



US009893422B2

(12) **United States Patent**  
**Chou**

(10) **Patent No.:** **US 9,893,422 B2**  
(45) **Date of Patent:** **Feb. 13, 2018**

(54) **ANTENNA WITH THE EIGHTH OF THE WAVELENGTH**

(71) Applicant: **WISTRON CORP.**, New Taipei (TW)

(72) Inventor: **Chen-Yu Chou**, New Taipei (TW)

(73) Assignee: **WISTRON CORP.**, 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 104 days.

(21) Appl. No.: **14/217,492**

(22) Filed: **Mar. 18, 2014**

(65) **Prior Publication Data**

US 2015/0097750 A1 Apr. 9, 2015

(30) **Foreign Application Priority Data**

Oct. 9, 2013 (TW) ..... 102136603 A

(51) **Int. Cl.**

**H01Q 9/04** (2006.01)  
**H01Q 5/371** (2015.01)  
**H01Q 1/22** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 9/42** (2006.01)

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

CPC ..... **H01Q 5/371** (2015.01); **H01Q 1/22** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 5/371; H01Q 9/42  
USPC ..... 343/700 MS, 702, 843, 848  
See application file for complete search history.

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*Primary Examiner* — Dameon E Levi

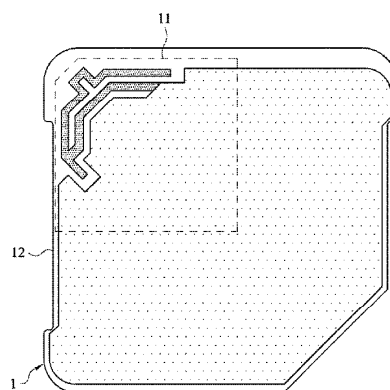
*Assistant Examiner* — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — CKC & Partners Co., Ltd.

(57) **ABSTRACT**

An antenna includes a grounding conductor, a feed conductor, a resonant conductor, and a radioactive conductor. The feed conductor is disposed apart from the grounding conductor. The resonant conductor having a resonant width is disposed along the grounding conductor and disposed apart from the grounding conductor by a resonant-ground distance. The resonant conductor connects to the feed conductor. The radioactive conductor has a radioactive width. One end of the radioactive conductor connects to one end of the resonant conductor with the feed conductor, and another end of the radioactive conductor is disposed apart from the grounding conductor. The radioactive conductor is disposed along the resonant conductor and disposed apart from the resonant conductor by a resonant-radioactive distance. The resonant conductor is positioned between the radioactive conductor and the grounding conductor. A proportion of the resonant-ground distance, the resonant width, the resonant-

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US009893425B2

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

(10) **Patent No.:** **US 9,893,425 B2**

(45) **Date of Patent:** **Feb. 13, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING THE SAME**

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

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Geng-Hong Liou**, New Taipei (TW);  
**Yen-Hui Lin**, New Taipei (TW)

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343/893

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 461 days.

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(21) Appl. No.: **14/523,379**

TW M395272 U1 12/2010

(22) Filed: **Oct. 24, 2014**

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(65) **Prior Publication Data**

US 2015/0180131 A1 Jun. 25, 2015

*Primary Examiner* — Dameon E Levi

*Assistant Examiner* — David Lotter

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

(30) **Foreign Application Priority Data**

Dec. 23, 2013 (CN) ..... 2013 1 0715661

(57) **ABSTRACT**

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

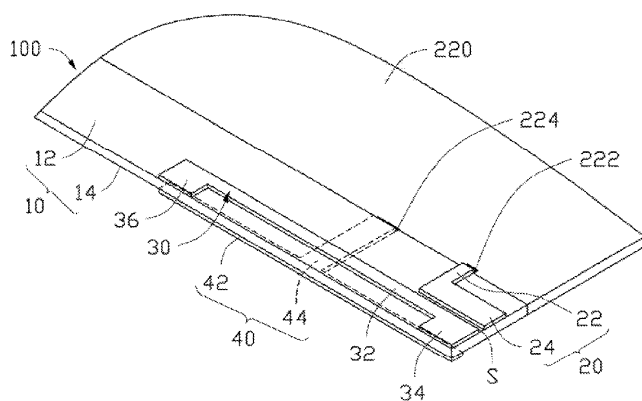
An antenna structure includes a baseplate, a first radiator plate, a second radiator plate, and a third radiator plate. The baseplate has a first surface and a second surface opposite to the first surface. The first radiator plate is disposed on the first surface. The second radiator plate is disposed on the first surface. The third radiator plate is disposed on the second surface. A slot is defined between the first radiator plate and the second radiator plate, and the second radiator plate is coupled to the first radiator plate and the third radiator plate.

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/0414** (2013.01); **H01Q 9/045** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 9/0414; H01Q 9/045

**15 Claims, 5 Drawing Sheets**

200





(10) **Patent No.:** US 9,893,428 B2  
(45) **Date of Patent:** \*Feb. 13, 2018

- (52) **U.S. Cl.**  
CPC ..... *H01Q 13/00* (2013.01); *H01P 3/12*  
(2013.01); *H01P 3/16* (2013.01); *H01P 5/08*  
(2013.01); *H01P 5/107* (2013.01); *H01P 1/50*  
(2013.01); *H01Q 13/02* (2013.01); *H01Q*  
*13/0283* (2013.01); *H01Q 15/141* (2013.01);  
*H01Q 19/10* (2013.01); *H01Q 19/30* (2013.01)

- (58) **Field of Classification Search**  
CPC ..... H01Q 1/50; H01Q 19/10; H01Q 19/30;  
H01P 3/12; H01P 3/16; H01P 5/00; H01P  
5/08; H01P 5/107; H01P 11/00  
See application file for complete search history.

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- Primary Examiner* — Hoang Nguyen

- (74) *Attorney, Agent, or Firm* — Ramey & Schwaller,  
LLP

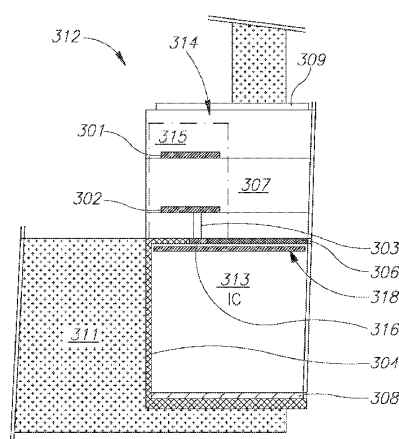
(57) **ABSTRACT**

An assembly for confining electromagnetic radiation in a waveguide. The assembly comprises a waveguide, comprising walls surrounding a cavity and an aperture in the walls that opens to the cavity, and a substrate assembly disposed in the aperture. The substrate assembly comprises a substrate comprising an antenna, wherein the antenna is located within the cavity and is configured for transmission of radiation within the cavity. The substrate assembly comprises an integrated circuit (IC) electrically connected to the substrate, where the IC comprises semi-conductor components and a ground plane on one side of the IC. The ground plane is located between the IC semi-conductor components and the antenna. The ground plane is located across the aperture to reduce the area of the aperture and to reflect some of the radiation directed to the aperture back into the cavity.

**18 Claims, 6 Drawing Sheets**

- (51) **Int. Cl.**  
*H01Q 13/00* (2006.01)  
*H01P 3/12* (2006.01)  
*H01P 3/16* (2006.01)  
*H01P 5/08* (2006.01)  
*H01P 5/107* (2006.01)  
*H01Q 1/50* (2006.01)  
*H01Q 15/14* (2006.01)  
*H01Q 19/10* (2006.01)

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US009893429B2

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

(10) **Patent No.:** **US 9,893,429 B2**  
(45) **Date of Patent:** **Feb. 13, 2018**

(54) **WIDEBAND SLOT ANTENNA FOR WIRELESS COMMUNICATION DEVICES**

(71) Applicant: **Futurewei Technologies, Inc.**, Plano, TX (US)

(72) Inventors: **Shing Lung Steven Yang**, San Diego, CA (US); **Hongyu Wang**, Shenzhen (CN); **Ping Shi**, San Diego, CA (US); **Daejong Kim**, San Diego, CA (US); **Wee Kian Toh**, San Diego, CA (US)

(73) Assignee: **Futurewei Technologies, Inc.**, Plano, TX (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 283 days.

(21) Appl. No.: **13/792,512**

(22) Filed: **Mar. 11, 2013**

(65) **Prior Publication Data**

US 2014/0253399 A1 Sep. 11, 2014

(51) **Int. Cl.**  
**H01Q 13/10** (2006.01)  
**H01Q 21/30** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 13/106** (2013.01); **H01Q 21/30** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 13/106  
USPC ..... 343/770, 702, 725, 867  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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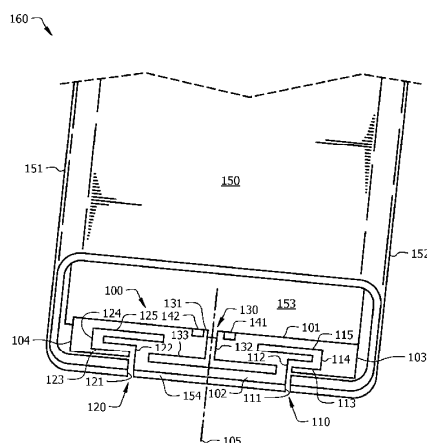
*Primary Examiner* — Dameon E Levi  
*Assistant Examiner* — Walter Davis

(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An antenna comprising a conductive base comprising a west edge, an east edge, a north edge, a south edge, and a center axis, a left slot of nonconductive material extending from the south edge toward the north edge and positioned between the west edge and the center axis, and a right slot of nonconductive material extending from the south edge toward the north edge and positioned between the east edge and the center axis.

**20 Claims, 8 Drawing Sheets**





US009893432B2

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

(10) **Patent No.:** **US 9,893,432 B2**

(45) **Date of Patent:** **Feb. 13, 2018**

(54) **ANISOTROPIC METAMATERIALS FOR ELECTROMAGNETIC COMPATIBILITY**

(71) Applicant: **Board of Regents, The University of Texas System**, Austin, TX (US)

(72) Inventors: **Raymond C. Rumpf**, El Paso, TX (US); **Cesar R. Garcia**, Westminster, CO (US)

(73) Assignee: **BOARD OF REGENTS, THE UNIVERSITY OF TEXAS SYSTEM**, Austin, TX (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.: **15/625,398**

(22) Filed: **Jun. 16, 2017**

(65) **Prior Publication Data**

US 2017/0288301 A1 Oct. 5, 2017

**Related U.S. Application Data**

(63) Continuation of application No. 14/747,914, filed on Jun. 23, 2015, now Pat. No. 9,768,515.

(60) Provisional application No. 62/016,478, filed on Jun. 24, 2014.

(51) **Int. Cl.**  
**H01Q 15/02** (2006.01)  
**H01Q 15/00** (2006.01)  
**H01Q 1/52** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 19/06** (2006.01)  
**H01Q 3/44** (2006.01)  
**H01Q 9/26** (2006.01)  
**H01Q 3/46** (2006.01)  
**H01Q 15/08** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 15/0086** (2013.01); **H01Q 1/526** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/245** (2013.01); **H01Q 3/44** (2013.01); **H01Q 3/46** (2013.01); **H01Q 9/26** (2013.01); **H01Q 15/0006** (2013.01); **H01Q 15/08** (2013.01); **H01Q 19/062** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 15/0006; H01Q 9/26; H01Q 15/08; H01Q 1/243; H01Q 3/44; H01Q 19/062; H01Q 3/46  
USPC ..... 343/909, 908, 911, 702, 700, 753, 754  
See application file for complete search history.

(56) **References Cited**

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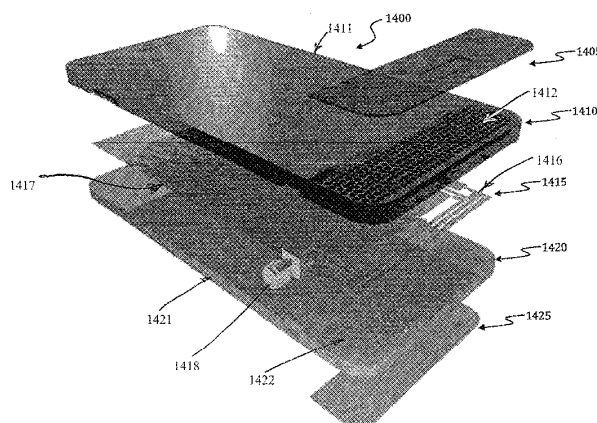
*Primary Examiner* — Joseph Lauture

(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

An electromagnetic device includes: a first layer having a first material with a first dielectric constant, the first layer having a plurality of channels or holes filled with a second material with a second dielectric constant that is different from the first dielectric constant; and, a second layer having a plurality of antennas disposed on the first layer. Adjacent ones of the plurality of channels of the first layer have an average spacing therebetween of less than one quarter of an operating wavelength of at least one of the plurality of antennas.

**28 Claims, 19 Drawing Sheets**





US009894787B2

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

(10) **Patent No.:** **US 9,894,787 B2**

(45) **Date of Patent:** **Feb. 13, 2018**

(54) **SYSTEMS AND METHODS FOR COUPLING SECTIONS OF AN ELECTRONIC DEVICE**

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

(72) Inventors: **Nicholas Merz**, Cupertino, CA (US);  
**Daniel Jarvis**, 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 394 days.

(21) Appl. No.: **14/323,566**

(22) Filed: **Jul. 3, 2014**

(65) **Prior Publication Data**

US 2014/0311767 A1 Oct. 23, 2014

**Related U.S. Application Data**

(63) Continuation of application No. 12/987,741, filed on Jan. 10, 2011, now Pat. No. 8,772,650.

(51) **Int. Cl.**  
**H05K 5/02** (2006.01)  
**G06F 1/16** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H05K 5/0247** (2013.01); **G06F 1/1656** (2013.01); **H05K 5/0004** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC .. G06F 1/1656; H05K 5/0004; H05K 5/0217;  
H05K 5/0247

See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — William H Mayo, III

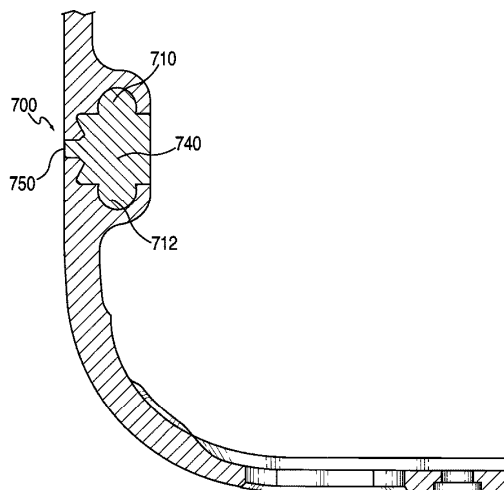
*Assistant Examiner* — Hiram E Gonzalez

(74) *Attorney, Agent, or Firm* — Brownstein Hyatt Farber Schreck, LLP

(57) **ABSTRACT**

This is directed to systems and methods for coupling sections of an electronic device together. Sections of an electronic device can be coupled together via “knuckles.” The particular shape and structure of the knuckles can be based on various design considerations. For example, in some embodiments each section can function as an individual antenna. In this case, the knuckles can be designed in order to provide electrical isolation between the sections, thus allowing proper operation of the antennas. For example, the knuckles can be formed from a dielectric material, etc. As another design example, the knuckles can be designed in order to provide increased strength in areas of high strain, and/or to counteract torsional twisting in areas of high impact. As yet another design example, the knuckle can be designed in a manner that is aesthetically pleasing or which otherwise meets cosmetic requirements.

**18 Claims, 15 Drawing Sheets**





US009899728B2

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

(10) **Patent No.:** **US 9,899,728 B2**

(45) **Date of Patent:** **Feb. 20, 2018**

(54) **MOBILE TERMINAL**

(71) Applicant: **HUAWEI DEVICE (DONGGUAN) CO., LTD.**, Dongguan (CN)

(72) Inventors: **Hongyu Wang**, Shenzhen (CN); **Yufei Sun**, Shanghai (CN); **Huimin Zhang**, Shenzhen (CN); **Dongjian Zhang**, Shenzhen (CN); **Kun Feng**, Shanghai (CN)

(73) Assignee: **HUAWEI DEVICE (DONGGUAN) CO., LTD.**, Dongguan (CN)

(\*) 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.: **14/947,042**

(22) Filed: **Nov. 20, 2015**

(65) **Prior Publication Data**

US 2016/0079659 A1 Mar. 17, 2016

**Related U.S. Application Data**

(63) Continuation of application No. PCT/CN2014/077949, filed on May 21, 2014.

(30) **Foreign Application Priority Data**

May 22, 2013 (CN) ..... 2013 1 0196497

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

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/48** (2013.01); **H01Q 21/28** (2013.01); **H04M 1/0283** (2013.01)

(58) **Field of Classification Search**

USPC ..... 343/702, 700 MS

See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Jessica Han

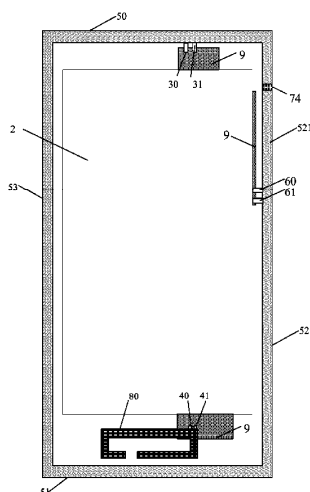
*Assistant Examiner* — Hai Tran

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

(57) **ABSTRACT**

An embodiment of the present invention discloses a mobile terminal, which relates to the field of communications technologies and is invented to enable the mobile terminal to have relatively good metal texture and appearance. The mobile terminal includes a metal rear cover used as a grounding component and at least one antenna, where the antenna includes a grounding pin, and the grounding pin is electrically connected to the metal rear cover. The present invention is mainly applicable to mobile terminal products.

**17 Claims, 8 Drawing Sheets**





US009899729B2

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

(10) **Patent No.:** **US 9,899,729 B2**  
(45) **Date of Patent:** **Feb. 20, 2018**

(54) **ANTENNA SYSTEM**

(71) Applicants: **Jianchun Mai**, Shenzhen (CN); **Chao Wang**, Shenzhen (CN)

(72) Inventors: **Jianchun Mai**, Shenzhen (CN); **Chao Wang**, Shenzhen (CN)

(73) Assignee: **AAC TECHNOLOGIES PTE. LTD.**, Singapore (SG)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 162 days.

(21) Appl. No.: **15/011,458**

(22) Filed: **Jan. 29, 2016**

(65) **Prior Publication Data**

US 2017/0012341 A1 Jan. 12, 2017

(30) **Foreign Application Priority Data**

Jul. 9, 2015 (CN) ..... 2015 2 0493051 U

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 13/16** (2006.01)  
**H01Q 21/28** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 13/10** (2013.01); **H01Q 13/16** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 21/28; H01Q 1/24; H01Q 13/10  
USPC ..... 343/702  
See application file for complete search history.

(56) **References Cited**

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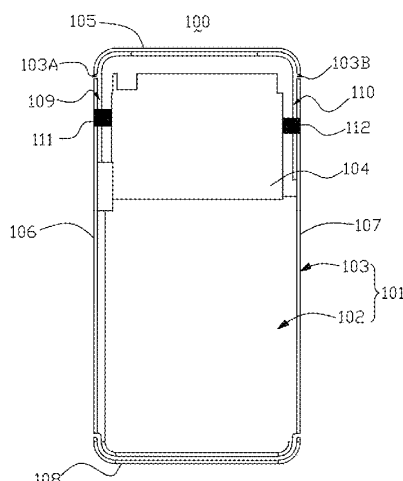
*Primary Examiner* — Huedung Mancuso

(74) *Attorney, Agent, or Firm* — Na Xu; IPro, PLLC

(57) **ABSTRACT**

An antenna system applicable to a mobile communication device is provided in the present disclosure. The antenna system includes a metal shell with a metal frame and a metal back cover, a printed circuit board (PCB) housed in the metal shell, and an antenna part with a first feed point and a second feed point. A first break point and a second break point are formed at two opposite sides of the metal frame; a first gap and a second gap are respectively formed at two opposite sides of the metal back cover for defining a first clearance area and a second clearance area. The first feed point is located in the first clearance area and contacts a left frame portion of the metal frame; the second feed point is located in the second clearance area and contacts a right frame portion of the metal frame.

**8 Claims, 2 Drawing Sheets**







US009899730B2

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

(10) **Patent No.:** **US 9,899,730 B2**

(45) **Date of Patent:** **Feb. 20, 2018**

(54) **BROADBAND ANTENNA IN THE CRASH PAD FOR VEHICLE**

(71) Applicants: **Tae Hoon Yang**, Gyeonggi-do (KR);  
**Sung Min Cho**, Gyeonggi-do (KR);  
**Sang A Ju**, Gyeonggi-do (KR); **Byeong Chan Yu**, Gyeonggi-do (KR); **Sang Hoon Lim**, Gyeonggi-do (KR); **Jin Kyu Hwang**, Incheon (KR)

(72) Inventors: **Tae Hoon Yang**, Gyeonggi-do (KR);  
**Sung Min Cho**, Gyeonggi-do (KR);  
**Sang A Ju**, Gyeonggi-do (KR); **Byeong Chan Yu**, Gyeonggi-do (KR); **Sang Hoon Lim**, Gyeonggi-do (KR); **Jin Kyu Hwang**, Incheon (KR)

(73) Assignee: **INFAC ELECS 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.

(21) Appl. No.: **15/600,239**

(22) Filed: **May 19, 2017**

(65) **Prior Publication Data**

US 2017/0346174 A1 Nov. 30, 2017

(30) **Foreign Application Priority Data**

May 31, 2016 (KR) ..... 10-2016-0067483

(51) **Int. Cl.**  
**H01Q 1/32** (2006.01)  
**H01Q 5/371** (2015.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/3291** (2013.01); **H01Q 5/371** (2015.01); **H04B 1/3827** (2013.01); **H04B 1/40** (2013.01); **H01Q 21/28** (2013.01); **H01Q 21/30** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01C 1/3275  
See application file for complete search history.

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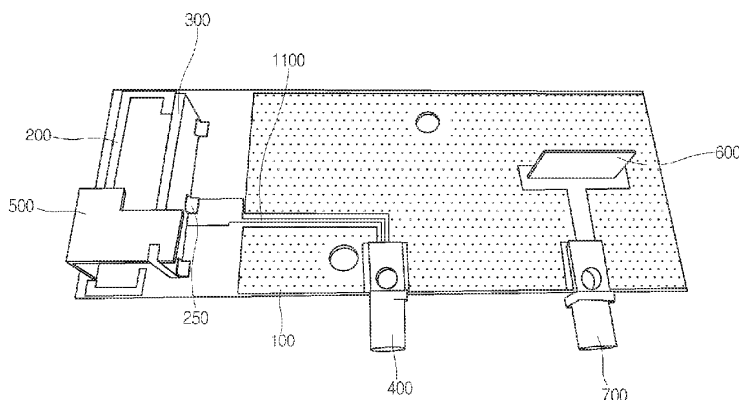
*Primary Examiner* — Hsin-Chun Liao

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

(57) **ABSTRACT**

Disclosed herein is a vehicle broadband antenna that is an antenna for LTE & V2X installed in the vicinity of a crash pad of a vehicle. The crash pad broadband antenna is installed in the vicinity of a vehicle crash pad and includes a main PCB, an LTE low-band antenna pattern formed on the main PCB to transmit and receive an LTE low-band signal, a first sub-PCB having LTE high-band antenna patterns configured to transmit and receive an LTE high-band signal, the first sub-PCB being vertically coupled to the main PCB, and a first terminal connected to an external communication module for transmitting and receiving the signals to/from the LTE low-band antenna pattern and the LTE high-band antenna patterns. It is possible to overcome existing spatial limitations by applying the broadband antenna to the vehicle, and to significantly reduce the time required to manufacture and develop an existing mold.

**12 Claims, 7 Drawing Sheets**





(45) **Date of Patent:** **Feb. 20, 2018**

See application file for complete search history.

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*Primary Examiner* — Graham Smith

(74) *Attorney, Agent, or Firm* — Fitzpatrick, Cella, Harper & Scinto

(57) **ABSTRACT**

An antenna that comprises a feeding point, a first conductor and a second conductor is provided. The first conductor is connected to the feeding point, includes, as an open end, an end which is not connected to the feeding point, and has a linear shape. The second conductor is formed to branch from the first conductor, includes, as an open end, an end on an opposite side of a point branching from the first conductor, and has a linear shape. At least part of the first conductor and at least part of the second conductor are formed on different planes and include coupling portions electromagnetically coupled to each other.

*H01Q 1/24* (2006.01)

*H01Q* 9/42 (2006.01)

**H01Q 1/50** (2006.01)

*H01Q 5/30* (2015.01)

U.S. Cl.

CPC ..... *H01Q 9/0407* (2013.01); *H01Q 1/243*

(2013.01);  $\tilde{H}01Q$  1/50 (2013.01);  $H01Q$  5/30

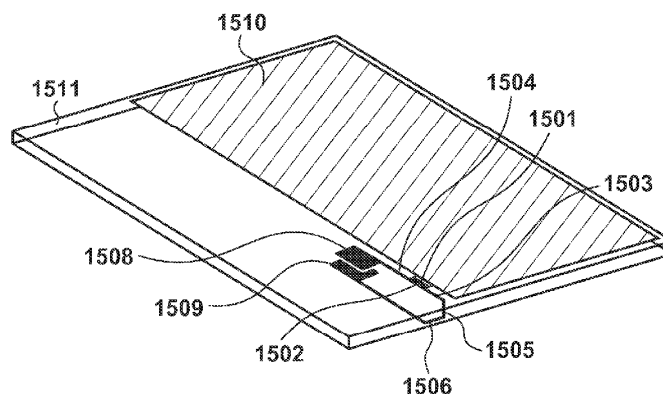
(2015.01); *H01Q* 5/371 (2015.01); *H01Q* 9/40

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

(58) **Field of Classification Search**

CPC ..... H01Q 9/24; H01Q 1/243

**12 Claims, 18 Drawing Sheets**





US009899739B2

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

(10) **Patent No.:** **US 9,899,739 B2**

(45) **Date of Patent:** **\*Feb. 20, 2018**

(54) **HYBRID ANTENNA**

(71) Applicant: **MediaTek Inc.**, Hsin-Chu (TW)

(72) Inventors: **Kuo-Fong Hung**, Changhua (TW);  
**Chia-Wei Chi**, Taipei (TW)

(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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/162,850**

(22) Filed: **May 24, 2016**

(65) **Prior Publication Data**

US 2016/0268690 A1 Sep. 15, 2016

**Related U.S. Application Data**

(62) Division of application No. 13/868,383, filed on Apr. 23, 2013, now Pat. No. 9,608,332.

(51) **Int. Cl.**  
**H01Q 1/38** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/357** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/357** (2015.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/243; H01Q 1/38; H01Q 9/42  
See application file for complete search history.

(56) **References Cited**

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| 2011/0109509 A1 | 5/2011  | Chou et al. |           |

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| CN | 202633498 | 12/2012 |
| JP | 10270920  | 10/1998 |

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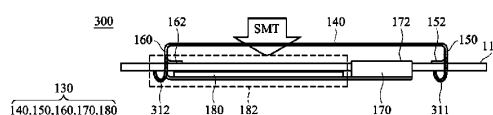
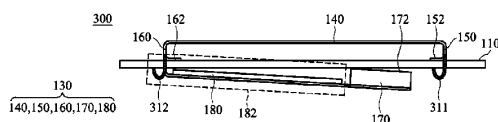
*Primary Examiner* — Dieu H Duong

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

(57) **ABSTRACT**

A hybrid antenna includes a dielectric substrate and a stamping element. The stamping element includes a main radiator, a first holder, a second holder, a feeding element, and an extension branch. The main radiator is substantially disposed above the dielectric substrate. The first holder is coupled to a first end of the main radiator. The second holder is coupled to a second end of the main radiator. The feeding element is coupled to a signal source. The extension branch is substantially disposed below the dielectric substrate, and is coupled between the second holder and the feeding element.

**4 Claims, 8 Drawing Sheets**





US009899740B2

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

(10) **Patent No.:** **US 9,899,740 B2**

(45) **Date of Patent:** **\*Feb. 20, 2018**

(54) **HYBRID ANTENNA**

(71) Applicant: **MediaTek Inc.**, Hsin-Chu (TW)

(72) Inventors: **Kuo-Fong Hung**, Changhua (TW);  
**Chia-Wei Chi**, Taipei (TW)

(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 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/384,828**

(22) Filed: **Dec. 20, 2016**

(65) **Prior Publication Data**

US 2017/0104273 A1 Apr. 13, 2017

**Related U.S. Application Data**

(63) Continuation of application No. 13/868,383, filed on Apr. 23, 2013, now Pat. No. 9,608,332.

(51) **Int. Cl.**  
**H01Q 1/38** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/357** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/42** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/38** (2013.01); **H01Q 5/357** (2015.01); **Y10T 29/49016** (2015.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 9/42; H01Q 1/38; H01Q 5/357

See application file for complete search history.

(56) **References Cited**

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| 9,608,332 B2 *  | 3/2017  | Hung ..... H01Q 9/42 |
| 2007/0008221 A1 | 1/2007  | Tseng                |
| 2009/0256763 A1 | 10/2009 | Chi                  |
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| JP | 10270920  | 10/1998 |

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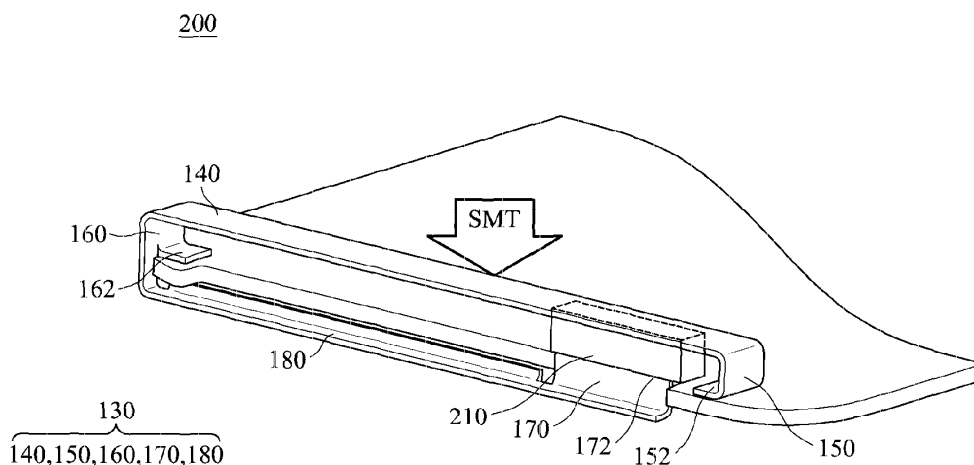
*Primary Examiner* — Dieu H Duong

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

(57) **ABSTRACT**

A hybrid antenna (and related method for manufacturing the antenna) includes a dielectric substrate and a stamping element. The stamping element includes a main radiator, a first holder, a second holder, a feeding element, an extension branch, a first trace, and a first via. The main radiator is substantially disposed above the dielectric substrate. The first holder is coupled to a first end of the main radiator. The second holder is coupled to a second end of the main radiator. The feeding element is coupled to a signal source. The extension branch is substantially disposed below the dielectric substrate, and is coupled between the second holder and the feeding element. The first trace is disposed on a second surface of the dielectric substrate, and the first via is formed through the dielectric substrate, and coupled between an end of the first trace and the first holder.

**22 Claims, 8 Drawing Sheets**





US009900038B2

(12) **United States Patent**  
**Chou**

(10) **Patent No.:** **US 9,900,038 B2**

(45) **Date of Patent:** **Feb. 20, 2018**

(54) **COMMUNICATION DEVICE**

(71) Applicant: **JIENG TAI INTERNATIONAL  
ELECTRONIC CORP.**, New Taipei  
(TW)

(72) Inventor: **Yu-Pang Chou**, New Taipei (TW)

(73) Assignee: **JIENG TAI INTERNATIONAL  
ELECTRONIC CORP.**, 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 0 days.

(21) Appl. No.: **15/245,158**

(22) Filed: **Aug. 23, 2016**

(65) **Prior Publication Data**  
US 2017/0294931 A1 Oct. 12, 2017

(30) **Foreign Application Priority Data**  
Apr. 8, 2016 (TW) ..... 105111107 A

(51) **Int. Cl.**  
**H04B 1/40** (2015.01)  
**H04B 1/3827** (2015.01)  
**H01Q 1/52** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H04B 1/3833** (2013.01); **H01Q 1/52**  
(2013.01)

(58) **Field of Classification Search**

CPC ..... H04B 1/40; H04B 1/3822; H04B 1/406;  
H04B 1/44; H04B 1/48; H04B 1/525;  
H04B 1/18  
USPC ..... 455/75, 76, 77, 78, 550.1  
See application file for complete search history.

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343/745  
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455/77

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*Primary Examiner* — Nhan Le

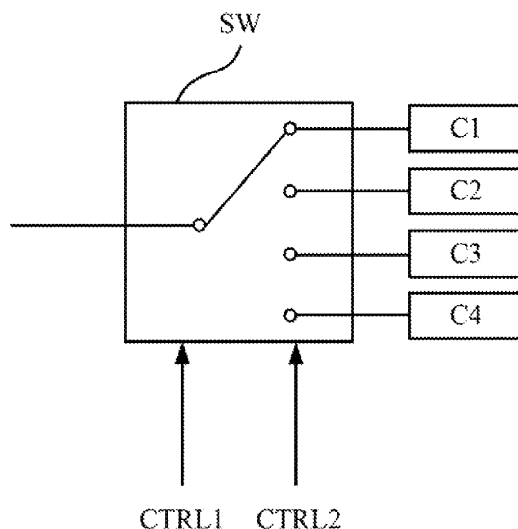
(74) *Attorney, Agent, or Firm* — CKC & Partners Co.,  
Ltd.

(57) **ABSTRACT**

A communication device includes an antenna unit, an adjustment unit and a sensing and processing unit. The sensing and processing unit is electrically coupled to the antenna unit and the adjustment unit. The antenna unit is configured to transmit a radio frequency (RF) signal. The adjustment unit is configured to adjust a frequency and a bandwidth of the RF signal. The sensing and processing unit is configured to sense a capacitance, so as to control the adjustment unit to adjust the frequency of the RF signal according to the capacitance, and to control the adjustment unit to adjust the bandwidth of the RF signal according to a system signal.

**9 Claims, 5 Drawing Sheets**

530





US009905908B2

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

(10) **Patent No.:** **US 9,905,908 B2**

(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ANTENNA STRUCTURE WITH PROXIMITY SENSOR**

(71) Applicant: **LUXSHARE-ICT CO., LTD.**, Taipei (TW)

(72) Inventors: **Ching Chung Tang**, Taoyuan County (TW); **Sheng Hsin Chang**, Kaohsiung (TW)

(73) Assignee: **LUXSHARE PRECISION INDUSTRY CO., LTD.**, Shenzhen, Guangdong Province (CN)

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

(21) Appl. No.: **14/154,858**

(22) Filed: **Jan. 14, 2014**

(65) **Prior Publication Data**

US 2015/0200447 A1 Jul. 16, 2015

(51) **Int. Cl.**  
**H01Q 1/44** (2006.01)  
**H01Q 5/00** (2015.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/371** (2015.01)  
**H01Q 5/378** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 5/371** (2015.01); **H01Q 5/378** (2015.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/44; H01Q 1/2258; H01Q 1/2266; H01Q 1/2291; H01Q 1/24; H01Q 1/241;

H01Q 1/242; H01Q 1/243; H01Q 5/307; H01Q 5/342; H01Q 5/357; H01Q 5/364; H01Q 5/371; H01Q 5/378; H01Q 5/392

USPC ..... 343/720  
See application file for complete search history.

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455/575.7  
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*Primary Examiner* — Tho G Phan

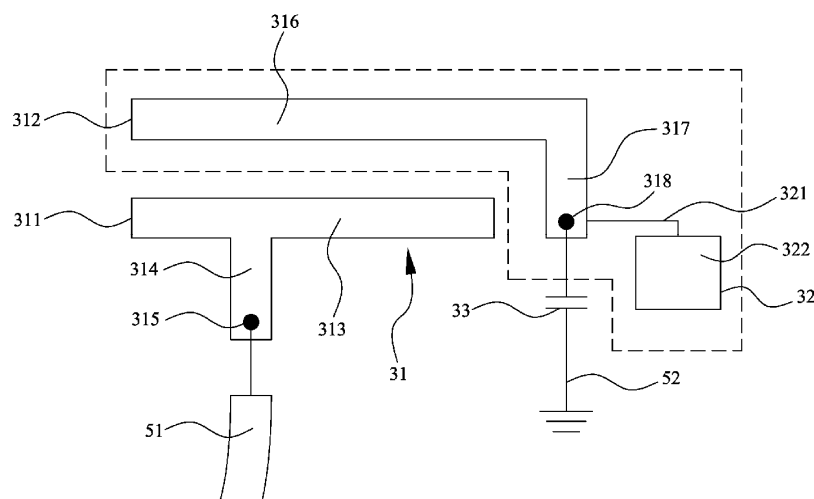
*Assistant Examiner* — Patrick Holecek

(74) *Attorney, Agent, or Firm* — Cheng-Ju Chiang

(57) **ABSTRACT**

An antenna structure includes a dielectric layer, on one side thereof a patterned conductive layer, a proximity sensor and a capacitor are provided. The patterned conductive layer includes a first and a second conductive layer that together form a coupled-fed antenna and respectively have a first and a second feed terminal connected to a signal feed line and a ground signal line. The proximity sensor includes a peripheral circuit connected to the second feed terminal, and a capacitance to digital circuit. The capacitor is connected between the ground signal line and the second feed terminal. By integrating the coupled-fed antenna and the proximity sensor on one circuit substrate, a part of the antenna can be used as the proximity sensor's capacitor electrode to reduce the volume and manufacturing cost of the antenna, and the proximity sensor is not interfered by other parts of the antenna and thereby has increased sensitivity.

**9 Claims, 9 Drawing Sheets**





US009905909B2

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

(10) **Patent No.:** **US 9,905,909 B2**  
(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ANTENNA MODULE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Geng-Hong Liou**, New Taipei (TW);  
**Yen-Hui Lin**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 188 days.

(21) Appl. No.: **14/868,551**

(22) Filed: **Sep. 29, 2015**

(65) **Prior Publication Data**

US 2017/0093020 A1 Mar. 30, 2017

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 1/50** (2006.01)  
**H01Q 5/328** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/50** (2013.01); **H01Q 5/328** (2015.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 1/50; H01Q 13/10  
USPC ..... 343/702, 767  
See application file for complete search history.

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|                   |        |        |       | 343/729    |

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*Primary Examiner* — Dameon E Levi

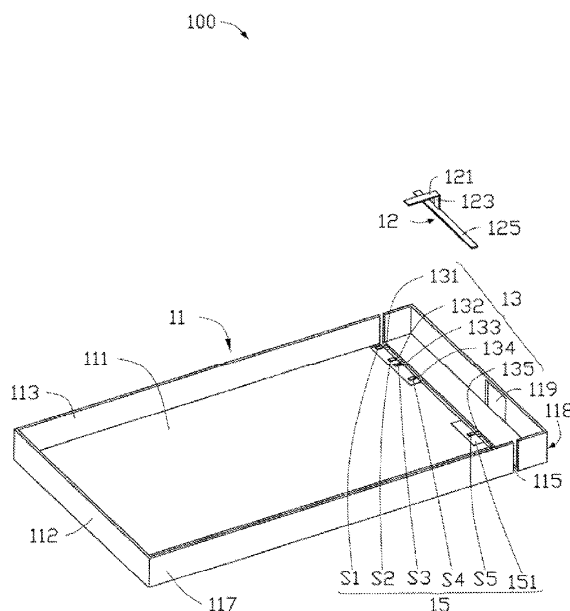
*Assistant Examiner* — Hasan Islam

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

(57) **ABSTRACT**

An antenna module includes a metallic member and a first radiating portion. The metallic member defines a slot. The slot is configured to divide the metallic member into a first metallic portion and a second metallic portion. The second metallic portion is spaced apart from the first metallic portion. The first radiating portion is positioned in the second metallic portion and is spaced apart from the second metallic portion. The first metallic portion is grounded. The first radiating portion is configured to receive a current signal and couple the current signal to the second metallic portion. The second metallic portion and the first metallic portion are configured to cooperatively activate a plurality of resonating modes through the slot.

**18 Claims, 8 Drawing Sheets**





US009905910B2

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

(10) **Patent No.:** **US 9,905,910 B2**  
(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ELECTRONIC DEVICE AND MULTI-BAND ANTENNA**

(56) **References Cited**

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(71) Applicant: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

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343/702  
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343/720

(72) Inventors: **Wei-Yu Chen**, New Taipei (TW);  
**Yueh-Chu Lin**, 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 102 days.

(21) Appl. No.: **14/886,615**

(22) Filed: **Oct. 19, 2015**

(65) **Prior Publication Data**

US 2017/0047950 A1 Feb. 16, 2017

(30) **Foreign Application Priority Data**

Aug. 11, 2015 (CN) ..... 2015 1 0488121

(51) **Int. Cl.**  
**H01Q 1/24** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 21/28** (2006.01)  
**H01Q 5/371** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/371**  
(2015.01); **H01Q 9/42** (2013.01); **H01Q 21/28**  
(2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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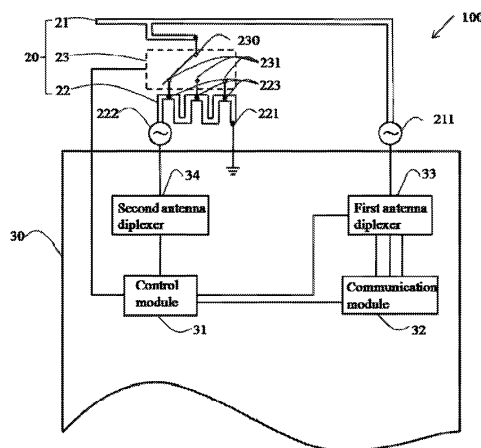
*Primary Examiner* — Christopher Grey

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

(57) **ABSTRACT**

An electronic device with multi-band antenna includes a first antenna frame, a second antenna frame, and a switching unit being electrically coupled between the first antenna frame and the second antenna frame. A first feed point only is located on the first antenna frame and multiple electrical connection points, a second feed point, and a ground point are located on the second antenna frame. One end of the first antenna frame can be connected to one of the electrical connection points by controlling the switching unit, and multiple radiating elements, able to radiate signals in different frequency bands, are formed on the multi-band antenna. Radiating elements are formed between the first feed point and the second feed point and the ground point.

**11 Claims, 1 Drawing Sheet**







US009905911B2

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

(10) **Patent No.:** **US 9,905,911 B2**

(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ANTENNA FOR ELECTRONIC DEVICE**

USPC ..... 343/845

See application file for complete search history.

(71) Applicant: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

(56) **References Cited**

(72) Inventors: **Wei-Yu Chen**, New Taipei (TW);  
**Yueh-Chu Lin**, New Taipei (TW)

U.S. PATENT DOCUMENTS

(73) Assignee: **HON HAI PRECISION INDUSTRY CO., LTD.**, New Taipei (TW)

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343/702  
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343/845

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

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*Primary Examiner* — Andrea Lindgren Baltzell

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

(21) Appl. No.: **14/920,613**

(22) Filed: **Oct. 22, 2015**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2017/0062930 A1 Mar. 2, 2017

An electronic device includes a control module, a first antenna frame, and a second antenna frame. A first ground point, a first feed point, and a second ground point are respectively located on the first antenna frame. A second feed point, a third ground point, and a third feed point are respectively located on the second antenna frame. A switching unit and a low-pass circuit being electrically coupled between one end portion of the first antenna frame and one end portion of the second antenna frame, wherein the switching unit is controlled by the control module to selectively connect the first antenna frame and the second antenna frame. If the switching unit is closed, an antenna element formed between the first ground point and the third feed point is enabled, and the antenna element is operated to receive and/or transmit low frequency signal.

(30) **Foreign Application Priority Data**

Aug. 31, 2015 (CN) ..... 2015 1 0546222

(51) **Int. Cl.**

**H01Q 9/42** (2006.01)

**H01Q 1/24** (2006.01)

**H01Q 5/35** (2015.01)

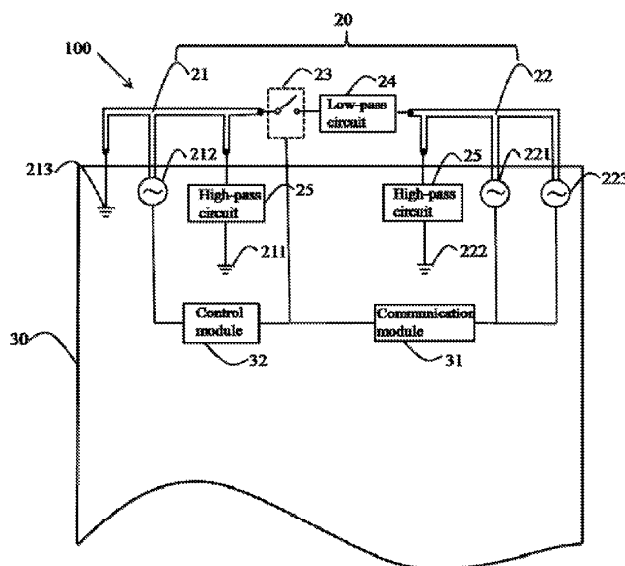
(52) **U.S. Cl.**

CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/243; H01Q 5/35; H01Q 9/42

**13 Claims, 1 Drawing Sheet**





US009905912B2

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

(10) **Patent No.:** **US 9,905,912 B2**

(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ANTENNA MODULE**

(71) Applicant: **PEGATRON CORPORATION**, Taipei (TW)

(72) Inventors: **Chien-Yi Wu**, Taipei (TW);  
**Cheng-Hsiung Wu**, Taipei (TW);  
**Chao-Hsu Wu**, Taipei (TW);  
**Shih-Keng Huang**, Taipei (TW)

(73) Assignee: **PEGATRON 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 0 days.

(21) Appl. No.: **15/335,461**

(22) Filed: **Oct. 27, 2016**

(65) **Prior Publication Data**

US 2017/0162932 A1 Jun. 8, 2017

(30) **Foreign Application Priority Data**

Dec. 3, 2015 (TW) ..... 104140521 A

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 21/00** (2006.01)

**H01Q 1/48** (2006.01)

**H01Q 13/10** (2006.01)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 13/10** (2013.01); **H01Q 21/00** (2013.01)

(58) **Field of Classification Search**

CPC ..... **H01Q 13/10**; **H01Q 1/243**; **H01Q 1/48**;  
**H01Q 21/00**; **H01Q 1/24**

See application file for complete search history.

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Primary Examiner — Tho G Phan

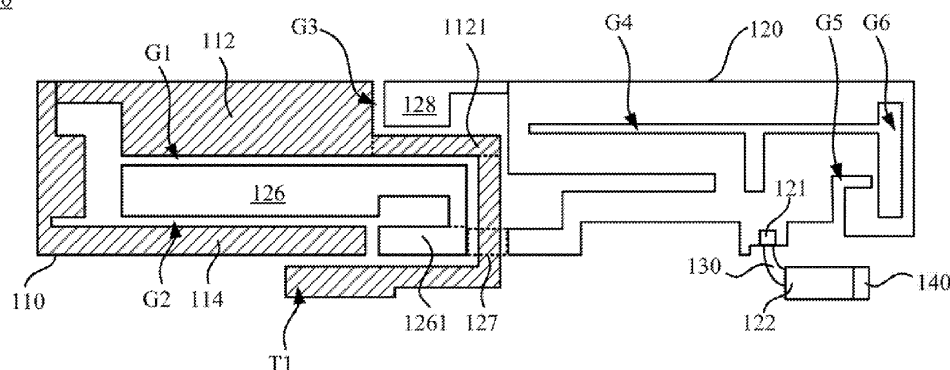
(74) Attorney, Agent, or Firm — CKC & Partners Co., Ltd.

(57) **ABSTRACT**

An antenna module includes a parasitic unit and a first antenna unit. The parasitic unit includes a first parasitic radiation portion and a second parasitic radiation portion. The second parasitic radiation portion is electrically connected to the first parasitic radiation portion. The first parasitic radiation portion and the second parasitic radiation portion surround a central area. The first antenna unit includes a feeding terminal, a ground terminal and a first radiation portion, in which the ground terminal is electrically connected to a ground portion. The feeding terminal is configured to transmit and receive a first antenna signal. The first radiation portion is configured to collaborate with the parasitic unit to generate a first resonant mode. The first resonant mode includes a central frequency, a frequency twice of the central frequency and a frequency three times of the central frequency.

**10 Claims, 9 Drawing Sheets**

100





US009905913B2

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

(10) **Patent No.:** **US 9,905,913 B2**  
(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Kai-Ting Hung**, New Taipei (TW);  
**Cho-Kang Hsu**, New Taipei (TW);  
**Men-Hsueh Tsai**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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

(21) Appl. No.: **15/651,037**

(22) Filed: **Jul. 17, 2017**

(65) **Prior Publication Data**  
US 2018/0026350 A1 Jan. 25, 2018

**Related U.S. Application Data**

(60) Provisional application No. 62/364,876, filed on Jul. 21, 2016.

(30) **Foreign Application Priority Data**

Jun. 9, 2017 (TW) ..... 106119261 A

(51) **Int. Cl.**  
**H04M 1/00** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/371** (2015.01)  
**H01Q 5/10** (2015.01)  
**H01Q 13/10** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/243** (2013.01); **H01Q 5/10** (2015.01); **H01Q 5/371** (2015.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/243; H01Q 5/371; H01Q 13/10; H01Q 5/10  
USPC ..... 455/575.7, 90.2, 90.3  
See application file for complete search history.

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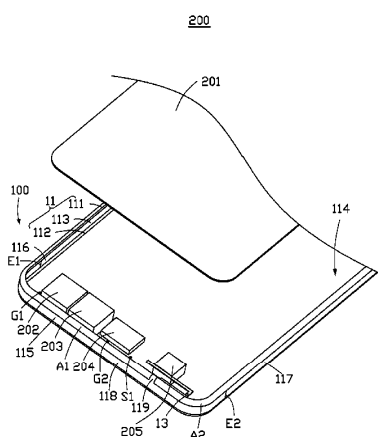
*Primary Examiner* — April G Gonzales

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

(57) **ABSTRACT**

An antenna structure includes a metal housing, a first feed portion, a first ground portion, a second ground portion, and a radiator. The metal housing includes a front frame, a backboard, and a side frame. The side frame defines a slot and the front frame defines a gap. The metal housing is divided into at least a long portion and a short portion by the slot and the gap. One end of the first feed portion is electrically connected to the long portion for feeding current to the long portion and another end of the first feed portion is electrically connected to the backboard. The first and second ground portions are both electrically connected to the long portion for grounding the long portion. The radiator is positioned in the metal housing, electrically connected to the backboard, and is spaced apart from the short portion.

**20 Claims, 21 Drawing Sheets**





US009905918B2

(12) **United States Patent**  
**Huang**

(10) **Patent No.:** **US 9,905,918 B2**  
(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ELECTRONIC APPARATUS AND LAND GRID ARRAY MODULE**

(71) Applicant: **Huawei Device Co., Ltd.**, Shenzhen (CN)

(72) Inventor: **Benwei Huang**, Shenzhen (CN)

(73) Assignee: **HUAWEI DEVICE CO., LTD.**, Shenzhen (CN)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 468 days.

(21) Appl. No.: **14/580,991**

(22) Filed: **Dec. 23, 2014**

(65) **Prior Publication Data**

US 2015/0116186 A1 Apr. 30, 2015

**Related U.S. Application Data**

(63) Continuation of application No. PCT/CN2013/089994, filed on Dec. 19, 2013.

(30) **Foreign Application Priority Data**

Dec. 21, 2012 (CN) ..... 2012 1 0562834

(51) **Int. Cl.**  
**H01Q 1/22** (2006.01)  
**H01Q 1/50** (2006.01)  
(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/50** (2013.01); **H01Q 1/22** (2013.01); **H05K 1/0243** (2013.01); **H05K 1/111** (2013.01);  
(Continued)

(58) **Field of Classification Search**  
CPC ..... H05K 1/0243; H05K 1/111; H05K 1/18; H05K 1/141; H05K 2201/094;  
(Continued)

(56) **References Cited**

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*Primary Examiner* — Dameon E Levi

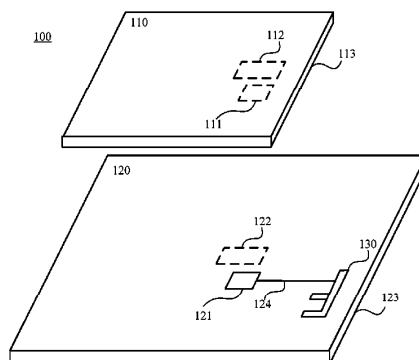
*Assistant Examiner* — Hasan Islam

(74) *Attorney, Agent, or Firm* — Conley Rose, P.C.

(57) **ABSTRACT**

An electronic apparatus and a land grid array LGA module. The electronic apparatus includes: a first printed circuit board, a lower surface of the first printed circuit board is provided with a first radio frequency pad and a first non-radio frequency pad; a motherboard, including a second printed circuit board, where an upper surface of the second printed circuit board is provided with a second radio frequency pad and a second non-radio frequency pad, the first radio frequency pad is connected to the second radio frequency pad, and the first non-radio frequency pad is connected to the second non-radio frequency pad; an antenna, located on the motherboard and connected to the second radio frequency pad, the first radio frequency pad and the second radio frequency pad are configured to transmit, between the LGA module and the motherboard, a radio frequency signal transmitted by the antenna.

**20 Claims, 8 Drawing Sheets**





US009905927B2

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

(10) **Patent No.:** **US 9,905,927 B2**

(45) **Date of Patent:** **Feb. 27, 2018**

(54) **ANTENNA DEVICE, CIRCUIT BOARD AND  
MEMORY CARD**

(71) Applicant: **FUJITSU COMPONENT LIMITED,**  
Tokyo (JP)

(72) Inventors: **Masahiro Yanagi**, Tokyo (JP); **Shigemi  
Kurashima**, Tokyo (JP); **Hideaki Yoda**,  
Tokyo (JP)

(73) Assignee: **FUJITSU COMPONENT LIMITED,**  
Tokyo (JP)

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

(21) Appl. No.: **15/178,731**

(22) Filed: **Jun. 10, 2016**

(65) **Prior Publication Data**

US 2016/0301137 A1 Oct. 13, 2016

**Related U.S. Application Data**

(62) Division of application No. 13/417,513, filed on Mar.  
12, 2012, now Pat. No. 9,391,358.

(30) **Foreign Application Priority Data**

Mar. 29, 2011 (JP) ..... 2011-073642

(51) **Int. Cl.**  
**H01Q 9/04** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 9/42** (2006.01)  
**H01Q 1/48** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/04** (2013.01); **H01Q 1/24**  
(2013.01); **H01Q 1/48** (2013.01); **H01Q 9/42**  
(2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 9/42; H01Q 9/30  
See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Daniel J Munoz

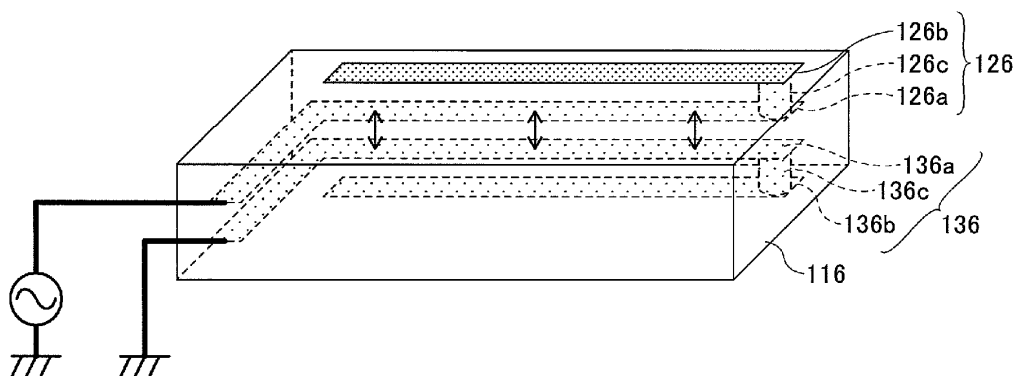
(74) *Attorney, Agent, or Firm* — IPUSA, PLLC

(57) **ABSTRACT**

A disclosed antenna device includes a substrate made of a dielectric material, an antenna element formed on one side of the substrate, and a ground element formed on another side of the substrate.

**5 Claims, 28 Drawing Sheets**

109





US009912039B2

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

(10) **Patent No.:** **US 9,912,039 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **WIRELESS COMMUNICATION DEVICE  
AND ANTENNA ASSEMBLY**

(71) Applicant: **TYCO ELECTRONICS  
CORPORATION**, Berwyn, PA (US)

(72) Inventors: **Hilario Lepe**, Gilroy, CA (US); **Bruce  
Foster Bishop**, Aptos, CA (US);  
**Junwon Kim**, Capitola, CA (US)

(73) Assignee: **TE Connectivity Corporation**,  
Berwyn, PA (US)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 118 days.

(21) Appl. No.: **14/921,001**

(22) Filed: **Oct. 23, 2015**

(65) **Prior Publication Data**

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(51) **Int. Cl.**  
**H01Q 13/12** (2006.01)  
**H01Q 13/18** (2006.01)  
**H01Q 1/24** (2006.01)  
**G06F 1/16** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 1/22** (2006.01)  
**H01Q 21/28** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/24** (2013.01); **G06F 1/1618**  
(2013.01); **G06F 1/1633** (2013.01); **G06F**  
**1/1681** (2013.01); **G06F 1/1696** (2013.01);  
**H01Q 1/2266** (2013.01); **H01Q 1/241**  
(2013.01); **H01Q 1/243** (2013.01); **H01Q**  
**13/10** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/24; H01Q 1/241; H01Q 1/243;  
H01Q 13/10; H01Q 13/12; H01Q 13/18  
See application file for complete search history.

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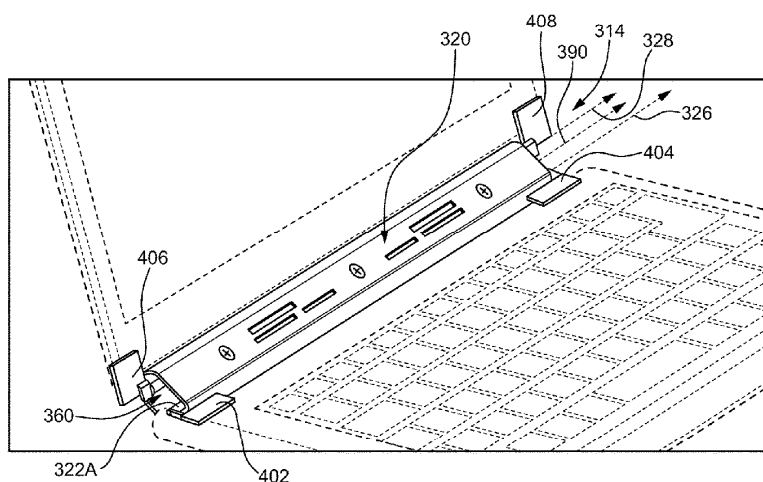
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*Primary Examiner* — Hoang Nguyen

(57) **ABSTRACT**

Wireless communication device includes a first device section. The first device section has a first edge. The wireless communication device also includes a second device section that has a second edge. The wireless communication device also includes a floating hinge that joins the first and second edges and permits the first and second device sections to move between a closed state and an operating state. The floating hinge and the first device section are rotatable about a first axis of rotation that extends through the floating hinge. The floating hinge and the second device section are rotatable about a second axis of rotation that extends through the floating hinge. The floating hinge includes a slot antenna that is communicatively coupled to a processor and is configured to at least one of transmit wireless signals or receive wireless signals.

**20 Claims, 7 Drawing Sheets**





US009912040B2

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

(10) **Patent No.:** **US 9,912,040 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **ELECTRONIC DEVICE ANTENNA CARRIER  
COUPLED TO PRINTED CIRCUIT AND  
HOUSING STRUCTURES**

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

(72) Inventors: **Erdinc Irci**, Sunnyvale, CA (US);  
**Hongfei Hu**, Santa Clara, CA (US);  
**Mattia Pascolini**, San Francisco, CA  
(US); **Yijun Zhou**, Sunnyvale, 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 413 days.

(21) Appl. No.: **14/262,486**

(22) Filed: **Apr. 25, 2014**

(65) **Prior Publication Data**

US 2015/0311579 A1 Oct. 29, 2015

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 9/42** (2006.01)

**H01Q 13/10** (2006.01)

**H01Q 1/22** (2006.01)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 9/42**  
(2013.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/241–1/243; H01Q 1/2258; H01Q  
1/2266; H01Q 9/0421; H01Q 9/30; H05K  
1/182

USPC ..... 343/702, 906, 700 MS, 878, 706;  
361/760, 753, 799

See application file for complete search history.

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Primary Examiner — Hoang Nguyen

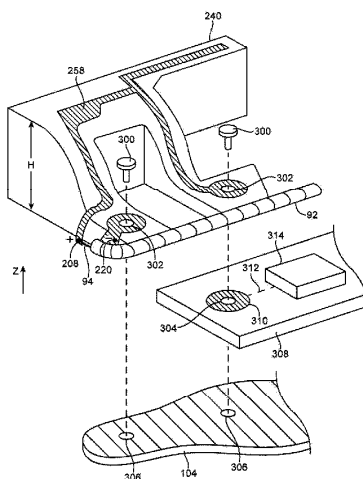
Assistant Examiner — Awat Salih

(74) Attorney, Agent, or Firm — Treyz Law Group, P.C.;  
G. Victor Treyz; Tianyi He

(57) **ABSTRACT**

Electronic device antenna structures may include first and second antennas. A housing may have a periphery that is surrounded by peripheral conductive structures such as a segmented peripheral metal member. A segment of the peripheral metal member may be separated from a ground by an opening. An antenna feed for the first antenna may have a positive antenna terminal coupled to the peripheral metal member and a ground terminal coupled to the ground. A return path for the first antenna may span the opening in parallel with the antenna feed. A plastic carrier may be mounted to a printed circuit and a metal housing structure using screws. The plastic carrier may support an antenna resonating element for the second antenna and may support the return path for the first antenna. The screws may short metal structures on the plastic carrier to the metal structures and traces on the printed circuit.

**11 Claims, 11 Drawing Sheets**





US009912049B2

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

(10) **Patent No.:** **US 9,912,049 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **ANTENNA STRUCTURE AND ELECTRONIC DEVICE HAVING SAME**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Tze-Hsuan Chang**, New Taipei (TW);  
**Cho-Kang Hsu**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 322 days.

(21) Appl. No.: **14/527,127**

(22) Filed: **Oct. 29, 2014**

(65) **Prior Publication Data**

US 2016/0111789 A1 Apr. 21, 2016

(30) **Foreign Application Priority Data**

Oct. 15, 2014 (CN) ..... 2014 1 0544108

(51) **Int. Cl.**

**H01Q 1/48** (2006.01)

**H01Q 1/24** (2006.01)

**H01Q 9/04** (2006.01)

**H01Q 9/42** (2006.01)

**H01Q 5/00** (2015.01)

**H01Q 5/371** (2015.01)

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

CPC ..... **H01Q 1/48** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/0442** (2013.01); **H01Q 9/42** (2013.01)

(58) **Field of Classification Search**

CPC .... H01Q 9/0407; H01Q 5/371; H01Q 9/0442; H01Q 9/42

See application file for complete search history.

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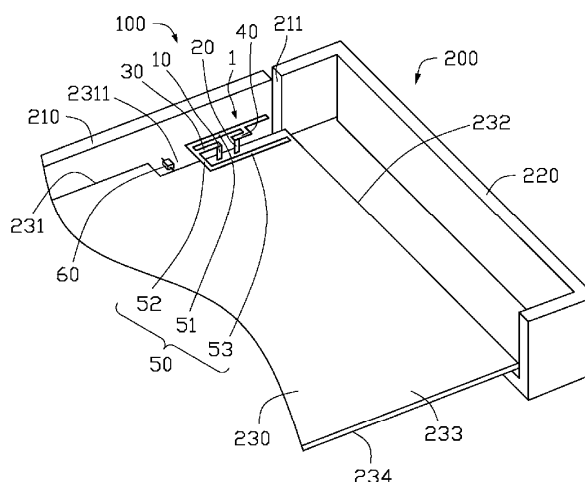
*Primary Examiner* — Daniel J Munoz

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

(57) **ABSTRACT**

A dual-band Wi-Fi antenna structure includes a metallic middle frame of a casing of a handheld electronic device, a grounding plane received in the middle frame, an antenna body connected to the grounding plane, and an adjusting element. The grounding plane defines a rectangular recess in a corner thereof. The antenna body has a radiation patch having a part located over the recess. The adjusting element is located in the recess. An effective length of the recess is adjustable by adjusting a parameter of the adjusting element, which is a coefficient of self-inductance when the adjusting element is an adjustable inductor. By adjusting the effective length of the recess, a resonant frequency of the antenna structure at a low frequency band is adjustable, while a resonant frequency thereof at a high frequency band is not altered.

**24 Claims, 6 Drawing Sheets**







US009912056B2

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

(10) **Patent No.:** **US 9,912,056 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **MULTIBAND ANTENNA AND  
MANUFACTURING METHOD THEREOF**

(71) Applicants: **Hiroyuki Noda**, Mie (JP); **Tomokazu  
Sonozaki**, Mie (JP)

(72) Inventors: **Hiroyuki Noda**, Mie (JP); **Tomokazu  
Sonozaki**, Mie (JP)

(73) Assignee: **NTN CORPORATION**, Osaka (JP)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 127 days.

(21) Appl. No.: **14/384,884**

(22) PCT Filed: **Mar. 14, 2013**

(86) PCT No.: **PCT/JP2013/057251**

§ 371 (c)(1),

(2) Date: **Sep. 12, 2014**

(87) PCT Pub. No.: **WO2013/137404**

PCT Pub. Date: **Sep. 19, 2013**

(65) **Prior Publication Data**

US 2015/0061963 A1 Mar. 5, 2015

(30) **Foreign Application Priority Data**

Mar. 16, 2012 (JP) ..... 2012-060231

(51) **Int. Cl.**  
**H01Q 5/00** (2015.01)  
**H01Q 21/28** (2006.01)

(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 5/0072** (2013.01); **B29C 45/1671**  
(2013.01); **H01Q 5/371** (2015.01);  
(Continued)

(58) **Field of Classification Search**

CPC ..... H01Q 5/0072; H01Q 5/371; H01Q 1/38;  
H01Q 1/243; H01Q 9/0407; H01Q 21/28  
(Continued)

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tion.

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*Primary Examiner* — Dameon E Levi

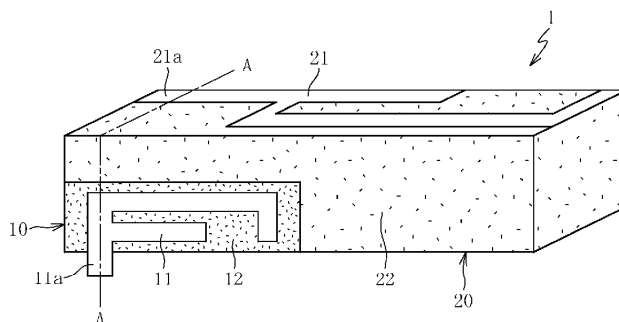
*Assistant Examiner* — Ab Salam Alkassim, Jr.

(74) *Attorney, Agent, or Firm* — Wenderoth, Lind &  
Ponack, L.L.P.

(57) **ABSTRACT**

A multiband antenna includes a first antenna unit (10) and a  
second antenna unit (20). The first antenna unit (10) includes  
a first antenna pattern (11) formed of a conductor and a first  
substrate (12) formed of a dielectric, for holding the first  
antenna pattern (11). The second antenna unit (20) includes  
a second antenna pattern (21) formed of a conductor and a  
second substrate (22) formed of a dielectric having a dielec-  
tric constant different from the dielectric constant of the first  
substrate (12), for holding the second antenna pattern (21).  
In the multiband antenna, by injection molding the second  
substrate (22) with the first antenna unit (10) and the second

(Continued)





US009912058B2

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

(10) **Patent No.:** **US 9,912,058 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **HYBRID ANTENNA, ANTENNA  
ARRANGEMENT AND METHOD FOR  
MANUFACTURING AN ANTENNA  
ARRANGEMENT**

(71) Applicant: **Infineon Technologies AG**, Neubiberg  
(DE)

(72) Inventors: **Petteri Palm**, Regensburg (DE);  
**Martin Buchsbaum**, Graz (AT); **Josef  
Gruber**, St. Ruprecht (AT); **Juergen  
Hoelzl**, Graz (AT); **Frank Pueschner**,  
Kelheim (DE); **Peter Stampka**,  
Burglengenfeld (DE)

(73) Assignee: **Infineon Technologies AG**, Neubiberg  
(DE)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 425 days.

(21) Appl. No.: **14/519,166**

(22) Filed: **Oct. 21, 2014**

(65) **Prior Publication Data**

US 2016/0111787 A1 Apr. 21, 2016

(51) **Int. Cl.**  
**H01Q 7/08** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 21/24** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 7/08** (2013.01); **H01Q 1/243**  
(2013.01); **H01Q 21/24** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 7/08; H01Q 1/243; H01Q 21/24  
USPC ..... 343/788  
See application file for complete search history.

(56) **References Cited**

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*Primary Examiner* — Dameon E Levi

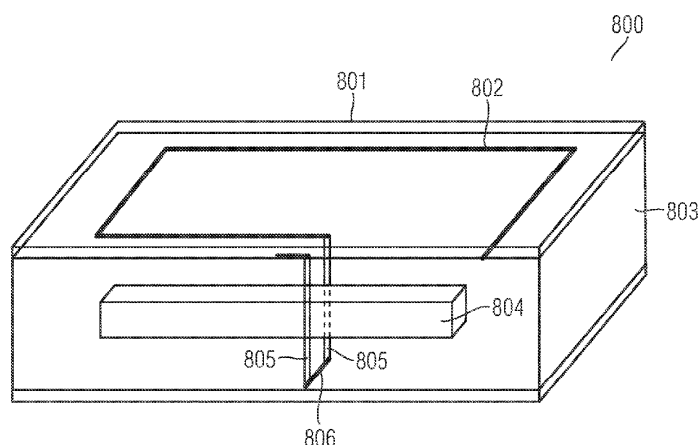
*Assistant Examiner* — David Lotter

(74) *Attorney, Agent, or Firm* — Viering, Jentschura &  
Partner mbB

(57) **ABSTRACT**

According to one embodiment, a hybrid antenna is described  
comprising a plurality of windings wherein each winding  
comprises a loop antenna portion arranged in a plane and a  
ferrite antenna portion arranged at least partially outside of  
the plane.

**23 Claims, 16 Drawing Sheets**





US009912065B2

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

(10) **Patent No.:** **US 9,912,065 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **DIPOLE ANTENNA MODULE AND ELECTRONIC APPARATUS INCLUDING THE SAME**

(58) **Field of Classification Search**

CPC ..... H01Q 9/285

(Continued)

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

(56) **References Cited**

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343/700 MS  
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343/700 MS

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(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si (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 143 days.

KR 2011-0064848 6/2011  
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WO 2012-071315 5/2012

(21) Appl. No.: **13/928,524**

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(22) Filed: **Jun. 27, 2013**

(65) **Prior Publication Data**

US 2014/0132468 A1 May 15, 2014

**Related U.S. Application Data**

(60) Provisional application No. 61/726,674, filed on Nov. 15, 2012.

Search Report and Written Opinion dated Jan. 21, 2014 issued in International Application No. PCT/KR2013/008789.  
Extended European Search Report dated Feb. 20, 2014 issued in EP Application No. 13193070.3.  
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*Primary Examiner* — Dameon E Levi

*Assistant Examiner* — Walter Davis

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

(30) **Foreign Application Priority Data**

Jan. 8, 2013 (KR) ..... 10-2013-0002155

(57) **ABSTRACT**

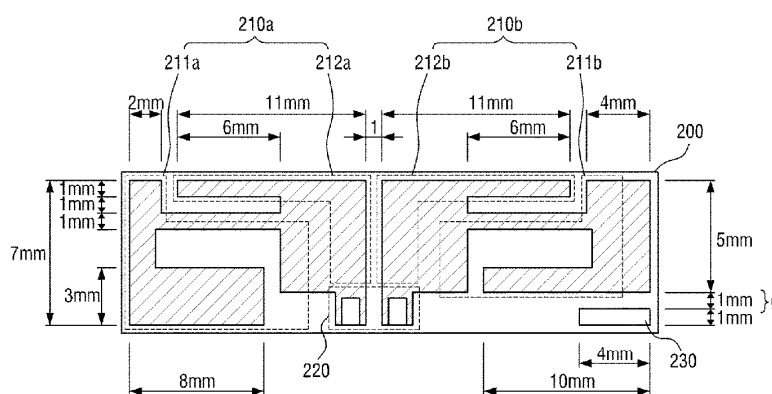
A dipole antenna module and an electronic apparatus include an antenna element, a power feeder formed at an end of the antenna element and connected to a circuit board to process an antenna signal through a cable, and a ground part to ground a ground of the cable such that the ground part keeps a preset gap from the antenna element and is grounded to a conductor of the circuit board.

(51) **Int. Cl.**  
**H01Q 9/28** (2006.01)  
**H01Q 9/26** (2006.01)

(Continued)

(52) **U.S. Cl.**  
CPC ..... **H01Q 9/285** (2013.01); **H01Q 5/371** (2015.01); **H01Q 9/26** (2013.01); **H01Q 1/2266** (2013.01); **H01Q 1/48** (2013.01)

**25 Claims, 12 Drawing Sheets**





US009912066B2

(12) **United States Patent**  
**Tai**

(10) **Patent No.:** **US 9,912,066 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **TUNABLE ANTENNA MODULE USING  
FREQUENCY-DIVISION CIRCUIT FOR  
MOBILE DEVICE WITH METAL COVER**

- (71) Applicant: **MEDIATEK INC.**, Hsin-Chu (TW)  
(72) Inventor: **Chen-Fang Tai**, New Taipei (TW)  
(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 146 days.

(21) Appl. No.: **14/965,819**

(22) Filed: **Dec. 10, 2015**

(65) **Prior Publication Data**

US 2017/0005413 A1 Jan. 5, 2017

**Related U.S. Application Data**

(60) Provisional application No. 62/188,130, filed on Jul. 2, 2015.

(51) **Int. Cl.**  
**H01Q 1/48** (2006.01)  
**H01Q 13/10** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 5/314** (2015.01)

(52) **U.S. Cl.**  
CPC ..... **H01Q 13/10** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/314** (2015.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/243; H01Q 1/48; H01Q 5/314; H01Q 13/10

See application file for complete search history.

(56) **References Cited**

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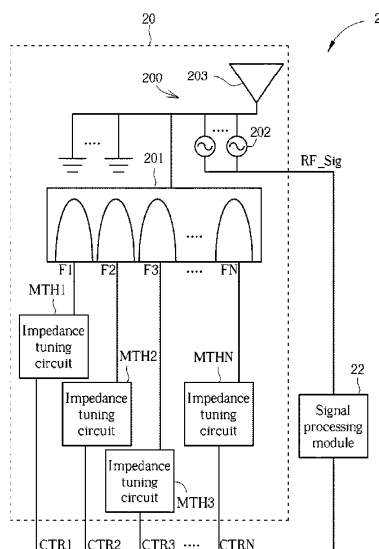
*Primary Examiner* — Hoang Nguyen

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

(57) **ABSTRACT**

A tunable antenna module for a mobile device includes an antenna, a frequency-division circuit and one or more impedance-tuning circuits. The frequency-division circuit is coupled to a radiator of the antenna for forming one or more signal paths for one or more of component frequencies of a radio-frequency signal of the antenna. One or more the impedance-tuning circuits are coupled to the frequency-division circuit for tuning an impedance of the antenna at one or more of the component frequencies of the radio-frequency signal.

**18 Claims, 11 Drawing Sheets**





US009912071B2

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

(10) **Patent No.:** **US 9,912,071 B2**  
(45) **Date of Patent:** **Mar. 6, 2018**

(54) **QUASI-YAGI-TYPE ANTENNA**

(56) **References Cited**

(71) Applicant: **QUALCOMM Incorporated**, San Diego, CA (US)

U.S. PATENT DOCUMENTS

(72) Inventors: **Iddo Diukman**, Haifa (IL); **Alon Yehezkel**, Haifa (IL)

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343/700 MS

(73) Assignee: **QUALCOMM Incorporated**, San Diego, CA (US)

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 119 days.

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(21) Appl. No.: **14/561,680**

(22) Filed: **Dec. 5, 2014**

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(65) **Prior Publication Data**

US 2015/0194736 A1 Jul. 9, 2015

DE 2020192 A1 11/1971  
EP 2575213 A1 4/2013  
GB 765465 A 1/1957

**Related U.S. Application Data**

OTHER PUBLICATIONS

(60) Provisional application No. 61/925,011, filed on Jan. 8, 2014.

International Search Report and Written Opinion—PCT/US2014/069105—ISA/EPO—Mar. 11, 2015, 11 pages.

(51) **Int. Cl.**

**H01Q 13/18** (2006.01)  
**H01Q 19/30** (2006.01)  
**H01Q 1/50** (2006.01)  
**H01Q 1/48** (2006.01)  
**H01Q 9/20** (2006.01)  
**H01Q 21/00** (2006.01)  
**H01Q 21/06** (2006.01)

*Primary Examiner* — Dameon E Levi

*Assistant Examiner* — David Lotter

(74) *Attorney, Agent, or Firm* — Qualcomm Incorporated-Toler

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

CPC ..... **H01Q 19/30** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/50** (2013.01); **H01Q 9/20** (2013.01); **H01Q 21/0006** (2013.01); **H01Q 21/062** (2013.01)

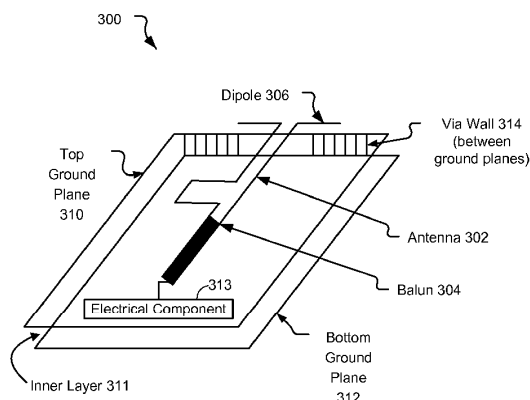
(57) **ABSTRACT**

An apparatus includes a first ground plane, a second ground plane, an antenna, and a balun coupled to the antenna. The balun is disposed between the first ground plane and the second ground plane.

(58) **Field of Classification Search**

CPC ..... H01Q 19/30; H01Q 1/50; H01Q 1/48; H01Q 21/0006; H01Q 21/062  
USPC ..... 343/818, 820, 821  
See application file for complete search history.

**20 Claims, 6 Drawing Sheets**





US009917351B2

(12) **United States Patent**  
**Tai**

(10) **Patent No.:** **US 9,917,351 B2**

(45) **Date of Patent:** **Mar. 13, 2018**

(54) **ANTENNA AND ANTENNA ASSEMBLY**

(71) Applicant: **FOXCONN INTERCONNECT TECHNOLOGY LIMITED**, Grand Cayman (KY)

(72) Inventor: **Lung-Sheng Tai**, New Taipei (TW)

(73) Assignee: **FOXCONN INTERCONNECT TECHNOLOGY Limited**, Grand Cayman (KY)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 7 days.

(21) Appl. No.: **15/095,171**

(22) Filed: **Apr. 11, 2016**

(65) **Prior Publication Data**

US 2016/0301124 A1 Oct. 13, 2016

(30) **Foreign Application Priority Data**

Apr. 9, 2015 (TW) ..... 104111356 A

(51) **Int. Cl.**

**H01Q 1/24** (2006.01)

**H01Q 13/10** (2006.01)

**H01Q 1/22** (2006.01)

**H01Q 21/28** (2006.01)

**H01Q 5/371** (2015.01)

**H01Q 9/04** (2006.01)

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

CPC ..... **H01Q 1/243** (2013.01); **H01Q 1/2258** (2013.01); **H01Q 5/371** (2015.01); **H01Q 13/10** (2013.01); **H01Q 13/103** (2013.01); **H01Q 21/28** (2013.01); **H01Q 9/0407** (2013.01)

(58) **Field of Classification Search**

CPC ..... H01Q 1/2258; H01Q 1/243; H01Q 5/371; H01Q 9/0407; H01Q 13/103; H01Q 21/28

See application file for complete search history.

(56) **References Cited**

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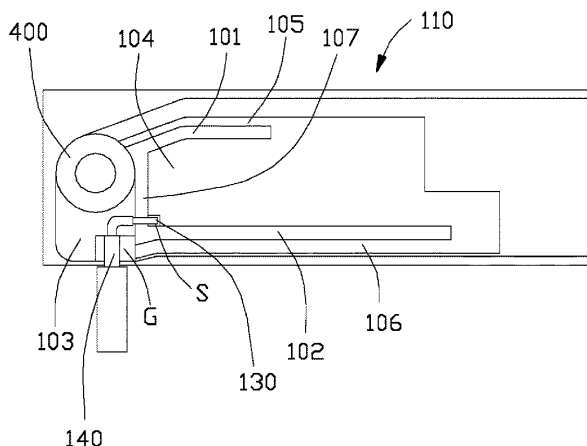
*Primary Examiner* — Hoang Nguyen

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

(57) **ABSTRACT**

An antenna comprises a main body and a cable connecting to the main body. The main body has a grounding portion, a cantilevered arm, a first connecting portion and a second connecting portion. The first connecting portion connects the grounding portion and the cantilevered arm. The first connecting portion is located at the upper side of the cantilevered arm and defines a first slot with the cantilevered arm. The second connecting portion connects the grounding portion and the cantilevered arm. The second connecting portion is located at the lower side of the cantilevered arm and defines a second slot with the cantilevered arm.

**18 Claims, 6 Drawing Sheets**





US009917357B2

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

(10) **Patent No.:** **US 9,917,357 B2**  
(45) **Date of Patent:** **Mar. 13, 2018**

(54) **ANTENNA SYSTEM**

(56) **References Cited**

(71) Applicant: **Sony Corporation**, Tokyo (JP)

U.S. PATENT DOCUMENTS

(72) Inventors: **Masato Tanaka**, Chiba (JP); **Hideaki Shoji**, Tokyo (JP); **Aiko Yoshida**, Tokyo (JP)

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343/702

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

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 302 days.

(21) Appl. No.: **13/911,765**

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(22) Filed: **Jun. 6, 2013**

Primary Examiner — Graham Smith

Assistant Examiner — Noel Maldonado

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

(65) **Prior Publication Data**

US 2014/0361948 A1 Dec. 11, 2014

(57) **ABSTRACT**

(51) **Int. Cl.**  
**H01Q 1/38** (2006.01)  
**H01Q 1/24** (2006.01)  
**H01Q 9/04** (2006.01)

Discussed herein is an antenna system that comprises a feed element and a radiating element that are formed on a dielectric substrate positioned above a circuit board which includes a feed circuit and a ground layer. Specifically, the feed element is disposed within an outer periphery defined by the radiating element. A capacitive coupling is formed between the feed element and the radiating element. With the aforesaid configuration, the antenna system is less affected by the circuit board and interference from other elements that are mounted on the circuit board. Further, manufacturing costs are reduced as compared to the case where the feed element and the radiating element are respectively formed on a front and rear surface of a resin layer.

(52) **U.S. Cl.**  
CPC ..... **H01Q 1/38** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0457** (2013.01)

(58) **Field of Classification Search**  
CPC ..... H01Q 1/50; H01Q 1/38; H01Q 1/243; H01Q 9/0457  
USPC ..... 343/700, 702, 861  
See application file for complete search history.

**20 Claims, 11 Drawing Sheets**

