
Primary Examiner — Jason M Crawford

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

(57) **ABSTRACT**

An apparatus including a first antenna element operable at least one frequency within a first frequency range; a second antenna element operable at at least one frequency within a second frequency range; radio frequency circuitry electrically connected to the first antenna element via a first electrical path and electrically connected to the second antenna element via a second electrical path, wherein the first and second electrical paths are common where they connect to the radio frequency circuitry; a first frequency-dependent filter arrangement, within the first electrical path, arranged to accept frequencies within the first frequency range and reject frequencies within the second frequency range; a first impedance level transformation arrangement, having a first tapped inductor, within the first electrical path; and a second frequency-dependent filter arrangement, within the second electrical path, arranged to accept frequencies within the second frequency range and reject frequencies within the first frequency range.

20 Claims, 3 Drawing Sheets



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US008421705B2

(12) **United States Patent**
Chen

(10) **Patent No.:** **US 8,421,705 B2**
(45) **Date of Patent:** **Apr. 16, 2013**

(54) **ANTENNA STRUCTURE**

(75) Inventor: **Shuen-Sheng Chen**, Taipei Hsien (TW)

(73) Assignee: **Wistron NeWeb Corporation**,
Hsi-Chih, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 350 days.

(21) Appl. No.: **12/767,805**

(22) Filed: **Apr. 27, 2010**

(65) **Prior Publication Data**

US 2011/0234470 A1 Sep. 29, 2011

(30) **Foreign Application Priority Data**

Mar. 26, 2010 (TW) 99109089 A

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

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

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

(56) **References Cited**

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Primary Examiner — Douglas W Owens

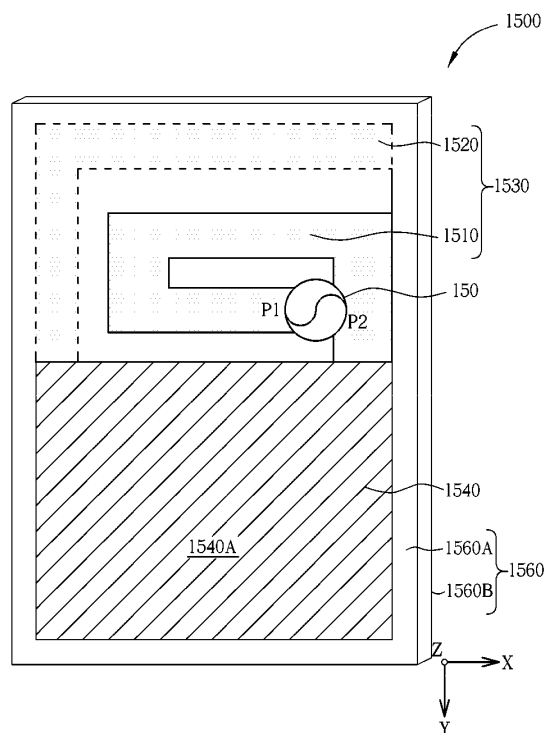
Assistant Examiner — Collin Dawkins

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

(57) **ABSTRACT**

An antenna structure includes a positive feeding point, a negative feeding point, a radiation element, and a grounding element. The radiation element includes a first radiator and a second radiator. The first radiator has a first end coupled to the positive feeding point, and has a plurality of first side edges. The second radiator has a first end coupled to the negative feeding point, and has a plurality of second side edges. Herein the second radiator at least partially surrounds the first radiator, such that there are a plurality of predetermined gaps existed in between the plurality of first side edges of the first radiator and the plurality of second side edges of the second radiator to form coupling effects. The grounding element is coupled to the second radiator.

17 Claims, 18 Drawing Sheets



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