

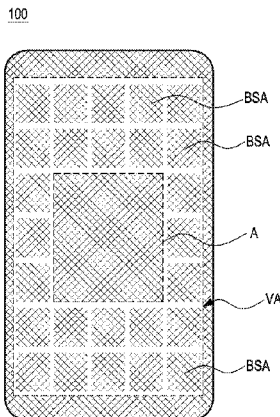
(12) **United States Patent**
Kim et al.

(10) **Patent No.:** **US 10,326,196 B2**
(45) **Date of Patent:** **Jun. 18, 2019**

- (54) **ANTENNA DEVICE**
- (71) Applicant: **Samsung Electronics Co., Ltd.**,
Suwon-si (KR)
- (72) Inventors: **Yoon-Geon Kim**, Busan (KR);
Won-Bin Hong, Seoul (KR);
Seung-Tae Ko, Bucheon-si (KR)
- (73) Assignee: **Samsung Electronics Co., Ltd** (KR)
- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 393 days.
- (21) Appl. No.: **14/866,423**
- (22) Filed: **Sep. 25, 2015**
- (65) **Prior Publication Data**
US 2016/0093939 A1 Mar. 31, 2016
- (30) **Foreign Application Priority Data**
Sep. 25, 2014 (KR) 10-2014-0128716
- (51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/50 (2006.01)
(Continued)
- (52) **U.S. Cl.**
CPC **H01Q 1/22** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/44** (2013.01); **H01Q 1/50**
(2013.01);
(Continued)
- (58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/243; H01Q 1/50;
H01Q 15/006
(Continued)

- (56) **References Cited**
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cation No. PCT/KR2015/010230, dated Jan. 12, 2016.
(Continued)
- Primary Examiner* — Dameon E Levi
Assistant Examiner — Ab Salam Alkassim, Jr.
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm,
P.C.

- (57) **ABSTRACT**
- According to an embodiment of the present disclosure, an antenna device implemented in a display device may comprise a dielectric layer provided in the display device, an antenna area disposed in a transparent area of the display device and having at least one or more antenna patterns transmitting or receiving an electromagnetic wave through a plurality of conductive grids, a power feeding area provided in at least one of the transparent area and an opaque area of the display device and having a power feeding pattern providing a signal current to the antenna pattern through the plurality of conductive grids, and a transmission line portion connecting a substrate portion provided in the display device with the power feeding pattern. Further, the antenna device according to the present disclosure may also be implemented in other various embodiments.
- 14 Claims, 23 Drawing Sheets**





US010327317B2

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

(10) **Patent No.:** **US 10,327,317 B2**
(45) **Date of Patent:** **Jun. 18, 2019**

(54) **MOBILE WIRELESS TERMINAL**
(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi, Kyoto-fu (JP)
(72) Inventors: **Tsuyoshi Tokunaga**, Nagaokakyo (JP);
Kenichi Ishizuka, Nagaokakyo (JP)
(73) Assignee: **MURATA MANUFACTURING CO., LTD.**,
Kyoto (JP)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 42 days.

(21) Appl. No.: **15/830,017**
(22) Filed: **Dec. 4, 2017**

(65) **Prior Publication Data**
US 2018/0103531 A1 Apr. 12, 2018

Related U.S. Application Data
(63) Continuation of application No.
PCT/JP2017/020889, filed on Jun. 5, 2017.

(30) **Foreign Application Priority Data**
Jun. 21, 2016 (JP) 2016-122687

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H05F 3/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H05F 3/04** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 1/42** (2013.01); **H01Q 1/48**
(2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/243; H01Q 1/48;
H01Q 5/335; H02H 5/04; H02H 3/26
(Continued)

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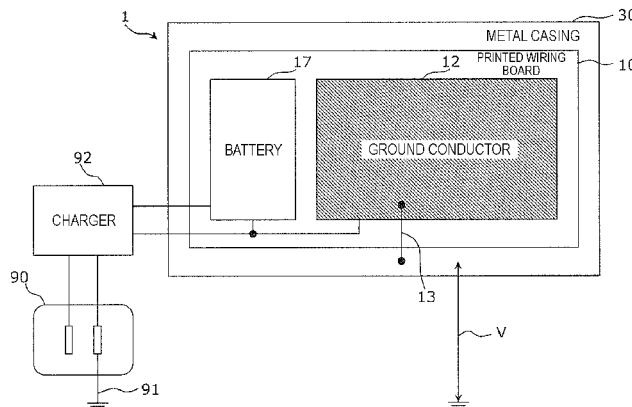
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No. PCT/JP2017/020889, dated Aug. 22, 2017.
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Primary Examiner — Joseph J Lautre
(74) *Attorney, Agent, or Firm* — Keating & Bennett, LLP

(57) **ABSTRACT**
A mobile wireless terminal includes a metal casing, a printed wiring board disposed in the metal casing and including a ground conductor thereon, the ground conductor defining a ground plane for both a power supply circuit and an antenna, a capacitor connected to the metal casing and the ground conductor, and an overcurrent protective element connected to the metal casing and the ground conductor and having an operating voltage higher than a maximum instantaneous value of a commercial power supply voltage. A capacitance of the overcurrent protective element may be smaller than a capacitance of the capacitor. The capacitor may be a multilayer ceramic capacitor, and the overcurrent protective element may be a discharge gap overcurrent protective element.

9 Claims, 18 Drawing Sheets





US010333198B2

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

(10) **Patent No.:** **US 10,333,198 B2**

(45) **Date of Patent:** **Jun. 25, 2019**

(54) **ANTENNA APPARATUS AND COMMUNICATION TERMINAL APPARATUS**

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

(71) Applicant: **Murata Manufacturing Co., Ltd.**,
Nagaokakyo-shi, Kyoto-fu (JP)

(56) **References Cited**

(72) Inventors: **Hiroimitsu Ito**, Nagaokakyo (JP);
Hiroshi Nishida, Nagaokakyo (JP);
Kunihiro Komaki, Nagaokakyo (JP)

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(73) Assignee: **MURATA MANUFACTURING CO., LTD.**, Kyoto (JP)

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

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JP 2000-114050 A 4/2000
(Continued)

(21) Appl. No.: **15/700,439**

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(22) Filed: **Sep. 11, 2017**

Official Communication issued in International Patent Application No. PCT/JP2016/056911, dated May 17, 2016.

(65) **Prior Publication Data**

US 2018/0013202 A1 Jan. 11, 2018

Primary Examiner — Robert Karacsony

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

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2016/056911, filed on Mar. 7, 2016.

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Mar. 12, 2015 (JP) 2015-049887

An antenna apparatus includes a conductive radiating element, a conductive member, and a first impedance circuit. The first impedance circuit includes a first parallel resonant circuit (an LC parallel resonant circuit) and is directly connected between the radiating element and the conductive member (the conductor plate). Since the first parallel resonant circuit has high impedance in its resonant frequency band and is equivalently in an open state, one end of the radiating element is opened in the resonant frequency band. Accordingly, the radiating element defines and functions as a standing-wave antenna that contributes to electric-field radiation and a loop portion including the radiating element, the conductive member, and the first impedance circuit defines and functions as a magnetic-field radiation antenna that contributes to magnetic-field radiation.

(51) **Int. Cl.**

H01Q 1/24 (2006.01)

H01Q 1/42 (2006.01)

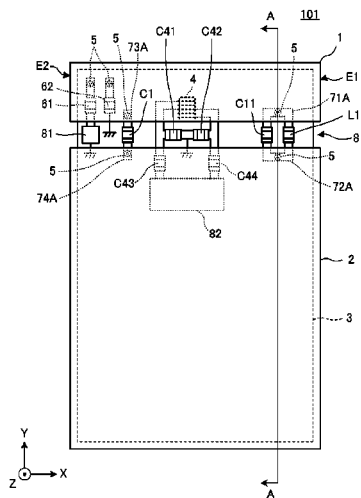
(Continued)

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

CPC **H01Q 1/243** (2013.01); **H01Q 1/42** (2013.01); **H01Q 5/321** (2015.01); **H01Q 5/328** (2015.01);

(Continued)

8 Claims, 31 Drawing Sheets



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

(10) **Patent No.:** **US 10,333,199 B2**
(45) **Date of Patent:** **Jun. 25, 2019**

(54) **WIRELESS HANDHELD ELECTRONIC DEVICE**

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

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

(21) Appl. No.: **15/784,814**

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

(65) **Prior Publication Data**

US 2018/0040943 A1 Feb. 8, 2018

Related U.S. Application Data

(63) Continuation of application No. 14/612,187, filed on Feb. 2, 2015, now Pat. No. 9,793,598, which is a (Continued)

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

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/24** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/48** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/273; H01Q 7/00; H01Q 13/10; H01Q 1/38; H01Q 1/46; H01R 2201/02

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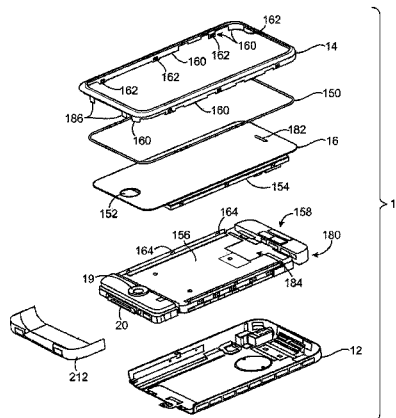
Primary Examiner — Joseph J Lauture

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

(57) **ABSTRACT**

A handheld electronic device may be provided that contains a conductive housing and other conductive elements. The conductive elements may form an antenna ground plane. One or more antennas for the handheld electronic device may be formed from the ground plane and one or more associated antenna resonating elements. Transceiver circuitry may be connected to the resonating elements by transmission lines such as coaxial cables. Ferrules may be crimped to the coaxial cables. A bracket with extending members may be crimped over the ferrules to ground the coaxial cables to the housing and other conductive elements in the ground plane. The ground plane may contain an antenna slot. A dock connector and flex circuit may overlap the slot in a way that does not affect the resonant frequency of the slot. Electrical components may be isolated from the antenna using isolation elements such as inductors and resistors.

20 Claims, 38 Drawing Sheets



(12) **United States Patent**
O'Driscoll et al.

(10) **Patent No.:** **US 10,333,201 B2**
(45) **Date of Patent:** **Jun. 25, 2019**

(54) **MULTI-ANTENNA WEARABLE DEVICE**

(71) Applicant: **Verily Life Sciences LLC**, Mountain View, CA (US)

(72) Inventors: **Stephen O'Driscoll**, San Francisco, CA (US); **Jiang Zhu**, Cupertino, CA (US); **Uei-ming Jow**, San Jose, CA (US); **Maryam Fathi**, Palo Alto, CA (US)

(73) Assignee: **VERILY LIFE SCIENCES LLC**, South San Francisco, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 234 days.

(21) Appl. No.: **15/231,904**

(22) Filed: **Aug. 9, 2016**

(65) **Prior Publication Data**

US 2018/0048055 A1 Feb. 15, 2018

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 1/27 (2006.01)
H01Q 1/22 (2006.01)
H01Q 1/36 (2006.01)
H01Q 1/42 (2006.01)
H01Q 1/48 (2006.01)
H01Q 1/52 (2006.01)
H01Q 7/00 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

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

CPC **H01Q 1/273** (2013.01); **H01Q 1/2208** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 1/36** (2013.01); **H01Q 1/38** (2013.01); **H01Q 1/42** (2013.01); **H01Q 1/48** (2013.01); **H01Q 1/521** (2013.01); **H01Q 7/00** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/48; H01Q 1/521; H01Q 21/28
See application file for complete search history.

(56) **References Cited**

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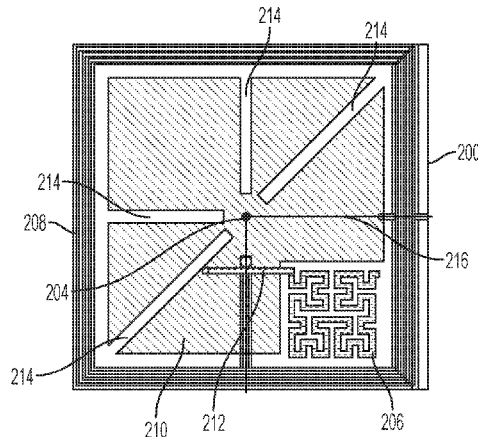
Primary Examiner — Graham P Smith

(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

A multi-antenna device may include a high-frequency antenna, a low-frequency antenna, and a patterned metal ground plane defining channels having capacitors operable a short circuit for the high-frequency antenna and an open-circuit for the low-frequency antenna. The high-frequency antenna, the low-frequency antenna, and the patterned metal ground plane may be coupled to a multi-layer printed circuit board of the multi-antenna device. The channels of the metal ground plane conductor may have dimensions to, themselves, operate as the capacitors. In other aspects, discrete capacitors may be positioned on the metal ground plane proximate to the channels to reduce eddy currents during operation of the low-frequency antenna.

31 Claims, 7 Drawing Sheets





US010340581B2

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

(10) **Patent No.:** **US 10,340,581 B2**
(45) **Date of Patent:** **Jul. 2, 2019**

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

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

(72) Inventors: **Cheng-Han Lee**, New Taipei (TW);
Yi-Wen Hsu, New Taipei (TW);
Wei-Xuan Ye, 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.: **15/651,027**

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

(65) **Prior Publication Data**
US 2018/0026348 A1 Jan. 25, 2018

Related U.S. Application Data

(60) Provisional application No. 62/364,298, filed on Jul. 19, 2016.

(30) **Foreign Application Priority Data**
Jun. 27, 2017 (TW) 106121493

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/44 (2006.01)
H01Q 5/10 (2015.01)
H01Q 5/371 (2015.01)
H01Q 13/10 (2006.01)
H01Q 9/42 (2006.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/44** (2013.01); **H01Q 5/10** (2015.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01); **H01Q 13/10** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/242; H01Q 1/243
See application file for complete search history.

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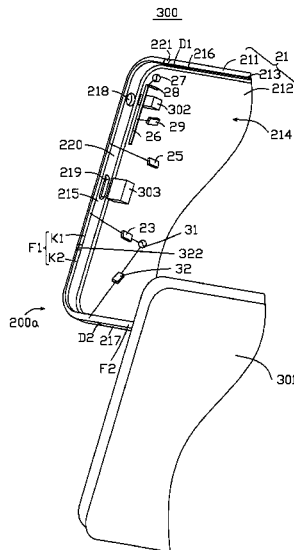
Primary Examiner — Wen W Huang

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

(57) **ABSTRACT**

An antenna structure includes a metal housing, a first feed source, a first ground portion, and a first switching circuit. 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 first gap and a second gap. The metal housing is divided into at least a first portion by the slot, the first gap, and the second gap. The first feed source is electrically connected to the first portion for supplying current to the first portion. The first ground portion is electrically connected to the first portion for grounding the first portion. One end of the first switching circuit is electrically connected to the first portion. Another end of the first switching circuit is grounded.

29 Claims, 36 Drawing Sheets





US010340591B2

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

(10) **Patent No.:** **US 10,340,591 B2**
(45) **Date of Patent:** **Jul. 2, 2019**

(54) **ANTENNA WITH BRIDGED GROUND PLANES**

(58) **Field of Classification Search**

CPC H01Q 1/48; H01Q 23/00; H01Q 9/0414;
H01Q 1/526; H01Q 9/0421; H01Q
9/0407; H01Q 1/38
See application file for complete search history.

(71) Applicant: **HEWLETT-PACKARD
DEVELOPMENT COMPANY, L.P.**,
Houston, TX (US)

(72) Inventors: **Chang-Cheng Hsieh**, Taipei (TW);
Hung-Wen Cheng, Taipei (TW); **Leo
Joseph Gerten**, Austin, TX (US)

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Primary Examiner — Ricardo I Magallanes

(74) *Attorney, Agent, or Firm* — HPI Patent Department

(21) Appl. No.: **15/304,931**

(22) PCT Filed: **Apr. 29, 2014**

(86) PCT No.: **PCT/US2014/035780**

§ 371 (c)(1),

(2) Date: **Oct. 18, 2016**

(87) PCT Pub. No.: **WO2015/167445**

PCT Pub. Date: **Nov. 5, 2015**

(57) **ABSTRACT**

An antenna system with a bridged ground plane includes a printed circuit board, a first ground plane, a bridge, an antenna radiating element, an antenna connection, and at least one electronic component. The first ground plane is coupled to a first face of the printed circuit board. The bridge couples the first ground plane to the second ground plane. The antenna radiating element is coupled to the second ground plane via the antenna connection. The electronic component or components are coupled to a second face of the printed circuit board.

(65) **Prior Publication Data**

US 2017/0207525 A1 Jul. 20, 2017

(51) **Int. Cl.**

H01Q 1/38 (2006.01)

H01Q 1/48 (2006.01)

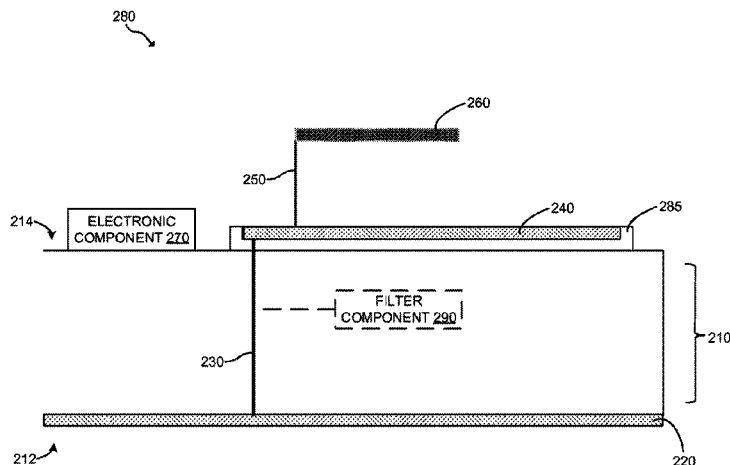
H01Q 9/04 (2006.01)

H01Q 23/00 (2006.01)

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

CPC **H01Q 1/48** (2013.01); **H01Q 1/38**
(2013.01); **H01Q 9/045** (2013.01); **H01Q**
9/0407 (2013.01); **H01Q 23/00** (2013.01)

18 Claims, 5 Drawing Sheets





US010340592B2

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

(10) **Patent No.:** **US 10,340,592 B2**
(45) **Date of Patent:** **Jul. 2, 2019**

(54) **ELECTRONIC DEVICE INCLUDING MULTIPLE ANTENNAS**

(56) **References Cited**

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

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(72) Inventors: **Ho Jung Nam**, Gyeonggi-do (KR);
Min Cheol Seo, Seoul (KR); **Hae Yeon Kim**,
Gyeonggi-do (KR); **Se Hyun Park**, Gyeonggi-do (KR)

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(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.

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(21) Appl. No.: **15/664,772**

(22) Filed: **Jul. 31, 2017**

Primary Examiner — Hoang V Nguyen
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(65) **Prior Publication Data**
US 2018/0034148 A1 Feb. 1, 2018

(30) **Foreign Application Priority Data**
Jul. 29, 2016 (KR) 10-2016-0097564

(57) **ABSTRACT**

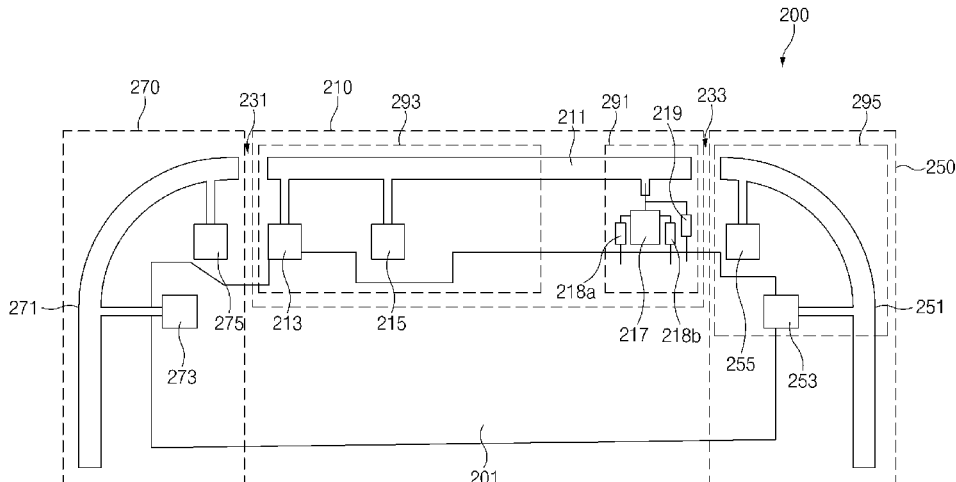
An electronic device is provided. The electronic device includes a first antenna configured to transmit and receive signals of a plurality of frequency bands, and a second antenna disposed at an area adjacent to the first antenna. The first antenna includes a first wireless communication circuit, a first radiator, a first feeding part configured to connect the first wireless communication circuit to the first radiator, a first ground part configured to be connected to one end of the first radiator, a switching circuit configured to be connected to the first radiator in an area adjacent to the second antenna, at least one frequency band element in which a first end is connected to the switching circuit and a second end is connected to the first ground part, and at least one isolation element configured to connect the first radiator to the ground part in the area adjacent to the second antenna.

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 5/35 (2015.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/523** (2013.01); **H01Q 1/243** (2013.01); **H01Q 1/50** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/52; H01Q 1/523; H01Q 1/50; H01Q 1/243; H01Q 5/35
See application file for complete search history.

22 Claims, 9 Drawing Sheets



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

(10) **Patent No.:** **US 10,340,609 B2**
(45) **Date of Patent:** **Jul. 2, 2019**

(54) **MULTIBAND ANTENNA, MULTIBAND ANTENNA ARRAY, AND WIRELESS COMMUNICATIONS DEVICE**

(58) **Field of Classification Search**
CPC H01Q 21/30; H01Q 15/14; H01Q 21/06
See application file for complete search history.

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

(56) **References Cited**

(72) Inventors: **Keishi Kosaka**, Tokyo (JP); **Hiroshi Toyao**, Tokyo (JP)

U.S. PATENT DOCUMENTS

(73) Assignee: **NEC CORPORATION**, Tokyo (JP)

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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 16 days.

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(21) Appl. No.: **15/544,699**

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(22) PCT Filed: **Feb. 10, 2016**

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(86) PCT No.: **PCT/JP2016/000694**

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§ 371 (c)(1),

(2) Date: **Jul. 19, 2017**

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(87) PCT Pub. No.: **WO2016/132712**

International Search Report of PCT/JP2016/000694 filed Apr. 26, 2016.

PCT Pub. Date: **Aug. 25, 2016**

Primary Examiner — Daniel Munoz

Assistant Examiner — Bamidele A Jegede

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

(65) **Prior Publication Data**

US 2018/0287268 A1 Oct. 4, 2018

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Feb. 16, 2015 (JP) 2015-027372

An object of the present invention is to provide a multiband antenna, an antenna array, and a wireless communications device that can achieve miniaturization while preventing deterioration in radiation efficiency. To this end, an antenna according to the present invention includes: a conductor reflection plate; a first antenna that includes a first antenna element and is provided on the conductor reflection plate; and a second antenna that includes a second antenna element having an electromagnetic resonance frequency that is a frequency different from an electromagnetic resonance frequency of the first antenna element included in the first antenna, and that is provided on the conductor reflection plate, wherein each of the first antenna element and the second antenna element includes: a C-shaped conductor that is a substantially C-shaped conductor having a split section formed in such a way that an annular conductor becomes

(51) **Int. Cl.**

H01Q 21/30 (2006.01)

H01Q 13/10 (2006.01)

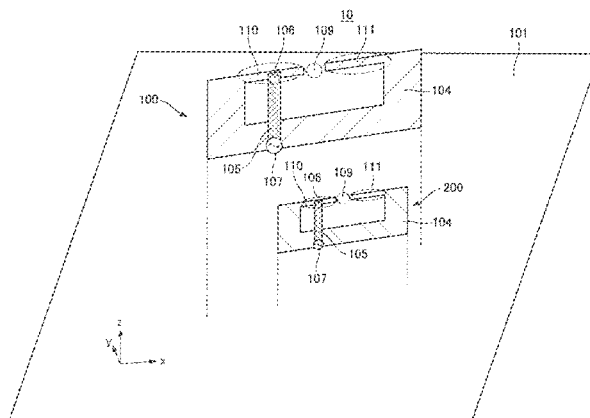
(Continued)

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

CPC **H01Q 21/30** (2013.01); **H01Q 5/42** (2015.01); **H01Q 13/10** (2013.01); **H01Q 15/14** (2013.01);

(Continued)

(Continued)



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

(10) **Patent No.:** **US 10,341,477 B2**
(45) **Date of Patent:** **Jul. 2, 2019**

(54) **MOBILE TERMINAL**

H04Q 5/328; H04Q 9/045; H04Q 13/10;
H04Q 21/28; H04M 1/0202; H04M
1/0249; H04M 1/026; H04M 1/0274;
H04B 1/3833

(71) Applicant: **LG ELECTRONICS INC.**, Seoul
(KR)

USPC 455/90.3, 575.1, 575.5, 575.7
See application file for complete search history.

(72) Inventors: **Changho Hong**, Seoul (KR); **Geunsu Kim**, Seoul (KR); **Doochan Jung**, Seoul (KR); **Hyunyun Hwang**, Seoul (KR)

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(73) Assignee: **LG ELECTRONICS INC.**, Seoul
(KR)

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(Continued)

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

Primary Examiner — Quochien B Vuong
(74) *Attorney, Agent, or Firm* — Lee, Hong, Degerman, Kang & Waimey PC

(21) Appl. No.: **15/946,644**

(22) Filed: **Apr. 5, 2018**

(57) **ABSTRACT**

(65) **Prior Publication Data**
US 2019/0058781 A1 Feb. 21, 2019

There is disclosed a mobile terminal comprising a body; a ground of a printed circuit board loaded in the body; a data port located in the body to have an external input terminal inserted therein and connected with the ground; a metallic member defining an exterior of the body and comprising a slit; a feeding portion connected with a first point of the metallic member and configured to supply power; a first ground line connected with the ground at a second point located between the first point of the metallic member and the slit; and a second ground line connected with the data port connected with the ground when the external input terminal is inserted in the data port, so that the mobile terminal has to include no additional switch to reduce the number of the components and the antenna of the mobile terminal may be selectively and structurally connected without the algorithm configured to manipulate the switch by sensing that the external input terminal is inserted in the data port to operate the switch to minimize the expense increase cost to improve the antenna performance.

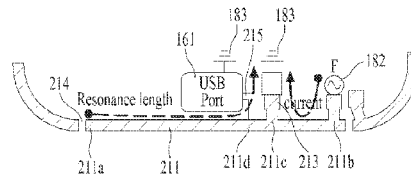
(30) **Foreign Application Priority Data**
Aug. 17, 2017 (KR) 10-2017-0104026

(51) **Int. Cl.**
H04M 1/00 (2006.01)
H04B 1/38 (2015.01)
H04M 1/02 (2006.01)
H04B 1/3827 (2015.01)
H01Q 1/24 (2006.01)
H01Q 1/38 (2006.01)

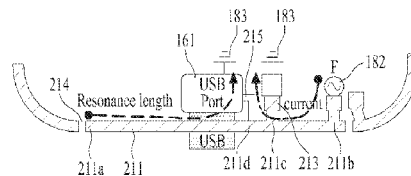
(52) **U.S. Cl.**
CPC **H04M 1/0277** (2013.01); **H01Q 1/243** (2013.01); **H04B 1/3833** (2013.01); **H01Q 1/38** (2013.01)

(58) **Field of Classification Search**
CPC H04Q 1/243; H04Q 1/38; H04Q 1/44; H04Q 1/46; H04Q 5/35; H04Q 5/321;

8 Claims, 8 Drawing Sheets



(a)



(b)



US10347965B2

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

(10) **Patent No.:** **US 10,347,965 B2**
(45) **Date of Patent:** **Jul. 9, 2019**

(54) **ELECTRONIC APPARATUS WITH SHIELDED ANTENNA SPACE**

(56) **References Cited**

(71) Applicant: **LENOVO (SINGAPORE) PTE. LTD.**,
Singapore (SG)

U.S. PATENT DOCUMENTS
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343/700 MS

(72) Inventors: **Shigekazu Hawaka**, Yokohama (JP);
Osamu Yamamoto, Yokohama (JP);
Takaaki Okada, Yokohama (JP)

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(73) Assignee: **LENOVO (SINGAPORE) PTE. LTD.**,
Singapore (SG)

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

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(21) Appl. No.: **15/699,672**

Primary Examiner — Daniel Munoz

(22) Filed: **Sep. 8, 2017**

Assistant Examiner — Patrick R Holecek

(65) **Prior Publication Data**

US 2018/0375189 A1 Dec. 27, 2018

(74) *Attorney, Agent, or Firm* — Shimokaji IP

(30) **Foreign Application Priority Data**

Jun. 22, 2017 (JP) 2017-122208

(57) **ABSTRACT**

(51) **Int. Cl.**

H01Q 1/22 (2006.01)
H01Q 1/52 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)
H01Q 21/28 (2006.01)

The present disclosure provides an electronic apparatus having an antenna unit at a body chassis. The electronic apparatus includes: a body chassis; an antenna supporting member disposed in an antenna space at a periphery of the body chassis, and having an upper face on which an antenna pattern is formed, the antenna space being surrounded with a dielectric cover; a shield wall for the antenna space, including a conductive thin film covering an entire lateral face of the antenna supporting member close to a center of the body chassis, an upper antenna ground element connected to the conductive thin film and the rear face of a keyboard cover member, and a lower antenna ground element connected to the conductive thin film and the rear face of a bottom-face cover member. The conductive thin film, the upper antenna ground element and the lower antenna ground element define the shield wall.

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

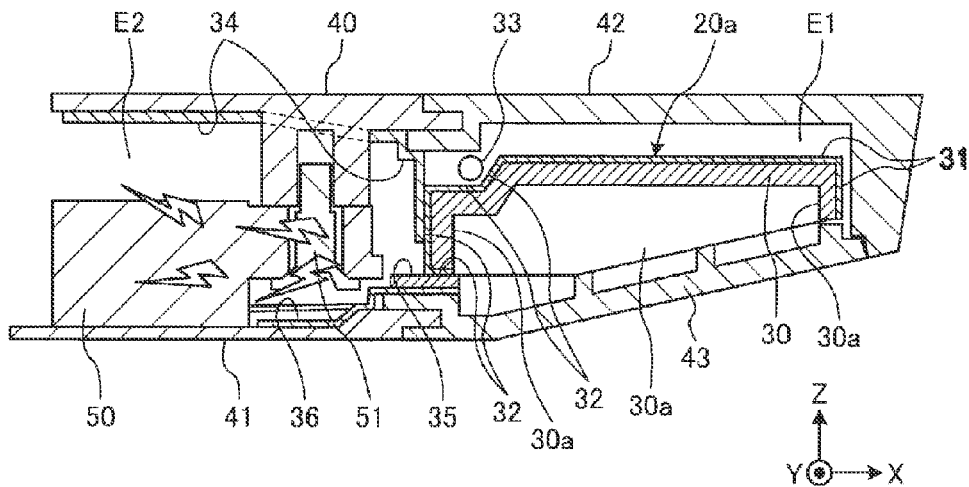
CPC **H01Q 1/2266** (2013.01); **H01Q 1/526** (2013.01); **H01Q 1/48** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 21/28** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/2258; H01Q 1/2266; H01Q 1/48; H01Q 1/52; H01Q 1/526

See application file for complete search history.

2 Claims, 3 Drawing Sheets



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

(10) **Patent No.:** **US 10,347,966 B2**
(45) **Date of Patent:** **Jul. 9, 2019**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

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

(72) Inventors: **Woosup Lee**, Gyeonggi-do (KR);
Hyunjeong Lee, Gyeonggi-do (KR);
Bumjin Cho, Gyeonggi-do (KR);
Hongil Kwon, Gyeonggi-do (KR);
Gaun Lee, Gyeonggi-do (KR);
Soyoung Lee, Gyeonggi-do (KR);
Changho Lee, Gyeonggi-do (KR);
Chihyun Cho, Gyeonggi-do (KR);
Jaebong Chun, Gyeonggi-do (KR)

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

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

(21) Appl. No.: **15/817,394**

(22) Filed: **Nov. 20, 2017**

(65) **Prior Publication Data**
US 2018/0151943 A1 May 31, 2018

(30) **Foreign Application Priority Data**
Nov. 28, 2016 (KR) 10-2016-0159326

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 1/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H01Q 1/2283** (2013.01); **H01Q 1/243** (2013.01); **H01Q 5/35** (2015.01); **H01Q 9/0421** (2013.01);

(58) **Field of Classification Search**
CPC .. H01Q 1/2283; H01Q 13/106; H01Q 9/0421; H01Q 1/243; H01Q 5/35;
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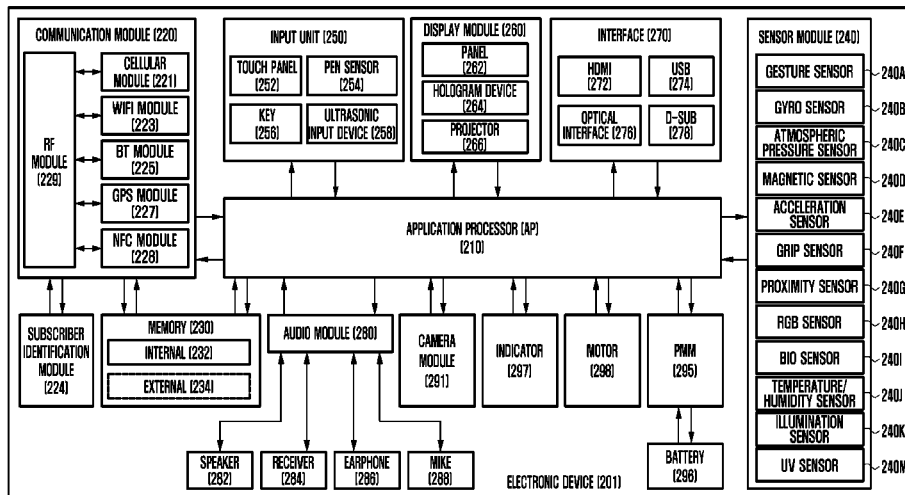
(56) **References Cited**
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Primary Examiner — Jean B Jeanglaude
(74) *Attorney, Agent, or Firm* — Cha & Reiter, LLC.

(57) **ABSTRACT**
An electronic device includes a housing antenna formed from a conductive material. At least parts of a side member and a rear cover that constitute the housing of the electronic device are used as an antenna. Accordingly, radiation patterns generated by this antenna are formed on the rear surface of the electronic device as well as at the upper portion of the electronic device. It is therefore possible to perform wireless communication with higher accuracy.

20 Claims, 25 Drawing Sheets





US010347971B2

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

(10) **Patent No.:** **US 10,347,971 B2**
(45) **Date of Patent:** **Jul. 9, 2019**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA**

(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**, Suwon-si, Gyeonggi-do (KR)

(72) Inventors: **Min Young Kwon**, Gimhae-si (KR); **Seung Hyun Yeo**, Daegu (KR); **Jung Min Lee**, Daegu (KR); **Hyun Su Lee**, Daegu (KR); **Soon Sang Park**, Daegu (KR); **Hyun Suk Choi**, Daegu (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 145 days.

(21) Appl. No.: **15/480,583**

(22) Filed: **Apr. 6, 2017**

(65) **Prior Publication Data**
US 2017/0331175 A1 Nov. 16, 2017

(30) **Foreign Application Priority Data**
May 13, 2016 (KR) 10-2016-0059104

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 9/42 (2006.01)
H04B 1/3827 (2015.01)
H01Q 21/28 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/245** (2013.01); **H01Q 9/42** (2013.01); **H01Q 21/28** (2013.01); **H04B 1/3838** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/245; H01Q 21/28; H01Q 9/42; H04B 1/3838
USPC 343/718
See application file for complete search history.

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| KR | 10-2015-0128250 | 11/2015 |

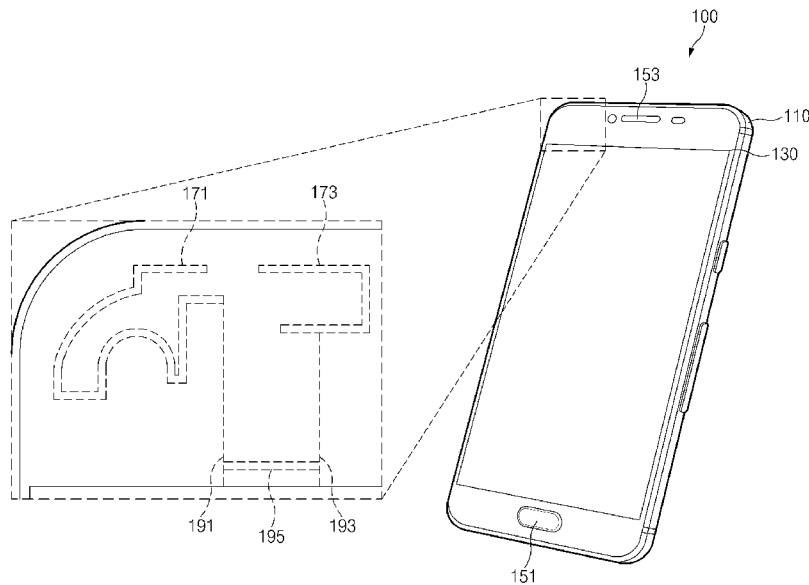
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Primary Examiner — Brian K Young
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye P.C.

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a first antenna, a first feeding line electrically connected to the first antenna, a second antenna, a second feeding line electrically connected to the second antenna element, a conductive line connecting a point of the first antenna or the first feeding line and a point of the second antenna or the second feeding line, and a sensor module electrically connected to a point of at least one of the first antenna element, the second antenna element, the first feeding line, the second feeding line, and the conductive line.

19 Claims, 16 Drawing Sheets





US010347984B2

(12) **United States Patent**
Le Thuc et al.

(10) **Patent No.:** **US 10,347,984 B2**
(45) **Date of Patent:** **Jul. 9, 2019**

- (54) **ANTENNA SYSTEM FOR REDUCING THE ELECTROMAGNETIC COUPLING BETWEEN ANTENNAS**
- (71) Applicants: **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, Paris (FR); **UNIVERSITE DE NICE SOPHIA ANTIPOLIS**, Nice (FR)
- (72) Inventors: **Philippe Le Thuc**, Grasse (FR); **Robert Staraj**, Saint Paul (FR); **Aliou Diallo**, Nice (FR); **Mickaël Jeangeorges**, Nice (FR)
- (73) Assignees: **UNIVERSITE DE NICE SOPHIA ANTIPOLIS**, Nice (FR); **CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE—CNRS**, Paris (FR)

- (52) **U.S. Cl.**
CPC **H01Q 1/521** (2013.01); **H01Q 1/243** (2013.01); **H01Q 9/0421** (2013.01); **H01Q 21/28** (2013.01)
- (58) **Field of Classification Search**
CPC H01Q 1/48; H01Q 1/521; H01Q 1/526; H01Q 9/0421; H01Q 21/28
See application file for complete search history.

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

- (56) **References Cited**
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- (21) Appl. No.: **15/312,352**
- (22) PCT Filed: **May 19, 2015**
- (86) PCT No.: **PCT/EP2015/061025**
§ 371 (c)(1),
(2) Date: **Nov. 18, 2016**
- (87) PCT Pub. No.: **WO2015/177170**
PCT Pub. Date: **Nov. 26, 2015**

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International Search Report for corresponding International PCT application No. PCT/EP2015/061025.
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Primary Examiner — Robert Karacsony
(74) *Attorney, Agent, or Firm* — Hauptman Ham, LLP

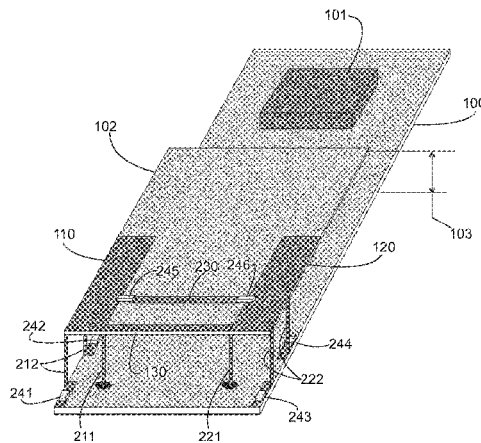
- (65) **Prior Publication Data**
US 2017/0084990 A1 Mar. 23, 2017

(57) **ABSTRACT**

Antenna system comprising at least two radiating elements, a first line for neutralizing electromagnetic coupling between the at least two radiating elements, at least one radiofrequency power supply line for each radiating element and at least one short-circuiting line to a ground plane of the antenna system per radiating element, characterized in that the antenna system further comprises: at least one second line for neutralizing electromagnetic coupling between said at least two radiating elements; elements for activating at least some of the neutralization lines; and in that the activation elements are configured to selectively activate or
(Continued)

- (30) **Foreign Application Priority Data**
May 19, 2014 (FR) 14 54478

- (51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 9/04 (2006.01)
(Continued)





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

(10) **Patent No.:** **US 10,347,985 B2**
(45) **Date of Patent:** **Jul. 9, 2019**

(54) **ANTENNA DEVICE AND ELECTRONIC DEVICE INCLUDING THE SAME**

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

(72) Inventors: **Hyunjin Kim**, Seoul (KR);
Kwanghyun Baek, Hwaseong-si (KR);
Byungchul Kim, Yongin-si (KR);
Jungmin Park, Seoul (KR); **Youngju Lee**, Seoul (KR); **Sungchul Park**,
Seoul (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 0 days.

(21) Appl. No.: **15/685,363**

(22) Filed: **Aug. 24, 2017**

(65) **Prior Publication Data**
US 2018/0062256 A1 Mar. 1, 2018

(30) **Foreign Application Priority Data**
Aug. 25, 2016 (KR) 10-2016-0108334

(51) **Int. Cl.**
H01Q 1/52 (2006.01)
H01Q 1/24 (2006.01)
H01Q 13/02 (2006.01)
H01Q 13/08 (2006.01)
H01Q 21/24 (2006.01)
H01P 5/107 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/525** (2013.01); **H01Q 1/243** (2013.01); **H01Q 13/02** (2013.01); **H01Q 13/085** (2013.01); **H01Q 21/24** (2013.01); **H01P 5/107** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/525; H01Q 3/00; H01Q 13/02
USPC 343/702
See application file for complete search history.

(56) **References Cited**
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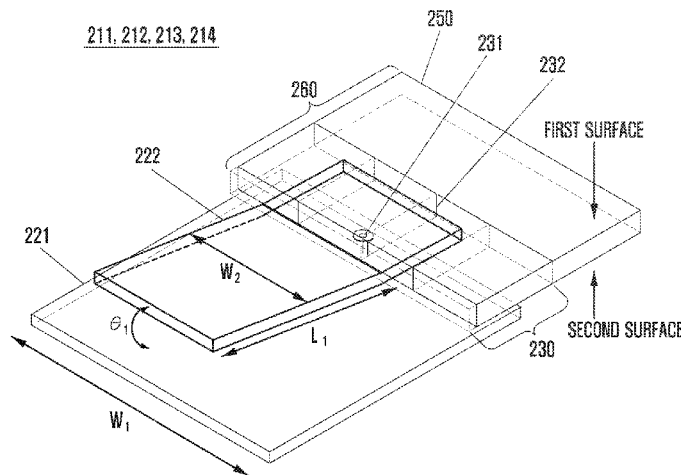
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Primary Examiner — Peguy Jean Pierre
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**
An electronic device is provided that includes a circuit board received in the electronic device and in which at least one board is layered, a communication module disposed at one surface of the circuit board and electrically connected to the circuit board, an antenna electrically connected to the communication module, and a metal structure whose one surface is separated from the other surface of the circuit board to form a space within the electronic device by enclosing the circuit board and in which at least one aperture is formed at one side thereof.

25 Claims, 36 Drawing Sheets





US010348357B2

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

(10) **Patent No.:** **US 10,348,357 B2**
(45) **Date of Patent:** **Jul. 9, 2019**

(54) **SINGLE FEED-IN DUAL-BRAND ANTENNA STRUCTURE**

(58) **Field of Classification Search**
CPC H01Q 1/2291; H01Q 1/243; H01Q 1/38;
H01Q 5/335-371; H01Q 9/42; H01Q
9/0407

(71) Applicant: **Power Wave Electronic Co., Ltd.**,
Taipei (TW)

See application file for complete search history.

(72) Inventors: **Wen-Jiao Liao**, Taipei (TW);
Wei-Hong Tsai, Taipei (TW);
Yun-Chan Tsai, Taipei (TW)

(56) **References Cited**

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(73) Assignee: **POWER WAVE ELECTRONIC CO., LTD.**, Taipei (TW)

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343/700 MS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 289 days.

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Primary Examiner — Dameon E Levi
Assistant Examiner — Hasan Z Islam

(21) Appl. No.: **15/614,610**

(74) *Attorney, Agent, or Firm* — Chun-Ming Shih; HDLS IPR Services

(22) Filed: **Jun. 6, 2017**

(57) **ABSTRACT**

(65) **Prior Publication Data**

US 2018/0351252 A1 Dec. 6, 2018

A single feed-in dual-band antenna structure includes a first radiation unit, a basal plate and a plurality of matching components. The basal plate includes a front side, a back side and an edge side. A first ground unit, a signal feed-in unit, a second radiation unit and an electrode part are arranged on the front side. A third radiation unit is arranged on the edge side. A second ground unit is arranged on the back side of the basal plate. The first radiation unit is electrically connected to the electrode part. The first radiation unit is adjusted to control the 2.45 GHZ frequency range impedance, resonant frequency, bandwidth and radiation effect. The third radiation unit frequency wave length controls the 5 GHZ frequency range to achieve the predetermined target impedance, resonant frequency, bandwidth and radiation efficiency. The antenna size can be reduced effectively.

(51) **Int. Cl.**

H01Q 1/22 (2006.01)
H04B 1/52 (2015.01)
H01Q 1/36 (2006.01)
H01Q 9/42 (2006.01)
H01Q 5/335 (2015.01)
H01Q 5/371 (2015.01)

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

CPC **H04B 1/52** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 1/36** (2013.01); **H01Q 5/335** (2015.01); **H01Q 5/371** (2015.01); **H01Q 9/42** (2013.01)

15 Claims, 5 Drawing Sheets

