



US008593348B2

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

(10) **Patent No.:** **US 8,593,348 B2**

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

(54) **DISTRIBUTED COUPLING ANTENNA**

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(75) Inventors: **Steve Krupa**, Tiberias (IL); **Snir Azulay**, Tiberias (IL)

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(73) Assignee: **Galtronics Corporation Ltd.**, Tiberias (IL)

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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 82 days.

(21) Appl. No.: **13/203,109**

(22) PCT Filed: **Apr. 7, 2010**

(86) PCT No.: **PCT/IL2010/000291**

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(2), (4) Date: **Nov. 4, 2011**

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PCT Pub. Date: **Oct. 14, 2010**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/167,247, filed on Apr. 7, 2009.

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

(52) **U.S. Cl.**
USPC **343/700 MS**; 343/745; 343/846;
343/860

(58) **Field of Classification Search**
USPC 343/700 MS, 745, 846, 850, 860
See application file for complete search history.

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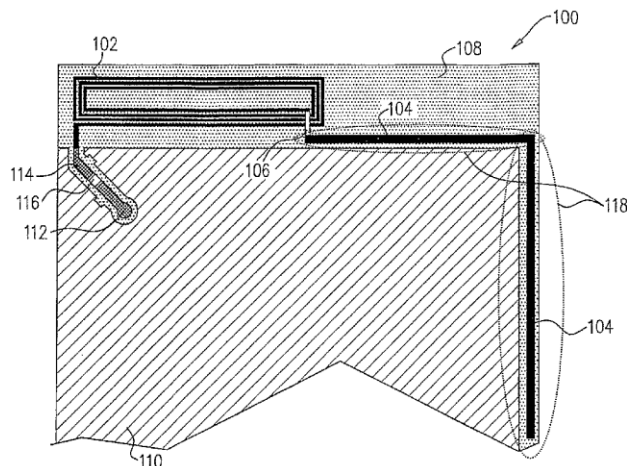
Primary Examiner — David G Phan

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

(57) **ABSTRACT**

An antenna including a ground plane region, a feed element having associated with it a first reactance and a coupling element having associated with it a second reactance, the second reactance being of opposite sign to the first reactance, the coupling element being coupled to the feed element and to the ground plane region and being located in close proximity to the ground plane region, wherein an impedance and hence a resonant frequency of the antenna depend on the first and second reactances.

29 Claims, 3 Drawing Sheets





US008593351B2

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

(10) **Patent No.:** **US 8,593,351 B2**
(45) **Date of Patent:** **Nov. 26, 2013**

(54) **PORTABLE ELECTRONIC DEVICE**

(75) Inventors: **Shih-Wei Hsieh**, Taipei (TW);
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(73) Assignee: **Mediatek Inc.**, Hsin-Chu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 355 days.

(21) Appl. No.: **12/855,608**

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

(65) **Prior Publication Data**

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

(52) **U.S. Cl.**
USPC **343/702**; 343/895; 343/818

(58) **Field of Classification Search**
USPC 343/702, 895, 783, 817-819, 872, 878,
343/700 MS

See application file for complete search history.

(56) **References Cited**

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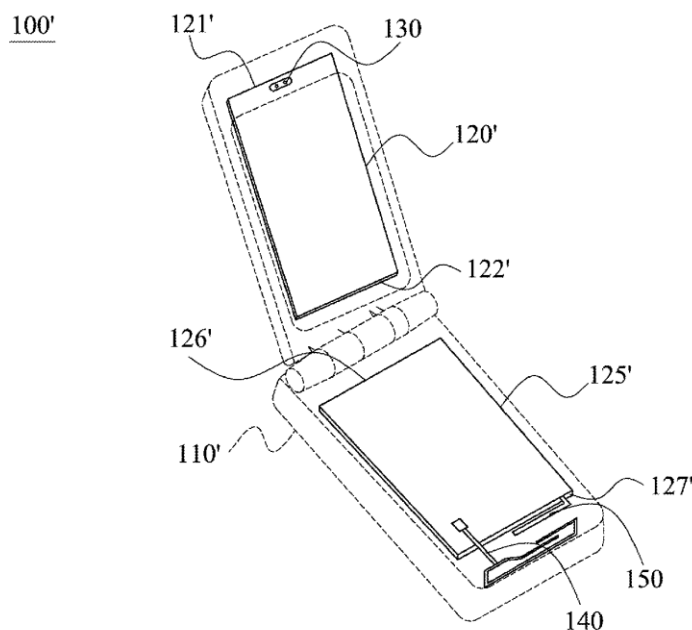
Primary Examiner — Daniel D Chang

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

(57) **ABSTRACT**

A portable electronic device is provided. The portable electronic device includes a housing, a circuit board, an amplifier, an antenna and a short element. The circuit board is disposed in the housing, wherein the circuit board includes a first edge and a second edge, and the first edge is opposite to the second edge. The amplifier is disposed on the circuit board and adjacent to the first edge. The antenna is disposed on the second edge of the circuit board, wherein the antenna transmits a wireless signal. The short element is disposed on the second edge of the circuit board, wherein the short element is separated from the antenna, and the short element couples with the antenna to reduce Specific Absorption Rate (SAR) value around the amplifier.

15 Claims, 4 Drawing Sheets





US008593352B2

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

(10) **Patent No.:** **US 8,593,352 B2**
(45) **Date of Patent:** **Nov. 26, 2013**

(54) **TRIPLE-BAND ANTENNA WITH LOW PROFILE**

(75) Inventors: **Hsien-Sheng Tseng**, Tu-Cheng (TW);
Shang-Jen Chen, Tu-Cheng (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 617 days.

(21) Appl. No.: **12/857,764**

(22) Filed: **Aug. 17, 2010**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 17, 2009 (TW) 98127534

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/48 (2006.01)

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

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 767, 846, 848
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Michael C Wimer

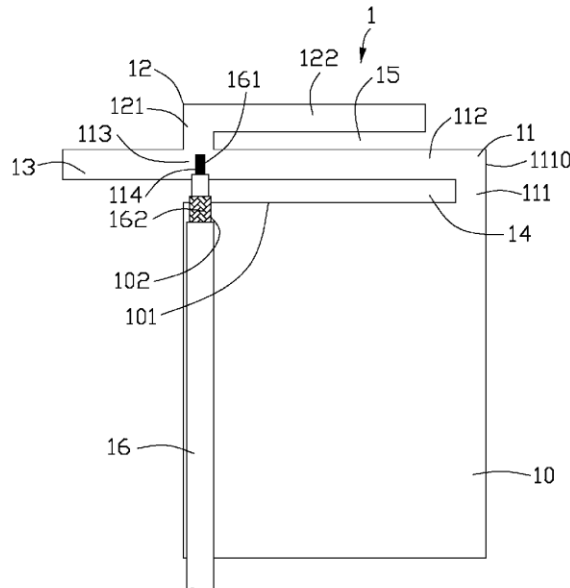
Assistant Examiner — Hasan Islam

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

(57) **ABSTRACT**

A multi-band antenna includes a grounding element having an edge and a grounding point, a first radiating arm being substantially of L shape and located above the grounding element, a second radiating arm working at a first frequency band and being substantially of L shape above the first radiating arm, a third radiating arm working at a second frequency band and being substantially of rectangular metal patch parallel to the edge of the grounding element, and a feeding line including an inner conductor connected to the first radiating arm and an outer conductor connected to the grounding point of the grounding element. The feeding line, the first radiating arm, the grounding element commonly compose a slot operating at a third frequency band.

20 Claims, 3 Drawing Sheets





US008593353B2

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

(10) **Patent No.:** **US 8,593,353 B2**
(45) **Date of Patent:** **Nov. 26, 2013**

(54) **ANTENNA DEVICE FOR A PORTABLE
TERMINAL**

(75) Inventors: **Joon-Ho Byun**, Suwon-si (KR);
Soon-Ho Hwang, Seoul (KR); **Mun-Il
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(KR); **Hyun-Seok Park**, Seoul (KR)

(73) Assignees: **Samsung Electronics Co., Ltd.** (KR);
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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 368 days.

(21) Appl. No.: **12/999,802**

(22) PCT Filed: **Jun. 12, 2009**

(86) PCT No.: **PCT/KR2009/003171**

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(2), (4) Date: **May 20, 2011**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jun. 19, 2008 (KR) 10-2008-0057814

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

(52) **U.S. Cl.**
USPC 343/702; 343/700 MS; 343/749

(58) **Field of Classification Search**
USPC 343/700 MS, 702, 749, 829, 846
See application file for complete search history.

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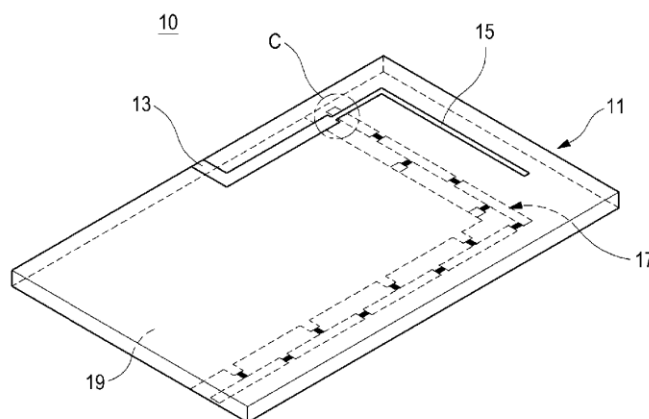
Primary Examiner — Tho G Phan

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

(57) **ABSTRACT**

An antenna device for a portable terminal includes: a ground pattern provided on one surface of a circuit board; a first antenna pattern configured to resonate at a first frequency band and provided on an opposite surface of the circuit board; and a second antenna pattern configured to resonate at a second frequency band different from the first frequency band and arranged along a periphery of the ground pattern. The second antenna pattern is a zeroth order mode resonator including a plurality of capacitors and a plurality of inductors. The antenna device easily secures the operation characteristics of different operation frequency bands and contributes to miniaturization of the portable terminal. Thus, a user can conveniently carry and use the portable terminal.

12 Claims, 7 Drawing Sheets





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

(10) **Patent No.:** **US 8,593,354 B2**

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

(54) **MULTI-BAND ANTENNA**

(75) Inventors: **Lung-Sheng Tai**, New Taipei (TW);
Chun-Ming Chiu, New Taipei (TW);
Po-Kang Ku, New Taipei (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 393 days.

(21) Appl. No.: **13/007,784**

(22) Filed: **Jan. 17, 2011**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Jan. 15, 2010 (TW) 99200813

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

(52) **U.S. Cl.**
USPC **343/702; 343/700 MS; 343/846;**
343/908

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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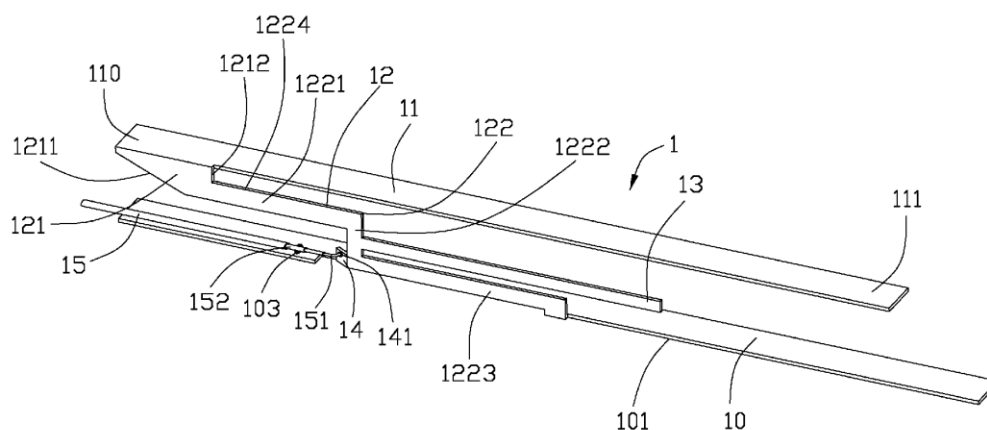
Primary Examiner — Trinh Dinh

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

(57) **ABSTRACT**

A multi-band antenna (1), comprising a grounding element (10) extending horizontally along a longitudinal direction, comprising a side edge (101) with a connecting point (102) and a grounding point (103) distanced from the connecting point by a length; a radiating element (11) disposed at an upper level parallel to the grounding element and defining a first end and a second end, and operating in a first frequency band; a connecting element (12) located between the radiating element and the grounding element, comprising a first portion (121) connecting to the first end of the radiating element and a second portion (122) linking to said connecting point of the grounding element; a parasitic element (13) extending from the second portion of the connecting element towards the second end of the radiating element along the longitudinal direction, and operating in a second frequency band; a feeding point (141) disposed on the second portion of the connecting element and under the parasitic element; and a feeding line (15) comprising an inner conductor connected to the feeding point and an outer conductor connected to the grounding point; wherein said connecting element, the grounding element, the feeding point and the grounding point together forming a slot (16) operating in a third frequency band.

20 Claims, 3 Drawing Sheets





US008593355B1

(12) **United States Patent**
Tonn

(10) **Patent No.:** **US 8,593,355 B1**
(45) **Date of Patent:** **Nov. 26, 2013**

(54) **RECONFIGURABLE BUOYANT CABLE
ANTENNA WITH IMPROVED GAIN**

(75) Inventor: **David A. Tonn**, Charlestown, RI (US)

(73) Assignee: **The United States of America as
represented by the Secretary of the
Navy**, Washington, DC (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **12/822,523**

(22) Filed: **Jun. 24, 2010**

(51) **Int. Cl.**
H01Q 1/34 (2006.01)

(52) **U.S. Cl.**
USPC **343/709**

(58) **Field of Classification Search**
USPC 343/709
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Hoang V Nguyen

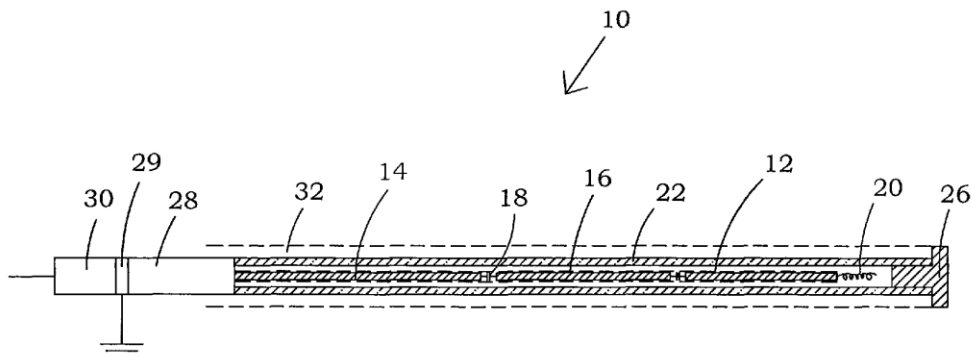
Assistant Examiner — Kyana R Robinson

(74) *Attorney, Agent, or Firm* — James M. Kasischke;
Jean-Paul A. Nasser; Michael P. Stanley

(57) **ABSTRACT**

An antenna element with a single-conductor antenna is provided within a removable core. The removable core is mounted within a hollow liner by sliding the core into the hollow liner. A pull cable may be attached to an end of the removable core to pull the core through the outboard end of the hollow liner. Due to reduced strain on the core as compared to the liner, the single-conductor antenna may be formed in segments interconnected with capacitors for adjusting the antenna gain to a maximum in the vicinity of a desired operating frequency or frequencies.

14 Claims, 4 Drawing Sheets





US008593358B2

(12) **United States Patent**
Rappaport

(10) **Patent No.:** **US 8,593,358 B2**

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

(54) **ACTIVE ANTENNAS FOR MULTIPLE BANDS
IN WIRELESS PORTABLE DEVICES**

(71) Applicant: **Theodore S. Rappaport**, Riner, VA
(US)

(72) Inventor: **Theodore S. Rappaport**, Riner, VA
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
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(21) Appl. No.: **13/713,804**

(22) Filed: **Dec. 13, 2012**

(65) **Prior Publication Data**

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Related U.S. Application Data

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Aug. 14, 2009, now Pat. No. 8,350,763.

(60) Provisional application No. 61/088,829, filed on Aug.
14, 2008.

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

(52) **U.S. Cl.**
USPC **343/745; 343/702**

(58) **Field of Classification Search**
USPC **343/702, 722, 745**
See application file for complete search history.

(56) **References Cited**

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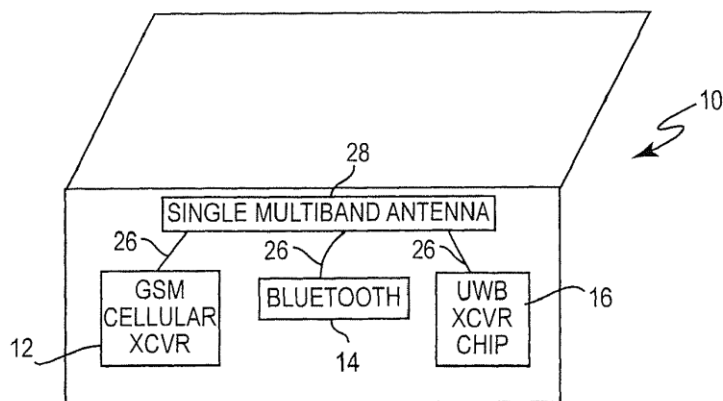
Primary Examiner — Tho G Phan

(74) *Attorney, Agent, or Firm* — Whitham Curtis
Christofferson & Cook, PC

(57) **ABSTRACT**

Wireless devices, and particularly mobile devices such as cellphones, PDAs, computers, navigation devices, etc., as well as other devices which transmit or receive data or other signals at multiple frequency bands utilize at least one antenna to transmit and receive and a plurality of different bands (e.g., GSM cellular communication band; Bluetooth short range communication band; ultrawideband (UWB) communications, etc.). These wireless devices can simultaneously transmit or receive at a plurality of different bands, or simultaneously transmit and receive at different bands. The wireless devices have the ability to use a single physical structure (e.g., an antenna) for transmission and reception of many different bands. The antenna can be either actively tuned or passively tuned using one or more elements.

31 Claims, 3 Drawing Sheets





US008593360B2

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

(10) **Patent No.:** **US 8,593,360 B2**

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

(54) **SLOTTED GROUND-PLANE USED AS A SLOT ANTENNA OR USED FOR A PIFA ANTENNA**

(75) Inventors: **Carles Puente Baliarda**, Barcelona (ES); **Jaime Anguera Pros**, Castellon (ES)

(73) Assignee: **Fractus, S.A.**, Sant Cugat del Valles (ES)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/336,127**

(22) Filed: **Dec. 23, 2011**

(65) **Prior Publication Data**

US 2012/0092226 A1 Apr. 19, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/958,522, filed on Dec. 2, 2010, now Pat. No. 8,111,199, which is a continuation of application No. 11/884,991, filed as application No. PCT/EP2006/060766 on Mar. 15, 2006, now Pat. No. 7,872,605.

(30) **Foreign Application Priority Data**

Mar. 15, 2005 (EP) 05005540

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

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

(58) **Field of Classification Search**

USPC 343/700 MS, 702, 767, 846, 848
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Tan Ho

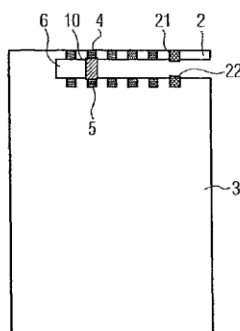
(74) *Attorney, Agent, or Firm* — Winstead PC

(57)

ABSTRACT

A wireless device includes a ground plane with at least two portions. On each of the at least two portions at least one connecting means is provided. The two connecting means are connected with an electric component for connecting the at least two portions of the ground plane. The ground plane is partially covered with an insulating material and the connecting means are given by a part of the ground plane which is not covered by any insulating material.

20 Claims, 6 Drawing Sheets





US008593363B2

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

(10) **Patent No.:** **US 8,593,363 B2**
(45) **Date of Patent:** **Nov. 26, 2013**

(54) **END-FED SLEEVE DIPOLE ANTENNA
COMPRISING A $\frac{3}{4}$ -WAVE TRANSFORMER**

(75) Inventors: **James McLean**, Austin, TX (US);
Kunio Yata, Tokyo (JP); **Robert Sutton**,
Austin, TX (US); **Hidetsugu Sakou**,
Tokyo (JP); **Nobutaka Misawa**, Tokyo
(JP)

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

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 440 days.

(21) Appl. No.: **13/015,280**

(22) Filed: **Jan. 27, 2011**

(65) **Prior Publication Data**

US 2012/0194401 A1 Aug. 2, 2012

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

(52) **U.S. Cl.**
USPC **343/792; 343/822**

(58) **Field of Classification Search**
USPC 343/791, 790, 792, 820, 821, 822
See application file for complete search history.

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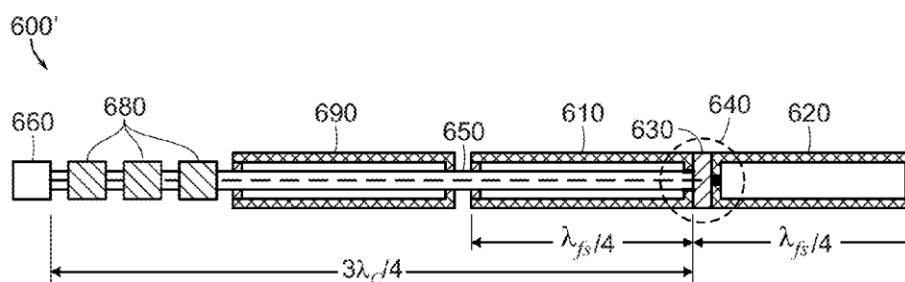
Primary Examiner — Hoanganh Le

(74) Attorney, Agent, or Firm — Kevin L. Daffer; Daffer
McDaniel LLP

(57) **ABSTRACT**

An end-fed sleeve dipole is provided herein with improved impedance match and increased bandwidth by incorporating a $\frac{3}{4}$ -wavelength transformer in the antenna design. The $\frac{3}{4}$ -wavelength transformer is compatible with a number of different choking schemes, including but not limited to, a single $\frac{1}{4}$ -wave choke sleeve, a single $\frac{1}{4}$ -wave choke sleeve with additional ferrite beads, and two or more $\frac{1}{4}$ -wave choke sleeves with or without ferrite beads. In some embodiments, one or more shunt resonators may be used to provide additional impedance compensation.

20 Claims, 8 Drawing Sheets





(10) **Patent No.:** **US 8,593,366 B2**
(45) **Date of Patent:** **Nov. 26, 2013**

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Primary Examiner — Hoang V Nguyen
(74) Attorney, Agent, or Firm — Crowell & Moring LLP

(57) **ABSTRACT**(57) **ABSTRACT**(57) **ABSTRACT**(57) **ABSTRACT**

This multi-antenna apparatus includes a first antenna element and a second antenna element, and an ungrounded passive antenna element arranged between the first antenna element and the second antenna element, wherein the passive antenna element has a first opposing portion opposed to the first antenna element, a second opposing portion opposed to the second antenna element and a coupling portion coupling the first opposing portion and the second opposing portion with each other.

18 Claims, 6 Drawing Sheets





US008593368B2

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

(10) **Patent No.:** **US 8,593,368 B2**
(45) **Date of Patent:** **Nov. 26, 2013**

(54) **MULTI-BAND ANTENNA AND ELECTRONIC APPARATUS HAVING THE SAME**

(75) Inventors: **Cheng-Tse Lee**, Yilan County (TW);
Saou-Wen Su, Keelung (TW)

(73) Assignees: **Lite-On Electronics (Guangzhou) Limited**, Guangzhou (CN); **Lite-On Technology 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 286 days.

(21) Appl. No.: **13/207,387**

(22) Filed: **Aug. 10, 2011**

(65) **Prior Publication Data**

US 2012/0326940 A1 Dec. 27, 2012

(30) **Foreign Application Priority Data**

Jun. 27, 2011 (CN) 2011 1 0174026

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

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

(58) **Field of Classification Search**
USPC 343/860, 700 MS, 702, 846
See application file for complete search history.

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Primary Examiner — Huedung Mancuso

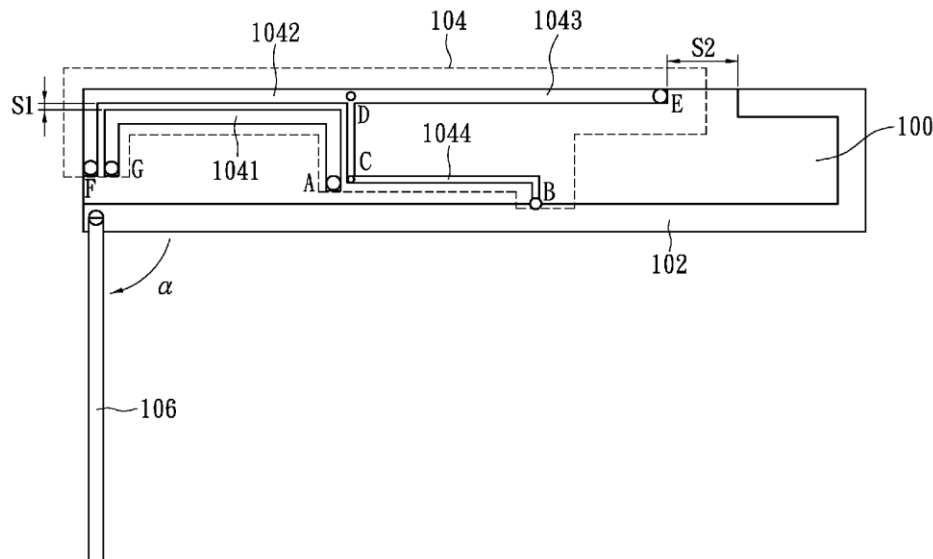
(74) *Attorney, Agent, or Firm* — Li & Cai Intellectual Property (USA) Office

(57) **ABSTRACT**

A multi-band antenna includes an antenna substrate, an antenna ground, an antenna unit, and a matching conductor. The antenna ground has a signal ground terminal and at least one bend. The antenna unit is adjacent to the antenna ground. The matching conductor is electrically coupled to the antenna ground, and an angle exists between the matching conductor and the antenna ground. A length of the first matching conductor is about a quarter of the wavelength corresponding to a frequency of the first operating band. The antenna unit includes a coupling conductor, a feeding conductor, a radiating conductor, and a shorting conductor. The feeding conductor has a signal feeding terminal. One end of the radiating conductor is facing to the antenna ground, and a distance exists between the feeding conductor the antenna ground. Two ends of the shorting conductor are respectively electrically coupled to the antenna ground and the coupling conductor.

20 Claims, 9 Drawing Sheets

10





US008599074B2

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

(10) **Patent No.:** **US 8,599,074 B2**
(45) **Date of Patent:** **Dec. 3, 2013**

(54) **MOBILE COMMUNICATION DEVICE AND ANTENNA THEREOF**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Cheng-Tse Lee, Taipei Hsien (TW)

(73) Assignee: **Acer Inc.**, 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 271 days.

(21) Appl. No.: **12/648,365**

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

(65) **Prior Publication Data**

US 2011/0084883 A1 Apr. 14, 2011

(30) **Foreign Application Priority Data**

Oct. 8, 2009 (TW) 98134200 A

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

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

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

(56) **References Cited**

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Primary Examiner — Robert Karacsony

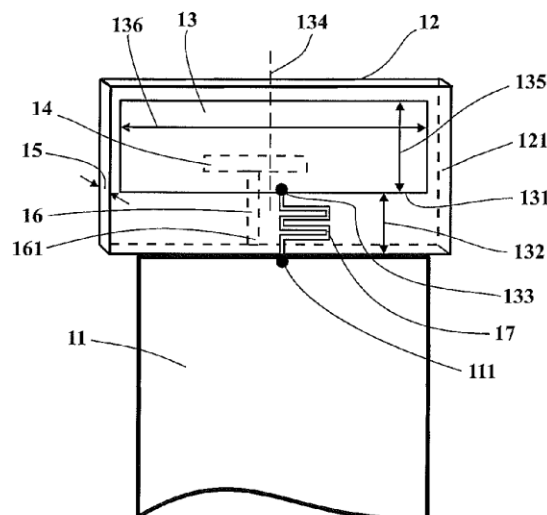
(74) *Attorney, Agent, or Firm* — Alan Kamrath; Kamrath IP Lawfirm, P.A.

(57) **ABSTRACT**

A mobile communication device has a ground plane and an antenna. The antenna is disposed on a dielectric substrate and includes a radiating metal portion, a coupling metal portion, and a shorting metal portion. One edge of the radiating metal portion faces the ground plane and has a distance between the edge and the ground plane. The coupling metal portion is electrically connected to a source via a connecting metal strip. One end of the shorting metal portion is electrically connected to the radiating metal portion, and the other end of the shorting metal portion is electrically connected to the ground plane.

7 Claims, 5 Drawing Sheets

1





US008599084B2

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

(10) **Patent No.:** **US 8,599,084 B2**

(45) **Date of Patent:** **Dec. 3, 2013**

(54) **MOBILE COMMUNICATION DEVICE AND ANTENNA**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Po-Wei Lin, Taipei Hsien (TW);
Chih-Hua Chang, Taipei Hsien (TW)

(73) Assignee: **Acer Incorporated**, Hsichih, 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 340 days.

(21) Appl. No.: **13/088,561**

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

(65) **Prior Publication Data**
US 2012/0098721 A1 Apr. 26, 2012

(30) **Foreign Application Priority Data**
Oct. 22, 2010 (TW) 99136065 A

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

(52) **U.S. Cl.**
USPC **343/749**

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

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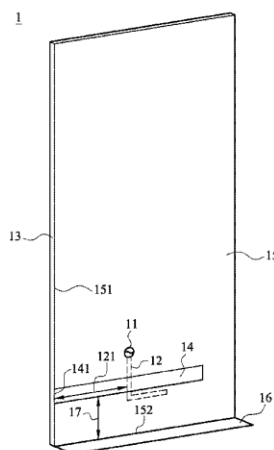
Primary Examiner — Seung Lee

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

(57) **ABSTRACT**

A mobile communication device is provided. The mobile communication device includes a system circuit board with a surface, a ground plane having a monopole slot on the surface, a microstrip feedline, and a metal element, wherein the ground plane has a longer edge and a shorter edge. The monopole slot has a first operating band and a second operating band. The microstrip feedline is located on the system circuit board, wherein one end of the microstrip feedline passes over the monopole slot, and the other end of the microstrip feedline is connected to a signal source. The metal element is electrically connected to the shorter edge of the ground plane, and is substantially perpendicular to the ground plane. A distance between the open end of the monopole slot and the shorter edge of the ground plane where the metal element is connected is shorter than 0.05 wavelength of the lowest operating frequency of the first operating band.

20 Claims, 7 Drawing Sheets





US008599086B2

**(12) United States Patent
Wong et al.****(10) Patent No.: US 8,599,086 B2****(45) Date of Patent: Dec. 3, 2013****(54) MONOPOLE SLOT ANTENNA****(75) Inventors:** **Kin-Lu Wong**, Taipei Hsien (TW);
Fang-Hsien Chu, Taipei Hsien (TW)**(73) Assignee:** **Acer Incorporated**, 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 398 days.**(21) Appl. No.: 12/536,584****(22) Filed:** **Aug. 6, 2009****(65) Prior Publication Data**

US 2010/0245176 A1 Sep. 30, 2010

(30) Foreign Application Priority Data

Mar. 27, 2009 (TW) 98110256 A

(51) Int. Cl.**H01Q 13/10** (2006.01)**H01Q 1/00** (2006.01)**H01Q 1/24** (2006.01)**(52) U.S. Cl.**USPC **343/767**; 343/702; 343/729**(58) Field of Classification Search**USPC 343/700 MS, 702, 846, 729, 767-771;
455/575.1, 575.7

See application file for complete search history.

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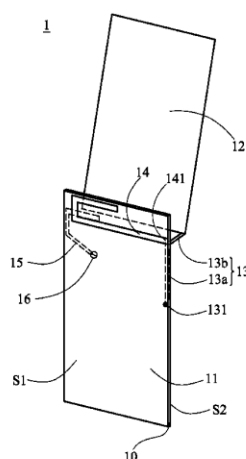
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Office Action of its corresponding TW patent application issued on Nov. 2, 2012.

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Primary Examiner — Michael C Wimer*Assistant Examiner* — Hasan Islam**(74) Attorney, Agent, or Firm** — Wang Law Firm, Inc.; Li K. Wang; Stephen Hsu**(57) ABSTRACT**

A monopole slot antenna applicable to a mobile communication device includes a dielectric substrate, a first ground plane, a second ground plane, a monopole slot, and a microstrip feedline. The first ground plane is disposed on the dielectric substrate. The second ground plane is in the vicinity of the first ground plane and electrically connected to the first ground plane via a metal wire. A section of the metal wire is disposed on one surface of the dielectric substrate. The monopole slot is disposed on the first ground plane and has an open end disposed near the metal wire that connects the first and the second ground planes. The microstrip feedline is disposed on a surface of the dielectric substrate opposite to the first ground plane with one end of the microstrip feedline extended across the monopole slot and the other end connected to a signal source.

14 Claims, 5 Drawing Sheets



US008599087B2

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

(10) **Patent No.:** **US 8,599,087 B2**
(45) **Date of Patent:** **Dec. 3, 2013**

(54) **ANTENNAS WITH PERIODIC SHUNT INDUCTORS**

(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)

(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.: **13/269,884**

(22) Filed: **Oct. 10, 2011**

(65) **Prior Publication Data**

US 2012/0026052 A1 Feb. 2, 2012

Related U.S. Application Data

(63) Continuation of application No. 12/759,598, filed on Apr. 13, 2010, now Pat. No. 8,044,873, which is a continuation of application No. 11/958,824, filed on Dec. 18, 2007, now Pat. No. 7,705,795.

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

(52) **U.S. Cl.**
USPC **343/768; 343/772; 343/857**

(58) **Field of Classification Search**
USPC **343/743, 746, 749, 750, 767, 768, 769, 343/772, 857, 700 MS**
See application file for complete search history.

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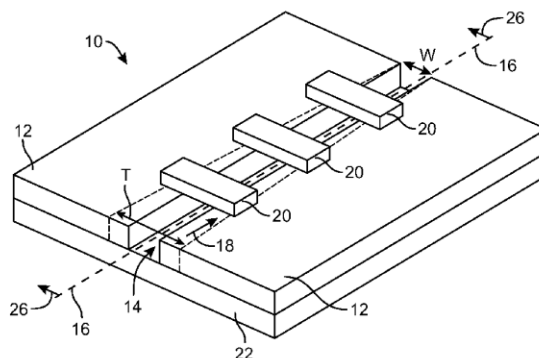
Primary Examiner — Jany Richardson

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

(57) **ABSTRACT**

An antenna may be formed from conductive regions that define a gap that is bridged by shunt inductors. The inductors may have equal inductances and may be located equidistant from each other to form a scatter-type antenna structure. The inductors may also have unequal inductances and may be located along the length of the gap with unequal inductor-to-inductor spacings, thereby creating a decreasing shunt inductance at increasing distances from a feed for the antenna. This type of antenna structure functions as a horn-type antenna. One or more scatter-type antenna structures may be cascaded to form a multiband antenna. Antenna gaps may be formed in conductive device housings.

22 Claims, 21 Drawing Sheets





US008599088B2

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

(10) **Patent No.:** **US 8,599,088 B2**
(45) **Date of Patent:** **Dec. 3, 2013**

(54) **DUAL-BAND ANTENNA WITH ANGLED SLOT FOR PORTABLE ELECTRONIC DEVICES**

(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); **Hao Xu**, Cupertino, 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 1080 days.

(21) Appl. No.: **11/959,191**

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

(65) **Prior Publication Data**

US 2009/0153411 A1 Jun. 18, 2009

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

(52) **U.S. Cl.**
USPC **343/770**

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

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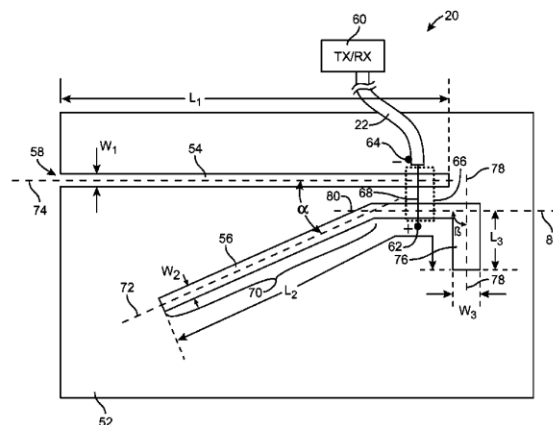
Primary Examiner — Robert Karacsony

(74) Attorney, Agent, or Firm — Treyz Law Group; G. Victor Treyz; Michael H. Lyons

(57) **ABSTRACT**

Dual slot antennas are provided for portable electronic devices such as handheld electronic devices. A dual slot antenna may have an open slot that has an open end that is not encircled by conductive material and may have a closed slot in which each end is surrounded by conductor. The closed and open slots may have portions that run parallel to each other. The antenna may be fed using feed terminals that bridge the closed and open slots in the vicinity of the portions of the slots that run parallel to each other. The slots may have portions that are angled with respect to each other. An end portion of one of the slots may be bent and widened for impedance matching and broadened bandwidth. Other portions of the slots may also be angled with respect to their main longitudinal axes.

5 Claims, 7 Drawing Sheets





US008599089B2

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

(10) **Patent No.:** **US 8,599,089 B2**
(45) **Date of Patent:** **Dec. 3, 2013**

(54) **CAVITY-BACKED SLOT ANTENNA WITH NEAR-FIELD-COUPLED PARASITIC SLOT**

(75) Inventors: **Peter Bevelacqua**, Cupertino, CA (US);
Robert J. Hill, Salinas, 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 569 days.

(21) Appl. No.: **12/750,661**

(22) Filed: **Mar. 30, 2010**

(65) **Prior Publication Data**

US 2011/0241948 A1 Oct. 6, 2011

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

(52) **U.S. Cl.**
USPC 343/770; 343/767; 343/775

(58) **Field of Classification Search**
USPC 343/767, 770, 769, 775
See application file for complete search history.

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Primary Examiner — Hoang V Nguyen

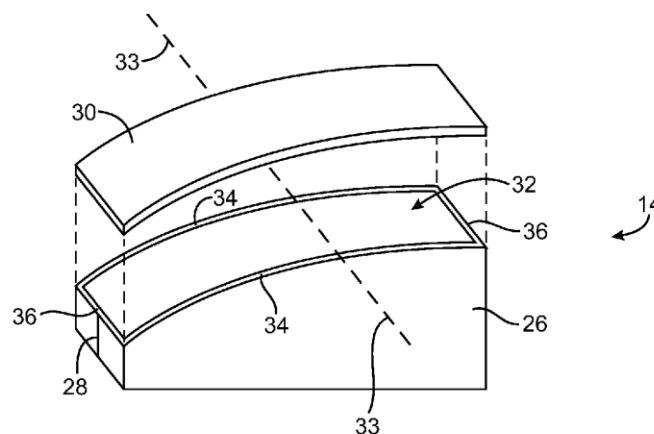
Assistant Examiner — Kyana R McCain

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

(57) **ABSTRACT**

Electronic devices may be provided with antennas. The antennas may include conductive antenna cavities. Antenna resonating elements may be mounted in the antenna cavities to form cavity antennas. An antenna cavity may be formed from metal structures with curved edges that define a curved cavity opening. A flexible printed circuit substrate may be coated with a layer of metal. Slot antenna structures such as a directly fed antenna slot and a parasitic antenna slot may be formed from openings in the metal layer. The flexible printed circuit substrate may be flexed so that the antenna resonating element forms a non-planar curved shape that mates with the opening of the antenna cavity. A ring of solder may be used to electrically seal the edges of the cavity opening to the metal layer in the antenna resonating element. The curved opening may be aligned with curved housing walls in an electronic device.

18 Claims, 7 Drawing Sheets





US008599093B2

(12) **United States Patent**
Ridgeway

(10) **Patent No.:** **US 8,599,093 B2**

(45) **Date of Patent:** **Dec. 3, 2013**

(54) **WIDEBAND ANTENNA FOR PRINTED
CIRCUIT BOARDS**

(75) Inventor: **Robert Wayne Ridgeway**, Saratoga
Springs, UT (US)

(73) Assignee: **Digi International Inc.**, Minnetonka,
MN (US)

(*) 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.: **12/952,669**

(22) Filed: **Nov. 23, 2010**

(65) **Prior Publication Data**

US 2011/0122043 A1 May 26, 2011

Related U.S. Application Data

(60) Provisional application No. 61/264,109, filed on Nov.
24, 2009.

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

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

(58) **Field of Classification Search**
USPC 343/860, 702, 700 MS; 29/601
See application file for complete search history.

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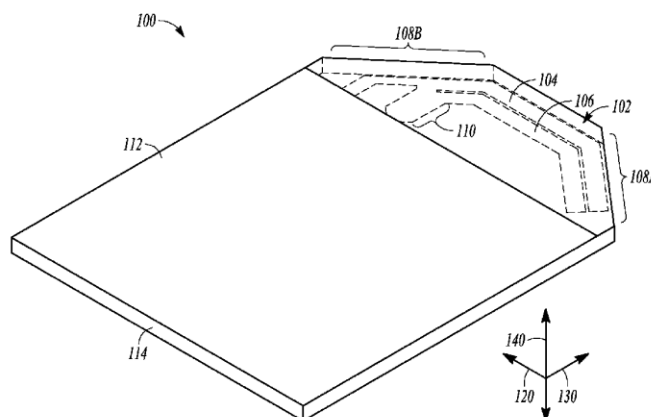
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Fogg & Powers LLC

(57) **ABSTRACT**

A planar antenna, such as included as a portion of a wireless
communication assembly, can include a dielectric portion, a
first conductive portion, extending along a surface of the
dielectric portion, and a second conductive portion, parallel to
the first conductive portion, extending along the surface of the
dielectric portion, the second conductive portion laterally
offset from the first portion to provide a specified lateral
separation between the first and second conductive portions.
The first and second conductive portions can be configured to
provide respective resonant operating frequencies ranges off-
set from each other, and the first and second conductive por-
tions can be configured to follow a commonly-shared path,
including at least one bend, along the surface of the dielectric
portion.

20 Claims, 6 Drawing Sheets





US008599094B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 8,599,094 B2**

(45) **Date of Patent:** **Dec. 3, 2013**

(54) **LOOP ANTENNA**

(75) Inventor: **Jong-hyuck Lee**, Seongnam-si (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 355 days.

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(21) Appl. No.: **13/012,383**

(22) Filed: **Jan. 24, 2011**

(65) **Prior Publication Data**

US 2011/0291912 A1 Dec. 1, 2011

(30) **Foreign Application Priority Data**

May 28, 2010 (KR) 10-2010-0050170

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

(52) **U.S. Cl.**
USPC **343/867**; 343/866

(58) **Field of Classification Search**
USPC 343/860, 861, 866, 867, 741, 742
See application file for complete search history.

(56) **References Cited**

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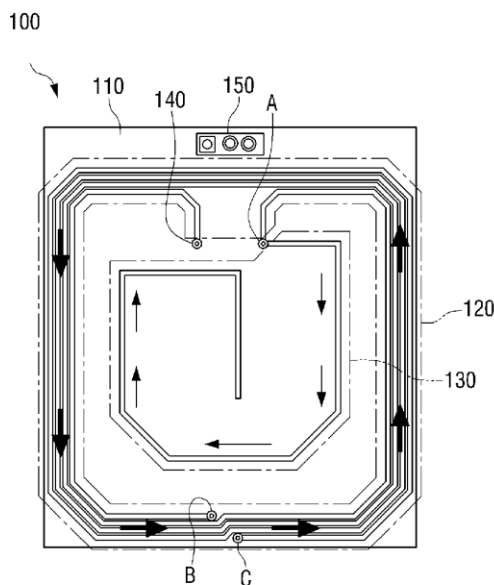
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

A loop antenna is provided. The loop antenna includes: a substrate; an outer pattern including at least one loop on a surface of the substrate; and an inner pattern in an inner region of the at least one loop of the outer pattern, an end of the inner pattern being connected to an end of the outer pattern, wherein the inner pattern is configured so that an electric current flows in the inner pattern in a direction opposite to a direction in which the electric current flows in the outer pattern. Accordingly, an H-field characteristic of the loop antenna can be enhanced, thereby allowing the loop antenna to have a decreased size and an improved performance.

18 Claims, 6 Drawing Sheets





US008599101B2

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

(10) **Patent No.:** **US 8,599,101 B2**
(45) **Date of Patent:** **Dec. 3, 2013**

(54) **DIELECTRICALLY LOADED ANTENNA AND RADIO COMMUNICATION APPARATUS**

(75) Inventors: **Andrew Robert Christie**, Northamptonshire (GB); **David Michael Wither**, Northamptonshire (GB); **Martyn Leslie Tongue**, Leicestershire (GB); **Frank Kwasi Frimpong**, Northamptonshire (GB)

(73) Assignee: **Sarantel Limited**, Wellingborough (GB)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 371 days.

(21) Appl. No.: **13/014,984**

(22) Filed: **Jan. 27, 2011**

(65) **Prior Publication Data**

US 2011/0221651 A1 Sep. 15, 2011

Related U.S. Application Data

(60) Provisional application No. 61/313,222, filed on Mar. 12, 2010.

(30) **Foreign Application Priority Data**

Jan. 27, 2010 (GB) 1001331.6

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

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

(58) **Field of Classification Search**
USPC 343/895, 700 MS, 702, 906, 850
See application file for complete search history.

(56) **References Cited**

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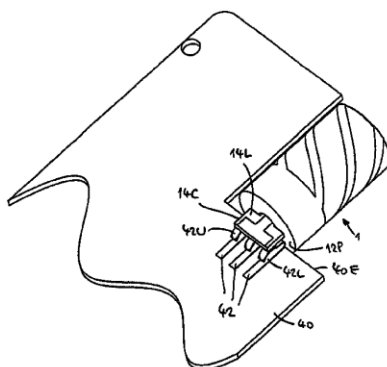
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

A radio communication apparatus including: (a) a backfire dielectrically loaded antenna for operation at a frequency in excess of 200 MHz comprising: an electrically insulative dielectric core of a solid material having a relative dielectric constant greater than 5 and having an outer surface including oppositely directed distal and proximal surface portions extending transversely of an axis of the antenna and a side surface portion extending between the transversely extending surface portions, the core outer surface defining an interior volume the major part of which is occupied by the solid material of the core; a three-dimensional antenna element structure including at least one pair of elongate conductive antenna elements disposed on or adjacent the side surface portion of the core and extending from the distal core surface portion towards the proximal core surface portion; a feed structure in the form of an axially extending elongate laminate board comprising at least a transmission line section acting as a feed line which extends through a passage in the core from the distal core surface portion to the proximal core surface portion, the antenna having exposed contact areas on or adjacent the core proximal surface portion; and (b) radio communication circuit means having an equipment laminate circuit board with at least one conductive layer, the conductive layer or layers having a plurality of contact terminal support areas to each of which is conductively bonded a respective spring contact positioned so as to bear resiliently against respective ones of the exposed contact areas of the antenna.

17 Claims, 15 Drawing Sheets





US008604979B2

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

(10) **Patent No.:** **US 8,604,979 B2**
(45) **Date of Patent:** ***Dec. 10, 2013**

(54) **BROAD BAND ANTENNA**

(56) **References Cited**

(75) Inventors: **JunXiang Ge**, Tokyo (JP); **Wasuke Yanagisawa**, Tokyo (JP); **Ryo Horie**, Tokyo (JP)

(73) Assignee: **Yokowo 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 945 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/997,696**

(22) PCT Filed: **Aug. 3, 2006**

(86) PCT No.: **PCT/JP2006/315788**

§ 371 (c)(1),

(2), (4) Date: **May 7, 2010**

(87) PCT Pub. No.: **WO2007/015583**

PCT Pub. Date: **Feb. 8, 2007**

(65) **Prior Publication Data**

US 2010/0220023 A1 Sep. 2, 2010

(30) **Foreign Application Priority Data**

Aug. 4, 2005 (JP) 2005-227154

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

H01Q 13/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/700 MS; 343/772; 343/846**

(58) **Field of Classification Search**

None

See application file for complete search history.

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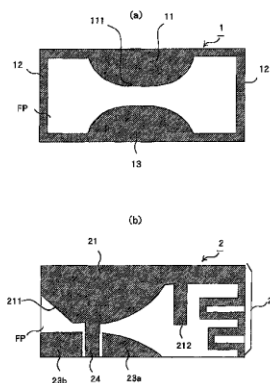
Primary Examiner — Trinh Dinh

(74) Attorney, Agent, or Firm — Bachman & LaPointe, P.C.

(57) **ABSTRACT**

Provided is a wide band antenna having ultra-wide band and high performance at a low cost. An antenna element constituting a part of an opening cross section structure of a double cylinder ridge waveguide is spread on a plane. The antenna element has a ridge element portion (21) for adjusting antenna characteristic corresponding to a ridge portion and a radiation element portion (22) for electromagnetic wave radiation. Substantially at a leading end portion of the ridge element portion (21), a feeder terminal (24) is formed. Ground portions (23a and 23b) are maintained at a ground potential and the feeder terminal (24) is guided to an outside as a coplanar waveguide.

13 Claims, 30 Drawing Sheets





US008604980B2

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

(10) **Patent No.:** **US 8,604,980 B2**
(45) **Date of Patent:** **Dec. 10, 2013**

(54) **ANTENNA SYSTEM WITH
NON-RESONATING STRUCTURE**

(75) Inventors: **Vijay Asrani**, Round Lake, IL (US);
Adrian Napoles, Lake Villa, IL (US);
Louis Vannatta, Crystal Lake, IL (US)

(73) Assignee: **Motorola Mobility LLC**, Libertyville,
IL (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 944 days.

(21) Appl. No.: **12/645,038**

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

(65) **Prior Publication Data**

US 2011/0148731 A1 Jun. 23, 2011

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

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

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

(56) **References Cited**

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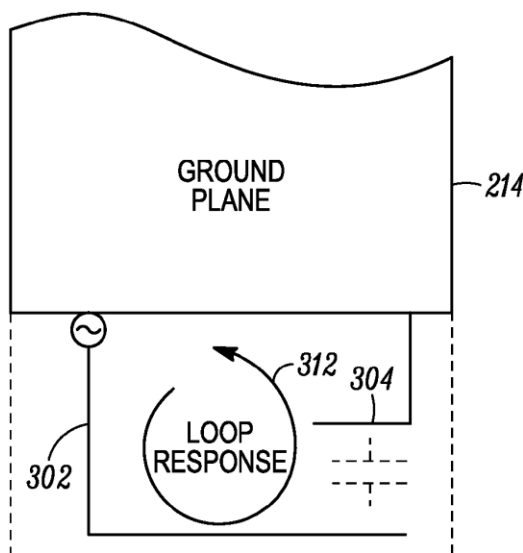
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Daniel R. Collopy;
Ingrassia Fisher & Lorenz, PC; Sylvia Chen

(57) **ABSTRACT**

An antenna system for reception and transmission of radio frequency (RF) signals and a method for tuning the antenna system are provided. The antenna system includes a ground plane, a first element and a second element. The first element includes a driven unbalanced antenna element that resonates within at least one predetermined first frequency band to transmit and receive radio frequency (RF) signals modulated at one or more frequencies within the at least one predetermined first frequency band. The second element is non-resonating within the at least one predetermined first frequency band and is located within an antenna volume of the first element to create a partial loop response within the antenna volume of the first element by capacitively coupling to the first element when connected to the ground plane.

14 Claims, 21 Drawing Sheets





US008604988B2

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

(10) **Patent No.:** **US 8,604,988 B2**

(45) **Date of Patent:** **Dec. 10, 2013**

(54) **MULTI-FUNCTION ARRAY FOR ACCESS POINT AND MOBILE WIRELESS SYSTEMS**

(75) Inventors: **Laurent Desclos**, San Diego, CA (US);
Sebastian Rowson, San Diego, CA (US); **Jeffrey Shamblin**, San Marcos, CA (US)

(73) Assignee: **Ethertrionics, 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 0 days.

(21) Appl. No.: **13/612,833**

(22) Filed: **Sep. 13, 2012**

(65) **Prior Publication Data**

US 2013/0099987 A1 Apr. 25, 2013

Related U.S. Application Data

(63) Continuation-in-part of application No. 13/029,564, filed on Feb. 17, 2011, now Pat. No. 8,362,962, which is a continuation of application No. 12/043,090, filed on Mar. 5, 2008, now Pat. No. 7,911,402.

(60) Provisional application No. 61/533,553, filed on Sep. 12, 2011.

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

(52) **U.S. Cl.**
USPC **343/745; 343/725; 343/813; 343/815**

(58) **Field of Classification Search**

USPC 343/700, 722, 725, 745, 750, 853, 813, 343/815

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Tho G Phan

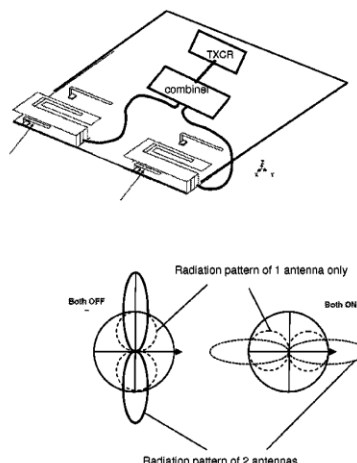
(74) *Attorney, Agent, or Firm* — Coastal Patent Law Group; Joshua S. Schoonover, P.C.

(57) **ABSTRACT**

A multi-function array is described where several communication system functions are realized using the same antenna architecture. An array of antenna elements where each antenna element can generate multiple radiation patterns is described; the multiple radiation patterns from each antenna element provides increased capability and flexibility in generating a phased array, a MIMO antenna system, a receive diversity antenna system, as well as direction finding feature by way of an interferometer function provided by one or multiple elements. The small volume attributes of the antenna elements populating the array lend this technique to mobile wireless devices as well as access points.

7 Claims, 13 Drawing Sheets

Practical Realization of Modal Array





US008604998B2

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

(10) **Patent No.:** **US 8,604,998 B2**

(45) **Date of Patent:** ***Dec. 10, 2013**

(54) **GROUND RADIATION ANTENNA**

(75) Inventors: **Hyeng-cheul Choi**, Seoul (KR); **Jaeseok Lee**, Seoul (KR); **Oul Cho**, Suwon-si (KR); **Hyungjin Lee**, Ansan-si (KR); **Bumki Park**, Seoul (KR)

(73) Assignee: **Radina Co., Ltd**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 296 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/081,014**

(22) Filed: **Apr. 6, 2011**

(65) **Prior Publication Data**

US 2011/0193762 A1 Aug. 11, 2011

Related U.S. Application Data

(63) Continuation of application No. PCT/KR2010/009338, filed on Dec. 24, 2010.

(30) **Foreign Application Priority Data**

Feb. 11, 2010	(KR)	10-2010-0012775
Apr. 9, 2010	(KR)	10-2010-0032922
May 7, 2010	(KR)	10-2010-0043186
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Jun. 14, 2010	(KR)	10-2010-0056207
Dec. 23, 2010	(KR)	10-2010-0133919

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

(52) **U.S. Cl.**
USPC **343/845; 343/846; 343/847**

(58) **Field of Classification Search**

USPC 343/845, 846-847
See application file for complete search history.

(56) **References Cited**

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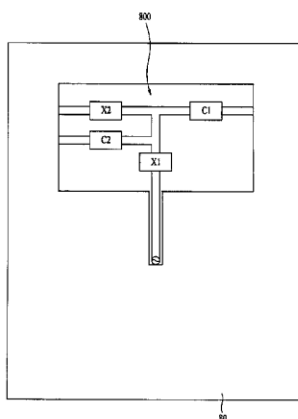
Primary Examiner — Kristy A Haupt

(74) *Attorney, Agent, or Firm* — Park, Kim & Suh, LLC

(57) **ABSTRACT**

A ground radiation antenna is disclosed. Herein, the ground radiation antenna provides a radiator-forming circuit, which is formed to have a simple structure using a capacitive element, as well as a feeding circuit suitable for the provided radiator-forming circuit. Thus, the structure of the antenna becomes simpler and the size of the antenna becomes smaller. Accordingly, the fabrication process of the antenna is simplified, thereby largely reducing the fabrication cost.

16 Claims, 8 Drawing Sheets





US008605003B2

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

(10) **Patent No.:** **US 8,605,003 B2**
(45) **Date of Patent:** **Dec. 10, 2013**

(54) **MINIATURE WIRE ANTENNA**

(75) Inventors: **Ming-Iu Lai**, Taipei (TW);
Chun-Hsiung Wang, 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 873 days.

(21) Appl. No.: **12/725,750**

(22) Filed: **Mar. 17, 2010**

(65) **Prior Publication Data**

US 2010/0271266 A1 Oct. 28, 2010

(30) **Foreign Application Priority Data**

Apr. 24, 2009 (TW) 98113697 A

(51) **Int. Cl.**
H01Q 1/36 (2006.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

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

(58) **Field of Classification Search**
USPC 343/700 MS, 895, 702, 725, 729, 846,
343/848

See application file for complete search history.

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Primary Examiner — Michael C Wimer

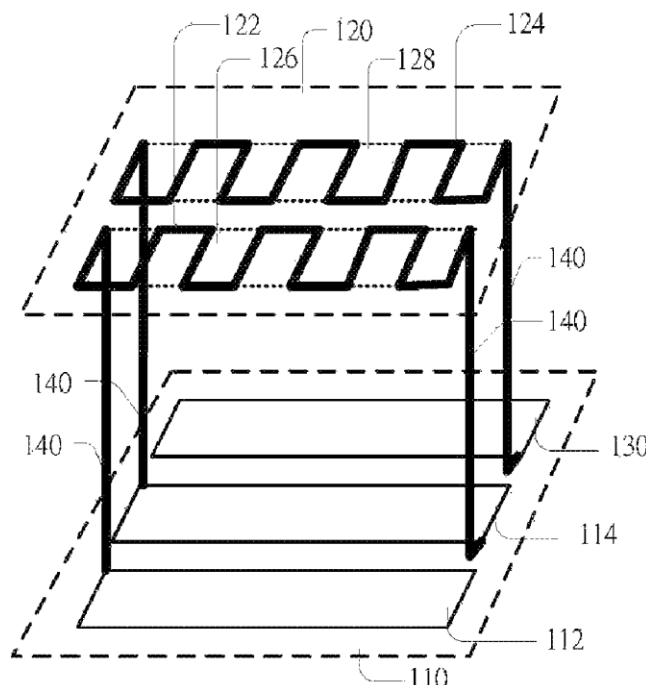
Assistant Examiner — Hasan Islam

(74) *Attorney, Agent, or Firm* — Jianq Chyun IP Office

(57) **ABSTRACT**

A miniature wire antenna includes N rectangular metal plates located at a first layer of a PCB, a tunable metal plate located at the first layer of the PCB and N serpentine lines located at a second layer of the PCB. The positions of the N serpentine lines correspond to the positions of the rectangular metal plates. A first end of each of the serpentine lines is connected to the corresponding rectangular metal plate, and a second end of each of the serpentine lines is connected to the next rectangular metal plate. A first end of the last serpentine line is connected to the corresponding rectangular metal plate, and a second end of the last serpentine line is connected to the tunable metal plate.

8 Claims, 10 Drawing Sheets





US008605922B2

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

(10) **Patent No.:** **US 8,605,922 B2**

(45) **Date of Patent:** **Dec. 10, 2013**

(54) **ANTENNA SYSTEM WITH PARASITIC
ELEMENT FOR HEARING AID COMPLIANT
ELECTROMAGNETIC EMISSION**

(56) **References Cited**

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(71) Applicant: **Motorola Mobility LLC**, Libertyville,
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(57)

ABSTRACT

A system for production of an electromagnetic (EM) field having EM emissions mitigated at one or more predetermined locations within a Hearing Aid Compliant (HAC) measurement plane is provided. The EM field mitigation system includes a ground plane, an antenna element, and a parasitic resonator element. The antenna element is coupled to the ground plane and resonates within at least one predetermined frequency band for transmitting and receiving the radio frequency (RF) signals modulated at one or more frequencies within the at least one predetermined first frequency band. The parasitic resonator element includes at least a half-wavelength resonator portion floating above the ground plane and a second half-wavelength resonator portion floating above the ground plane, crossing an effective electric field mid-line of the ground plane, and located a predetermined distance from the antenna element for mitigation of the EM emissions of the antenna element at the one or more predetermined locations within the HAC measurement plane.

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H01Q 1/38 (2006.01)

H01Q 1/48 (2006.01)

H01Q 9/04 (2006.01)

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H04B 1/04 (2006.01)

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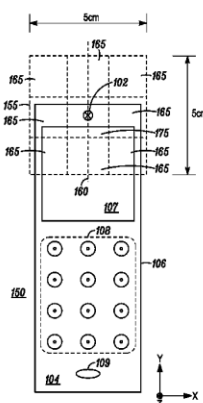
USPC **381/312**; 343/700 MS; 343/702;
343/833; 343/846; 455/129; 455/550.1; 455/575.7

(58) **Field of Classification Search**

USPC 381/312; 455/575.7; 343/700 MS, 702,
343/833

See application file for complete search history.

14 Claims, 36 Drawing Sheets





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

(10) **Patent No.:** **US 8,610,626 B2**

(45) **Date of Patent:** **Dec. 17, 2013**

(54) **ANTENNA WITH SLOT**

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

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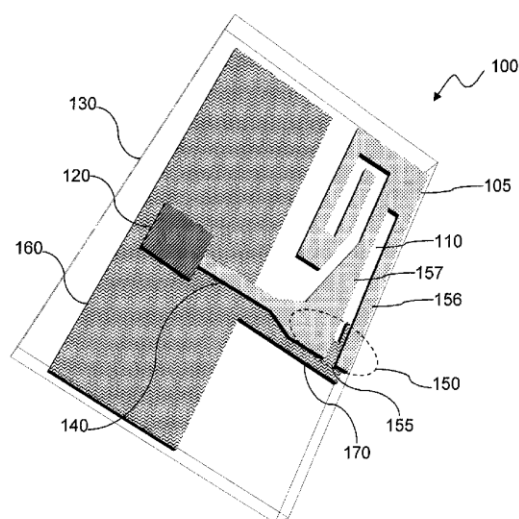
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(74) Attorney, Agent, or Firm — Lowe Hauptman & Ham,
LLP

(57) **ABSTRACT**

An antenna having a signal feeding structure, an antenna
conductor coupled to the signal feeding structure and forming
a slot in the antenna conductor. A closing portion capacitively
closing the at least one slot at a mechanically open end of the
slot.

19 Claims, 8 Drawing Sheets





US008610628B2

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(54) **WIDEBAND ANTENNA**

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

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(57) **ABSTRACT**

A wideband antenna includes: a substrate, having a first surface and a second surface; a ground plane, disposed on the second surface; an exciting element, disposed on the first surface, and having a feed point coupled to a signal source; a connection element, disposed on the first surface, and coupled to the ground plane; a first branch, disposed on the first surface, and coupled to the connection element; a second branch, disposed on the first surface, and coupled to the connection element; and a coupling element, disposed on the first surface, and coupled to the connection element.

20 Claims, 7 Drawing Sheets

