



US008384598B2

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

(10) **Patent No.:** **US 8,384,598 B2**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **SURFACE-MOUNTED ANTENNA, ANTENNA
DEVICE USING THE SAME, AND RADIO
COMMUNICATION EQUIPMENT**

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(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 694 days.

(21) Appl. No.: **12/607,229**

(22) Filed: **Oct. 28, 2009**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Oct. 28, 2008 (JP) 2008-276706

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

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

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

See application file for complete search history.

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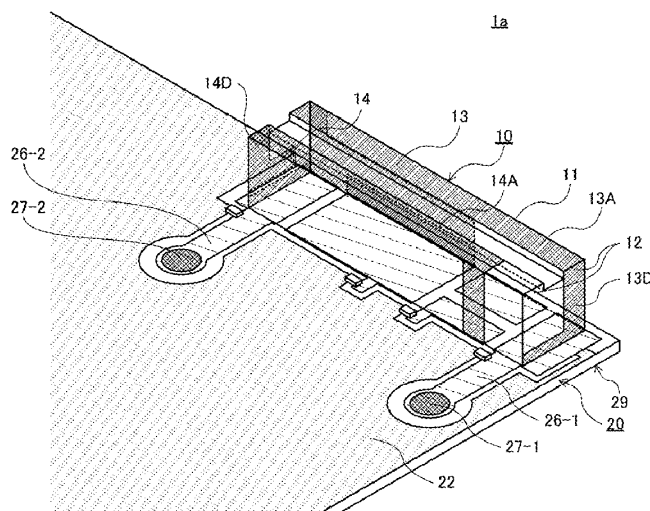
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Young Law Firm, P.C.

(57) **ABSTRACT**

A surface-mounted antenna has a base having a substantially rectangular parallelepiped shape, an antenna element formed on the surface of the base and having a first radiation electrode subjected to direct power supply, and an antenna element formed on the surface of the base and having a radiation electrode subjected to capacitive coupling power supply. With this, the smaller surface-mounted antenna of a combo antenna type can be provided.

9 Claims, 11 Drawing Sheets



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US008384600B2

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

(10) **Patent No.:** **US 8,384,600 B2**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **HIGH GAIN METAMATERIAL ANTENNA
DEVICE**

(75) Inventors: **Wei Huang**, San Diego, CA (US);
Gregory Poilasne, El Cajon, CA (US);
Vaneet Pathak, San Diego, CA (US)

(73) Assignee: **Tyco Electronics Services GmbH** (CH)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 434 days.

(21) Appl. No.: **12/722,481**

(22) Filed: **Mar. 11, 2010**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/159,320, filed on Mar. 11, 2009.

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

(52) **U.S. Cl.** **343/700 MS; 343/702; 343/767; 343/770**

(58) **Field of Classification Search** **343/700 MS, 343/90, 729, 767, 770, 702, 787, 788, 846**
See application file for complete search history.

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Wei Huang et al., "Composite Right-Left Handed Metamaterial Ultra-Wideband Antenna", Antenna Technology, 2009. IWAT 2009. IEEE International Workshop on, Mar. 2, 2009, pp. 1-4.
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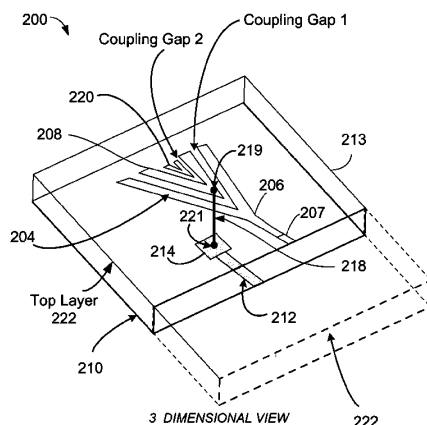
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Primary Examiner — Vibol Tan

(57) **ABSTRACT**

An antenna is presented having a flared structure wherein charge is induced from one portion of the structure to another. The flared structure may be a V-shaped or other shaped element. The antenna includes at least one parasitic element to increase the gain of the antenna and extend the radiation pattern generated by the antenna in a given direction.

20 Claims, 22 Drawing Sheets



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US008384603B2

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

(10) **Patent No.:** **US 8,384,603 B2**

(45) **Date of Patent:** **Feb. 26, 2013**

(54) **PCB AND EMBEDDED ANTENNA FOR
MOBILE COMMUNICATION TERMINAL
HAVING DOUBLE FEED POINTS USING THE
SAME**

(75) Inventors: **Chi Sun Kim**, Seongnam-si (KR);
Chang Won Jang, Suwon-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **11/935,231**

(22) Filed: **Nov. 5, 2007**

(65) **Prior Publication Data**
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(30) **Foreign Application Priority Data**
Nov. 6, 2006 (KR) 2006-0108975

(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

See application file for complete search history.

(56) **References Cited**

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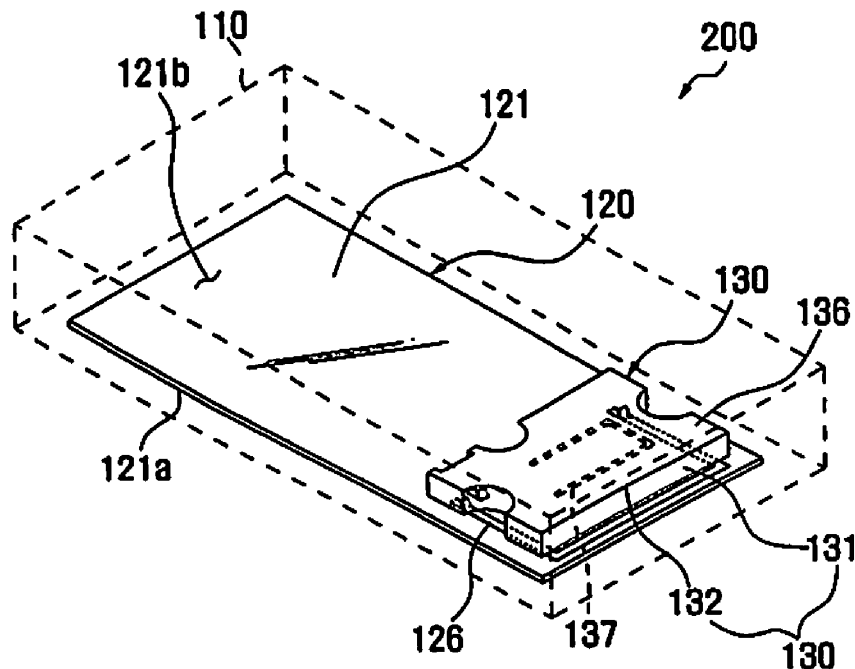
Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

A Printed Circuit Board (PCB) and an embedded antenna for a mobile communication terminal having double feed points using the same are provided. The embedded antenna includes a PCB having an emission carrier. The emission carrier includes first and second feed points connected to a feed wiring layer of the PCB, as well as an emission pattern to which the feed points are connected. The feed wiring layer supplies a current to one of the feed points, and has a connection wiring for supplying a current from the feed point to the other feed point. Through overlapping between a first resonance spot created by the first feed point, and a second resonance spot, which branches off from the first feed point and connects to the PCB, the frequency bandwidth can be expanded, which accommodates any frequency shift minimizes deterioration resulting from the influence of human bodies, and maintains stable antenna characteristics.

12 Claims, 7 Drawing Sheets



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US008384606B2

(12) **United States Patent**
Shoji

(10) **Patent No.:** **US 8,384,606 B2**
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(54) **ANTENNA DEVICE AND COMMUNICATION
TERMINAL**

(75) Inventor: **Hideaki Shoji**, Chiba (JP)

(73) Assignees: **Sony Corporation**, Tokyo (JP); **Sony
Mobile Communications Inc.**, Tokyo
(JP)

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patent is extended or adjusted under 35
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(21) Appl. No.: **12/424,862**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H01Q 9/00 (2006.01)
H01Q 1/50 (2006.01)

(52) **U.S. Cl.** **343/745; 343/860**

(58) **Field of Classification Search** **343/745,
343/860**

See application file for complete search history.

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Primary Examiner — Douglas W Owens

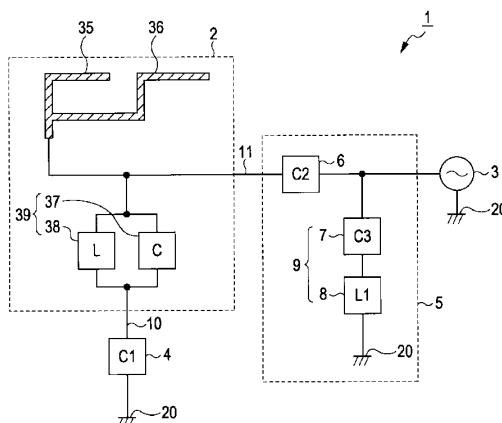
Assistant Examiner — Jennifer F Hu

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

(57) **ABSTRACT**

An antenna device includes: an antenna element that transmits or receives wireless signals in a predetermined first frequency band and in a second frequency band higher in frequency than the first frequency band; a feeding terminal portion; a first bandwidth adjustment circuit that includes a first capacitor for widening a bandwidth of the first frequency band to a predetermined bandwidth, the capacitance of the first capacitor being set at a predetermined value in accordance with the predetermined bandwidth; and a second bandwidth adjustment circuit that includes second and third capacitors and a first inductor for widening a bandwidth of the first frequency band to the predetermined bandwidth, the capacitance of each of the second and third capacitors and the inductance of the first inductor being respectively set at predetermined values in accordance with the predetermined bandwidth.

4 Claims, 28 Drawing Sheets



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US008384608B2

(12) **United States Patent**
DeJean

(10) **Patent No.:** **US 8,384,608 B2**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **SLOT ANTENNA**

- (75) Inventor: **Gerald R. DeJean**, Redmond, WA (US)
(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 445 days.

(21) Appl. No.: **12/789,471**

(22) Filed: **May 28, 2010**

(65) **Prior Publication Data**
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H01Q 13/10 (2006.01)
(52) **U.S. Cl.** **343/770; 343/767**
(58) **Field of Classification Search** **343/700 MS, 343/767, 770**
See application file for complete search history.

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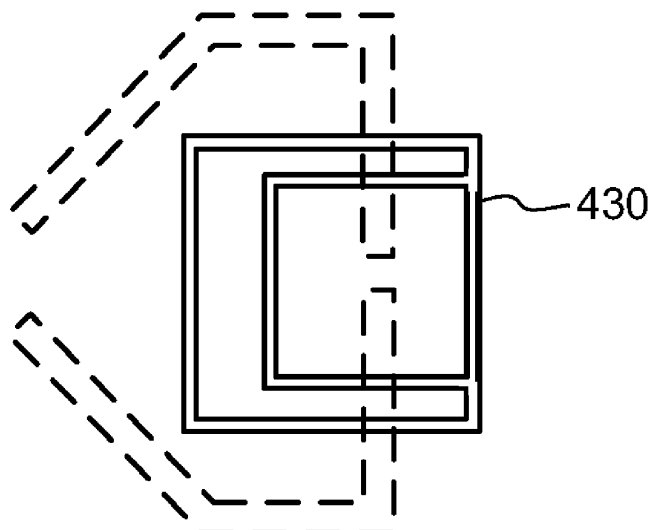
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Primary Examiner — Tho G Phan

(57) **ABSTRACT**

Technology is described for a slot antenna. The slot antenna can include a substrate having a metal layer on a first side of the substrate. A feed line can be located on a second side of the substrate. A first polygon shaped slot can be formed in the metal layer of a first side of the substrate. A second polygon shaped slot can also be formed in the metal layer of the first side of the substrate. The second polygon shaped slot can be recessed within a perimeter of the first polygon shaped slot and the second polygon shaped slot and first polygon shaped slot share a common side. Examples of the first and second polygon shapes may include square or diamond shapes.

20 Claims, 7 Drawing Sheets



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

- (54) **ANTENNA DEVICE, ANTENNA REFLECTOR,
AND WIRELESS COMMUNICATION UNIT
INCORPORATING ANTENNA**

- (75) Inventors: **Kenji Asakura**, Fukui (JP); **Kiyotada Yokogi**, Tokyo (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 839 days.

- (21) Appl. No.: 11/652,952

- (22) Filed: **Jan. 12, 2007**

- (65) **Prior Publication Data**

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- (30) **Foreign Application Priority Data**

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- (51) **Int. Cl.**
H01Q 19/10 (2006.01)





US008384612B2

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

(10) **Patent No.:** **US 8,384,612 B2**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **ANTENNA WITH DIVIDED GROUND PLANE**

(75) Inventors: **Sagiv Zeltser**, Tel Aviv (IL); **Yohan Cohen**, Oranit (IL)

(73) Assignee: **Google Inc.**, Mountain View, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 409 days.

(21) Appl. No.: **12/786,963**

(22) Filed: **May 25, 2010**

(65) **Prior Publication Data**

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Related U.S. Application Data

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

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

See application file for complete search history.

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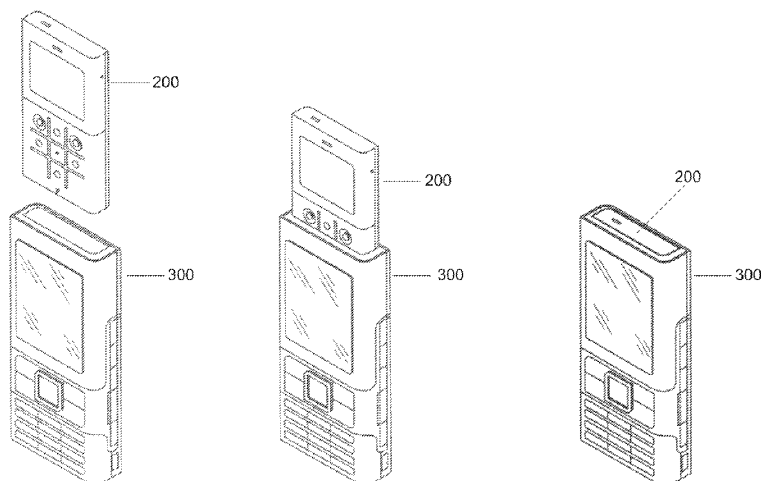
Primary Examiner — Anh Tran

(74) *Attorney, Agent, or Firm* — Soquel Group LLC

(57) **ABSTRACT**

A transceiver, including a multi-layer printed circuit board including a layer that serves as a first ground plane, and an antenna for transmitting and receiving radio signals, a second ground plane, and at least one ground contact for connecting the first ground plane and the second ground plane, wherein the first ground plane is too short for the antenna to resonate at a desired frequency, but the first and second ground planes, when connected, provide a combined ground plane sufficient for the antenna to resonate at the desired frequency.

18 Claims, 5 Drawing Sheets



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US008385446B2

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

(10) **Patent No.:** **US 8,385,446 B2**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **RECEIVING APPARATUS AND METHOD
FOR MAXIMUM LIKELIHOOD IN A SINGLE
CARRIER SYSTEM**

(75) Inventors: **Jong-Ho Lee**, Seoul (KR); **Joo-Hyun Lee**, Suwon-si (KR); **Sung-Hwan Kim**, Suwon-si (KR); **Jong-Hyeuk Lee**, Anyang-si (KR); **Sung-Yoon Jung**, Seoul (KR); **Chungyong Lee**, Seoul (KR); **Jaesang Ham**, Seoul (KR); **Myoung-Seok Kim**, Seoul (KR)

(73) Assignees: **Samsung Electronics Co., Ltd.**, Suwon-si (KR); **Industry-Academic Cooperation Foundation, Yonsei University**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1001 days.

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(22) Filed: **Apr. 1, 2009**

(65) **Prior Publication Data**

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H04L 5/12 (2006.01)

(52) **U.S. Cl.** **375/262**; 375/260; 375/265; 375/267; 375/299; 375/316; 375/340; 375/341; 375/347;

455/101; 455/132; 455/296; 455/500; 455/562.1; 370/210; 370/334; 370/464; 370/480; 714/751; 714/752; 714/794; 714/795; 714/796

(58) **Field of Classification Search** 375/260, 375/262, 265, 267, 299, 316, 340, 341, 347; 455/101, 132, 296, 500, 562.1; 370/210, 370/334, 464, 480; 714/751, 752, 794, 795, 714/796

See application file for complete search history.

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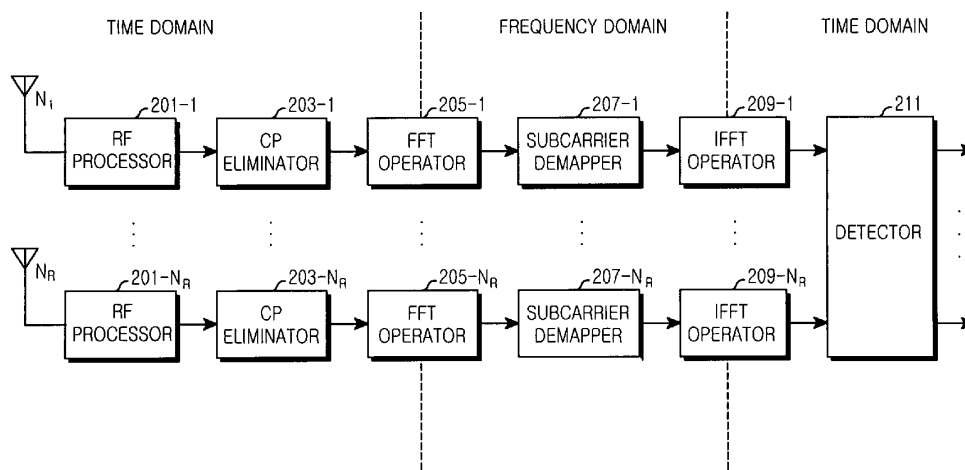
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Primary Examiner — Leon Flores

(57) **ABSTRACT**

A receiving apparatus and method of a Maximum Likelihood (ML) scheme in a Single-Carrier (SC) system are provided. The apparatus includes at least two antennas, at least two Orthogonal Frequency Division Multiplexing (OFDM) demodulators, at least two subcarrier mappers, at least two OFDM modulators, and a detector. The antennas receive signals. The OFDM demodulators convert the signals into frequency domain signals. The subcarrier mappers confirm signals mapped to frequency domain subcarriers. The OFDM modulators convert the signals into time domain signals. The detector constructs at least one set for candidate transmission symbols and detects receive signals through ML detection using the set.

17 Claims, 9 Drawing Sheets



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US008385455B2

(12) **United States Patent**
Fujimoto

(10) **Patent No.:** **US 8,385,455 B2**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **MULTI-ANTENNA WIRELESS COMMUNICATION METHOD, MULTI-ANTENNA WIRELESS COMMUNICATION SYSTEM, AND MULTI-ANTENNA WIRELESS COMMUNICATION DEVICE**

(75) Inventor: **Atsushi Fujimoto**, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 193 days.

(21) Appl. No.: **13/058,402**

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(86) PCT No.: **PCT/JP2009/003497**

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(2), (4) Date: **Feb. 10, 2011**

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H04L 1/02 (2006.01)

(52) **U.S. Cl.** **375/267; 375/259; 375/260**

(58) **Field of Classification Search** **375/267**
See application file for complete search history.

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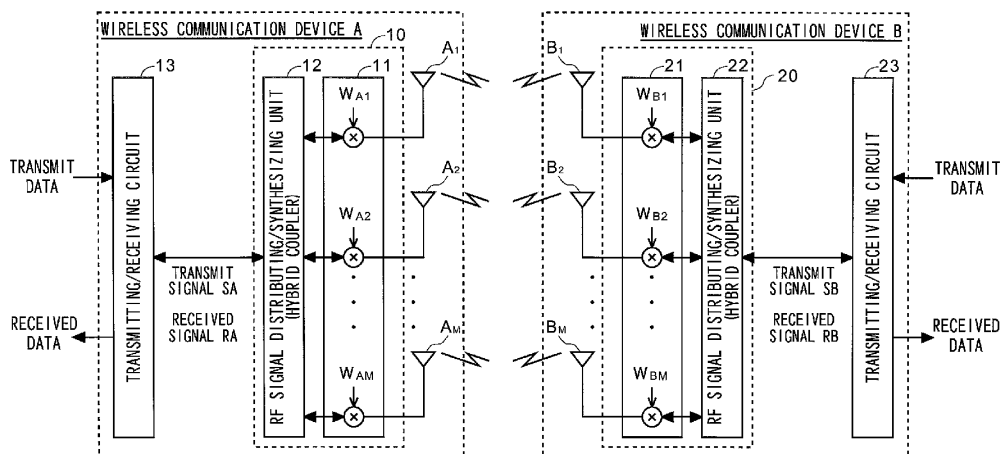
Primary Examiner — Erin File

(74) Attorney, Agent, or Firm — Westerman, Hattori, Daniels & Adrian, LLP

(57) **ABSTRACT**

Wireless communication devices A and B perform wireless communication with the MIMO technology. The wireless communication devices A and B determine the optimal diversity combining information that optimizes a diversity reception state through a two-way training signal transfer. This determination can be made based on reception level information, baseband reception IQ information, correlation information between a diversity-combining received signal and a predetermined information sequence, or the like, which are obtained when the diversity combining information with respect to each antenna is sequentially changed. The optimal diversity combining information can be determined by receiving training frames or symbols (the number of antennas+1) times.

20 Claims, 33 Drawing Sheets



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US008385845B1

(12) **United States Patent**
Cortese

(10) **Patent No.:** **US 8,385,845 B1**
(45) **Date of Patent:** **Feb. 26, 2013**

(54) **SHUNT DEVICE FOR SWITCH**

(56) **References Cited**

(75) Inventor: **Philippe Cortese**, Longwood, FL (US)

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(73) Assignee: **Triquint Semiconductor, Inc.**,
Hillsboro, OR (US)

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

Primary Examiner — Nay A Maung

Assistant Examiner — Angelica Perez

(74) *Attorney, Agent, or Firm* — Schwabe Williamson & Wyatt

(21) Appl. No.: **12/577,101**

(57) **ABSTRACT**

(22) Filed: **Oct. 9, 2009**

Embodiments include but are not limited to apparatuses and systems including a first active device located on a signal path between an antenna terminal and a transmit and/or receive (T/R) terminal, and a self-biasing shunt device coupled to the first active device and including a second active device having a DC-blocked source terminal and a non-DC-blocked drain terminal. Other embodiments may be described and claimed.

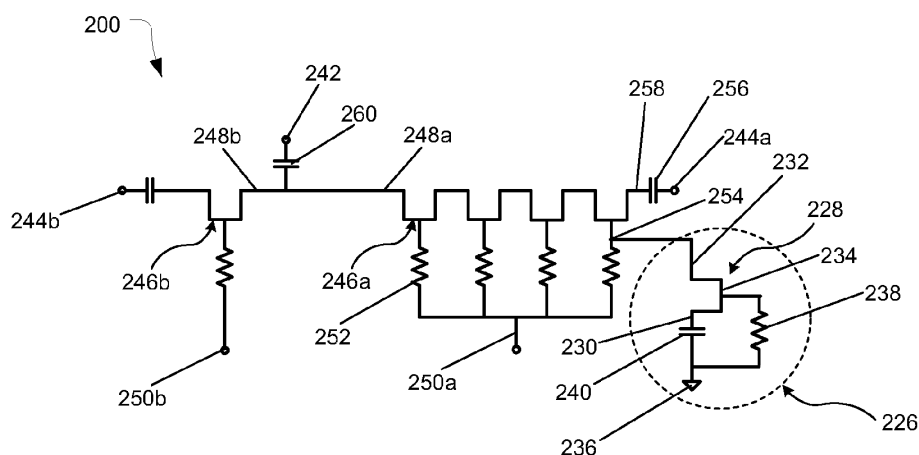
(51) **Int. Cl.**
H04B 1/44 (2006.01)

(52) **U.S. Cl.** **455/78; 455/79; 455/83**

(58) **Field of Classification Search** 455/78,
455/83, 79–82; 370/278, 282

See application file for complete search history.

20 Claims, 5 Drawing Sheets



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US008385847B2

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

(10) **Patent No.:** **US 8,385,847 B2**
(45) **Date of Patent:** ***Feb. 26, 2013**

(54) **SWITCHING ELEMENT, ANTENNA SWITCH CIRCUIT AND RADIO FREQUENCY MODULE USING THE SAME**

(75) Inventors: **Takashi Ogawa**, Tokyo (JP); **Shinichiro Takatani**, Koganei (JP); **Shigeki Koya**, Kokubunji (JP); **Hiroyuki Takazawa**, Hino (JP); **Shinya Osakabe**, Maebashi (JP); **Akishige Nakajima**, Higashiyamato (JP); **Yasushi Shigeno**, Maebashi (JP)

(73) Assignee: **Renesas Electronics Corporation**, Kanagawa (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.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/929,940**

(22) Filed: **Feb. 25, 2011**

(65) **Prior Publication Data**

US 2011/0156983 A1 Jun. 30, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/805,409, filed on Jul. 29, 2010, now Pat. No. 7,899,412, which is a continuation of application No. 12/314,644, filed on Dec. 15, 2008, now Pat. No. 7,783,265, which is a continuation of application No. 11/291,815, filed on Dec. 2, 2005, now abandoned.

(30) **Foreign Application Priority Data**

Dec. 7, 2004 (JP) 2004-353715

(51) **Int. Cl.**
H04B 1/44 (2006.01)

(52) **U.S. Cl.** **455/83; 455/82; 455/13.3; 455/78; 343/876**

(58) **Field of Classification Search** 455/83, 455/82, 13.3, 78, 19, 562.1, 575.7; 343/876; 257/192, 72, 59

See application file for complete search history.

(56) **References Cited**

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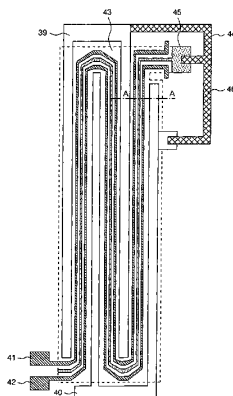
Primary Examiner — Minh D Dao

(74) *Attorney, Agent, or Firm* — Stites & Harbison, PLLC; Juan Carlos A. Marquez, Esq.; Stephen J. Weyer, Esq.

(57) **ABSTRACT**

A switching element is provided that realizes an stabilize a potential between the gates of the multi-gates without an increase in the insertion loss, and an antenna switch circuit and a radio frequency module each using the switch element. The switching element includes two ohmic electrodes **39**, **40** formed on a semiconductor substrate, at least two gate electrodes **41**, **42** disposed between the two ohmic electrodes, and a conductive region **45** disposed between the adjacent gate electrodes among the at least two gate electrodes, a field effective transistor being structured by the two ohmic electrodes, the at least two gate electrodes, and the conductive region. The conductive region has a wider portion that is wider in width than the conductive region interposed between the adjacent gate electrodes on one end thereof. The distance between the adjacent gate electrodes is narrower than the width of the wider portion. Resistors **44**, **46** are connected in series between the two ohmic electrodes through the wider portion.

20 Claims, 17 Drawing Sheets



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US008387232B2

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

(10) **Patent No.:** **US 8,387,232 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **METHOD OF MANUFACTURING ANTENNA FORMED WITH CASE**

(75) Inventors: **Ha Ryong Hong**, Gyeonggi-do (KR); **Jae Suk Sung**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**, 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 0 days.

(21) Appl. No.: **13/345,907**

(22) Filed: **Jan. 9, 2012**

(65) **Prior Publication Data**

US 2012/0104652 A1 May 3, 2012

Related U.S. Application Data

(62) Division of application No. 12/171,064, filed on Jul. 10, 2008, now Pat. No. 8,120,539.

(30) **Foreign Application Priority Data**

Jul. 11, 2007 (KR) 10-2007-69566

(51) **Int. Cl.**

H01P 11/00 (2006.01)

H01Q 13/00 (2006.01)

(52) **U.S. Cl.** **29/600**; 343/702; 343/873

(58) **Field of Classification Search** 29/600, 29/592.1, 830-832; 343/700 MS, 868
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Minh Trinh

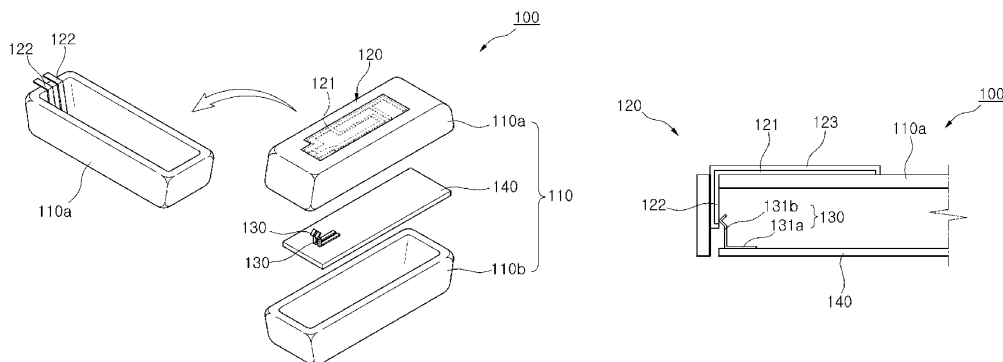
(74) *Attorney, Agent, or Firm* — Lowe Hauptman Ham & Berner, LLP

(57)

ABSTRACT

There is provided an antenna integrally formed with a case and a method of manufacturing the same. An antenna integrally formed with a case according to an aspect of the invention includes: a case unit formed of a dielectric material; a radiator including a radiation unit tightly fixed to an outer surface of the case unit and terminal units each extending from an end portion of the radiation unit, passing through the case unit, and exposed on the inside of the case unit; and contact pins provided on a board disposed adjacent to the case unit and electrically connected to the individual terminal units.

11 Claims, 8 Drawing Sheets



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US008390394B2

(12) **United States Patent**
Ando

(10) **Patent No.:** **US 8,390,394 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **HIGH FREQUENCY SWITCH**

(56) **References Cited**

(75) Inventor: **Akira Ando**, Urayasu (JP)

(73) Assignee: **Soshin Electric Co., Ltd.**, Saku (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 341 days.

(21) Appl. No.: **12/746,288**

(22) PCT Filed: **Dec. 18, 2008**

(86) PCT No.: **PCT/JP2008/073042**

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

(87) PCT Pub. No.: **WO2009/078456**

PCT Pub. Date: **Jun. 25, 2009**

(65) **Prior Publication Data**

US 2010/0253445 A1 Oct. 7, 2010

(30) **Foreign Application Priority Data**

Dec. 19, 2007 (JP) 2007-327418
Mar. 28, 2008 (JP) 2008-085927

(51) **Int. Cl.**
H01P 1/10 (2006.01)
H01P 1/15 (2006.01)

(52) **U.S. Cl.** 333/103; 333/104

(58) **Field of Classification Search** 333/101,
333/103, 104

See application file for complete search history.

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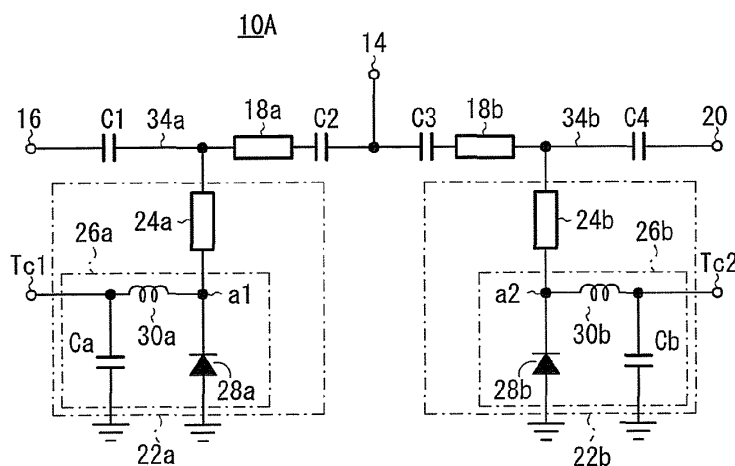
Primary Examiner — Dean O Takaoka

(74) *Attorney, Agent, or Firm* — Burr & Brown

(57) **ABSTRACT**

Disclosed is a high frequency switch wherein a first switch circuit is connected in series to a first $\lambda/4$ signal transmission path connected between an antenna connecting terminal and a transmission terminal. In the first switch circuit, a first $\lambda/4$ transmission path and a first parallel resonant circuit, which includes one first PIN diode, are connected in series. In a first inductor of the first parallel resonant circuit, a constant is set so that a resonance frequency of the first parallel resonant circuit and the center frequency of a first antenna switch are the same when the first PIN diode is turned off.

7 Claims, 20 Drawing Sheets



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US008390517B2

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

(10) **Patent No.:** **US 8,390,517 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **WIRELESS SIGNAL ANTENNA**

(75) Inventors: **Yuh-Yuh Chiang**, Taipei (TW);
Shang-Ching Tseng, Taipei (TW)

(73) Assignee: **Wistron NeWeb Corp.**, Hsichih, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 384 days.

(21) Appl. No.: **12/623,979**

(22) Filed: **Nov. 23, 2009**

(65) **Prior Publication Data**

US 2010/0127941 A1 May 27, 2010

(30) **Foreign Application Priority Data**

Nov. 21, 2008 (TW) 97145112 A

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

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

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

(56) **References Cited**

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Primary Examiner — Trinh Dinh

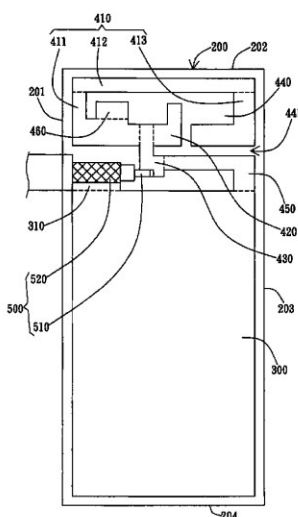
(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, PLLC

(57) **ABSTRACT**

The invention discloses a wireless signal antenna including a substrate, a grounding element, a metal radiator element, a signal transmission line, and a ground connection part. The metal radiator element includes a first radiator unit, a second radiator unit, and a signal feed-in point. The ground connection part is electrically connected to the signal feed-in point and the grounding element. The first radiator unit is disposed on the substrate and bent to include a first radiator part, a second radiator part, and a third radiator part, wherein at least a part of the first radiator unit is disposed along edges of the substrate. The second radiator unit is disposed between the first radiator unit and the grounding element. The signal transmission line includes a signal line and a ground line respectively connected to the signal feed-in point and a layout area of the grounding element. The signal transmission line receives electrical signals from a signal source and then excites the metal radiator element to generate a first frequency band mode and a second frequency band mode.

11 Claims, 5 Drawing Sheets

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US008390519B2

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

(10) **Patent No.:** **US 8,390,519 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **DUAL-FEED DUAL BAND ANTENNA
ASSEMBLY AND ASSOCIATED METHOD**

(75) Inventors: **Dong Wang**, Waterloo (CA); **Qinjiang Rao**, Waterloo, CA (US)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 494 days.

(21) Appl. No.: **12/683,965**

(22) Filed: **Jan. 7, 2010**

(65) **Prior Publication Data**

US 2011/0163922 A1 Jul. 7, 2011

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 1/24 (2006.01)

H01Q 5/01 (2006.01)

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

(58) **Field of Classification Search** 343/700 MS,
343/702, 826, 828, 829, 846, 858, 725, 729
See application file for complete search history.

(56) **References Cited**

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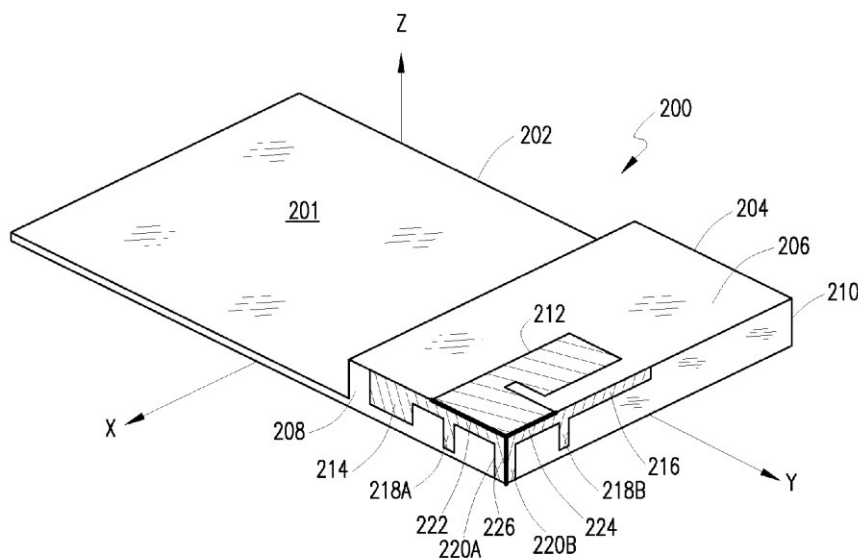
Primary Examiner — Michael C Wimer

(74) *Attorney, Agent, or Firm* — The Danamraj Law Group, P.C.

(57) **ABSTRACT**

A dual-feed port dual band (DFDB) antenna module comprising a first antenna element disposed on a first planar surface, a second antenna element disposed on a second planar surface, and a third antenna element disposed on a third planar surface. A first feed port is coupled to a first transceiver circuit adapted to operate in a first band and a second feed port is coupled to a second transceiver circuit adapted to operate in the first band and to a receiver circuit adapted to operate in a second band. The first and second feed ports are oriented substantially orthogonal with respect to each other.

13 Claims, 9 Drawing Sheets



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US008390522B2

(12) United States Patent
Sorvala et al.**(10) Patent No.: US 8,390,522 B2****(45) Date of Patent: *Mar. 5, 2013****(54) ANTENNA, COMPONENT AND METHODS****(75) Inventors:** **Juha Sorvala**, Oulu (FI); **Petteri Annamaa**, Oulunsalo (FI); **Kimmo Koskineniemi**, 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 0 days.

This patent is subject to a terminal disclaimer.

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(21) Appl. No.: 13/215,021**(22) Filed: Aug. 22, 2011****(65) Prior Publication Data**

US 2012/0068889 A1 Mar. 22, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/871,481, filed on Aug. 30, 2010, which is a continuation of application No. 11/648,429, filed on Dec. 28, 2006, now Pat. No. 7,786,938.

(30) Foreign Application Priority DataJun. 28, 2004 (FI) 20040892
Aug. 18, 2004 (FI) 20041088
Mar. 16, 2005 (WO) PCT/FI2005/050089
Jun. 28, 2005 (WO) PCT/FI2005/050247**(51) Int. Cl.**
H01Q 1/38 (2006.01)**(52) U.S. Cl.** **343/700 MS****(58) Field of Classification Search** 343/700, 343/702, 846

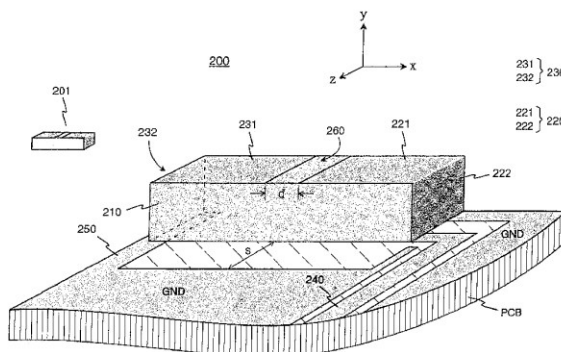
See application file for complete search history.

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Primary Examiner — Tho G Phan**(74) Attorney, Agent, or Firm** — Gazdzinski & Associates, PC**(57) ABSTRACT**

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

73 Claims, 5 Drawing Sheets

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US008390523B2

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

(10) **Patent No.:** **US 8,390,523 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **PLANAR INVERTED-F ANTENNA AND WIRELESS NETWORK DEVICE HAVING THE SAME**

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

(75) Inventors: **Yu-Jen Wang**, Taipei (TW); **Wei-Bin Lee**, Taipei (TW)

(56) **References Cited**

(73) Assignee: **Cameo Communications Inc** (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 337 days.

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Primary Examiner — Hoang V Nguyen

(21) Appl. No.: **12/807,585**

(22) Filed: **Sep. 8, 2010**

(65) **Prior Publication Data**

US 2011/0304510 A1 Dec. 15, 2011

(30) **Foreign Application Priority Data**

Jun. 9, 2010 (TW) 99210938 U

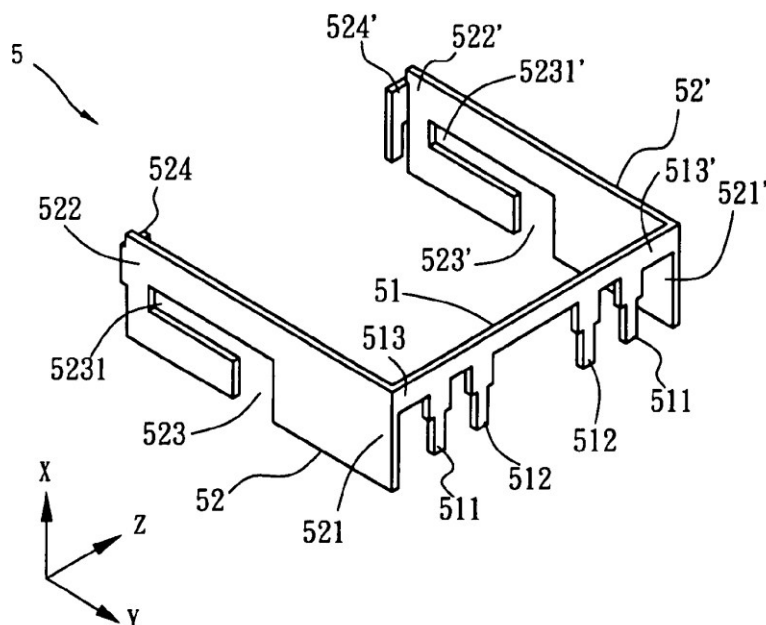
(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)

(57) **ABSTRACT**

A planar inverted-F antenna for use in a wireless network device comprises a connecting member and two radiators. The connecting member has at least one input end and at least one ground end. Each radiator has a first end portion perpendicularly connected to one of the two ends of the connecting member, and the two radiators are parallel and correspond in shape to each other. Each radiator further has an L-shaped notch and thus forms a barb. A second end portion of each radiator is bent to form an engaging end which is generally parallel to the connecting member and configured to fasten with a substrate of the wireless network device.

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

18 Claims, 11 Drawing Sheets



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

- (54) **PCB SPIRAL ANTENNA AND FEED NETWORK FOR ELINT APPLICATIONS**
- (75) Inventors: **Lee M. Paulsen**, Cedar Rapids, IA (US);
Richard A. Freeman, Cedar Rapids, IA (US); **James B. West**, Cedar Rapids, IA (US)
- (73) Assignee: **Rockwell Collins, Inc.**, Cedar Rapids, IA (US)
- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 406 days.
- (21) Appl. No.: **12/822,339**
- (22) Filed: **Jun. 24, 2010**
- (51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 1/50 (2006.01)
- (52) **U.S. Cl.** **343/895; 343/700 MS**
- (58) **Field of Classification Search** **343/767, 343/770, 895, 700 MS**
- See application file for complete search history.

Primary Examiner — Don Le

(74) *Attorney, Agent, or Firm* — Donna P. Suchy; Daniel M. Barbieri

(57) **ABSTRACT**

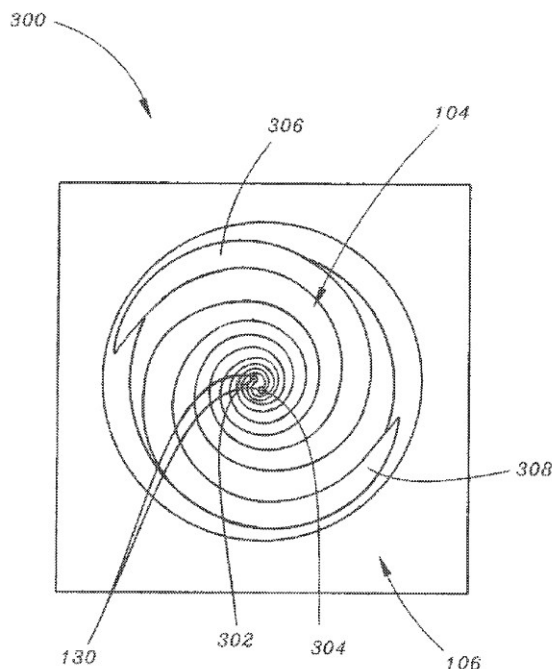
The present invention is directed to an integrated antenna and feed network assembly. The integrated antenna and feed network assembly includes a spiral antenna which is suitable for implementation with ELINT DF systems. The integrated antenna and feed network assembly further includes a feed network, which may include a stripline Balun feed. The feed network is electrically connected to the antenna. Further, the integrated antenna and the feed network assembly provides for integration of the antenna and the feed network into a single PCB assembly.

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18 Claims, 3 Drawing Sheets



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US008391806B2

(12) **United States Patent**
Muhammad

(10) **Patent No.:** **US 8,391,806 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **WIRELESS COMMUNICATIONS DEVICE
WITH AN ADJUSTABLE IMPEDANCE
MATCHING NETWORK AND ASSOCIATED
METHODS**

(75) Inventor: **Khurram Muhammad**, Irving, TX (US)

(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 255 days.

(21) Appl. No.: **12/984,170**

(22) Filed: **Jan. 4, 2011**

(65) **Prior Publication Data**

US 2012/0171970 A1 Jul. 5, 2012

(51) **Int. Cl.**
H04B 1/02 (2006.01)
H04K 3/00 (2006.01)

(52) **U.S. Cl.** **455/107**; 343/850

(58) **Field of Classification Search** 455/107,
455/126; 333/24 R, 109; 343/850, 860
See application file for complete search history.

(56) **References Cited**

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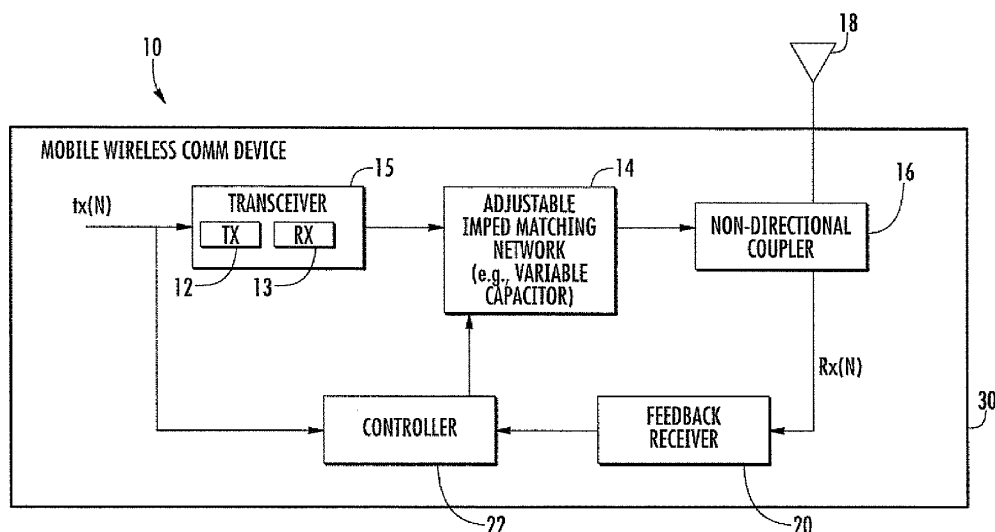
Primary Examiner — Lee Nguyen

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

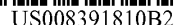
(57) **ABSTRACT**

A mobile wireless communications device includes a portable housing, a transmitter carried by the portable housing and configured to modulate an input signal, and an adjustable impedance matching network coupled downstream from the transmitter. An antenna is coupled downstream from the adjustable impedance matching network, and a non-directional coupler is coupled between the adjustable impedance matching network and the antenna. A feedback receiver is coupled to the non-directional coupler to generate a feedback signal. A controller is configured to control the adjustable impedance matching network based upon the input signal and the feedback signal.

28 Claims, 6 Drawing Sheets



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(10) **Patent No.:** US 8,391,810 B2
(45) **Date of Patent:** *Mar. 5, 2013

- (58) **Field of Classification Search** 455/67.11,
455/67.14, 69, 115.2, 423-424, 522, 552.1,
455/553.1

See application file for complete search history.

- (56)
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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 240 days.

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Primary Examiner — Lee Nguyen

- (74) *Attorney, Agent, or Firm* — Thomas|Horstemeyer, LLP.

- (21) Appl. No.: 12/837,102

- (22) Filed: **Jul. 15, 2010**

- (65) **Prior Publication Data**

US 2010/0279633 A1 Nov. 4, 2010

Related U.S. Application Data

- (63) Continuation of application No. 11/832,609, filed on Aug. 1, 2007, now Pat. No. 7,792,502.

- (60) Provisional application No. 60/895,665, filed on Mar. 19, 2007.

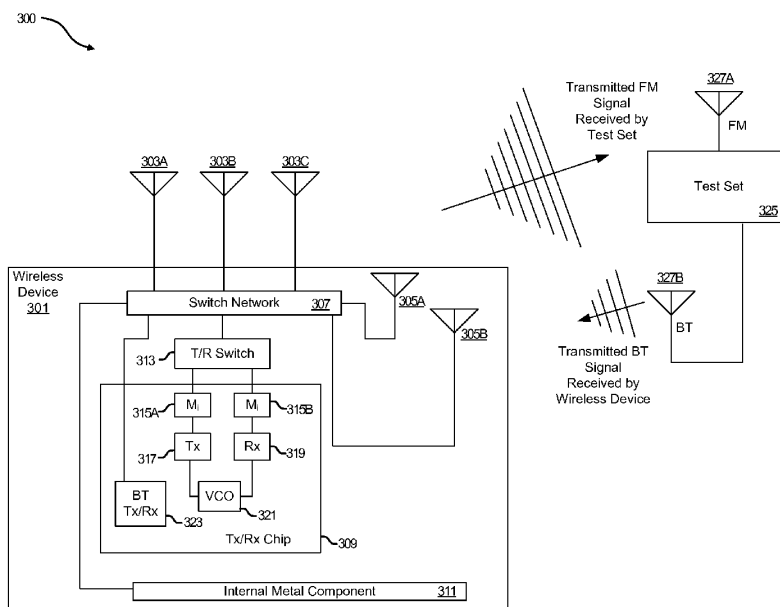
- (51) **Int. Cl.**
H03C 1/62 (2006.01)
H04K 3/00 (2006.01)

- (52) **U.S. Cl.** **455/115.2**; 455/67.14; 455/69;
455/423

(57) **ABSTRACT**

A method and system for wireless communication is provided and may include transmitting FM radio signals utilizing antenna configurations in a wireless device including a frequency modulation (FM) radio transmitter, an FM radio receiver, and one or more other receivers. The transmitter may be calibrated based on a signal received from a second wireless device via the other receivers. The second wireless device may include an FM radio receiver and corresponding other transmitters that may utilize other wireless protocols. The signal received at the wireless device may be generated at the second wireless device via the other transmitters. A frequency of the transmitted FM radio signals may be varied, and may be utilized adjust the antenna configurations. An impedance of the antenna configurations may be matched based on the frequency variation. A capacitive and/or inductive load for the matching of the impedance of the antenna configurations may be programmably adjusted.

23 Claims, 9 Drawing Sheets



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US008391817B2

(12) **United States Patent**
Noel

(10) **Patent No.:** **US 8,391,817 B2**
(45) **Date of Patent:** **Mar. 5, 2013**

(54) **METHOD OF AND SYSTEM FOR TUNING AN ANTENNA**

(75) Inventor: **Denis Noel**, Grez-Doiceau (BE)

(73) Assignee: **NXP B.V.**, Eindhoven (NL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 190 days.

(21) Appl. No.: **13/001,568**

(22) PCT Filed: **May 19, 2009**

(86) PCT No.: **PCT/IB2009/052071**

§ 371 (c)(1),

(2), (4) Date: **Dec. 27, 2010**

(87) PCT Pub. No.: **WO2009/156879**

PCT Pub. Date: **Dec. 30, 2009**

(65) **Prior Publication Data**

US 2011/0111706 A1 May 12, 2011

(30) **Foreign Application Priority Data**

Jun. 27, 2008 (EP) 08104565

(51) **Int. Cl.**

H04B 1/18 (2006.01)

H04K 3/00 (2006.01)

(52) **U.S. Cl.** **455/193.1**; 455/226.1

(58) **Field of Classification Search** 455/193.1–193.3,
455/226.2

See application file for complete search history.

(56) **References Cited**

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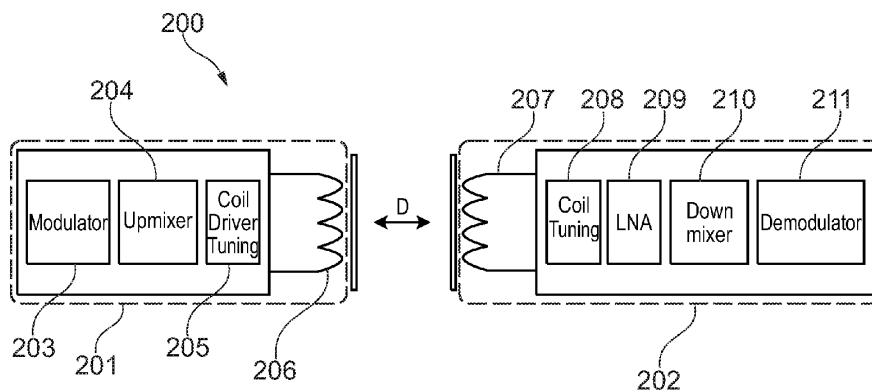
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Primary Examiner — Lee Nguyen

(57) **ABSTRACT**

A method of tuning an antenna is provided, wherein the method comprises receiving a first signal strength indicator indicating a signal strength of a first data signal transmitted by an antenna on a first frequency, receiving a second signal strength indicator indicating a signal strength of a second data signal transmitted by the antenna on a second frequency different to the first frequency, determining a tuning control signal based on the first signal strength indicator and the second signal strength indicator, and tuning the antenna based on the control signal.

19 Claims, 4 Drawing Sheets



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US008391927B2

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

(10) **Patent No.:** **US 8,391,927 B2**

(45) **Date of Patent:** ***Mar. 5, 2013**

(54) **MULTIPLE MODE RF TRANSCEIVER AND
ANTENNA STRUCTURE**

(75) Inventors: **Jesus Alfonso Castaneda**, Los Angeles,
CA (US); **Franco De Flaviis**, Irvine, CA
(US); **Ahmadreza (Reza) Rofougaran**,
Newport Coast, CA (US)

(73) Assignee: **Broadcom Corporation**, Irvine, 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.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **12/814,441**

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

(65) **Prior Publication Data**

US 2010/0245191 A1 Sep. 30, 2010

Related U.S. Application Data

(63) Continuation of application No. 11/443,946, filed on
May 30, 2006, now Pat. No. 7,761,115.

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

(52) **U.S. Cl.** **455/562.1**; 455/66.1; 455/561;
455/447; 455/277.1; 455/69; 455/63.4; 455/135;
343/895; 343/702; 343/821; 343/873; 375/346;
330/301

(58) **Field of Classification Search** 455/562.1,
455/561, 447, 69, 63.4, 277.1, 135, 66.1;
330/301; 343/895, 702, 821, 873, 700 MS,
343/846; 375/346; 340/572.1, 10.41

See application file for complete search history.

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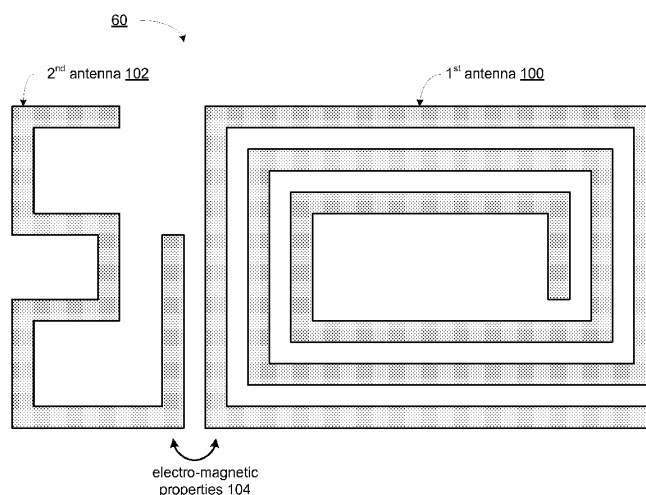
Primary Examiner — Marceau Milord

(74) *Attorney, Agent, or Firm* — Garlick & Markison; Kevin
L. Smith

(57) **ABSTRACT**

An antenna structure includes first and second antennas. The first antenna has a first geometry corresponding to a first frequency. The second antenna has a second geometry corresponding to a second frequency. The second antenna is proximal to the first antenna and utilizes electrical-magnetic properties of the first antenna to transceive signals at the second frequency.

20 Claims, 10 Drawing Sheets



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US008395549B2

(12) **United States Patent**
Liu

(10) **Patent No.:** **US 8,395,549 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **TRIPLE BAND ANTENNA**

(75) Inventor: **Ming-Yen Liu**, Taipei (TW)

(73) Assignee: **ASUSTek Computer Inc.**, Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 330 days.

(21) Appl. No.: **12/212,056**

(22) Filed: **Sep. 17, 2008**

(65) **Prior Publication Data**

US 2009/0184876 A1 Jul. 23, 2009

(30) **Foreign Application Priority Data**

Jan. 22, 2008 (TW) 97102350 A

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

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

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

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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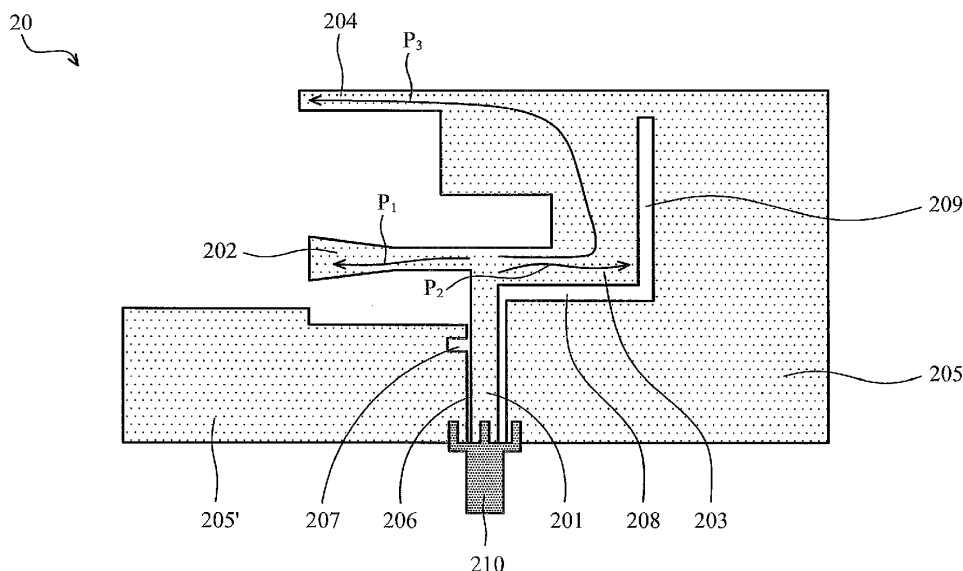
Primary Examiner — Hoang V Nguyen

Assistant Examiner — Kyana R Robinson

(57) **ABSTRACT**

A triple band antenna includes a feed-in portion, a first radiating portion, a second radiating portion, a third radiating portion and a grounding portion. The first radiating portion is connected to a first side of a first end of the feed-in portion. A second end of the second radiating portion is connected to a second side of the first end of the feed-in portion. The third radiating portion is connected to a third end of the second radiating portion. The grounding portion is located at two sides of the feed-in portion.

19 Claims, 7 Drawing Sheets



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US008395550B2

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

(10) **Patent No.:** **US 8,395,550 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **MICRO STRIP ANTENNA**

(75) Inventors: **Jeong Ki Ryoo**, Anyang (KR); **Jae Yul Choo**, Yongin (KR); **Chu Yong Lee**, Seoul (KR); **Hosung Choo**, Seoul (KR); **Ikmo Park**, Yongin (KR)

(73) Assignee: **LS Industrial Systems Co., Ltd.**, Anyang-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 483 days.

(21) Appl. No.: **12/714,393**

(22) Filed: **Feb. 26, 2010**

(65) **Prior Publication Data**
US 2011/0193747 A1 Aug. 11, 2011

(30) **Foreign Application Priority Data**
Feb. 9, 2010 (KR) 10-2010-0012070

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/38 (2006.01)
H01Q 19/00 (2006.01)

(52) **U.S. Cl.** **343/700 MS**; 343/833; 343/810; 343/853; 343/829; 343/846

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

(56) **References Cited**

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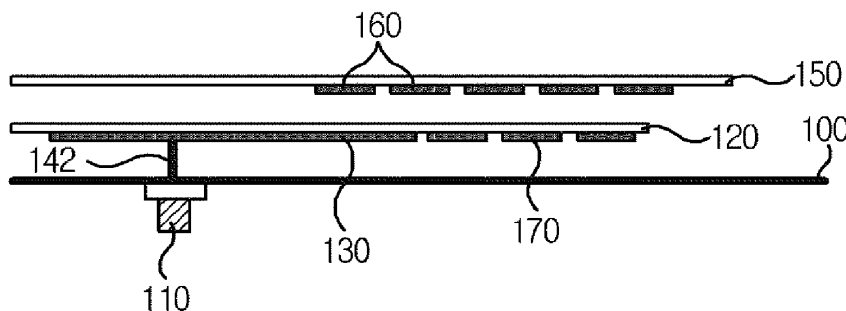
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey

(57) **ABSTRACT**

The invention provides a micro strip antenna used for both a near-field region and a remote-field region. A micro strip antenna comprises: a first dielectric substrate; a main patch, having a triangle shape under the first dielectric substrate, configured to feed a radiation current; a second dielectric substrate over the first dielectric substrate; and a sub patch, formed under the second dielectric substrate, configured to desert a current from the main patch to provide a vertical magnetic field.

6 Claims, 13 Drawing Sheets



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US008395551B2

(12) **United States Patent**
Huang

(10) **Patent No.:** **US 8,395,551 B2**

(45) **Date of Patent:** **Mar. 12, 2013**

(54) **ANTENNA MODULE AND ELECTRONIC
DEVICE USING THE SAME**

(75) Inventor: **Chin-Ting Huang**, Taipei (TW)

(73) Assignee: **Pegatron Corporation**, Beitou District,
Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 367 days.

(21) Appl. No.: **12/843,059**

(22) Filed: **Jul. 26, 2010**

(65) **Prior Publication Data**

US 2011/0037663 A1 Feb. 17, 2011

(30) **Foreign Application Priority Data**

Aug. 13, 2009 (TW) 98127291 A

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

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

(58) **Field of Classification Search** **343/700 MS,**
343/702, 846, 895

See application file for complete search history.

(56) **References Cited**

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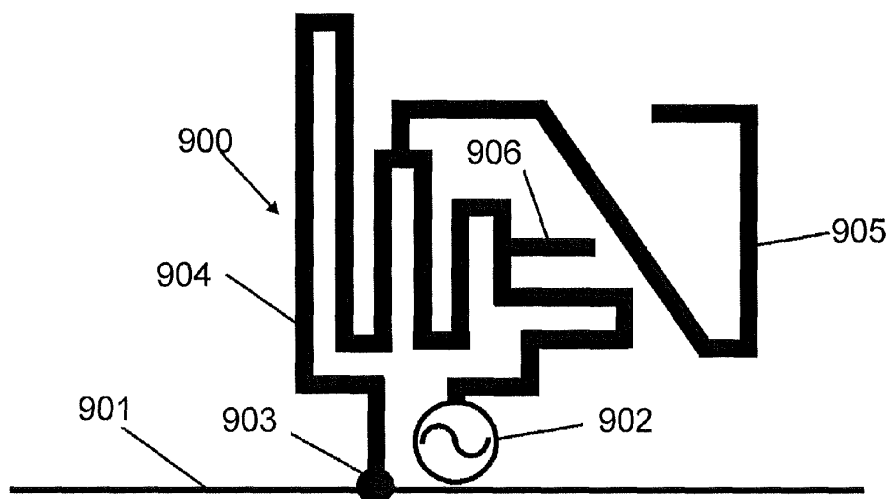
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

This invention provides an antenna module and an electronic device using the same. The antenna module includes a signal feeding part, a ground part, and a first asymmetric meander line. One terminal of the first asymmetric meander line is connected with the signal feeding part, the other terminal is connected with the ground part, and the first asymmetric meander line does not meander toward its inner side. A signal is fed in via the signal feeding part to allow the first asymmetric meander line to excite a first resonance frequency. An area of the antenna module in the invention is smaller than that of a conventional planar antenna, and the antenna module can generate an inductive effect to improve antenna radiation efficiency. Besides, since the area of the antenna module is small, a metal electronic component in the electronic device and the antenna module won't overlap thus to reduce interference.

24 Claims, 9 Drawing Sheets



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US008395552B2

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

(10) **Patent No.:** **US 8,395,552 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **ANTENNA MODULE HAVING REDUCED SIZE, HIGH GAIN, AND INCREASED POWER EFFICIENCY**

(75) Inventors: **Anton L. Geiler**, Chestnut Hill, MA (US); **Carmine Vittoria**, Charlestown, MA (US); **Vincent G. Harris**, Sharon, MA (US)

(73) Assignees: **Metamagnetics, Inc.**, Canton, MA (US); **Northeastern University**, Boston, MA (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.: **13/301,377**

(22) Filed: **Nov. 21, 2011**

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

(60) Provisional application No. 61/416,679, filed on Nov. 23, 2010.

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

(52) **U.S. Cl.** **343/700 MS; 343/767; 343/787**

(58) **Field of Classification Search** **343/700 MS, 343/767, 770, 787**
See application file for complete search history.

(56) **References Cited**

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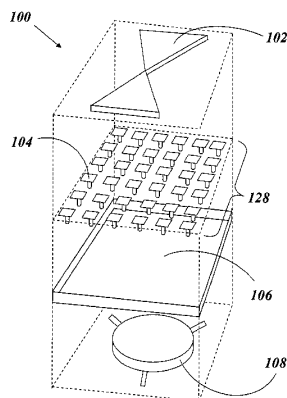
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Lisa M. Treannie, Esq.; Sean D. Detweiler, Esq.; Morse, Barnes-Brown & Pendleton, P.C.

(57) **ABSTRACT**

A broadband integrated circulator antenna (BICA) module for receiving and transmitting signals with high efficiency and high gain. The BICA can have a bandwidth of over 70% of a radar band and can operate in frequencies from UHF to S-band and above. The BICA has a stack configuration that includes a low profile antenna, a reflecting layer or a metamaterial substrate layer, and a circulator. The circulator is placed proximal to antenna, which greatly reduces the size of the BICA. The circulator can be a stripline Y-junction ferrite circulator and the antenna can be a coaxial center fed bow-tie antenna. The reflecting layer or metamaterial substrate layer can comprise electronic bandgap metamaterial and a high permeability ferrite substrate. The high permeability ferrite substrate can be cobalt substituted Z-type barium hexaferrite.

10 Claims, 11 Drawing Sheets



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US008395553B2

(12) **United States Patent**
Oh

(10) **Patent No.:** **US 8,395,553 B2**

(45) **Date of Patent:** **Mar. 12, 2013**

(54) **MOBILE TERMINAL HAVING ANTENNA MOUNTED IN FLEXIBLE PCB OF SIDE KEY**

(75) Inventor: **Hyun Jong Oh**, Daegu (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 293 days.

(21) Appl. No.: **12/386,283**

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

(65) **Prior Publication Data**

US 2009/0278752 A1 Nov. 12, 2009

(30) **Foreign Application Priority Data**

May 8, 2008 (KR) 10-2008-0042656

(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, 906, 720, 872**

See application file for complete search history.

(56) **References Cited**

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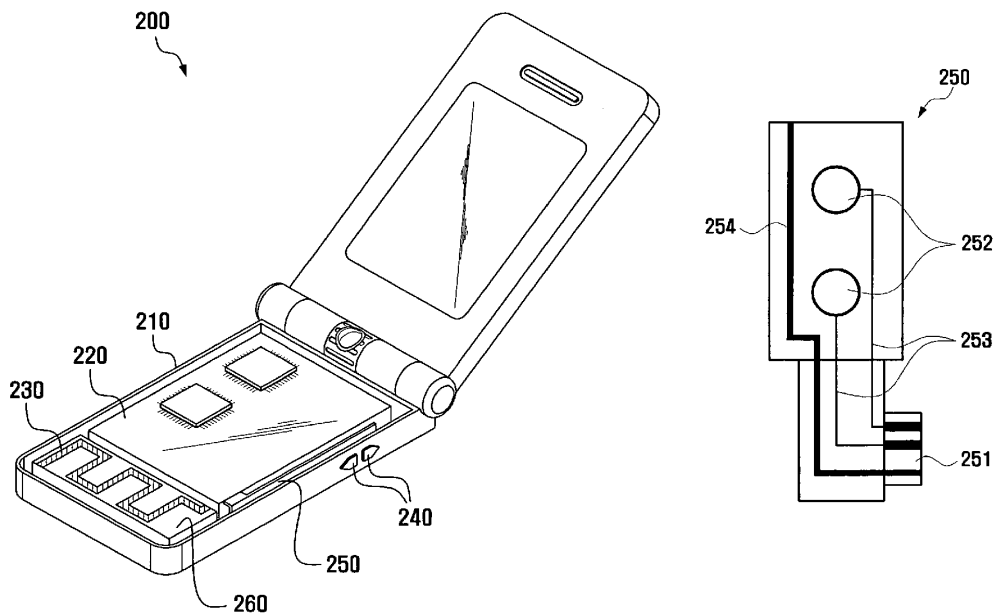
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Primary Examiner — Tan Ho

(57) **ABSTRACT**

A mobile terminal wherein a second antenna is mounted in a flexible PCB of a side key positioned at a location separated from a first antenna is provided. The mobile terminal includes: a main body; the first antenna and a printed circuit board (PCB) positioned on the inside of the main body; a side key positioned at a side surface of the outside of the main body; and a flexible PCB of the side key positioned on the inside of the main body. The flexible PCB of the side key including the second antenna. Therefore, by mounting a second antenna in a flexible PCB of a side key positioned at a location separated from a first antenna, an emission and reception performance of the first antenna and the second antenna can be improved.

20 Claims, 4 Drawing Sheets



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US00839554B2

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

(10) **Patent No.:** **US 8,395,554 B2**

(45) **Date of Patent:** **Mar. 12, 2013**

(54) **ANTENNA APPARATUS AND MOBILE
TERMINAL HAVING THE SAME**

(75) Inventors: **Jae Min Seo**, Gyeonggi-do (KR); **Hyun
Soo Kim**, Seoul (KR); **Jae Sun Park**,
Gyeonggi-do (KR)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **12/796,923**

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

(65) **Prior Publication Data**

US 2011/0006954 A1 Jan. 13, 2011

(30) **Foreign Application Priority Data**

Jul. 13, 2009 (KR) 10-2009-0063369

(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

See application file for complete search history.

(56) **References Cited**

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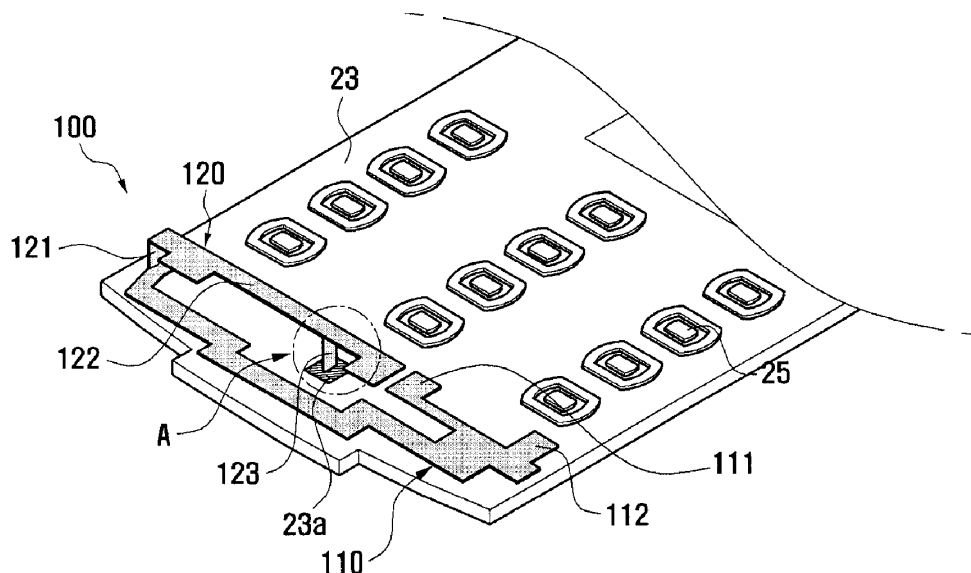
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

An antenna apparatus and a mobile terminal having the same are disclosed. The antenna apparatus includes: a first antenna portion patterned at one surface of the electronic circuit board; and a can type second antenna portion electrically connected to one end of the first antenna portion and separated from the one surface of the electronic circuit board, wherein one end of the second antenna portion is connected to the one end of the first antenna portion using a SMD method and the other end of the second antenna portion is connected to the one surface of the electronic circuit board using a SMD method through a floating pad formed in the one surface of the electronic circuit board.

13 Claims, 7 Drawing Sheets



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US00839555B2

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

(10) **Patent No.:** **US 8,395,555 B2**
(45) **Date of Patent:** ***Mar. 12, 2013**

(54) **WIRELESS HANDHELD ELECTRONIC
DEVICE**

(75) Inventors: **Phillip M. Hobson**, Menlo Park, CA
(US); **Stephen P. Zadesky**, Portola
Valley, CA (US); **Erik L. Wang**,
Redwood City, CA (US); **Tang Yew Tan**,
San Francisco, CA (US); **Richard Hung**
Minh Dinh, San Jose, CA (US); **Adam**
D. Mittleman, San Francisco, CA (US);
Kenneth A. Jenks, Cupertino, CA (US);
Robert J. Hill, Salinas, 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 0 days.

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **13/008,586**

(22) Filed: **Jan. 18, 2011**

(65) **Prior Publication Data**
US 2011/0109516 A1 May 12, 2011

Related U.S. Application Data

(63) Continuation of application No. 12/142,552, filed on
Jun. 19, 2008, now Pat. No. 7,876,274.

(60) Provisional application No. 60/936,796, filed on Jun.
21, 2007.

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

(52) **U.S. Cl.** **343/702**; 343/846; 455/575.7

(58) **Field of Classification Search** 343/700 MS,
343/702, 718, 846, 741, 767, 905, 906; 455/575.7
See application file for complete search history.

(56) **References Cited**

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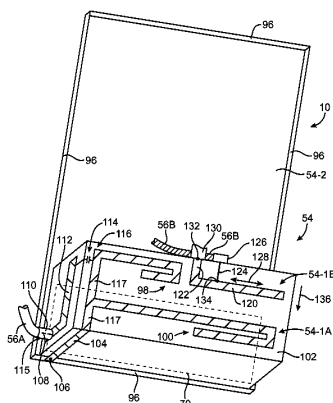
Primary Examiner — Michael C Wimer

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

(57) **ABSTRACT**

A handheld electronic device may be provided that contains a
conductive housing and other conductive elements. The con-
ductive 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 compo-
nents may be isolated from the antenna using isolation ele-
ments such as inductors and resistors.

18 Claims, 38 Drawing Sheets



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US008395557B2

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

(10) **Patent No.:** **US 8,395,557 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **BROADBAND ANTENNA HAVING
ELECTRICALLY ISOLATED FIRST AND
SECOND ANTENNAS**

(75) Inventors: **Matthew G. Goins**, San Marcos, CA
(US); **Allan C. Goetz**, La Jolla, CA (US)

(73) Assignee: **Northrop Grumman Systems
Corporation**, Falls Church, VA (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 1871 days.

(21) Appl. No.: **11/741,466**

(22) Filed: **Apr. 27, 2007**

(65) **Prior Publication Data**
US 2012/0229361 A1 Sep. 13, 2012

(51) **Int. Cl.**
H01Q 1/28 (2006.01)
H01Q 9/16 (2006.01)

(52) **U.S. Cl.** **343/708; 343/793; 343/700 MS;**
343/893; 343/850

(58) **Field of Classification Search** 343/708,
343/712, 793, 700 MS, 795, 801, 826, 829
See application file for complete search history.

(56) **References Cited**

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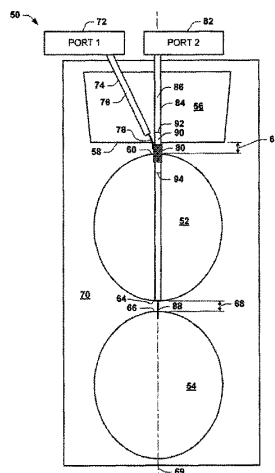
Primary Examiner — Hoang V Nguyen
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — Tarolli, Sundheim, Covell
& Tummino LLP

(57) **ABSTRACT**

A broadband antenna includes a first antenna element having first and second ends spaced apart by a surface thereof. A second antenna element is substantially co-planar with the first antenna element, the second antenna element having first and second ends spaced apart by a surface thereof. The first end of the second antenna element is spaced apart from the second end of the first antenna element by a first air gap. A conductive structure is spaced apart from the first end of the first antenna element by a second air gap, the conductive structure being configured to provide for structural excitation of the antenna over a lower frequency range of an available broadband antenna bandwidth, such as may be a continuous operating bandwidth.

14 Claims, 5 Drawing Sheets



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US008395561B2

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

(10) **Patent No.:** **US 8,395,561 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **DUAL POLARIZATION BROADBAND ANTENNA HAVING WITH SINGLE PATTERN**

(75) Inventors: **Joo Sung Park**, Incheon-shi (KR); **Jae Sun Jin**, Incheon-shi (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 435 days.

(21) Appl. No.: **12/296,105**

(22) PCT Filed: **Apr. 2, 2007**

(86) PCT No.: **PCT/KR2007/001597**

§ 371 (c)(1),

(2), (4) Date: **Oct. 3, 2008**

(87) PCT Pub. No.: **WO2007/114620**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 3, 2006 (KR) 10-2006-0030232

Mar. 14, 2007 (KR) 10-2007-0025085

(51) **Int. Cl.**

H01Q 9/26 (2006.01)

H01Q 21/26 (2006.01)

H01Q 9/28 (2006.01)

H01Q 21/20 (2006.01)

H01Q 1/38 (2006.01)

(52) **U.S. Cl.** **343/803; 343/797; 343/795; 343/798; 343/799; 343/804; 343/700 MS**

(58) **Field of Classification Search** **343/797, 343/795, 798, 799, 803, 804, 700 MS**

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Jacob Y Choi

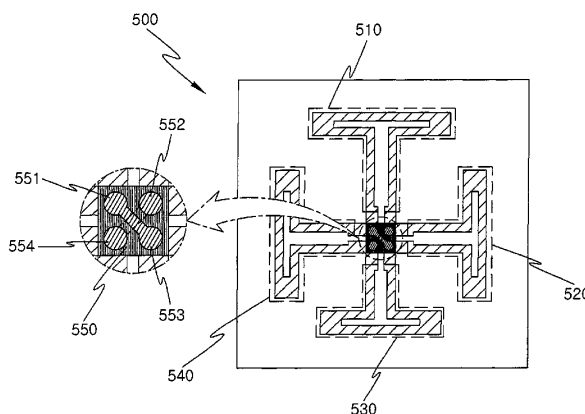
Assistant Examiner — Graham Smith

(74) Attorney, Agent, or Firm — LRK Patent Law Firm

(57) **ABSTRACT**

The present invention relates to a dual polarization broadband antenna having a single pattern, which is provide with a radiation device having a square structure, in which a plurality of folded dipole elements are formed in a single continuously-connected pattern, and a feeding portion for feeding signals to the plurality of folded dipole elements is formed on the radiation device. Accordingly, the plurality of folded dipole elements formed on the radiation device are connected in a single square and rectangular pattern, so that the structure thereof is simplified, with the result that the cost can be reduced. Furthermore, the feeding portion, that dually feeds signals, and the plurality of folded dipole elements, connected in a single pattern, are coupled, so that the dual polarization characteristic can be easily acquired. Furthermore, currents input to the feeding points of the feeding portion are induced only to the folded dipole elements without having to flow into other feeding points, so that excellent isolation can be achieved.

6 Claims, 11 Drawing Sheets



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US008395562B2

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

(10) **Patent No.:** **US 8,395,562 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

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

(75) Inventors: **Cho-Kang Hsu**, Tu-Cheng (TW);
Yi-Ting Chen, 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 352 days.

(21) Appl. No.: **12/844,989**

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

May 25, 2010 (TW) 99116597

(51) **Int. Cl.**
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(52) **U.S. Cl.** **343/803; 343/793; 343/866**

(58) **Field of Classification Search** 343/793-795,
343/866, 842
See application file for complete search history.

(56) **References Cited**

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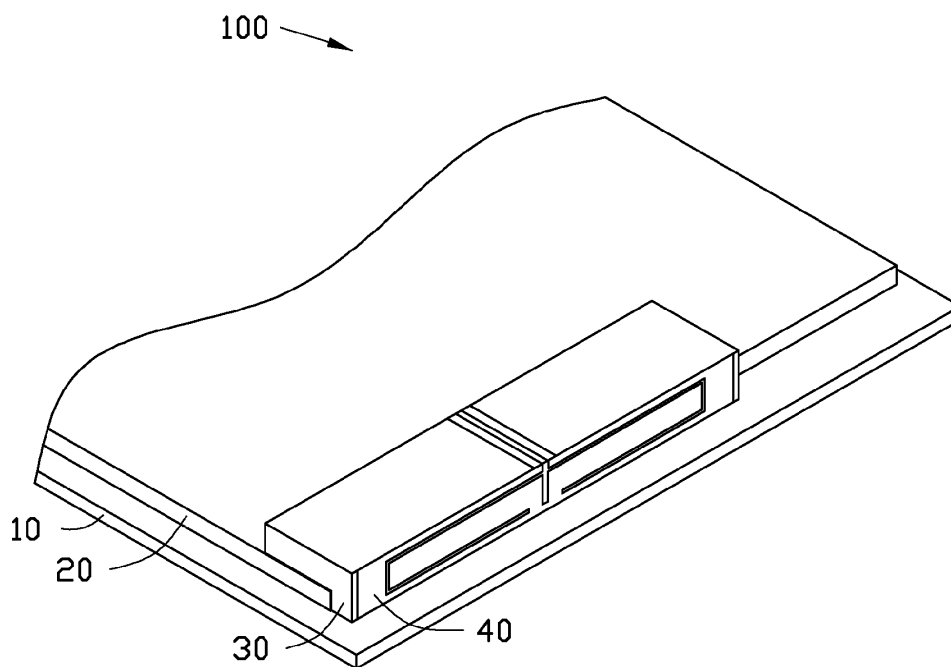
Primary Examiner — James H Cho

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

(57) **ABSTRACT**

An antenna module for a portable electronic device includes a loop portion, a dipole portion, a feeding end portion and a grounding end portion. The dipole portion is positioned in the loop portion and connected to the loop portion. The feeding end portion and the grounding end portion are connected to the loop portion.

16 Claims, 7 Drawing Sheets



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US008396516B2

(12) **United States Patent**
Rogo

(10) **Patent No.:** **US 8,396,516 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **SINGLE-ANTENNA VEHICLE
TRANSPONDER WITH A POWER-SAVE
FUNCTION**

(75) Inventor: **Johan Rogo**, Habo (SE)

(73) Assignee: **Kapsch TrafficCom AB** (SE)

(*) 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.: **13/252,904**

(22) Filed: **Oct. 4, 2011**

(65) **Prior Publication Data**

US 2012/0083227 A1 Apr. 5, 2012

(30) **Foreign Application Priority Data**

Oct. 5, 2010 (EP) 10186530

(51) **Int. Cl.**
H04B 1/38 (2006.01)
H04B 1/16 (2006.01)

(52) **U.S. Cl.** **455/574**; 455/343.1; 455/343.5

(58) **Field of Classification Search** 455/41.1,
455/41.2, 343.1, 343.2, 343.5, 127.1, 127.5,
455/574; 340/10.1, 10.3

See application file for complete search history.

(56) **References Cited**

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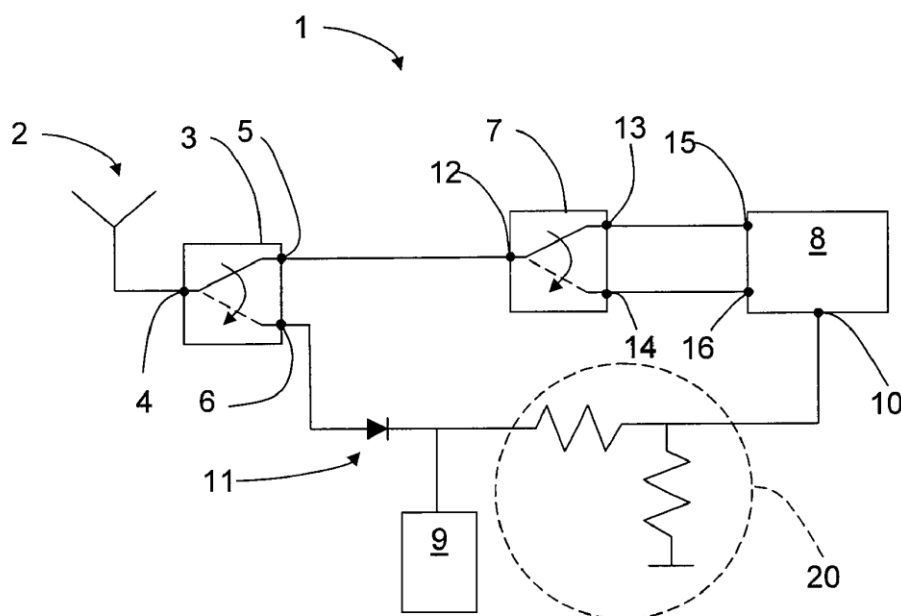
Primary Examiner — Sonny Trinh

(74) *Attorney, Agent, or Firm* — Schwegman Lundberg & Woessner, P.A.

(57) **ABSTRACT**

Embodiments of the present invention relates to a vehicle transponder comprising an active radio unit, an antenna, a wake-up unit and a power directing means which has a first port, a second port and a third port, where the power directing means is arranged to direct power from the first port to the second port and/or the third port. The antenna is connected to the first port and the second port is connected to the radio unit. Furthermore, the third port is connected both to a power detection port at the radio unit and to the wake-up unit, such that during a first mode of operation, a part of a signal that is transmitted from the radio unit to the antenna is coupled from the second port to the third port and further fed to the power detection port.

9 Claims, 4 Drawing Sheets



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US008396521B2

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

(10) **Patent No.:** **US 8,396,521 B2**
(45) **Date of Patent:** **Mar. 12, 2013**

(54) **ANTENNA COVER AND OPERATING SECTION FOR PORTABLE TERMINAL DEVICE**

(75) Inventors: **Hiroki Horimoto**, Tokyo (JP); **Ryo Tsuchiya**, Tokyo (JP); **Ryota Matsumoto**, Tokyo (JP); **Nobuhiro Oguma**, Saitama (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 267 days.

(21) Appl. No.: **12/614,055**

(22) Filed: **Nov. 6, 2009**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 3, 2008 (JP) 2008-308971

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

(52) **U.S. Cl.** **455/575.7; 455/575.1**

(58) **Field of Classification Search** 455/550.1, 455/90.3, 575.5, 556.1-556.2, 562.1, 575.1-575.8
See application file for complete search history.

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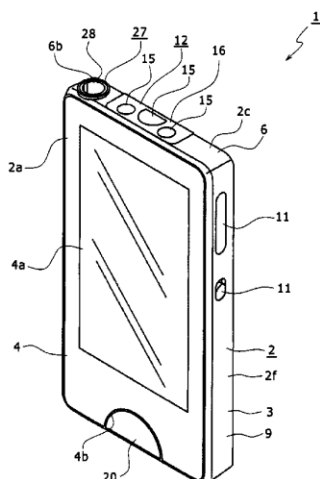
Primary Examiner — Brandon Miller

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

(57) **ABSTRACT**

Disclosed herein is a portable terminal device including an antenna, a casing, and an operation unit. The casing at least part of which is formed from a metallic material is disposed so that the antenna is exposed. The operation unit is formed from a resin material and mounted to the casing so as to cover the exposed antenna.

9 Claims, 24 Drawing Sheets



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US008397997B2

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

(10) **Patent No.:** **US 8,397,997 B2**

(45) **Date of Patent:** **Mar. 19, 2013**

(54) **REMOVABLE MEDIA SPINDLE AND
ANTENNA ASSEMBLY FOR PRINTER**

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

(21) Appl. No.: **13/356,014**

(22) Filed: **Jan. 23, 2012**

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

(63) Continuation of application No. 11/833,714, filed on
Aug. 3, 2007, now Pat. No. 8,127,991.

(51) **Int. Cl.**
G06K 19/06 (2006.01)

(52) **U.S. CL.** **235/492**; 235/375; 235/439; 235/451;
235/487; 343/876; 343/893

(58) **Field of Classification Search** 235/375,
235/439, 451, 487, 492; 343/876, 893
See application file for complete search history.

(56) **References Cited**

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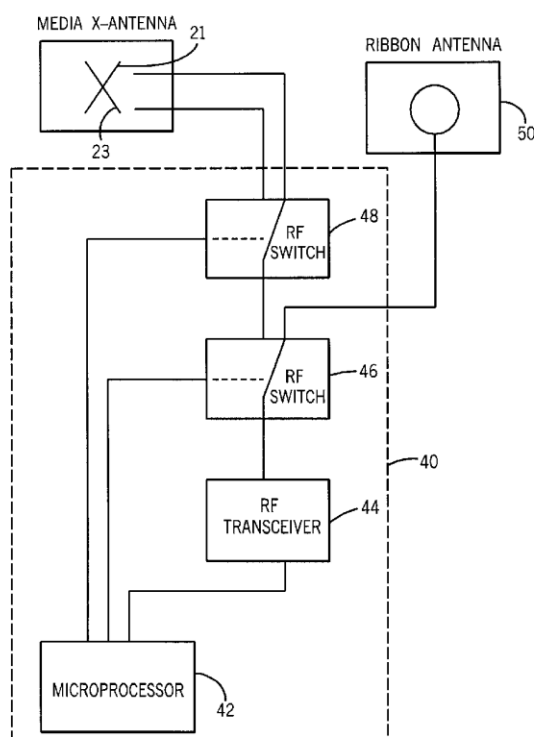
Primary Examiner — Allyson Trail

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

(57) **ABSTRACT**

A removable spindle for use in a thermal transfer printer houses dual RFID reader antennas that are used to read an RFID tag attached to the core of the print media. The information provided by the RFID tag enables the printer to self-calibrate based on the type of media loaded. The antenna design eliminates “null” areas at which the tag cannot be read, and enables the tag to be read around and across the entire length of the printer spindle. The design also allows the media holder to be easily removed from the printer.

12 Claims, 7 Drawing Sheets



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US008398209B2

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

(10) **Patent No.:** **US 8,398,209 B2**
(45) **Date of Patent:** **Mar. 19, 2013**

(54) **INTEGRATED STRUCTURE OF A PRINTER
HEAD AND AN ANTENNA**

(75) Inventors: **Feng-Yi Tai**, Chung-Ho (TW);
Ta-Cheng Hsiung, Hsinchu (TW)

(73) Assignee: **Godex International 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 748 days.

(21) Appl. No.: **12/617,699**

(22) Filed: **Nov. 12, 2009**

(65) **Prior Publication Data**

US 2011/0109671 A1 May 12, 2011

(51) **Int. Cl.**
B41J 2/14 (2006.01)
B41J 2/16 (2006.01)

(52) **U.S. Cl.** **347/50; 347/58**

(58) **Field of Classification Search** 347/2, 20,
347/49, 50, 56-59

See application file for complete search history.

(56) **References Cited**

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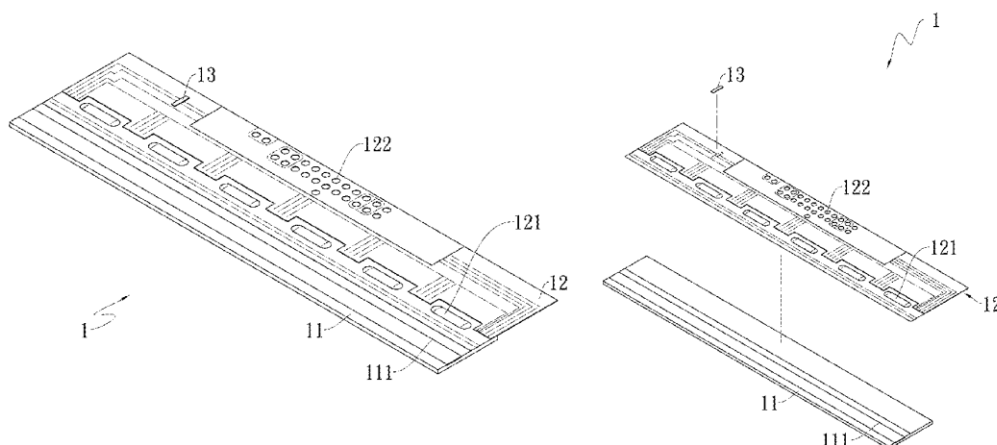
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Primary Examiner — Juanita D Jackson

(57) **ABSTRACT**

An integrated structure of an inkjet head and an antenna includes a metal heat dissipation board, a flexible (or rigid) circuit board and an antenna module. The metal heat dissipation has an elongated printing ribbon. The flexible (or rigid) circuit board is mounted on the metal heat dissipation board, and has one end electrically connected with the printing ribbon and the other end having a plurality of parallel circuits mounted thereon and connected to external control circuits. The antenna module is directly mounted on and electrically connected with the flexible (or rigid) circuit board. Given the integrated structure, the antenna module is effectively mounted on the inkjet head to reduce the size of the structure and lower the cost thereof.

6 Claims, 2 Drawing Sheets



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US008400360B2

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

(10) **Patent No.:** **US 8,400,360 B2**
(45) **Date of Patent:** **Mar. 19, 2013**

(54) **COUPLED-LOOP CHIP ANTENNA**

(56) **References Cited**

(75) Inventors: **Yueh-Lin Tsai**, Hsinchu (TW); **Meng Hsueh Tsai**, Hsinchu (TW); **Chin Huang Cheng**, Hsinchu (TW)

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(73) Assignee: **Inpaq Technology Co., Ltd.** (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 744 days.

Primary Examiner — Robert Karacsony

(74) *Attorney, Agent, or Firm* — Seyfarth Shaw, LLP

(21) Appl. No.: **12/355,147**

(57)

ABSTRACT

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

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jul. 8, 2008 (TW) 97125755 A

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

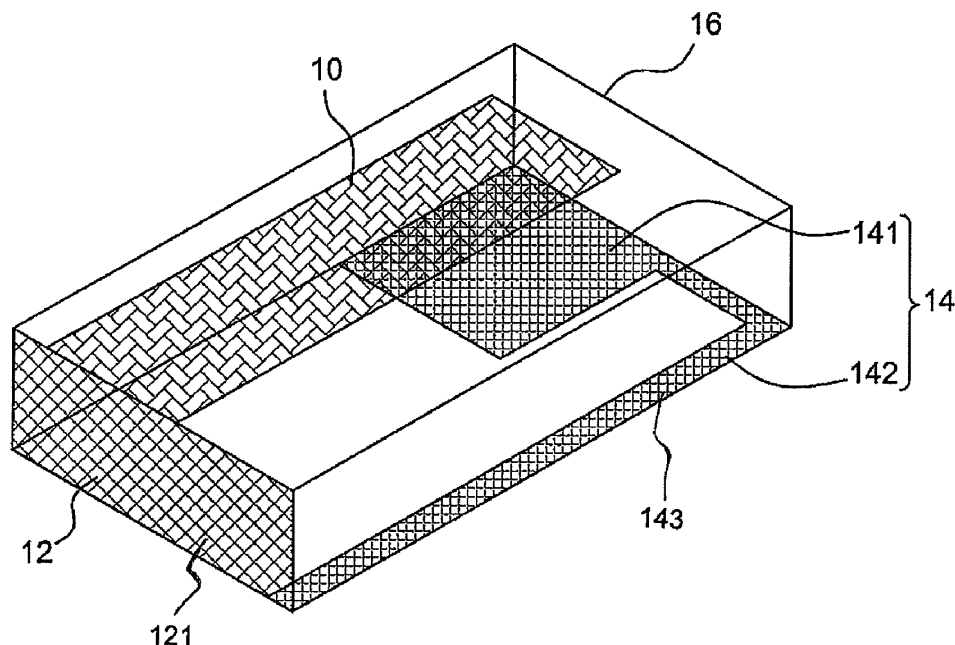
(52) **U.S. Cl.** **343/700 MS**

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

See application file for complete search history.

A loop antenna for communication is provided, which includes a microwave substrate, being a hexahedron; a first conductive layer, disposed on an upper surface of the substrate for forming a first loop; a second conductive layer, disposed on a first side surface of the substrate, and electrically connected to a feed-in point and a ground point; and a third conductive layer, disposed on a lower surface of the substrate for forming a second loop. The first conductive layer and the second conductive layer are electrically connected at the junction between the upper surface and the first side surface, and the second conductive layer and the third conductive layer are electrically connected at the junction between the first side surface and the lower surface. The antenna also has an appropriate bandwidth for wireless communication application.

3 Claims, 4 Drawing Sheets



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US008400361B2

(12) **United States Patent**
Rofougaran

(10) **Patent No.:** **US 8,400,361 B2**
(45) **Date of Patent:** **Mar. 19, 2013**

(54) **INTEGRATED CIRCUIT MEMS ANTENNA STRUCTURE**

(75) Inventor: **Ahmadreza Rofougaran**, Newport Coast, CA (US)

(73) Assignee: **Broadcom Corporation**, Irvine, 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.: **13/538,647**

(22) Filed: **Jun. 29, 2012**

(65) **Prior Publication Data**

US 2012/0280873 A1 Nov. 8, 2012

Related U.S. Application Data

(63) Continuation of application No. 11/648,828, filed on Dec. 29, 2006, now Pat. No. 8,232,919.

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

(52) **U.S. CL.** **343/700 MS; 343/873**
(58) **Field of Classification Search** **343/700 MS,**
343/873, 772, 753, 909, 773, 793, 840

See application file for complete search history.

(56) **References Cited**

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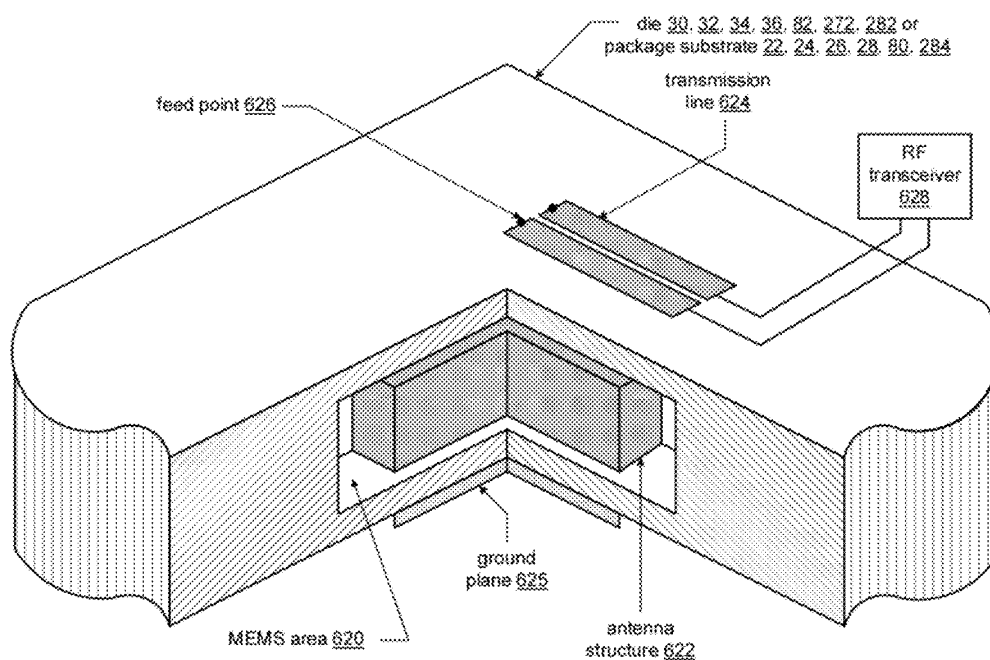
Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Garlick & Markison; Holly L. Rudnick

(57) **ABSTRACT**

An integrated circuit (IC) antenna structure includes a micro-electromechanical (MEM) area, a feed point, and a transmission line. The micro-electromechanical (MEM) area includes a three-dimensional shape, wherein the three dimensional-shape provides an antenna structure. The feed point is coupled to provide an outbound radio frequency (RF) signal to the antenna structure for transmission and to receive an inbound RF signal from the antenna structure. The transmission line electrically coupled to the feed point.

20 Claims, 38 Drawing Sheets



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US008400364B2

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

(10) **Patent No.:** **US 8,400,364 B2**
(45) **Date of Patent:** **Mar. 19, 2013**

(54) **MULTIBAND PLANAR ANTENNA AND ELECTRONIC EQUIPMENT**

(75) Inventors: **Yuki Kotaka**, Tachikawa (JP); **Shigeru Yagi**, Tokyo (JP)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 389 days.

(21) Appl. No.: **12/776,583**

(22) Filed: **May 10, 2010**

(65) **Prior Publication Data**

US 2010/0302111 A1 Dec. 2, 2010

(30) **Foreign Application Priority Data**

May 27, 2009 (JP) 2009-127122

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

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

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

See application file for complete search history.

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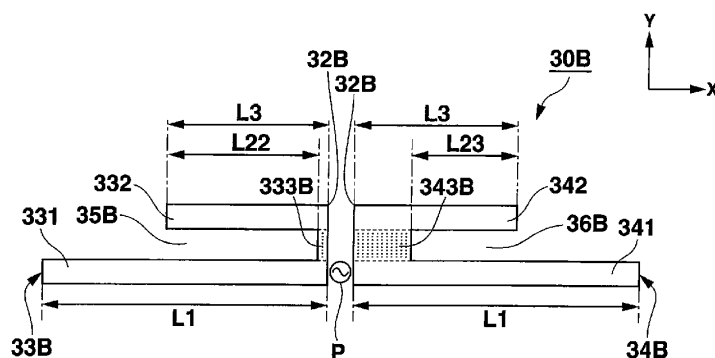
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

Disclosed is a multiband planar antenna including: an insulating film, a first antenna section and a second antenna section facing to the first antenna section across a feeding point on a film, wherein the first antenna section includes: a first antenna element including a side having a length in an extending direction corresponds to a first resonance frequency; a shorter second antenna element at a predetermined distance from and in parallel with the first antenna element; and a first coupling section to couple the first and second antenna elements, wherein a length in the extending direction of a first clearance corresponds to a resonance frequency higher than the first resonance frequency, and wherein the second antenna section includes: third and fourth antenna elements; a second coupling section; and a second clearance similar to the above.

5 Claims, 15 Drawing Sheets



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US008400369B2

(12) **United States Patent**
Shoji

(10) **Patent No.:** **US 8,400,369 B2**
(45) **Date of Patent:** **Mar. 19, 2013**

(54) **MULTIBAND ANTENNA AND RADIO COMMUNICATION TERMINAL**

(75) Inventor: **Hideaki Shoji**, Chiba (JP)

(73) Assignee: **Sony Mobile Communication Japan, Inc.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 303 days.

(21) Appl. No.: **12/473,682**

(22) Filed: **May 28, 2009**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 25, 2008 (JP) 2008-166421

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

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

(58) **Field of Classification Search** 343/745, 749, 702, 861, 853
See application file for complete search history.

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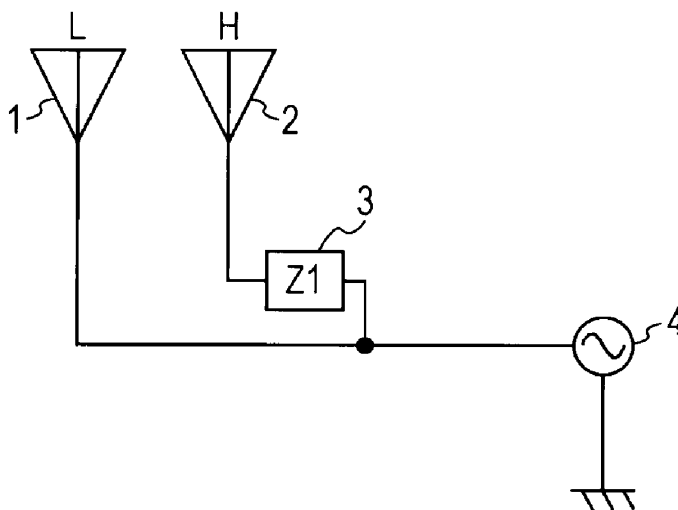
Primary Examiner — Huedung Mancuso

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

(57) **ABSTRACT**

A multiband antenna includes at least two antenna elements for use in a low frequency band and a high frequency band, a feeding point unit configured to be shared by both of the antenna elements for use in the low frequency band and the high frequency band and an impedance matching unit configured to be inserted into and connected to a position between an end of the antenna element for use in the high frequency band on the side of the feeding point unit and an open end thereof.

7 Claims, 6 Drawing Sheets



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