



US008872704B2

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

(10) **Patent No.:** **US 8,872,704 B2**

(45) **Date of Patent:** **Oct. 28, 2014**

(54) **INTEGRATED ANTENNA AND METHOD FOR OPERATING INTEGRATED ANTENNA DEVICE**

(75) Inventors: **Shyh-Jong Chung**, Hsinchu (TW);
Ya-Ping Chen, Hsinchu (TW)

(73) Assignee: **National Chiao Tung University** (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

(21) Appl. No.: **13/343,333**

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

(65) **Prior Publication Data**

US 2013/0082894 A1 Apr. 4, 2013

(30) **Foreign Application Priority Data**

Oct. 4, 2011 (TW) 100135964 A

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 9/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0457** (2013.01); **H01Q 9/285** (2013.01)
USPC **343/700 MS**

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 9/0407; H01Q 9/0421
USPC 343/700 MS
See application file for complete search history.

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Primary Examiner — Dameon E Levi

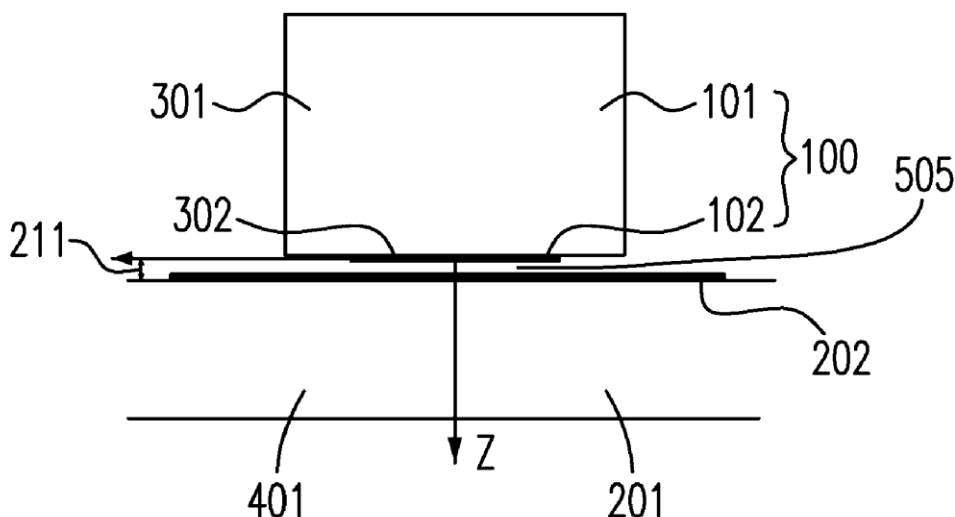
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Volpe and Koenig, P.C.

(57) **ABSTRACT**

An integrated antenna is provided. The integrated antenna includes a first resonant element disposed on a chip, and receiving a first signal having a frequency from the chip; and a second resonant element disposed on a substrate, wherein the chip is disposed on the substrate, and the first signal enables a non-contact resonant coupling to be established between the first resonant element and the second resonant element due to the frequency to cause the second resonant element to generate and radiate a second signal.

19 Claims, 7 Drawing Sheets





US008872705B2

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

(10) **Patent No.:** **US 8,872,705 B2**
(45) **Date of Patent:** **Oct. 28, 2014**

(54) **DUAL-BAND MOBILE COMMUNICATION
DEVICE HAVING AN ANTENNA STRUCTURE
INTEGRATED WITH A COUPLING FEED
THEREOF**

(75) Inventors: **Kin-Lu Wong**, Taipei Hsien (TW);
Wei-Yu Chen, 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 408 days.

(21) Appl. No.: **12/851,588**

(22) Filed: **Aug. 6, 2010**

(65) **Prior Publication Data**
US 2011/0267237 A1 Nov. 3, 2011

(30) **Foreign Application Priority Data**
May 3, 2010 (TW) 99114095 A

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/36 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/00 (2006.01)
H01Q 1/38 (2006.01)

(52) **U.S. Cl.**
CPC . **H01Q 9/42** (2013.01); **H01Q 1/36** (2013.01);
H01Q 5/0062 (2013.01); **H01Q 1/38** (2013.01)
USPC **343/702**; 741/700 MS; 741/848

(58) **Field of Classification Search**
USPC 343/702, 700 MS, 741, 848
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

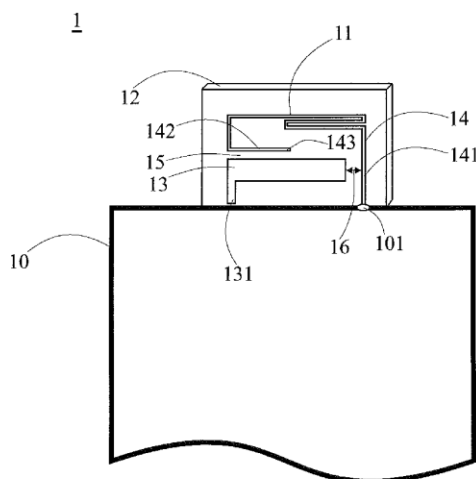
Assistant Examiner — Jae Kim

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

(57) **ABSTRACT**

A dual-band mobile communication device includes a ground plane and an antenna located on a dielectric substrate and including a feeding portion and a shorted radiating portion. One end of the feeding portion is a feeding point of the antenna. A length of the shorted radiating portion is at least twice that of the feeding portion. A first end of the shorted radiating portion, electrically connected to the ground plane, is a shorting end, and the second end of the shorted radiating portion is an open end. The shorted radiating portion includes multiple bendings which form multiple fractional sections. The open end of the shorted radiating portion extends toward a first fractional section of the shorting end of the shorted radiating portion. A coupling gap exists between a second fractional section of the open end of the shorted radiating portion and the feeding portion.

13 Claims, 4 Drawing Sheets





US008872706B2

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

(10) **Patent No.:** **US 8,872,706 B2**

(45) **Date of Patent:** **Oct. 28, 2014**

(54) **ANTENNA SYSTEM WITH RECEIVER DIVERSITY AND TUNABLE MATCHING CIRCUIT**

(75) Inventors: **Ruben Caballero**, San Jose, CA (US);
Mattia Pascolini, Campbell, CA (US);
Mohit Narang, Cupertino, CA (US);
Matt A. Mow, Los Altos, CA (US);
Robert W. Schlub, 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 591 days.

(21) Appl. No.: **12/941,010**

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

(65) **Prior Publication Data**
US 2012/0112969 A1 May 10, 2012

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)
H01Q 9/04 (2006.01)
H01Q 1/44 (2006.01)
(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 1/44** (2013.01)
USPC **343/702**; **343/725**
(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/242; H01Q 21/28
USPC **343/702**, **725**
See application file for complete search history.

(56) **References Cited**

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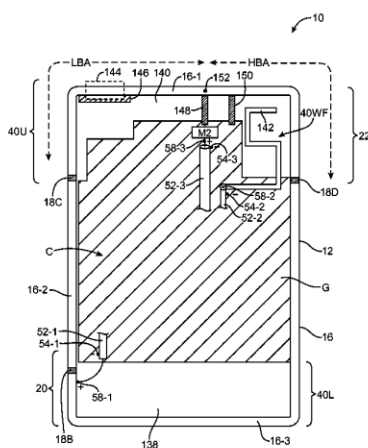
Primary Examiner — Graham Smith

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

(57) **ABSTRACT**

Electronic devices may be provided that contain wireless communications circuitry. The wireless communications circuitry may include radio-frequency transceiver circuitry and antenna structures. An electronic device may include a display mounted within a housing. A peripheral conductive member may run around the edges of the display and housing. Dielectric-filled gaps may divide the peripheral conductive member into individual segments. A ground plane may be formed within the housing from conductive housing structures, printed circuit boards, and other conductive elements. The ground plane and the segments of the peripheral conductive member may form antennas in upper and lower portions of the housing. The radio-frequency transceiver circuitry may implement receiver diversity using both the upper and lower antennas. The lower antenna may be used in transmitting signals. The upper antenna may be tuned using a tunable matching circuit.

25 Claims, 11 Drawing Sheets





US008872707B2

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

(10) **Patent No.:** **US 8,872,707 B2**
(45) **Date of Patent:** **Oct. 28, 2014**

(54) **MULTI-BAND ANTENNA FOR TABLET COMPUTER**

(75) Inventors: **Wen-Shan Chen**, Tainan (TW);
Wei-Chiang Jhang, Tainan (TW)

(73) Assignee: **Southern Taiwan University of Technology**, Tainan (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 179 days.

(21) Appl. No.: **13/537,290**

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

(65) **Prior Publication Data**

US 2014/0002308 A1 Jan. 2, 2014

(51) **Int. Cl.**
H01Q 5/01 (2006.01)

(52) **U.S. Cl.**
USPC **343/702**; 343/700 MS; 343/828;
343/829

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

(56) **References Cited**

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Primary Examiner — Dameon E Levi

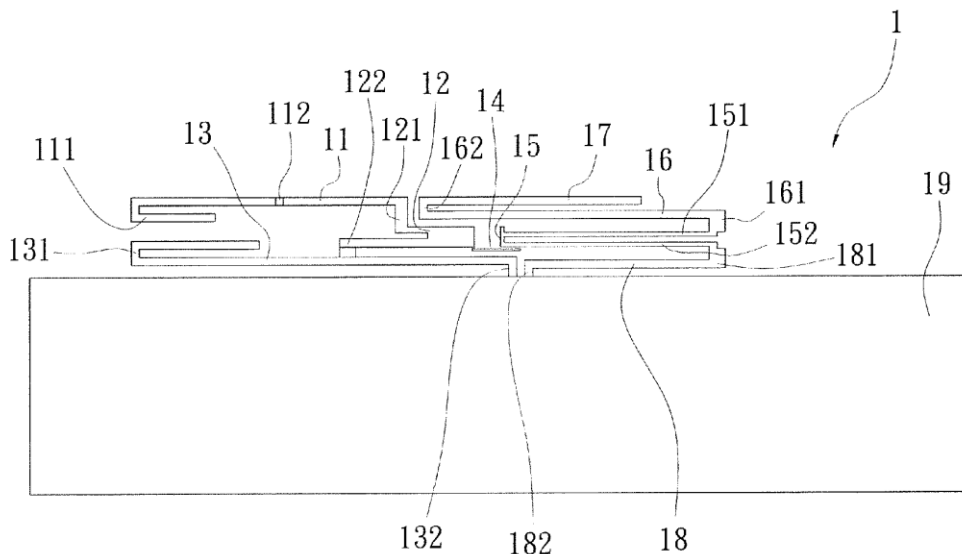
Assistant Examiner — Harold L Rappaport

(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(57) **ABSTRACT**

A multi-band antenna for tablet computers is revealed. The antenna includes a first path, a second path, a third path, a fourth path, a fifth path, a sixth path, a seventh path, an eighth path and a grounding portion, connected to one another. Thereby the antenna can cover the GSM 850/900/1800/1900/UMTS and LTE 700/2300/2700 operations.

1 Claim, 26 Drawing Sheets





US008872708B2

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

(10) **Patent No.:** **US 8,872,708 B2**

(45) **Date of Patent:** ***Oct. 28, 2014**

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

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)

(72) Inventors: **Robert J. Hill**, Salinas, CA (US);
Robert W. Schlub, Cupertino, CA (US);
Juan Zavala, Watsonville, CA (US);
Ruben Caballero, San Jose, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/718,524**

(22) Filed: **Dec. 18, 2012**

(65) **Prior Publication Data**

US 2013/0106665 A1 May 2, 2013

Related U.S. Application Data

(63) Continuation of application No. 11/650,187, filed on Jan. 4, 2007, now Pat. No. 8,350,761.

(51) **Int. Cl.**

H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/01 (2006.01)
H01Q 21/30 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/29 (2006.01)
H01Q 9/42 (2006.01)
H01Q 13/10 (2006.01)
H01Q 5/00 (2006.01)

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

CPC **H01Q 21/30** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 21/29** (2013.01); **H01Q 9/42** (2013.01); **H01Q**

13/10 (2013.01); **H01Q 5/0072** (2013.01);

H01Q 5/0058 (2013.01)

USPC **343/702**; 343/725; 343/767; 343/846

(58) **Field of Classification Search**

USPC 343/700 MS, 725, 729, 767, 770, 771, 343/846, 702

See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Michael C Wimer

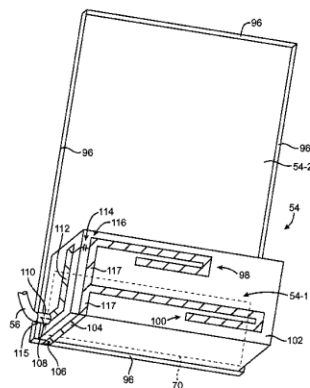
(74) *Attorney, Agent, or Firm* — Treyz Law Group; G. Victor Treyz; Michael H. Lyons

(57)

ABSTRACT

Handheld electronic devices are provided that contain wireless communications circuitry having at least one antenna. The antenna may have a planar ground element and a planar resonating element. The planar ground element may have a rectangular shape that matches a rectangular housing shape for a handheld electronic device. A dielectric-filled slot may be formed in one end of the planar ground element. The planar resonating element may be located above the slot. The antenna may be a hybrid antenna that contains both a slot antenna structure formed from the slot and a planar inverted-F structure formed from the planar resonating element and the planar ground element. The antenna may be fed using a single transmission line or two transmission lines. With two transmission lines, one transmission line may be associated with the slot antenna structure and one transmission line may be associated with the planar inverted-F antenna structure.

18 Claims, 11 Drawing Sheets





US008872712B2

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 8,872,712 B2**
(45) **Date of Patent:** **Oct. 28, 2014**

(54) **MULTI-BAND ANTENNA**

(75) Inventor: **Cheng-Jung Lee**, Santa Clara, CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Reno, NV (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 396 days.

(21) Appl. No.: **13/211,138**

(22) Filed: **Aug. 16, 2011**

(65) **Prior Publication Data**

US 2012/0313830 A1 Dec. 13, 2012

Related U.S. Application Data

(60) Provisional application No. 61/494,799, filed on Jun. 8, 2011.

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

(52) **U.S. Cl.**
USPC **343/729**

(58) **Field of Classification Search**
USPC 343/729, 846, 848, 850, 852, 700 MS, 343/702
See application file for complete search history.

(56) **References Cited**

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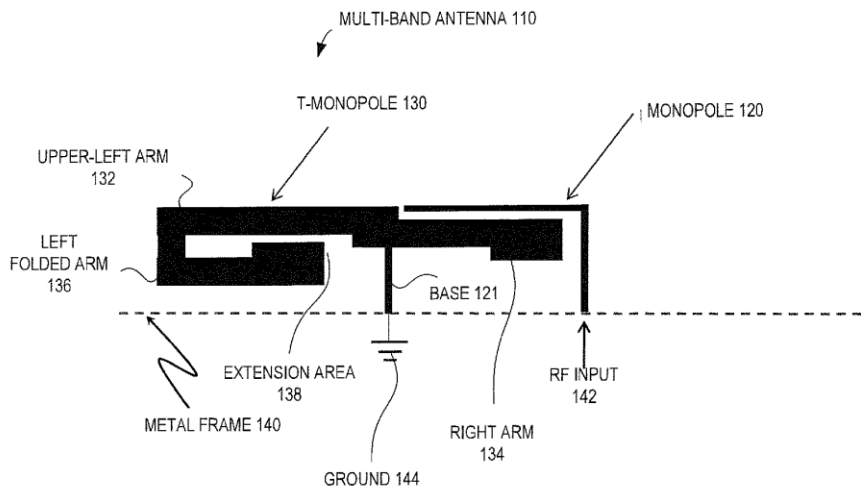
Primary Examiner — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(57) **ABSTRACT**

Methods and systems for extending a bandwidth of a multi-band antenna of a user device are described. A multi-band antenna includes a single radio frequency (RF) input coupled to a first antenna, the first antenna configured to provide a first resonant mode. The multi-band antenna also includes a second antenna parasitically coupled to the first antenna to provide additional resonant modes of the multi-band antenna.

28 Claims, 8 Drawing Sheets





US008873683B2

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

(10) **Patent No.:** **US 8,873,683 B2**

(45) **Date of Patent:** **Oct. 28, 2014**

(54) **INTERFERENCE AND NOISE ESTIMATION
IN A MULTIPLE INPUT MULTIPLE OUTPUT
(MIMO) RECEIVER**

FOREIGN PATENT DOCUMENTS

WO WO 2012/093953 A2 * 7/2012 H04L 5/00

(71) Applicant: **Intel Mobile Communications GmbH**,
Neubiberg (DE)

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(72) Inventors: **Rajarajan Balraj**, Duesseldorf (DE);
Biljana Badic, Duesseldorf (DE);
Tobias Scholand, Muelheim (DE)

LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation (3GPP TS 36.211 Version 10.4.0 Release 10); ETSI TS 136 211 v10.4.0 Jan. 2012.

(73) Assignee: **Intel Mobile Communications GmbH**,
Neubiberg (DE)

"Discussion on DM-RS for Enhanced DL Beamforming"; 3GPP TSG RAN WG1 #58bis, Miyazaki, Japan, Oct. 12-16, 2009, p. 1-4. "DMRS for MU-MIMO"; 3GPP TSG RAN WG1#61bis; Dresden, Germany Jun. 28-Jul. 2, 2010, p. 1-11.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 70 days.

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(21) Appl. No.: **13/707,779**

Primary Examiner — Sophia Vlahos

(22) Filed: **Dec. 7, 2012**

(74) Attorney, Agent, or Firm — Eschweiler & Associates, LLC

(65) **Prior Publication Data**

US 2014/0161157 A1 Jun. 12, 2014

(51) **Int. Cl.**
H04B 1/10 (2006.01)
H04B 1/711 (2011.01)

(52) **U.S. Cl.**
CPC **H04B 1/711** (2013.01)
USPC **375/346**; 375/144; 375/148; 455/63.1;
455/114.2; 455/278.1; 455/296; 455/501

(58) **Field of Classification Search**
USPC 375/144, 148, 346; 455/114.2, 501,
455/63.1, 278.1, 296
See application file for complete search history.

(56) **References Cited**

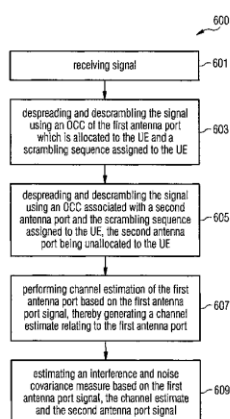
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(57) **ABSTRACT**

A receiver circuit receives a signal including a first reference signal from a first antenna port that is allocated to the UE. The receiver circuit includes a descrambling and despreading unit that despreads and descrambles the signal using a spreading code of the first antenna port and a scrambling sequence assigned to the UE to generate a first antenna port signal. The descrambling and despreading unit despreads and descrambles the signal using a spreading code of a second antenna port and the scrambling sequence assigned to the UE, wherein the second antenna port is unallocated to the UE to generate a second antenna port signal. A channel estimator generates a channel estimate of the first antenna port based on the first antenna port signal. An estimation unit estimates an interference and noise covariance measure based on the first antenna port signal, the channel estimate and the second antenna port signal.

25 Claims, 6 Drawing Sheets





US008878727B2

(12) **United States Patent**
Goldberger

(10) **Patent No.:** **US 8,878,727 B2**
(45) **Date of Patent:** **Nov. 4, 2014**

(54) **ANTENNA-MODULE HYBRID CIRCUIT**

(75) Inventor: **Haim Goldberger**, Modi'in (IL)

(73) Assignee: **Origin GPS Ltd.**, Jerusalem (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 559 days.

(21) Appl. No.: **12/702,363**

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

(65) **Prior Publication Data**

US 2010/0201580 A1 Aug. 12, 2010

Related U.S. Application Data

(60) Provisional application No. 61/151,870, filed on Feb. 12, 2009.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 23/00 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 23/00** (2013.01); **H01Q 9/0407** (2013.01)
USPC **343/700 MS**; 343/720; 343/730;
343/906; 343/841

(58) **Field of Classification Search**

CPC H01Q 5/00; H01Q 1/38; H01Q 9/0407;
H01Q 9/0485; H01Q 1/52
USPC 343/700 MS, 720, 730, 906, 841
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Dameon E Levi

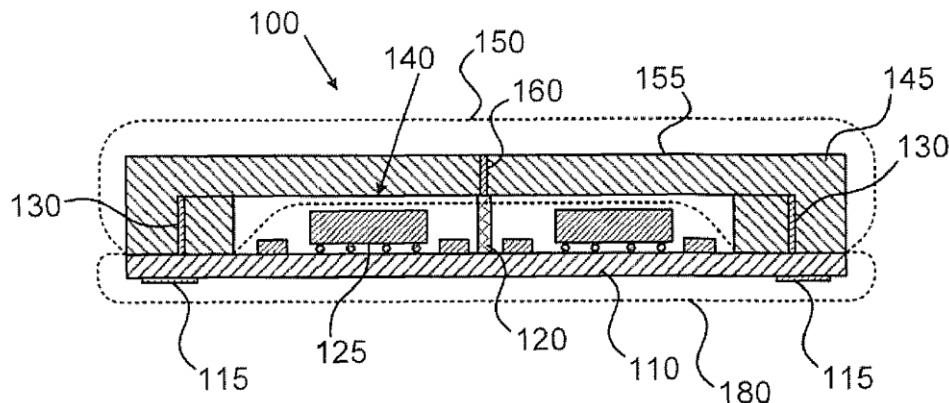
Assistant Examiner — Collin Dawkins

(74) *Attorney, Agent, or Firm* — Soroker-Agmon

(57) **ABSTRACT**

A hybrid circuit with an integral antenna module, including an electronic circuit that includes circuit elements; and an antenna module including a dielectric material shaped to form a void enclosed by the dielectric material, a conducting patch on one side of the dielectric material. Wherein the circuit elements are enclosed by the dielectric material, so that the elements of the circuit are positioned inside the void formed by the dielectric material.

10 Claims, 2 Drawing Sheets





US008878731B2

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

(10) **Patent No.:** **US 8,878,731 B2**

(45) **Date of Patent:** ***Nov. 4, 2014**

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

(71) Applicant: **BlackBerry Limited**, Waterloo (CA)

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

(73) Assignee: **BlackBerry Limited**, Waterloo, Ontario (CA)

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

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/933,251**

(22) Filed: **Jul. 2, 2013**

(65) **Prior Publication Data**

US 2013/0293431 A1 Nov. 7, 2013

Related U.S. Application Data

(63) Continuation of application No. 13/488,101, filed on Jun. 4, 2012, now Pat. No. 8,531,336, which is a continuation of application No. 13/038,540, filed on Mar. 2, 2011, now Pat. No. 8,207,896, which is a continuation of application No. 12/331,518, filed on Dec. 10, 2008, now Pat. No. 7,916,087, which is a continuation of application No. 11/838,751, filed on Aug. 14, 2007, now Pat. No. 7,466,271, which is a continuation of application No. 11/456,025, filed on Jul. 6, 2006, now Pat. No. 7,283,097, which is a continuation of application No. 10/723,840, filed on Nov. 26, 2003, now Pat. No. 7,224,312.

(30) **Foreign Application Priority Data**

Nov. 28, 2012 (WO) PCT/CA02/01842

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

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

USPC **343/700 MS**; 343/702; 343/770

(58) **Field of Classification Search**

USPC 343/700 MS, 702, 767, 770
See application file for complete search history.

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Primary Examiner — Tan Ho

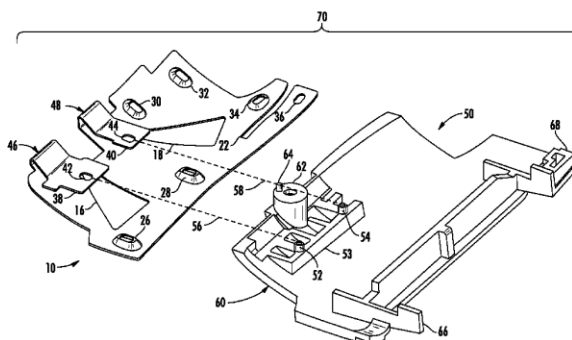
(74) *Attorney, Agent, or Firm* — Allen, Dyer, Doppelt, Milbrath & Gilchrist, P.A.

(57)

ABSTRACT

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

23 Claims, 7 Drawing Sheets





US008878732B1

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

(10) **Patent No.:** **US 8,878,732 B1**

(45) **Date of Patent:** ***Nov. 4, 2014**

(54) **ANTENNA DEVICE OF MOBILE TERMINAL**

(71) Applicant: **Samsung Electronics Co., Ltd.**,
Gyeonggi-do (KR)

(72) Inventors: **Sang Bong Sung**, Gyeongsangbuk-do
(KR); **In Jin Hwang**,
Gyeongsangbuk-do (KR)

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

This patent is subject to a terminal dis-
claimer.

(21) Appl. No.: **14/464,451**

(22) Filed: **Aug. 20, 2014**

Related U.S. Application Data

(63) Continuation of application No. 13/962,483, filed on
Aug. 8, 2013, which is a continuation of application
No. 13/458,453, filed on Apr. 27, 2012, now Pat. No.
8,531,342, which is a continuation of application No.
12/489,044, filed on Jun. 22, 2009, now Pat. No.
8,188,930.

(30) **Foreign Application Priority Data**

Jun. 20, 2008 (KR) 10-2008-0058619

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

(52) **U.S. Cl.**
CPC . **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01)

USPC **343/702**; 343/846

(58) **Field of Classification Search**

CPC H01Q 1/243; H01Q 1/38; H01Q 9/0421

USPC 343/702, 846, 700 MS, 848

See application file for complete search history.

(56) **References Cited**

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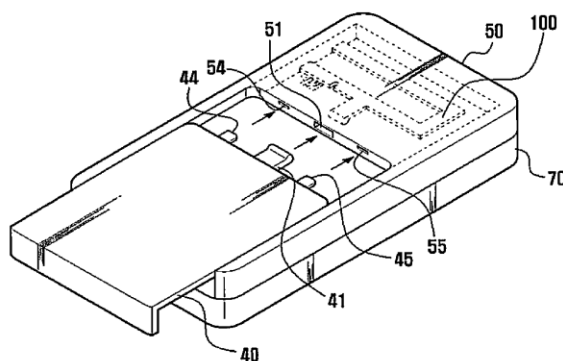
Primary Examiner — Hoanganh Le

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

(57) **ABSTRACT**

Various mobile communication terminals and methods hav-
ing antenna improvements are discussed. One mobile com-
munication terminal is described which includes an outer
front side with a display, an outer rear side having conductive
and non-conductive parts, a battery, and an antenna including
a radiation unit, part of which is located between the outer
front side and the non-conductive part of the outer rear side, a
feeding unit which electrically connects the radiation unit to
a circuit board, and a ground part which is connected to the
conductive part of the outer rear side, electrically connects the
radiation unit to the conductive part of the outer rear side, and
is separated from the feeding unit by a space.

30 Claims, 7 Drawing Sheets





US008880132B2

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

(10) **Patent No.:** **US 8,880,132 B2**

(45) **Date of Patent:** **Nov. 4, 2014**

(54) **MOBILE TERMINAL HAVING ANTENNA**

(75) Inventors: **Oh Yong Kwon**, Hwaseong-si (KR);
Jeon Il Lee, Suwon-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 240 days.

(21) Appl. No.: **13/404,281**

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

(65) **Prior Publication Data**

US 2013/0079069 A1 Mar. 28, 2013

(30) **Foreign Application Priority Data**

Sep. 23, 2011 (KR) 10-2011-0096203

(51) **Int. Cl.**

H04M 1/00 (2006.01)

H01Q 13/16 (2006.01)

H01Q 1/52 (2006.01)

H01Q 1/24 (2006.01)

H01Q 1/48 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 13/16**
(2013.01); **H01Q 1/52** (2013.01); **H01Q 1/48**
(2013.01)

USPC **455/575.7**; 455/575.3; 455/575.4;
455/575.5; 455/575.1; 343/725; 343/718;
343/878; 343/872

(58) **Field of Classification Search**

USPC 455/575.7, 575.1, 575.2, 575.8
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Charles Appiah

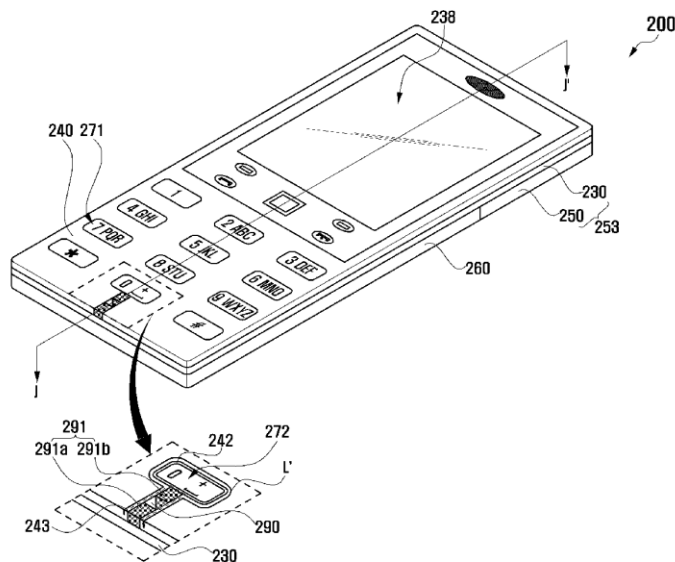
Assistant Examiner — Randy Peaches

(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

A mobile terminal that can prevent radiation performance deterioration of an antenna is provided. The mobile terminal includes a circuit board in which an antenna and one or more key buttons are mounted, a housing mounted on the antenna and the circuit board, and a case for enclosing a periphery of the one or more key buttons and having a plurality of openings according to the quantity of the key buttons, wherein an antenna adjacent opening among the plurality of openings is extended through a slot toward an edge of the case to embody a loop antenna. Therefore, radiation deterioration of an antenna due to a case can be prevented. In addition, production costs can be minimized, and a desired external appearance of the mobile terminal is not compromised.

12 Claims, 12 Drawing Sheets





US008884824B2

(12) **United States Patent**
Andrenko

(10) **Patent No.:** **US 8,884,824 B2**

(45) **Date of Patent:** **Nov. 11, 2014**

(54) **PLANAR INVERTED-F ANTENNA**

H01Q 9/42; H01Q 21/28; H01Q 9/0421;

H01Q 1/243; H01Q 9/0407

See application file for complete search history.

(75) Inventor: **Andrey Andrenko**, Kawasaki (JP)

(73) Assignee: **Fujitsu Limited**, Kawasaki (JP)

(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 181 days.

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(21) Appl. No.: **13/703,604**

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(22) PCT Filed: **Jun. 28, 2010**

(86) PCT No.: **PCT/JP2010/004266**

§ 371 (c)(1),

(2), (4) Date: **Dec. 11, 2012**

(87) PCT Pub. No.: **WO2012/001729**

PCT Pub. Date: **Jan. 5, 2012**

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(65) **Prior Publication Data**

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Primary Examiner — Trinh Dinh

(74) Attorney, Agent, or Firm — Arent Fox LLP

(51) **Int. Cl.**

H01Q 1/04 (2006.01)

H01Q 5/00 (2006.01)

H01Q 9/04 (2006.01)

H01Q 1/52 (2006.01)

H01Q 9/42 (2006.01)

H01Q 1/24 (2006.01)

H01Q 21/28 (2006.01)

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

CPC **H01Q 9/04** (2013.01); **H01Q 9/0421**

(2013.01); **H01Q 5/0072** (2013.01); **H01Q**

1/521 (2013.01); **H01Q 9/42** (2013.01); **H01Q**

1/243 (2013.01); **H01Q 21/28** (2013.01)

USPC **343/700 MS**; **343/767**; **343/702**

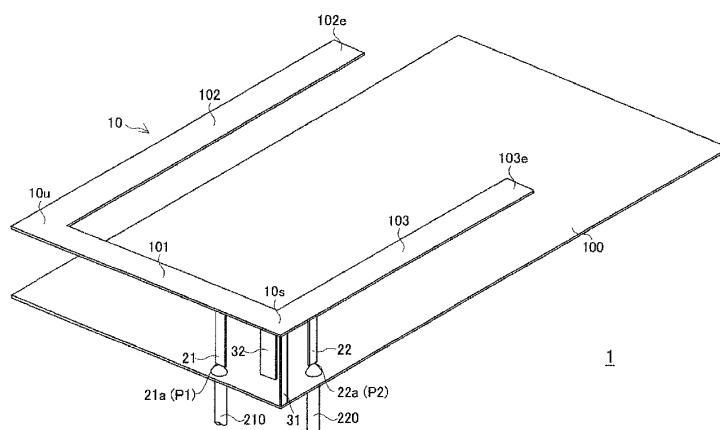
(58) **Field of Classification Search**

CPC H01Q 1/521; H01Q 5/0072; H01Q 9/04;

(57) **ABSTRACT**

The planar inverted-F antenna for multi-band operation is compact while achieving good decoupling performance between feed ports for different frequency bands. The antenna has a ground plane (100); a radiating element having substantially a U-shape; first and second shorting elements (31, 32) located at a first corner (10s) of the radiating element (10) or adjacent area thereof; and first and second feed ports (P1, P2) electrically connected to the radiating element.

5 Claims, 23 Drawing Sheets





US008884825B2

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

(10) **Patent No.:** **US 8,884,825 B2**

(45) **Date of Patent:** **Nov. 11, 2014**

(54) **MULTI-SLOT ANTENNA AND MOBILE DEVICE**

(71) Applicant: **BlackBerry Limited**, Waterloo (CA)

(72) Inventors: **Firass Mirza Badaruzzaman**, Forest Park, IL (US); **Michael Kühn**, Bochum (DE); **Shing Lung Steven Yang**, San Diego, CA (US)

(73) Assignee: **BlackBerry 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 0 days.

(21) Appl. No.: **14/018,923**

(22) Filed: **Sep. 5, 2013**

(65) **Prior Publication Data**

US 2014/0009354 A1 Jan. 9, 2014

Related U.S. Application Data

(63) Continuation of application No. 12/835,601, filed on Jul. 13, 2010, now Pat. No. 8,587,491.

(60) Provisional application No. 61/226,500, filed on Jul. 17, 2009.

(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/00 (2006.01)
H01Q 13/10 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 13/106** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 5/0051** (2013.01); **H01Q 9/0471** (2013.01); **H01Q 13/10** (2013.01); **H01Q 1/243** (2013.01)

USPC **343/700 MS**; 343/767; 343/770

(58) **Field of Classification Search**

USPC 343/700 MS, 767, 770
See application file for complete search history.

(56) **References Cited**

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Primary Examiner — Douglas W Owens

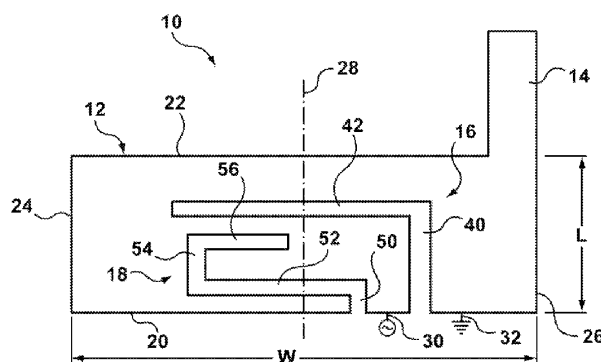
Assistant Examiner — Jae Kim

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

(57) **ABSTRACT**

A mobile communications device having a patch antenna which has defined therein at least two slots each having two or more parts. The at least two slots may include an L-shaped slot and a C-shaped slot, wherein the slots can be open or closed. The L-shaped slot may be an open-slot projecting into the patch antenna from the edge. Ground and signal connections may be at the edge of the patch on either side of the L-shaped slot. The C-shaped slot may be nested within the L-shaped slot.

9 Claims, 9 Drawing Sheets





US008884835B2

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

(10) **Patent No.:** **US 8,884,835 B2**

(45) **Date of Patent:** **Nov. 11, 2014**

(54) **ANTENNA SYSTEM, METHOD AND MOBILE COMMUNICATION DEVICE**

(75) Inventors: **Mauro Pelosi**, Aalborg (DK);
Alexandru Daniel Tatomirescu,
Aalborg (DK); **Mikael Bergholz**
Knudsen, Gistrup (DK); **Gert F.**
Pedersen, Stovorde (DK); **Osama**
Nafeth Alrabadi, Aalborg (DK);
Samantha Caporal Del Barrio, Aalborg
(DK); **Poul Olesen**, Stovring (DK);
Peter Bundgaard, Aalborg (DK)

(73) Assignee: **Intel Mobile Communications GmbH**,
Neubiberg (DE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 202 days.

(21) Appl. No.: **13/570,327**

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

(65) **Prior Publication Data**

US 2014/0043201 A1 Feb. 13, 2014

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

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

(58) **Field of Classification Search**
USPC 343/702, 846, 848, 767, 745, 746
See application file for complete search history.

(56) **References Cited**

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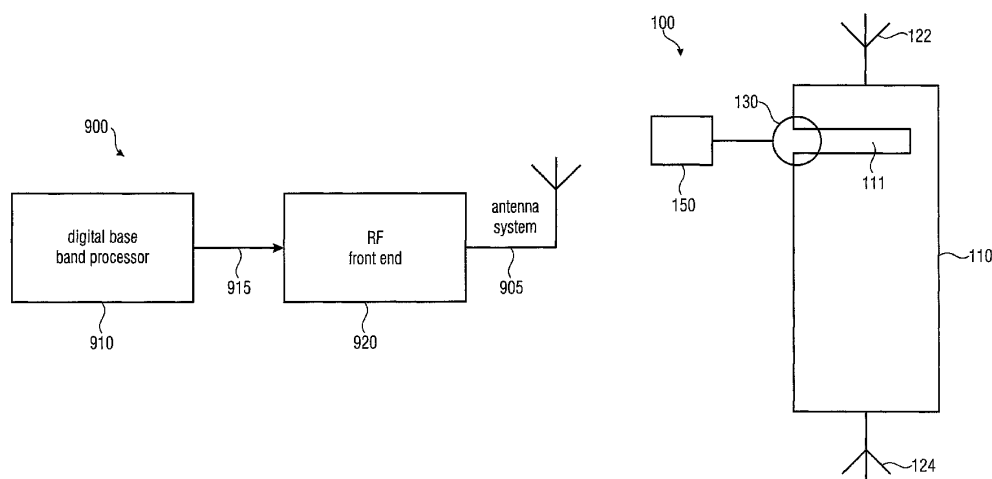
Primary Examiner — Hoang V Nguyen

(74) Attorney, Agent, or Firm — Eschweiler & Associates, LLC

(57) **ABSTRACT**

An antenna system includes a ground plane including at least one slot, a first antenna element coupled to a first portion of the ground plane, a second antenna element coupled to a second portion of the ground plane which is spaced apart from the first portion and a tuner configured to change the influence of the slot to a current flow through the ground plane from the first portion to the second portion.

22 Claims, 14 Drawing Sheets





US008884836B2

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

(10) **Patent No.:** **US 8,884,836 B2**

(45) **Date of Patent:** **Nov. 11, 2014**

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

(75) Inventors: **Byong-Nam Kim**, Kyeonggi-Do (KR);
Young-Hoon Shin, Seoul (KR)

(73) Assignee: **Ace Technologies Corporation**, Incheon (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 518 days.

(21) Appl. No.: **12/811,485**

(22) PCT Filed: **Jan. 8, 2009**

(86) PCT No.: **PCT/KR2009/000095**

§ 371 (c)(1),
(2), (4) Date: **Feb. 8, 2011**

(87) PCT Pub. No.: **WO2009/088231**

PCT Pub. Date: **Jul. 16, 2009**

(65) **Prior Publication Data**

US 2011/0181487 A1 Jul. 28, 2011

(30) **Foreign Application Priority Data**

Jan. 8, 2008 (KR) 10-2008-0002266

(51) **Int. Cl.**
H01Q 3/00 (2006.01)
H01Q 9/38 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/38 (2006.01)
H01Q 5/00 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC . **H01Q 1/36** (2013.01); **H01Q 1/38** (2013.01);

H01Q 5/0058 (2013.01); **H01Q 5/0093**

(2013.01); **H01Q 9/42** (2013.01)

USPC **343/860**; 343/700 MS; 343/861;
343/895

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

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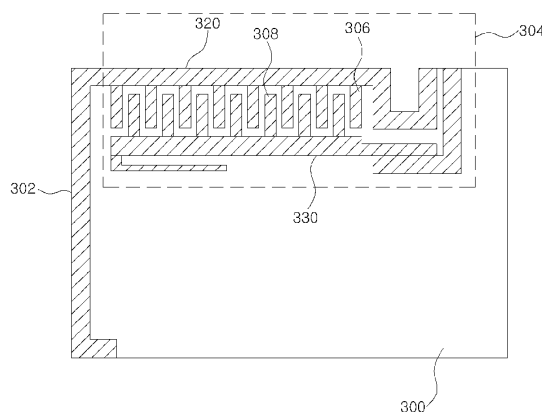
Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Edwards Wildman Palmer LLP; Kongsik Kim; Carolina E. Save

(57) **ABSTRACT**

A multi band internal antenna is disclosed. The antenna may include a board, an impedance matching/feeding part formed on the board, and a first radiation element joined to the impedance matching/feeding part, where the impedance matching/feeding part may include: a first matching element of a particular length that is coupled to a ground, and a second matching element of a particular length that is arranged with a distance from the first matching element and is electrically coupled to a feeding point, and where the distance between the first matching element and the second matching element may vary partially. Thus, a multi band internal antenna can be provided that utilizes coupling matching to achieve wide-band characteristics even for multi-band designs.

8 Claims, 13 Drawing Sheets





US008884837B2

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

(10) **Patent No.:** **US 8,884,837 B2**

(45) **Date of Patent:** **Nov. 11, 2014**

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

(56) **References Cited**

U.S. PATENT DOCUMENTS

(75) Inventors: **Chia-Hao Chang**, Taipei (TW); **Min-Jui Huang**, Taipei (TW)

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(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 404 days.

(21) Appl. No.: **13/220,165**

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(22) Filed: **Aug. 29, 2011**

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CN	1780047	A	5/2006
CN	101420467	A	4/2009

(65) **Prior Publication Data**

US 2012/0050116 A1 Mar. 1, 2012

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(30) **Foreign Application Priority Data**

Aug. 30, 2010 (CN) 2010 1 0266488

Primary Examiner — Trinh Dinh

(74) *Attorney, Agent, or Firm* — Muncy, Geissler, Olds & Lowe, P.C.

(57) **ABSTRACT**

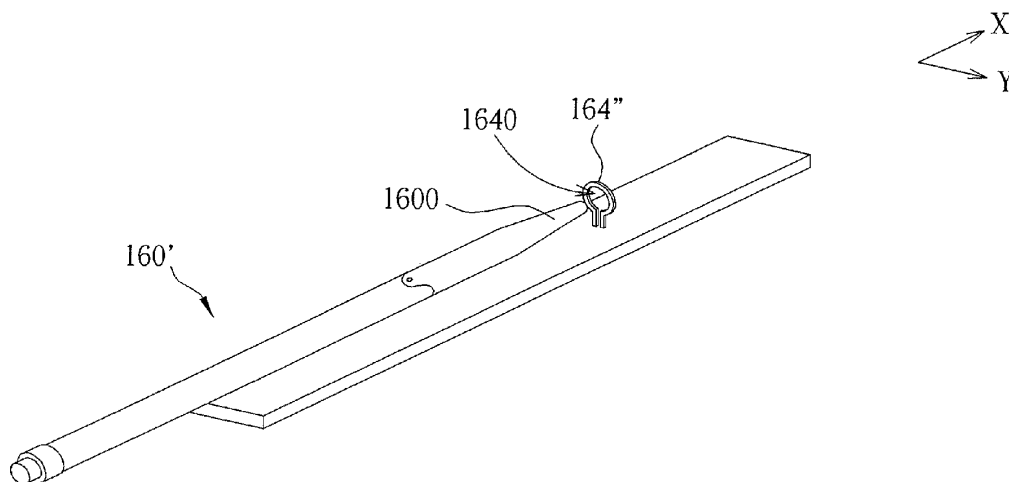
An antenna module includes an antenna body, a signal feeding element and a conducting element. The signal feeding element is mounted on the antenna body, and the antenna body can move between a first position and a second position relative to the signal feeding element. When the antenna body is at the first position, the antenna body contacts and conducts with the conducting element to form a loop. When the antenna body is at the second position, the antenna body does not contact with the conducting element. In an embodiment, antenna receives signal well in both position.

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

(52) **U.S. Cl.**
CPC **H01Q 1/244** (2013.01)
USPC **343/889**; 343/724; 343/906

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

8 Claims, 7 Drawing Sheets





US008890751B2

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

(10) **Patent No.:** **US 8,890,751 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **ANTENNA HAVING A PLANAR CONDUCTING ELEMENT WITH FIRST AND SECOND END PORTIONS SEPARATED BY A NON-CONDUCTIVE GAP**

(75) Inventors: **Forrest D. Wolf**, Reno, NV (US);
Claude Jean Michel Laurent, Aalborg (DK)

(73) Assignee: **Pinyon Technologies, Inc.**, Reno, NV (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 69 days.

(21) Appl. No.: **13/434,594**

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

(65) **Prior Publication Data**

US 2013/0214985 A1 Aug. 22, 2013

Related U.S. Application Data

(60) Provisional application No. 61/599,932, filed on Feb. 17, 2012.

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

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

(58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 1/38
USPC 343/700 MS, 741, 866
See application file for complete search history.

(56) **References Cited**

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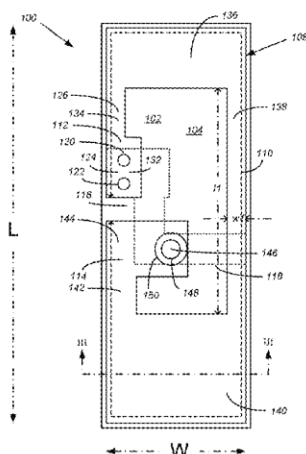
Primary Examiner — Hoang V Nguyen

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

(57) **ABSTRACT**

In one embodiment, an antenna includes a dielectric material and a planar conducting element. The dielectric material has a first side opposite a second side, with the planar conducting element residing on the first side. The planar conducting element defines a conductive path between first and second end portions of the planar conducting element, which end portions are separated by a non-conductive gap. In another embodiment, an antenna has a planar conducting element defining a conductive path between first and second end portions of the planar conducting element. The planar conducting element has at least two different widths transverse to the conductive path. The first and second end portions of the planar conducting element are separated by a non-conductive gap.

5 Claims, 15 Drawing Sheets





US008890752B2

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

(10) **Patent No.:** **US 8,890,752 B2**
(45) **Date of Patent:** **Nov. 18, 2014**

(54) **RECONFIGURABLE ANTENNA**

USPC 343/700 MS; 343/702; 343/853;
343/860

(75) Inventors: **Peter Chun Teck Song**, Birmingham
(GB); **Peter Hall**, Birmingham (GB);
James Robert Kelly, Sheffield (GB)

(58) **Field of Classification Search**
CPC ... H01Q 1/243; H01Q 5/0065; H01Q 5/0072;
H01Q 9/40; H01Q 9/42
USPC 343/702, 745, 850, 852, 853, 860,
343/700 MS
See application file for complete search history.

(73) Assignee: **The University of Birmingham**,
Birmingham (GB)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 278 days.

(56) **References Cited**

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(21) Appl. No.: **13/503,111**

(22) PCT Filed: **Oct. 18, 2010**

(86) PCT No.: **PCT/GB2010/001918**

§ 371 (c)(1),

(2), (4) Date: **Jun. 18, 2012**

(87) PCT Pub. No.: **WO2011/048357**

PCT Pub. Date: **Apr. 28, 2011**

(65) **Prior Publication Data**

US 2012/0242558 A1 Sep. 27, 2012

(30) **Foreign Application Priority Data**

Oct. 21, 2009 (GB) 0918477.1

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 5/00 (2006.01)

H01Q 9/42 (2006.01)

H01Q 9/40 (2006.01)

H01Q 1/24 (2006.01)

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

CPC **H01Q 1/243** (2013.01); **H01Q 5/0065**
(2013.01); **H01Q 5/0072** (2013.01); **H01Q 9/42**
(2013.01); **H01Q 9/40** (2013.01)

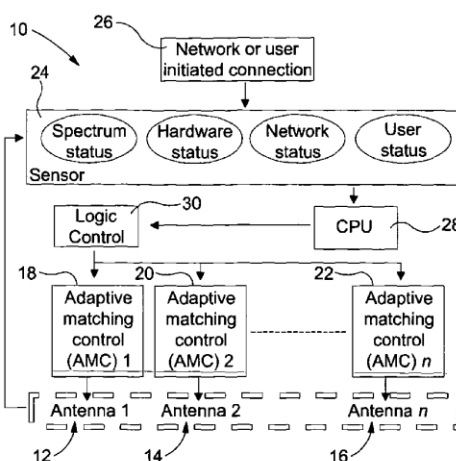
Primary Examiner — Tho G Phan

(74) Attorney, Agent, or Firm — Barnes & Thornburg LLP

(57) **ABSTRACT**

A reconfigurable antenna comprises two or more mutually coupled radiating elements and two or more impedance-matching circuits configured for independent tuning of the frequency band of each radiating element. In addition, each radiating element is arranged for selective operation in each of the following states: a driven state, a floating state and a ground state.

18 Claims, 8 Drawing Sheets





US008890753B1

(12) **United States Patent**
Lee

(10) **Patent No.:** **US 8,890,753 B1**
(45) **Date of Patent:** **Nov. 18, 2014**

(54) **ANTENNA STRUCTURE WITH SPLIT-FEED
ANTENNA ELEMENT AND COUPLED
PARASITIC GROUNDING ELEMENT**

(71) Applicant: **Amazon Technologies, Inc.**, Reno, NV
(US)

(72) Inventor: **Tzung-I Lee**, San Jose, CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Reno, NV
(US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 171 days.

(21) Appl. No.: **13/626,403**

(22) Filed: **Sep. 25, 2012**

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

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01)
USPC **343/702**; 343/846; 343/848

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 5/0027
USPC 343/702, 846, 848
See application file for complete search history.

(56) **References Cited**

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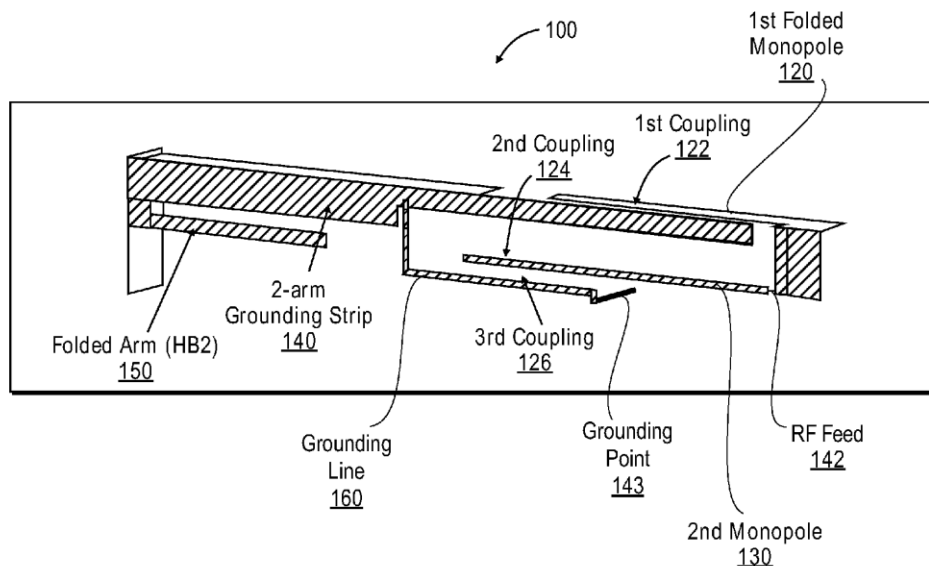
Primary Examiner — Hoang V Nguyen

(74) *Attorney, Agent, or Firm* — Lowenstein Sandler LLP

(57) **ABSTRACT**

Antenna structures of electronic devices and methods of oper-
ating the electronic devices with the antenna structures are
described. One apparatus includes a RF feed coupled to a
split-feed antenna element of an antenna structure. The
antenna structure also includes a parasitic grounding element
coupled to a ground plane. The split-feed antenna element
is configured to operate as a feeding structure to the parasitic
grounding element that is not conductively connected to the
RF feed.

21 Claims, 9 Drawing Sheets





US008890754B2

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

(10) **Patent No.:** **US 8,890,754 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **ANTENNA APPARATUS INTEGRATING
METAL SHELL**

(71) Applicants: **Yen-Hui Lin**, New Taipei (TW);
Chien-Chang Liu, New Taipei (TW)

(72) Inventors: **Yen-Hui Lin**, New Taipei (TW);
Chien-Chang Liu, 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 106 days.

(21) Appl. No.: **13/689,784**

(22) Filed: **Nov. 30, 2012**

(65) **Prior Publication Data**
US 2014/0055304 A1 Feb. 27, 2014

(30) **Foreign Application Priority Data**
Aug. 27, 2012 (TW) 101131082

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

(52) **U.S. Cl.**
CPC **H01Q 1/24** (2013.01)
USPC **343/702; 343/700 MS**

(58) **Field of Classification Search**

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

(56) **References Cited**

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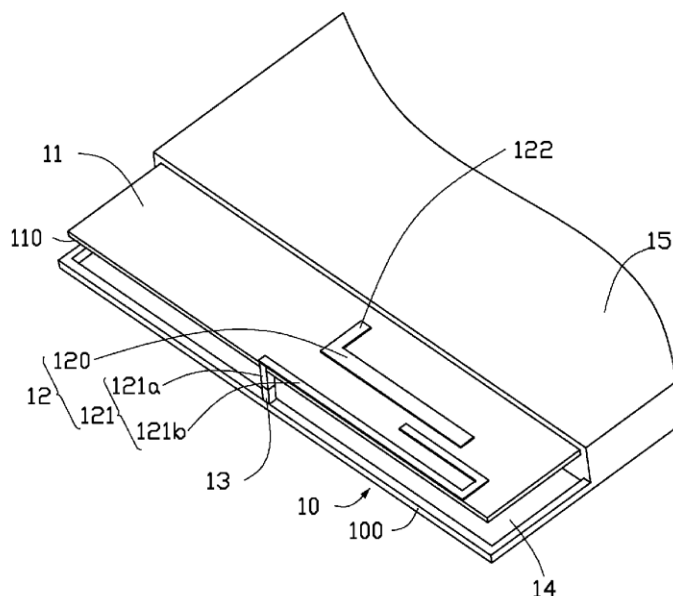
Primary Examiner — Tan Ho

(74) *Attorney, Agent, or Firm* — Novak Druce Connolly
Bove + Quigg LLP

(57) **ABSTRACT**

An antenna apparatus includes a metal shell, a circuit board parallel to the metal shell which forms a space between the circuit board and the shell, a tunable matching circuit mounted in the space with an terminal electrically connected to the shell, and an capacitive feed coupling antenna mounted on the circuit board. The capacitive feed coupling antenna includes a coupling ground strip mounted on the circuit board and a feed strip. The feed strip includes a first portion and a second portion mounted on the circuit board with a portion extending along an edge of the circuit board. The first portion is electrically interconnected between the other terminal of the tunable matching circuit and the second portion.

5 Claims, 2 Drawing Sheets





US008890760B2

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

(10) **Patent No.:** **US 8,890,760 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **DUAL WIDEBAND DIPOLE ANTENNA**

(56) **References Cited**

(71) Applicant: **Southern Taiwan University of Technology**, Tainan (TW)

U.S. PATENT DOCUMENTS

(72) Inventors: **Wen-Shan Chen**, Tainan (TW);
Hung-Ying Lin, Tainan (TW)

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(73) Assignee: **Southern Taiwan University of Science and Technology**, Tainan (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 175 days.

Primary Examiner — Dieu H Duong

(74) *Attorney, Agent, or Firm* — Rosenberg, Klein & Lee

(21) Appl. No.: **13/685,970**

(22) Filed: **Nov. 27, 2012**

(57) **ABSTRACT**

A dual wideband dipole antenna used for wireless communication and receiving electromagnetic signals is revealed. The antenna mainly includes a dielectric substrate, two radiating metal portions and a feed line. Each radiating metal portion consists of a metal plate, an L-shaped metal piece and a rectangular metal sheet. An initial end of the metal plate has a feeding point. The metal plate has a regulatory segment and a projecting segment. The L-shaped metal piece is between a terminal end of the metal plate and the regulatory segment. The L-shaped metal piece has a turning portion. The rectangular metal sheet is between the terminal end of the metal plate and a rear end of the regulatory segment of the other metal plate. The feed line connects the feeding points. Thus the antenna is excited to produce resonance frequencies at 0.85, 1.13, 1.68, 1.93 and 2.29 GHz and cover GSM850/900/1800/1900 bands.

(65) **Prior Publication Data**

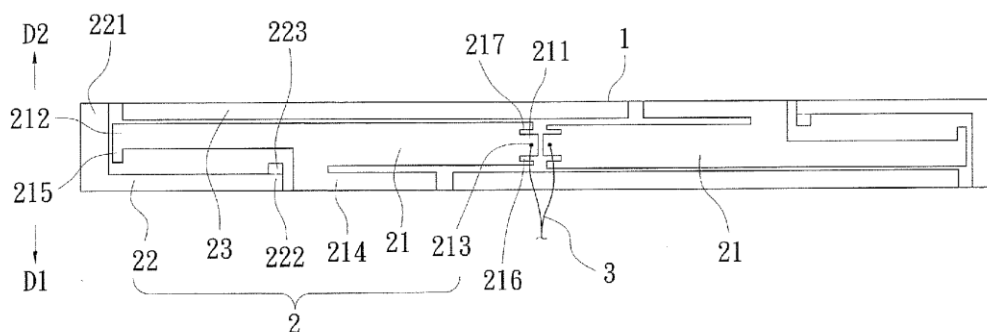
US 2014/0145895 A1 May 29, 2014

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

(52) **U.S. Cl.**
CPC **H01Q 9/16** (2013.01)
USPC **343/795; 343/803**

(58) **Field of Classification Search**
CPC H01Q 9/16
USPC 343/793, 795, 803
See application file for complete search history.

12 Claims, 25 Drawing Sheets





US008890762B2

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

(10) **Patent No.:** **US 8,890,762 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **COMMUNICATION ELECTRONIC DEVICE
AND ANTENNA STRUCTURE THEREOF**

(75) Inventors: **Kin-Lu Wong**, New Taipei (TW);
Yeh-Chun Kao, New Taipei (TW)

(73) Assignee: **Acer Incorporated**, Xizhi Dist., 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 138 days.

(21) Appl. No.: **13/316,547**

(22) Filed: **Dec. 11, 2011**

(65) **Prior Publication Data**

US 2013/0076587 A1 Mar. 28, 2013

(30) **Foreign Application Priority Data**

Sep. 27, 2011 (TW) 100134786 A

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

(52) **U.S. Cl.**
CPC **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01)
USPC **343/848**

(58) **Field of Classification Search**
USPC 343/848
See application file for complete search history.

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Primary Examiner — Dameon E Levi

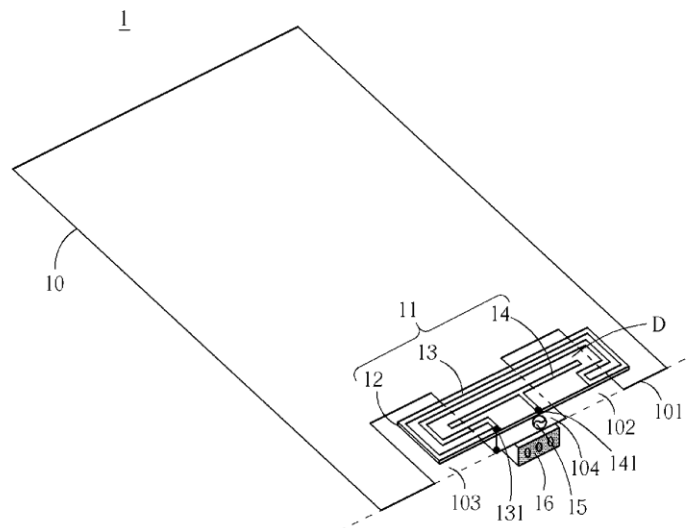
Assistant Examiner — Andrea Lindgren Baltzell

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

(57) **ABSTRACT**

A communication electronic device includes a grounding element and an antenna element. There is a first notch, a second notch and a first protruded portion disposed at an edge of the grounding element, and the first notch and the second notch are not located at corners of the edge of the grounding element. The first protruded portion is located between the first notch and the second notch. The antenna element and the grounding element are disposed on different planes. The antenna element has a projection on the grounding element, and the projection covers a portion of the first protruded portion, a portion of the first notch and a portion of the second notch.

18 Claims, 5 Drawing Sheets





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

- (54)
- MULTIANTENNA UNIT AND COMMUNICATION APPARATUS**

- (75) Inventors: **Daisuke Aizawa**, Daito (JP); **Naoyuki Wakabayashi**, Daito (JP)

- (73) Assignee: **Funai Electric Co., Ltd.**, Daito-shi (JP)

- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 225 days.

- (21) Appl. No.: 13/397,762

- (22) Filed: Feb. 16, 2012

- (65) **Prior Publication Data**

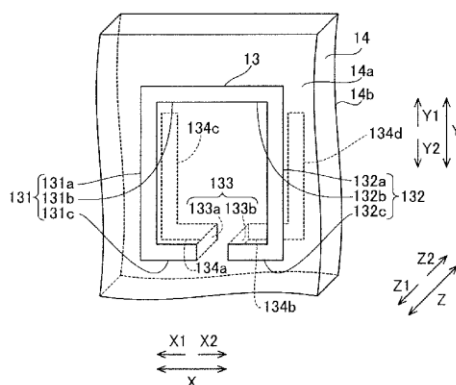
- US 2012/0212389 A1 Aug. 23, 2012

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

- | | | |
|---------------|------------|------------|
| Feb. 21, 2011 | (JP) | 2011-34206 |
| Mar. 22, 2011 | (JP) | 2011-62960 |

- (51) **Int. Cl.**
H01Q 5/01 (2006.01)
H01Q 1/36 (2006.01)
H01Q 21/28 (2006.01)
H01Q 1/52 (2006.01)
H01Q 9/42 (2006.01)

- (52) **U.S. Cl.**
CPC *H01Q 21/28* (2013.01); *H01Q 1/36*
(2013.01); *H01Q 1/521* (2013.01); *H01Q 9/42*
(2013.01)
USPC **343/853**; 343/893; 343/833





US008890766B2

(12) **United States Patent**
Huynh

(10) **Patent No.:** **US 8,890,766 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **LOW PROFILE MULTI-BAND ANTENNAS
AND RELATED WIRELESS
COMMUNICATIONS DEVICES**

(75) Inventor: **Minh-Chau Huynh**, Redwood City, CA
(US)

(73) Assignees: **Sony Corporation**, Lund (SE); **Sony
Mobile Communications AB**, Lund
(SE)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 334 days.

(21) Appl. No.: **13/361,267**

(22) Filed: **Jan. 30, 2012**

(65) **Prior Publication Data**

US 2013/0141303 A1 Jun. 6, 2013

Related U.S. Application Data

(60) Provisional application No. 61/565,728, filed on Dec.
1, 2011.

(51) **Int. Cl.**
H01Q 1/12 (2006.01)
H01Q 25/00 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/02 (2006.01)
H01Q 23/00 (2006.01)

(52) **U.S. Cl.**
USPC **343/878**; 343/879; 343/845; 343/844;
343/700 MS

(58) **Field of Classification Search**
CPC ... H01Q 1/243; H01Q 5/0062; H01Q 9/0457;
H01Q 5/0037; H01Q 13/10
USPC 343/878, 792
See application file for complete search history.

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Primary Examiner — Dameon E Levi

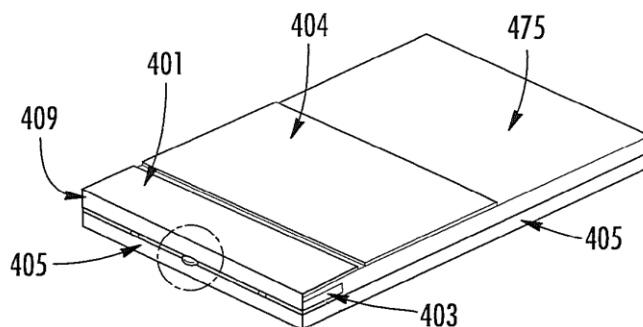
Assistant Examiner — Ricardo Magallanes

(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley &
Sajovec

(57) **ABSTRACT**

Low-profile antenna systems are provided including a ground
plane; an upper antenna element parallel to and spaced apart
from the ground plane; at least one vertical plate configured to
vertically connect the upper antenna element and the ground
plane; first and second metallic wings each connected at one
end to respective sides of the at least one vertical plate and
spaced apart from both the ground plane and the upper anten-
na element; an electrically floating plate on a same plane
as the upper antenna element and spaced apart from the upper
antenna element to provide a gap therebetween; and a metal-
lic feed plate parallel to and between the upper antenna ele-
ment and the ground plane and extending beneath the gap
between the electrically floating plate and the upper antenna
element. Related wireless communications devices are also
provided.

20 Claims, 13 Drawing Sheets





US008891232B2

**(12) United States Patent
Wang****(10) Patent No.: US 8,891,232 B2****(45) Date of Patent: Nov. 18, 2014****(54) SUPPORT STAND AND STANDABLE
HAND-HELD DEVICE****(75) Inventor: Cheng-Lin Wang**, Taoyuan County
(TW)**(73) Assignee: HTC Corporation**, Taoyuan County
(TW)**(*) Notice:** Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 206 days.**(21) Appl. No.: 13/241,223****(22) Filed: Sep. 23, 2011****(65) Prior Publication Data**

US 2013/0077211 A1 Mar. 28, 2013

(51) Int. Cl.**H05K 5/00** (2006.01)**H05K 7/00** (2006.01)**G06F 1/16** (2006.01)**H05K 7/02** (2006.01)**H05K 7/04** (2006.01)**F16L 3/00** (2006.01)**A47F 5/00** (2006.01)**A47F 7/00** (2006.01)**F16M 11/00** (2006.01)**F16M 13/00** (2006.01)**A45D 19/04** (2006.01)**A47J 47/16** (2006.01)**F16M 11/04** (2006.01)**F16M 11/06** (2006.01)**H05K 7/14** (2006.01)**A47G 29/00** (2006.01)**F16M 11/22** (2006.01)**F16M 11/24** (2006.01)**H04N 5/645** (2006.01)**F16M 11/16** (2006.01)**F16M 11/10** (2006.01)**(52) U.S. Cl.**CPC **G06F 1/1613** (2013.01); **F16M 11/04**
(2013.01); **F16M 11/06** (2013.01); **H05K 7/14**
(2013.01); **G06F 1/1601** (2013.01); **G06F**
1/1607 (2013.01); **G06F 1/1637** (2013.01);
F16M 13/005 (2013.01); **A47G 29/00**
(2013.01); **F16M 11/00** (2013.01); **F16M 11/22**
(2013.01); **F16M 11/24** (2013.01); **H04N 5/645**
(2013.01); **H05K 7/00** (2013.01); **G06F 1/16**
(2013.01); **F16M 11/16** (2013.01); **F16M 11/10**
(2013.01); **F16M 2200/028** (2013.01); **Y10S**
248/917 (2013.01); **Y10S 248/918** (2013.01);
Y10S 248/919 (2013.01); **Y10S 248/92**
(2013.01); **Y10S 248/921** (2013.01); **Y10S**
248/922 (2013.01); **Y10S 248/923** (2013.01)USPC **361/679.3**; 361/679.01; 361/679.02;
361/679.21; 361/679.26; 361/679.55; 361/
679.56; 361/679.6; 361/807; 361/809; 361/810;
248/121; 248/122.1; 248/125.1; 248/127;
248/176.1; 248/917; 248/918; 248/919; 248/920;
248/921; 248/922; 248/923**(58) Field of Classification Search**CPC **A47G 29/00**; **F16M 11/00**; **F16M 11/04**;
F16M 11/06; **F16M 11/22**; **F16M 11/24**;
G06F 1/16; **G06F 1/1601**; **G06F 1/1607**;
G06F 1/1613; **G06F 1/1637**; **H04N 5/645**;
H05K 7/00; **H05K 7/14**USPC 361/679.01, 679.02, 679.21,
361/679.55–679.56, 679.26, 679.6, 807,
361/809–810, 679.3; 248/121, 122.1,
248/125.1, 127, 176.1, 917–923

See application file for complete search history.

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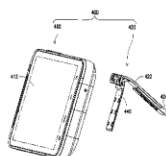
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Primary Examiner — Anthony Haughton

Assistant Examiner — Zhengfu Feng

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

(57) ABSTRACTA support stand suitable for a hand-held device is provided.
The support stand has a first support member and a second
support member. The second support member slidably fits the
first support member and could be temporarily fixed at differ-
ent positions on the first support member to adjust the
length of the support stand. The hand-held device has a dis-
play screen and an antenna. Because the length of the support
stand is variable, the hand-held device could be laid on the
table by various inclination angles. Besides, the projections of
the support stand and the antenna on the display screen are not
overlapped, and the influence of the support stand made of
metal on the signal of the antenna would be lowered.**26 Claims, 13 Drawing Sheets**



US008892049B2

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

(10) **Patent No.:** **US 8,892,049 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **HANDHELD ELECTRONIC DEVICES WITH
ANTENNA POWER MONITORING**

(75) Inventors: **Michael N. Rosenblatt**, Campbell, CA
(US); **Louie J. Sanguinetti**, Los Gatos,
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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 2062 days.

(21) Appl. No.: **11/974,115**

(22) Filed: **Oct. 10, 2007**

(65) **Prior Publication Data**

US 2009/0096683 A1 Apr. 16, 2009

(51) **Int. Cl.**
H04B 17/00 (2006.01)
H01Q 1/24 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/242** (2013.01)
USPC **455/67.11; 343/702; 343/703**

(58) **Field of Classification Search**
USPC **455/67.11; 343/702, 703**
See application file for complete search history.

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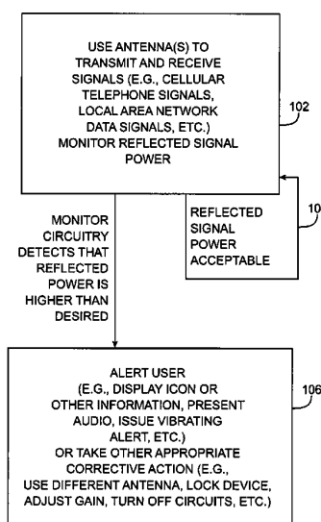
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(57) **ABSTRACT**

Handheld electronic devices are provided that contain wireless communications circuitry. The wireless communications circuitry may include an antenna. A radio-frequency coupler may be coupled to the antenna. Transceiver circuitry may be used to transmit and receive radio-frequency signals through the coupler and the antenna. A reflected power detection circuit may be connected to the coupler. When the transceiver circuitry transmits radio-frequency signals, some of the signals are reflected back from the antenna into the coupler. The coupler directs the reflected antenna signals into the reflected power detection circuit. Processing circuitry may analyze a reflected power signal from the reflected power detection circuit to determine whether operation of the antenna is being disrupted by the placement of a user's hand over the antenna or other proximity effects. If antenna operation is being disrupted, the user may be alerted or other suitable actions may be taken.

17 Claims, 9 Drawing Sheets





US008892160B2

(12) **United States Patent**
Daniel

(10) **Patent No.:** **US 8,892,160 B2**

(45) **Date of Patent:** **Nov. 18, 2014**

(54) **AUTOMATIC DETECTION OF MOBILE
PHONE ANTENNAS**

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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 334 days.

Primary Examiner — Marisol Figueroa

(21) Appl. No.: **13/475,727**

(22) Filed: **May 18, 2012**

(65) **Prior Publication Data**

US 2013/0310107 A1 Nov. 21, 2013

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

(52) **U.S. Cl.**
USPC **455/552.1; 455/550.1**

(58) **Field of Classification Search**
CPC H04W 88/02; H01Q 1/242; H01Q 1/243
USPC 455/550.1, 552.1
See application file for complete search history.

(57) **ABSTRACT**

A method and device is provided that determines whether an antenna is electrically connected to its respective coupling device. The first side of the device includes coupling device, a mechanical switch, and an application processor. The second side includes an antenna contact that that is creates an electrical connection with a coupling device on the first side when the first side is securely attached to the second side. The mechanical switch is configured to be in an "open" state when the antenna contact does not make an electrical connection with the coupling device. Each mechanical switch is configured to be in a "closed" state when the antenna contact does make an electrical connection with its coupling device. The application processor determines the state of each mechanical switch. When any switch is an "open" state, it provides a notification on an interface of the mobile device.

22 Claims, 7 Drawing Sheets

